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ΔΙΔΑΚΤΟΡΙΚΗ ΔΙΑΤΡΙΒΗ

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List of Abbreviations

A	(in) Oriental Institute, University of Chicago, Chicago, Illinois, USA
AfO	Archiv für Orientforschung
AJA	American Journal of Archaeology
AJSL	American Journal of Semitic Languages and Literatures
AKT 1	Bilgiç, E., H. Sever, C. Günbatti, and S. Bayram. 1990. *Ankara Kültepe Tabletleri I*. Ankara: Türk Tarih Kurumu Yayınlarından.
AKT 2	Bilgiç, E., and S. Bayram. 1995. *Ankara Kültepe Tabletleri II*. Ankara: Türk Tarih Kurumu Yayınlarından.
AKT 3	Bilgiç, E., and C. Günbatti. 1995. *Ankaraner Kültepe-Texte III: Texte der Grabungskampagne 1970*. Stuttgart: Franz Steiner Verlag Stuttgart.
AKT 5	Veenhof, K.R. 2010. *Kültepe Tabletleri V: The Archive of Kuliya, Son of Ali-abum (Kt. 92/k 188-263)*. Ankara: Türk Tarih Kurumu Basımevi.
AKT 6a	Larsen, M.T. 2010. *Kültepe Tabletleri VI-a: The Archive of the Šalim-Aššur Family.* Vol. 1, *The First Two Generations*. Ankara: Türk Tarih Kurumu Basımevi.
AKT 6b	Larsen, M.T. 2013. *Kültepe Tabletleri VI-b: The Archive of the Šalim-Aššur Family.* Vol. 2, *Ennam-Aššur*. Ankara: Türk Tarih Kurumu.
AKT 6c	Larsen, M.T. 2014. *Kültepe Tabletleri VI-c: The Archive of the Šalim-Aššur Family.* Vol. 3, *Ali-ahum*. Ankara: Türk Tarih Kurumu.
Alisar	(in) Museum of Anatolian Civilisations, Ankara, Turkey
AMM	Museum of Anatolian Civilisations (Anadolu Medeniyetleri Müzesi), Ankara, Turkey
AMNH	American Museum of Natural History, New York, New York, USA
AnatSt	Anatolian Studies

Ank.	Museum of Anatolian Civilisations, Ankara, Turkey
AnOr	Analecta Orientalia
AntK	Antike Kunst
AO	Antiquités Orientales, Louvre, Paris, France
AOAT	Alter Orient und Altes Testament
AoF	Altorientalische Forschungen
ArabAEpigr	Arabian Archaeology and Epigraphy
ArAn	Archivum Anatolicum
ArOr	Archív Orientální. Quarterly Journal of African and Asian Studies
ARM	Archives Royales de Mari
ARM 13	Dossin, G, J. Bottéro, M. Birot, M. Lurton Burke, J.-R. Kupper, and A. Finet. 1964. *Textes divers*. ARM 13. Paris: Editions Recherche sur les Civilisations.
ARM 25	Limet, H. 1986. *Textes administratifs relatifs aux métaux*. ARM 25. Paris: Editions Recherche sur les Civilisations.
Ashm.	Ashmolean Museum, Oxford, UK
ATHE	Kienast, B. 1960. *Die altassyrischen Texte des orientalischen Seminars der Universität Heidelberg und der Sammlung Erlenmeyer-Basel*. Untersuchungen zur Assyriologie und vorderasiatischen Archäologie 1. Berlin: De Gruyter.
AulaOr.	Aula Orientalis. Revista de Estudios del Próximo Oriente Antiguo
BAR-IS	British Archaeological Reports – International Series
BASOR	Bulletin of the American Schools of Oriental Research
Belleten	Belleten: Türk Tarih Kurumu
BibO	Bibliotheca Orientalis
BibO 73	Veenhof, K.A. 2016. “A Difficult Old Assyrian Business Venture. Mannum-kī-Aššur Tries his Luck with Iron.” *BibO* 73(1-2): 13-39.
BIN	Babylonian Inscriptions in the Collection of James B. Nies, Yale University (New Haven 1917-1987)
BM	British Museum, London, UK

Bod S S	(in) Ashmolean Museum, Oxford, UK
Bruce	Bruce, Mrs. James (private collection)
BSA	The Annual of the British School at Athens
Bursa	Bursa Archaeological Museum, Kayseri, Turkey
CBS	(in) University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia, Pennsylvania, USA
CCT	Cuneiform Texts from Cappadocian Tablets in the British Museum (London 1921-1975)
CDLI	Cuneiform Digital Library Inititiative. https://cdli.ucla.edu/
Chantre	Chantre, E. 1898. *Mission en Cappadoce: 1893 - 1894*. Paris: Leroux.
CMK	Michel, C. 2001. *Correspondance des marchands de Kaniš au début du IIe millénaire avant J.-C.* Littératures anciennes du Proche-Orient 19. Paris: Les Éditions du Cerf.
CRRAI	Compte rendu de la Rencontre Assyriologique lnternationale
CTH	Laroche, E., ed. 1971. *Catalogue des textes hittites*. Paris : Klincksieck
CTMMA	Cuneiform Texts in the Metropolitan Museum of Art (New York 1988-2014)
CurrAnthr	Current Anthropology
DTCFD	[Ankara Üniversitesi] Dil ve Tarih-Coğrafya Fakültesi Dergisi (Ankara 1943-2015)
EL	Eisser, E., and J. Lewy. 1930-1935. *Die altassyrischen Rechtsurkunden vom Kültepe*. Leipzig: Hinrichs.
EMC	Egyptian Museum in Cairo, Cairo, Egypt
FAOS	Freiburger Altorientalische Studien
FAOS 4	Ulshöfer, A.M. 1995. *Die altassyrischen Privaturkunden*. Freiburger Altorientalische Studien 4. Stuttgart: Franz Steiner Verlag.
FS Garelli	Charpin, D., and F. Joannès, eds. 1991. *Marchands, Diplomates et Empereurs: Études sur la Civilisation Mésopotamienne Offertes à Paul Garelli*. Paris: Éditions Recherche sur les Civilisations.

FS Larsen	Dercksen, J.G., ed. 2004. *Assyria and Beyond: Studies Presented to Mogens Trolle Larsen*. Leiden: Nederlands Instituut voor het Nabije Oosten.
FS Matouš 2	Hruška, B., and G. Komoróczy, eds. 1978. *Festschrift Lubor Matouš II*. Budapest: Eötvös Loránd Tudományegyetem, Ókori Történeti tanszék.
FS Oelsner	Marzahn, J., and H. Neumann, eds. 2000. *Assyriologica et Semitica: Festschrift für Joachim Oelsner anläßlich seines 65. Geburtstages am 18. Februar 1997*. AOAT 252. Münster: Ugarit-Verlag.
FS N. Özgüç	Mellink, M.J., E. Porada, and T. Ozgüç, eds. 1993. *Aspects of Art and Iconography: Anatolia and Its Neighbors. Studies in Honor of Nimet Özgüç*. Ankara: Türk Tarih Kurumu Basımevi.
FS T. Özgüç	Emre, K., M. Mellink, B. Hrouda, and N. Özgüç, eds. 1989. *Anatolia and the Ancient Near East: Studies in Honor of Tahsin Özgüç*. Ankara: Türk Tarih Kurumu Basımevi.
FS Sachs	Leichty, E., M. deJ. Ellis, and P. Gerardi, eds. 1988. *A Scientific Humanist: Studies in Memory of Abraham Sachs*. Occasional Publications of the Samuel Noah Kramer Fund 9. Philadelphia: University of Pennsylvania Museum.
FS Veenhof	Van Soldt, W.H., ed. 2001. *Veenhof Anniversary Volume: Studies Presented to Klaas R. Veenhof on the Occasion of his Sixty-Fifth Birthday*. Leiden: Nederlands Instituut voor het Nabije Oosten.
FuB	Forschungen und Berichten: Staatliche Museen zu Berlin
GMII	Pushkin State Museum of Fine Arts, Moscow, Russia
Gou.	Sammlung Goudchaux (private collection)
HD	Heidelberger Orientalisches Seminar, Heidelberg, Germany
HS	Hilprecht-Sammlung, University of Jena, Germany
HSS	Harvard Semitic Studies
HUCA	Hebrew Union College Annual

ICK	Inscriptions cunéiformes du Kultépé: 1: Hrozný, B. (Prag 1952) 2: Matouš, L. (Prag 1962)
IrAnt	Iranica Antiqua
IstMitt	Istanbuler Mitteilungen
JAnthArch	Journal of Anthropological Archaeology
JAOS	Journal of the American Oriental Society
JARCE	Journal of the American Research Center in Egypt
JAS	Journal of Archaeological Science
JCS	Journal of Cuneiform Studies
JEA	The Journal of Egyptian Archaeology
JEOL	Jaarbericht van het Vooraziatisch-egyptisch genootschap “Ex Oriente Lux“
JESHO	Journal of the Economic and Social History of the Orient
JFA	Journal of Field Archaeology
JJP	Journal of Juristic Papyrology
JNES	Journal of Near Eastern Studies
JRGZM	Jahrbuch des Römisch-Germanischen Zentralmuseums, Mainz
JSOR	Journal of the Society of Oriental Research
Kayseri	Unedited tablets of the Kayseri Archaeological Museum, Kayseri, Turkey
Ka.	karum Kanesh/Kültepe Texts, Istanbul Archaeology Museums, Istanbul, Turkey
KBo	Keilschrifttexte aus Boghazköi
KKS	Matouš, L., and M. Matoušová-Rajmová. 1984. *Kappadokische Keilschrifttafeln mit Siegeln aus den Sammlungen der Karlsuniversität in Prag*. Prag: Karlsuniversität Prag.
KTB	Lewy, J. 1929. *Die Kültepetexte der Sammlung Rudolf Blanckertz, Berlin*. Berlin: Heintz & Blanckertz.
KTH	Lewy, J. 1930. *Die Kültepetexte aus der Sammlung Frida Hahn, Berlin*. Leipzig: Hinirich’sche Buchhandlung.
KTK	Jankowskaja, N.B. 1968. *Klinopisnye Teksty iz Kjul'-Tepe v Sobranijach SSSR: pis’ma I dokumenty torgovogo ob-edinenja v*

	maloj Azii XIX v. do n.e. Pamjatniki pis'mennosti vostoka 14. Moskau: Izd. Nauka.
KTP	Stephens, F.J. 1927. "The Cappadocian Tablets in the University of Pennsylvania Museum." *JSOR* 11: 101-36.
KTS	Keilschrifttexte in den Antiken-Museen zu Stambul. Die altassyrischen Texte vom Kültepe bei Kaisarīje: 1: Lewy, J. (Istanbul 1926) 2: Donbaz, V. (Stuttgart 1989)
KUB	Keilschrifturkunden aus Boghazköi
KUG	Hecker, K. 1966. *Die Keilschrifttexte der Universitätsbibliothek Giessen*. Giessen: Universitätsbibliothek Giessen.
LAPO	Littératures anciennes du Proche-Orient
LB	de Liagre Böhl Collection, Netherlands Institute for the Near East, Leiden, Netherlands
LNP	Lisht North Pyramid cemetery, excavated by the Metropolitan Museum of Art (MMA)
M.	(in) Los Angeles County Museum of Art (LACMA), Los Angeles, California, USA
MAH	Musée d'Art et d'Histoire, Geneva, Switzerland
Mari	Mari: Annales de Recherches Interdisciplinaires
Michel, Innaya II	Michel, C. 1991. *Innāya dans les tablettes paléo-assyriennes II*. Paris : Recherche sur les Civilisations
Mindat.org	Online Mineral Database, Hudson Institute of Mineralogy. https://www.mindat.org/
MMA	Metropolitan Museum of Art, New York, New York, USA
MNK	Krakow National Museum, Krakow, Poland
MRAH	Musées Royaux d'Art et d'Histoire, Brussels, Belgium
MS	Schøyen Collection, Oslo, Norway
Nashef, TAVO B 83	Nashef, K. 1987. *Rekonstruktion der Reiserouten zur Zeit der altassyrischen Handelsniederlassungen*. Beihefte zum Tübinger Atlas der Vorderen Orients 83. Wiesbaden: Dr. Ludwig Reichert Verlag.

NBC	Nies Babylonian Collection, Yale Babylonian Collection, New Haven, Connecticut, USA
NMS	National Museum of Scotland, Edinburgh, Scotland
NMSDez	National Museum of Syria, Deir ez-Zor
OA	Oriens Antiquus
OAA	Old Assyrian Archives
OAA 1	Larsen, M.T. 2002. *The Aššur-nādā Archive*. Old Assyrian Archives 1. Leiden: Nederlands Instituut voor het Banije Oosten.
OAAS	Old Assyrian Archives, Studies
OAAS 4	Michel, C., ed. 2008. *Old Assyrian Studies in Memory of Paul Garelli*. Old Assyrian Archives, Studies 4. PIHANS 112. Leiden: Nederlands Institu voor het Nabije Oosten.
OACT	Dercksen J.G. 1996. *The Old Assyrian Copper Trade in Anatolia*. Istanbul: Nederlands Historisch-Archaeologisch Institut.
OIP	Oriental Institute Publications
OJA	Oxford Journal of Archaeology
OLZ	Orientalistische Literaturzeitung
OrNS	Orientalia Nova Series
OXALID	Oxford Archaeological Lead Isotope Database from the Isotrace Laboratory. http://oxalid.arch.ox.ac.uk/default.html
PIHANS	Publications de l'Institut historique-archéologique néerlandais de Stamboul
POAT	Gwaltney, W.C. 1983. *The Pennsylvania Old Assyrian Texts*. HUCA Suppl. 3. Cincinnati: Hebrew Union College-Jewish Institute of Religion.
Prag	Hecker, K., G. Kryszat, and L. Matouš. 1998. *Kappadokische Keilschrifttafeln aus den Sammlungen der Karlsuniversität Prag*. Praha: Institute of Ancient Near Eastern Studies, Charles University.
Prague I	Charles University, Prague, Czech Republic
PRU	Le Palais Royal D'Ugarit

RA	Revue d'Assyriologie et d'archéologie orientale
RÉg	Revue d’Égyptologie
REL	Revised Eponym List
RSO	Rivista degli studi orientali
Sch.	Schaeffer collection
SIMA	Studies in Mediterranean Archaeology
TC 1	Tablettes cappadociennes du Louvre : TC 1 = TCL 4 TC 2 = TCL 14 TC 3 = TCL 19-21
TMH	Texte und Materialien der Frau Professor Hilprecht Collection of Babylonian Antiquities im Eigentum der Friedrich-Schiller-Universität Jena (Leipzig 1932-2012)
TPAK 1	Michel, C., and P. Garelli. 1997. *Tablettes paleo-assyriennes de Kültepe.* Vol. 1*, (Kt 90/k)*. Paris: De Boccard.
TTC	Contenau, G. 1919. *Trente tablettes cappadociennes*. Paris: Librairie Paul Geuthner.
TUAT.NF	Texte aus der Umwelt des Alten Testaments. Neue Folge
TüBA-Ar	Türkiye Bilimler Akademisi Arkeoloji Dergisi
UgaritF	Ugarit-Forschungen: Internationales Jahrbuch für die Altertumskunde Syrien-Palästinas
UM L-	(in) University of Pennsylvania Museum of Archaeology and Anthropology, Philadelphia, Pennsylvania, USA
Van der Meer, Correspondance	Van der Meer, P. 1931. *Une correspondance commerciale Assyrienne de Cappadoce I*. Roma: Imprimerie Pie X.
VAT	Vorderasiatisches Museum, Berlin, Germany
VS	Vorderasiatische Schriftdenkmäler der Königlichen Museen zu Berlin (Berlin 1907-1917)
WAG	= WAM Walters Art Museum, Baltimore, Maryland, USA
WML	World Museum Liverpool, Liverpool, UK
WorldArch	World Archaeology
WZKM	Wiener Zeitschrift für die Kunde des Morgenlandes

1 Introduction

This research investigates the distribution and the acquisition of metals during the 2nd millennium BC in the Near East. In this study, the word "distribution" signifies the way in which metals were spread throughout the lands of the ancient Near East (ANE). This involves any possible means of transporting, exchanging or acquiring metals. It includes commercial trade, diplomatic gift-exchanging, tribute paying, but also smuggling, the payment of tolls and for services provided. Similarly, the word "acquisition" denotes any means of gaining possession of a commodity. This entails the act of receiving a gift, being paid for a service, plundering in times of war, or even seizing and stealing goods from a caravan.

Peace, or alliance, treaties were always accompanied by the exchange of gifts between the two parties. However, these were very often presented to the people of the receiving kingdom as tribute, paid because of its greater power over the other party. Such an example demonstrated by the treaty signed between the Hittite King Šuppiluliuma I (c. 1344-1322 BC) with the king of Ugarit, Niqmaddu II (c. 1353-1318 BC). The Hittite King was seeking to strengthen his position in Syria in his war against the kingdom of Mitanni.[1] Another example of this "mode of exchange" is the so-called "eternal treaty" signed by the Pharaoh Ramesses II and the Hittite King Ḫattušili III in c. 1259 BC, following the historical battle of Kadeš, for which both sides claimed victory.[2] A more obvious example of gifts offered as tributes by a vassal state are those received in various occasions by the Pharaoh.[3]

In long-distance trading activities, there are always some secondary transactions that should be considered when studying the trade and distribution of commodities. In order to ensure safe passage of the trading goods from one land to the other way-stations are established, where every trader has to pass through and pay the tolls due – much like the modern customs agencies. Along with the legal ways of trading commodities, there were and there always are illegal ones. A major illegal way of transporting goods was smuggling, either by "neglecting" to report goods or by avoiding tolls altogether. Both tolls/taxes and smuggling, as well as other *en route* expenses, are well-attested in the Old Assyrian (OA) texts found in the trading colony of Kaneš (Kültepe) in Anatolia.[4]

[1] Knoppers 1993; Bryce 2005, 155-66.
[2] Klengel 2002; Bryce 2006. More on this subject in Chapter 2.1.
[3] Liverani 1990, 255-69.
[4] Veenhof 1972, 229-342. See also Larsen 1967, 3-6.

As far as trade and exchange are concerned, the work of Karl Polanyi[5] has provided the stepping stone to an in-depth discussion and a more accurate identification of the various modes of the exchange of goods in prehistoric times. In Polanyi's view, "trade" was in general terms "*the acquisition of goods from a distance*" and was classified in three different types: "*gift trade*", "*administered or treaty trade*" and "*market trade*".[6] His terminology did not contain the word exchange, which is very often used when we speak about goods changing hands in prehistoric societies. His idea of "*gift trade*" was what we would call "gift exchange", his "*market trade*" would be exactly what we would call "trade" and his "adm*inistered or treaty trade*" would be the already-mentioned treaty-based tribute.

By Polanyi's definition, "*market trade*" was that trade operating inside and according to the rules of a market, i.e. an institution whose basic function was to serve the supply-demand-price mechanism, with the inevitable outcome of profit or loss. A better expressed definition of the term "trade" is offered by Dogan, who writes that "*(t)rade is (…) a large-scale, organized activity whose aim is profit or the accumulation of capital*", it is "*an activity which requires at least one middleman, who practices it as a profession, whether with a view to gaining profit or at least a living*".[7] Today, the meaning of the word *trade* has a more commercialised, business-related connotation. It is a selling and buying activity, performed by specific people (traders, merchants) and according to an agreed exchange value (money), which is formed based on the relative supply and demand. Most importantly, these activities will in turn bring gain or loss of capital to the respective parties.

On the other hand, exchange is an activity that does not presuppose the use of a monetary system but, on the contrary, in a way excludes it. The "worth" of the offered goods is relatively evaluated and is thus equally repaid. Within this study, the word "exchange" is not used to denote the form of barter exchange of goods, but the exchange of goods in the form of gifts. The reciprocal relationship between the two parties that participate in gift-exchanging was initially shown by Malinowski and his study of the Kula ring exchange, observed in the Trobriand Islands of the eastern New Guinea, and later further discussed by Polanyi.[8] The Amarna letters are representative of the complex and covert character of gift-exchanging in diplomatic relationships between kingdoms of the Late Bronze Age (LBA) Near East.[9]

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[5] Polanyi *et al*. 1957; Polanyi 1975.
[6] Polanyi 1975, 133-34, 149-53.
[7] Doğan and Michailidou 2008, 20; Doğan 2010, 36.
[8] Malinowski 1922; Polanyi 2001, 49-53.
[9] Mauss 2002; Liverani 1990; Hénaff 2014.

These mechanisms of distributing and acquiring commodities are unequivocally related to things. Hodder has expressed the entangled relationship between humans and things.[10] In his words:

> *Humans depend on things in order to build, maintain and justify power. They depend on things to control others. Power makes use of the flows of meaning and energy in things, their associations and relationships. In terms of TT dependences* [*things depend on things*], *things are at the heart of the creation of relative value and the construction of forms of exchange and capital. Power is constrained by technologies and the availability of materials. In terms of TH dependences* [*things depend on humans*], *the unruliness of things and their complex temporalities entrap humans into forms of care and maintenance, so providing a raison d'être for inequality and social constraint*.[11]

In other words, humans are the ones that give value and power to objects and are also the ones that create the illusion of value, wealth and power by simply owing things. Value is a relative concept and the value of things is based on, as well as increased by, various factors, such as the difficulty in finding and acquiring an object and the skill required for its manufacture. The former aspect is, moreover, connected to the object's rarity and the distance from its source when acquired. These characteristics that give value to things, along with the will and "need" of humans to own new, rare, valuable, and beautiful things, are the formative powers of the mechanisms of trade and gift-exchanging. In the same way that the symbolism given to and carried by objects is what supports the gift-exchanging mechanism, it also supports trade. The only difference between the two being the fact that the former is mostly associated with the higher social strata and refers to well-crafted and probably also rarer and more valuable objects.

In this way, the mechanisms described above are related and supportive of the entangled relationship of humans and things. But the one cannot be studied without the other. An examination of the modes of exchange, the human and the artefactual agents, separately or in pairs, offers only a partial image of the whole picture. Thus, it is better to study them *in tandem*. For this reason and in contrast to existing studies, this research will examine not only the metal objects, but also the human factor in their creation, valuation and circulation, through the analysis of texts recording trade and gift-exchange.

The textual evidence selected to outline the trade mechanism is the text corpus from Kaneš in Anatolia, which roughly dates from the beginning of the 2nd millennium BC to about 1715 BC.[12] The textual source used to demonstrate the mechanism of gift-exchange is the

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[10] Hodder 2012.
[11] Hodder 2012, 213-14.
[12] Veenhof 1972; Kulakoğlu and Kangal 2010.

international correspondence recorded in the Amarna letters of Egypt, dating to the mid-14th century BC.[13] The latter are replete with references to the diplomatic game and the power plays that served and were served by the reciprocal exchange of gifts between the various kings of the LBA Near East, but they are also descriptive of trade masked as an exchange of gifts between Alašiya and Egypt.

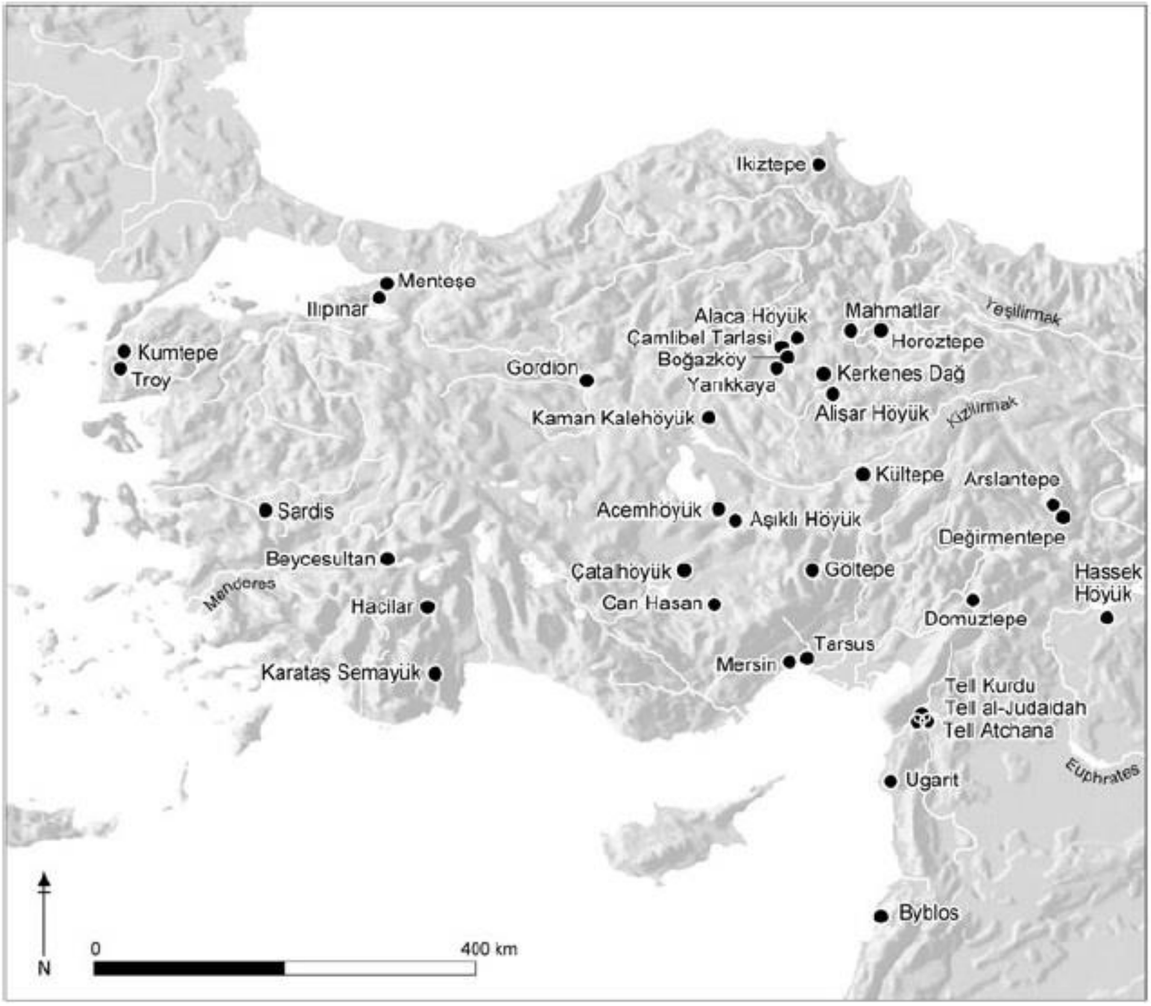

Figure 1. Map of western and central Anatolia (Lehner and Yener 2014, fig. 20.2).

The following chapter, Chapter 2, is principally an introduction to and a presentation of the textual sources used in the frame of this research. Before the analysis of the archives, however, Subchapter 2.1 discusses the economic theories of Polanyi and Liverani in connection to the Old Assyrian (OA) trade and the Amarna period diplomacy and gift-exchanging mechanisms. The following subchapters include an introduction to the trade performed by the

[13] Moran 1992; Rainey 2015.

OA traders (Subchapter 2.2), to the exchange described in the Amarna letters (Subchapter 2.3.1), as well as a discussion regarding the trade or diplomatic nature of the relationship between Alašiya and Egypt (Subchapter 2.3.2). Moreover, the examination is not strictly limited to these two archives. Other contemporaneous written records, like the texts found in the ancient city of Mari in Syria, are occasionally taken into consideration. These supplementary texts are listed in **Appendix 3**.

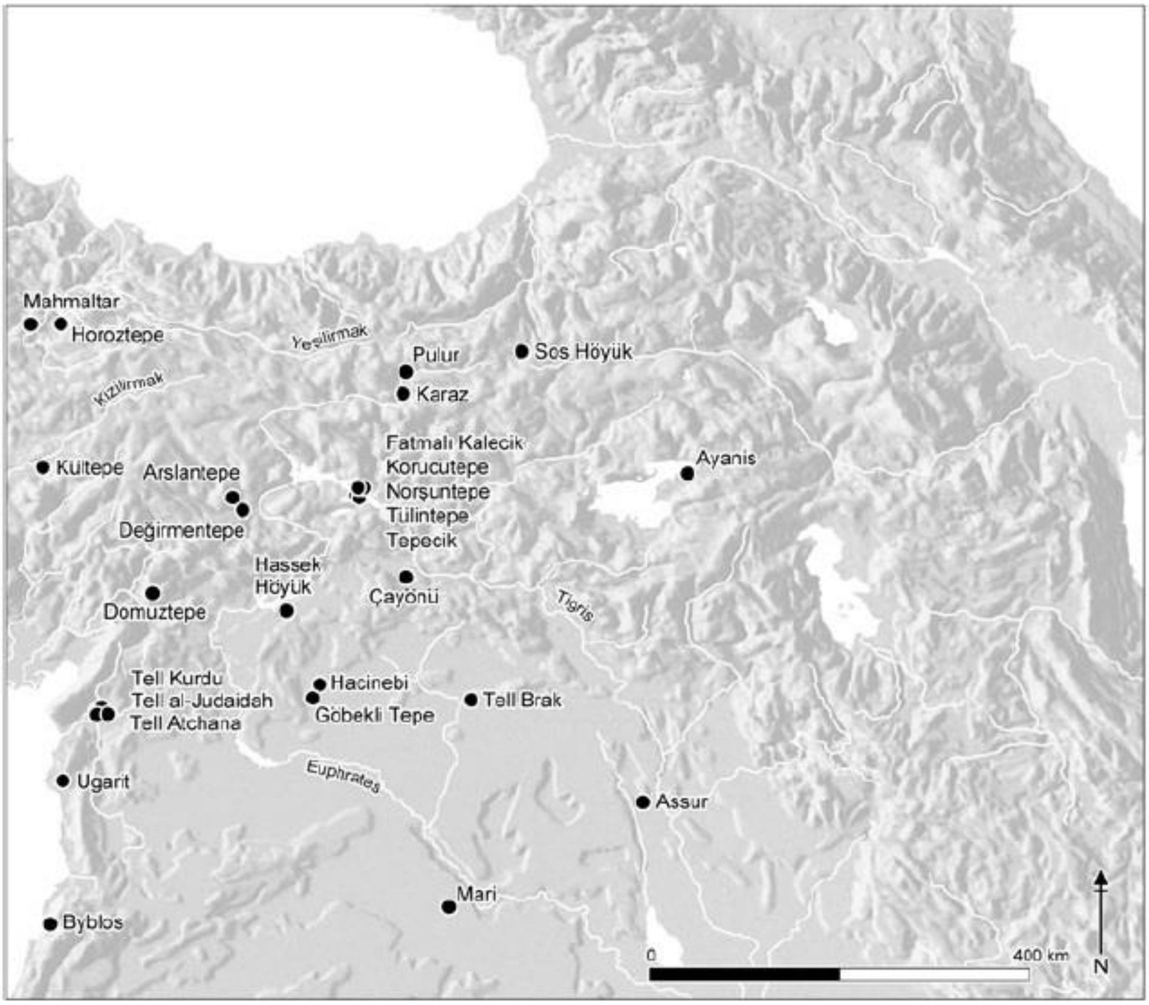

Figure 2. Map of eastern Anatolia, north Syria and north Mesopotamia
(Lehner and Yener 2014, fig. 20.3).

Chapter 3 regards the analytical examination of the texts from Kaneš and Amarna. This is divided into two subchapters: metals mentioned in the OA texts (Subchapter 3.1) and in the Amarna letters (Subchapter 3.2). Each subchapter is further subdivided into two distinct parts. The first part (Subchapters 3.1.1 and 3.2.1) is an examination of the provenances and destinations as well as the amount of each metal transported or exchanged, depending on whether we are talking about the OA trade or the exchange of gifts described in the Amarna letters. As far as the Amarna letters are concerned, the analysis also contains an examination of the purpose of each offering, namely given as bride-price, dowry, greeting-gift, or payment of some sort. Charts are used to illustrate which kingdom sends or receives an amount of metal (in the form of raw material or finished objects) and for what purpose each metal was most widely used. The second part refers to the qualifications of metals recorded in the texts. These terms are used in a basic statistical analysis, which presents and compares the frequency of each term in the texts with the frequency of each term being related to transport. In this way, we can understand the "popularity" of each variety of metal.

The most important part of the analysis – linked to Chapter 4 – is the study of the meaning of each Akkadian word that accompanies and characterises a metal. Every phrase and word are descriptive of the quality, external appearance, provenance, or treatment applied to a metal. By studying these qualifications, we can extract information about the specific type of each metal that was traded or exchanged by preference. Additionally, the numerous varieties of each metal recorded in the texts are listed with their Akkadian word and/or logogram, along with the translation in English that has been chosen to be used in this study, the translation with which it is (usually) found in the literature and the respective textual reference(s) (**Appendix 4-Appendix 5**).

Characteristics and treatments like those described in the texts can be linked to actual artefacts excavated from sites of the wider Near East and from periods in the 2nd millennium BC. Dercksen undertook a similar analysis, regarding copper and its trade in the OA period in Anatolia.[14] Chapter 4 comprises exactly this kind of investigation of the archaeometallurgical data for an assortment of metal objects. The chemical or lead isotope analysis data that are used in this research have been taken from a plethora of published articles and are presented in **Appendix 6-Appendix 9**. For each metal, a discussion is made based on the available analytical data, as well as on the geology of each region and its metal sources. Moreover, this analytical data is used to evaluate theories concerning the varieties of metals and the treatments of metals observed in the texts. Gold and silver are examined in the same Subchapter (4.1), while bronze (4.2) and iron (4.3) are examined next. The examination of the varieties of gold and silver is made in reverse chronological order, meaning that varieties of metals read in the Amarna letters are discussed before the varieties recorded in the OA texts. This is a result of the greater number of samples and information available from Egypt than from Anatolia. On

[14] Dercksen 1996.

the other hand, the matter of bronze is reviewed in chronological order, due to the higher amount of references regarding copper found in the OA texts, along with the very limited number of bronze artefacts' samples from Amarna. Moreover, despite the fact that iron is not yet widely used during the Bronze Age, there are a few iron artefacts from the Near East dating from even before the Middle Bronze Age (MBA), at approximately the mid-3rd millennium BC. The discussion on iron further includes an assessment of the matter of the difference between terrestrial and extra-terrestrial, i.e. meteoric, iron and how this could have been perceived and identified by the peoples of the Bronze Age (Subchapters 4.3.1 and 4.3.2).

Finally, Chapter 5 reiterates the concluding observations derived from both aspects of the textual analysis, as well as from the archaeometallurgical analysis. Within this chapter, the issue of the role and of the importance of colour, in general and more specifically in metal artefacts and their manufacture, is reflected upon.

2 Exchange patterns and metals

For the purposes of this research, two specific assemblages of cuneiform tablets from the Bronze Age Near East have been selected and analysed. First, the archive found in Kaneš in Anatolia (modern Turkey), dated to the 20th-18th centuries BC.[15] Second, the royal archive in Amarna (Egypt), dated at c. 1365-1335 BC.[16] Despite the great chronological gap between these archives, they have been deliberately chosen due to their unique and distinct nature. They are each representative of a different kind of mechanism in the exchanging of goods and of two distinct aspects of the economy: the commercial and the political. The former archive recounts the business and the personal lives of the Assyrian, as well as of the native Anatolian traders. It represents the clearly commercial part of the exchange system of goods in the Near East, run by individuals and not palaces – no matter the level of control palaces had over this trade. It comprises letters (business-related or personal), legal documents, lists, memoranda, and notes.[17] The second textual corpus, on the other hand, consists of letters written by or sent to the Pharaoh. It is part of the royal correspondence between the Pharaoh and the Great Kings and the minor kings of the Near East. The exchanges recorded are mostly gift or tribute transfers, which can by no means be described as trade. A sole exception to this may be the letters exchanged between the Pharaoh and the king of Alašiya, i.e. Cyprus – an issue that will be discussed in Subchapter 2.3.2.

Before entering the discussion on the two assemblages and the exchange model they represent, certain economic theories that closely relate to the subject have to be reviewed. These matters were first voiced in 1944 and have since then been thoroughly and intensely debated.

2.1 Economic theories

In 1944, Karl Polanyi wrote *The Great Transformation*, which describes the shift towards an industrialised Europe and the market economy, and the accompanying changes in ideas, ideologies, and social and economic policies.[18] A few years later, in 1957, he wrote a

[15] Veenhof 2008, 32-4; Barjamovic *et al*. 2012, 55.
[16] Kühne 1973, 13-6, 125-33; Moran 1992, xxxiv-xxxix.
[17] Larsen 1967; Veenhof 1985; 1991; 1995b, 859-62; 2013, 27-45; Dercksen 2004b, 1; Michel 2008a, 119-33; 2011, 103; Veenhof 2008, 50-4; Barjamovic 2011, 56-7. For the history and publication of the tablets from Kaneš, see: Veenhof 1972, xxi-xxvii; Larsen 1974, 468-9; 2008; Michel 2008, 118-19; 2011, 94-102; Veenhof 2008, 41-50, 62-82; Barjamovic 2011, 55-6.
[18] Polanyi 2001, vii-xvii.

series of essays in *Trade and Market in the Early Empires*, which discuss aspects of early civilisations' economies, such as those of the 2nd millennium BC in the Near East.[19] In these publications, Polanyi expressed his views on the existence of *marketless* trade in the ANE, focusing on the OA colony at Kaneš, and the types of relationships formed between exchanging parties, thus introducing the terms of *reciprocity* and *redistribution*. According to Polanyi, these three patterns, i.e. reciprocity, redistribution and (market) exchange, are the three "*principles of behaviour*" or "*forms of integration*", which give the economy its unity and stability.[20]

The discussion begins with the issue of the market and whether one existed during the OA period. Polanyi's definition of a market trade contained two essential and intertwined elements, which are the following: an actual market-place and a supply-demand-price mechanism with the prospective profit/loss outcome.[21] He maintained that a market trade was stimulated by supply and demand, which in turn formed prices generating profit and/or losses to the independent merchants or firms:[22]

> *A market economy is an economic system controlled, regulated, and directed by market prices; order in the production and distribution of goods is entrusted to this self-regulating mechanism. An economy of this kind derives from the expectation that human beings behave in such a way as to achieve maximum money gains. It assumes markets in which the supply of goods (including services) available at a definite price will equal the demand at that price. It assumes the presence of money, which functions as purchasing power in the hands of its owners. Production will then be controlled by prices, for the profits of those who direct production will depend upon prices, for prices form incomes, and it is with the help of these incomes that the goods produced are distributed amongst the members of society. Under these assumptions order in the production and distribution of goods is ensured by prices alone*.[23]

Polanyi believed that this was not the case with the OA trade at Kaneš, stating that "*in this marketless trade there was no loss on prices, no speculation, no failure of debtors. It was exciting as an occupation, but risk-free as a business*".[24] Yet, a brief study of the OA trade at Kaneš proves this idea erroneous.[25] Veenhof[26] argues that in a variety of Near Eastern cities

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[19] See Polanyi 1957a; 1957c.
[20] Polanyi 1966, 193-94; 1968b, 307-10; Dalton 1968, xiv-xv, xxxiv-xxxvi; Machado 2011, 121, n. 3; Maucourant and Plociniczak 2013, 524-25.
[21] Polanyi 1957c, 265, 267; 1966, xxiii; 1975, 150, 153. See also Meijer 2001, 328-29.
[22] Polanyi 1957a, 17-26. See also Polanyi 1957c, 267; 1975, 150.
[23] Polanyi 2001, 71-2.
[24] Polanyi 1957a, 22. See also Polanyi 1957b, 67.
[25] Gledhill and Larsen 1982, 203-13; Larsen 2015, 271-80. See also: Adams *et al*. 1997, 246; Pálfi 2014, 217-20.
[26] Veenhof 1972, 348-49, 351-57. See also: Muhly 1982, 252; Renger 1984, 31-47, 76-9, 89-99, 113-14; Meijer 2001; Veenhof 2003, 105-15.

there is written evidence for the existence of a market-place, although these cannot by analogy prove the existence of a free market trade, as opposed to *administrated* or *treaty trade*, as outlined by Polanyi.[27] He also stresses that merchants in different cities may have had a different relationship to their respective kings and palaces.[28] Concerning Polanyi's statement of a *risk-free business*, the OA trade was based on a system of exchange rates for the trade goods. Exchange rates gave traders the opportunity to make a profit simply by acquiring more silver (and gold), i.e. money, than what was originally invested, or created loss.[29] Taking loans and having debts was a typical aspect of an OA trader's life. This shows that OA commercial activities were not risk-free enterprises.[30]

Furthermore, there is the reciprocal and the redistributive relationship between the two parties, as outlined by Polanyi.[31] By definition, reciprocity implies a two-way, i.e. mutual interchange of commodities, a continuous movement and a balanced system of gifts and counter-gifts between two equal partners (*gift trade*).[32] This scheme is observed in the Amarna letters, where it is enveloped in formal courtesies and declarations of friendship and brotherhood.[33] On the other hand, the redistributive scheme entails an accumulation of commodities at a centre and their re-distribution. It represents an asymmetrical relationship between the parties: a central authority and its subordinates. This scheme appears in the form of tributes and treaties (*administrated* or *treaty trade*) and is represented by the vassal correspondence in the Amarna letters.[34]

Each of these two *forms of integration* is governed by a certain rationale. According to the norm of reciprocity a gift should be graciously accepted and reciprocated, or in Polanyi's words:

> *Reciprocity demands adequacy of response, not mathematical equality. Consequently, transactions and decisions cannot be grouped with any precision from the economic point of view, i.e., according to the manner in which they affect material want-satisfaction. Figures, if any, do not correspond to facts. Though the economic*

[27] Polanyi 1957c, 262; 1975, 149-53.
[28] See also: Larsen 1977, 119-20; 1987, 49-50.
[29] Veenhof 1997, 339-40, 347, 362-63; 2003, 105, 111-15. See also: Larsen 1977, 132-39; Dercksen 1996, 157-61; Monroe 2005.
[30] Adams 1992, 148; Veenhof 1997, 343-63; 2013, 37-9, 46-50; Larsen 2015, 217-27. See also Veenhof 1977, 117-18.
[31] Polanyi 2001, 49-55; 1957b, 262; 1975, 149-50. See also" Liverani 1990, 19-24; 1994, 13-8, 189-95.
[32] Polanyi 1957c, 149; Zaccagnini 1973, 4, 125; Machado 2011, 121 n. 3.
[33] Zaccagnini 1973, 4, 100-17.
[34] Polanyi 1957c, 262; 1968a, 187; Zaccagnini 1973, 4, 125; Machado 2011, 121 n. 3. See also Polanyi 1975, 149-50.

significance of an act may be great, there is no way of assessing its relative importance.[35]

The act of gift-giving shows the generosity of the donor which, in turn, raises his/her prestige. This, of course, acts as a pretence for the real goal of this kind of relationship, which is to gain as much as possible, whilst giving as least as possible. This is done despite the claim of the involved parties that their main concern is to please their partners and to offer as much as possible.[36] By contrast, the norm of redistribution does not involve the exchange of material gift for material gift of equal value. The superior party receives "gifts" that are due from the subordinate. These can be in raw material form, which is dependent on what commodities each land produces, or ready-made and most often luxurious objects. One part of these "gifts" remain in the hands of the sovereign, while another part is distributed to the people of the land of the sovereign, for example as commercial goods.[37] In return for the received gifts, the sovereign offers the weaker party military security, civil protection and judicial authorities.[38] In this case, prestige is added to the receiving party, the sovereign, who is generous in his/her non-material offers to the subordinate.[39] Another important aspect of both of these systems is the exclusion of profit and so the non-utterance of prices and money – as opposed to the market system.[40] Nevertheless, these norms only define the "orthodox", as Liverani described it, Polanyian approach; they do not correspond with "reality".[41] In the LBA Near East, there is no actual parity in rank (wealth, prestige, fame, place in society, just to name a few), as well as one's state in the negotiation (the one who started it, the one in need, etc.); these are decisive elements of one's rank and position in exchange situations. There is no actual equivalence between the two exchanged goods: each party has a different perception of value and conventions are to be met, and an exchange described as redistributive from one partner can be described as reciprocative from the other.[42]

Regarding the latter point, while the private epistolary documents present incoming goods as "gifts", the public inscriptions present them as "tribute".[43] This has generally been

[35] Polanyi 1957b, 73.
[36] Zaccagnini 1973, 107, 135; Polanyi 1975, 151; Liverani 1994, 189, 194-95; Kozal and Novàk 2007, 336-37. See also Hénaff 2014, 76-7. See also the discussion further below in Subchapter 2.3.1.
[37] Zaccagnini 1973, 125. See also Kóthay 2013, 882-86.
[38] Polanyi 1975, 151-52.
[39] Liverani 1979a, 11; 1994, 191-92.
[40] Polanyi 1957c, 256-57, 265, 267; 1975, 150; Zaccagnini 1973, 80; Liverani 1979b, 30; Snodgrass 1991, 18; Maucourant and Plociniczak 2013, 524; Hénaff 2014, 72, 77.
[41] Liverani 1990, 22.
[42] Liverani 1990, 22-4. See also Ragionieri 2000, 48.
[43] Zaccagnini 1973, 133; Liverani 1979a, 13-4. See also Liverani 1994, 217-60. In Egyptian, there are two terms in connection with this subject, *inw* and *b3k.w*. According to Kubisch (2007), who follows Bleiberg's (1984;

argued for Egypt, where the particular term from its public (usually monumental) inscriptions, *inw*, has been translated either as "gift", or as "tribute", based on the political status of the supplying country. In truth, however, *inw* simply means "supply" and it "*defines the physical displacement of a material good and its change in ownership, and in particular a displacement toward the subject*".[44] Thus, it would be ill-advised to deduce a country's political status based on the translation of this word, as it would be equally deceptive to translate the word based on the political status of the country. The fact that this term appears on public inscriptions, whose sole purpose is to propagate to the people of the state the idea of a superior, preeminent and powerful king, shows us the bias of the text and of the portrayed event.[45] The propagandistic purpose of the inscriptions can also be vividly observed in the way Ramesses II is exalted for his victory in the battle of Kadeš, in the Ramesseum reliefs and inscriptions, while in reality the outcome of that battle was, at best, a tie between the Egyptian and the Hittite armies and a failure for the Pharaoh.[46] The inscriptions refer to the Hittite King as "the vanquished, wretched chief of Kheta"[47] and even after the two powers have drawn up the "eternal treaty" and the Hittite King Ḫattušili III agreed to offer one of his daughters in marriage to the Pharaoh, Hittite messengers were recorded to have carried "tribute to the fame of his majesty".[48] On the other hand, the goods supplied by Ugarit to the Hittites were described as "tribute" in Ugaritic texts: "And Šuppiluliuma, the gre[at] king, made a treaty with Niqmaddu. Here is the tribute which Niqmaddu brings to the Sun of Arinna".[49] Also: "The tribute which Niqmaddu, king of Ugarit, brings to the Sun, the great king, his lord".[50] Nevertheless, the Hittite king refers to them as "gifts", using the typical Akkadian word for reciprocal gifts, *šulmānu*: "Le Grand-roi a place également ces cadeaux à la charge du roi de l'Ugarit".[51] This should also be considered as

1988) interpretations, the former represents gifts from a person and are to be used by the Pharaoh, and the latter describes a regular tribute from a people, which is to be further redistributed (Liverani 1990, 255-60); cf. Janssen 1993, 90-4. See also Spalinger 1996.

[44] Liverani 1990, 260-61.

[45] See Liverani 1990, 262-64; 2000, 17.

[46] For the battle of Kadeš, see: Klengel 2002, 55-70; Bryce 2005, 234-41. See also Breasted 1906, 155 §341-347, 174 §392.

[47] Breasted 1906, 154 §338 (line 1).

[48] Breasted 1906, 180 §410. See also Roth 2003, 183-87.

[49] KTU 3.1 (lines 16-19): *wṯpllm.mlk.r*[*b*…] *mṣmt.lnqmd*.[…]*št hlny.ʾargmn* (Knoppers 1993, 83). See also PRU IV, 44-6: RS 11.772+780+782+802 (lines 15'-18').

[50] KTU 3.1 (lines 24-26): *ʾargmn.nqmd.mlk ʾugrt. dybl.lšpš mlk.rb. bʿlh* (Knoppers 1993, 83). See also PRU IV, 44-6: RS 11.772+780+782+802 (lines 23'-25').

[51] PRU IV, 80-3: RS 17.382+380 (lines 47-49): *šarru rabû šul-ma-na-ti*^{M} *an-nu-ti a-na muḫ-ḫi šàr* $^{mat\ al}$*ú-ga-ri-it a-kán-na iš-ku-un-šu-nu-ti*; Liverani 1990, 268; cf. PRU IV, 40-3: RA 17.227 (lines 15-20): "Grand-roi a connu (ainsi) la loyauté de Niqmadu. Alors Šuppiluliuma, Grand-roi, roi du Ḫatti, a fait un accord pour Niqmadu, roi de l'Ugarit, en ces termes : 'Ton tribut au soleil Grand-roi ton maître (sera :)" *šarru rabû ki-it-ta ša* ^{I}*ni-iq-ma-an-d*[*a*(?)] *i-ta-mar-ma anumma*^{ma} ^{I}*šu-up-pí-lu-li-ma šarru rabû šàr* ^{mat}*ḫa-at-ti r[i]-kí-il-ta a-na* ^{I}*níq*^{íq}*-ma-an-da šàr* $^{mat\ al}$*ú-ga-ri-it a-kán*^{an}*-na ir-ku-us ma-a ma-an-da-at-ka a-na* ^{il}*šamši*^{ši} *šarri rabi beli-ka*.

propaganda, although it was not planned for the population of the Hittite kingdom but for the city and the king of Ugarit, with whom the Hittite kingdom needed to create a peaceful alliance against a mutual enemy, i.e. the Mitanni, rather than a vassal-overlord relationship.

From the above points, certain conclusions can be drawn: 1) words such as the Egyptian *inw*, whose range of meanings can be rather broad, cannot be "frozen" at one definitive translation and should not affect, or be affected by, the political status of the country to which they refer to;[52] 2) every narrative medium of events is biased in its own way and for its own purposes and should not be taken too literally or as the one and only truth;[53] 3) a tribute (according to contemporary meaning) is a supply of goods offered by a vassal to his sovereign, whose type, quantity and frequency is decided on by the sovereign and is recorded in a treaty, signed by both parties; it is a word with a strong political connotation and for that reason we should be careful of how we use it;[54] 4) kings always employ all "tools" available to them to convey the message they want/need to; they will use the proper phraseology, specifically formulated for diplomatic correspondence and diplomatic negotiations with other kings, and at the same time they will glorify themselves and their accomplishments in the eyes (and ears) of the people of their kingdom.[55]

2.2 The Old Assyrian period

The lower town of Kaneš was a commercial quarter and consisted of four archaeological strata, levels IV, III, II and Ib. Level II is believed to have started in the first decades of the 2nd millennium BC and lasted until c. 1840 BC; the vast majority of the excavated tablets belong to this period. Around 1890 BC (REL 80) there is a significant increase of dated documents, which rapidly decreases around 1860 BC (REL 110).[56] The first

[52] Spalinger 1996, 266. The Egyptian *inw*, which has been translated as "tribute" or "gift", literally means "supply" (Liverani 1990, 255; Spalinger 1996, 366). The Akkadian *šulmānum* denotes "well-being", "health", "present", "gift", as well as "retaining fee" and "gratuity" (CAD Š(3), 244-47). The Akkadian *maddattum* (*mandattum*) is translated as "tribute", "work assignment", "compensation", or even "rent" (CAD M(1), 13-6). The Akkadian *biltum*, which in the Amarna letters is used by the Canaanite rulers and is translated as "tribute", also means "load", "pack", "burden", "yield" (of a field, etc.), "produce" (of a region), "tax", or "rent" and it is logographically written as GÚ or GÚ.UN, denoting "talent" (the weight unit) (CAD B, 229-36).
[53] See also Liverani 2000, 17.
[54] Liverani 1979a, 17; 1990, 268-69. See Liverani (1990, 255-60), where *b3k* is described as a supply by countries, at a yearly pace and of predetermined goods, and *inw* as a supply by rulers, with no regularity and of unforeseen content or amount.
[55] See also Liverani 1990, 25, 264-65.
[56] Barjamovic *et al*. 2012, ch. 1; Larsen 2015, 65-79; Barjamovic 2018, 136-37.

texts of level Ib appear just a few years after the destruction of level II, which was in turn destroyed shortly after 1715 BC.[57]

The basic outline of the OA trade is that travelling agents (*tamkārum*s) loaded donkeys in the city of Aššur with tin, woollen textiles, and other precious goods, and transported them to trading colonies (*kārum*s) and trading stations (*wabartum*s) in Anatolia.[58] The goal was to sell the merchandise there and acquire gold and silver, which was sent back to Aššur. Every caravan was equipped with "hand-tin", i.e. tin given to the hands of the caravan leader to pay the *en route* expenses. Before a caravan departed, it had to be evaluated, it had to pay an export-tax of 1/20 of its value, and it had to have all merchandise sealed. Upon arrival at Kaneš, the sealed packages were opened and taxed accordingly. Only then was the merchandise cleared to be sold.[59] Of vital importance to the overland trade between Aššur and Kaneš were the messages (tablets) that were carried to the respective recipient. A merchant entrusting goods to be transported wrote a notifying message to his chief or his agent(s) at the point of destination, which contained the character of the shipment, the name of the transporter and orders regarding the handling of the commodities. This was sent ahead of the caravan with a faster messenger. When the caravan reached its destination, another letter had to be written. This was composed by the recipient of the shipment and it contained the receipt of the shipment and a detailed account of the recipient's activities, including possible taxes paid and all sales and purchases made.[60] All these types of messages applied not only the Aššur-Kaneš trade, but transactions made between Kaneš and other Anatolian cities as well. This well-organised commercial network greatly differed from the roughly synchronous venture-trade exercised by the Babylonians. Babylonian merchants travelled to various foreign markets and "central places" to buy the goods they needed, in contrast to the Assyrians, who waited for the trade commodities to come to Aššur.[61] It is very unfortunate that no other archive has been found in Anatolia – at least not yet.

An important aspect of the OA trade is its purely commercial character. The extent of the OA trade system is revealed to us through these cuneiform texts, which are filled with financial terms and words denoting costs, prices, purchases, accounts, investments, profit, loss

[57] The beginning of Level II can only be dated as a *terminus post quem* of Level III. Veenhof 2010c, 34-6; Barjamovic *et al*. 2012, 55.
[58] See Larsen 2015.
[59] Larsen 1967, 3-6; Klengel 2009, 178-79; Michel 2009, 75-9; Veenhof 2010d; Barjamovic 2011, 13, 16; Larsen 2015, 180. See also: Donbaz 1997; Dercksen 2007, 189-91.
[60] Larsen 1967, 6; Klengel 2009, 177-78; Barjamovic 2011, 15-8; Veenhof 2013, 40-2, 51-2; Larsen 2015, 171-74, 180.
[61] Veenhof 1997, 339; Barjamovic 2018, 142. See also Leemans 1960, 131-35.

and the market (*maḫīrum*).[62] For all goods in each market there was an accepted equivalency, tied to a standard of quality. This equivalency was the price, which fluctuated depending on lack or abundance of the respective goods in the market. These fluctuations were used by the traders in their search for higher profit.[63] The primary goal was to make as much silver and gold as possible to send it back to Aššur, in order for it to be invested in a new caravan for Anatolia and so earn more silver and gold, thus perpetuating the cycle.[64] Tin and precious stones such as lapis lazuli came to Aššur from the east of the Zagros Mountains, and textiles and copper from Mesopotamia. The Old Assyrians bought what they needed with silver (and maybe also rarely with gold) and shipped it to Anatolia, where the traders sold it with the aim of acquiring more silver and gold.[65] During this period, silver seems to have functioned as currency and not only a standard of value or a simple means of payment.[66] From the OA texts we know that silver was used in Aššur to buy tin and textiles, as well as to pay for other expenses of every-day life.[67] Gold, on the other hand, may have been used to buy goods from foreign exporters in Aššur, who preferred payment with this metal. This opinion is formed from the existence of strict regulations on gold circulation and the amounts of gold reaching Aššur from Anatolia. Veenhof[68] maintains that it may well have been used to buy tin, based on the fact that Elamites were not included in the prohibition of selling gold[69] and that texts from Mari attest to the purchase of tin in Elam with gold.

What is more, metals were not only traded but also exchanged as gifts, as can be deduced from various texts from Mari and some OA texts.[70] Both cases are based on a notion of reciprocity, as is discussed in the following subchapter, without any mention of prices and without the elements of prestige and interest, which were important for the LBA palatial exchange.[71] Pfälzner[72] concludes that, although the commercial aspect of gift-exchanging is the dominant practice, it extends to the sphere of diplomacy, of political coalitions and alliances, which ultimately concern the "political aspect" of the economy.

[62] Veenhof 1972, 345-57, see also pp. 358-400; 2003, 105-15; 2010a, 44-8.
[63] Veenhof 2003, 111-14.
[64] Veenhof 1972, 350; 1997, 340.
[65] See also: Larsen 1987, 52, fig. 5.3; Veenhof 2010a, 49 and n. 19.
[66] Veenhof 1972, 350-51; 1997, 363; Rahmstorf 2016, 295-96. See also Powell 1996, 226-31, 235-38.
[67] Veenhof 1997, 340.
[68] Veenhof 2003, 95-6.
[69] See Kt 79/k 101.
[70] Pfälzner 2007, 111-16; Barjamovic 2011, 309-10.
[71] Pfälzner 2007, 114; Barjamovic 2011, 310.
[72] Pfälzner 2007, 111, 116.

2.3 The Late Bronze Age and the Amarna period

The Amarna letters were found in the "Records Office",[73] east of the King's House, in the Central City of Tell el-Amarna, the ancient Akhetaten.[74] They span about fifteen to thirty years, depending on the number of years of co-regencies of Amenhotep III (c. 1390-1353 BC) with Amenhotep IV (Akhenaten) (c. 1353-1336 BC), and of Smenkhare (c. 1336-1334 BC) with Amenhotep IV.[75] The city was built at about 1347 BC and abandoned at about 1332 BC, but this chronological frame does not necessarily apply to the time span of the tablets themselves.[76]

2.3.1 International relations

The Amarna tablets constitute letters exchanged between kings of the 14th century BC Near East. Most of them were sent to Egypt, but three were sent from Egypt to Babylonia, one to Arzawa and seven to Egyptian vassals.[77] These letters represent the international diplomatic and state correspondence of the LBA Near East. In them, we see kings sending (diplomatic) gifts to each other and pronouncing their "brotherhood" and their love for each other. This exchange of gifts corresponds to the Polanyian term of reciprocity, according to which gifts are exchanged among partners of equal rank (from Great King to Great King), which should be recompensed with gifts of the same quality and of higher quantity. It is a system forced by social conventions and with a prominent social value.[78]

Despite the rules of ceremonial gift exchange, we often see kings behaving contrary to the norms of etiquette.[79] Time and again kings ask for specific gifts to be sent to them, despite the notion that gifts should not be asked for. We see requests being conveyed with brief phrases such as "send me much gold",[80] "may my brother send much gold",[81] or "send refined silver",[82]

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[73] The "Bureau of Correspondence of Pharaoh", as it was written on the walls of the building (Amarna Project 2017, The Central City).
[74] Amarna Project 2017, "The Central City"; Rainey 2015, 4-5.
[75] Moran 1992, xxxiv-xxxix. Chronology according to Hornung *et al*. 2006.
[76] Amarna Project 2017. Mynářová 2014, 16-8.
[77] EA 1, EA 5 and EA 14, EA 31, and EA 99, EA 162, EA 163, EA 190, EA 367, EA 369 and EA 370, respectively. Moran 1992, xvii.
[78] Zaccagnini 1973, 100-8; Liverani 1979a, 11; 1994, 13-8. See also Liverani 1990, 197-202; Snodgrass 1991, 16; Rössler 2007, 4-5; Mynářová 2015, 156.
[79] Zaccagnini 1973, 108-17; Liverani 1990, 211-17, 219-22; 2003, 124; Bryce 2003, 70-8, 92-4; Kopanias 2015, 199. See also Peyronel 2014, 356-59.
[80] EA 9 (line 16): *ep-pu-uš* KÙ.GI *ma-a-da šu-bi-la*"; EA 16 (line 33): "K[Ù,G]I *ma-da šu-bi-la*. Translations and transcriptions of the Amarna letters follow Rainey 2015.
[81] EA 27 (line 104): Š[EŠ-˹*ia*˺ KÙ.GI *ma-a-*˹*da*˺ ˹*li*˺*-še-e-bi-*˹*la*˺.
[82] EA 37 (line 18): KÙ.BABBAR *ṣa-ar-pa šu-bi-la*.

or even more pressingly “[yo]ur very best gold, a lot, before your envoy [comes to me], now quickly during this harvest season send to me, either in the month of Tammuz or in the month of Ab!”[83] Furthermore, kings often complain about the quality or the quantity of the gift(s) received, even though all gifts should be graciously and thankfully accepted and each gift merits a counter-gift of equal value: “These thirty minas of gold which yo[u sent, are not equ]al to the [gr]eeting gift that I sent to you in any sing[le] year,”[84] “three times your envoys have come hither, but you have not sent me any really nice greeting gift and I also have not sent you any really nice greeting gift”[85] and “since they said, ‘The trip is difficu[lt], water is scarce and the weather is ho[t].’ I have not sent to [you] a nice large greeting gift.”[86]

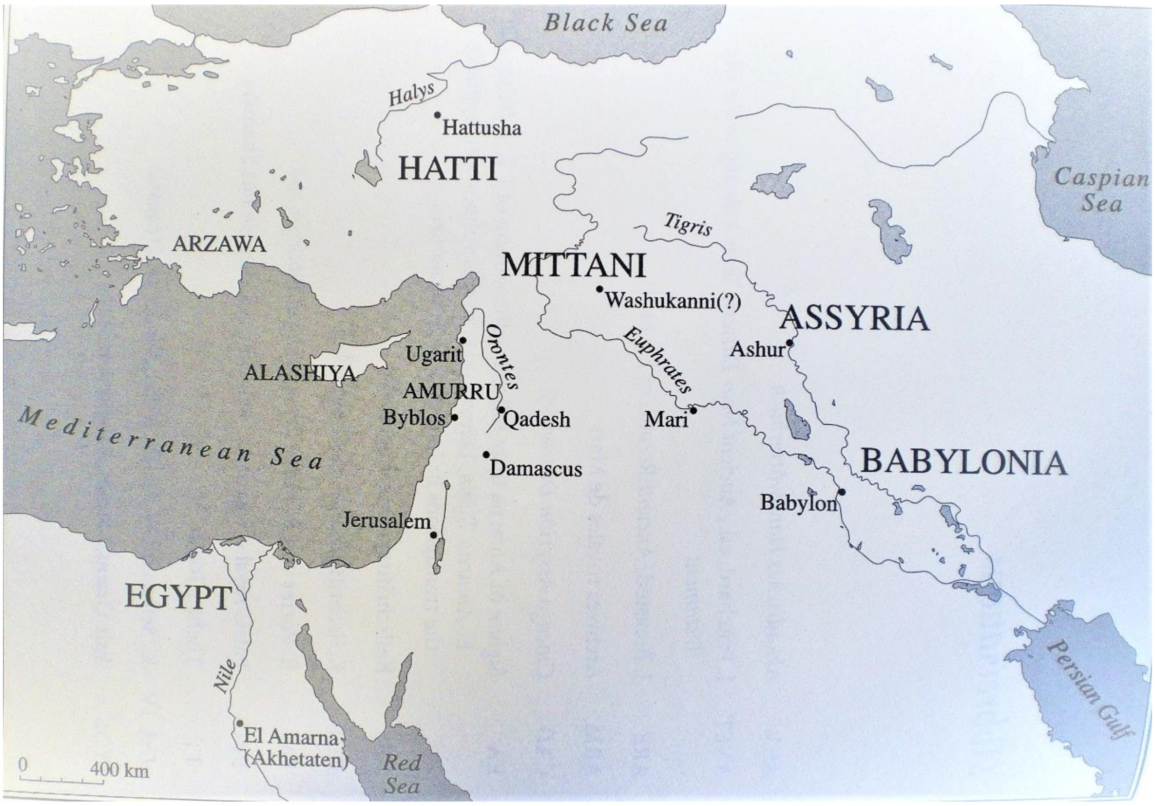

Figure 3. Map of the ancient Near East during the Amarna period

(Cohen and Westbrook 2000, map on p. xii).

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[83] EA 4 (lines 36-39): KÙ.GI.DIRI-*k*[*a*] *ma-ʾa-da la-am* DUMU *ši-ip-ri-ka a-na mu-uḫ-ḫi-ia* ⸢*i*⸣[*-la-kam*] *i-na-an-na ḫa-mu-ut-ta i-na* ŠÀ BURU$_{14}$ *an-ni-I lu-ú i-na* ITI ŠU.NUMUN.NA *lu-ú i-na* ITI NE.NE.GAR.

[84] EA 3 (lines 21-22): [*a*]*n-nu-ú* 30 *ma-na* KÙ.GI *ša tu*[*-še-bi-la*] *šul-ma-ni ša-a e-em* MU.1[KAM^{v} *ú-še-bi-la-ak-ku ul ma-ṣi-*]*i*.

[85] EA 10 (lines 11-15): *i-na-an-na a-na-ku ù ka-ša ṭa-bu-tu ni-nu* DUMU.MEŠ *ši-ip-ri-ka a-di* 3-*šu it-ta-al-ku-ni ù šu-ul-ma-na ba-na-a mi-im-ma ul tu-še-bi-lam ù a-na-ku-ma šu-ul-ma-na ba-na-a mi-im-ma*.

[86] EA 7 (lines 53-55): *ù ki-i iq-bu-ni-im-ma ge-er-ru da-an-n*[*a-at*] *mu-ú ba-at-qu ù u$_{4}$-mu em*[*-mu*] *šu-ul-ma-na ma-ʾa-da ba-na-a ul ú-še-bi-la-ak*[*-ku*].

However, each occasion of a ceremonial exchange of gifts (greeting-gifts, international marriages, accession to the throne) carried a deeper meaning than the simple and superficial procurement of luxurious and exotic goods. A unilateral, enduring and harmonious gift-exchange relationship was based on mutual recognition and respect, on a decision to form and maintain diplomatic relations.[87] Still, these elements are frequently absent from, or even in contrast to the reality of the international correspondence, despite the fact that an enduring alliance was based on the undisturbed exchange of messages and gifts.[88] Pfälzner[89] inferred that gifts were symbolically as well as commercially motivated and that both of these aspects of diplomacy, political coalitions and alliances were equally important. His recent conclusion is that ceremonial gift exchanges "*are primarily commitments through precious goods that serve as symbols*".[90] The true meaning of ceremonial gift exchange, however, cannot be so easily determined. Before coming to a conclusion regarding this matter, a multiplicity of factors has to be examined, such as: Who used these gifts? What was their objective and subjective value? What other advantages could be hidden behind the obvious?

Some scholars support the idea that the ultimate goal of ceremonial gift exchanging was the acquisition of goods.[91] The Amarna letters are representative of this more obvious and of course inarguable desire of the kings of the Near East. They plainly asked for what they wanted and at times even criticised the quality or quantity of what they received.[92] According to Liverani,[93] the fact that Great Kings presented goods, such as gold, which were rare in their countries, and at the same time made a request of the same (rare for them) goods, "*is 'irrational' on an economically abstract plain, but agrees well with the aim of provoking the reaction of the prestige mechanism*",[94] which involved a counter-gift of the same commodity. Nevertheless, as he himself further admits, most of these *irrational* offers were a part of the long dowry-gifts lists and "*do not evidently belong in this particular mechanism of stimulation*".[95] The only case of greeting gifts sent by a Near Eastern king to a Pharaoh and which included rare commodities, for that particular state, are those offered by King Tušratta of Mitanni. His gifts included horses, chariots, jewellery and vessels of gold, jewellery with

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[87] Pfälzner 2007, 116; Hénaff 2014, 71-7. See also: Zaccagnini 1973, 32-40, 79, 192-93; Bryce 2003, 78.
[88] Zaccagnini 1987, 62.
[89] Pfälzner 2007, 116.
[90] Hénaff 2014, 77.
[91] Zaccagnini 1973, 172-74, 177-78; 1999, 191-93; Liverani 1990, 263-65; 2003, 124.
[92] The Pharaoh's most evident request is for foreign princesses and that of the Near Eastern kings is for gold from Egypt.
[93] Liverani 1979b, 22-6.
[94] Liverani 1979b, 25; cf. Zaccagnini 2000, 147-48.
[95] Liverani 1979b, 25.

stones set in gold, lapis lazuli, garments, shirts, bows, quivers set in gold, bronze arrows, and maces.[96] It is obvious that many of his offers were produced from raw materials imported from external regions. The Mitanni state lies in the northern part of Mesopotamia, neighbouring Hatti to the north and Babylonia to the south and stretching from the Zagros Mountains at the east, to Kizzuwatna and northern Syria to the west.[97] It is an area with no lapis lazuli, gold, or tin sources to make bronze and, as a result, much of its wealth and thus its gifts were procured from neighbouring states. Therefore, we cannot agree to the existence of such a provocative tactic, as the Mitanni state had no precious commodities, fit for a king, to offer and all its "wealth" must have come (mainly) from trade. Assyria, situated in a nodal point between east and west, greatly benefited from the plethora of goods reaching its borders.[98] Regarding the dowries and marriage-gifts, even Egypt and Babylonia offer goods which are not found in their state and have had to be imported. The Pharaoh's gifts include carnelian, gold, lapis lazuli, onyx, obsidian, ebony, alabaster, silver, copper, bronze, quartz and various stones, while the Babylonian dowry contains glass, gold, sweet oil, copper, silver, bronze, lapis lazuli, chariots, cedar, ebony, linen cloth, ivory and various stones.[99] Thus, the argument that kings offered goods that were rare in their country in order to stimulate a gift of the same, not so rare for the counter-party, should be kept in mind. It may not, however, be the most apposite argument to prove the claim that the kings' ultimate goal from gift-exchanging in the frame of an international correspondence was wealth accumulation. This process is better appreciated as a prestige accretion technique.

What is more, there is the practice of international marriage. A royal bride was of the highest value in ceremonial circles. According to the norms of reciprocity, a woman should be exchanged with a woman, but cases of international marriage between a Near Eastern princess and a Pharaoh demonstrate an explicit deviation from this scheme.[100] According to Egyptian tradition, or policy, no Egyptian princess was to be married to a foreigner: "From of old a daughter of the king of Egypt has never been given to anyone".[101] For the Egyptians, even giving a beautiful woman of non-royal descent was not a matter of discussion:

> You are a king; you can [do] whatever you want. If you were to give (a daughter) who c[ould say] anything? (…) There are grown daughters [of someone], beautiful women.

[96] See EA 17, EA 19, EA 20, EA 21, EA 26, EA 27 and EA 29.
[97] Van de Mieroop 2004, 142-43.
[98] See also Harrak 1987, 283-84.
[99] See EA 13 and EA 14, respectively.
[100] Zaccagnini 1973, 14-20; 1987, 59; Liverani 1979b, 31-3. See also Polanyi 1975, 150.
[101] EA 4 (lines 6-7): *um-ma-a ul-tu$_4$ pa-na* ˹DUMU˺.˹MUNUS˺ LUGAL *ša* KUR *Mi-iṣ*[*-ri-i*] *a-na ma-am-ma ul in-na-ad-di-in*.

> Send one as if she were [yo]ur [daughter]. Who will say, 'She is not the king's daughter'?[102]

Considering the fact that this policy equally applied to all foreign kings, the marriage of an Egyptian princess to a foreign ruler would mean the elevation of that particular king to a higher status than the others rulers of the ANE, maybe even similar to the one enjoyed by the Pharaoh, which was unheard of.[103] It was only at the beginning of the 14th century BC that Egypt started seeing other states as *quasi*-equals and so taking foreign princesses as wives.[104] Even after the great battle of Kadeš, the treaty that was drawn between the two super powers, Egypt and Hatti, was sealed with the marriage of Pharaoh Ramesses II with one of Ḫattušili III's daughter, but no Egyptian princess was ever given to the Hittite king in marriage.[105] The few cases of Egyptian princesses getting (or being sought) married with foreign kings and princes was at a time when Egypt was at its weakest.[106] Egyptian belief implied that offering a woman of royal descend in marriage with a foreign ruler automatically entailed an acknowledgement of superiority. Thus, as Egypt saw herself as the supreme power of the Near East, she would not offer such a high honour to any other state, leaving the other Great Kings obliged to accept the Pharaoh's directives and settle for the next best alternative counter-gift, i.e. much gold and many other precious goods in the form of a bride-price (*terḫatu*, logographically NÍG.BA.MEŠ MUNUS.UŠ.MEŠ).[107] That is, if they wanted to have amicable relationships with Egypt, an undeniably great power, and call her their ally and friend.[108]

However, it is important to note that each marriage signified a bond between two kings, not between their respective states. This meant that each time a king died or a new king came to the throne, a new bond via marriage had to be formed between them. This is a reason why Amenhotep III married two Babylonian and two Mitanni wives, one from the father and one from his son and heir. This is also a reason why Amenhotep IV, after his father's death, married the Mitanni princess who was previously married to his father.[109] Kopanias[110] recently

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[102] EA 4 (lines 8-13): LUGAL *at-ta ki-i* ŠÀ-*ka te-ep*[*-pu-uš*] *šum-ma ˹ta˺-at-ta-di-in ma-an-nu mi-na-a ˹i˺*[*-qa-ab-bi*] … *a-ka-an-na al-ta-˹ap˺-ra um-ma-a* DUMU.MUNUS.MEŠ GAL.M[EŠ *ša ma-am-ma*] MUNUS.MEŠ *ba-na-tu*$_4$ *i-ba-aš-ša-a* 1 MUNUS *ba-ni-ta ki-˹i˺* [DUMU.MUNUS-*k*]*a ˹ši˺-i šu-bi-la ma-an-nu i-qa-ab-bi um-ma-a ul* DUMU.MUNUS.LUGAL *˹ši˺-˹i˺*.
[103] Schulman 1979, 191; Cohen 1996, 17, 22; Jönsson 2000, 194-95; Bryce 2003, 101, 110; Roth 2003, 178.
[104] Jakob 2006, 15.
[105] Klengel 2002, 51-93, 121-39; Quack 2002, 290-91; Bryce 2003, 106-10; 2005, 275-79, 282-83. See also Gnirs 2013, 711-12.
[106] Schulman 1979, 187, 192; Bryce 2003, 105
[107] Zaccagnini 1973, 16-20, see also p. 176; 1985; Liverani 1979b, 31-4; Bryce 2003, 101-2; cf. Pintore 1978.
[108] Bryce 2003, 101. See also Schulman 1979, 188-90.
[109] Schulman 1979, 183-85.
[110] Kopanias 2015, 202.

suggested another possible reason for kings and Pharaohs to want more wives and that is that, according to the Amarna letters preambles, a king's status primarily depended on the extent of his household and the number of his wives and sons. In the beginning of every letter the sender wished for the well-being of his brother, the king, his household, wives (or chief-wives), sons, high officials, chariots and horses, warriors and country, in this exact order. He then assured for his well-being, as well as for the well-being of everyone and everything mentioned above. These were the elements which defined a king's wealth.[111] From the point of view of the king that offered the bride, a diplomatic marriage resulted in having a permanent representative and simultaneously an ambassador in his brother's and ally's court.[112]

Moreover, there was an even more important reason for certain states to form an alliance and have amicable relationships with Egypt: that was border security and military assistance. This was especially true for the Mitanni state, which needed to secure at least one of its borders. Furthermore, an alliance against a powerful, or even a prospectively strong, enemy was another good reason to want to form one. And this was true regardless of whether that enemy was at one's doorstep or not. This was the case with Babylonia and its king, who reminds the king of Egypt of the existing alliance between them and *tells* the Pharaoh not to do business with the Assyrians.[113] This order-like request from Babylonia was aimed at ensuring that no alliance or friendly relationship would form between Egypt and Assyria. The latter lay at Babylonia's northern borders and it was undesirable that it should grow to become a political or military threat. This was also the case with the marriage uniting Egypt with Arzawa.[114] The latter was on the southwest coast of Anatolia and a known adversary of the Hittites, so Egypt's move was intended to gain support against the Hittites.[115]

But the most evident reward from marriage agreements was the rich and luxurious gifts. The bride's father received the already-mentioned bride-price, while the Pharaoh received the princess' dowry. Both of them constitute the lengthiest lists of items offered by one Great King to another, containing a great variety of goods. When a Pharaoh asked for a bride, the arrangement was that the king would offer a large dowry and the Pharaoh would, in return for the bride and the dowry, offer a great number of goods and most importantly gold. After all,

[111] Kopanias 2015, 200-2.
[112] Jakob 2006, 15-6.
[113] EA 9 (lines 31-35). Emphasis by the author.
[114] EA 31.
[115] Schulman 1979, 189-90. See also: van de Mieroop 2004, 135-37, 141-60, 169-71; Cancik-Kirschbaum 2002, 285-86; Bryce 2005, 119, 144, 147; Genz 2011, 313-14.

gold was what kings always requested when asked to give one of their daughters in marriage.[116] Nevertheless, no bride-price was ever limited to gold. Just like every dowry, every bride-price also contained precious goods of every imaginable kind: metals and metal objects, precious stones and stone vessels, chariots, wood, and textiles.

On the basis of the wealth of commodities exchanged and the eagerness to receive the bride-price of gold, or the dowry, one could claim that wealth accumulation was the primary interest of Great Kings.[117] But a letter sent from the Mitanni king considering the dispatch of the bride-price may lead us to another conclusion. The letter reads as follows:

> The gold of the…, that your father sent to my grandfather as the bride price, the (gold), that you have sent to my father as bride price was much more than that of your father. And my brother has not done the same for me, like that which he has sent to my father as bride price. And *may my brother make me glorious in the eyes of the kings, my colleagues (and) the other lands*. *With gold in large quantity may my brother see that I am supplied and they may behold me*. And may my brother, moreover(?) see to my foreign relations for once and may he not distress my heart. And may my brother give, in the desired manner in ac[cordance with my heart, [that which] (corresponds to my wishes). And may my brother grant(?) to me much more than my forefathers, and *may my brother make (me) very splendid in the eyes of my lands*, and may my brother not distress my heart![118]

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[116] See, for example, EA 4 (lines 36-50), EA 19 (lines 47-48), EA 24 (III §25 lines 67-70), EA 29 (lines 21-27) and EA 31 (lines 11-16, 22-26).

[117] This refers to the apparent impatience of Pharaoh Ramesses II to receive the dowry of princess Maathorneferure, daughter of Puduhepa and King Ḫattušili III, to which Puduhepa commented as follows: “Does my brother possess nothing at all? Only if the Son of the Sun-god, the Son of the Storm-god, and the Sea have nothing, do you have nothing! Yet, my brother, you seek to enrich yourself at my expense! That is worthy of neither your reputation nor your status!” (Bryce 2003, 107) A-NA ŠEŠ-YA-*ma* NU.GÁL *im-ma ku-it-ki ma-a-an* A-NA DUMU ^{d}UTU *na-aš-ma* DUMU ^{d}U Ú-UL *ku-it-k[i] e-eš-zi tu-uk-ka*$_{4}$ Ú-UL *ku-it-ki e-eš-zi* ŠEŠ-YA-*ma am-me-e-da-za* NÍG.TUKU-*ti ku-it-ki* Ú-UL-*at* ŠUM-*an iš-ḫa-aš-šar-wa-tar-ra* (KUB 21.38 (lines 15’-16’): translation in Bryce 2003, 107; transcription in Hoffner and Beckman 2009, 281-90). See also: Beckman 1996, 125-29 No. 22 E (lines 15’-16’); Bryce 2005, 282-86.

[118] EA 24 (III §25 lines 67-90) (here emphasis by the author) in Hurrian: KÚ.SIG$_{17}$ *at-ta-i-wu-uš am-ma-ti-íw-wu-ú-a ú-˹a˺-du-ra-a-an-na ge-pa-a-nu-u-ša-a-aš-še we-e-eš-ša-a-an at-ta-íw-wu-ú-a ú-˹a˺-[d]u-ra-a-an-na ge-pa-a-nu-u-šu-u-uš-še te-a at-ta-i-ib-be-né-e-tan t[iš-š]a-an-na-ma-an šu-u-wa-ma-a-an še-e-ni-íw-wu-uš ir-nu-u-ḫu-ši-a-a-ma ˹at˺-ta-íw-wu-ú-e-né-e-en-na ge-pa-a-nu-u-ša-a-aš-še še-e-ni-íw-wu-ú-ut-ta-a-an ˹su˺-bi-a-a-maš-ti-en éw-re-en-na-a-ša i-ri-i-in-na-ar-ti-íw-wu-ú-a u-u-ul-a-a-ša* KUR *u-u-mi-i-in-na-a-ša wu-ri-a-ša ḫi-ia-ru-uḫ-ḫa-a-at-ta-a-an t[e]-u-u-na<-e> še-e-ni-íw-wu-uš ge-pa-a-nu-en wu-ur-te-ni-it-ta-a-an še-e-ni-íw<-wu>-uš-ša-a-an ul-˹lu˺-i ti-wi-íw-we šuk-ku ta-a-na-aš-ti-en ti-ši-íw-we-en-na-a-an ḫi-s[u-ú-ḫ]i-wa-a-en ša-a-li-íw-wu-ú-e-en še-e-ni-íw-wu-ú-e-né-e-we aš-ti-i-we ˹š[e-e-ni-íw-w]u-uš˺ za-lam-ši ḫi-ia-ru-uḫ-ḫé na-˹ak˺-k[a-a]š-[š]a ku-x[(.)]x [še-e-ni-íw-wu-u]š ta-a-na-aš-ti-en ma-a-nu-ú-˹un˺-na-a-a[l-la-a-a]n* [….] [………(…)-]˹*ši*$^{?}$-*ru*˺-[.]-*in*-[*n*]*a-a-an u-lu-xxxxx-en*(-)[(…)] […….(..)]*x x*[… *a*$^{?}$-*nam*$^{?}$]-˹*mil*$^{?}$-*la-ma*˺-*an ut-ta-aš-ti-te-e*[*n*] […..(..)-*n*]*i*-˹*i*˺-*in še*-[*e-ni-í*]*w*-˹*wu*˺-[*u*]*š* ˹*be*˺ *ti-ša-a-tan ta-a-ni*-˹*a*˺ [….(.)]-˹*un*˺-*na-a-ma-a-an e-t*[*i*]-˹*i*˺-*tan-x*-[.]*x-an e-el-mi-i-ḫi ú-ru-uḫ-l*[*i*] [….-*t*]*a-ma-a-an e-ti-i-ta*[*n-n*]*a-ma-an* [. (.)-*g*]*u-ú-un-na* […]-*a-an u-u*-[*ul*$^{?}$]-*lu*-˹*ḫi-duk*˺-*ku-u-un i*-˹*i-duk*˺-[*ku*]-*un-na-ma-an še-e-ni-íw-wu-ú-an* [……] *ḫi-i-x x* ˹*ti-ši-íw-we-en-na*˺-*a-an ḫi-su-ú-ḫi-wa*-˹*a-en*˺ *a-ri-en-na-a-an še-e*-˹*ni-íw*˺-*w*[*u-uš*] *ša-a-ru-ši*-˹*im*˺-*p*[*u*]-˹*ú*˺$^{?}$-[*u*]*š*-[*šu*]-*uḫ-ḫa ti-ši-íw-wu-ú-un-nu-uḫ-ḫa ši-ra*-[*aš-še*] *an-za-a-an-nu-u*-[*ḫi-e-ni-tan*] *še-e-ni-íw-wu-uš at-ta-a-ar-ti-íw-wu-tan tiš-ša-ni-it*-[*ta-a*]-˹*an*˺ *ti*[*š*]-*š*[*a-na-an*]$^{?}$ *su-bi-a-maš-ti-e*-˹*ni-tan*˺ *še-e-ni-íw-wu-uš* KUR *u-<u->mi-i-ni-íw-wu-ú-a wu-ri*-[*i*]-*ta t*[*i-ši-í*]*w-we-en*-˹*na-a-an*˺ *še-e-ni-íw*-[*wu*]-*uš ḫi-su-ú-ḫi-wa-a-en an-du-ú-a-na-an* [*šuk*$^{?}$-*k*]*án*.

This passage demonstrates the great importance kings gave to other kings' views of them. A great gift denoted love between two kings. This is in turn translated into power and high status, not to mention the added wealth acquired by this "love" – an issue to which we shall return. Thus, what King Tušratta underlines in his letter is not that the gifts should be sent as such, but that the Pharaoh should thereby grant him glory.

Furthermore, letter EA 4 reveals that every Great King originally desired and endeavoured to have an Egyptian princess as wife. However, the widely-known Egyptian policy of non-export of Egyptian women left them with the next best thing coming from Egypt, namely a lot of gold. If an Egyptian princess was to marry a Near Eastern king, she would be accompanied by a very rich dowry, part of which would be gold. This is automatically translated in wealth and it is the objective value of a woman and a wife. However, this position could have also been achieved with a large greeting gift from the Pharaoh. The true significance of a princess as wife is her symbolic value. As already mentioned, being allowed to marry an Egyptian princess would mean status elevation for the particular king and would create a constant bond with the Egyptian court and the Pharaoh (just to mention a few of the advantages). More lavish gifts mean more wealth, which means higher prestige for a king. An Egyptian princess as wife means not only wealth and prestige through this wealth but also greater status and a higher rank among other Near Eastern kings, and so even more prestige. As a result, it appears that the actual goal of the Near Eastern kings was not wealth *per se* but prestige, through wealth and/or status.

However, diplomatic correspondence is a rather complex issue and much like a coin – with two sides. The above cited passage from Tušratta's letter (EA 24) demonstrates how a king can be interested in gaining prestige through gifts and wealth. Similarly, other passages attest to a king's interest in wealth accumulation. Letter EA 4, sent from the Babylonian King Kadašman-Enlil I to Amenhotep III, is a very good example of a marriage negotiation that can be interpreted both ways. Westbrook[119] made quite a compelling argument that the Babylonian king's complaint, ruse and threat had the ultimate objective of subtly pushing the Pharaoh toward raising the bride-price that he will/has to offer.

Furthermore, ceremonial gifts were normally luxurious commodities. These were added to the receiver's, personal or/and state wealth. In the case of the Amarna letters, the receiver was most often the Pharaoh. The question then arises, what happened to these goods.

[119] Westbrook 2000, 380-82.

Did they become part of the Pharaoh's holdings, or did they enter the state treasury?[120] It has been suggested that since the introduction of the office of the "overseer of sealed things", from the 11th Dynasty on, the Pharaoh's property was separated from that of the state. The "treasury" of ancient Egypt literally translates as the "house of silver" or "white house", in Egyptian written as *pr ḥḏ*. This was most likely the place in the palace, where precious commodities were stored, administrated and crafted into new artefacts.[121] This office was run by the "overseer of sealed things", who was second only to the vizier, who was second to the Pharaoh. The vizier was in charge of the palace as an economic unit and among his responsibilities were all royal works, among which belonged the Pharaoh's mortuary complex as well.[122] Thus, one could claim that the ceremonial gifts received by the Pharaoh entered his treasury and were in part used to decorate and enrich his final resting place. As a matter of fact, in Tutankhamun's tomb there were found objects which could be of foreign origin.[123] Moreover, the "treasury" could have also been the source of income for (high) officials. Evidence dating to the Old Kingdom show that largesse was offered to a priest and "sealed objects" to a deceased person. Both of these favours/gifts were drawn from the "treasury".[124] One may imagine that such a mode of "payment" of high officials still existed in the New Kingdom and the Amarna period. During this period, these positions were held by non-royal families, which had to be kept loyal and, in a way, dependent on the Pharaoh. When state positions were opened up to officials of non-royal origin, as in the case of the vizier, the Pharaohs implemented a new policy. This was to marry princesses to those high officials, in order to safeguard their loyalty. Moreover, there is evidence that children of important elite families were raised close to the royal family for the same purpose.[125] Thus, ceremonial gifts could enter the Pharaoh's "treasury" and be used for various reasons and in various cases, such as the decoration of a royal tomb, payments to high officials, or even to be offered as a gift to another "brother".[126]

Let us now return to the issue and the ability of luxury and wealth to grant and elevate prestige and, hence, power on its owner. A luxurious gift from a foreign land is a discreet association with the exotic, which is further linked to rarity and hence preciousness. To anyone who holds such commodities, the exotic is a clear symbol of wealth, as well as the foundation

[120] Grajetzki 2013, 239.
[121] Helck 1958, 76-82, 180-91; Liverani 1990, 241-42; Grajetzki 2013, 245-46, see also p. 229.
[122] Bárta 2013, 162. See also: Grajetzki 2013, 229, 238; Spalinger 2013, 394; Shirley 2013, 601.
[123] As for example the dagger, the bracelet and the miniature headrest made of iron found in this Pharaoh's tomb.
[124] Papazian 2013, 73.
[125] Bárta 2013, 170; Kóthay 2013, 482-83. See also Shirley 2013, 596-601.
[126] See Liverani 1990, 227.

of prestige and power.[127] To a high ranking official and a member of an important family in Egypt, this meant distinction among his equals and power (through wealth) for his family, thus ensuring the family's state and satisfying his own, or the family's, ambitions.[128] However, luxurious commodities had an even deeper meaning to a king. A king did not only need to emphasise his wealth and his power to his subjects, for example by building grandiose (funerary and religious) structures and organising lavish festivals, he also needed to demonstrate his wealth, self-sufficiency, power and status as a ruler and as a king among kings. What is more, a king needed to have his kingdom at peace and his household secure. One way to achieve the latter was by sharing precious gifts with the high officials, who were responsible of the administration of the palace and the safety of the king, by keeping them close and so keeping them loyal.[129]

Inarguably, the most sought-after good by all kings and the most precious one was gold. It has been written that kings concealed their desire for (more) gold under the guise of ambitious projects, so as not to lower the level of conversation to that of simple mercantile negotiations, or to show their insufficiency.[130] The Babylonian King Kadašman-Enlil I needed gold for his new palace,[131] his heir King Burna-Buriaš II needed gold for the adornment of a temple,[132] the Assyrian King Aššur-uballiṭ I asked for gold for his new palace,[133] the Mitanni King Tušratta was building a mausoleum for his grandfather and was also asking for gold as a bride-price.[134] A thorough reading of the Amarna international correspondence indicates even further possible examples. The Mitanni king says in EA 20: "[And with regard to the gold] which my brother sent, I assembled all my [foreign gue]sts,"[135] and continues: "May Teshub and Amon grant that my brother reveal love of me, that my brother cause me to be glorified(!) in the presence of my country and in the presence of my foreign guests".[136] In letter EA 24, King Tušratta also wishes that the Pharaoh may "assemble the entire land and all the other countries and the honored

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[127] See also: Faist 2001, 239; Hodder 2012, 213-14.
[128] See also Wason 1994, 55-6, 103, 106.
[129] See Moreno García 2013b, 1051-56, 1063-65.
[130] Zaccagnini 1973, 117-24; 1983, 59; Liverani 1990, 224-27; Zaccagnini 1994, 202-8; Bryce 2003, 94-5; Peyronel 2014, 359-60; Kopanias 2015, 203. See also Zaccagnini 1983, 220-21.
[131] EA 5 (lines 13-33).
[132] EA 9 (lines 15-18).
[133] EA 16 (lines 13-18).
[134] EA 19 (lines 39-46, 54-58).
[135] EA 20 (lines 46-47): [*ú aš-šum* KÙ.GI] *ša* ŠEŠ-*ia ú-se-bi-lu* [*ú-ba-ru-t*]*u*$_4$*-ia gáb-bá up-te-eḫ-ḫé-er*.
[136] EA 20 (lines 73-75): *ki-i-me-e* ŠEŠ-*ia a-na pa-ni* KUR-*ia ki-i-me-e a-na pa-ni* LÚ.MEŠ *ú-bá-ru-ti-ia* ŠEŠ-*ia ma-ˀa-dá ú-šar*!(BAR)-*ra-ḫa-an-ni* [d]IŠKUR *ù* ˹d˺*A-m[a-n]u li-id-din-ma a-na da-ra-tim-ma ša* ŠEŠ-*ia ša lìb-bi-šu lu-pu-uš ù* ŠEŠ-*ia*.

guests (and) all envoys should be present."[137] From these passages we understand that the Mitanni king received envoys bearing greeting or marriage gifts in the presence of people from his and from other countries. These were possibly envoys and ambassadors from neighbouring lands, who were in his city at the time.[138] This is also evident in a passage from a letter sent from Pharaoh Amenhotep III to the Babylonian King Kadašman-Enlil I. In this passage, the Pharaoh cites the words of the Babylonian king, as they were written in a previews letter sent from the king:

> As you spoke, saying, "He placed my chariots among the chariots of the city rulers, you did not review them separately! You humiliated them before the throng which is thus and(?) you did not rev[ie]w them separately."[139]

This further implies that a similar presentation before various guests also happened in the Egyptian court: one can only imagine that this was an international custom. In such gatherings, the gifts were publicly seen and assessed as to their quantity and quality. These two elements were markers of the love between two Great Kings, which signified a strong alliance and a united power, and gave prestige and glory to the receiving party.[140] This statement becomes more apparent from passages like the following, which was sent to Amenhotep IV by the Babylonian King Burna-Buriaš II:

> [When] your [fa]ther sent much gold to Kurigalzu, what was more than the [greeting gift] of Kurigalzu? In the palace of [my father, what was] lacking? In order that the neighboring kings might hear, saying: "The go[ld is plentiful. Between] the kings there are brotherhood, amity and [good] relations. [It is he] who is rich in precious stones, rich in silver, rich in [gold]!".[141]

and in another one sent to the same Pharaoh from King Tušratta of Mitanni:

> (…) May] we show love and may we rejoice as long as we live. [And more than all the other countries, o[ur [countries will] enrich their abundance and they will say thus,

[137] EA 24 (III §21 lines 24-26) in Hurrian: *še-e-ni-íw-wu-uš-ša-a-an* KUR *u-<u->mi-i-ni šu-ú-an-na-ma-an pu-uk-lu-uš-ti-en u-u-ul-la-a-an* KUR *u-u-mi-i-in-na šu-ú-al-la-ma-an wi-i-ra-te-e-na-a-an pa-aš-ši-i-it-ḫé-na*$^{\text{MEŠ}}$ *šu-ú-al-la-ma-an tup-pu-la-in*.
[138] On more than one occasion we read about an envoy being detained for many months, or even years, in the palace and the country to which they have been sent. See, for example, EA 3 (lines 13-14), EA 28 (lines 12-19), EA 36 (line 18) and EA 138 (lines 71-93).
[139] EA 1 (lines 89-92): *um-ma-a it-ta-din* GIŠ.GIGIR.MEŠ-*ia i-na lìb-bi* GIŠ.˹GIGIR˺.˹MEŠ˺ LÚ.MEŠ *ḫa-za-nu-ti ú-ul ta-mu-ur-šu-nu a-ḫi-ta*$_5$ *tu-ṭe*$_4$*-pí-il*$_5$*-šu-nu a-na pa-ni ma-a-ti ša ki-ka* (\)*ù? ú-ul ta-mu*$_{<}$*-ur*$_{>}$*-šu-nu a-ḫi-ta*$_5$ *lu-ú an-ni-ka*.
[140] See Cohen 1996, 23, 25. See also: Liverani 1990, 242, 265-66; Bryce 2003, 89-93.
[141] EA 11 (rev. lines 19-23): [*ki-I a-*]*bu-ka a-na Ku-ri-gal-zu* KÙ.GI *ma-ʾa-da ú-še-bi-i-lu* [*šu-ul-ma-na*] *ša Ku-ri-gal-zu mi-nu-ú i-ta-ti-ir-ma i-na* É.GAL [*a-bi-ia*] [*mi-nu-ú i*]*n-da-ṭi aš-˹šum˺* LUGAL.MEŠ *ša li-mi-ti še-mé-e um-ma-a* KÙ.[GI *ma-ʾa-du i-na*] [*bi-ri*] LUGAL.MEŠ *aḫ-ḫu-tu*$_4$ *ṭa-bu-tu*$_4$ *sa-li-mu ù a-ma-tu*$_4$ [*ba-ni-tu*$_4$] [*šu-ú-ma k*]*a-bi-it* NA$_4$.MEŠ *ka-bi-it* KÙ.BABBAR *ka-bi-it* [KÙ.GI].

> "How [the kings of the land of Ḫanigalbat and of the land of Egy]pt [show love for each other]." If it is thus, more than all the lands, [our lands will flourish] very [much and] all the lands will speak of us.[142]

The picture emerging is that envoys entered the city and the palace, of which the latter in particular must have inspired awe with its lavish decorations, part of which could/should have come from gifts sent from foreign kings. Apart from the palace, similar feelings of admiration could/should have been aroused by various other buildings in the capital city. Such buildings were temples and mausoleums: they would all symbolise the wealth of the state and the king.[143] Moreover, it would be a bit unreasonable to expect that greeting gifts remained locked in the personal treasury of each king and were not taken out and displayed for foreign visitors; such riches could create the aforementioned awe for the wealth and power of the king. Gifts requested for the decoration of important buildings demanded greater quantity, for example of gold, than those destined simply for a king. Consequently, the projects reported by the kings, in order to acquire more gold from the Pharaoh, could have been essentially truthful, but exaggerated. They should not be taken literally.

Returning to Hénaff's[144] proposition that "*the purpose of these exchanges is not only to exchange precious goods, in a spirit of civility, not even as an expression of generosity, but to achieve reciprocal public recognition and establish lasting alliances through these goods*", it is time we turn to the matter of establishing and maintaining alliances. Ethnographic evidence has shown that a true reciprocal exchange of gifts (such as the Kula ring), symbolising an everlasting alliance between parties, does indeed occur.[145] However, the international correspondence of the LBA, as presented in the Amarna letters, reveals a very different situation. As already mentioned, the ceremonial exchange of gifts between the Great Kings of the Near East and the Pharaoh does not seem to actually follow the norms of reciprocity. If gifts were just symbols of an existing alliance between two partners, an alliance based on and supplemented by the reciprocal exchange of gifts, then the rules of reciprocity would be followed. This means that ample gifts of the proper quality and quantity would always be

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[142] EA 29 (line 132-135): … *lu-ú*] *ni-ir-ta-na-ʾa-am ù lu-ú-ni-˹ḫa˺-ad-du ˹a˺-di ni-i-nu-ú-ma* [*ù el* KUR.KUR.MEŠ-*ti gáb-ba-ši-na-ma* KUR.KUR.MEŠ-*tu₄-n*]*i la-le-e-ši-na ú-la-al-la ù i-qáb-bu-ú um-ma-a ki-i* [*ir-ta-na-ʾa-mu* LUGAL.MEŠ KUR *Ḫa-ni-gal-bat ù* KUR *Mi-iṣ-r*]*i-i šum-ma ka-an-na el* KUR.KUR.MEŠ-*ti gáb-ba-ši-na-ma ma-˹dì˺-iš* [*dan-niš* KUR.KUR.MEŠ-*tu₄-ni la-le-e-ši-na ú-la-al-la ù i-*]*qáb-bu-ú* KUR.KUR.MEŠ-*tu₄ gáb-ba-ši-na-ma i-na muḫ-ḫi-ni*.

[143] The imposing presence of such buildings and their lavish decorations generating sentiments of admiration and submission were also used as a tool of power in other cultures, such as the Vikings (see Steinsland *et al*. 2011, 187-88).

[144] Hénaff 2014, 71-2.

[145] See: Malinowski 1920; Mauss 2002, 10-59; Ziegler 2007; Hénaff 2014, 75-7.

offered, all gifts would be gratefully accepted and befittingly reciprocated and no complaints regarding the quality or/and quantity of a gift would ever be voiced. This behaviour would be a sign of mutual respect and of a desire to keep the partner pleased and to stay in his good graces.

In fact, the behaviour that took place was part of an international power play.[146] When king A offers a gift to king B and king B complains about the gift, there are two possibilities: a) King A did indeed send a suitable gift, but king B wants more or something better, and so complains in order to expose king A's inability to provide a befitting gift. This means that king A does not possess enough wealth, or prestige and power over his people. This move would aim to lower king A's prestige and power among the kings of the Near East. b) King A did not send an appropriate gift to king B, so the latter would be within his "rights" to complain. But the complaint, however, would reveal king B's desire or even need for something better or more, which would consequently lower king B's prestige among the kings. From king A's point of view, such a ploy could have been deliberate (to push king B into the embarrassing position of complaining), and so achieve the desired outcome, as stated above. Whatever the case, it would seem that both parties agree to form an alliance and exchange gifts, because they needed those luxurious commodities for the above-mentioned purposes. By doing so they also consciously entered into a rather elaborate game of one-upmanship, where no real alliance and fair-play exists.[147]

Nevertheless, each pair's relationship must be judged on its own merits. The Egyptian-Babylonian correspondence reveals an obvious power-play and interdependence between the two kingdoms. In the eyes of the Babylonian king, the Mitanni state is of low status, as low as the Kaška and Ugarit. At the time of Amenhotep III and early in the reign of Amenhotep IV, the last city could be described as an "*autonomous state with strong Egyptian influence*".[148] Kadašman-Enlil I is the only Babylonian king who we see claiming an Egyptian daughter in marriage. He is the only one who we see trying to coerce the Pharaoh into giving him what he wants, seeing that he cannot have an Egyptian woman as a wife in return for his own daughter. And in spite of the accusations, the threats and the insults expressed toward the Pharaoh, the

[146] See also: Cohen 1996, 14-5, 25; Zaccagnini 1999, 182.

[147] See also Bryce 2003, 92-4.

[148] See Watson and Wyatt 1999, 621-27. See also the salutation form of the Ugaritic king towards the Pharaoh in letter EA 45 (line 1-2), which is characteristic of a vassal status or at least a king of admittedly lower rank in comparison to the Pharaoh: "[Speak to the king], the sun god,[my lord; the message of ˁAmm]istam[ri, your servant." [*a-na* LUGAL]˹*d*˺UTU-ši [EN-*ia qí-bí-ma*] [*um-ma* *ᴵAm-m*]*i-is-tam*-[*ri* ÌR-*ka*.

latter provided as much gold as the king wanted and inside the time-frame that was required of him.[149]

Until the mid-14th century BC, the Mitanni state was a formidable opponent to Egypt and the only obstacle to its expansion to northern Syria. Yet, during the Amarna period, the state suffered internally as well as externally, and finally subdued by the Hittite power. The Mitanni state was caught between the Hittites on the one side, which continually raided its lands, and Egypt on the other, which was trying to take control of the coastal region.[150] The result was that the newly-formed Mitanni-Egyptian alliance was beneficial for both parties. Egypt would not have to fight for the coastal regions, as the rebels there would not have the support of the Mitanni against Egypt anymore and the Mitanni would have a powerful ally to help them against the Hittites, who were considered equal to the Pharaoh.[151] Thus, during the reign of Amenhotep III there was a cordial relationship between the two states, full of gratitude and in accordance with the norms of reciprocity. This is amply shown in letters EA 17-22. However, from the time of the writing of EA 24 and Amenhotep IV's reign, things change and the Mitanni begin to lose ground. The king desperately tries to reconnect with the Pharaoh and rekindle the good relations between them. Unfortunately for him the Pharaoh does not seem to be interested. The latter had already lost its grip on the northwestern (NW) coastal areas to the Hittites, and signs of the Mitanni state's imminent disintegration have also begun to show.[152] The richness and the variety of the greeting gift sent to the Pharaoh in the last Mitanni letter of the Amarna corpus (EA 29) testifies to the state's losing struggle to hold onto its membership in the "Club of Great Kings". Assyria was the "successor" of the Mitanni kingdom and was regarded as vassal to Babylonia, even though this was most probably not the case.[153] This arising state was trying to find its place among the Great Powers of the Near East. But it was a slow and painstaking procedure and full of setbacks.[154]

The different characteristics of each correspondence and each relationship show us that every king and state benefited from gift-exchanging in its own way. One could claim that the limited correspondence between two equals, namely Egypt and Hatti, offered the simple satisfaction of receiving luxurious gifts and the assurance of amity and peace. Then the

[149] See: EA 1 (lines 54-61); EA 3 (lines 13-22); EA 4 (lines 4-22, 41-50); EA 5. See also Cohen 1996, 17-20.
[150] Harrak 1987, 10-11, 15-9; Cancik-Kirschbaum 2002, 281-83; van de Mieroop 2004, 142-45; Bryce 2005, 116-18, 138, 156-63. See also: Bryan 2000, 71-80, 83-4; Artzi 2000.
[151] This is evident in EA 42 (lines 15-22). Van de Mieroop 2004, 147-48. See also Bryce 2005, 154-89.
[152] See: Harrak 1987, 42-6; van de Mieroop 2004, 143; Bryce 2005, 156-58, 161-63.
[153] See: EA 1 (lines 36-46); EA 9 (lines 31-35). Bryce 2003, 75-6; van de Mieroop 2004, 164.
[154] See: EA 15; EA 16. Harrak 1987, 15-9, 37-42, 47-50, 278-84; Bryce 2003, 75-8; van de Mieroop 2004, 169-71. See also Liverani 1990, 215.

Babylonian-Egyptian relationship seems more co-dependent and antagonistic, than one between really equal powers. The gifts exchanged between them served prestige and power, as well as wealth accumulation purposes.[155] For the Mitanni, exchanging gifts with the Pharaoh and maintaining a good relationship with Egypt meant, above all else, power and glory. And to the Assyrians, a correspondence and the accompanying exchange of gifts with Egypt meant their acknowledgement by the Great Powers of the Near East, it brought them prestige and power and helped them gain status in the international scene, paving their way to becoming a strong empire.

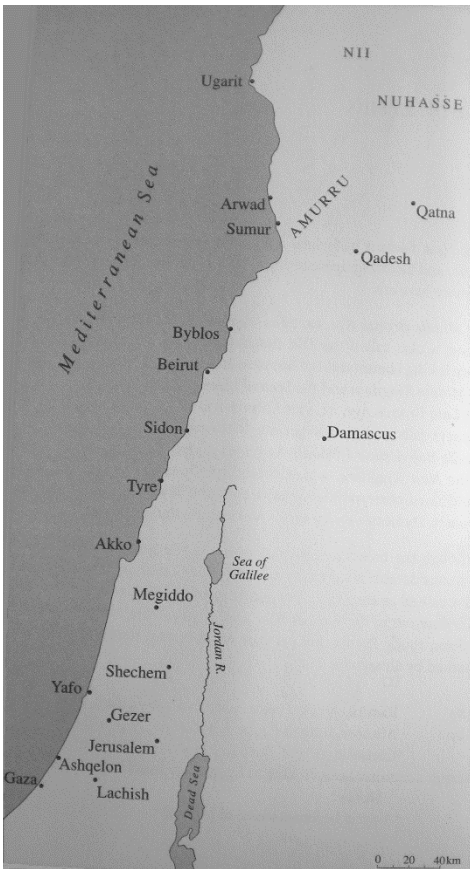

Figure 4. Map of Canaan during the Amarna Period (Cohen and Westbrook 2000, map on page xiv).

In addition, there is the vassal correspondence between the Pharaoh and the rulers of Syria and Palestine. The vast majority of these letters are addressed to the Pharaoh and they contain reports on the current political situation or/and pleas for assistance (military, economic, or otherwise). The few letters sent by the Pharaoh, on the other hand, concern official/political matters, orders, the acquisition of personnel and goods, or arrangements for supplies for the king's troops.[156] Exchanges between "lord" (i.e. the Pharaoh) and "servant" (i.e. the vassal) are

[155] See also Ragionieri 2000, 52.
[156] Moran 1992, xxvi-xxxiii; Mynářová 2015, 159-61.

made according to Polanyi’s redistributive model.[157] This system implies a tributary relationship between partners of unequal rank, which increases the receiver’s prestige, i.e. the Pharaoh’s. This model does not require any counter-offers, if not of an ideological character, and it is enforced by political-military means.[158]

The difference between the international and the vassal correspondence is rather clear and it starts with the letters’ preambles. Even the salutations of the rulers towards the Pharaoh are meant to show subordination and inferiority in front of the Pharaoh’s greatness.[159] Then there is the matter of the tribute. In the vassal correspondence there are only a few instances where the preparation of and a (payment of) tribute were mentioned but, still, they align with the vassal status of these city-states: Aziru of Amurru wrote “Now I am preparing all the requests of the king, my lord, and whatever comes forth [f]rom the mouth of the ki[ng], m[y] lord, [my god, my sun god, I will prepare”[160] and “O k]ing, my lord, send [with] all haste [your envoy wi]th [my] envoy, [and] the tribute of the king, my lord, will I deliver”[161]; Labʾayu of Sechem said “I have not withheld my tribute”,[162] while ʿAbdi-Ḫeba of Jerusalem wrote that “a bringer of the king’s tribute am I”.[163] Furthermore, what the vassal rulers asked from the Pharaoh, their suzerain, were troops and provisions to withstand enemy assaults and protect their cities, and thus their lord’s land and property.[164] Moreover, contrary to the non-utterance of the term “price” in the letters of the kings to one another, in the vassal correspondence the phrase “as payment” (*i-na na-da-ni*) is very common.[165] The sole text referring to “the price” (SÀM)[166] (not the “bride price” (*terḫatu*),[167] which appears in much of the international correspondence) is EA 369, where the Pharaoh says: “Total: 40 female cupbearers, 40 (shekels

[157] Zaccagnini 1973, 125; 1983, 219.
[158] Liverani 1979a, 11; 1994, 13-8, 57-8, 191-92. See also Moran 2003.
[159] See Mynářová 2007, 183-84.
[160] EA 160 (lines 9-13): *a-nu-um-ma gáb-bi mé-re-eš*$_{15}$*-te*^{MEŠ} *ša* LUGAL EN-*ia ú-še-eš-še-er ù ša it-ta-aṣ-ṣí* [*i*]*š-tu* UZU.KA *pí-i* LU[GAL] ˹EN˺-˹*ia*˺ *ú-še-eš-še-er*. See also EA 325 (lines 15-22).
[161] EA 160 (lines 41-44): *š*]*àr-ru* EN-*ia* [LÚ.DUMU.KIN-*ri-ka*?] [*it-*]*ti* LÚ.DUMU.KIN-[*ri-ia*?] [*i-na*] *ḫa-mut-iš uš-še-ra-am* [*ù*]*bi-il-ta-šu ša* LUGAL EN-*ia ú-ba*[*l*]; Knudtzon (1915, 621) and Moran (1992, 246) translate “*he* will deliver” instead of “I”.
[162] EA 254 (line 13): *la-a a-kal-li* GÚ.UN.ḪI.A-*ia*; Moran (1992, 307) translates “I have not held back my payments of tribute”.
[163] EA 288 (line 12): *ú-bi-il* GUN *šàr-ri a-na-ku*. Note that the Akkadian word for “tribute” is *biltu*, log. GUN, denoting “load” and “talent” (the weight unit) (CAD B, 229-36).
[164] See Mynářová 2015, 159-61.
[165] See, for example, EA 74 (line 16), EA 85 (line 14), EA 101 (line 9) and EA 107 (line 37). CAD N(1), 42-3: *nadānu* (*tadānu*) = verb meaning “to give”, “to make a payment”, “to offer a gift, a sacrifice”, “to grant a share”, “to transfer persons, valuables, real estate in legislative and economic contexts” (with *ana*), “to sell” (with *ana kaspi*, *ana šīmi*, *ana maḫara*), among others.
[166] CAD Š(3), 20, 25-6: *šīmu*, logographically written and ŠÀM = subject meaning “price” (paid or fetched), “proceeds of a sale”, “value”.
[167] CAD T, 350, 352-3: *terḫatu*, logographically written and NÍG.SAL.ÚS(.A) = subject meaning “dowry”, “bridal gift”.

of) silver being the price of a female cupbearer".[168] Contrary to the letters exchanged between Great Kings, where gifts were evaluated and had to be compensated with an equally valuable gift without any price mentioned or put on them, as this process would have been done privately, in the vassal correspondence, where there were no formal courtesies, such common language was allowed.

2.3.2 Trade

Up until now we have referred to all the Great Kings of the Near East but one, the king of Alašiya. Despite the fact that Alašiya did not seem to be a great military power, it was a member of the Great Powers of the LBA Near East, because of its control of an economically and militarily significant material, namely copper. Despite the fact that the letters' preambles, the phraseology used and the occasional exchange of greeting gifts between "brothers" point toward a diplomatic correspondence, such as the one described above between the Pharaoh and the Great Kings of the Near East, the relationship between the Pharaoh and the King of Alašiya seems also, and probably primarily, to involve trade negotiations.[169] Starting with letter EA 34, the king sends an ambassador carrying a considerable amount of copper and makes a rather lengthy and very specific list of items that should be brought to him. He then refers to business agents that should go to him, so that a treaty may be made between the king and the Pharaoh, which will include the continuous exchange of envoys. At this point, it is important to note that the word used for the business agents is the Akkadian word *tamkārum*, already seen in OA trade letters.[170] This alone is indicative of the business relation being formed between them. Another significant difference from the "traditional" diplomatic correspondence seen thus far, apart from the request for very specific items and not generally "much gold", is the request for silver, the metal which was widely used as currency in the LBA Near East and which is never asked for between the Great Kings. Additionally, not only did the Great Kings never ask for silver, but they also never uttered the term "price". Of course, all gifts received underwent a process of evaluation, but their value was never (verbally) attached to a price, as this would lower the character of the exchanges to that of mercantile relations, which is exactly what applies in the case with Alašiya.[171]

[168] EA 369 (lines 13-14): ŠU.NIGIN-*ma* MUNUS.DÉ 40 40 ˹KÙ˺.BABBAR ŠÁM MUNUS.DÉ.MEŠ.
[169] See also: Liverani 1979b, 27-9; Gestoso Singer 2011, 261; Kassianidou 2013, 137.
[170] EA 34 (lines 16-25, 39-40, 42-46).
[171] Zaccagnini 1973, 79-80, 120; 1983, 220-21. See also Peyronel 2014, 359-60.

What is more, letter EA 35 presents a great example of trade negotiations.[172] In order to better demonstrate this, Liverani referred to the negotiation of the Theban envoy Wen-Amun with Zakar-Baʿal, the king of Byblos in the 11th century BC. The key point of the negotiations was the "refusal" to give what was asked for, due to some problem or other, but instead to offer a small amount, a sample of proof of availability, quality, etc. as an incentive for due payment. This move of holding the goods back had the purpose of stimulating an in-advance payment and allowed bargaining for higher price.[173] In the case of the king of Alašiya, he evoked the "hand of Nergal" for not sending an adequate amount of copper or the amount that was requested. This was a plague, which has killed the copper workers. He then goes on saying: "Send your envoy with my envoy quickly and whatever copper that you request, my brother, I will send it to you".[174] This passage carries two points of interest: first, there is the explicit reference to copper as the commodity that the Pharaoh needs and, second, there is the matter of the detained envoy, which is one of the things that the king asked to be sent to him. The rest of the letter is a list of the matters that the king needs resolved, before he sends the copper to the Pharaoh: he mentions silver, certain requested items and payment for the lumber delivered. He writes: "so, my brother, [pay] the sums that are due".[175] Regarding the matter of the detained envoys, the king appears to have also detained for years one of the Pharaoh's envoys and it seems like he was holding him as another bargaining chip against the Pharaoh. Letter EA 35 ends with a reminder of what the king requested, but not before he said: "Now, my brother, send your envoy with my envoy safely and quickly and I will send my brother's greeting gift."[176] This is a straight *quid pro quo* situation: return my envoy, which will carry the requested items, i.e. the payment, and I will send you your gift, meaning the shipment of copper requested. Therefore, the conclusion that can be drawn from the Alašiyan letters is that there a power-play seems to have been conducted between the king and the Pharaoh. They both detained envoys and shipments, until they got what they wanted, depending on who was the more in need.

Moreover, the Alašiyan letters document merchants, operating under the auspices of the King:[177]

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[172] Liverani 1990, 247-51.
[173] Liverani 1990, 250. See also Liverani 2000, 24.
[174] EA 35 (lines 16-18): LÚ.DUMU.KIN-*ka it-ti* LÚ.DUMU.KIN-*ia ar-ḫi-iš uš-še-er ù mi-nu-um-me* URUDU *ša te-ri-iš-šu* ŠEŠ-*ia ù a-na-ku ul-te-bi-la-ak-ku*. See also Liverani 2000, 25.
[175] EA 35 (line 29): *ù* ŠEŠ-*ia* ŠÀM.MEŠ *ši-[mi i-din]*. EA 35 (lines 16-29). Zaccagnini (2000, 146) further notes that when the Alašiyan king asks for "silver", he means the "price", the equivalent of what he has offered.
[176] EA 35 (lines 39-42): *i-na-an-na* ŠEŠ-*ia* LÚ.DUMU.KIN-*ka it-ti* LÚ˺.˹DUMU˺.KIN-*ia na-aṣ-ri-iš ar-ḫi-iš uš-še-er ù šu-ul-ma-na ša* ŠEŠ-*ia ul-te-bi-la-ak-ku*.
[177] Zaccagnini 1973, 119, 124; Liverani 2003, 121-22.

> My brother, as for my messengers send them quickly and safely so that I may hear of your welfare. These men are my merchants. My brother, send them safely (and) quick[l]y. As for my merchant(s) (and) my ship, may your customs' inspector not draw near to them.[178]

Such merchants existed in other courts as well, e.g. in Babylonia: "Now, my merchants who had set out with Aḫu-ṭābu, were detained in the land of Canaan on business matters."[179] But their presence is rarely and barely noticed in the international correspondence among Great Kings.[180]

2.4 Discussion

The earliest documentation, of the 2nd millennium BC, chosen for this research is the private archives of the OA merchants at Kaneš, which focus on the trade relations between Aššur and Kaneš in Anatolia. The latest is the 14th century BC Amarna letters, which record primarily the international relations among the Great Kings, as well as between the Pharaoh and his vassals, and secondarily the trade and diplomatic relations between Egypt and Alašiya. These archives, however, are not the only tablet collections that have been unearthed in the Near East. Another important city of the ANE which yielded a notable archive is Mari, situated on the west bank of Euphrates, in Syria. During the reign of king Zimri-Lim (c. 1775-1760 BC), Mari was a prosperous trading centre with a royal archive attesting to its international diplomatic relations with other Near Eastern cities. Indeed, in addition to the wealth of information regarding goods and their prices in Mari, which supplements the information provided by the Kaneš archives, it also testifies to the diplomatic relationships with other cities and kingdoms, the exchange of gifts and the practice of intermarriage as do the Amarna letters.[181]

The Kaneš archives, the letters exchanged between Egypt and Alašiya as well as the tablets concerned with commercial issues from Mari, have a point in common, namely trade. A further common denominator is the use of the terms "money" and "price". The role of

[178] EA 39 (lines 10-20): ŠEŠ-*ia* LÚDUMU.KIN-*ri-ia ḫa-mu-ut-ta na-aṣ-ri-iš uš-še-ra-šu-nu ù iš-mé šu-lu-um-ka* LÚ *an-nu-ú* DAM.GÀR-*ia* ŠEŠ-*ia na-aṣ-ri-iš ḫa-mu-[ut-t]a uš-še-ra-šu-nu* LÚ.DAM.GÀR-*ia* GIŠ.MÁ-*ia* ˹LÚ˺ *pa-qá-ri-ka-ul ia-qá-ar-ri-ib it-ti-šu-nu*.
[179] EA 8 (lines 13-15): *i-na-an-na* DAM.GÀR.MEŠ-*ú-a ša it-ti* ŠEŠ-*ṭa-a-bu te-bu-ú i-na* KUR *Ki-na-aḫ-ḫi a-na ši-ma-a-ti-*˹*ta*˺*-ak-lu-ú*. See also EA 11 (lines 6-12).
[180] Zaccagnini 1973, 124.
[181] Michel 1996, 397; Lafont 2001, 289-93, 315-20; van de Mieroop 2004, 96-7; Liverani 2014, 229; Peyronel 2014, 365.

currency during the OA as well as the Amarna periods was assumed primarily by silver and secondarily gold.[182] Silver was used by the OA merchants in Aššur to buy tin and textiles and was mentioned in the vassal correspondence of the Amarna archive. When not referring to silver artefacts, the word always had an economic/monetary character. Whenever we read about "money" in the Amarna letters, the original text records the Akkadian word for silver, KÙ.BABBAR in singular or KÙ.BABBAR.MEŠ in plural.[183] In the OA letters, silver as "currency" was distinguished from silver as "merchandise". The latter served as a way of acquiring silver, while the former was the ultimate goal of the OA trade.[184] On the other hand, gold was probably used by the OA merchants for the payment of certain traders, regarding specific goods, and was referred to by the Great Kings in the Amarna letters in the context of prestigious offerings or requests for the completion of high-status tasks.[185]

Just as trade is the commercial aspect of the economy, gift exchanging is its political aspect: both time-periods present us with examples of both of these aspects.[186] Kaneš may not provide us with international gift-exchanging evidence, but the synchronous Old Babylonian sources (e.g. from Mari) do. Although diplomatic correspondence in the Old Babylonian period did not entail a specific ceremonial behaviour, as was the case in the LBA and specifically the Amarna period, according to Zaccagnini[187] its structure showed notable similarities.[188]

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182 Liverani 1979b, 30. See also: Polanyi 1968a; van de Mieroop 2014, 17-24; Rahmstorf 2016, 295-96; Massa and Palmisano 2018, 81.

183 MEŠ is a logogram marking plurality (Huehnergard 2011, 534). For example, see: EA 8 (line 27): "pa[y] the money that they took away" KÙ.BABBAR *ša it-ba-lu šu-ul-l[i-im-šu]*; EA 55 (lines 51-52): "As for the money of their ransom, as much as it may be, and I will verily pay the money" *˹lik˺-[šu?-du]-˹ni₇˺ ˹be˺-lí-ia* KÙ.˹BABBAR˺.MEŠ *ip-ṭe₄-re-šu-nu ˹ki˺-˹i˺-me-e ˹šu˺-ú-ut ù lu-ud-din* KÙ.BABBAR.MEŠ; EA 107 (lines 37-38): "There is no silver to pay for horses" *ia-nu* KÙ.BABBAR.MEŠ *a-na na-da-ni a-na* ANŠE.KUR.RA *ga-mi-ir*.

184 See, for example, the following phrases (Balkan 1967, 395): "so that I can do my utmost to earn for them one shekel of silver" TÚG.ḪI.A *lu-šé-bi₄-lu-nim-m[a]* KÙ.BABBAR 1 GÍN *ra-mì-ni lá-ak-bu-ús-ma lu-da-mì-iq=ší-na-tí* [ICK 1, 192 (lines 22-23)], "so that I may make a shekel of silver by selling a *šulupka*-garment" KÙ.BABBAR 1 GÍN *i-na ší-im šu-lu-up-ki-im* [(CCT 2, 26a (lines 16-17)], "According to the order of 'the man' buy the tin and the garments; do the utmost in your power to let him make one or two minas of silver" *ni-nu-ma a-ma-lá té-er-tí a-wi-lim* AN.NA *ú* TÚG^ḪI.A *le-qé-ma* KÙ.BABBAR 1 MA.NA *ú* 2 MA.NA [(kt h/k 347 (lines 10-14)]; Veenhof 1972, 350. For the history of money, see Powell 1978; cf. Peyronel 2010, 926-35. See also Faist 2001, 60.

185 See, for example, letter EA 9 (lines 15-18), where the king of Babylonia says to the Pharaoh: "Now, my work on the god's house is extensive and I am seriously engaged in carrying it out. Send me much gold" *i-na-an-na du-ul-li i-na* É DINGIR *ma-a-ad ù ma-gal ṣa-ab-ta-ku-ú-ma ep-pu-uš* KÙ.GI *ma-a-da šu-bi-la*; in EA 11 (lines Rev. 27-30) he adds: "with utmost has[te] let them bring to me much gold that is yours alone. May they bring [much gold]. By the end of [this very] year I wish to complete my work in a hurry" *ki-I du-lu-uḫ-t[i-iš]* KÙ.GI *ma-ʾa-da at-tu-ka-a-ma li-il-qu-ni* [KÙ.GI ma-ʾa-da] *˹li˺-il-qu-ni a-na ku-ta-al ša-at-ti [an-ni-ti-im-ma] du-ul-li ḫa-mu-ut-ta lu-uk-šu-ud* and letter EA 16 (lines 16-18) where the king says: "I am engaged in building a new palace. Send as much gold as needed for its adornment and its needs" *i-sa-aḫ-ḫu-ur* É.GAL-*la* GIBIL *ú-ka-al i-ip-pu-uš* KÙ.GI *ma-la uḫ-ḫu-zi-ša ù ḫi-še-eḫ-ti-ša šu-bi-la*. See also Zaccagnini 1983, 237-40.

186 Pfälzner 2007, 116.

187 Zaccagnini 1973; 1983.

188 Zaccagnini 1983, 190-94, 251-53, see also pp. 194-98.

Metals during the 2nd millennium BC were on the move from one corner of the ANE to the other, via trade routes and as trade commodities. They were exchanged as gifts, in the form of raw materials, or ready-made artefacts, and were used as modes of exchange and payment, in the form of ingots, pieces of ingots, broken objects, bars, rings or spirals, while silver was used as currency.[189] These two different mechanisms do not cancel each other out, but rather supplement each other in ensuring the distribution of metals throughout the ANE world. In this regard, another point worth mentioning is that, apart from these "official" modes of acquiring and distributing metals, there were also other "unofficial" or even illegal ways. Merchants, during their journeys, passed through small or bigger towns, where they were obliged to pay tolls (in the form of metal). Additionally, merchants as well as messengers travelling from city to city during their weeks-long journeys had to rest, eat and replenish their food and fodder supplies, which required currency. And finally, the road to any destination was not always safe. Thieves lurked by the side of the road, taking whatever they could from these passing messengers and merchants. An example of such events is mentioned in EA 287, sent by the ruler of Jerusalem:

> I have dispatched [a caravan (or: caravans)] to the king, [m]y lord, viz. *x* number of prisoners and five thousand [(shekels) of silver and] eight caravaniers of the king. They were taken in the open territory of the city of (A)yalon. May the king be apprised.[190]

In this way, metals and especially silver and tin were dispersed throughout the land.

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[189] For the use of metals "broken into pieces", rings, etc. as currency, see: Dayton 1974; Powell 1996, 235-38; Gestoso Singer 2011; 2013; 2015; Ialongo *et al*. 2018a.

[190] EA 287 (lines 52-58): *an-ni-ka-nu* [KASKAL.Ḫ]I.A *mu-še-er-ti a-na šàr-ri* EN-[*i*]*a* [*x* L]Ú.MEŠ *a-si-ru* 5 *li-im* [KÙ.BABBAR] [*ù*] 8 LÚ.MEŠ *ù-bi-li-mi* [KA]SKAL.ḪI.A *šà*[*r-ri*] ˹*la*˺-*qí*-˹*ḫu*˺ ˹*i*˺-˹*na*˺ ˹*ú*˺ ˹*ga*˺-*ri* \ *ša-de*$_4$-*e* URU *Ia-lu-na* KI *li-de*$_4$-*mi šàr-ri* EN-*ia la-a a-la-á*ʾ*e*.

3 Analysing the texts

Prior to the analysis of the texts and especially of the weight of the shipments, a reference should be made to the various weight systems existing in the ANE, during the late MBA and the LBA. The most common ANE weight unit was the talent and its subunits, the mina and the shekel. During the OA period some of the units in use were the so-called Mesopotamian, Syrian, and Karkemiš shekels, as well as the "weight of the land", known to the Old Assyrians as *aban mātim*.[191] The same weight units were used during the LBA as well. The Mesopotamian talent comprised 60 minas of 60 shekels, or 3600 shekels, each and each shekel comprised 180 grains. One Mesopotamian talent weighed c. 30.2 kg, one mina about 504 g, and one shekel approximately 8.4 g. The Syrian (later also known as Western, or Ugaritic) talent comprised 60 minas of 50 shekels, or 3000 shekels, each. One Syrian talent weighed c. 28.2 kg, one mina about 470 g and one shekel approximately 9.4 g. The Karkemiš talent comprised 60 minas of 60 shekels (c. 7.8 g), or 3600 shekels, each. The Karkemiš shekel weighed about 7.8 g. Moreover, the later Hittite talent comprised 60 minas of 40 shekels, or 2400 shekels, each. One Hittite mina weighed about 470 g and one shekel approximately 11.75 g. The "weight of the land" was a local Anatolian (probably Kanešite) weight standard, almost exclusively concerned with the inter-Anatolian copper trade.[192] The Anatolian mina was about 10% lighter than a Mesopotamian, weighing about 450 g instead of about 500 g. Merchants had to make conversions from one weight unit to the other in order to complete their businesses. Nevertheless, cases of weights deviating from the standards and so manipulating the weighing procedures were rather common.[193]

The weights that have been found in Kaneš correspond with the Mesopotamian and the Syrian weight units. Unfortunately, the texts do not speak of such differences. They simply denote the weight in talents, minas, shekels and sometimes grains. Even when we are dealing with the inter-Anatolian copper trade, we cannot be sure if the weight unit referred to is the "weight of the land" or not. As there is no way of being sure which weight unit was meant in the Kaneš letters, a concord has to be made to choose one measuring system for all weights

[191] Parise 1984; 1989; Dercksen 1996, 80-9; Pulak 1996, 26-31; Reiter 1997, xlvii; Zaccagnini 2000a; Alberti and Parise 2005, 381-84, Pl. LXXXIIIa-b; Rahmstorf 2006, 16-24. On the *aban mātim*, see: Dercksen 1996, 86-9; Zaccagnini 2000a, 1207-11; AKT 5, 45 note on l. 15'; AKT 6a, 251; FS Garelli 239 = FT4; AKT 5, 46. This is a simplified view (of the use) of the existing weight systems of the Bronze Age Near East. The actual situation is much more complicated as these systems became conflated (Ialongo *et al*. 2018b).

[192] Apart from this Kanešite weight system, there were probably other local Anatolian systems. One example is that of Purušhattum (*aban mātim ša Purušhadim*) (Barjamovic 2011, 376).

[193] See: Zaccagnini 2000a, 1211; Mederos and Lamberg-Karlovsky 2004.

mentioned. Thus, in the following analysis and for the purposes of this research the Mesopotamian system will be followed, with no reference to weight in kilos or grams. This choice can also be supported from the study of the weights found in Kaneš, which have an average weight of 8.257368 g.[194] As Zaccagnini[195] already pointed out, the OA shekel units were centred on two different median values of c. 8.1 g and c. 8.48 g. The latter corresponds to the already known Mesopotamian shekel, while the former can be interpreted as "*an underweight unit of the same Mesopotamian shekel*".[196]

Furthermore, all Amarna letters sent from Near Eastern kings to the Pharaoh include the weight of a shipment in talents, minas and shekels. And most Amarna letters are sent to Egypt from Babylonia, Assyria, Mitanni, Syria, Alašiya and Hatti. Babylonia used the Mesopotamian weight units, while the Upper Mesopotamian kingdoms of Assyria and Mitanni most probably used the Syrian units.[197] In Cyprus, archaeologists have found weights of all the known weight systems of the ANE.[198] As Alberti and Parise[199] rightly put it: "*This composite pattern is not a surprise, due to the geographical position of the island and its importance in the Mediterranean trade system of the period.*" Finally, the Hittites probably used their own Hittite shekel.

The only exception here is presented in letter EA 369. This is a letter sent from the Pharaoh to Milkilu, the ruler of Gezer. In this letter the Pharaoh places an order for female cupbearers and the price he offers is recorded in deben, the Egyptian *dbn*. The passage is translated as follows:[200]

> Total: one hundred and sixty *diban*.
> Total: 40 female cupbearers.
> Forty (shekels of) silver is the price of a female cupbearer.[201]

while the original Akkadian text writes:

> ŠU.NIGIN-*ma ša* 1 *me šu-ši ṭì-ba-an*
> ŠU.NIGIN-*ma* MUNUS.DÉ 40
> 40 ˹KÙ˺.BABBAR ŠÁM MUNUS.DÉ.MEŠ

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[194] Özgüç 1986, 78-81; Dercksen 1996, 80, Appendix 5; Massa and Palmisano 2018, 68-9, figs. 3-4, table 4.
[195] Zaccagnini 2000a, 1204.
[196] Zaccagnini 2000a, 1204.
[197] Pulak 1996, 31.
[198] Petruso 1984; Alberti and Parise 2005, 384-85.
[199] Alberti and Parise 2005, 385.
[200] Rainey 1970, 37; Moran 1992, 366; Rainey 2015, 1251.
[201] EA 369 (lines 12-14).

In the original Akkadian text, the word for "shekel" GÍN in the last line of the cited passage is absent. This was later added by the editor of the text in order to make it more understandable. Based on the reading of "*diban*" in line 12, Moran[202] concluded that "*the shekel here (10 shekels = 1 dbn) is not the Babylonian shekel (8.416 g) but the slightly heavier Syrian one (ca. 9 g)*". During the New Kingdom in Egypt, a deben (*dbn*) comprised 10 qedet (*qdt*) of about 9.1-9.8 g, corresponding to the Syrian shekel.[203] But as right as Moran's logic might be, we cannot agree with this addition and translation. An observed rule generally followed in most, if not all, tablets is that the same weight unit is referred to in the entirety of a tablet, unless a different one is specifically mentioned. This is in the frame of the consistency that is required in cuneiform tablets and will be mentioned again further below. Thus, since the total value stated in line 12 was measured in deben and the total price of the female cupbearers in line 14 does not mention any weight unit, then the same weight unit as in line 12 should also be understood. According to the aforementioned rule, letter EA 369 discusses amounts of silver measured in debens. In support of this opinion is a statement made by Pulak,[204] which mentions that "*the qedet was by far the most commonly used standard in Egypt and the basis for nearly all expressions of weight from the Eighteenth Dynasty onward*". So, it would be better to replace the phrase "shekels of" with "qedets of" and thus have a more homogenous text.

In conclusion, the most commonly used weight unit and the most probable one to have been used by the Pharaohs of Egypt is the Syrian one. For this reason, this system will be used in the analysis of the Amarna letters; all other units have to be converted to it. In this view, if we assume that the Babylonian shipments were measured according to the Mesopotamian system, a conversion to the Syrian standard has to be made. For this purpose, the total amount of each Babylonian shipment recorded in Mesopotamian shekels was accordingly multiplied by 0.9.[205] This number is the quotient of 8.4/9.4, equivalent to the weight of the Mesopotamian shekel divided by the weight of the Syrian shekel. The resulting number was then rounded off to one decimal digit.[206] EA 41 is a Hittite letter and the only one that records an amount of silver; due to the equivalency of the Hittite and the Syrian minas, a conversion is here unnecessary.[207]

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[202] Moran 1992, 366 n. 3.

[203] Parise 1984, 127; Parise (1989, 334-37) refers to a qedet of 9.33 g, 9.44 g and 9.78 g; Pulak (1996, 32) gives a 93 g weight for the deben and a qedet mass range from 8.97g to 9.86 g; Mederos and Lamberg-Karlovsky (2004, 202, chart 1) refer to a gold deden of 12.83 g and a qedet of 9.4 g; Rahmstorf 2006, 13-8. See also Castle 2000, 42-105.

[204] Pulak 1996, 32.

[205] The exact number was 0.893617021276595744680851063829 79.

[206] Amounts of gold in EA 2, EA 3, EA 7, EA 9 and EA 10.

[207] Otten 1954-56; Parise 1984, 127-29; de Roos 2008, 2.

3.1 Metals in the Old Assyrian texts

3.1.1 Transport

The archives found in the lower town of Kaneš presently total approximately 23,500 tablets, of which only about 20% or less have been edited. For the purposes of this study, a total of 937 tablets have been analysed.[208] The texts that have been selected predominantly document: a) trade or inter-regional exchange, b) a variety or toponym/provenance of a metal, and c) some kind of metal treatment. Moreover, texts mentioning one of the words that have been associated with the metal iron are also included. **Appendix 1** is a detailed catalogue of the tablets used in this research, accompanied by bibliographical reference(s), excavation number, museum collection number and CDLI number.

The accumulated information for the tablets from Kaneš serves a dual purpose. First, it allows us to track the movements of the exchanged metals, as well as their respective amounts. Second, it provides a record of the existing, exchanged and preferred varieties of metals. As far as the first function of the Kaneš texts is considered, prior studies have already demonstrated the metal exchange routes of the OA period from Aššur to Kaneš and from there further into Anatolia.[209] In addition, Barjamovic[210] recently built on those studies and comprehensively recreated the vast network of trade settlements, colonies and stations used by the OA traders. This analytical work gives us the ability to better understand and visualise the paths followed from Aššur to Kaneš and inside Anatolia.

In the frame of this research, the process of tracking the trade-related movements of the metals helps us to appreciate the reason(s) of transfer and circulation. For this purpose, tables presenting the starting point and destination, along with the number of references and the exact texts in which these can be found, have been drawn up. Starting points and destinations are arranged according to geographical location along the assumed path that each metal followed. For instance, gold is presumably following a west-to-east inter-Anatolian movement, heading to Kaneš and then directed on to Aššur. As a result, the initial west-to-east and then north-to-

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[208] Michel 2003, v-vii; Michel 2014, 69. Texts that were published only in Turkish, were not included. By the time of the submission of my Dissertation, three more volumes of the AKT series were published (one in English and two in Turkish), but there was no time to analyse and incorporate these texts.
[209] Garelli 1963; Larsen 1967, 3-7; 1976, 86-92, 227-46; Veenhof 1995, 862-64; Brisch and Bartl 1995, 135-36; Dercksen 2004b; Veenhof 2008, 62-90. See also Veenhof 1972.
[210] More information and bibliography regarding the geography of Anatolia during the OA period can be found in Barjamovic 2011. See also **Figure 39**.

south axes are followed in listing the places of origin and likewise destinations. Furthermore, the principal travel path in each table is highlighted with a dark grey colour, while a lighter grey colour points to a noteworthy secondary one.

More often than not correspondents omitted to mention the name of the place from which the caravan started its journey and its exact destination. For this reason, in creating the above-mentioned tables certain concessions had to be made. Based on the context of a text transporting tin and textiles, we could infer whether the goods were sent from Aššur to Anatolia. It is assumed that tin was dispatched from Aššur to Kaneš. Several texts document shipments being sent directly to other trade stations or colonies, as for example Purušhattum.[211] Merchants used Kaneš only as a base of operations, from where they would venture out all across Anatolia. In cases when we are uncertain about the provenance of a shipment but we know, or we can presume, that this was Kaneš, a single starting point has been created for the following tables, with the name "Kaneš/Anatolia".

The second step of the examination comprises a calculation of the total, the average (or mean value) and the mode (the value that appears most often in the dataset) values of the recorded amounts of each metal. Subsequently, further and more specific calculations supplement the analysis. All recorded amounts and their mean value are presented on their corresponding scatter charts. This type of charts offers the ability to present the spread of the recorded amounts transported and to detect possible clusters and/or unique points. The vertical axis of the charts shows the weight unit used, while the horizontal one represents the individual shipments recorded.

The third step was to address the issue of the specific varieties mentioned in the OA texts. Metals were regularly accompanied by a word or a phrase that gave more information about them. Features recorded are the quality, colour, form, state, or possible treatment. Since transcription and further translations of the texts began, many scholars with a unique perception and understanding of each Akkadian term have been involved. This resulted in multiple translations of the same Akkadian word or phrase. For this reason, an effort to define the (closest possible to the) proper meaning of the Akkadian terms was here made. A good example is the term *damqum*, often written with the logogram SIG_5. This has been translated as "good", "of good quality", "fine" or "refined". The CAD[212] translates it as "of good quality, in good condition", further referring to the verb *damāqu* which translates as "to improve". This is an

[211] For example, see BIN 4, 24. See also Barjamovic 2011, 357-78.
[212] CAD D, 68. See also CAD D, 61.

example of the polysemy of (any) language. In order to avoid misunderstandings and misinterpretations, when we are dealing with varieties of metals that have controversial translations the original Akkadian word is used. In addition, in the case of an Akkadian word/phrase accompanied by a translation in quotation marks, this translation is the proper one and not that which better describes the word's or phrase's meaning.

An examination of the language *per se* is outside the scope of this research. Instead, a list of the varieties of metal found in the texts has been compiled in **Appendix 4**. Moreover, a statistical analysis of the references to these varieties and the references that are connected with a transport has been done. The relevant tables have been drawn up. These include the following fields: 1) the variety of the metal described with its original Akkadian word or phrase and its corresponding translation in English,[213] 2) the number of tablets that refer to each of these varieties (Variety References, VR), 3) the number of the recorded references to a transport of these varieties (Variety Transports, VT), 4) the percentage of each variety being transported (VT/VR %), 5) the percentage of each variety's transport references in comparison to the sum of the transport references related to the varieties of the relative metal (VT %), and 6) the percentage of each variety's transport references compared with the total number of transports (TT) recorded for the relative metal (VT/TT %).

3.1.1.1 Gold

Gold represents a valuable and much desired medium of exchange for the Old Assyrians. This is supported by the information presented in **Table 1** and further statistical analysis of these data. Approximately 73% of the references (n = 77) mention or imply Aššur as the final destination of gold. Moreover, this metal is first brought to Kaneš, in order to be transported to Aššur. About 14% of the references record Kaneš as a destination point.

Apart from the places listed in **Table 1**, there are several additional secondary or tertiary movements that include one or more unspecified locations. These are a) one reference from Purušhattum to an unspecified location,[214] b) one reference from Durhumit to an unspecified location,[215] c) three references from Anatolia to an unspecified location,[216] d) one reference

[213] For reasons of ease and consistency, when the translation is in another language, then this is put into English.
[214] AKT 6c, 636.
[215] OAA 1, 78.
[216] AKT 6a, 203; TC 2, 29; TPAK 1, 58.

probably from Kaneš to an unspecified location,[217] e) one reference from an unspecified location probably to Kaneš[218] and f) three references from and to unspecified locations.[219]

Table 1. Transport of gold in the OA texts.

From	To	References	
Wahšušana	(probably) Kaneš	2	CCT 3, 332; MNK 635
Durhumit	(probably) Kaneš	1	AKT 6a, 285
Purušhattum	(probably) Kaneš	1	kt c/k 257
Marithum	(probably) Kaneš	1	AKT 6c, 617
Anatolia	(probably) Kaneš	5	CCT 6, 46c; kt c/k 263; RA 81, 1; TPAK 1, 20; TPAK 1, 21a
Kaneš/Anatolia	Timelkia	1	TMH 1, 24e
Kaneš/Anatolia	Hahhum	1	AKT 6a, 3
Kaneš/Anatolia	Sirmiya	1	KTP 6
Kaneš/Anatolia	Aššur	51[220]	
Šalatuwar	probably Aššur	1	VS 26, 29
Katila	probably Aššur	1	AKT 6b, 337b

The total amount of gold being transported is 68 minas 1 ¾ shekels 98 ½ grains. Roughly 70% of this amount (c. 47 minas 23 ½ shekels) is moving towards Aššur. And in fact, almost three out of four times, Aššur is its final destination.[221] Single amounts range from 1 shekel to 6 minas 18 shekels, the mean is c. 49.2 shekels and the most frequently transported amount of gold is 60 shekels, which equals 1 mina. **Chart 1** shows all recorded amounts of gold being transported at an inter-regional level and the red line signifies the mean value. Three distinctive high points are displayed on the chart: The highest one belongs to a transport towards Kaneš and equals 6 minas 18 shekels (CCT 6, 46b), while the second and third ones

[217] AKT 3, 93.
[218] BIN 4, 66.
[219] CCT 3, 24; RA 81, 21; TPAK 1, 141.
[220] AKT 3, 64; AKT3, 72; AKT 3, 73; AKT 3, 90; AKT 5, 51; AKT 6a, 166; AKT 6b, 303; AKT 6b, 336; AKT 6b, 362; AKT 6c, 647; AKT 6c, 684; Anatolica, 12, 138f.; ATHE 18; BIN 4, 122; BIN 4, 194; BIN 4, 30; BIN 4, 88; BIN 6, 31; BIN 6, 65; BIN 6, 75; BIN 6, 90; CCT 1, 14a; CCT 1, 16a; CCT 1, 21b; CCT 2, 32a; CCT 3, 18a; CCT 3, 22a; CCT 4, 6f; CCT 5, 41a; CCT 5, 41b; CMK 151; FlorAn 121; ICK 1, 167; ICK 2, 85; ICK 2, 87; KTS 1, 52c; KTS 1, 53a; KTS 2, 40; KUG 16; KUG 5; Ichisar, Imdilum 413ff.; RA 59, 29 no. 8; RA 59, 172 no. 32; RA 59, 40 no. 12; RA 81, 7; TC 2, 54; TC 3, 210; TC 3, 36; TC 3, 43; TC 3, 72; TPAK 1, 40.
[221] Aššur can also be the final destination of a caravan from Anatolia/Kaneš to Timelkia, Hahhum and Sirmiya.

are heading to Aššur and amount to 5 minas (TC 3, 72) and 4 minas (BIN 6, 75), respectively. Further support to the claim that gold is first accumulated in Kaneš to be finally sent to Aššur is provided by the fact that this *locus* is the final destination of the highest, by far, recorded amount of gold being transported.

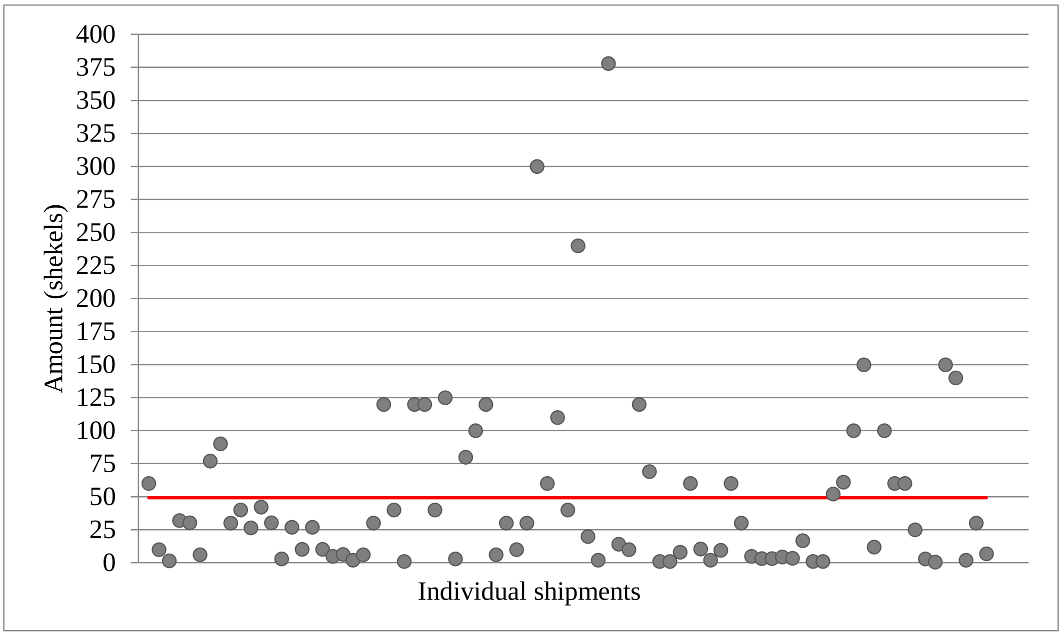

Chart 1. Amounts of transported gold in the OA texts.

Table 2 presents the terms that are used to qualify gold in the texts. In total, 73 tablets record a variety of this metal. An important observation is that only 32.5% of all the transport references (TT) mention a specific variety of gold, while 25 out of a total of 87 variety references (i.e. about 29%) were involved in a transport. The most often mentioned variety is *pašallum* gold, followed by gold "of its stone", "good", *kuburšinnum* and "*pašallum* of very good quality". As far as transports are concerned, many of the same varieties that are mostly mentioned appear, but gold "of its stone" is not accordingly represented in this category. The latter variety, along with "*pašallum* of very good quality" and "*pašallum* of its stone" have the fewest variety transports. *Pašallum* gold seems to have been exchanged more often, registering a VT/VR percentage of 38.5%. Compared to the number of the TT, however, only 13% of this variety is being shipped. Moreover, *kiššum, "good kuburšinnum*", *liqtum*, "of very good quality", "white", "red", "good blood-coloured", "boiled", "of its water" and gold "of the sea"[222] do not appear to be sent anywhere. The first of the aforementioned varieties, i.e. *kiššum*

[222] Reiter (1997, 17) mentions "gold of the sea", which is written as GUŠKIN *ša ti'āmtim* (TC 1, 104), along with gold "ore", written as GUŠKIN *ša abnišu,* literally translating into "gold of its stone".

gold, is mentioned thrice and is involved in debt payments.[223] "White" gold was traded for silver in KTS 1, 52b and in FS Matouš 2, 125 Itūr-ilī told Ennam-Aššur not to involve himself with any of it, saying "You must know that there is a lot of white gold here!"[224] Finally, according to kt c/k 48, 8 ½ or 9 shekels of silver are exchanged for each shekel of "red gold of good quality" and according to kt c/k 257, 6 shekels of silver are exchanged for each shekel of *kuburšinnum* gold.[225]

Presenting and examining the transported amounts of each variety of gold in a pie chart (**Chart 2**) confirms these observations. The order of the number of references of each variety is the same as the order in which the transported amounts of these varieties appear in the chart. Once again *pašallum* gold takes up the largest part. However, this is just 20.9% of the entirety, meaning that only about 1/5 of the total transported amount of gold was of this variety. The amount of *pašallum* gold in comparison to the total amount of transported gold may not be great, but it is considerable. This can be better realised and evaluated in **Chart 3**. It is noteworthy that this type of gold appears to have been the most favoured and it was transported in individual shipments weighing between 5 shekels and 2 ½ minas (150 shekels), which can be placed in the most populated area of the scatter chart (**Chart 1**). This reveals a considerable association between *pašallum* and simple gold, as regards trade transactions.

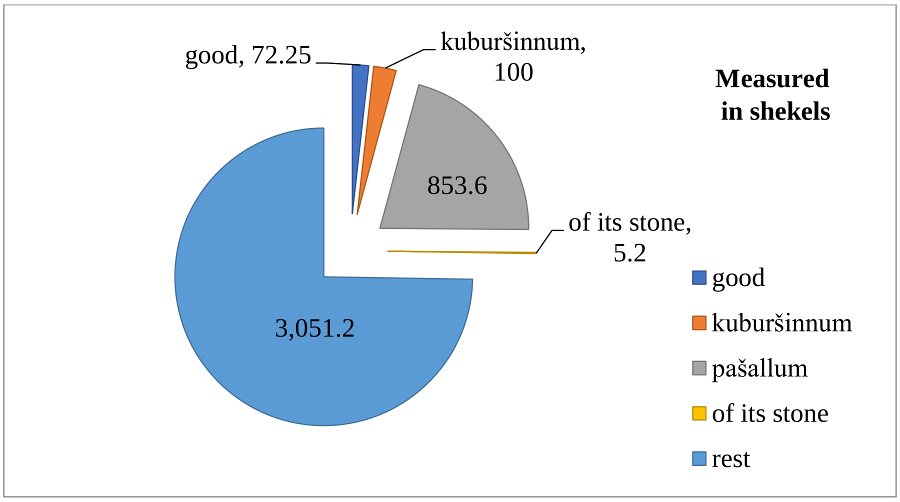

Chart 2. Transported amounts of all varieties of gold in the OA texts.

[223] AKT 5, 16.
[224] Larsen 1978, 114-15. FS Matouš 2, 125 (lines 26-27): *lá tí-de$_8$-e ki-ma a-na-kam pu-ṣí-ù ma-du-ú-ni*.
[225] Balkan 1965, 151. See also Garelli 1963, 268-69.

Table 2. Varieties of gold compared to transports in the OA texts.

Gold (KÙ.GI/KÙ.SIG$_7$/*ḫurāṣum*)					
Variety	**VR**	**VT**	**VT/VR%**	**VT%**	**VT/TT%**
SIG$_5$/*damqum* "good"	10	3	30	12	3.9
SIG$_5$ DIRI / *damqum watrum* "very good"	2	-	-	-	-
HUŠ.A "red"	1	-	-	-	-
HUŠ.A SIG$_5$ "red of good quality"	1	-	-	-	-
kiššum	2	-	-	-	-
kiššum SIG$_5$ *"kiššum* of good quality"	1	-	-	-	-
kuburšinnum	8	3	37.5	12	3.9
SIG$_5$ *kuburšinnum* "good quality *kuburšinnum*"	1	-	-	-	-
liqtum	1	-	-	-	-
pašallum	26	10	38.5	40	13
pašallum SIG$_5$ "*pašallum of* good quality"	4	4	100	16	5.2
pašallum SIG$_5$ DIRI / *damqum watrum* / DIRIG "*pašallum* of very good quality"	8	2	25	8	2.6
pašallum ša abnišu "*pašallum* of its stone"	1	1	100	4	1.3
puṣium "white"	2	-	-	-	-
ša abnišu "of its stone"	11	2	18.2	8	2.6
SIG$_5$ *ša abnišu* "good (quality) of its stone"	1	-	-	-	-
ša šabšulim "that has been boiled"	1	-	-	-	-
SIG$_5$ *ša damu* "good quality blood-coloured"	1	-	-	-	-
ša mā'ešu "of its water"	2	-	-	-	-
sa'amum "red"	1	-	-	-	-
sa'amum ša šabšulim "red that has been boiled"	1	-	-	-	-
ša tiāmtim "of the sea"	1	-	-	-	-
Sum	87	25	28.7	100	32.5
Total transports	-	77	-	-	100

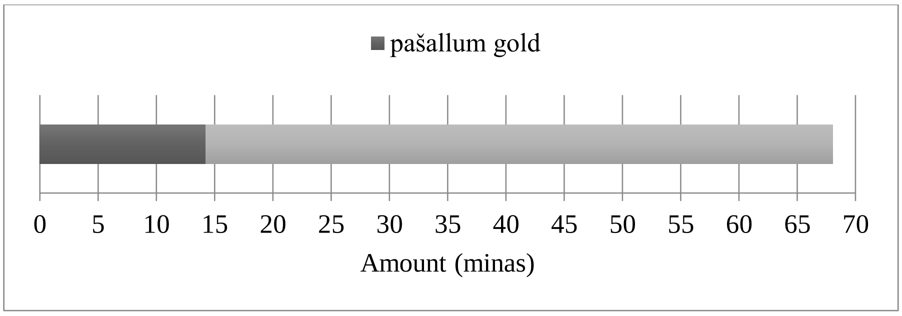

Chart 3. Comparison between the amounts of *pašallum* and the rest of the transported gold in the OA texts.

3.1.1.2 Silver

Silver was a valuable and widely used metal. In its OA contexts, it was collected to be used mostly for payments and purchases of any possible kind. It only rarely occurs as a commodity, but it is traded for tin and other imported and local goods in Aššur. Transport of silver occurs 309 times in 298 tablets. First stop on its way to Aššur was again Kaneš. A somewhat similar percentage of silver to that of gold being forwarded to Kaneš, i.e. about 14%, was also sent from somewhere in Anatolia to Kaneš. Moreover, from Kaneš it would be circulated within Anatolia as well, as for instance in Durhumit or Purušhattum, to serve as money. Most often, though, it was shipped to Aššur, making stops to one of the cities on the southern route (e.g. Hurama, Timelkia, Hahhum, Zalpa, Uršu or Nihriya). These observations can be seen in **Table 3**.

In addition to the shipments included in **Table 3**, there are several others that were not chosen to be presented in the table, because they involved unspecified, vague (as for example "Inner Land") and unknown locations (as for example ZU-ni) or due to their tertiary importance. This pattern of non-inclusion will be followed for all tables of this kind in the analysis. The additional references to shipments of silver are a) eight from and to Anatolia,[226] b) one from Šalatuwar to the "Inner Land",[227] c) four probably from Kaneš further into Anatolia,[228] d) one from Kaneš to an unspecified location,[229] e) one from Purušhattum to Anatolia,[230] f) two from Purušhattum to an unspecified location,[231] g) two from Durhumit to

[226] AKT 6b, 399; AKT 6c, 570; AKT 6c, 677; CCT 1, 36a; FS Sachs 33ff.; FS Garelli 239 = FT4; TC 2, 62; VS 26, 69.
[227] AKT 3, 45.
[228] AKT 6b, 483; CCT 2, 26b; RA 59, 25 no. 5; TPAK 1, 21a.
[229] ATHE 28.
[230] AKT 6c, 671.
[231] AKT 6c, 636; TC 2, 58.

an unspecified location,[232] h) one from Marithum probably to Kaneš,[233] i) one from an unspecified location to Sana,[234] j) one from Anatolia to Sana,[235] k) one from ZU-ni to Sana,[236] l) one from Ta'išama to Sana,[237] m) three from an unspecified location to Anatolia,[238] n) one from the "Heartland" to Anatolia,[239] o) one from Katila, probably to Aššur,[240] p) 11 from Anatolia to an unspecified location[241] and q) six to and from an unspecified location.[242]

Table 3. Transport of silver in the OA texts.

From	To	References	
Purušhattum	Kaneš	4	AKT 3, 90; AKT 6a, 173; BIN 4, 149; CCT 1, 31b
Wahšušana	Kaneš	3	CCT 3, 33a; CCT 5, 37a; kt m/k 71
Šalatuwar	Kaneš	2	AKT 6c, 599; KTS 1, 55a
Durhumit	Kaneš	1	AKT 6a, 285
Hanaknak	Kaneš	1	AKT 6b, 336
Anatolia	Kaneš	26[243]	
Kaneš/Anatolia	Durhumit	1	AKT 6b, 348
Kaneš/Anatolia	Nihriya	1	AnOr 6, 15
Kaneš/Anatolia	Ushania	1	OIP 27, 54
Kaneš/Anatolia	Sirmiya	1	KTP 6
Kaneš/Anatolia	Hurama	2	AKT 6c, 537; AKT 6c, 563
Kaneš/Anatolia	Timelkia	1	TMH 1, 24e
Kaneš/Anatolia	Hahhum	1	AKT 6a, 3
Kaneš/Anatolia	Zalpa	2	CCT 1, 38a; RA 58, 64 Sch. 8
Kaneš/Anatolia	Uršu	1	BIN 4, 148
Kaneš/Anatolia	Aššur	194[244]	

[232] Two transports in OAA 1, 78.
[233] AKT 6c, 617.
[234] KUG 26.
[235] RA 59, 40 no. 16.
[236] KUG 26.
[237] KUG 26.
[238] BIN 4, 51; ICK 1, 82; RA 59, 172 no. 32.
[239] AKT 6c, 642.
[240] AKT 6b, 337b.
[241] AKT 6a, 203; AKT 6b, 301; AKT 6c, 642; BIN 4, 204; BIN 4, 217; CCT 1, 36c; CCT 5, 40a; ICK 1, 55; ICK 1, 179; ICK 2, 104a; RA 58, 66 Sch. 11.
[242] Belleten 40, 182; BIN 4, 50; BIN 4, 226; RA 81, 21; TPAK 1, 141; TPAK 1, 142.
[243] AKT 3, 313; AKT 6a, 128; AKT 6b, 340; AKT 6b, 438; AKT 6b, 446; AKT 6c, 577; AKT 6c, 592; AKT 6c, 631; AKT 6c, 649; AKT 6c, 652; AKT 6c, 689; BIN 4, 52; CCT 2, 37b; CCT 3, 17b; CCT 6, 46b; FS Larsen 179; ICK 1, 82; KTS 1, 9b; RA 59, 25 no. 6; RA 81, 1; TC 3, 46; TPAK 1, 20; TPAK 1, 21a; TPAK 1, 35; VS 26, 127; VS 26, 69.
[244] AKT 1, 23; AKT 3, 28; AKT 3, 61; AKT 3, 64; AKT 3, 70; AKT 3, 72; AKT 3, 73; AKT 3, 82; AKT 3, 90; AKT 3, 102; AKT 3, 110; AKT 5, 50; AKT 5, 51; AKT 6a, 2; AKT 6a, 8; AKT 6a, 25; AKT 6a, 74; AKT 6a,

Wahšušana	Aššur	1	AKT 5, 71
Šalatuwar	Aššur	3	AKT 6a, 176; AKT 6b, 496; VS 26, 29
Purušhattum	Aššur	2	BIN 4, 24; CCT 4, 46a
Aššur	Kaneš	1	AKT 6a, 143
Hahhum and Zalpa Cluster[245]	Kaneš	1	AKT 6c, 547
Hurama	Kaneš	1	AKT 6c, 563

Excluding exchanges concerning debt payments and purchases of slaves or goods apart from metals, the transported silver amounts to 93 talents 45 minas 17 ½ shekels (and 24 bunches). More than 80% of the transported silver (approximately 76 talents 54 minas 43 ¾ shekels) is once more moving towards Aššur. It is also worth pointing out that the greatest amounts of silver are destined for Aššur, as was the case with gold as well. The largest shipments of silver were recorded in texts AKT 3, 82 and KTS 2, 7, respectively, and they can be clearly seen at the top of **Chart 4**. A single load of this metal ranges from 1/3 shekel 53 ½ grains to 4 talents 40 minas. The average is about 18 minas 12.3 shekels, marked with a red line in **Chart 4**, and the mode is 10 minas, i.e. 600 shekels. Amounts greater than about 1 talent (i.e. 3,600 shekels) or even 2 talents (i.e. 7,200 shekels) are distinctly rare.

128; AKT 6a, 163; AKT 6a, 166; AKT 6a, 167; AKT 6a, 173; AKT 6a, 174; AKT 6a, 203; AKT 6a, 249; AKT 6a, 303; AKT 6a, 317; AKT 6a, 318; AKT 6a, 329; AKT 6a, 332; AKT 6a, 334; AKT 6a, 336; AKT 6a, 368; AKT 6a, 378; AKT 6b, 416; AKT 6b, 427; AKT 6b, 448; AKT 6b, 449; AKT 6b, 467; AKT 6b, 469; AKT 6b. 478; AKT 6b, 482; AKT 6b, 519; AKT 6c, 554; AKT 6c, 603; AKT 6c, 647; AKT 6c, 648; AKT 6c, 684; Anatolica 12, 138f.; AnOr 6, 20; ATHE 18; BIN 4, 27; BIN 4, 29; BIN 4, 30; BIN 4, 52; BIN 4, 87; BIN 4, 88; BIN 4, 122; BIN 4, 145; BIN 4, 155; BIN 4, 173; BIN 4, 184; BIN 4, 194; BIN 4, 228; BIN 6, 31; BIN 6, 75; BIN 6, 78; BIN 6, 131; BIN 6, 148; CCT 1, 14a; CCT 1, 15b; CCT 1, 16a; CCT 1, 21b; CCT 1, 28d; CCT 1, 36b; CCT 2, 2; CCT 2, 26b; CCT 2, 34; CCT 2, 35; CCT 2, 36a; CCT 3, 2a; CCT 3, 5a; CCT 3, 13; CCT 3, 17b; CCT 3, 18a; CCT 3, 22a; CCT 3, 27a; CCT 4, 1a; CCT 4, 10a; CCT 4, 11a; CCT 4, 13a; CCT 4, 13b; CCT 4, 15a; CCT 4, 17b; CCT 4, 21c; CCT 4, 32b; CCT 5, 5b; CCT 5, 7a; CCT 5, 26c; CCT 5, 30c; CCT 5, 38a; CCT 5, 40b; CCT 5, 41a; CCT 5, 41b; CCT 5, 49c; CCT 6, 8d; CCT 6, 11a; CCT 6, 27b; CMK 14; CMK 148; CMK 151; CMK 363; CTMMA 1, 75; FlorAn 121; FS Oelsner 481; ICK 1, 71; ICK 1, 167; ICK 1, 192; ICK 2, 80; ICK 2, 85; ICK 2, 87; ICK 2, 88; ICK 2, 97; ICK 2, 311; ICK 2, 333; ICK 2, 339; JCS 41, 54; Kienast 2008, 1; KKS 27; kt 92/k 142; kt a/k 913; KTB 2; KTH 24; KTH 25; KTH 26; KTP 45; KTS 1, 2a; KTS 1, 28; KTS 1, 52c; KTS 1, 53a; KTS 2, 7; KTS 2, 10; KTS 2, 26; KTS 2, 27; KTS 2, 33; KTS 2, 36; KTS 2, 50; KUG 16; KUG 28; OrNS 50 no. 1; OrNS 50 no. 2; OAA 1, 2; Ichisar, Imdilum 413ff.; OAA 1, 86; Prag 480; Prag 590; Prag 733; RA 58, 66 Sch. 9; RA 59, 29 no. 7; RA 59, 29 no. 8; RA 59, 32 no. 10; RA 59, 165 no. 27; RA 59, 172 no. 32; RA 59, 40 no. 12; RA 60, 111 no. 43; RA 81, 8; RA 81, 60; RA 81, 71; TC 1, 2; TC 1, 11; TC 1, 15; TC 1, 20; TC 2, 6; TC 2, 14; TC 2, 54; TC 3, 36; TC 3, 41; TC 3, 43; TC 3, 51; TC 3, 53; TC 3, 54; TC 3, 58; TC 3, 67; TC 3, 69; TC 3, 72; TC 3, 106; TC 3, 171; TC 3, 210; TPAK 1, 143; TTC 19; VS 26, 47; VS 26, 73; VS 26, 102; VS 26, 127.

[245] Barjamovic 2011, 87-122. See also Forlanini 2006, 163-67.

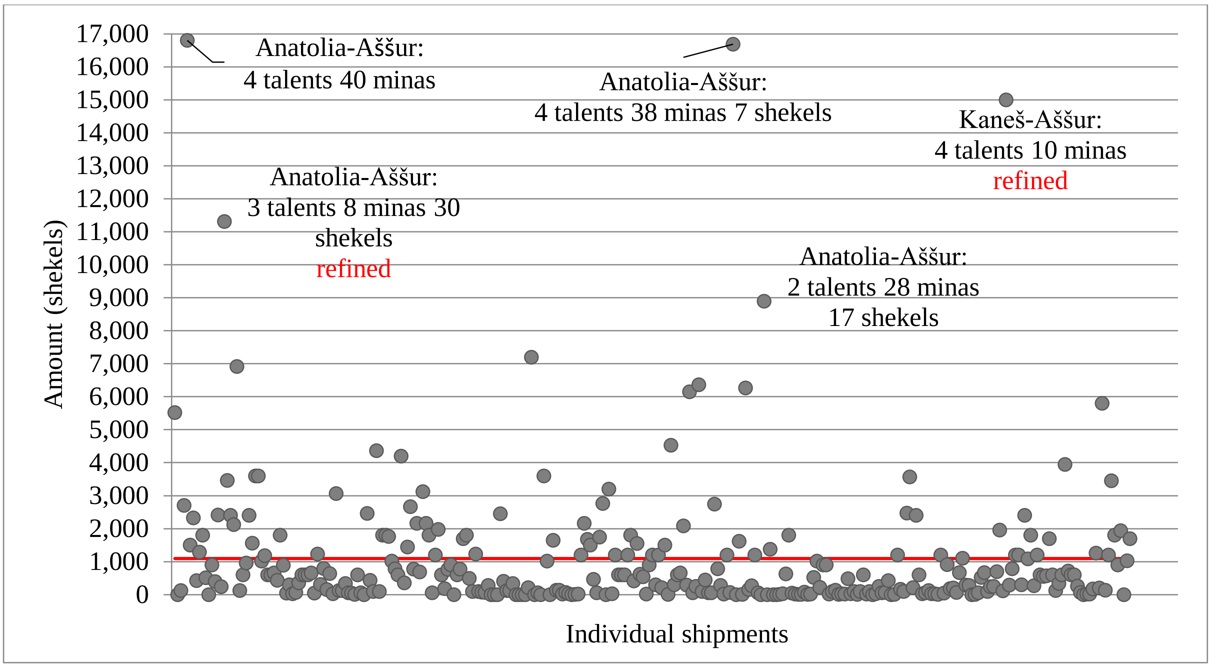

Chart 4. Amounts of transported silver in the OA texts.

Varieties of silver are recorded 256 times in 237 texts. **Table 4** presents all recorded varieties of silver, where the "refined" variety dominates with 182 references. Regardless of the size of this number in comparison to the total number of variety references, only 18% of the variety references are part of a transport. Moreover, silver records only 46 qualified references, which are composed of four varieties. This observation includes two points. First, the total number of qualified references (VT-sum) in comparison to the sum of variety references (VR-sum) gives the impression that silver was silver and there was not much regard for type or quality. Nevertheless, a little more than 89% of the qualified references regard "refined" silver. This, in addition to the fact that about 20% of the silver sent to Aššur is of the same variety, leads to the conclusion that silver was (to be) transacted in a "refined" form.[246] Second, it appears that only half of the varieties recorded in this research were included in a trade-related transport. These varieties are *lītum*, "bad", "checked (in fire)" and "refined" silver. In addition, there is the so-called "silver at hand" which, just like "tin at hand" discussed below, was given to caravan leaders in order to pay *en route* expenses. This does not refer to a specific variety of silver and will not be listed in the table below. According to AKT 6b, 438, 1 ½ mina of *lītum* silver is to be sent from somewhere in Anatolia to Kaneš. An amount of 9 ½ minas of "bad" silver, mentioned in ICK 1, 82, is transported inside Anatolia as well.

[246] Both Sturm (1995, 501 n. 68) and Lewy (1961, 69, n. 218) underline the value of "refined silver" as money, and thus of "checked (in fire) silver" as well.

Furthermore, as it will be mentioned in more detail below, "checked (in fire)" silver is to be equated with "refined" silver. For this reason, any transported amount of "checked (in fire)" silver is added to the latter's amounts.

Table 4. Varieties of silver compared to transports in the OA texts.

Silver (KÙ.BABBAR/*kaspum*)					
Variety	**VR**	**VT**	**VT/VR%**	**VT%**	**VT/TT%**
ammurum "checked (in fire)"	27	3	11.1	6.5	1
SIG_5/*damqum* "good"	3	-	-	-	-
hušā'ū "scrap"	1	-	-	-	-
hušā'ū SIG_5 "scrap of good quality"	1	-	-	-	-
lītum	3	1	33.3	2.2	0.3
lītum SIG_5 "good *lītum*"	6	-	-	-	-
mussuḫum "bad"	15	1	6.7	2.2	0.3
SAḪAR.BA "dust"	3	-	-	-	-
saḫḫertum "in small pieces"	3	-	-	-	-
ṣarpum "refined"	182	41	22.5	89.1	13.3
tirum	11	-	-	-	-
zakuum "clear"	1	-	-	-	-
Sum	256	46	18	100	14.9
Total transports	-	309	-	-	100

Additionally, about 73% of the transport references and approximately 87% of the transported amount of "refined" and "checked (in fire)" silver is destined for Aššur. These percentages provide further support to the above-made claim that the OA merchants preferably dealt with silver in a refined, from impurities, state. Shipments of this variety of the metal were ranging between 10 shekels and 1 talent 5 minas 44 shekels. In **Chart 4**, the five larger shipments of silver have been distinctively marked. The third and fourth highest amounts are composed of the "refined" variety of silver and are loads of 4 talents 10 minas and 3 talents 8 minas 30 shekels, recorded in texts CCT 5, 41b and AKT 6a, 74, respectively.

In general, the OA texts record significant quantities of silver. **Chart 5** illustrates the total of the transported amounts of silver. In this chart, the weight unit chosen is the talent, because a smaller weight unit would require expression in much greater and not so easily comprehensible numbers. Furthermore, the chart shows the proportion of the sum that belongs to “refined” and “checked (in fire)” silver (c. 19%), the single most transferred variety of this metal, in proportion to the rest of the transported silver. Finally, **Chart 6** shows the contribution of each variety of silver to the total amount of transported silver. Here, minas are used instead of shekels, which were used in the previous chart regarding gold, due to the greater recorded amounts.

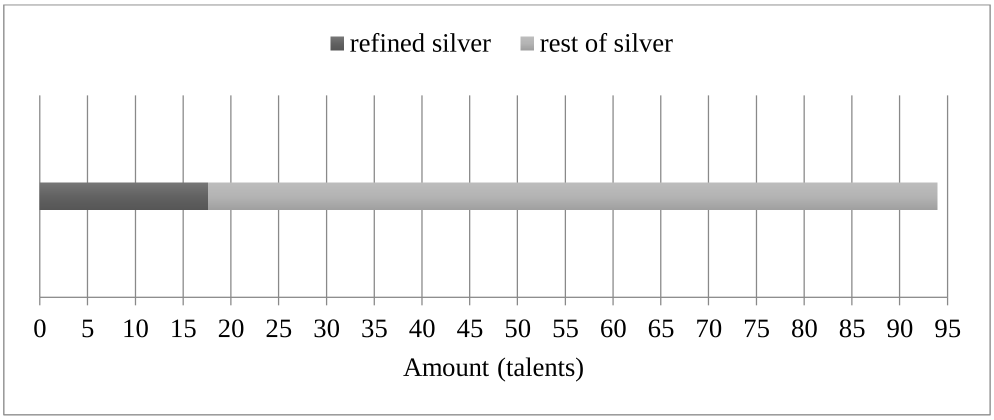

Chart 5. Comparison between the amounts of refined and the rest of the transported silver in the OA texts.

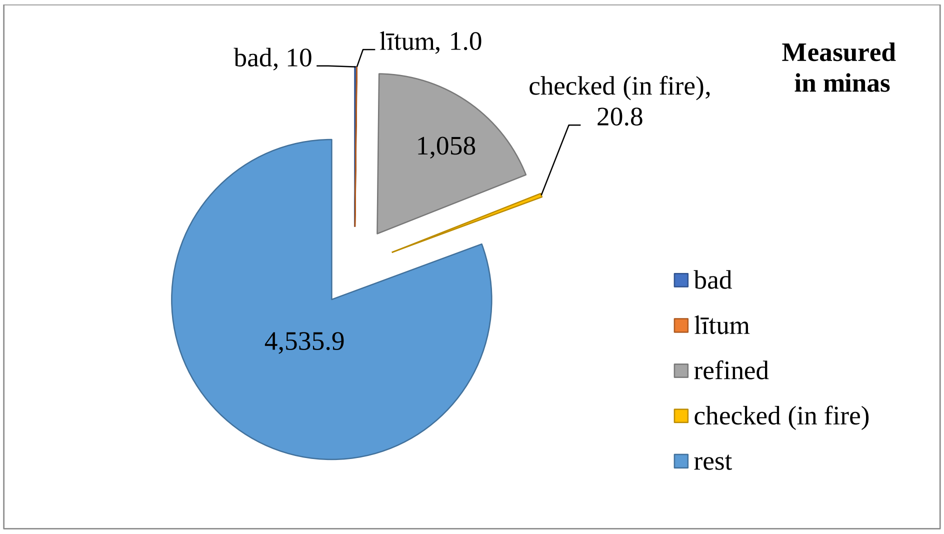

Chart 6. Transported amounts of all varieties of silver in the OA texts.

3.1.1.3 Tin

Tin was probably the main reason why a trade network in the OA period was established in the first place.[247] Anatolian polities needed and were willing to trade for tin, which came via Aššur to Kaneš or Purušhattum and thence further into Anatolia. Approximately 78% of a total of 187 texts record tin heading towards Kaneš, passing for instance via Uršu, Hahhum and Zalpa. Sometimes, tin was also sent from Aššur to one of the colonies in western Anatolia, such as Purušhattum. Examining the trade of tin from the point of view of the Kaneš texts alone, the idea emerges that tin was more commonly distributed from Kaneš to western Anatolia.

In addition to the listed shipments in **Table 5**, there is a) one reference from an unspecified location to Zalpa,[248] b) one reference from an unspecified location to Kuburnat,[249] c) three references from an unspecified location to Wahšušana,[250] d) one reference from an unspecified location to Purušhattum,[251] e) 11 references from an unspecified location to Kaneš/Anatolia,[252] f) one reference from an unspecified location to Durhumit,[253] g) one reference from Anatolia to the "Heartland",[254] h) one reference to and from Anatolia,[255] i) one reference from Anatolia probably to Kaneš,[256] j) one reference from Anatolia to an unspecified location[257] and k) one reference from Hahhum to an unspecified location.[258]

[247] See Veenhof 2008, 147-52.
[248] AKT 3, 103.
[249] AKT 6a, 276.
[250] AKT 6c, 631; CCT 2, 46b; KUG 37.
[251] AKT 6c, 636.
[252] AKT 3, 101; AKT 6c, 642; ATHE 10; BIN 4, 51; BIN 4, 115; BIN 6, 24; CCT 3, 39a; KTS 1, 51b; KTS 1, 53c; TC 2, 17; TPAK 1, 61.
[253] KTS 1, 55a.
[254] AKT 6c, 642.
[255] AKT 6c, 671.
[256] CCT 2, 26b.
[257] AKT 6a, 203.
[258] Chantre 14.

Table 5. Transport of tin in the OA texts.

From	To	References	
Aššur	Uršu	1	CTMMA 1, 81
Aššur	Timelkia	1	TC 3, 95
Aššur	Hahhum	2	AKT 6c, 557; BIN 4, 7
Aššur	Zalpa	1	AKT 6c, 564
Aššur	Kaneš/Anatolia	131[259]	
Aššur	Purušhattum	4	AKT 3, 75; BIN 4, 24; CCT 2, 46a; TC 2, 13
Hahhum and Zalpa Cluster	Kaneš	1	AKT 6c, 544
Hahhum	Kaneš	1	TMH 1, 27a
Zalpa	Kaneš	1	AKT 6c, 580
Timelkia	Kaneš	1	KUG 34
Nihriya	Kaneš	1	AnOr 6, 15
Kaneš/Anatolia	Durhumit	2	AKT 6b, 348; RA 60, 128;
Kaneš/Anatolia	Purušhattum	1	BIN 4, 149
Kaneš/Anatolia	Wahšušana	2	kt h/k 18; TC 1, 72
Kaneš/Anatolia	Šalatuwar	2	AKT 6c, 598; BIN 4, 115
Kaneš/Anatolia	Anatolia	8[260]	
Kaneš/Anatolia	Timelkia	2	AKT 6b, 466; TMH 1, 24e
Kaneš/Anatolia	Tegarama	1	KTS 1, 51b
Kaneš/Anatolia	Zalpa	2	KTS 2, 56; TC 3, 50
Ushania	Malitta	1	OIP 27, 54

[259] AKT 1, 18; AKT 1, 23; AKT 1, 82; AKT 2, 22; AKT 3, 24; AKT 3, 61; AKT 3, 65; AKT 3, 70; AKT 3, 72; AKT 3, 73; AKT 3, 75; AKT 3, 76 twice; AKT 3, 78; AKT 3, 95; AKT 5, 50; AKT 6a, 120; AKT 6a, 143; AKT 6a, 162; AKT 6a, 164; AKT 6a, 166; AKT 6a, 185; AKT 6a, 206; AKT 6a, 249; AKT 6b, 322; AKT 6b, 335; AKT 6b, 337b; AKT 6b, 416; AKT 6b, 466; AKT 6b, 507; AKT 6c, 536; AKT 6c, 566; AKT 6c, 606; AKT 6c, 659; AKT 6c, 706; Anatolica 12, 138f.; AnOr 6, 18; ATHE 17; ATHE 37; BIN 4, 13; BIN 4, 159; BIN 4, 27; BIN 4, 29; BIN 4, 30; BIN 4, 61; BIN 4, 92; BIN 6, 12; BIN 6, 78; BIN 6, 79; BIN 6, 83; BIN 6, 90; BIN 6, 131; BIN 6, 140; BIN 6, 165; BIN 6, 185; BIN 6, 186; BIN 6, 230; BIN 6, 231; BIN 6, 252; C 17 twice; CCT 1, 20a; CCT 1, 24a; CCT 1, 24b; CCT 1, 25; CCT 2, 2; CCT 2, 4a; CCT 2, 34; CCT 3, 4; CCT 3, 5a; CCT 3, 27a; CCT 4, 1a; CCT 4, 1b; CCT 4, 2b; CCT 4, 11a; CCT 4, 17b; CCT 5, 5a; CCT 5, 29a; CCT 5, 50h; CCT 6, 1c; CCT 6, 4b; CCT 6, 46b; CMK 14; CMK 151; Cole 6; CTMMA 1, 74; CTMMA 1, 75; ICK 1, 58; ICK 1, 79; ICK 1, 124; ICK 1, 126; ICK 1, 188; JCS 14, 3; Michel, Innaya II, 324f. no. 256 98; KKS 27; KTB 17; KTH 18; KTS 1, 28; KTS 1, 30; KTS 1, 31a; KTS 1, 59c; KTS 2, 10; KTS 2, 31; KTS 2, 53; KUG 21; OAA 1, 2; Ichisar, Imdilum 413ff.; Prag 480; RA 59, 162 no. 26; RA 60, 111 no. 43; RA 81, 3; RA 81, 20; TC 1, 80; TC 2, 6; TC 2, 8; TC 3, 18; TC 3, 21; TC 3, 22; TC 3, 24; TC 3, 72; TC 3, 96; TC 3, 157; TPAK 1, 149; TPAK 1, 150; VS 26, 11; VS 26, 47; VS 26, 58; VS 26, 73; VS 26, 145; VS 26, 149; VS 26, 151.

[260] AKT 6b, 340; AKT 6b, 477; AKT 6b, 483; CCT 3, 10; Michel, Innaya II, 324f. no. 256; KTH 11; Ichisar, Imdilum 240f.; TC 3, 178.

As far as the recorded weight of tin is concerned, the total weight documented in shipments amounts to 481 talents 47 minas and 55 ½ shekels. Approximately three quarters of this tin appears to be moving from Aššur towards Kaneš. Moreover, only a small proportion (about 7%) of the total transported tin seems to be sent from Kaneš to western Anatolia. However, due to the nature of the studied texts this figure has to be certainly grossly misleading. Kaneš acted as a main distribution centre for the imported goods, but the trade within Anatolia was conducted by commissioned traders in a procedure that left no records other than loan documents expressed in silver.[261] The average transported amount per transaction was 2 talents 32 minas 57 shekels (i.e. about 9,177 shekels). This is indicated by a red line in **Chart 7**. Tin was shipped in donkey loads weighing 2 talents 10 minas each, divided in two saddle bags weighing one talent each and a "top pack" weighing 10 minas. Submultiples (i.e. 1 talent 5 minas, recorded twice) and multiples (i.e. 3 talents 15 minas, recorded once; 4 talents 20 minas, recorded four times; 6 talents 30 minas, recorded once; 8 talents 40 minas, recorded thrice; 10 talents 50 minas, recorded twice) of this amount are frequently attested.[262] The range of the transferred amounts is from a minimum of 5 shekels to a maximum of 20 talents 5 minas. Shipments of tin, when leaving Aššur, were put under seal and they could not be opened until they had crossed the Euphrates and reached Hahhum.[263]

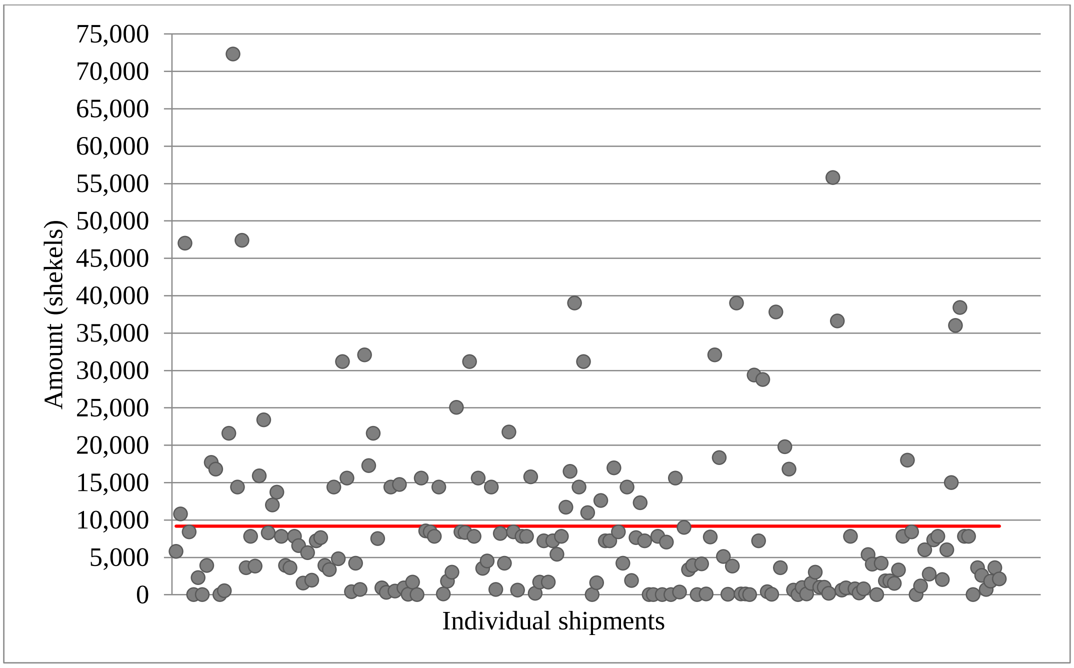

Chart 7. Amounts of transported tin in the OA texts.

[261] See Veenhof 2008, 51, 131.
[262] See: Larsen 1967, 147; Veenhof 1972, 13-23, 45; Dercksen 2004b, 278. See also Larsen 2002, xxi.
[263] Barjamovic 2008, 91-4; 2011, 87-107.

Furthermore, an amount of tin was given to caravan leaders to use as currency, with which to pay *en route* expenses and tolls on their journey to Anatolia. This type of tin was known as "hand tin", described in Akkadian as *ša qātim* – literally "for the hand". By using tin to pay for tolls, food, drinks, accommodation etc., this much desired and needed metal spread across regions along the caravan routes. Sometimes, such tin was given to caravans leaving Kaneš and heading to the west, to use for the same purpose.[264] "Hand" tin is mentioned in 66 transactions and amounts to a total of 25 talents 48 minas 30 ½ shekels. If this amount is added to the weight of the transported tin, then a sum of 507 talents 36 minas 26 shekels of tin has been transferred from Aššur northwards and into Anatolia. The smallest recorded amount of "hand tin" given to a caravan leader is 11 shekels and the greatest is 1 talent 32 minas 38 shekels.[265] It is important to note that the quantity of this type of tin, used for expenses, depended on the overall size and value of the caravan and its goods. **Chart 8** is a representation of the dispersion of the amounts of "hand" tin recorded in the texts from Kaneš. The average stands at 24 minas 11.7 shekels (i.e. 1,451.7 shekels), while the mode is 5 minas (i.e. 300 shekels) and it is found in only four transactions.

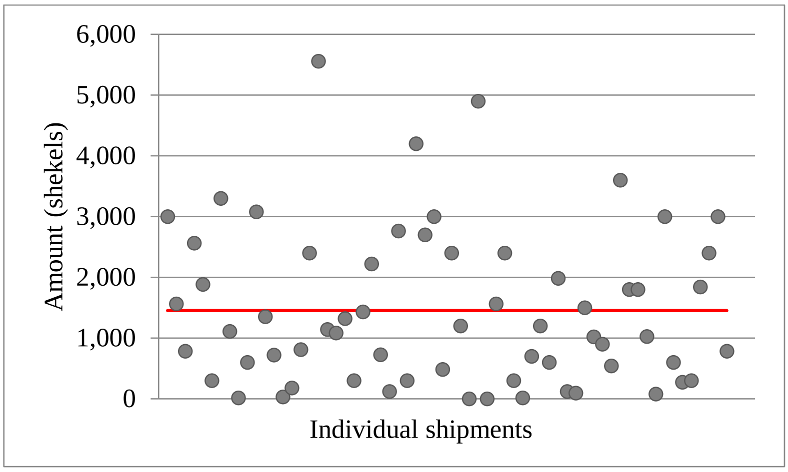

Chart 8. Amounts of "hand" tin in the OA texts.

Of interest to this study is the total amount of tin transported and how this is divided among the two categories, i.e. tin as a commodity and tin as a kind of currency for on-road expenses. **Chart 9** shows the correlation between these two constituents. The amounts of

[264] AKT 6a, 273: from Kaneš to Wašhaniya (see Barjamovic 2011, 317-26); TC 1, 72: probably from Kaneš to Wahšušana; CCT 1, 36a: moving inside Anatolia, but uncertain from which city; Ichisar, Imdilum 240f.: probably from Kaneš to an Anatolian city.
[265] BIN 4, 226 and CCT 1, 36a, accordingly.

“hand” tin given to the caravans make up about 5% of the amount of tin carried for trade reasons. However, it must be kept in mind that the amount of tin given into the hands of the caravan leader depended not only on the load’s worth, but also on the distance being travelled. Thus, a larger caravan that was headed directly to Anatolia was provided with more “hand” tin than a smaller caravan, whose first destination was the intermediary trading stations just north of the Euphrates. Furthermore, there are many more on-road expenses and payments which do not appear in the texts and which cannot be calculated. Only seldom is there a record of such payments.[266] If every single transport contract and note of payment was available to us, then the amount of tin seen to be transported from Aššur would be much greater.

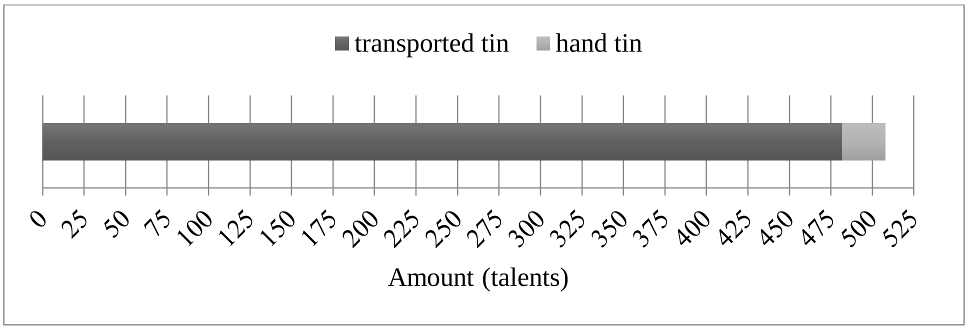

Chart 9. Comparison between the amounts of the transported and the “hand” tin in the OA texts.

Table 6. Varieties of tin compared to transports in the OA texts.

Tin (AN.NA/*annakum*)					
Variety	**VR**	**VT**	**VT/VR%**	**VT%**	**VT/TT%**
masīrum	1	-	-	-	-
mussuḫum “bad”	1	-	-	-	-
ša tamsium “washed”	1	-	-	-	-
SIG_5 “good”	7	1	14.3	100	0.5
SIG_5 *watrum* “of very good quality”	1	-	-	-	-
zakuum “clear”	1	-	-	-	-
Sum	12	1	8.3	100	0.5
Total transports	-	189	-	-	100

[266] See Veenhof 1972, 270-302.

Contrary to other metals, tin was normally not characterised by its quality or type when it was imported. In a total of 189 transports, there is one reference of "good" tin, mentioned in RA 81, 20. In it, tin "of good quality" and textiles are listed together as goods for transport. This instance can be understood as representative of a trade transaction and as a result it is regarded as a qualified reference of tin. Moreover, there are 12 recorded VR in as many texts. The most often read qualification of tin is that which is designated "for the hand" (*ša qātim*). However, this is not a variety, but designates a specific purpose this metal was used for. In addition, there is also mention of "good", "very good", "bad" and "clear" quality tin, as well as "washed" and *masīrum* tin.

3.1.1.4 Copper

During the OA period, according to the texts from Kaneš and contrary to the pattern established for the preceding metals, mainly traded between Aššur and Kaneš, copper was traded primarily within Central Anatolia. This metal was also used as a mode of exchange inside Anatolia. **Table 7** presents the most important shipments documented in the texts from Kaneš.[267] Durhumit, Marithum and Tawiniya were referred to as markets where copper was both traded and converted into a better quality.[268]

In addition to the listed shipments in **Table 7**, there are a) one reference from Durhumit to an unspecified location,[269] b) four references from Anatolia to an unspecified location,[270] c) two references from an unspecified location to Purušhattum,[271] d) one reference from an unspecified location to Wahšušana,[272] e) one reference from an unspecified location to Anatolia,[273] f) one reference from an unspecified location to Tuhpiya,[274] g) two references from Kaneš to an unspecified location[275] and h) one reference to and from unspecified locations.[276] Noteworthy is that unspecified locations are most often to be found inside Anatolia and, thus, all of the additional shipments mentioned have starting points and destinations in Central Anatolia. This observation further supports that already made above, namely that copper is

[267] Copper was often sent to Aššur to serve as offering to the Gods; these texts have not been included in **Table 7**.
[268] Dercksen 1996, 147-48; Barjamovic 2011, 393. For the role of Marithum, see Barjamovic 2011, 387.
[269] OAA 1, 78.
[270] AKT 6b, 316; AKT 6c, 627; RA 58, 66 Sch. 10; RA 60, 115 no. 45.
[271] AKT 6a, 184; AKT 6c, 636.
[272] CCT 4, 10b.
[273] BIN 4, 51.
[274] CCT 3, 1.
[275] AKT 1, 17; CCT 2, 40a.
[276] KUG 25.

principally transported and traded inside Anatolia and is not so often exported to the south, to Aššur.

The total weight of copper traded is 428 talents 1 mina 30 shekels and it is recorded in 75 tablets. Individual transactions of copper range from 25 shekels to 30 talents. The most frequently transported amount is 5 minas, i.e. 300 shekels. The mean transported amount is about 5 talents 33 minas 31.6 shekels (i.e. 20,011.56 shekels) and it is highlighted with a red line in **Chart 10**. As has been already pointed out, in addition to the inter-Anatolian movement of copper, there are a few shipments destined for Aššur. Unfortunately, the typical omission of the sender's, or the receiver's, location hinders our understanding of the layout of the copper exchange routes and amounts. From what we can infer from the explicitly, or somewhat clearly, stated *loci* in the Kaneš texts, around 32% of the copper was heading to Kaneš, while another 33% was destined for one of the markets of Central Anatolia, i.e. Purušhattum, Šalatuwar and Wahšušana. Moreover, approximately 5% of the texts mention Durhumit as the origin of a shipment of copper. Durhumit probably was located in the vicinity of copper sources and so it acted as a central marketplace for the exchange of this metal. Nevertheless, its role in the inter-Anatolian copper trade may be misrepresented in the archive under study, because of its location outside of the main trade routes. These could start from Durhumit, pass by Wahšušana (and Šalatuwar) and then head towards Purušhattum.[277]

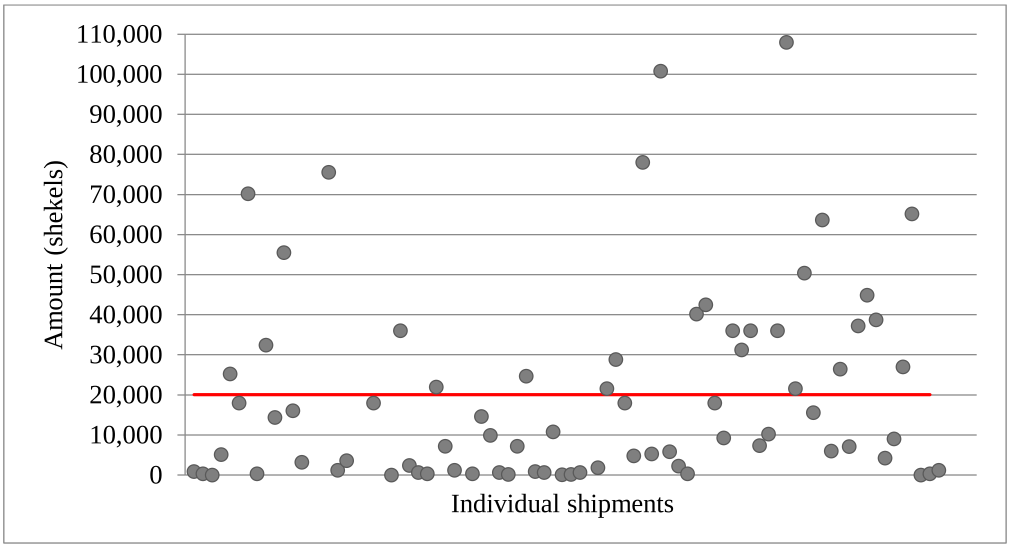

Chart 10. Amounts of transported copper in the OA texts.

[277] Barjamovic 2008, 95.

Table 7. Transport of copper in the OA texts.

From	To	References	
Durhumit	Kaneš/Anatolia	3	AKT 6b, 348 (twice); BIN 4, 54
Purušhattum	Durhumit	1	BIN 4, 64
Ulama	Anatolia	1	BIN 4, 31
probably Kaneš	Anatolia	3	AKT 3, 74; ICK 2, 321; TC 3, 178
Anatolia	Anatolia	13[278]	
Anatolia	Kaneš		14[279]
Anatolia	Durhumit	1	BIN 4, 54
Anatolia	Purušhattum	6[280]	
Anatolia	Wahšušana	1	CCT 2, 29
Kaneš	Wahšušana	1	AKT 3, 91
Malitta	Wahšušana	1	TC 1, 53
probably Kaneš/Anatolia	Šalatuwar	3	AKT 6a, 176; AKT 6a, 246; BIN 4, 148
Wahšušana	Šalatuwar	1	AKT 3, 45
probably Kaneš	Nihriya	1	AnOr 6, 15
probably Kaneš	Tegarama	1	KTS 1, 51b
Anatolia	Timelkia	1	TMH 1, 24e
Kaneš/Anatolia	Aššur	5[281]	
Hahhum and Zalpa Cluster	Kaneš	1	AKT 6c, 547
Uršu	Anatolia	1	CTMMA 1, 81

As far as the recorded varieties of copper are concerned, this metal is the most multivariate of all in the OA texts. Dercksen[282] conducted an analysis of the terminology of this metal, in an attempt to determine the meaning of the numerous terms used to express a variety and link them with particular types of copper. In 190 tablets, there is a total of 12 different sorts of this metal, presented in **Table 8**. Six of these are listed as part of a shipment.

[278] AKT 2, 39; AKT 3, 66; AKT 6b, 377; AKT 6b, 443; AKT 6c, 671; AKT 6c, 677; BIN 4, 148; KTS 1, 54d; KTS 2, 8; RA 58, 66 Sch. 4; TC 2, 62; TC 3, 97; KTH 1.
[279] AKT 3, 72; AKT 6b, 352; AKT 6b, 404; AKT 6b, 417; AKT 6c, 689; BIN 4, 31 twice; CCT 6, 46b; kt 87/k 462; KTS 1, 55a; KTS 2, 22; OIP 27, 31; RA 59, 25 no. 6; TC 2, 33.
[280] AKT 6a, 208b; ATHE 37; BIN 4, 1; CCT 1, 22a; CTMMA 1, 71; kt c/k 263.
[281] AKT 5, 51; BIN 4, 88; TC 1, 108; TC 2, 54; TC 3, 53.
[282] Dercksen 1996, 33-60.

Copper is the only metal, in addition to iron, whose VR surpasses its TT. There are 237 variety references, but only 84 transport references. Regarding how many of these variety references are involved in actual transports, it appears that about 51% of the transport references of copper concern a single one of its varieties. Similarly, there is a significantly low percentage of qualified references, which is calculated at approximately 18%. The most common variety in the texts from Kaneš is "good" copper. "Washed" copper has nearly a third of the references of the former and is closely followed by *šikkum* copper. Apropos the qualified references, however, "good" copper has as many references as "washed" copper, while *šikkum* copper is transported less than half as often as "washed" copper. This means that "good" and "washed" copper are the most sought-after types of this metal.

Table 8. Varieties of copper compared to transports in the OA texts.

Copper (URUDU/*wērium*)					
Variety	**VR**	**VT**	**VT/VR%**	**VT%**	**VT/TT%**
SIG_5/*damqum* "good"	104	17	16.3	39.5	20.2
SIG_5 *watrum* "of very good quality"	1	-	-	-	-
hušā'ū "scrap"	11	2	18.2	4.7	2.4
lammunum "poor"	10	1	10	2.3	1.2
masium "washed"	42	15	35.7	34.9	17.9
masium SIG_5 "washed of good quality"	2	1	50	2.3	1.2
masium SIG_5/*damqum šaburum* "washed of good quality (and) broken"	2	-	-	-	-
maṭium "inferior/inadequate"	1	-	-	-	-
mussuḫum "bad"	1	-	-	-	-
SIG_5 *mussuḫum* "good (but of) bad quality"	1	-	-	-	-
SIG_5 *šabburum* "good, broken"	1	-	-	-	-
šaduwānum la ukalu "that does not contain haematite"	1	-	-	-	-
ṣaḫḫirum "in small pieces"	8	-	-	-	-
ṣalmum "black"	7	-	-	-	-
ša šaduišu "of its stone"	5	-	-	-	-
šikkum	39	7	17.9	16.3	8.3
zakuum "clear"	1	-	-	-	-
Sum	237	43	18.1	100	51.2
Total transports	-	84	-	-	100

In spite of the fact that “good” copper is more often referred to and records as many qualified references as “washed” copper, the latter is transported in greater amounts. The sum of the transported “good” copper amounts to 291,660 shekels, or 81 talents 1 mina. A single shipment of “good” copper may range in weight from 3 minas up to 21 talents. On the other hand, “washed” copper records a total of 360,020 shekels, or 100 talents 20 shekels. Individual shipments contain between 5 minas and 30 talents of “washed” copper. **Chart 11** shows the total amounts of “good” and “washed” copper compared to the rest of the transported copper, while **Chart 12** presents the way the amounts of the transported varieties of copper are distributed.

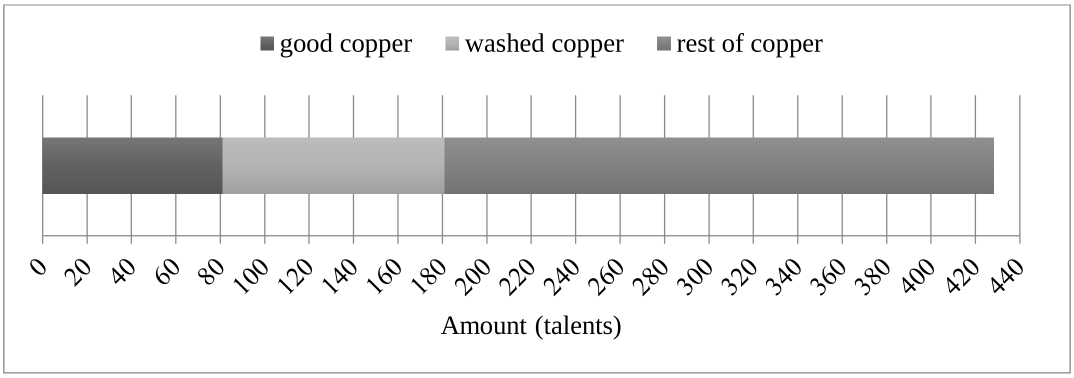

Chart 11. Comparison between the amounts of good, washed and the rest of the transported copper in the OA texts.

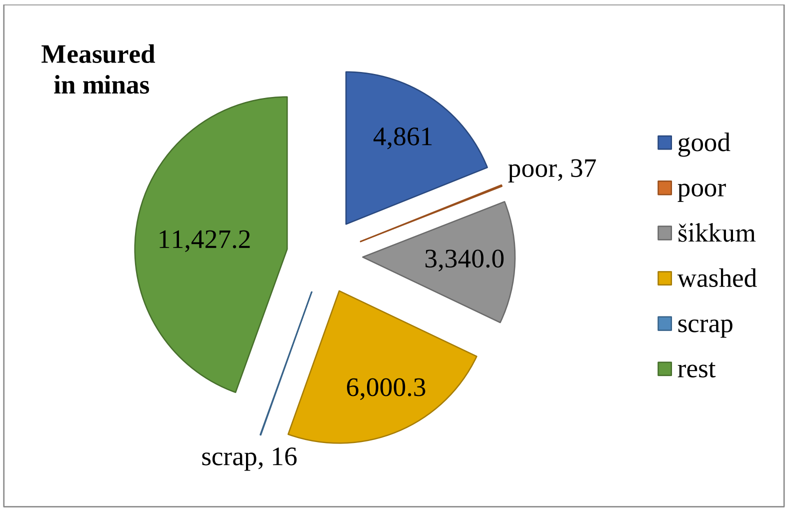

Chart 12. Transported amounts of all varieties of copper in the OA texts.

3.1.1.5 Iron

The fifth metal in the analysis and the rarest one known during this period is iron. There are four different words in the OA texts that have been linked to this metal. These are *aši'um*, *amūtum*, KÙ.AN and *parzillum*. The first three are different words that have been seemingly interchangeably used and translated as "iron" or most often "meteoric iron". The last has simply been left as "*parzillum* iron." However, due to the uncertainty of the translations, these words will remain untranslated here. Words associated with iron can be found in 103 tablets, from which only 17 record a transport situation and not all of them recorded weight. Most often, it is *amūtum* which is brought or sent somewhere, or to someone, and it is unclear whether all transports of this metal have a business, i.e. profit-making, purpose, or if they are settlements of accounts.

Table 9 lists the origin and destination towns documented in the Kaneš texts. Among them, we find Kaneš, Wahšušana, Tuhpiya and Timelkia, while as points of origin the places mentioned are Aššur, Šalatuwar and Tišmurna. The emerging arrangement implies a movement from western Central Anatolia towards the gathering point of Kaneš. A notable town is Šalatuwar, which is in the vicinity of the so-called Inner Land, where merchants appear to be going to find *amūtum* and *aši'um*.[283] The "route" that records the highest number of references is the one leaving Aššur and heading towards Kaneš. The "City Hall" in Aššur was controlling the circulation of this commodity in Assyria, while Kaneš assumed this role for Anatolia.[284] As a consequence of the insufficient data, a statistical analysis of the starting and destination points of the metal seems uncalled-for. Texts documenting, for instance, regulations and their effects, or transactions in certain towns, appear to be more helpful in understanding which places were more important in the circulation of this commodity.[285] Concerning the transaction places, *amūtum* is bought in Šalatuwar, Inner Land and Hattum,[286] and sold to the palace of Wahšušana in return for copper, in Purušhattum and Tišmurna.[287]

[283] See also Erol 2015.
[284] Larsen 1976, 198-200; Veenhof 2016, 13.
[285] See: AKT 5, 1-3, 6; in BIN 4, 45 where Sūe'a asks for *amūtum* to be sent to him, but without the *kārum* knowing about it; in FS Matouš 2, 127-128 someone was imprisoned because he sold *amūtum* in Purušhattum.
[286] These purchases are recorded in texts AAA I/3, 5, AKT 3, 45 and ICK 1, 1, respectively.
[287] These transactions are recorded in texts BibO 73, 20-21 no. B, Cole 2 and FS Matouš 2, 127-128, and CCT 6, 12a, respectively.

Table 9. Transport of KÙ.AN/*amūtum* and *aši'um* in the OA texts.

From	To	References	
Aššur	Kaneš	4	AKT 6a, 46; AKT 6c, 524; AKT 6c, 628; AKT 6c, 630
probably Aššur	Anatolia	1	KTS 1, 30
probably Aššur	Timelkia	1	ATHE 62
unspecified	Anatolia	1	FS Garelli 239 = FT4
Anatolia	Wahšušana	1	CCT 4, 4a
Šalatuwar	Wahšušana	2	AKT 3, 45; BibO 73, 22 no. C
Tišmurna	Anatolia	1	TPAK 1, 170
Anatolia	Tuhpiya	2	ArAn 2, 25f.; TC 1, 39
Anatolia	probably Kaneš	1	VS 26, 61
Anatolia	Anatolia	3	BIN 4, 50; FS Sachs 33ff.; TPAK 1, 20

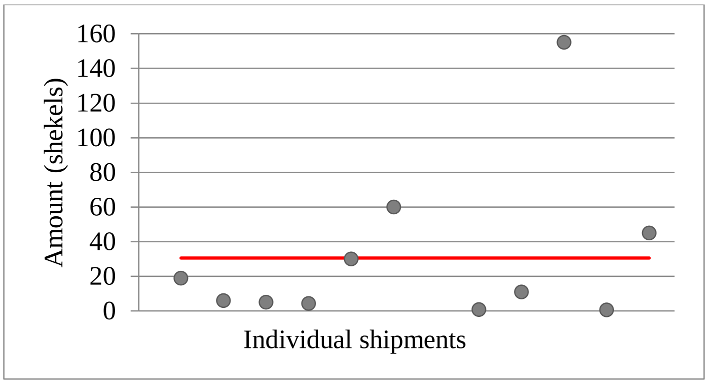

Chart 13. Amounts of transported KÙ.AN/*amūtum* in the OA texts.

The sum of the transported metal, recorded in 17 tablets, is approximately 5 minas 36 shekels and single shipments range from ½ shekel up to 2 ½ minas 5 shekels, seen in **Chart 13**. The mean transported quantity is about 30 3/5 shekels and it is marked with a red line. Nevertheless, the highest amount recorded is an extreme outlier from the standard weights mentioned. It is documented in text TPAK 1, 170 and regards amounts of KÙ.AN.[288] All other transported amounts are up to 1 mina, i.e. 60 shekels.

[288] TPAK 1, 170 (lines 1-23): "Anuppī-Ištar, fils d'Aššur-muttabbil, nous a saisis contre Iddin-abum, fils d'Aššur-ṭāb. Voici ce qu'(a déclaré) Anuppī-Ištar contre Iddin-abum : « J'ai confié 2 ½ mines 5 sicles de fer de météorite, un gage à mon sceau, à Šudāya, fils d'Ikūnum, dans Tišmurna, et Šudāya te l'a apporté. Informe-moi dans la mesure où tu as remis (ce) fer de météorite à quelques garants (de dettes). » Voici ce qu'Iddin-abum (a répondu) : « Šudāya ne m'a pas donné de fer de météorite ! » Pour cette affaire, le *kārum* de Hattuš nous a désignés. Par devant le poignard d'Aššur, nous avons donné notre témoignage. Par devant Aššur-ennam, fils

In contrast to the way all other metals are studied in this research, and due to the limited number of texts associated with this metal and in particular related to transports, all references to any of the words regarding iron are taken into consideration. **Table 10** presents the four three words ascribed to iron that appear in the OA texts, the number of references (VR) and the number of transports (VT). The vast majority of the texts record *amūtum* metal, logographically written KÙ.AN, while a few refer to *aši'um*. *Parzillum*, which appears in just four out of a total of 103 texts that refer to any of the words related to iron, has not been found in any transport-related texts. On the other hand, *amūtum* appears to be transported 12 out of 66 times and KÙ.AN three out of 15 times. This means that about 18-20% of *amūtum* and KÙ.AN references involve transportation. *Aši'um* appears to have been transported only twice in 23 texts. These numbers are certain to change once the kt 89/k archive and Erol's study are published.[289]

Table 10. References of types of "iron" compared to transports in the OA texts.

Type	**VR**	**VT**	**VT/VR%**	**VT%**	**VT/TT%**
KÙ.AN	15	3	20	17.6	17.6
amūtum	66	12	18.2	70.6	70.6
āšiʾum	23	2	8.7	11.8	11.8
parzillum	4	-	-	-	-
Sum	108	17	15.7	100	100
Total transports	-	17	-	-	100

Table 11 represents the recorded varieties of *amūtum*, KÙ.AN and *aši'um*, and their qualified transports. Except from *parzillum*, all other words which are related to iron record varieties and transports of varieties. *Amūtum* and KÙ.AN are qualified as "good" and "clear". *Amūtum* alone is further qualified as *ṣahertum* "in small pieces" and KÙ.AN alone as *kīšum*. The last, untranslated variety is logographically written as KI.DIRI and in Akkadian found as *ša ki-ší-a*. Donbaz[290] left this phrase untranslated, noting that it probably was of poor quality.

d'Aššur-bāni, par devant Aššur-malik, fils d'Eta-bāni, Šalim-ahum, fils de Luzina, (était) notre associé."*A-nu-pí*-Ištar DUMU *A-šur-mu-ta=bi$_4$=il$_5$ a-na I-dí-a-bi-im* DUMU *A-šur*-DU$_{10}$ *iṣ-ba-at-ni-a-tí-ma um-ma A-nu-pí-Ištar / a-na I-dí-a-bi$_4$-ma 2 ½ ma-na* 5 GÍN KÙ.AN *ša-pár-tám iš-té-et ku-nu-ki-a a-na Šu-da-a* DUMU *I-ku-nim i-na Tí-šu-wu-ur-na áp-qí-id-ma / Šu-da-a ub-lá-kum a-ma-ma-an bé-lu qá-ta-tim / a-šar* KÙ.AN *ta-ta-dí-nu úz-ni pí-té um-ma I-dí-a-bu-ma mì-ma / Šu-da-a /* KÙ.AN *lá i-dí-nam a-na a-wa-tim a-ni-a-tim kà-ru-um Ha-tù-uš i-dí-ni-a-tí-ni ni-dí-in* IGI *A-šur-e-nam* DUMU *A-šur-ba-ni* IGI *A-šur-ma-lik* DUMU *E-ta-ba-ni Ša-lim-a-ḫu-um* DUMU *Lu-zi-na ta-pá-i-ni* (Michel and Garelli 1997, 230-31).

[289] Prof. Hakan Erol (Ankara University) is currently working on a project, based on both published and unpublished OA texts regarding metals (pers. com., December 19, 2017).

[290] Donbaz 1988a; 2001a, 83-7.

Dercksen[291] writes that KI.DIRI is the OA form of the Sumerian *gi.diri*, which signified a lump of ore. Moreover, *amūtum* also appears in "lumps", a form described by two different words: *kiṣrum* and the logogram NA_4 = Akkadian *abnum*. The former denotes a "lump of metal", while the latter has the more general meaning of a "stone".[292] This latter word is also used to qualify *aši'um* in text kt 89/k 206. In the same tablet, *aši'um* is found in the form of a "bar", expressed with the Akkadian word *urākum*, which literally denotes a "wire" or a "rod". The very limited sample does not allow of further conclusions. As a result, the fact that only "good" KÙ.AN, *amūtum* "in small pieces" and *amūtum* in the form of a "lump" partake in a transport cannot be taken as determining factors, but merely as indicators.

Table 11. Varieties of KÙ.AN/*amūtum* and *aši'um* compared to transports in the OA texts.

"Iron" (KÙ.AN/*amūtum*; *aši'um*; *parzillum*)					
Variety	**VR**	**VT**	**VT/VR%**	**VT%**	**TT%**
amūtum NA_4 "stone"	1	-	-	-	-
amūtum SIG_5/*damqum* "good"	2	-	-	-	-
SIG_5 KÙ.AN "good"	1	1	100	25	5.9
amūtum SIG_5/*damqum la watar* "good but not very good"	1	-	-	-	-
amūtum kiṣrum "lump"	2	1	50	25	5.9
amūtum ṣahertum "in small pieces"	3	2	66.7	50	11.8
amūtum ṣahertum zakuum "clear and in small pieces"	1	-	-	-	-
KÙ.AN ša KI.DIRI/*kīšum*	2	-	-	-	-
KÙ.AN zakuum "clear"	1	-	-	-	-
amūtum zakuum "clear"	2	-	-	-	-
aši'um abnum "stone"	1	-	-	-	-
aši'um urākum "bar"	1	-	-	-	-
aši'um zakuum ša šarrūtim "clear and of royal quality"	1	-	-	-	-
Sum	19	4	21.1	100	23.5
Total transports	-	17	-	-	100

[291] Dercksen 1992, 796.
[292] See **Appendix 4**.

3.1.1.6 Varia

Other metals found in the Kaneš texts include bronze, in Akkadian written as *siparrum* and lographically as UD.KA.BAR, and possibly also antimony, mentioned as *lulā'um* in Akkadian in four texts: AKT 6a, 216, AKT 3, 52, Ank. 64 and KTS 1, 7a. There is also lead, written in Old Assyrian as *abārum*, mentioned only once in AKT 6b, 300.[293] Bronze occurs 19 times,[294] four of which refer to items, such as bowls, dishes, pins and nails that are being sent to someone. Only once is the weight of the bronze objects attested and it is 3 minas 50 shekels, as read in text TC 2, 54.

3.1.1.7 Contradistinction

Chart 14 shows the qualified, unqualified and total variety of references to all metals. From this chart, it is easy to realise how often we come across a variety of copper and silver, the two metals which were mostly used as modes of exchange in Anatolia. However, the bar representing tin in this chart does not include references to "hand" tin, because it was not used as a trade commodity but as currency to cover the travel costs. With regard to the overall number of variety references, the least recorded concerns tin and then "iron", as described by any of its related words. The former comprises 12 and the latter 19 variety references. Far above these two comes gold with 87 references. The two remaining metals are copper and silver, existing in much greater numbers – 237 and 256 references, respectively. For each metal, the qualified references (i.e. "no-transport") are naturally far less than the unqualified (i.e. "transport"). Regarding both constituents of each metal, i.e. qualified and unqualified references, the fewest appear to concern tin. Next seems to be iron, followed by gold and then copper and silver. However, if we compare the percentages of the qualified references of each metal, then a somewhat different sequence occurs. This is due to the relative totals of variety references. As a result, tin is first, followed by copper, silver, iron and then gold. As the total numbers for each metal are not equally high and sufficient, these percentages should not be taken as determinative. We can, however, realise that the metals that were mostly used as modes of exchange in transactions in Anatolia are equally often characterised by displaying the greatest variety.

[293] Dercksen 2005, 29-30.
[294] AKT 6a, 184; AKT 6b, 335; AKT 6b, 491; AKT 6c, 535; AKT 6c, 539; AKT 6c, 547; AKT 6c, 570; AKT 6c, 571; CCT 2, 36a; CCT 3, 20; CCT 4, 20a; Donbaz, FS N. Özgüç, 143-145; KTS 1, 12; LB 1202; OAA 1, 102; OAAS 4, 57-58; RA 60, 111 no. 42; RA 81, 55; TTC 16.

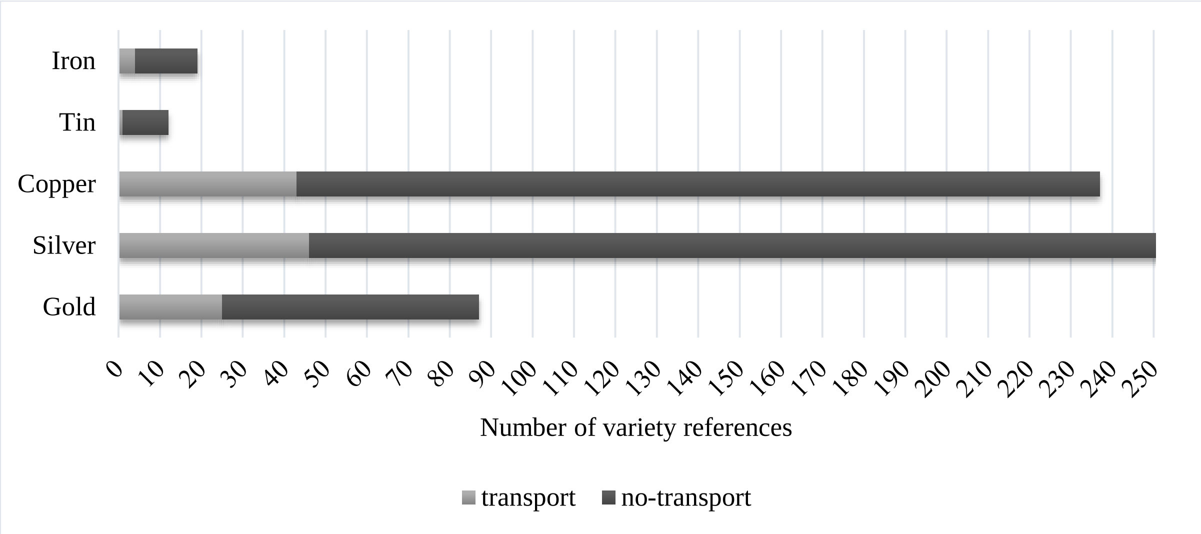

Chart 14. Comparison between the varieties' transport and no-transport references in the OA texts.

Chart 14 provides further information and support of the use of silver, as well as copper inside Anatolia, as currency. Such was usually exchanged in a refined and good quality, which is at times implied. On the other hand, gold was a very precious metal for the Assyrians. So, its specific variety and shape had to be mentioned in every possible detail. Similarly, tin appears to be imported from the east and forwarded to Anatolia in a standard form and quality, except from the explicitly distinguished "hand" tin.

Chart 15 shows a broadly similar pattern for the two different aggregates from the previous chart. It offers an analysis and comparison of the qualified and the total transport references. From this chart we see the size of the number of references and the frequency of each metal's varieties appearing in the texts. Here, bronze makes an appearance as a transported metal with no further specifications. Moreover, tin is represented by a single qualified reference, while the rest of its references regard transports with no specification of a variety. This observation further supports the statement that tin was traded in a standard quality, with only extremely rare exceptions. Likewise, transported silver is rather rarely distinguished by a specific variety. This could be due to the role of silver and that its refined state was not only implied, but also self-evident. On the contrary, copper and most importantly gold were very often shipped with detailed specifications. Gold was a very precious metal, whose price fluctuated depending on quality, purity and colour. These were also characteristics that were of importance to any goldworker. Copper was a primary commodity for the manufacture of bronze and specifying its quality and purity was likewise of importance to the metalworker.

Simultaneously, as was the case with gold, merchants dealing with copper transacted according to the already-mentioned characteristics of the metal.

In addition, examining the data from another angle, silver and tin are the metals that document the highest numbers of transport references. This is in keeping with their roles in the OA trade. The former probably had an unconditional value as currency, while the latter was the prime import commodity. It was imported into Assyria and then into Anatolia in a standard form and with no further qualifications. Whatever treatment was done to it to bring it to a ready-for-alloying state, it was performed prior to its entry into Assyria. As a result, varieties of tin are dramatically rare in the Kaneš texts.

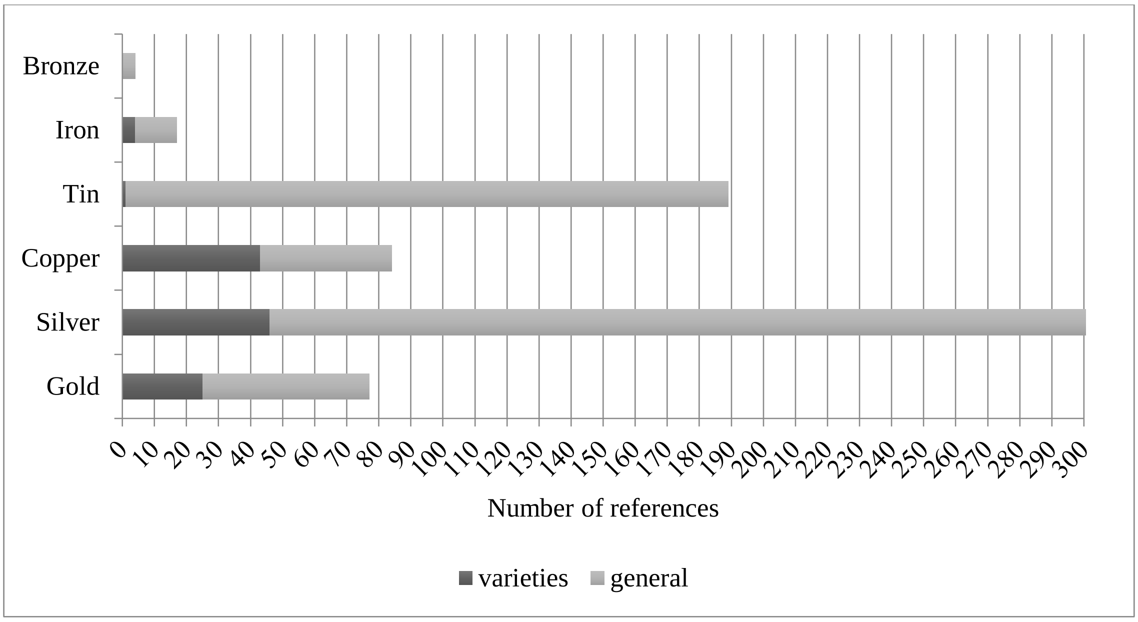

Chart 15. Comparison between the varieties' transport and the rest of the transport references in the OA texts.

Chart 16 presents a comparison of the transported amounts for all metals. The weight unit used for this representation is the talent, to restrict the length of the horizontal axis. As a reminder, 1 talent is equal to 60 minas and to 3600 shekels. Thus, taking into account the nature and origin of the analysed texts, tin is obviously the metal recording the greatest quantities transported; a total of about 481.8 talents. Not surprisingly, copper comes second, with a total of around 429 talents. Silver comes third, after a great gap. Its sum amounts to merely around 93.9 talents: this is because the focus of this research is not the monetary use and exchange of silver. Certainly, if all the silver being given or paid in return for any sorts of other goods or commodities were to be added, its total would grow exponentially. The second lowest amount belongs to gold, which records a total of approximately 1.1 talent. It must likewise be underlined that gold's sum would also increase greatly, if texts recording purchases made with gold in Aššur were to be included in the analysis. Last comes iron, with a total transported amount of 0.09 talent, i.e. about 5.6 minas. However, there is still much uncertainty as to whether the words now related to and regarded as iron, do actually refer to the metal iron.

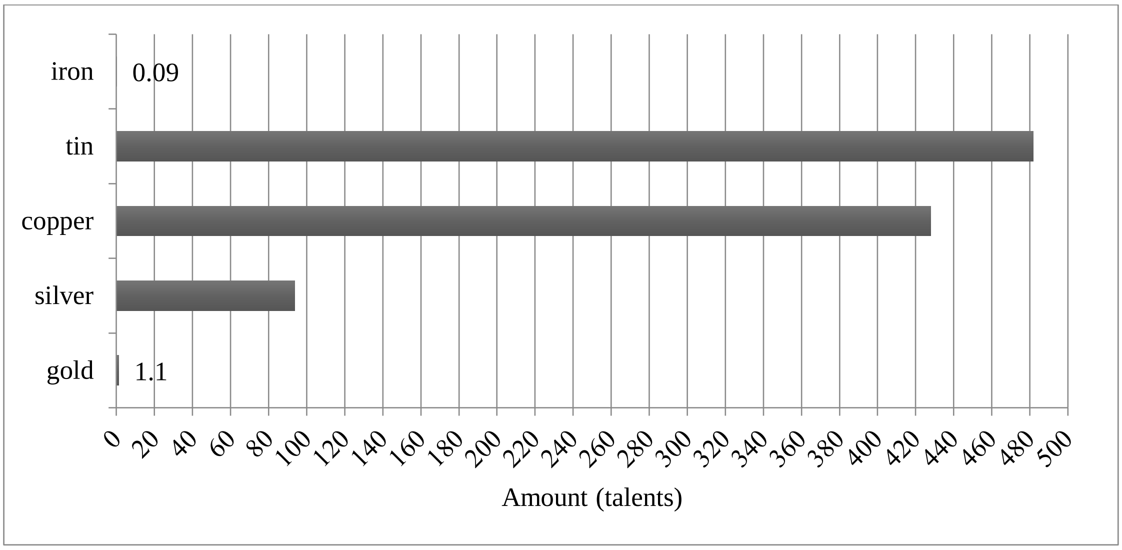

Chart 16. Comparison among transported amounts of the metals in the OA texts.

3.1.2 Metal varieties

This section focuses on the nomenclature employed to describe the varieties of metals existing; it explores all the information deriving from the studied texts. Observations regarding the type, content, quality, provenance and value of the varieties of metals so mentioned are made here. A similar attempt to record such a nomenclature was previously made by Forbes in 1971.[295]

3.1.2.1 Gold

A law of the OA period in Aššur was issued to prevent gold from being exported from the city of Aššur. It stated that:

[295] See also Reiter (1997), who is mainly examining the Early Dynastic Ebla, Ur III and Mari texts, and Dercksen (1996), who focuses on OA copper terminology.

> Assyrians can sell gold among each other, but in accordance with the words of the stele, no Assyrian whosoever shall give gold to an Akkadian, Amorite or Subaraean. Who does so shall not stay alive![296]

Gold must have been hoarded in the city and was also possibly used to pay for goods from "*importers who preferred or insisted on payment in gold*,"[297] such as those dealing in tin or lapis lazuli.[298] This strategy was vital for the acquisition of these particular merchandise and so it was necessary to keep gold away from other Mesopotamian traders' hands.[299]

From the many recorded varieties of gold, three have not been translated yet, namely *kiššum*, *liqtum* and *kuburšinnum*. *Kiššum* gold is mentioned thrice: in the heavily damaged tablet AKT 5, 16, kt 88/k 263 and kt c/k 440. Passages of the latter two texts were published by Donbaz,[300] in his discussion of the word *kīšum*. The same adjective, spelled *ki-ša-am*, can also be found in FS Veenhof, Donbaz 85ff. In this text, this term describes KÙ.AN and is written as *ša ki-ši-a*. Apart from this accordance and a short discussion from Donbaz, in which he demonstrates that the determinative *kīšum*, when it refers to gold, denotes a type of gold of good quality, "*a lesser quality of extra fine quality of pašallu gold*" and a native Anatolian product, no more information is available.[301] *Liqtum* gold is documented in a school exercise text and could have been an error in writing.[302]

The type of gold, which is described with the word *kuburšinnum* appears to be of a medium quality.[303] In TC 1, 47, Aššur-idī demands from Aššur-taklāku that no one should send him "any alluvial gold or any *kuburšinnu*-gold; if the *pašallu*-gold is of good quality, then send me some."[304] It may be that there is an abundance of these two types of gold where Aššur-idī is and/or that there is a higher demand for *pašallum* gold, which may also be of higher value and quality. Furthermore, from TC 3, 43 we learn that this variety of gold was sold at a rate of 6.6:1 and from ICK 2, 335 that it was bought at a rate of 6:1. These exchange rates are quite low in comparison to other varieties of gold; a fact that leads us to conclude that this particular variety was of a rather poor quality and thus of low(er) value.

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[296] Kt 79/k 101 (lines 13-25): *a-ḫu-um a-na a-ḫi-im a-na ší-mì-im i-da-an ki-ma / a-wa-at na-ru-a-im* DUMU *A-šùr šu-um-šu* KÙ.GI *a-na a-ki-dí-im a-mu-ri-im ù šu-bi-ri-im ma-ma-an la i-da-an ša i-du-nu ú-lá i-ba-la-aṭ*; Veenhof 1995a, 1733-735; 2003, 95-6; Hecker 2004, 44-5.
[297] Veenhof 2003, 96.
[298] See also Dercksen 2004b, 81-2.
[299] Veenhof 1995, 1733-735; Dercksen 2005, 25; Barjamovic 2011, 7-8.
[300] Donbaz 1988a.
[301] Donbaz 1988a, 50.
[302] Akkadica 42, 7.
[303] Dercksen 2005, 26.
[304] Larsen 2002, 58-9. TC 1, 47 (lines 16-21): KÙ.GI *lu ša ma-i-šu lu ku-bu-ur-ší-nu-um ma-ma-an i-na ba-ri-ku-nu lá ú-šé-bi$_4$-lá-am šu-ma* KÙ.GI *pá-ša-lúm* SIG$_5$; cf. BIN 6, 137 (lines 1-2): "1 ½ Seqel gutes Gold der *kupuršinnum*-Qualität" 1 ½ GÍN KÙ.GI SIG$_5$ *ku-bu-ur-ší-ni-im* (Ulshöfer 1995, 334).

A further variety of gold that often occurs in the Kaneš texts is *pašallum*. Most often, this is translated as "pale gold" or "electrum". Electrum is recognised as a gold and silver alloy, containing more than about 20% of the latter metal.[305] The addition of silver to gold can modify its colour from deep gold-yellow to pale yellow (the colour of electrum) to yellowish-white and even to green or grey with increase in silver content.[306] Forbes[307] states that white gold is simply "*the natural electrum containing much silver*". The CAD[308] writes that "*the frequent occurrence of pašallum in Old Assyrian texts suggests that the word designates electrum, an alloy found in Anatolia*". However, this statement is unfounded. *Pašallum* gold is transported as often as "refined" silver, "good" copper and "washed" copper. This leads to an association of the quality of this variety of gold with the qualities of "refined" silver and "good" and "washed" copper. *Pašallum* gold appears in good or in very good quality and is found in the form of an ore (literally "of its stone" *pašallum ša abnišu*). In AKT 6a, 166, Kulumaya is transporting silver together with *pašallum* gold, for which he states that it is of "very good quality" and that even there "it costs 10:1 (in silver)", about the same rate at which "blood-coloured" gold can be found.[309]

Moreover, in a recently cited passage from text kt 87/k 461,[310] the writer mentions that he obtained a big piece of *pašallum* gold by boiling it (*ú-ša-áb-ší-il$_5$-šu-ma*), during which process there was a great loss of weight. The writer goes then further and tells his addressee that "it is of excellent quality" (*damqum watrum*) and that he should "not give it to anybody, keep it in your possession".[311] Most interestingly, though, in the following line of the same letter, the writer says that "I will produce gold of good quality by refining" GUŠKIN SIG$_5$ *ú-ša-áb-ša-al-ma*.[312] Of interest here is the verb of this sentence, *bašālum*, meaning "to boil", "to melt", to smelt, found also in the causative stem *šubšulum*.[313] In another text, Itūr-ilī writes to Ennam-Aššur "This is important: buy for the 16 minas of [*tiri*-]silver some red gold (KÙ.GI

[305] Gale and Stos-Gale (1981) also arbitrarily defined silver containing more than 5% gold as aurian silver; Moorey 1994, 217-18; Bachmann 1999, 269; Ogden 2000, 162-63.
[306] Palache et al. 1944, 91; Forbes 1971, 171-72; Plenderleith and Werner 1971, 214.
[307] Forbes 1971, 171-72.
[308] CAD P, 234.
[309] Larsen 2010, 281-82. AKT 6a, 166 (lines 8-9): "The gold is of extremely good quality, even here it costs 10:1 (in silver)" KÙ.GI *da-mì-iq wa-ta-ar a-na-kam-ma* 10 GÍN TA *ú-ba-al*. Kt c/k 48 records a rate of 8.5-9:1 of "blood-coloured" gold with silver.
[310] Veenhof 2014, 411-12: kt 87/k 461 (lines 15-30).
[311] Kt 87/k 461 (lines 20-21): *ana mamman la taddaššu iqqātika ka''ilšu*.
[312] Kt 87/k 461 (lines 29-30).
[313] Veenhof 2014, 410-12; CAD B, 135-37. See also Larsen 1978, 116 notes on lines 16-17.

sà-ma-am) for smelting (*ša ša-áb-šu-lim*) and send it to me".[314] Dercksen[315] suggests that the phrase KÙ.GI *sà-ma-am ša ša-áb-šu-lim* probably meant "red gold or gold which needs cupellation". Veenhof,[316] on the other hand, maintains that the writer must have meant red gold "which has been refined", because red is the colour of pure gold. In another text it is mentioned: "Je vous ai écrit quant à l'or de bonne qualité (KÙ.GI SIG_5) et j'ai déposé ce qui est à fondre (*ša ša-áb-šu-lim*)".[317] Once again, the phrase KÙ.GI *ša ša-áb-šu-lim* has generated various translations: "for smelting", "which is to be refined", "which needs cupellation".[318] There does not seem to be any particular reason why this phrase should be descriptive of a cupellation process. Such would imply a specific metallurgical process that results in the purification of gold from base metals, but not from silver.[319] Moreover, this verb also refers once to silver. In KTS 1, 2b, we read "Das Silber läutere (*ù-ša-áb-ša-al*) ich nur im Auftrage meines Prinzipals".[320]

A cupellation process can preferably be denoted by the verb *ṣarāpum*, which is most often found as an adjective characterising "refined" silver (KÙ.BABBAR *ṣarpum*).[321] However, in OAA 1, 97 we read that the gold was "smelted (*iṣ-ru-up-šu-ma*) and it turned into silver" (*a-na* KÙ.BABBAR^{pí}*-ma i-tù-ar*). As a result, the writer of the letter beseeches the addressee to "put that in the fire twice" (*a-na i-ša-tim šé-ni-šu ta-er-šu*).[322] The fact that there is no connection between *pašallum* gold and the type of gold that turned into silver after it was put in the fire and that needs to be put in the fire twice in order to make sure that its quality is good (enough), leads to the conclusion that *pašallum* gold is actually not the silver-containing type of gold, known as electrum.

Probably associated with the above-mentioned, possibly silver-containing, variety of gold is the one referred to as "white". Text FS Matouš 2, 125 writes "Do not involve yourself with any white gold. You must know that there is a lot of white gold here!".[323] But most

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[314] Larsen 1978, 114-15. FS Matouš 2, 125 (lines 15-17): *a-put-um ša* 16 *ma-na* KÙ.BABBAR KÙ.GI *sà-ma-am ša ša-áb-šu-lim* (…) *šé-bi₄-lam*.
[315] Dercksen 2005, 26 n. 33.
[316] Veenhof 2014, 411.
[317] Michel 1991, 135-37. Michel, Innaya II, 135ff. no. 100 (lines 56-57): *a-di* KÙ.GI SIG_5 *ù ša ša-áb-šu-lim a-ti-di*.
[318] Larsen 1978, 115; Michel 1991, 137; Dercksen 2005, 26 n. 68.
[319] De Jesus 1980, 86-7. On cupellation and cementation (and the salt process), see: Forbes 1971, 177, 180-81; De Jesus 1980, 86-7; Moorey 1994, 218-19; Dercksen 2005, 27.
[320] Sturm 1995, 503. KTS 1, 2b (lines 14-16): KÙ.BABBAR *a-šu-mì a-bi₄-a-ma ù-ša-áb-ša-al*.
[321] See also Veenhof 2014, 405-7.
[322] Larsen 2002, 138. OAA 1, 97 (lines 7-8, 22-23).
[323] Larsen 1978, 114-15. FS Matouš 2, 125 (lines 23-27): *lá ta-da-an a-na* KÙ.GI *pu-ṣí-e qá-at-kà lá tù-ba-al lá tí-de₈-e ki-ma a-na-kam pu-ṣí-ù ma-du-ú-ni*.

interestingly, the same text refers to the already-mentioned "red" gold.[324] Red-coloured gold is usually described by the logogram *HUŠ.A* or the Akkadian word *sa'amum*, but there is also a text in which a phrase meaning "blood-coloured" *ša damu* is employed.[325] In it, we read as follows:

> und in Kaniš 1 Mine oder 2 Minen gute Qualität Blut(farbenes Gold) (zu dem Preise) 8 ½ Schekel oder 9 Schekel (Silber für je 1 Schekel Gold) kauft für mich, aber wenn euch Wasch-Gold in die Hände fällt kauft für mich 1 Mine Gold zweimal (den Betrag des Hochwertigen)".[326]

With this passage we appreciate the high value of this red, "blood-coloured" gold. This is twice as valuable as gold "of its water" *ša mā'ešu*, translated as "Wasch-Gold" by Balkan and as "alluvial gold" by Larsen.[327] The last word of the passage cited above ("zweimal") is the Akkadian word *šinīšu*, which is an adjective meaning "twice". In the text, it is afound in the form *a-ši-ni-šu*, which means "in two", thus denoting a half amount. As a result, the passage should be understood as: "buy for me 1 mina gold (for) *half (the price)*".[328] The exchange ratio of 8.5:1 or 9:1 for "blood-coloured" gold is among the highest recorded. Unfortunately, there is only one reference of this type of gold, leaving us with not much information to go on.

Red is the colour of pure gold. Despite the belief that gold refinement, i.e. the separation of gold from silver, was not invented before the Achaemenid Period (after 540 BC), texts from Mari attest to the possibility of gold refining.[329] In text ARM 25, 313, published by Limet, we find the noun *lurpianum.* This word appears to be associated with gold separation and the CAD identifies it as a mineral, which may be salt.[330] The relative passage from the text ARM 25, 313 reads as follows: "2/3 de mine 5 sicles de … [*lu-ur-pí-a-nu*], pour la fabrication de l'or du trône de Šamas; reçu d'Ana'iš".[331] In view of testing the theory of the application of salt to purify gold, Wunderlich, Lockhoff and Pernicka[332] conducted a series of experiments. They proved that a parting technique using this mineral is fairly easy and that even a single processing cycle would yield a much purer gold than the original. Thus, it seems possible that a salt cementation

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[324] Larsen 1978, 114-15. FS Matouš 2, 125 (lines 16-17): KÙ.GI *sà-ma-am*.
[325] Kt c/k 48; cf. Balkan 1965, 151.
[326] Balkan 1965, 151. Kt c/k 48 (lines 35-40): *ù i-na Kà-ni-iš*[KI] GUŠKIN 1 MA.NA *ù* 2 MA.NA SIG$_5$ *ša da-me-e* 8 ½ GÍN.TA *ù lu* 9 GÍN.TA *ša-ma-nim ù šu-ma* GUŠKIN *ša ma-e-šu i-šé-ra-ku-nu-tí* 1 MA.NA GUŠKIN *a ší-ni-šu li-qí-a-nim*.
[327] Balkan 1965, 151; Larsen 2002, 58-9.
[328] Emphasis by the author. CAD Š(3), 44-6, especially p. 46.
[329] De Jesus 1980, 85-7. See also: Craddock 1995, 116; Ogden 2000, 163.
[330] CAD L, 256; Limet 1986, 288 n. 734; texts ARM 25, 313 and ARM 25, 734; Moorey 1994, 219.
[331] Limet 1986, 98. ARM 25, 313: 2/3 *ma-na* 5 *gín lu-ur-pí-a-nu a-[na] ši-pí-ir* KÙ.GI *ša* [giš]*gu-za ša* [d]*utu šu-ti-a A-na-i-iš.*
[332] Wunderlich *et al*. 2014.

process, to part gold from silver, could have been applied at least since the early 2nd millennium BC.[333] The subject of gold refinement will be further discussed in Chapter 4.1.1.1.2, below.

Another interesting variety of gold is that which is qualified as *ša mā'ešu*. Both Balkan and Larsen take this to be "alluvial" gold.[334] The phrase comes from the Akkadian *mû* meaning "water" – so literally "of its water".[335] The two texts that contain the variety of gold described as *ša mā'ešu* are TC 1, 47, which has already been mentioned and discussed in connection to *kuburšinnum* gold, and kt c/k 48, which has also been previously discussed in connection to the "blood-coloured" type of gold. First, in the former text and particularly in lines 16-22, the writer says that no one of the addressees should send the writer *ša mā'ešu* or *kuburšinnum* gold, but if there is any *pašallum* gold they should send him some. In this text, the two varieties of gold, *ša mā'ešu* and *kuburšinnum*, are put in the same level and at the same time in a lower position compared to *pašallum* gold. Furthermore, other texts document an exchange rate of *pašallum* gold with silver at 10:1 and of *kuburšinnum* gold with silver at 6-6.6:1. Moreover, if gold *ša mā'ešu* is of the same value as *kuburšinnum* gold, then it should also be of a rather poor quality and purity. Second, the latter text supports the conclusion drawn regarding the quality of *ša mā'ešu* gold. "Blood-coloured" gold is to be bought at a rate of 8.5-9:1, when *ša mā'ešu* gold is valued at half its price. As a result, the former variety should be considered as a very pure quality and the latter simply as half as valuable or as pure.[336]

Further, and in a way related to the above-discussed variety of gold, is gold *ša tiāmtim*. The Akkadian word *tâmtu* means "sea", "ocean", "lake", or any other large body of water and the surrounding region.[337] In the OA text FS Matouš 2, 126, it is understood and translated as "sea-gold": "1/2 mina 1/3 shekel of sea-gold, converted to silver at the rate 6:1; further, 3 shekels of gold from ore, converted at the rate 8:1".[338] The "gold from ore" that is mentioned in the second part of the passage, expressed with the Akkadian phrase KÙ.KI *ša áb-ni-šu*, literally is gold "of its stone". According to the passage, this type of gold is of higher value than "sea-gold", written as KÙ.GI *ša tí-a-am-tim*, literally gold "of the sea". The latter has nearly the same low exchange rate as gold *ša mā'ešu*, i.e. 4.5-6:1. On the other hand, the former

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[333] De Jesus 1980, 86-8; Bachmann 1999, 269-72. See also Forbes 1950, 155-60.
[334] Balkan 1965, 151 (kt c/k 48); Larsen 2002, 58-9 (TC 1, 47).
[335] CAD M(2), 149-55: *mû* (*mā'ū*) subject meaning "water" or "fluid, liquid matter".
[336] CAD (M(2), 156: *mû* (*mā'ū*) in ša *mā'īšu)* translates it as "a fine quality" of gold. Dercksen (2005, 26) suggested that gold *ša mā'ešu* refers to "alluvial gold". See also Veenhof 1972, 181.
[337] CAD T, 150-57.
[338] Larsen 1978, 116-17. FS Matouš 2, 126 (lines 5-6): *ú ½ ma-na* 1/3 GÍN KÙ.GI *ša tí-a-am-tim* 6 GÍN.TA *a-*KÙ.BABBAR *lá-qé a-ḫa-ma* 3 GÍN KÙ.KI *ša áb-ni-šu* 8 GÍN.TA *lá-qé*.

is valued at a price between that of a lower (*kuburšinnum* and *ša mā'ešu* gold at 6-6.6:1) and that of the highest quality of gold (*ša damu* and *pašallum* gold at 8.5-10:1). Hence, gold "of the sea" is of a poorer/lower quality as well. Chapter 4.1.1.2.3 contains a more detailed discussion concerning the varieties of gold named *ša mā'ešu* and *ša tiāmtim*.

3.1.2.2 Silver

Just like gold, silver also has certain terms describing a variety, which cannot be at present accurately translated. One of them is *lītum* silver, which always appears to be handed on to someone. In text AKT 6b, 488, "good *lītum*" and "good" silver are mentioned in a debt note.[339] A second untranslated term is *tirum*. Balkan[340] suggested that it is a short form of an adjective denoting a place of origin, namely Taritar (the Hittite Taritarra).[341]

A very rarely mentioned type of silver is the one called "at hand", Akkadian *ša qātim*, which was also used to express the already-mentioned "hand tin". However, it cannot be said what characteristics this type of silver had or even if it was of a specific variety, as for example refined. Moreover, it cannot be regarded as a specific variety of silver, but rather as silver being used for a specific purpose.

Silver was qualified according to its quality in "good", expressed with the logogram SIG_5 or its Akkadian counterpart *damqum*, and "bad", expressed with the Akkadian word *mussuḫum*.[342] In addition to the translation "of bad quality", the last variety of silver has also been understood as "dirty", "spoiled" or "rotten", while Dercksen[343] refers to it as "silver-rich slag", an impure, lead-containing, type of silver which needed further refining.[344] However, of great importance to the OA merchants was also the purity of the metal, which was in turn linked to its quality. Hence, there is a "refined" variety of silver, which is linked to the "checked (in fire)" variety. As it has been mentioned in the beginning of Chapter 3, both varieties are totalled as one volume of "refined" silver, thus demonstrating that though they were in some kind of way distinct, yet they still carried the same general meaning.[345] This "checked (in fire)" variety is expressed with the word *ammurum*, which was initially read as "Amorite". However,

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[339] See also Veenhof 2014, 396.
[340] Balkan 1965 quoted in Dercksen 1996, 44-5.
[341] See also Veenhof 2014, 397. A proposed location for Taritar is the area of Devrez Çay near Çankin, in Turkey (Dercksen 1996, 15 and n. 44). See also: Balkan 1965, 149; Barjamovic 2011, 263.
[342] CAD M(2), 236, 240. See also Dercksen (2005, 24), who understands *musukkūm* as "slag".
[343] Dercksen 2005, 23-4.
[344] See **Appendix 4**.
[345] Sturm 1995, 501-3; Veenhof 2014, 394-95.

Sturm[346] showed that this interpretation was wrong and that the word had no connection with the Amorites, but was a derivation of the verb *amārum* "to see/inspect".[347]

"Refined" silver, KÙ.BABBAR *ṣarpum*, appears to have been the most important type of silver in circulation. It is the most popular variety of this metal documented in the OA texts and it is a constituent of four types of transactions or transaction contexts: 1) debt, loan or debt payments, 2) transports, 3) purchases or trade and 4) handovers or payments. A rough calculation of the number of references to each type of transaction reveals that this variety of silver is mostly involved in debts and loans, and transports. Sometimes, it is used for purchasing wool, tin, carnelian, or slave girls. The least mentioned category of transactions is the one referring to payments and handovers, which may be connected to debts. Therefore, all of these types of transactions, which are not trade-related, are assigned to a separate category and are not taken into consideration in this study.

The refining of silver is done by a certain process, known as cupellation. More on the actual process will be mentioned in Chapter 4.1.1.1.1.[348] To be certain if the silver has been cleaned from its impurities and is thus refined, it has to be checked. The straight-forward way to see if the silver is pure enough is to place it in a fire. This checking by fire is described by the aforementioned "checked (in fire)" (*ammurum*) silver. The act of checking is attested in several OA texts and was accompanied by loss of weight.[349] The fact that the practice of checking the silver by fire was accompanied by loss of weight, due to the (further) refinement of the metal, is what makes the close connection between "refined" and "checked (in fire)" silver more obvious.

In addition, there are a few texts that refer to the washing of silver using the verb *masā'um*, meaning "to wash", "to clean".[350] This "washing" of the silver was followed by a loss of metal and was also applied to silver "of bad quality". Moreover, it is often found along with *išeratum*, which is also usually found together with *ṣa''udum* "to melt". Veenhof[351]

[346] Sturm 1995.
[347] CAD A(2), 5-27: *amāru* verb.
[348] See also kt a/k 913 (lines 7-14): "20 Mine Silber legten sie vor sie hin, zur Hälfte verfeinertes Silber, zur Hälfte (im Feuer) geprüftes. In das Haus der Stadt (Assur) brachten sie (das Silber) zum Kauf von Kupfer hinein. Und dann ergriffen sie verfeinertes Kupfer." 20 *ma-na* KÙ.BABBAR *i-na ma-aḫ-ri-šu-nu iš*-[*ku-nu*] *mì-ša-al* KÙ.BABBAR *da-m*[*u-qú-um*] [*mì-iš*]-*lu-um* / *a-mu-ru-u*[*m*] *a-na É*^{et} *a-lim*^{ki} *a-na* URUDU *ša-a-mì-im ù-šé-ri-bu-ma* (Sturm 1995, 500).
[349] See texts: CMK 151; ATHE 28; CCT 3, 27a; TC 3, 43; CCT 3, 5a. On silver refinement, i.e. cupellation, see: Forbes 1971, 245-46; De Jesus 1980, 72-3; Moorey 1994, 233; Dercksen 2005, 18-9. On the metal loss due to heat treatment, see: Veenhof 1972, 46-50; Dercksen 2005, 18-9. See also Veenhof 2014, 404-5.
[350] Dercksen 2005, 23-4; Veenhof 2014, 407-9.
[351] Veenhof 2014, 407-9.

mentions the possibility of this “washing” being a less drastic process than the refining-via-cupellation treatment of silver.

Furthermore, “clear” silver, actually meaning pure, is described in Akkadian with the word *zakuum*. This pure form of silver appears only once, in text kt 89/k 261. Moreover, the same Akkadian word is also once used in reference to tin,[352] once to copper[353] and thrice to KÙ.AN/*amūtum*.[354] It is never used to describe gold; something that is understandable considering the difficulty to completely separate gold from silver.

Additionally, it should be noted that the refinement of silver seems to have been an expense-incurring, time-consuming, tax-liable process, which had to be done when the silver was of bad quality. It was also very often performed in order to assure the quality, purity and actual value of the metal. ATHE 28 and VS 26, 50 illustrate how refining silver is an act liable to cost: “1 sicle d’argent pour le forgeron et pour le bois, nous avons payé”,[355] “[10 M]ine geläutertes Silber (und) [10 Min]e (im Feuer) geprüftes Silber wird euch […] Ikuppīja bringen. (Die) 20 Mine geläutertes Silber borgt den Geldgebern oder euren Stellvertretern auf Zins!”[356] KTS 1, 2b shows the merchant’s desire to and way of avoiding paying the additional tax for the refined silver: “Falls der Kārum an dich herantritt, so (sprich) folgendermaßen: ‘Das Silber läutere ich nur im Auftrage meines Prinzipals.’ Sprich mit keinem darüber, damit du nicht die *šaddu’utum*-Steuer zahlen musst!”[357]

Furthermore, the act of checking the silver may also refer to doing so by weighing it. This act has been a subject of many prior studies that found that different areas, towns or kingdoms of the Near East used different weight standards. The use of different weights caused variations in readings in the weight calculations, which meant that an amount of the metal was “missing” at the final count.[358] In CCT 3, 27a, Pilahaia and Irma-Aššur “checked the silver and (found) 2/3 mina missing”,[359] and in AKT 6a, 74, Šišara and Ištar-lamassī tell Ikūn-pīya to “let

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[352] Anatolica 12, 138.
[353] AKT 3, 56.
[354] FS Veenhof, Donbaz 83ff., ICK 1, 55 and CCT 4, 34c.
[355] Ichisar 1981, 281-82. ATHE 28 (lines 8-9): 1 GÍN KÙ.BABBAR *a-na na-pá-ḫi-im ù e-ṣí ni-dì-in*.
[356] Sturm 1995, 499-500. VS 26, 50 (line 4-11): [*x*] *ma-na* KÙ.BABBAR *ṣa-ru-pá-am* [*ù ma*]*-na* KÙ.BABBAR *a-mu-ra-am* […] *I-ku-pì-a na-áš-a-ku-nu-ti* 20 *ma-na* KÙ.BABBAR *ṣa-ru-pá-am a-na ṣí-ib-*[*tim*] *a-na um-mì-a-ni ù ša ki-ma ku-nu-ti* / *dì-ma*.
[357] Sturm 1995, 503. KTS 1, 2b (lines 13-19): *šu-ma kà-ru-um i-sà-ni-iq um-ma a-ta-ma* KÙ.BABBAR *a-šu-mì a-bī-a-ma ú-ša-áb-ša-al ma-ma-an lá ta-za-kà-ar ú ša-du-a-tám lá ta!-na-dí šu-ma*.
[358] Veenhof 1972, 50-2, 54-68; 2014, 405 n. 37; Parise 1989; Dercksen 1996, 82-9; Zaccagnini 2000a; further examination of this subject is beyond the scope of this research, but see Pulak 1996, 25-48.
[359] Larsen 1967, 11-2. CCT 3, 27a (lines 7-8): *ub-lam* KÙ.BABBAR *ni-is-ni-iq-ma* 2/3 *ma-na* KÙ.BABBAR *im-ṭì*.

him refine the silver and check it with the weight stones of the merchant, let him seal it and give it to you".[360]

3.1.2.3 Tin

There are only six recorded varieties of this metal in the studied sample. First, there is a variety called *masīrum*, encountered only once in AKT 6c, 655. The text reads as follows: "Until he has made me pay the *masīru*-tin, my dear brother, pay 7 shekels of silver per (mina) for my tin to my representatives".[361] Unfortunately, there is no further information about this type of tin available. Probably the most important type of tin, with regard to how many times it is attested, is "hand" tin (*ša qātim*), which was given to caravan leaders to spend on on-road expenses. It is unclear as to whether this type of tin was of a different and specific quality, or form. However, it may be possible to imagine that this tin "for the hand" was in pieces, smaller and lighter than a talent or even possibly of a mina. If this tin was used as currency, then it could have been of more or less standardised shapes and weights, in order to ease the transactions. It could have also been in the form of broken bars or ingots, or even of rings of tin. Nevertheless, "hand" tin cannot be regarded as a variety of tin *per se*, as it is a clear specific-purpose kind of tin.

Varieties of this metal are SIG_5 "good", SIG_5 *watrum* "of very good quality", *mussuḫum* "bad" and *zakuum* "clear". Most references to tin are requests (or orders) from merchants in Kaneš to their associates back in Aššur to buy and send them tin of "good" quality. Text RA 81, 20 is one of the two texts (the second one is BIN 6, 79) that specifically list "good" tin and textiles as part of the cargo of a caravan heading to Kaneš. In this particular text, Aššur-nādā is the person receiving the goods and in text TC 1, 15, the same person tells Aššur-idī to buy for him and send him tin of the above-mentioned quality. Moreover, in text Ka. 970 and specifically in line 7, Donbaz translates that Ištar-pilah informs Imdīlum that the tin that he sent him was "bad" (*ma-sú-hu-ni*).[362] "Bad" can mean that the metal has deteriorated. The text also states that the tin was "checked" (*as-ni-iq-šu-ma*). The word used here is derived from the Akkadian verb *sanāqum*, which denotes "to check", "to supervise", "to control", and it does

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360 Larsen 2010, 146-47. AKT 6a, 74 (lines 29-31): KÙ.BABBAR *lu-ṣa-ri-ip-ma i-na a-ba-an* DAM.GÀR-*ri-im lu-sa-ni-iq-ma li-ik-nu-uk-ma*.

361 Larsen 2014, 212-13. AKT 6c, 655 (lines 24-27): *i-zi-iz* AN.NA *ma-sí-ra-am ú-ša-áš-qí-li-ni a-hi a-ta* 7 GÍN TA KÙ.BABBAR *a-na* AN.NA-*ki-a* : *a-na ša ki-ma i-a-tí šu-qú-ul*.

362 Donbaz 2015, 105.

not suggest that the metal was put in fire in order to check the level of its purity, as in the case of silver.[363]

Furthermore, text TC 3, 50 records tin "que tu as raffinées", as Ichisar[364] translated the phrase *ša tamsium* – literally "that has been washed". This translation is rather puzzling because, as far as we know, no treatment was applied to the tin that entered Aššur. The preferred quality and variety of tin from the OA traders was one that was of good quality and refinement, or any other treatment, must have been performed before the metal arrived in Assyria.[365] Thus, a refinement process, speaking of tin, does not make sense. However, until more such references come to light, we cannot prove that it had some other meaning and that it did not mean "that it has been refined", just as we cannot prove that it did denote a refinement process.

3.1.2.4 Copper

Copper is the metal with most varieties and thus most varieties' references. Translations, however, occasionally confuse the literal and figurative meanings of the Akkadian words. The logogram SIG_5 and its Akkadian counterpart *damqum*, which literally mean "of good quality", have also been taken to denote "fine" or even "refined" copper.[366] In addition, the adjective *masium*, denoting "washed" copper, has been translated as "refined", "washed", "mixed", "cleaned", or even "purified" copper.[367] This adjective probably describes refined copper. It was a purer than naturally found, meaning of higher copper content, and of a good quality of copper.[368] It goes without saying that the higher the copper content, the better the quality of the piece. "Good" SIG_5/*damqum* and "washed" *masium* copper is what the OA merchants and smiths were looking for. There are many occasions where a merchant states that the copper is, or should be, turned into copper of good quality, especially in Durhumit.[369] For example text AKT 1, 17 writes:

> As for the rest of the copper, 10 talents from Kunanamit plus the 6 donkeys, I said: "Come, I shall pay you" – so I trusted you, but you cheated me, saying: "I shall lay

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[363] CAD S, 133, 138-39, 141-42.
[364] Ichisar 1981, 355-56.
[365] See Dercksen 2005, 19-20.
[366] See **Appendix 4**.
[367] Dercksen 1996, 34-5. See **Appendix 4**.
[368] See also Dercksen 1996, 34-5.
[369] AKT 1, 17; AKT 6c, 621; CCT 4, 27a; CCT 4, 47a.

claim to the 10 talents of copper and the 6 donkeys, turn that into copper of good quality in Durhumit, bring it to Kaneš and your representatives will pay me in full in silver".[370]

Moreover, there are occasions when "washed" copper appears to be equated with "good" copper. Such an example can be found in the text, cited by Dercksen:[371] "Send me your instructions if refined copper is in demand, and I will obtain fine copper".[372] Another rather interesting and important reference is recorded in text LB 1202, where Imdīlum asks for "cuivre de bonne qualité pour (la fabrication) du bronze" URUDU SIG_5 *a-na sí-pá-ri*.[373] There also seem to exist different levels of refinement or purity of copper. Thus, there is copper *masium* SIG_5 "washed of good quality", mentioned in texts AKT 6b, 377 and ICK 2, 99. Of the two tablets, the former mentions this type of copper in a transport context.

Furthermore, according to Dercksen,[374] copper scrap was of high quality and of high price, due to its ability to be re-melted and recast into new objects. When a metal is described as *hušā'ū* "scrap", it means that it is deemed unusable and it can thus be recycled. There is ample textual evidence of scrap metal, "small wares", sickles or nails being transported together with trade goods. Michel[375] notes that during the OA period the term *hušā'ū* was generally applied to both copper and bronze. As a matter of fact, most references specifying scrap metal speak about copper.[376] However, there are many more instances when the specific metal is not explicitly mentioned. These are mostly shipments of tin and textiles, to which scrap metal has been added. This "scrap" metal could also be bronze, as it is sometimes recorded along with nails.[377] In addition, text KTH 18 speaks of a caravan that is sent from Aššur to Kaneš, transporting a great amount of tin and textiles and referring to scrap metal:

> I gave them 2/3 minas of silver for their scrap metal or small wares; further, I gave them 1 shekel of silver for small wares just before the departure; they gave 10 minas of nails, 136 in number, for the carriage of 10 top-packs and 4 half-packs, and I personally paid the transportation costs until Qaṭṭara.[378]

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[370] Larsen 2002, 101-3. AKT 1, 17 (lines 25-31): *ší-tí* URUDU GÚ *ku-na-na-ma-i-um ù* 6 ANŠE *um-ma a-na-ku-ma / al-kam / lu-ša-qí-il₅-kà-ma at-kal / tú-ni-a-ni-ma / um-ma a-ta-=ma i-na* 10 GÚ URUDU *ù* 6 ANŠE *qá-tí lá-áš-ku-un-ma / i-na Tur₄-ḫu-mì-it a-na* URUDU SIG_5 */ lu-ta-er-ma / a-na Kà-ni-ìš lu-bi-il₅-ma / ša ki-ma / ku-a-tí* KÙ.BABBAR.*pí*.

[371] Dercksen 1996, 35.

[372] Kt a/k 579 (lines 11-14): *ší-im* URUDU *ma-sí-im i-ba-ší té-er-ta-kà li-li-kam-ma* URUDU SIG_5 *le-pu-uš.*

[373] Ichisar 1981, 241-42. LB 1202 (lines 28-29).

[374] Dercksen 1996, 45-6.

[375] Michel 2001, 454; Dercksen 1996, 45-6.

[376] See reference to this variety of copper in **Appendix 4**.

[377] See texts AKT 6b, 144 and AKT 6b, 145, which refer to the same shipment.

[378] Larsen 2002, 166-68. KTH 18 (lines 13-20): 2/3 *ma-na* KÙ.BABBAR *lu a-ḫu-ša-e lu a-na ṣa-ḫe-er-tim a-dí-šu-nu-tí a-ḫa-ma* 1 GÍN KÙ.BABBAR *a-ṣa-ḫe-er-tim* KÁ *ḫa-ra-nim a-dí=šu-nu=tí* 10 *ma-na sà-am-ru-a-tum* 1 *me-at* =36 *mu-nu-sí-na* 10 *e-li-a-tim ù* 4 *mu-ta-tim a-ta-ší-a-tim i-dí-nu-ma a-dí Qá-ṭá-ra ta-ší-a-tim a-na-ku a-dí-in*.

It is possible that these “scrap metal” and “small wares” (i.e. “in small pieces”), written as *ḫušae* and *ṣaḫertim* in the original Akkadian text, were the nails that were in the end given. Additionally, in text KTS 2, 8 an amount of copper is delivered from the north of Anatolia and the receiver complains that the scrap copper is missing.[379] This passage can be understood to mean that when amounts of copper are shipped from their sources in Anatolia, then it is somewhat expected that an amount of scrap metal to be included in the package as well. Otherwise, the receiver’s complaint could only be justified if there had been a previous letter stating that copper scrap would (or should) be included. In general, the nature of these pieces of metal that deemed unusable suggests that the sole purpose for their transportation is to be delivered to smiths in order for them to be refashioned into new metal objects, or to be used as currency. Scrap copper (and unusable or damaged bronze objects) is easy to melt and reform, as it is already smelted and clean from most impurities. Even if the metal contained unwanted impurities, it could be further refined by simply putting it into a crucible and melting it.

In the above-cited passage from KTH 18, apart from the variety of copper known as *hušā’ū* “scrap”, there is also the variety called *ṣaḫḫirum* “in small pieces”, found in the form *ṣaḫērtim* and translated as “small wares”. The form of the word that we read here derives from the subject *saḫirtum* (*saḫartum*), which denotes “small wares”, “sundries”.[380] This can also be connected to the Akkadian word *sāḫirum*, which denotes a peddler.[381] Moreover, the word *saḫirtum* appears to be related to the adjective *ṣiḫḫirum*, which means “small”, “broken up”, as well as to the verb *ṣeḫērum* (*ṣaḫārum*), which denotes “to become small”, “to break up (in smaller pieces?)”.[382] Nevertheless, the normalisation of the word that derives from the verb *ṣeḫērum* (*ṣaḫārum*) is unclear and, thus, the matter of the translation and of the exact meaning of the word *ṣaḫḫirum* is still under discussion.[383] For this reason, Larsen left the word untranslated in the publications of AKT 6a and 6b.[384] As far as this research is concerned, all records of the variety of copper read as *ṣaḫḫirum* will be given the translation “in small pieces”. They are all included in debt-notes and not one of them comes from a transport context with the means of trade. Additionally, AKT 6a, 183 and its duplicate, AKT 6a, 251, speak of

[379] KTS 2, 8 (lines 5-6): 3 *m[a-na] im-ṭì ḫu-ša-ú-š[u]*.
[380] CAD S, 57-9.
[381] AKT 6a, 183 note on line 2; CAD S, 60. See also CAD S, 55: *saḫḫiru* (fem. *saḫḫirtu*) = adjective meaning “roaming”, “going around”.
[382] CAD Ṣ, 120-24, 174.
[383] Veenhof (1972, 431 n. 547); Dercksen 1996, 40; Larsen 2010, 307 note on line 2 of text AKT 6a, 183.
[384] Larsen 2010; 2013.

"*sahhiru* copper from Durhumit", a place where copper is often sent to be turned into copper of good quality.[385]

Additionally, there is the variety of copper recorded as *šikkum* and its ascription to English is similarly potentially double and thus unclear. It comes from the Akkadian word *šīku* (or *šikku*) and it is either translated as "gestückeltes Kupfer" by Ulshöfer,[386] or left untranslated as "*šikkum* copper" e.g. by Dercksen,[387] Veenhof,[388] and Larsen.[389] Nevertheless, Dercksen[390] offers important information regarding its properties, quality and sale prices. He states that it was "*a primary smelting product containing many impurities*". What we can infer from the texts is that it was of a lower quality than "good" and "washed" copper and, at the same time, it was differentiated from "poor" copper. So, it must have stood in an intermediate position. Additionally, it was used as payment (as was "good" copper).[391] Moreover, in text TC 2, 33, 1 shekel of silver was exchanged for 3 minas of *šikkum* copper and a gold bead was exchanged for 1 talent of this type of copper. Thus, according to this text, the exchange rate of *šikkum* copper with silver is 1:180. Based on text TC 1, 23, Dercksen[392] gives a sale price at 1:140, when at the same time the sale price of "good" copper is at 1:68 and 1:70 with silver and 1:60 for "checked (in fire)" silver.[393] Thus, "good copper" seems to have been priced nearly twice as high, or even higher, as *šikkum* copper.

Then, there is a variety of copper that is often translated as "native" and written as *ša šaduišu* – literally "of its stone". The earliest published text containing this phrase is OIP 27, 62, where Gelb could not understand its meaning and thus left it untranslated.[394] Later, Ichisar[395] translated it as "à être payées comme sa taxe". Moreover, in the school text kt t/k 76 + kt t/k 79, Hecker[396] read *ša-du-pí-šu* where Dercksen, instead of the "*pí*" sign read an "*i*" sign for the word *ša-du-i-šu*.[397] Dercksen's publication in 1996 includes three of the five texts that

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385 See: AKT 1, 17; CCT 4, 27. See also: TC 2, 36. Dercksen 1996, 129, 154-55.
386 Ulshöfer 1995.
387 Decksen 1996, 42-3.
388 AKT 5 = Veenhof 2010b.
389 AKT 6a = Larsen 2010; AKT 6b = Larsen 2013; AKT 6c = Larsen 2014.
390 Dercksen 1996, 42-3.
391 See AKT 6b, 446.
392 Dercksen 1996, 42.
393 The 60:1 ratio between "good" copper and "checked (in fire)" silver is read in kt 87/k 462. There also is a 120:1 ratio between copper and silver (2 minas of copper for 1 shekel of silver) mentioned in RA 60, 143 (line 12-14).
394 Gelb 1935, 67-8.
395 Ichisar 1981, 388.
396 Hecker 1993, 286-90.
397 Dercksen 1996, 41, 215. Kt t/k 76 + kt t/k 79 (Rs. V. line 7): URUDU *ša ša-du-pí-šu*, which according to Hecker's translation means "bronze ring". Based on the fact that this is listed among other copper items, such as a cup, a bar and a rod, it seems logical to imagine that this phrase should remain as Hecker initially saw it URUDU *ša ša-du-pí-šu*.

mention the phrase *ša šaduišu*. The other two are found in AKT 5, published in 2006. Dercksen identified the word formation *ša šaduišu* as deriving from the word *šadu'um*, meaning "mountain". The Akkadian word *šadû*, according to the CAD, means "mountain" or "rock", designating a source of raw materials.[398] Unfortunately, all texts from Kaneš that refer to this kind of copper do not offer much information regarding its quality, or properties. In text AKT 5, 25, Veenhof notes that this type of copper probably was a product of local origin, which may have required further refining.[399] One would be inclined to relate this copper "of its mountain" – as Veenhof described it – with the "mountain copper" of the texts from Mari. The last, however, came to Mari from the king of Yamḫad, an area located near Aleppo.[400] In the case of Anatolia, copper sources were located primarily in the Pontic zone, north of where Durhumit and the area of Kunanamit are believed to be, as well as in northwest, central, eastern and southern Anatolia.[401]

What is more, apart from ingots or parts of ingots, copper is said to travel in one more form: "broken" *šabburum*. The word *šabburum* derives from the verb *šebērum* (*šabārum*), which has the meaning of "to break".[402] From the studied texts, three references to this variety exist. One of them is of "good, broken" (SIG$_5$ *šabburum*) copper, in text ATHE 37, and two of "washed, good, broken" (*masium* SIG$_5$/*damqum šabburum*) copper, in texts OIP 27, 56 and AKT 6b, 350. This shows that mostly copper of good quality was "broken".[403] Veenhof[404] is of the opinion that the form of copper called *šabburum* in the OA texts must have had the meaning of "*a '(rough) ingot' of undefined shape*".

Furthermore, it is worth mentioning that copper is a metal that is checked via weighing, like silver. Weight deficiencies in copper occurred due to the different weight standards used. Various merchants used their own weights, which often differed from the standard weights of, for example, the office of the colony, or even another merchant's weights.[405]

For a catalogue of the toponyms and the recorded varieties of copper, see **Table 12**. Durhumit seems to be the main copper processing and distribution centre.[406] If Dercksen's[407]

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[398] CAD Š(1), 49-59.
[399] AKT 5, 25 note on line 5f.
[400] Dercksen 1996, 30, 41-2.
[401] De Jesus 1977, 265-72; 1980, 190-94; Pernicka *et al*. 1984; Seelinger *et al*. 1985; Wagner *et al*. 1989; Wagner and Öztunalı 2000; Barjamovic 2011, 78, 242-67.
[402] CAD Š(2), 246-50.
[403] Dercksen 1996, 40-1.
[404] Veenhof 2014, 401-3.
[405] Veenhof 1972, 52-3; Dercksen 1996, 82-8.
[406] See also Barjamovic 2011, 242-67.
[407] Dercksen 1996, 44-5; cf. Barjamovic 2011, 261 n. 999.

proposition for the location of Taritar in the area of Devrez Çay is correct, then this would place it somewhere in the northwest of Durhumit. In addition, copper of good quality could be obtained from Taritar. The latter seems to be linked to the area of Habura(ta).[408] Habura(ta) might be situated west of the Kızılırmak.[409] From there not simply copper but also "good" copper was acquired. Text Anatolica 12, 133 mentions "extremely good copper from Habura(ta)" along with "copper from Tarita(r)".[410] Additionally, the latter seems to be cheaper than the former. It stands at 2 ½ minas for a shekel of silver, while the "extremely good copper from Habura(ta)" stands at 2 minas for a shekel of silver.[411] This is also the same price, stated in the same text, for "broken" copper. This text leads us to assume that there were two separate copper deposits that produced copper, one in Taritar and another in Habura(ta), the latter of which comprised copper of a lesser quality than that of the former source.

Good quality copper from Habura(ta) is once mentioned in the same text as "copper of good quality of Tišmurna", which some scholars locate south of Durhumit on the way to Wahšušana (**Figure 39**).[412] On the way to the latter is also located the area of Tuhpiya.[413] Copper from Wahšušana is only once mentioned in BIN 4, 218 and without any further details. Furthermore, there is a single reference to copper from Hurrama in ATHE 63, which is located southeast of Kaneš, on the way back to Aššur.[414] The text mentions that "Si les étoffes de Zalpa et le cuivre de Hurrama sont arrivés, envoyez-les par Tawinīya à Wahšušana".[415] Unfortunately, no further information is available for this peculiar provenance of copper, but it seems likely that the textiles and copper were simply stored in Zalpa and Hurrama and that the designation does not refer to their ultimate origin. East of this area are located the mines of the Ergani, but most scholars believe that its copper did not play a significant role in the copper trade conducted in central Anatolia.[416]

[408] Dercksen 1996, 43-4.
[409] Dercksen 1996, 15, 43; Barjamovic (2011, 263) notes that its location is unknown. See also Forlanini 2006, 155-56.
[410] Donbaz and Veenhof 1985, 133. Anatolica 12, 133 (lines 3-5): URUDA *ha-bu-ra-ta-am* SIG$_5$ *wa-at-ru-um*; (line 9): URUDA *ti-ri-ta-a-am*.
[411] Nevertheless, in kt a/k 822 (lines 6-10) we read about an exchange of 1 1/6 shekel of silver for each mina of copper from Taritar, which by analogy stands at about 51 2/5 shekels of copper for a shekel of silver.
[412] Dercksen 1996, 15-6, 45. On Tišmurna, see: Barjamovic 2011, 276-80. See also Barjamovic (2011, 339-60), on Wahšušana.
[413] Dercksen 1996, 45; Barjamovic 2011, 305-12.
[414] See also Barjamovic 2011, 180-87.
[415] Michel 2001, 131. ATHE 63 (lines 16-20): *šu-ma* TÚG.ḪI^{tù}*-a ša Za=al-pá ù*$^{!}$ *ša Ḫu-ra-ma e-ru-bu-nim ḫa-ra-an Ta-wi-[n]i-a-ma a-na Wa-aḫ-š[u-š]a-[na]*.
[416] Dercksen 1996, 16.

Table 12. Toponyms of copper provenance in the OA texts.

Toponym	Copper quality	References	
Kunanamit	not specified	3	AKT 1, 17; AKT 3, 57; CCT 2, 23
land of Šawit/d	not specified	1	CCT 2, 23
	pure	1	AKT 3, 56
Durhumit	black	1	CMK 33
	ṣaḫḫirum	2	AKT 6a, 183; AKT 6a, 251
Taritar	not specified	4	Anatolica 12, 133; CCT 4, 47a; CCT 6, 37a
			kt a/k 822
	good	1	ICK 2, 54
Habura(ta)	not specified	2	AKT 2, 39
			LB 1295
	good	1	JCS 14, 11
	very good	1	Anatolica 12, 133
Tišmurna[417]	good	1	JCS 14, 11
Tuhpiya	not specified	2	ArAn 2, 25f.
			KTS 2, 8
Wahšušana	not specified	1	BIN 4, 218
Hurrama	not specified	1	ATHE 63
Hasu	not specified	1	CCT 1, 42a

Another unusual reference can be found in texts CCT 1, 42a and CCT 6, 40b. The former records a variety of copper called by Nashef "ḫazäisches", where the original text reads URUDU *ha-zu-a-am*.[418]According to the text, this copper was brought to the writer of the letter "from the City". Generally, "the City" refers to the city of Aššur and so this must have come from there. Against that view, Lewy[419] had earlier suggested that the word *ha-zu-a-am* is the nisbe form of the toponym *Ha-su*, recorded in the annals of Tiglath-Pileser. This was identified by him as Mount al-Hass (Ğebel el-Ḥaṣṣ), located 25 km southwest of Qinnesrīn, in Syria. The city Hazu is mentioned twice in CCT 6, 40b:

> Von der Mitte des Berges zahlte ich für zwei Halbsäcke bis Ḫazu je 10 Seqel Zinn; von Lalga bis Ḫazu zahlte ich (für) zwei Halbsäcke und den oberen Sack 7 ½ Seqel Zinn; von Ḫazu bis Timilkia zahlte ich für die zwei Herren je 5 Seqel Zinn; von Timilkia bis

[417] Barjamovic 2011, 276-80.
[418] Nashef 1987, 28.
[419] Lewy 1952, 420.

Ḫurama zahlte ich 2 Seqel Silber (und) zwei Seqel Zinn; von Ḫurama bis Kaniš zahlte is 6 Seqel Silber als Miete für einen Esel.[420]

This may also be the Amorite city Haššu, possibly located north of Karkemiš on the banks of the Euphrates.[421] Geologists are of the opinion that Syria lacks copper deposits.[422] The copper though may have come from somewhere else. As a result, this particular word and reference to copper remains still untranslated and undetermined as to whether it is an unknown copper variety or if it refers to a toponym.

3.1.2.5 Iron

Iron, its terminology and known types during the OA period is among the most complicated of matters. More than one Akkadian word has been associated with the metal. First, there is the word *amūtum* and its logographic equivalent KÙ.AN, which the CAD describes simply as a precious metal.[423] Most recent publications translate it as "iron" and most researchers translate it as "meteoric iron", while two of the earliest publications have translated it as "*amūtum*-iron". Second, there is the word *āši'um*, which is accordingly described in the CAD as a precious metal as well.[424] In the OA texts from Kaneš that have been published, it can be found either as "iron" in the AKT publications, translated as "meteoric iron" by most researchers, or remaining untranslated and described as "*āši'um*-iron". Third, there is the word *parzillum*. This is documented only in two texts.[425] It is believed that the logogram KÙ.AN and the Akkadian *amūtum* were used in Anatolia to express iron, while the logogram AN.BAR and its Akkadian equivalent *parzillum* were used in Southern Mesopotamia and later replaced the Anatolian terms.[426] Due to the fact that there is no undisputed word for iron yet accepted by scholars and that the existing words believed to be associated with this metal do not have a definite translation in a modern language, the Akkadian words or logograms will be hereafter used instead of a translation.

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[420] Nashef 1987, 34-5. CCT 6, 40b: *iš-tù qá-ab-li*-[*im ša*] *ša-du-im* 10 GÍN.TA AN.NA *a-na* 2 *mu-té-té-en*$_6$ *a-dí Ḫa-zu áš-qúl iš-tù La-al-kà a-dì Ḫa-zu a-mu-té-té-en*$_6$ *ú e-li-tim* 5 ½ GÍN A[N.NA] *áš-qúl iš-tù Ḫa*=*zu a-dì Ti-me-el-ki-a a-na 2 a-wi-le*-[*en*$_6$] 5 GÍN.TA AN.NA *áš-qúl iš-tù Tí-me-el-ki-a a-dí Ḫu-ra-ma* 2 GÍN KÙ.BABBAR 2 GÍN AN.NA *áš-qúl iš-tù Ḫu-ra-ma a-dí Kà-ni-iš* 6 GÍN KÙ.BABBAR *ig-ri* ANŠE.
[421] Van de Mieroop 2004, 98.
[422] Dercksen 1996, 17.
[423] CAD A(2), 97-8.
[424] CAD A(2), 441-42.
[425] C 33 and Anatolica 12, 143.
[426] Forbes 1950, 450; 1972, 261; Maxwell-Hyslop 1972; Muhly and Wertime 1973, 116; Moorey, 1985, 2; 1994, 278-79; Muhly *et al*. 1985, 74-5; Yalçin 1998, 88; 1999, 182-83.

The logographic equivalent of parzillum is AN.BAR and it is found in the so-called "Anitta text". This was found in Ḫattuša, the Hittite capital, describing events that took place at the end of the OA colony period and was written in Old Hittite, one of the languages used in Anatolia during the OA period.[427] According to the text, the man from Purušḫanda brought to Anitta a throne and a sceptre of AN.BAR, i.e. iron.[428] During the first half of the 2nd millennium BC the Akkadian *parzillum*, as well as its logographic counterpart AN.BAR, were used in Mesopotamia, while only the Akkadian word appears on rare occasions in the OA texts from Kaneš; during the second half of the millennium, *parzillum* appears in Anatolian texts (from Ḫattuša), while AN.BAR appears in Mesopotamian, Anatolian and Egyptian texts (i.e. the Amarna letters).[429] Moreover, in Mari, an emporium on the banks of middle Euphrates, linking Mesopotamia with the Mediterranean, clay tablets were found, dating to c. 1800-1760 BC. In them, a few examples of the Akkadian word *parzillum* have been noted, but there are more than twenty references to the spelling *bar-zil*, i.e. *barzel*, which has been recognised as the Hebrew form for *parzillum* and the Ugaritic *brdl*.[430]

In the OA period, gold and silver were the two most highly valued and most sought for metals from traders inside Anatolia. The exchange ratios of *amūtum* with silver ranged from 35:1 up to 120:1, or even 3000:1, i.e. 50 minas of silver for 1 shekel of "clear" *amūtum*;[431] with copper from 2,618:1 up to 3,600:1 (meaning one shekel of iron for one talent of copper), or even higher, at 3,825:1 when it is exchanged with "washed copper". Moreover, *amūtum* was 400 times more expensive than tin.[432] More importantly, though, *amūtum* appears to be more expensive even than gold. The recorded exchange ratios are 2.5:1, meaning 2 ½ shekels gold "of its stone" for a shekel of *amūtum* "in small pieces", 8:1 and 10:1.[433] Additionally, the cited text kt 89/k 261 documents an exchange ratio for *aši'um*. This is placed at 30:1 in exchange for "clear" silver. Finally, Erol has recently presented an OA text where *parzillum* is for the first time accompanied by a price: 1 shekel of *parzillum* for 20 shekels of silver.[434]

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[427] Forbes 1950, 450; 1972, 265; Neu 1974, 1-2; Hoffner 1977, 78; Moorey 1994, 288; Topçuoğlu 2010, 25-7. Fort he location of Ḫattuša, see **Figure 1**.
[428] Neu 1974, 14-5 (line 75); Steiner 2001, 477. See also Dercksen 2010.
[429] Maxwell-Hyslop 1972, table on p. 162; Yalçin 1998, table 4.
[430] Artzi 1969; Bjorkman 1973, 114-15; Limet 1984, 192-95; Muhly *et al*. 1985, 75-6; Moorey 1994, 287.
[431] FS Veenhof, Donbaz 83ff.
[432] For *amūtum*-silver ratios, see: Muhly 1980, 35; Dercksen 2005, 28; Veenhof 2008, 85 n. 356; texts: FS Veenhof, Donbaz 83ff; kt s/k 89; kt 93/k 511; VS 26, 61. For *amūtum*-copper ratios, see: Reiter 1997, 389; Veenhof 2008, 84; text BibO 73, 22 no. C. For tin, see: Muhly 1980, 35.
[433] Dercksen 2005, 28-9; texts kt n/k 1686 (lines 3-6), CCT 4, 4a (line 44) and WZKM 86 (lines 32-35), respectively.
[434] The text has been presented in the 10th International Congress of Hittitology, which took place in late August 2017 in Chicago, and it is part of a soon to be published study on OA texts related to metals.

3.1.2.5.1 KÙ.AN/amūtum, aši’um

According to the texts and the past bibliography, the logogram KÙ.AN is the equivalent of *amūtum* (and *aši'um*?).[435] The following passages record KÙ.AN together with *amūtum*, *amūtum* together with *aši'um*, or KÙ.AN with *aši'um*. From the first text, BIN 4, 50, it can be understood that KÙ.AN is the equivalent of *amūtum*. The next two, AKT 3, 45 and BIN 4, 45, mention *amūtum* in connection with *aši'um*. The last two, AKT 5, 1 and kt 89/k 261, refer to KÙ.AN and *aši'um*. In order to assist an impartial judgement of the meaning of these words, these terms are given in their original language and not in their translated versions.

First, text BIN 4, 50 records instructions on selling KÙ.AN for silver and what to do with the silver acquired from the price of *amūtum*, i.e. KÙ.AN:

> Dis à Uzua, Masāya, Šumī-abīya, Aššur-malik, Amur-Aššur, Šū-Anum, Aššur-imittī et Amur-Ištar : ainsi (parle) Ilī-imittī. Amur-Aššur, Šū-Anum, Aššur-imittī et Amur-Ištar vous apportent 4 ⅙ sicles de KÙ.AN d'excellente qualité à mon sceau. Vous (êtes) mes frères. Là-bas, vendez le KÙ.AN. En plus de la demi-mine d'argent au sceau d'Iddin-abum qu'Amur-Aššur apporte chez nos gens, vous-mêmes, sur le prix du KÙ.AN, scellez une demi-mine d'argent et remettez-la à Amur-Aššur, afin qu'il apporte chez nos gens. Quant au reste de l'argent (issu) du prix du *amūtum*, selon l'argent qui est disponible, en fonction de mes instructions, achetez des (étoffes)-*pirikannum*, scellez-les, puis remettez-les à Amur-Ištar et Šū-Anum en recevront le bénéfice. Inscrivez dans votre lettre la quantité de *amūtum* qui a été vendue.[436]

Second, BIN 4, 45 starts on the subject of *amūtum*. The phrase "the *kārum* must not know"[437] can be linked to the regulation according to which everybody who had KÙ.AN in his possession, or had sold some, must register and pay the tithe and the *šadduʾutu*-tax.[438] This could be a good reason for a trader to not want the *kārum* to know. The text reads as follows:

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[435] Landsberger 1965, 290 n. 25; Bjorkman 1973, 114; Reiter 1997, 353-57; Reiter (1997, 344-400) produced the most comprehensive investigation into the subject of iron and its terminology in the ANE.

[436] Michel 2001, 275-76. BIN 4, 50 (lines 1-31): *a-na Ú-zu-a Ma-sà-a-bi=a A-šùr-ma-lik A-mur-A-šùr Šu-A-nim A-šur-i-mì-tí ù A-mur-Ištar qí-bi-ma um-ma Il*$_5$*-mì-tí-ma* 4 1/6 GÍN KÙ.AN SIG$_5$ DIRI *ku-nu-ki-a / A-mur-A-šur Šu-A-nim A-šur-i-mì-tí ù A-mur-Ištar na-áš-ú-ni-ku-nu-tí a-ḫ[u-ú]-a* a-tù-nu *a-ma-kam* KÙ.AN *a-na ší-mì=im dí-na-ma a-ṣé-er ½ ma-na* KÙ.BABBAR *ša I-dí-a-bi*$_4$*-im ša A-mur-A-šur / a-ṣé-er / ni-ší-ni na-áš-ú ù a-tù-nu i-na ší-im* KÙ.AN ½ *ma-na* KÙ.BABBAR *ku-un-kà-ma a-na A-mur-A-šur dí-na-ma a-ṣé-er ni-ší-ni lu-bi-il*$_5$ *a-na ší-tí* KÙ.BABBAR *ší-im a-mu-tim a-ma-lá* KÙ.*BABBAR i-za-ku-ú a-ma-lá na-áš-pé-ra-tí-a pì-ri-kà-ni / ša-a-ma-ma ku-nu-ki-ku-nu a-na A-mur-Ištar ù Šu-A-nim dí-na-ma lu-ub-lu-nim=ma a-na-kam pì-ri-kà-ni a-na* KÙ.BABBAR *li-tù-ra-ma* KÙ.BABBAR^{pì} *a-na-ku lá-al-qé né-ma-lam a-na A-mur-Ištar ù Šu-A-nim li-il*$_5$*-qé-ú ma-lá a-mu-tám i-na-dí-nu i-na na-áš-pè-er-tí-ku-nu lu-up-tá-nim*.

[437] BIN 4, 45 (line 19): *kà-ru-um / lá i-de*$_8$*-e*.

[438] Veenhof 2010b, 65; on the tithe, see Veenhof 2010b, 82-5; on the *šadduʾutu*-tax, see Larsen 1967, 144; Decksen 2004, 110-18. See texts AKT 5, 1, AKT 5, 2, AKT 5, 3 and AKT 5, 6.

> Dis à Puzur-Aššur : ainsi (parle) Sūe'a. (2-7) Si le *amūtum* que tu as pris auprès du fils d'Innāya est disponible, à moins que là-bas tu ne m'oublies, envoie-moi par ici le *amūtum*, mais le *kārum* ne doit pas le savoir. Ici, le *rabi sikkatim* d'Uša et *rabi sikkatim* de Hudurut ne cessent de me menacer en disant : « S'il y a du *aši'um* quelque part, écris afin qu'I-[x-x] et Šū-Nawar le prennent où qu'il y en ait) ! » (…) 1 ou 2 […], je n'ai rien promis pour le *aši'um*. Si tu penses envoyer du *amūtum*, ici, le *kārum* ne doit pas le savoir. Les gens sont devenus mauvais. Aussitôt qu'ils ont le *aši'um*, ils déposeront argent et or, (et) selon ton estimation, environ 5 mines d'argent te parviendront. Pour le *amūtum* d'Ilī-wēdāku qu'ils ont remis à l'*alahhinnum*, je ne connais rien du montant sur lequel ils se sont mis d'accord.[439]

Third, AKT 3, 45 once again mentions *amūtum* and, at some point, also *aši'um*:

> Ennum-Aššur packte uns gegen Mannum-kī-Aššur, Sohn von Aḫugar, und dann (sprach) Ennum-Aššur folgendermaßen: „11 Mine Silber bist du schuldig. Ich gab dir Ware, und meine Hand ist (darauf) gelegt." Folgendermaßen (antwortete) Mannum-kī-Aššur: „Ja, du gabst mir Ware. Weil es Verluste gegeben hatte, ging ich, (als) ich von *amūtum* im Landesinneren hörte, ins Landesinnere und kaufte *amūtum*; (darauf) ist deine Hand gelegt. Weil dein Silber nicht ausreichte, ließ ich das *amūtum* in Šalatuar. Dann ging ich nach Waḫšušana, nahm (dort) bei Šu-[Ištar], Sohn von Aššur-bāni, 10 Talent Kupfer zu je 1 Seqel [Zins] pro 1 Mine und brachte es nach Šalatuar. Wo es *aši'um* gab, verkaufte ich (es). Dann brachte ich das *amūtum* nach Waḫšušana, gab es dem Šu-Ištar, und Šu-Ištar verkaufte es dann, wo es zu verkaufen war. Steh mir zur Seite, nimm eine Tafel des Kārum, und wenn sie das *amūtum* in Waḫšušana nicht verkaufen konnten, will ich gehen und das *amūtum* hierher bringen. Für diese Angelegenheiten gab uns der Kārum Kaniš (als Zeugen), und wir gaben vor dem Dolch des Aššur unser Zeugnis. Vor Adada, vor Aššur-malik, vor Ṭāb-ṣill-Aššur.[440]

Moreover, there are two supplementary texts: TC 1, 39 and ArAn 2, 25f. The former mentions that the prince of Tuhpiya returned the gift of *aši'um* that Išme-Aššur offered him, while in the latter the prince himself states that the same person brought him *amūtum*, which he rejected.

[439] Michel 2001, 275-76. BIN 4, 45 (lines 1-26): *a-na Puzur$_4$-A-šur qí-bi-ma um-ma Sú-e-a-ma šu-ma a-mu-tum ša iš-tí* DUMU *I-na-a tal-qé-ú ta-ba-ší / a-m[a-k]am i-li-bi-kà a-ta-lá-ak-ma / a-mu-tám a-ni-ša-am / šé-bi-l[a]m-ma kà-ru-um / lá i-de$_8$-e a-na-kam* GAL *sí-ki-tim ù-ša-i-um ù* GAL *sí-ki-tim ḫu-du-ru-tí-im ig-da-na-ri-ú-ni um-ma šu-nu-ma šu-ma a-ší-um / a-a-kam-ma i-ba-ší / šu-pu-ur-ma I-[x x] ù Šu-Na-war$^{!}$ / il$_5$-ta-na-qé-ú šu-qú-lam-ma / ù 2 ku$^{!}$-nu-tí-ni a-na a-ší-im mì-ma / pu-I ù-lá a-dí-in šu-ma a-mu-tám / šé-bu-lam i-li-bi-kà / i-ba-ší a-na-kam / kà-ru-um / lá i-de$_8$-e ta-ni-iš-tù-um il$_5$-tí-mì-in i-re-eš$_{15}$ / a-ší-im* KÙ.BABBAR *ù* KÙ.GI */ i-na-ší-ú a-ma-lá ta-ší-im-tí-kà /* KÙ.BABBAR 5 *ma-na e-li-a-kum / a-na a-mu-tim ša Il$_5$-we-da-ku ša a-na a-lá-ḫi-nim i-dí-nu-ni / a-ma-lá i-mi-ig-ru=ni.*

[440] Bilgiç and Günbatti 1995, 67-9. AKT 3, 45 (lines 1-37): *En-um-A-šùr a-na Ma-num-ki-A-šùr* DUMU *A-ḫu-qar iṣ-ba-at-ni-a-tí-ma um-ma En-num-A-šùr-ma* 11 *ma-na* KÙ.BABBAR *ḫa-bu-lá-tí / lu-qú-tám a-dí-na-ku-ma qá-tí ša-ak-na-<at> um-ma Ma-num-ki-A-šùr-ma ke-na lu-qú-tám / ta-dí-na-ma ki-ma bi-it-qá-tù-ni a-mu-tám i-na ma-tim qé-er-bi-tim / áš-me-ma a-na ma-tim qé-er-bi-tim e-ru-ub-ma a-mu-tám áš-a-ma qá-at-kà / ša-ak-na-at ki-ma* KÙ.BABBAR^{áp}*-kà / lá kà-áš-[d]u-ni a-mu-tám i-na Ša-la-tù-ar e-zi-ib-ma a-na Wa-aḫ-šu-ša-na e-tí-iq-ma* 10 GÚ URUDU 1 GÍN.TA *[x] 1 ma-na.TA iš-tí Šu-[Ištar]* DUMU *A-šùr-ba-ni a[l-qé]-ma a-na Ša-la-tù-ar ú-bi-il$_5$-ma a-šar a-ší-um ib-ší-ú / a-dí-in-ma a-mu-tám / a-na Wa-aḫ-šu-ša-na ub-lam-ma a-na Šu-Ištar a-dí-in-ma Šu-Ištar-ma / a-šar ta-da$^{!}$-nim i-tí-dí-in i-ša-ḫa-tí-a i-zi-iz-ma ṭup-pá-m ša kà-ri-im li-qé-ma / šu-ma a-mu-tum i-na Wa-aḫ-<šu>-ša-na lá i-na-dí-nu ù lá-li-ik-ma a-mu-tám a-ni-ša-am lu-ub-lam a-na a-wa-tim a-ni-a-tim kà-ru-um Kà-ni-ìš i-dí-ni-[a]-t[í-ma]* IGI GÍR *ša A-šùr [ší]-bu-tí-ni / ni-dí-in* IGI *A-da-da* [IG]I *A-šùr-ma-lik* IGI DU$_{10}$*-ṣí-lá-A-šùr.*

Fourth, AKT 5, 1 is one of the texts recording the laws and regulations that were published regarding the distribution and possession of KÙ.AN. The rest of the tithe-related texts are AKT 5, 2 and AKT 5, 3 which record the words of Kaneš as instructed by the city of Aššur. All of these texts belong to Kuliya's archive, which is chronologically put in about the last fifteen years before the destruction of *kārum* level II (c. 1840 BC). AKT 5, 1 seems to be the primary declaration and reads as follows:

> Thus *kārum* Kanesh, say to the *dātu*-payers, our messenger, every single colony, and the trading stations: "A letter of the City has arrived. In the letter of the City (it is written): 'From this day on, whoever buys KÙ.AN, (the City of) Assur is not *entitled to* part of the profit made, the tithe on it *kārum* Kanesh will collect'. As soon as you have heard the letter, who(ever) over there has either sold it to a palace, or has offered it to palace officials, or still carried it with him without having yet sold it – all KÙ.AN he carries, write the exact amount of every (piece of) *aši'um*, his name and the name of his father in a tablet and send it here with our messenger. Send a copy of (this) letter of ours to every single colony and to all the trading stations. Even when somebody has sold KÙ.AN via a trading agent, register the name of that man.[441]

According to lines 12-14 the city of Aššur "cedes its right to tax the profit made on" KÙ.AN "to *kārum* Kanes, which henceforth will collect or acquire the tithe on it".[442] Texts AKT 5, 2 and AKT 5, 3 inform the traders of the colonies (*kārum*s) and of the trading stations (*wabartum*s) of the Kızılırmak (Halys) bend, where Kuliya seems to have operated, about the letter of Aššur.[443] In addition to Aššur's instructions, as mentioned in AKT 5, 1, they also refer to the obligatory payment of the tithe on KÙ.AN and the *šaddu'utu*-tax of 3 shekels per mina of KÙ.AN. Up until then, after the traders had completed their business and transactions in KÙ.AN in Anatolia and after they have shipped their proceeds in silver and gold to Aššur, they paid a part of their profit to the city of Aššur, the tithe.[444] According to Veenhof[445] this change was a result of the growth of the trade in iron (KÙ.AN) and especially of the increased role of Anatolian iron.

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[441] Veenhof 2010b, 66-8. AKT 5, 1 (lines 1-30): [*u*]*m-ma kà-ru-um Kà-ni-iš-ma a-na* <<*a-na*>> *ša-qí-il*$_5$ *da-tim ší-ip-ri-ni kà-ar kà-ar-ma ù wa-bar-ra-tim qí-bi*$_4$*-ma ṭup-pu-um ša a-lim*^{ki} *i-li-kam i-na ṭup-pí-im ša a-lim*^{ki} *iš-tù u*$_4$*-mì-im a-nim / ma-ma-an* KÙ.AN *i-ša-ú-mu-ni i-na né-mì-lim* ^{d} *A-šùr ú-lá e-wa / eš*$_{15}$*-ra-tí-šu kà-ru-um Kà-ni-iš i-lá-qé ki-ma ṭup-pì-ni ta-áš-me-a-ni / a-ma-kam lu a-na ší-mì-im a-na* É.GAL=^{lim} *i-dí-in lu té-ra-at* É.GAL^{lim} *ú-kà-lim lu na=ší-ma a-dí-ni lá i-dí-in ma-lá* KÙ.AN *na-áš-ú ni-bi*$_4$*-it a-ší-im šu-um-šu ú šu-mì a-bi*$_4$*-šu i-na ṭup-pì-im lu-up-ta-nim iš-tí ší-ip-ri-ni šé-bi*$_4$*-lá=nim me-ḫe-er ṭup-pì-ni [a]-na kà-ar kà-ar-ma ú wa-bar-ra-tim šé-bi*$_4$*-lá* KÙ.AN *lu a-na* DAM.QAR=$^{ru\text{-}tim}$ *i-dí-in šu-mì a-wi-lim lu-up-ta-nim*.
[442] AKT 5, 1 note on lines 12-14.
[443] Veenhof 2010b, 65, 80-1.
[444] On the tithe, see Veenhof 2010b, 82-5.
[445] Veenhof 2010b, 85; Veenhof 2008, 85.

Fifth, there is kt 89/k 261 (courtesy K.R. Veenhof), a damaged letter, copied by Y. Kawasaki, and dealing with the sale of *aši'um*:

> As for the KÙ.AN, about which you wrote me, saying: "They are offering us 30 times its weight in pure silver" – over there, if (the offer is) 30 times in silver, sell the ***aši'um***, put the silver under seal and send it to me with Ali-ahum. If it is not 30 times in silver, seal the ***aši'um*** and send it to me with the first opportunity.[446]

The question arises, then, as to what exactly all these words represent. It seems quite obvious that *amūtum* and KÙ.AN are synonyms. They share the exact shame varieties, which are "good" and "clear",[447] although there is an additional variety of *amūtum*, called *ṣahertum* (*zakuum*) "(clear) in small pieces", and an additional one of KÙ.AN, which has unfortunately not been translated and simply left as *kīšum*, written as *ša* KI.DIRI / *ša kišia*. Donbaz[448] argues that this type of KÙ.AN refers to the native Anatolian *amūtum*. It also seems to have been of low quality as, according to the text FS Veenhof, Donbaz 85ff., this type of KÙ.AN/*amūtum* will not be accepted.[449] Perhaps future publications will bring to light texts referring to KÙ.AN *ṣahertum* or *amūtum ša kišia*. Furthermore, KÙ.AN and *amūtum* have the same exchange ratios with silver. The context and nature of the references of *aši'um* in relation to KÙ.AN/*amūtum*, leads us to believe that *aši'um* was indeed related to KÙ.AN/*amūtum*. The fact that *amūtum* records higher prices in exchange with silver than *aši'um* is in accordance with the observed price fluctuations for *amūtum*.

Amūtum is the most common of the words that have been related to iron. It is found in 66 of the 108 texts that mention one of the iron-related words. Nevertheless, KÙ.AN is the one mentioned in all the tablets concerning the new regulations regarding the payment of the tithe and the *šaddu'utu*-tax. The most peculiar information about *amūtum* is that it allegedly got a man killed[450] and that it was the reason why a man was thrown into jail.[451] A probably related text refers to a man (probably the same one) being apprehended and thrown into jail because he smuggled *aši'um*.[452]

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[446] Veenhof 2016, 15 n. 13. Kt 89/k 261 (lines 1'-14') (courtesy K.R. Veenhof): [*u*]*m-ma* PN3-*ma*] *a-dí-i* KÙ.A[N] *š*[*a*] *ta-áš-pu-ra-nim um-ma a-tù-nu-ma* 30.TA KÙ.BABBAR-*ma za*!-*ku-a-am* x (erasure?) *ú-kà-lu-ni-a-tí a-ma-kam* : *šu-ma* 30.TA KÙ.BABBAR *a-šía-am* : *dí-na-ma* KÙ.BABBAR : *ku-un-kà-ma iš-tí* : *A-lá-hi-im šé-bi-lá-nim* : *šu-ma lá* 30.TA : KÙ.[BABBAR *a-š*]°*í-am*¿ *ku-un-kà*-[*ma*] *iš-tí pá-nim-m*[*a*] *šé-bi*$_4$-*lá-ni-šu*.

[447] See **Appendix 4**.

[448] Donbaz 1988a.

[449] Donbaz 2001, 87.

[450] See texts AKT 6c, 525 and AKT 6c, 527.

[451] See text FS Matouš 2, 127-128.

[452] See text ATHE 62.

More interestingly, though, certain texts record the treatment of *amūtum*. First of all, CCT 4, 4a has been the base of Maxwell-Hyslop's[453] – and many others after her – argument for the equation of *amūtum* with bloom iron. In this text, instructions are given regarding the selling of *amūtum* and its treatment, or not. It writes that *amūtum* must be sold for silver or gold, but not for copper. Then, we read about the intention to treat the *amūtum* with fire (*ṣarāpum*), but the writer of the letter refuses to allow this treatment. Nonetheless, the *amūtum* undergoes the process and the end-product is a 2/3-shekel stone-like object (*kiṣrum*).[454] Finally, in the end of the text an offer of 8 shekels of gold per shekel of *amūtum* was deemed too small and was thus declined. The text reads as follows:

> Dis à Pūšu-kēn : ainsi (parle) Puzur-Aššur. Tu m'as écrit ceci à propos d'une mine de *amūtum* que Bēlānum et le fils d'Elālī ont apportée : « Vends-le contre argent ou or, mais tu ne dois pas le vendre contre du cuivre ! » J'ai menacé Ennum-Aššur dans Wahšušana, et comme il ne veut pas verser d'argent, je ne (le) lui ai pas vendu. Je suis entré à Burušhattum, et comme le fonctionnaire-*mūṣûm* versera un faible prix en argent, j'ai (dit) ceci : « Ne le vends en aucun cas à un *hupšum* ! » Le *kārum* l'a appris et ils (ont déclaré) ceci : « Tu ne dois le vendre à personne tant que les représentants ne l'ont pas inspecté ! » En conséquence de la décision du *kārum*, il est (toujours) disponible ! J'ai ensuite consulté Ennum-Aššur et Iddin-Kūbum, et ils (ont décidé) ceci : « Porte le *amūtum* à Hardu. » Mais toi, tu (as parlé) ainsi : « Le transporteur m'a quitté pour (faire) le messager, il me l'a fait transporter chez toi. » J'ai apporté le *amūtum* à l'homme, et il m'a remis un(e) […] Il (a dit) ceci : « Je veux le fondre ! » (mais) j'(ai répondu) ainsi : « Je ne permets pas de le fondre ! » Il (a alors dit) ceci : « Puisque tu veux t'en aller, j'ai l'intention de le fondre ! Si cela tourne mal, mon seigneur pourra être en colère contre toi et contre moi ! » Il a (fini par) fondre le *amūtum*, et un morceau pesant ⅔ sicle en est sorti ! […] une perte de 4 sicles de la fonte et de la vérification. Pour le reste du *amūtum*, il m'a offert 8 sicles d'or par (sicle de fer), mais je (lui ai dit) ceci : « C'est (trop) peu […] ! ».[455]

Of interest in the text CCT 4, 4a is the word used to express the heat treatment that was done to the *amūtum*. In the above-cited passage, wherever this word occurs, it is underlined

[453] Maxwell-Hyslop 1972, 159.
[454] Maxwell-Hyslop 1972, 159-60; Bjorkman 1973, 112-13; Mulhy 1980, 35; Reiter 1997, 389-91; Dercksen 2005, 28-9.
[455] Michel 2001, 274-75. See also Dercksen 2005, 29. CCT 4, 4a (lines 1-46): 1 *ma-na a-mu-tám ša Be-lá=num ù* DUMU *E-la-lí ub-lu-ni-ni ta-áš-pu-ra-am um-ma a-ta-ma a-na* KÙ.BABBAR *ù* KÙ.GI *dí-in a-na* URUDU *la ta-da-ší En-nam-A-šur i-na Wa-aḫ-šu-ša*$^!$*=na ag-ri-ma ki-ma* KÙ.BABBAR *lá i-ša=qú-lu la a-dí-šu-um a-na Pu-ru-uš-ḫa-tim e-ru-ub-ma ki-ma mu-ṣí-um* KÙ.BABBAR *ba-at-qam i-ša-qú-lu um-ma a-na-ku-ma a-na ḫu-up=ší-im ra-bu-ma la ta-dí-ší kà-ru-um iš-me-ma um-ma šu-nu-ma a-dí mu-ṣí-um*$^!$ *la e-mu-ru a-na ma-ma-a la ta-da-ší i-dí-in kà-ri-im i-ba-ší iš-tí En-nam-A-šur ù I-dí-Ku-be áš-ta-al um-ma šu-nu-ma a-mu-tám a-na Ḫa-ar-tù bi-il*$_5$*-ma um-ma a-ta-ma ší-bu-um a-na ší-ip-ru-tim i-li-kà-ni a-na ṣé-ri=kà ú-šé-bi*$_4$*-lá-ni a-mu-tám* [*a*]*-na a-wi-lim ú-bi-il*$_5$*-ma* [*ki-ma mi*]*ì-gi*$_5$*-ir-tám i-dí-na-ni* [*um-ma*] *šu-ut-ma la-aṣ-ru-up-ší um-ma a-na-ku-ma a-na ṣa-ra-pì=im pí-i la a-da-na-kum um-ma šu-ut-ma iš-tù a-ta ta-ta-lu-ku la-aṣ-ru-*<*up*>*-ší-ma šu-ma a-na lá* [*a-m*]*u-tim i-tù-a-ar lu-mu-un li-bi-im a-na šu-a-tí ù i-a-ti bé-li li-ir-ší a-mu-tám iṣ-ru-up-ší-ma* 2/3 *ma-na ki-iṣ-ru-um e-li-a-am lu i-na ṣa-ra-pì-im lu i-na* <*i*>*-ší-ra-tim mu-ṭá-e* 4 GÍN.TA *a-na* KÙ.KI *aq-bi-a-ku*[*m um-ma*] *a-na-ku-ma e-iṣ i-na x*-[*x*]-*x-ma*.

with a double line. The sender of the letter used the word *ṣarāpum*, which according to the CAD has the meaning of a heat treatment, refinement, or a surface colouration manipulation.[456] The association of *amūtum* with the Akkadian word *ṣarāpum,* which implies a heat treatment like the one done to silver ("refined" *ṣarpum* silver), in addition to the end result of an amorphous mass (lump?, bloom??, *kiṣrum*) weighing 2/3 shekel, were the reasons why the opinion that *amūtum* denotes meteoric iron has been generally rejected and superseded by the belief that it stands for a bloom of iron instead.[457]

The letter CCT 4, 4a writes that there was a loss of weight of the original *amūtum* that was put into the fire either because of melting or because of checking.[458] The same decrease of *amūtum* and the same phrase (*i-na i-ší-ra-tim*) appears in another letter, kt n/k 757: "1 shekel 15 grains diminished due to *išerātum* and refining."[459] The Akkadian word *išerātum* is understood by Dercksen as weighing(?), while Michel translates "vérification", i.e. checking.[460] Maybe this "checking/weighing", written as *išerātum*, has to do with the inspection that every piece of *amūtum* has to go through before it can be sold.[461] Furthermore, the decrease of *amūtum* is witnessed in one more text, kt n/k 726: "With the son of Elimešar I saw *amūtum*, the *amūtum* decreased."[462]

Moreover, because of the heating process through which the *amūtum* passed in text CCT 4, 4a, a *kiṣrum* "un morceau", i.e. a "stone", came out. The same form of *amūtum* is once more recorded in KTS 1, 30, where it is accompanied by tin, textiles, black donkeys and lapis lazuli. All of these goods were handed to a merchant to be brought into Anatolia. In yet another letter, kt 87/k 387, an instruction is given that "if there is good quality *amūtum* take care to weigh out as big a lump as you can and buy it; if it is good, but not extremely good do not buy

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456 CAD Ṣ, 102-4: *ṣarāpu* A: verb denoting 1) "to refine" (metals by firing), "to fire" (bricks), 2) "to burn", 3) "to melt" (glass?); CAD Ṣ, 104-5: *ṣarāpu* B: verb denoting "to dye".

457 Garelli (1963, 275-76) rejects the translation of "meteoric iron" due to the fact that meteoric iron is generally very pure and does not need refinement. Bjorkman (1973, 112) notes that "*if the above text refers to a meteorite it cannot mean that the meteorite was melted, since the melting point of pure iron (1,535 °C) is changed little by the presence of nickel, and such a temperature was out of easy reach of the kilns of that day*". For a differentiation between meteoric and smelted nickel-rich iron, see: Photos 1989; Moorey 1994, 287. For more information on the recognition of meteoric iron, see: Craddock (1995, 104); Reiter 1997, 381-91; cf. Dercksen (2005, 28-9) who notes that *amūtum kiṣrum* is bloom iron and *amūtum* is bog iron (goethite), contrarily to the original idea of Maxwell-Hyslop (1972, 159-60) that *amūtum* is bloom iron and *amūtum kiṣrum* wrought iron. See also: Tylecote 1980, 209; Waldbaum 1980, 80. See also the discussion in Chapter 4.3, below.

458 CCT 4, 4a (lines 41-42): *lu ina ṣarapim lu ina iširatim*.

459 Dercksen 2005, 29. Kt n/k 757 (lines 6-8): *i-na i-ší-ra-tim ù ṣa-ra-pí-im* 1 GÍN 15 ŠE *im-ṭí*. Çeçen 1997, 221 n. 17; Sever 1997, 293; Dercksen 2005, 29 n. 50.

460 Michel 2001, 275; Dercksen 2005, 29.

461 See CCT 4, 4a (lines 17-19): "Tu ne dois le vendre à personne tant que les représentants ne l'ont pas inspecté!" *šu-nu-ma a-dí mu-ṣí-um*[!] *la e-mu-ru a-na ma-ma-an la ta-da-ší i-dí-in* (Michel 2001, 274-75).

462 Sever 1997, 293. Kt n/k 726 (lines 6-9): *a-mu-tum* KI DUMU *E-li-me-šar a-mu-ur-ma a-mu-tum ma-ṭí-a-at*. Çeçen 1997, 221 n. 16.

it. If it is available buy it!"[463] Here, the logogram NA$_4$ is used to express the word "lump". The Akkadian equivalent, used in the previous texts, is *abnum*. This word actually has the meaning of "stone", either "in natural form and location", or of a specific form for a specific purpose, or as gem, or even to describe glass in its liquid stage.[464] The general idea is of a solid mass of some material.

Apart from the fire treatment of *amūtum*, hammering is also attested in text kt 94/k 208: "I gave 12 shekels of silver to the blacksmith, who hammered the iron in the palace, for (making) teeth."[465] And in another letter, ICK 1, 55, Iddí-Suen requested pure *amūtum* that can be beaten, i.e. hammered.[466] The Akkadian word for "hammered", or "beaten", is *maḫāṣum*, which has the meaning of "to hit", "to strike".[467] Veenhof,[468] in his discussion on the matter, links this hammering of *amūtum* with the use of this metal as an inlay. He refers to the unpublished text kt 91/k 189, which reads: "You have in possession as pledge a golden cup weighing 78 shekels with an inlay of *amūtum*."[469] Aside from *amūtum*, no other word related to iron records any kind of treatment.

As far as the forms and shapes of the iron-related words are concerned, there are no occurrences of a form- or shape-determinative accompanying the logogram of the word *amūtum*, i.e. KÙ.AN. There are, however, a number of words characterising the form of *amūtum* and *aši'um*. First, we read about "stones", i.e. amorphous masses, expressed with the Akkadian *abnum* = logogram NA$_4$, already seen in passages cited above. This word most probably describes *amūtum* and *aši'um* in a naturally occurring form, i.e. as an ore. Second, we read about a "lump" of *amūtum*, expressed with the word *kiṣrum*. According to text CCT 4, 4a, this word describes an amorphous mass of a material that resulted from a heating treatment, which is described with the word *ṣarāpum*. However, in order to better understand the meaning of this word, we should take a look at the definition provided by the CAD.[470] It identifies the subject *kiṣrum* as a) a "knot", or "joint", or "bond", b) a "team" of men, or "collection" of

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463 Veenhof 2016, 15. Kt 87/k 387 (line 17-23): *šu-ma a-mu-tum* SIG$_5$ *i-ba-ší* / *iḫ-da-ma* NA$_4$ / *ma-lá ta-li=e-a-ni šu-uq-lá-ma ša-ma-nim šu-ma* SIG$_5$*-ma* / *lá wa-at=ra-at lá ša-a-ma-nim* - - - *šu-ma i-ba-ší-ma ta-ša-*[*a*]*=ma-nim*.
464 CAD A(1): 54-61.
465 Veenhof 2016, 14. Kt 94/k 208 (lines 26-30). The word translated as "teeth" is *šinnātum*, by which not human teeth but also teeth or blades of a tool, such as a saw or a plow, could be meant (CAD Š(3), 48-53: *šinnu* A). The original Akkadian text was not available and as a result the Akkadian word for "iron" is not specified. However, we can assume that the text refers to *amūtum*.
466 Veenhof 2016, 14 n. 10: ICK 1, 55 (lines 25-26): *šu-ma a-mu-tum za-ku-at-ma i-ma=ḫa-aṣ*.
467 CAD M(1), 71-84.
468 Veenhof 2016, 14 n. 10.
469 Veenhof 2016, 14 n. 10: kt 91/k 189, translated lines above 7-12, (lines 10-11): "a golden cup with an inlay of *amūtum*" *kāsam ša hurāšim ù amūtam ta-am-l*[*i*]*-/ta-ša*.
470 CAD K, 436-42.

objects, c) a "payment", d) "structure", or "concentration", or "strength", e) a "clasp", or "handle", and f) a "meteorite". Third, we read about a "bar" of *aši'um*, using the Akkadian word *urākum*. This is commonly used to describe shapes like a rod or a wire. Specifically the latter translation, i.e. "wire", is related to jewellery making. Nevertheless, the general picture is of an elongated and rather thin (not lump-like and not amorphous) object, much like a bar.[471]

Moreover, there are some references to *amūtum ṣahertum* "in small pieces" and one more of *amūtum ṣahertum zakuum* "clear and in small pieces". In addition, there are also objects like rings (*annuqum*),[472] toggle-pins (*tudittum*)[473] and diadems (*agû*)[474] of *amūtum* to be found in the OA texts. Pins made of gold and iron were found in Kaneš[475] (**Figure 5**) and a pin, whose head was inlaid with iron, has been reported in Alişar Hüyük, dating to c. 1900-1700 BC.[476] In the LBA, the only reference to this metal is a horse-shaped vessel of *amūtum*, with inlays of golden eagles and lapis lazuli, offered to the Pharaoh by the Mitanni king. Furthermore, a cup or goblet made of KÙ.AN is recorded in text CRRAI 34, 477.[477]

Figure 5. Pins of iron and gold from Kaneš (Kulakoğlu and Kangal 2010, 310 nos. 349-350).

It is important to note that the two forms of *aši'um* have recently been cited in an article by Veenhof.[478] The letter which contains both of these references is kt 89/k 206. It reads that a quantity of *aši'um* consists of a "big lump of ore" *áb-na-am*, a second one weighing 14 shekels,

[471] CAD U/W, 206: *urāku*. See also CAD A, 223-26: *arāku* = verb meaning "to become long", "to lengthen", "to extend".
[472] See ATHE 39; AKT 5, 11; AKT 6b, 411; AKT 6c, 524; ICK 1, 39b; kt a/k 1072; kt b/k 229; kt j/k 107; KTK 68. Ulshöfer (1995, 420) translates the phrase *a-nu-qum ša a-mu-tim* as "Zinn für das Meteoreisen".
[473] Kt n/k 695 (line 16): *tù-dí-tán ša a-mu-tim* (Veenhof 2016, 15 n. 12). See also Dercksen 2005, 31 n. 46.
[474] Kt c/k 18 (lines 40-42): 12 *a-gu₅-ú/ša a-mu-tim ú-ru-um ša* KÙ.KI.
[475] Kulakoğlu and Kangal 2010, 310 nos. 349-350; Veenhof 2016, 15 n. 12.
[476] Von der Osten 1937, 273 and fig. 284 e1555; Dercksen 2005, 31 n. 46. See also Yalçin 1999, 178 table 1. For the location of the site see **Figure 1**.
[477] CRRAI 34, 477 (lines 22-23): *lu kà-sá-tim ša KÙ.AN*. Donbaz (1989, 75-7) translates it as "plates of iron?", however, the word *kà-sá-tim* derives from the Akkadian word *kāsu* and denotes "goblet" or "cup" (CAD K, 253).
[478] Veenhof 2016, 15 n. 11.

and a “bar” *ú-ra-kà-am*: “take out of the *aši’um* the big lump of ore and the second, weighing 14 shekels, which is mine, and the bar”.[479]

As far as the relationship between KÙ.AN/*amūtum* and *aši’um* is concerned, further evidence is provided by the fact that they can both be found and bought in Šalatuwar.[480] Moreover, they are both prospected for in the so-called Inner Land.[481] *Amūtum* also appears to have been sold in Purušhattum and for this reason, according to text FS Matouš 2, 127-128 (and probably also ATHE 62), a man was thrown into jail because “he cheated the Kaneš colony and sold the *amūtum* in Purušhattum”.[482] What is more, despite the fact that *amūtum* is apparently the Akkadian synonym of the logogram KÙ.AN, the latter is not so often used. KÙ.AN is never associated with, or used in a letter describing, a treatment of this material. In contrast, it is used in the messages regarding the tithe and the *šaddu’utu*-tax, which are to be paid to Kaneš by anyone who has in his possession KÙ.AN, or anyone who has sold or will sell it to a palace or a palace official.

Finally, despite the not-so-apparent synonymity of KÙ.AN/*amūtum* with aši’um, texts from Kaneš show a most probable equation. Apart from the above cited texts referring to KÙ.AN and *aši’um*, there are also three texts which are interrelated. These are ICK 1,1, CCT 2, 43 and CCT 2, 48. In the first letter, silver is provided in order to buy KÙ.AN. The latter two texts record a discussion about gold and silver given to the same people as in the first text, in order to find and buy *aši’um*.

3.2 Metals in the Amarna letters

3.2.1 Exchanges

The tablets that have been discovered in Amarna (i.e. Akhetaten) amount to 382 (possibly around 75% or more of the original archive, due to illegal excavations), 350 out of which are letters and inventories found in “The Place of the Letters of the Pharaoh”. The vast majority of the archive consists of letters sent from the Pharaoh to various vassal rulers in

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[479] Veenhof 2016, 15 n. 11. Kt 89/k 206 (lines 3-7): *i-na a-ší-im* 1 *áb-na-am ra-bi*$_4$*-tám ša-ni-tám ša* 14 GÍN *i-a-tám ú ú-ra-kà-am* (Dercksen 1992, 797).

[480] See texts AAA I/3, 5, BibO 73, 22 no. C and AKT 3, 45.

[481] See texts AKT 3, 45 and CCT 2, 48.

[482] See also texts Cole 2 and AKT 6b, 380. FS Matouš 2, 127-128 (lines 11-13): “indicating that he cheated the Kaneš colony and (sold$^?$) the *amūtum* in Purušhattum – for that reason the primary assembly of the colony [threw him into jail$^?$].” *ša ki-ma kà-ra-am Kà-ni-iš*^{ki} *iṣ-li-ú-ma a-mu-tám* [*i-P*]*u-ru-uš-ha-d*[*im* (x)] *a-ší-a-tí kà-ru-um ṣa-hi-ir* GAL […] *ih-da-ma* (Larsen 1978, 118-20). See also ATHE 62 in Barjamovic 2011, 134.

Canaan.[483] The reason for communicating with these rulers was to acquire personnel and goods, arrange supplies for the Egyptian troops and secure obedience. Most vassals did not write to the king on their own accord, but it seems that they only replied to the king's messages.[484] However, a certain ruler, Rib-Hadda of Byblos, seems to have frequently written to the Pharaoh, in order to plea for his assistance and/or complain of anything that caused him distress. Few of these vassal letters contain useful information for the purposes of this research.

Most interesting is the international correspondence between the Pharaoh and various of the Great Kings of the Near East, i.e. from Babylonia, Assyria, Mitanni, Arzawa, Hatti and Alašiya. The letters exchanged consist of three categories: a) greeting-gifts, b) dowries, and c) bride-prices. The first category is the most recurrent among the letters; the second and third categories are the already-mentioned inventories. They are lengthy lists of the dowry sent from a Great King to the Pharaoh for his upcoming marriage with the Great King's daughter. Bride-prices were, in turn, sent from the Pharaoh to a Great King as a gift.

For the purposes of this research, a total of 44 tablets from the Amarna corpus have been analysed. For a catalogue of the tablets and their bibliographical and online database references, see **Appendix 2**. The selected texts document a) metals being offered as greeting-gift, dowry, or bride-price, b) metals being traded, c) metals used as payments (for ransoms, bribes etc.), and d) a specific characteristic or a variety of a metal. The collected data enable us to determine which metals and in what amounts were offered to whom, by whom and for what reason. However, what must be always kept in mind is that this archive is only partial and totally random. When Akhetaten, the capital of Pharaoh Akhenaten (i.e. Amenhotep IV), was abandoned and the Egyptian Foreign Office was transferred to its new destination, a great part of the existing letters was deemed unimportant and inconsequential to the bureaucrats and diplomats of the court. So, they were discarded in rubbish pits: it is these that were later excavated.[485] For this reason, observations and conclusions drawn from their examination cannot be definite; they represent only a part of the whole picture of the international correspondence.

Table 13 lists all the kingdoms and vassal states, along with the names of the corresponding kings and rulers, that are communicating with a Pharaoh. Additionally, the table includes the number of letters and the corresponding EA-numbers relative to its communiqué, that have been used in this research.

[483] Moran 1992, xv-xvi; Bryce 2003, 223; Mynářová 2007, 33-9; Rainey 2015, 3-4.
[484] Moran 1992, xxvi-xxxiii.
[485] Bryce 2003, 225-26; Rainey 2015, 5, 13-4.

Table 13. List of letters and correspondents in the Amarna letters.

Area	Ruler/king	Pharaoh	References	
Babylonia	Kadašman-Enlil I	Amenhotep III	5	EA 1, 2, 3, 4, 5
Babylonia	Burna-Buriaš II	Amenhotep IV	6	EA 7, 9, 10, 11, 13, 14
Assyria	Aššur-uballiṭ	Aya	1	EA 16
Mitanni	Tušratta	Amenhotep III	7	EA 17, 19, 20, 21, 22, 24, 25
Mitanni	Tušratta	Teye, Amenhotep III's wife	1	EA 16
Mitanni	Tušratta	Amenhotep IV	2	EA 27, 29
Arzawa	Arnuwanda I	Amenhotep III	1	EA 31
Alašiya	(King)	Amenhotep IV	5	EA 33, 34, 35, 36, 37
Alašiya	(Governor)	(Governor)	1	EA 40
Hatti	Šuppiluliuma	(Pharaoh)	1	EA 41
Hatti	(Son of the King)	Amenhotep III	1	EA 44
Qatna	Akizzi	Amenhotep IV	1	EA 55
Byblos	Rib-Hadda	Amenhotep III	2	EA 77, 91
Byblos	Rib-Hadda	Amenhotep IV	2	EA 109, 112
Tyre	Prince Abi-Milku	Amenhotep IV	1	EA 151
Ginti	Tagi	(Pharaoh)	1	EA 265
Gezer	Milkilu	Amenhotep IV	1	EA 270
Gezer	Milkilu	(Pharaoh)	1	EA 369
Gath	Suwardata	Amenhotep IV	2	EA 280, 283
Unknown	Adda-danu	(Pharaoh)	1	EA 292
Unknown	(vassal)	(Pharaoh)	2	EA 309, 313

3.2.1.1 Gold

The Amarna letters reveal that gold was the most desired metal for every Great King of the ANE. The Babylonian and the Assyrian kings ask for "much gold", the Mitanni king requests "much gold that has not been worked" (KÙ.GI.MEŠ *ma-a-at-ta ša ši-ip-ra la ep-šu*) and the Hittite king's son simply asks for gold. Based on the Amarna letters, the amounts of gold transported surpass all others, apart from copper.

The amounts of gold sent to and from Egypt can be seen in **Chart 17**. The total amount of gold documented sums to 23 talents 22 minas 20.9 shekels and 946 items. The greatest amount, by far, is offered by Pharaoh Amenhotep IV to the Babylonian King Burna-Buriaš II, as a bride-price for the upcoming union of the Pharaoh with the king’s daughter. It is recorded in letter EA 14 and it amounts to 1,200 minas, i.e. 20 talents, in total. The second largest amount of gold transferred comes from Babylonia and comprises a series of greeting gifts from Kadašman-Enlil I sent to Amenhotep III, and from Burna-Buriaš II to Amenhotep IV. These gifts are listed in letters EA 2, EA 3, EA 7, EA 9 and EA 10 and make up a total of 100.8 minas, i.e. 1 talent 40 minas 40 shekels, in total. In third place comes the Mitanni king’s daughter’s dowry. This is contained in the two longest letters of the Amarna corpus, EA 22 and EA 25, and records an amount of 74.1 minas, i.e. 1 talent 14 minas 6 shekels, in total. Last, there is Amenhotep III’s greeting-gift to the king of Arzawa, Arnuwanda I. This is letter EA 31 and consists of 20 minas of gold.

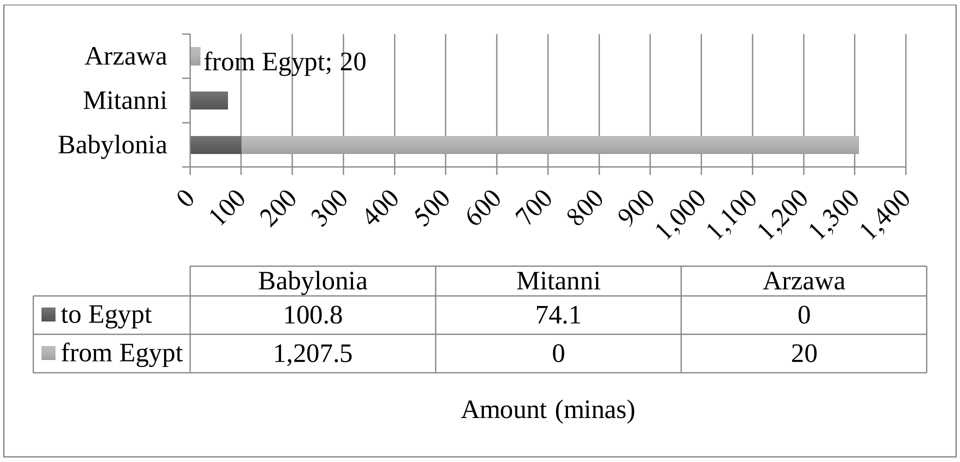
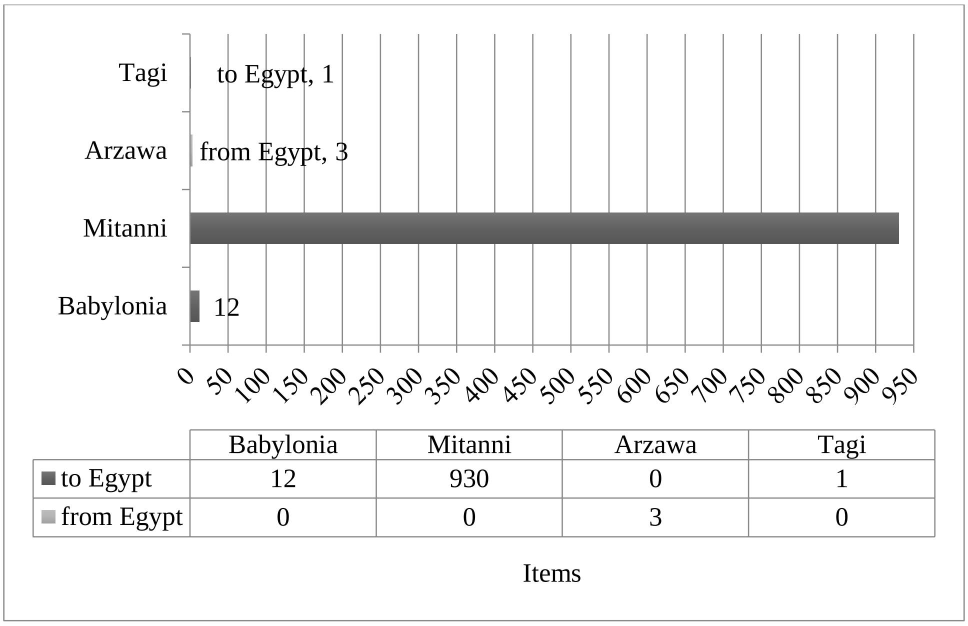


Chart 17. Amount of gold transferred in the Amarna letters.

However, the weight of the metal that was sent was not always recorded in the letter. For instance, Burna-Buriaš II’s daughter’s dowry did not mention any weights at all, although the same king’s greeting-gifts always did. It is worth mentioning that this letter, EA 13, must have been one of two, or more, tablets listing the dowry of the princess.[486] King Tušratta’s daughter’s dowry, found in letters EA 22 and EA 25, recorded gifts with, as well as without, the amount of metal used to produce them. However, his greeting-gifts, described in letters EA 17, EA 19, EA 20 and EA 21, were solely recorded as items. Nearly all of the documented gold items were sent to Egypt and **Chart 18** shows the number of gold objects transferred to and from this kingdom.

[486] Bryce 2003, 26 n. 1.



	Babylonia	Mitanni	Arzawa	Tagi
to Egypt	12	930	0	1
from Egypt	0	0	3	0

Chart 18. Amount of gold items transferred in the Amarna letters.

Charts 17-18 make it rather obvious that Egypt was an important provider of gold for the entire Near East of the Amarna period. In fact, approximately 87% of the transported gold was sent from Egypt to a fellow kingdom. Moreover, it is interesintg to see how these amounts of gold are spread, according to the prescribed categories of letters. For this purpose, **Charts 19-20** were created. These present the distribution of the amounts and the number of items of gold that were offered as dowry, bride-price and greeting-gifts, as documented in the Amarna letters.

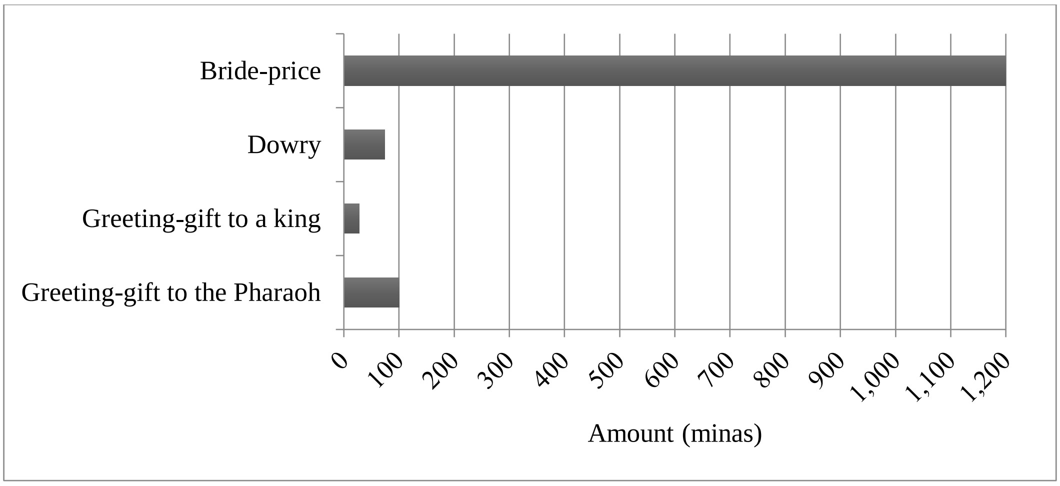


Chart 19. Distribution of amounts of gold offered in the Amarna letters.

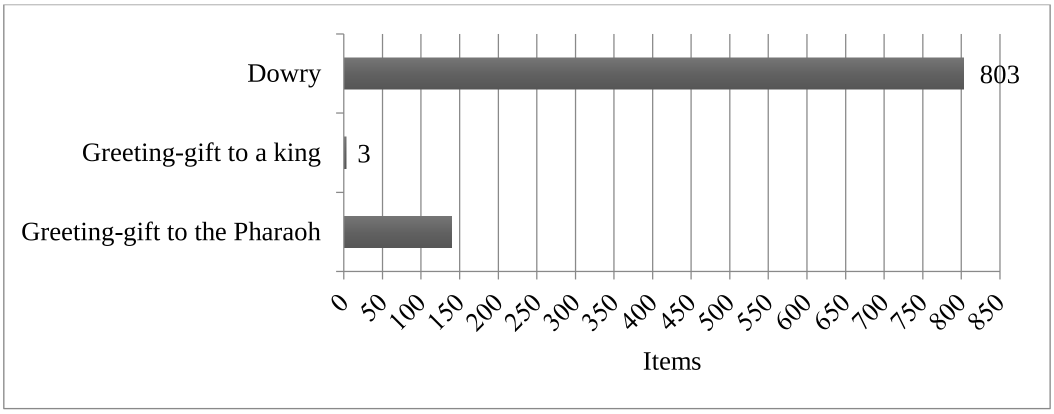


Chart 20. Distribution of amounts of gold items offered in the Amarna letters.

The general category of marriage-gifts understandably represents the primary reason for gift-offering and, thus, acquisition of precious goods and metals. Marriage-gifts include both bride-prices, that are offered from the Pharaoh, as well as dowries, that are offered to the Pharaoh from a "brotherly" king. Furthermore, it is noticeable how meticulous the Pharaoh was in recording the weight of every single piece of item he sent to a fellow king. This strategy was followed by the Babylonian king as well. On the other hand, Mitanni greeting-gifts and dowries (no tablet with the list of the bride-price has been found) were recorded without their weights.

The observation was made above that the Pharaoh always recorded the weight of the items he sent. In fact, the amount of gold that he sent to his brotherly kings was greater than what he received. Supposing that the 943 items of gold sent to Egypt weighed about 470 g (i.e. 1 mina) each, which seems rather unlikely based on the fact that most gold items were jewellery, then their total weight would reach approximately 442.9 kg. Egypt's gifts, however, accounted for about 576.9 kg.[487] Hence one may make the conclusion that Egypt is the main provider of gold in the Near East during the 14th century BC. However, it has to be kept in mind that Babylonia did not have an ample supply of gold so as to be a lavish provider. The Mitanni kingdom and its gold sources, though, is a matter that deserves further investigation.

[487] Egypt's gifts amount to precisely 61,374 shekels * 9.4 g = 576.9156 kg.

Table 14. Varieties of gold in the Amarna letters.

Gold (KÙ.GI/KÙ.SIG_{17}/*ḫurāṣum*)					
	Asks	**Sends**	**Receives**	**Tablets**	
Babylonia	"good"	-	-	1	EA 7
	-	-	"like silver"; "with the colour of ashes"	2	EA 3, 10
Mitanni	"not worked"	-	-	3	EA 19, 20, 29
	"solid cast" (statues)	-	-	1	EA 26
	"solid chased" (statues)	-	-	1	EA 29
	"molten" (image)	-	-	1	EA 24
	-	"with the colour of blood raised"	-	2	EA 22, 25
	-	"solid"	-	1	EA 25
Arzawa	-	-	"good"	1	EA 31
Gath	refers to: "multi-coloured"			1	EA 283

As far as varieties of gold are concerned, the Amarna letters contain a considerable number, which is listed in **Table 14**. In this table, the kingdom that requests, sends, or receives a variety of gold is recorded along with the letter(s) that mention(s) it. First, Arnuwanda I, king of Arzawa received a sack of gold of "good" quality (SIG_5) from Amenhotep III, as a gift in the marriage negotiations (EA 31). Second, in EA 7 King Burna-Buriaš II of Babylonia asks for "good" (*banum*) gold from Pharaoh Amenhotep IV, but it seems that what he received did not satisfy him. According to EA 10, "when they put them in the kiln, not five minas came out! [The gold] which did come out had the look of ashes when it turned dark (cooled)".[488] The same problem was faced by his predecessor, who claimed that the gold "looked like silver" (*ša ki* KU.BABBAR).[489] Third, there is a collection of references in the correspondence between Mitanni and Egypt. Most of these references concern requests made of the Mitanni king from the Pharaoh regarding gold "that has not been worked" and two statues of "solid

488 EA 10 (lines 20-21): *˹ù˺ a-na ú-tu-ni ki-i iš-ku-nu* 5 MA.NA KÙ.GI *ul i-la-a* [KÙ.GI] *˹ša˺ i-la-a i-na ṣa-la-mi pa-an ṭi-ki-ni ˹ša˺-˹ki˺-in*.
489 EA 3 (line 15).

cast", or "solid chased", gold.[490] Furthermore, the Mitanni king writes in EA 24: "I have at one time desired a molten gold image of my daughter".[491] The two dowry-list tablets, EA 22 and EA 25, however, include gold "with a reddish tinge" (*ša dá-ma šu-ú-lu-ú*) on toggle-pins and necklace stones, and "solid" (*up-pu-qù-tu*$_4$) gold toggle-pins. Finally, there is a reference to "the red gold of the king" (KÙ.GI!MEŠ! GÙN $^{\text{I}}$*šàr-ri* EN-*ia*), as line 7 of EA 283 is translated by Rainey,[492] which literally translates to "the multi-coloured gold of the king".

3.2.1.2 Silver

Silver's principal role in the LBA seems to have been that of currency.[493] This is very well reflected in the Amarna letters, where payments, pay offs, bribes, and/or maybe tributes are paid in silver. The fact that there is an abundance of attestations to this practice in the vassal correspondence with the Pharaoh, along with the fact that vassals ask for "much silver" instead of "much gold" to be sent to them, testifies to the lower, "commoner", value of silver in comparison to gold. Rib-Hadda of Byblos, Milkilu of Gezer, Suwardata of Qeltu and Baʿlu-dāni of Gezer are vassal rulers, who indirectly ask for the Pharaoh's help in paying the silver required as ransom, pay off, or bribery.[494] Furthermore, there is a payment to "the commissioner of the king" made in silver (EA 313), as well as a payment by the Pharaoh for buying female cup-bearers from Gezer (EA 369). Obviously, though, the greatest amounts of silver are recorded in the dowry and marriage-gift lists, found in letters EA 13 from Babylonia, EA 22 and EA 25 from the Mitanni and EA 14 to Babylonia. In fact, about 83% of the total amount of silver transported involves marriage-related gifts. Approximately 13% concerns the various kinds of payments that have already been mentioned and only about 4% greeting-gifts. Referring to the last kind only two letters exist, one to the Babylonian King Kadašman-Enlil I from Pharaoh Amenhotep III and the second one to a Pharaoh from the Hittite King Šuppiluliuma. The former is documented in letter EA 5 and amounts to 1 mina 8 ½ shekels, and the latter in letter EA 41 and records a total of 18 "Hittite" minas, which means 900 "Syrian" shekels. It should be noted here that the ransoms needed by Rib-Hadda have not been

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[490] EA 19 (lines 42, 59, 66), EA 20 (lines 49, 51, 71) and EA 29 (lines 138, 163): "gold that has not been worked" KÙ.GI *la ep-šu*. EA 26 (line 37) and EA 27 (line 19): "solid cast gold" KÙ.GI *ša-ap-ku*$_8$*-ú-tu*$_4$ *up-pu-qu-ú-tu*$_4$. EA 29 (line 145): "solid chased gold" KÙ.GI *up-pu-qu-ú-tu*$_4$ *muš-šu-ru-tu*.

[491] EA 24 (III §25 lines 90-91) in Hurrian: *še-e-ni-íw-wu-tan za-lam-ši* $^{\text{MUNUS}}$ša-a-˹li˺-íw-wu-ú-e ḫi-ia-ru-uḫ-ḫa *na-˹ak-ka-aš˺-ša ša-a-ru-ša-a-ú ia-me-e-ni-i-in˹-in˺ e-ti-íw-we pa-la-a-ú še-e-ni-˹íw-wu-uš˺*.

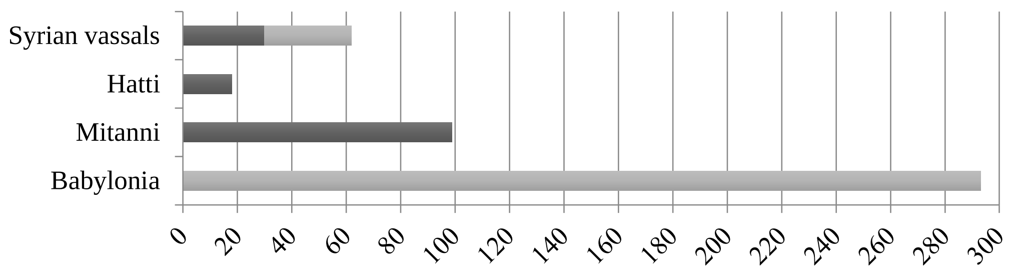
[492] Rainey 2015, 197.

[493] See also Veenhof 1972, 350.

[494] EA 91, EA 109 and EA 112, EA 270, EA 280, EA 292, respectively.

included in the calculations and the analysis, because there is no certainty that these amounts of silver were actually given by the Pharaoh.

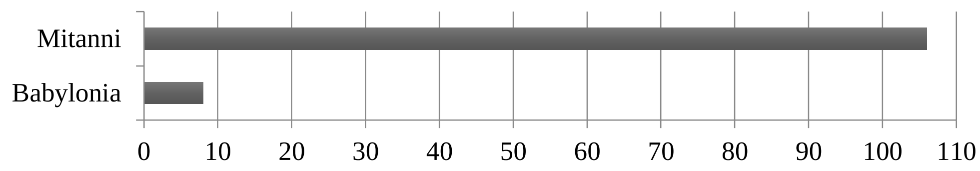
Charts 21-22 present the amounts of silver transported to and from Egypt. It can be easily observed that Egypt gave silver only to Babylonia, as part of a greeting-gift and a later bride-price, and as payment to Gezer for the requested cup-bearers. The amounts and number of silver and silver items offered by the Mitanni, as well as the items offered to Egypt from Babylonia, all regard dowries. The transported silver sums up to 7 talents 52 minas 22 shekels and 114 items. Approximately 69% of this weight was exported from Egypt, amounting to 5 talents 25 minas 11 ½ shekels, while all 114 items along with 2 talents 27 minas 10 ½ shekels of silver were sent to Egypt.



	Babylonia	Mitanni	Hatti	Syrian vassals
to Egypt	0	99	18	30
from Egypt	293.2	0	0	32

Amount (minas)

Chart 21. Amount of silver transferred in the Amarna letters.



	Babylonia	Mitanni
to Egypt	8	106
from Egypt	0	0

Items

Chart 22: Amount of silver items transferred in the Amarna letters

Chart 23 represents how the offered amounts of silver are distributed according to the category to which they belong. Bride-prices and dowries clearly prevail over the various payments recorded and the greeting-gifts presented.

Regarding silver varieties, there are only two texts that contain one such. In the Egyptian bride-price paid to the King of Babylonia in letter EA 14, we read about items of "clear" (*zakuum*) silver and in EA 37, the king of Alašiya asks for "refined" (*ṣarpum*) silver.[495]

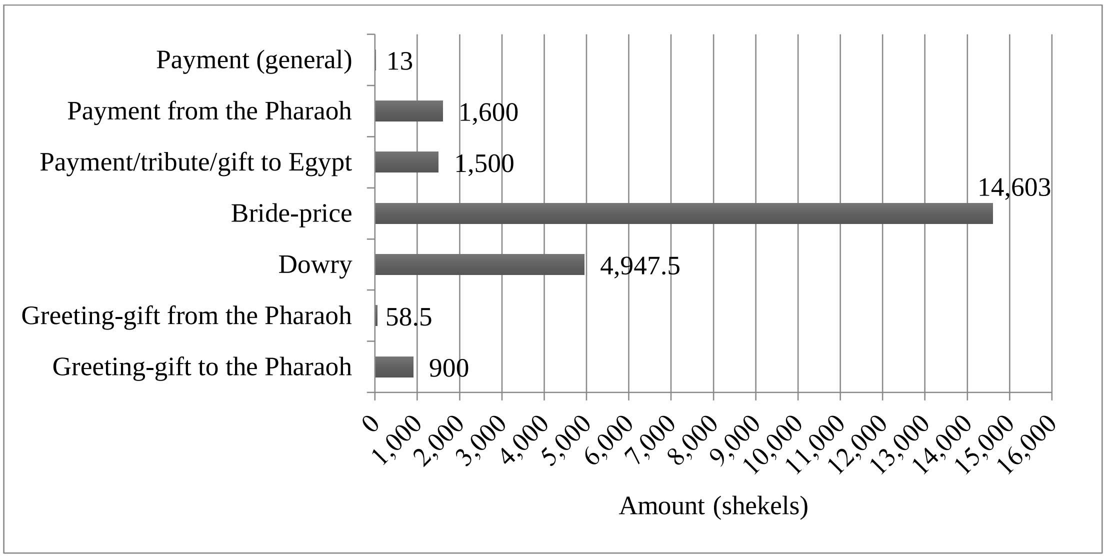


Chart 23. Distribution of amounts of silver offered in the Amarna letters.

3.2.1.3 Bronze

Bronze is the third most often cited metal in the Amarna letters. It is involved in the Babylonian King Burna-Buriaš II's daughter's marriage with Pharaoh Amenhotep IV. A variety of bronze vessels is presented to the Pharaoh and a selection of bronze objects (mirrors, vessels, ladles, razors etc.), with their weights mentioned, is presented to the king of Babylonia.[496] However, most of the bronze items listed in the Amarna corpus were offered from the Mitanni as dowry and as greeting-gifts.[497] Moreover, in EA 151, we read about an offer of five talents of bronze to the Pharaoh Amenhotep IV from the prince of Tyre, Abi-Milku. Tyre is considered among Egypt's vassal cities in Canaan. Byblos too was another vassal state of Egypt, located north of Tyre, and in text EA 77, the Pharaoh appears to have requested for copper to be sent to him from Byblos. Could it be that an offer of copper or bronze

[495] Moran (1992, 110) translates "pure".
[496] EA 13 and EA 14, respectively.
[497] EA 22 and EA 25, and EA 29, respectively.

was some kind of tribute, or were these Canaanite cities trading stations, suppliers of copper and producers of bronze?

The total amount of bronze transferred according to the Amarna letters is 19 talents 20 minas 20 shekels. Approximately 74% of this amount is exported from Egypt and 392 items are sent to Egypt. The vast majority of the bronze items are sent from the Mitanni and a few from Babylonia. **Charts 24-25** illustrate the amounts and number of items of bronze sent to and from Egypt.

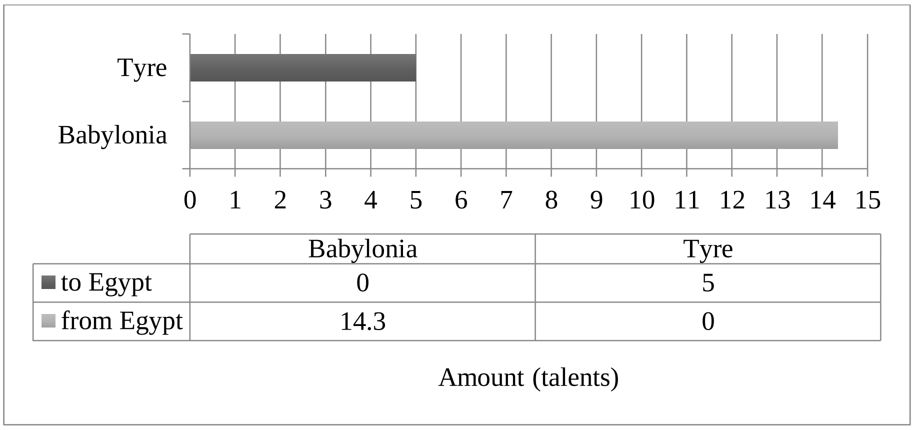


Chart 24. Amount of bronze transferred in the Amarna letters.

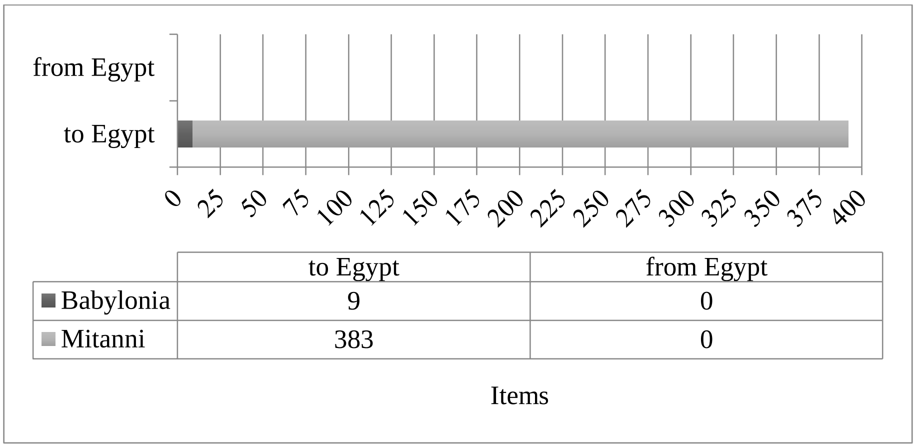


Chart 25. Number of bronze items transferred in the Amarna letters.

The strategy of recording the exact weight of the transported items is here followed only by the Pharaoh, not by the Babylonian and the Mitanni kings. The five talents of bronze that were offered from Tyre is a rather substantial quantity of this metal to be offered, especially when we compare it to the sum of 14 talents 20 minas 20 shekels that the Pharaoh presented as bride-price to the Babylonian king, an occasion which demanded special treatment and extravagant gifts (**Chart 24**).

3.2.1.4 Iron

Iron in this period is, as it was in the OA period as well, a unique type of metal. Once again, there are more than one word related to this metal. These are a) that one already-known from the OA texts from Kaneš, *amūtum*, b) another also known from the OA texts, but much rarer, *parzillum* (AN.BAR) and c) *ḫabalkinum*. It is noteworthy that only the Mitanni dowry-lists in letters EA 22 and EA 25 mention these words. The objects specified in the texts, connected to the above-mentioned words, are listed in **Table 15**. They comprise a mace, hand-bracelets, finger-rings, thin bracelets and a dagger blade of AN.BAR (i.e. *parzillum*),[498] dagger blades and javelin tips of *ḫabalkinum*,[499] and a horse-shaped vessel of *amūtum*.[500] The total number of these objects sums up to 30 items.

Table 15. Types of iron in the Amarna letters.

Iron-related word	**Items**	
AN.BAR (*parzillum*)	17	EA 22: 1 mace, 2 hand-bracelets, 1 dagger blade;
		EA 25: 3 finger-rings, 10 thin bracelets
ḫabalkinum	12	EA 22: 2 dagger blades, 10 javelin tips
amūtum	1	EA 22: 1 horse-shaped bottle

[498] EA 22 (I line 38): “1 mace, of iron, overlaid with gold” 1 GIŠ.TUKUL.DINGIR *ša* AN.BAR KÙ.GI GAR; EA 22 (II line 1): “1 ha[nd-brac]elet, of i[ro]n, [*overlaid with gol*]d” 1 ˹ḪUR˺.˹ŠU˺ *ša* AN.BAR K[Ù.GI GAR]; EA 22 (II line 3): “1 hand-bracelet, of iron, overlaid with gold” 1 ḪUR.ŠU *ša* AN.BAR KÙ.GI GAR; EA 25 (II line 22): “2 finger-rings, of *ir*[*on*]” 3 ŠU(!).GUR AN.[BAR]; EA 25 (II line 28): “10 thin bracelets, of iron, overlaid with gold” 10 ḪAR ŠU *ša* AN.BAR *ra-aq-qà-tu*$_4$ KÙ.GI GAR; EA 22 (II line 16): “1 dagger, the blade of which is of iron” 1 GÍR *ša* ˹EME˺-*šú* ˹AN˺.BAR. Where Rainey (2015) transcribes AN.BAR, Knudtzon (1915) transcribed *parzillu*.

[499] EA 22 (I lines 32-33): “[1] dagger, the blade of which is of i[r]on; its guard, of gold” [1] GÍR *ša* EME-*šú* ˹*ḫa*˺-˹*bal*˺-˹*ki*˺-˹*i*˺-˹*in*˺-˹*nu*˺ *[g]u-mu-ú-ri-šu* KÙ.GI; EA 22 (III lines 7-8): “1 dagger, the blade, of iron; its hilt, of gold” 1 GÍR *ša* EME-*šú ḫa-bal-ki-nu gu-mu-ú-ra-šu* KÙ.GI; EA 22 (III line 49): “10 *javelins*, with *ir*[*on*] tips” 10 ^{GI}*ia-ka-a-tu*$_4$ *ša ḫa-b*[*al-ki-ni*].

[500] EA 22 (I lines 55-56): “1 bottle, horse-*shaped*, of *amutu*-metal, with eagles of gold as inlay” 1 *la-ḫa-nu ša* ANŠE.KUR.RA.MEŠ *ša a-mu-*˹*ú*˺*-ti ša* Á.MUŠEN.MEŠ KÙ.GI *tam-lu-ú*.

3.2.1.5 Copper

Copper is the last metal in this analysis and the rarest to be found in the Amarna letters. It is mentioned in only a few series of letters. On the one hand, there are those exchanged between Egypt and Alašiya and a letter from the vassal ruler of Byblos.[501] On the other hand, there is the dowry list of the daughter of the Babylonian King Burna-Buriaš II.[502] EA 13 simply mentions a "kettle" of copper, while the parts of the tablet of EA 14, where the objects referring to copper are inscribed, are broken.[503] The most important references to copper are evidently the ones contained in the Alašiyan tablets.[504] Copper was not a precious metal, such as gold and silver, and so its near complete exclusion from the royal (wedding) gifts seems understandable. The Mitanni King Tušratta complained to the Pharaoh Amenhotep III that he sent to the king's father "gold bricks as if they were the equivalent of copper".[505] This passage implies that copper was more plentiful, very cheap and not very highly valued, or highly viewed, as a metal. Apart from the one item offered to the Pharaoh by the Mitanni, Alašiya shipped great quantities of copper to Egypt.

Chart 26 shows the amounts of copper transported to Egypt from Alašiya. These are divided in three distinct groups: Group 1 consists of the four largest amounts recorded, which constitute shipments of copper within the framework of trade; Group 2 consists of only one, significantly small, amount of copper; Group 3 includes the three amounts recorded in EA 40, sent by the governor of Alašiya to the governor of Egypt. The amounts belonging to Group 1 are recorded in a) EA 33, consisting of 200 talents of copper and 10 talents of good copper, b) EA 34, consisting of 100 talents of copper, and c) EA 36, comprising 120 talents of copper. The amount belonging to Group 2 is the one that was written in letter EA 35, about which there is much to be said.

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501 EA 33, EA 35, EA 36 and EA 40, and EA 77, respectively.
502 EA 13 and EA 14.
503 EA 13 (Rev. line 20).
504 The importance of the copper production in Alašiya (Cyprus) and its trade/export to Egypt is discussed in Kassianidou 2013.
505 EA 19 (line 38): SIG_4 KÙ.GI.MEŠ *ki-ma ša* URUDU.MEŠ *ma-ṣú-ú*. Following Moran's (1992, 44) translation; cf. Knudtzon (1915, 139) translates "eine *Platte* Gold, als ob es *legiertes* Kupfer wäre", reading the verb *mesûm* denoting "to refine metals" (CAD M(2), 30-2) and not the verb *maṣûm* meaning "to be equal to" (CAD M(1), 344-45); Rainey (2015, 143) translates "Bricks of gold, just like copper ones in size".

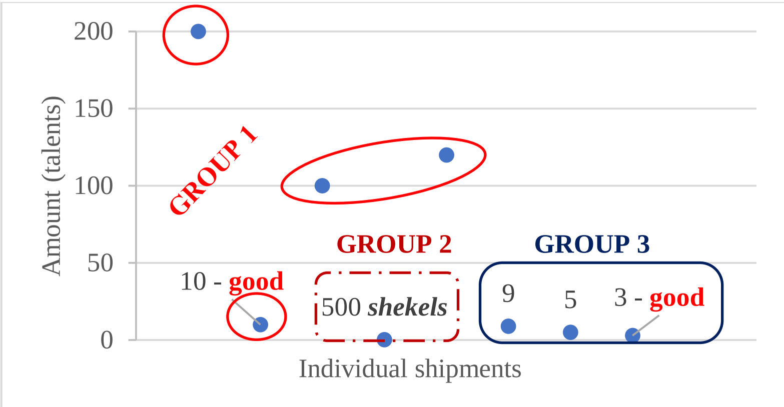


Chart 26. Amounts of transported copper in the Amarna letters.

As far as the letter EA36 is concerned, the registered amount of 120 talents is not absolutely certain, because the part of the tablet that contained this detail is damaged. Knudtzon's[506] transcription and restoration of line 6 of letter EA 36 was "ú-še-bi-lu *8*[*0 er*]û ri-ḫu 70 erû *ina bi*[*lti*]". Later, Moran[507] published *The Amarna Letters*, restoring this line as follows: "120 (+x?, Gordon) (talents) [of cop]per; 70 (talents) remain", noting that "i*n line 6 (end), AŠ G*[*Ú.UN*]*, '1 ta*[*lent*]'". This updated version of the line has been adopted by Cochavi-Rainey and Rainey.[508] However, Knudtzon[509] had noted that

> *after the lu sign, a vertical wedge can be seen. From this until the end of the probable erû there is a somewhat larger distance than there is from the vertical wedge of the following number 70 until the end of the following erû.*

Thus, he transliterated "80", which in cuneiform would be written as □□□ (i.e. 60+20). Gordon's version, on the other hand, would be □□ □□ (i.e. 100+20).[510]

Based on the existing space between the "*lu*" and the end of the word for copper, URUDU/*wērium*, it would seem that the number that was recorded there must have also occupied quite some space. This means that Knudtzon's "80" would not be enough to fill it. Moreover, judging by a photograph and the line-art of EA 36 (**Figure 6**), while a vertical wedge might have been visible at the edge of the broken piece, no more wedges could possibly be visible in between, as this piece of the tablet is entirely missing. As a result, the sign of 100, written as □□, is most probably to be found there, but the rest of the number is unknown. Furthermore, based on the existing space, a number higher than 110 (□□ □), or even maybe

[506] Knudtzon 1915, 288.
[507] Moran 1992, 109-10.
[508] Cochavi-Rainey 2003, 23; Rainey 2015, 344.
[509] Knudtzon 1915, 288 n. d.
[510] A vertical wedge, □, denotes the number 60. A diagonal wedge, □, represents the number 10 and the combination □□ is the sign for hundreds (written logographically as ME) (see Huehnergard 2011, 235-37).

120 (□□ □□), can be surmised.[511] For this reason, the amount of (at least) 120 talents is here kept to.

As far as Group 2 is concerned, the amount of 500 shekels is recorded in EA 35 and in particular in line 10. The original text writes: “Now I have sent to you 500 of copper” (*e-nu-ma a-na* UGU-*ka* 5 *me-at* URUDU *ul-te-bi-la-ak-ku*). The *communis opinio* is that this line is to be completed with the word “talents” following and specifying the number “500” 5 *me-at*.[512] This belief rests on two factors: a) that consistency is needed among the texts and b) that if the apology “My brother, that the amount of copper is small, may it not be taken to your heart” in line 12[513] is in fact ironical,[514] the sentence “You have not been ranked with the king of Ḫatti or with the king of Shanhar” in lines 49-50 would then seem justifiable.[515] Granted that consistency is indeed necessary, it is most necessary inside a single letter and not throughout the whole of the correspondence; not to mention that the whole of the correspondence between Alašiya and Egypt has certainly not survived. As can be seen from the transcribed line, no weight unit was mentioned by the scribe of this tablet, which is rather unusual when it concerns talents. Shekels, however, are sometimes omitted. Thus, I am inclined to agree with Liverani’s[516] view that the line must be completed with the word “shekels” instead of “talents”. Furthermore, it is totally illogical to be actually sending the largest (known to us) amount of copper (500 talents = c. 14,1 tons) and say that it is little. Though an amount of 500 shekels (about 4,7 kg) can indeed seem ridiculously small for a greeting gift for the Pharaoh, it can be logically explained. This could be just a sample of a potential larger shipment and an incentive for proper and in-advance payment. An analogy can be found in the bargaining strategy followed by Zakar-Baʿal in his negotiations with Wen-Amun, regarding a supply of cedar beams. In this case, Zakar-Baʿal offered only seven beams, asking to be paid in advance; Wen-Amun paid what was due, thus receiving the full shipment of hundreds of wooden beams.[517]

[511] See Gordon’s restoration: “120 (+x?)” (Moran 1992, 109).
[512] Knudtzon 1915, 285; Moran 1992, 35; Cochavi-Rainey 2003, 18.
[513] EA 35 (line 12): *a-ḫi ki-i* ⸢*ṣe*⸣*-ḫé-er* URUDU *i-na lìb-bi-ka la-a i-*⸢*ša*⸣*-ki-in*.
[514] That the apology was ironical was first suggested by Georgiou (1979, 96).
[515] EA 35 (lines 49-50): *it-ti* LUGAL *Ḫa-at-ti*$_7$ *ù it-ti* LUGAL *Ša-an-ḫa-ar it-ti-šu-nu la ta-ša-ki-in a-na-ku*; Moran 1992, 108 n. 2.
[516] Liverani 1990, 250-51.
[517] Liverani 1990, 249-51; Papadopoulou 2018, 63-5.

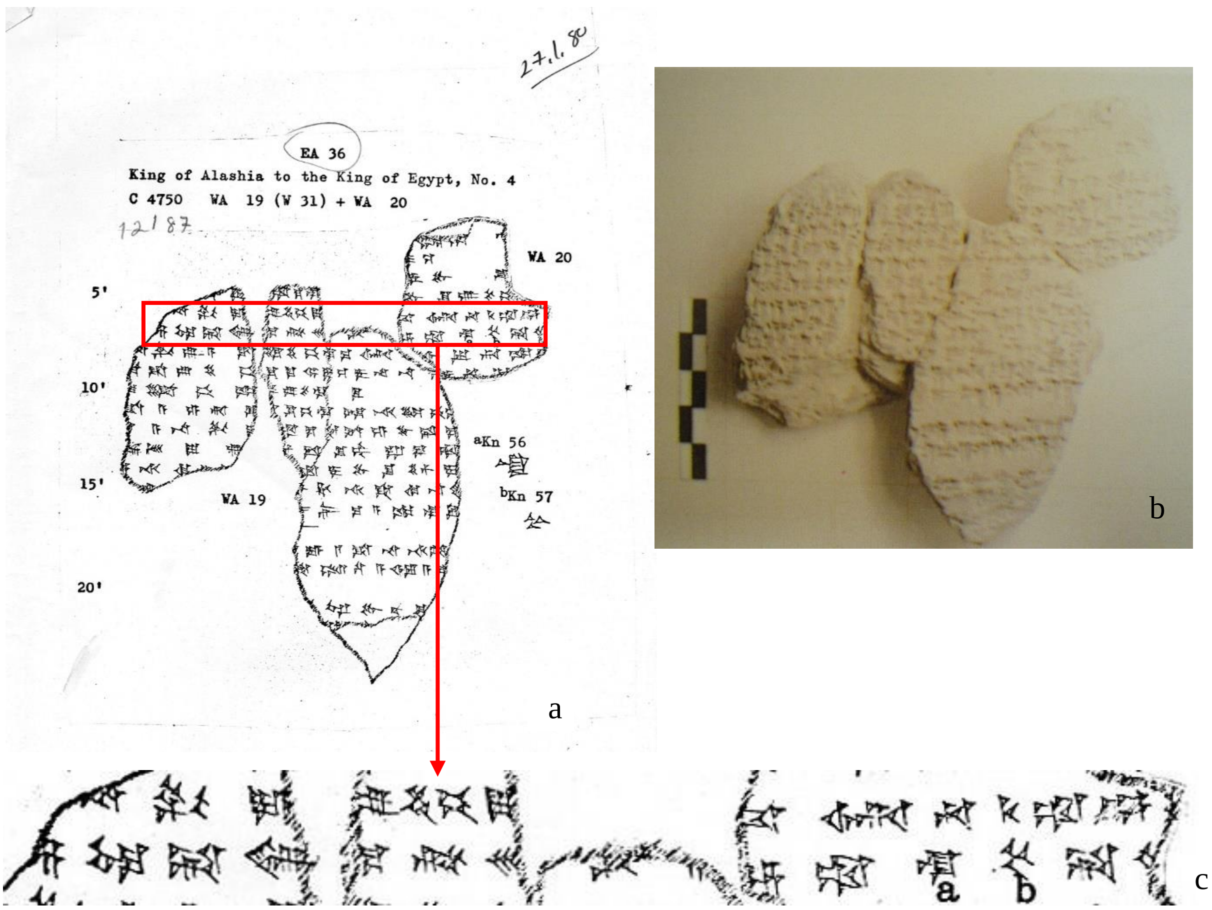


Figure 6. Tablet EA 36

a and c: Line-art of letter EA 36 and detail in line 6 (CDLI no. P270980)

b: Photograph of EA 36 (Hellbing 1979, 100).

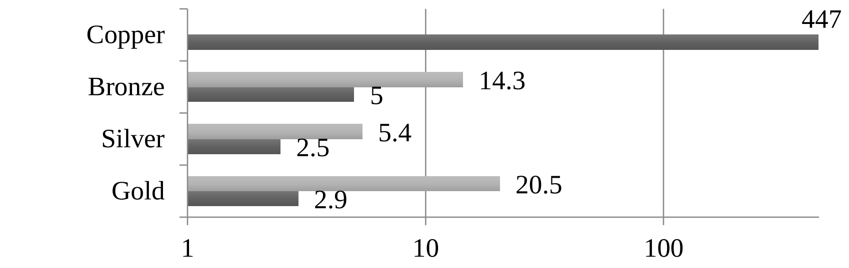
As far as varieties of copper are concerned, there are two references of "good" copper,[518] thus, differentiating "good" from regular copper. More interestingly, though, there is a reference to "multi-coloured (alloyed?)" copper in EA 36, which writes: "[among] some of the talents you may rejoice(?), 30+[1(?) among the tal]ents are multicolored (alloyed?)".[519]

3.2.1.6 Contradistinction

Because Egypt is the focal point of the Amarna letters, two charts have been created (**Charts 27-28**), where the sent and received amounts of each metal are shown. **Chart 27** represents the weight of the metals and **Chart 28** the number of items. Note that the former

[518] EA 33 (line 18): URUDU [DÙG]; EA 40 (line 13): URUDU D[Ù]G.G˹A˺; cf. Moran 1992, 105 n. 6.
[519] EA 36 (line 7): [ù GÚ.U]N *mim-ma ta-aḫ-ba-ṣí* 30 +[AŠ G]Ú.UN URUDU TAR KUR *ta-ḫi*[…].

chart has been designed in a logarithmic scale, due to the disproportionate size of the total copper amount. The weights are measured in talents.



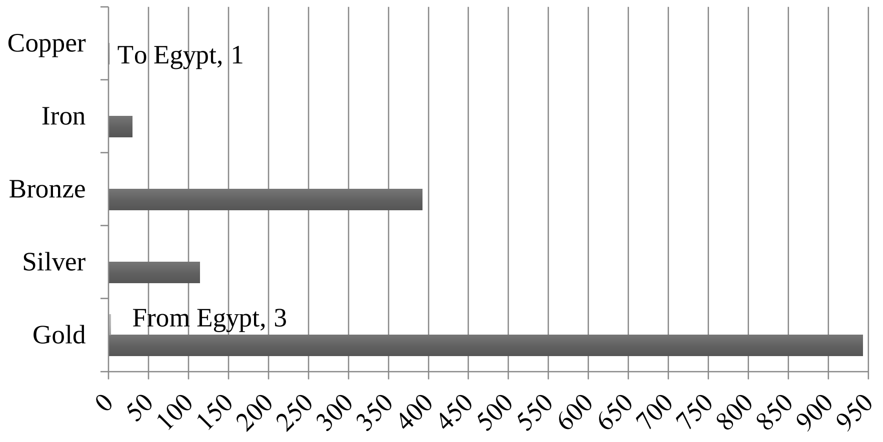
	Gold	Silver	Bronze	Copper
From Egypt	20.5	5.4	14.3	0
To Egypt	2.9	2.5	5	447.2

Amount (talents)

Chart 27. Comparison between the amounts of each metal sent to and from Egypt in the Amarna letters.

It has already been shown that as far as Egypt is concenrned, she is the provider of great quantities of gold, silver and bronze, and every documented object was recorded with its weight. It is also of interest to point out that, aside from the expected amount of gold exported from Egypt, bronze is also exported in significant amounts. The former metal records a total of 20 talents 27 minas 24 shekels (i.e. c. 20.5 talents) and the latter 14 talents 20 minas 20 shekels (i.e. c. 14.3 talents). The weight of the silver leaving Egypt is 5 talents 25 minas 11.5 shekels (i.e. c. 5.3 talents). On the other hand, as regards the metals imported to Egypt, copper is of course the one that records the greatest quantities by far, totalling up to 447 talents 10 minas. The second highest amount belongs to bronze, at 5 talents; third stands gold and then silver. The imported amounts of gold and silver are somewhat similar, registering just 2 talents 54 minas 46.9 shekels (i.e. c. 2.6 talents) and 2 talents 27 minas 10 ½ shekels (i.e. c. 2.9 talents), respectively.

Concerning the metal items transported, **Chart 28** clearly shows how sending items without recording their weight is a foreign and not at all an Egyptian practice. Egypt sent only three items of gold without recording their weight. However, it received great quantities of gold items of unknown and unspecified weight. The bronze items sent to Egypt came to less than half that of the gold; and silver objects accounted for even less than a third of the bronze ones. The order of succession of the metal items received from Egypt is rather in contrast to the sequence of metals when recorded by weight, as shown above in **Chart 27**.

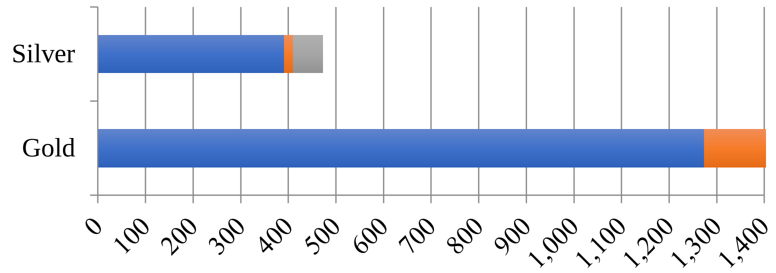


	Gold	Silver	Bronze	Iron	Copper
From Egypt	3	0	0	0	0
To Egypt	943	114	392	30	1

Items

Chart 28. Comparison between the number of items sent to and from Egypt in the Amarna letters.

Of the metals received from Egypt and whose weight was recorded, and when we exclude the five talents of bronze sent to Egypt from Tyre, what remains are silver and gold. **Chart 29** presents the purposes for which these two metals were used. Copper has been excluded, because its amounts are far greater than any other metal and because it was mainly involved in trade shipments, being unrepresented in bride-prices or dowries. What can be observed is that gold is documented in about 91% of the cases of marriage-related gifts and only in about 9% of the cases as greeting-gifts. On the other hand, silver is used in three circumstances. The vast majority of the references regards marriages (c. 83%) and only about 4% of the occasions relates to greeting-gifts. However, and in addition, silver is also involved in payments, documented at about 13% of the instances. Thus, gold seems to be a far more important metal in diplomatic situations, as for example marriage- and greeting-gifts. Silver is a significant metal both for diplomacy and prestige, as well as for the common occasions of payment.

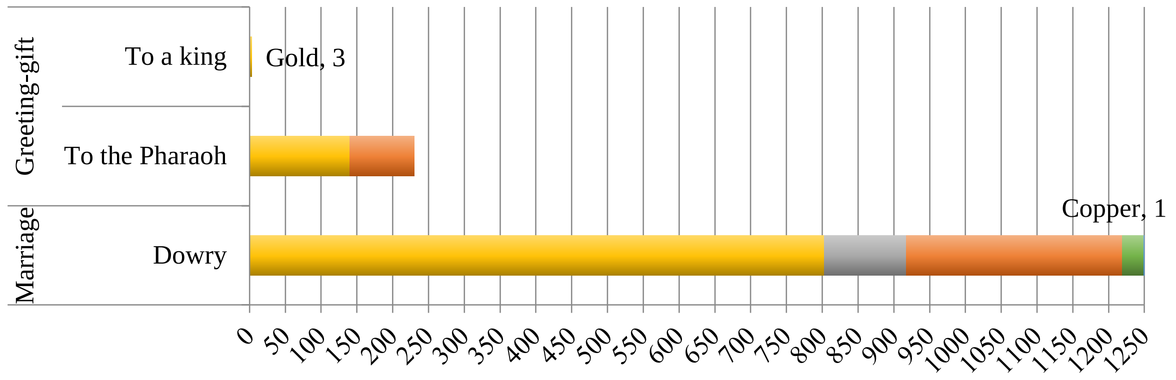


	Gold	Silver
Marriages	1,274.1	391
Greeting-gifts	128.3	19.2
Payments	0	62.3

Amount (minas)

Chart 29. Distribution of categories per metal (in weight) in the Amarna letters.

Due to the fact that most correspondents sent their gifts without mentioning their weight, **Chart 30**, based on items, examines the matter on the same parameters as does **Chart 29**. This new chart contains more metals but only concerns the two categories of marriage and greeting-gifts. Furthermore, the information is presented in a different way than in the previous chart, because thus it is more evident how and in what categories the metals were distributed. Considering the fact that the Pharaoh used to document in detail the weight of each object he offered, while the other Great Kings usually simply listed items, the conclusions drawn from this chart are as expected. Dowries are the number-one reason for offering metal objects, of every kind of metal. Specifically, gold is of course the most common one for dowries and greeting-gifts for the Pharaoh. About 64% of the marriage category and 61% of the greeting-gift category consist of gold. The second most popular metal among gifts is bronze. Approximately 24% of the dowries and 39% of the greeting-gifts for the Pharaoh refer to this metal. Finally, silver items appear to be sent to the Pharaoh only as a dowry and at just about 9% of the cases of metal items received.



	Marriage	Greeting-gift	
	Dowry	To the Pharaoh	To a king
Gold	803	140	3
Silver	114	0	0
Bronze	302	90	0
Iron	30	0	0
Copper	1	0	0

Items

Chart 30. Distribution of metal items per category in the Amarna letters.

These results lead us to deduce that in the Amarna period and as regards (mainly) kingly affairs gold and bronze were the most valuable metals. Silver and iron appear only in the background due to value reasons, which entail rarity or not, ease of access and/or production, even colour and people's colour preferences.

3.2.2 Metal varieties

This section focuses on the nomenclature of the varieties of metals existing and explores any information deriving from the studied texts. Observations regarding the type, content, quality and value of the varieties of metals mentioned in the texts are here made.

3.2.2.1 Gold

Gold is the only metal in the Amarna corpus that reveals a range of varieties. Apart from the quality-related varieties of gold, consisting of "good" gold alone, they can be divided into two distinct categories: those that take note of the appearance of the gold, i.e. its colour, and those that suggest gold-working. In the first category belongs gold that looked "like silver" *ša ki* KU.BABBAR or had the colour "of ashes" *ša ṭikmennu* and gold with the colour "of blood raised" *ša damu šūlû*. The variety of gold referred to as *burrumum* "multi-coloured" and translated as "red" in EA 283 needs further examination and a closer look at the tablet itself. The second category comprises all those Mitanni requests for "molten" *nākkāša*, "solid" *epēqum*, "solid cast" *šapkum epēqum*, "solid chased" *epēqum muššurum*, or gold that "has not been worked" *la epēšu*.

As regards the first category, we read about the complains over the colour and, thus, the quality of the gold that was presented to the king of Babylonia. He wrote that the gold "looked like ashes" KÙ.GI *ša ṭi-ki-ni* in text EA 10 and "like silver" KÙ.GI *ša ki* KÙ.BABBAR in text EA 3.[520] The mentioned hue implies a high silver content, which would make the gold appear greyish, indeed silvery. The passage relative to this specific colour of the gold, as recorded in text EA 10, was a complaint made by the Babylonian King Burna-Buriaš II to the Pharaoh Amenhotep IV. He writes:

> The twenty minas of gold that were sent were not complete. And when they put them in the kiln, not five minas came out! [The gold] which did come out had the look of ashes when it turned dark (cooled). [As for the gold, wh]en did they ever verify it?[521]

A very similar complaint was also reported by the Babylonian king's predecessor, Kadašman-Enlil I, and was addressed to Pharaoh Amenhotep III. This, earlier protestation was written as follows:

> Now, when I sent an envoy to you, six years have you detained him, but in the sixth year you have sent thirty minas of gold that looks like silver for my greeting gift. They melted down that gold in the presence of Kasî, your envoy and he witnessed (it).[522]

Both of these passages record the specific hue of the gold that is under discussion here. The former passage refers to the colour of the gold after it was treated with fire, while the latter to the colour of the metal as it was sent and because of which it had to be put in the fire. From the first passage we learn that the gold was put in a kiln in order to verify its quality and, thus, its purity. When the gold was taken out of the fire and it cooled down, it had a greyish hue which ultimately proved the impurity of the gold. The same test by fire seems to have been performed by the previous Babylonian king in order to verify the (im)purity of the gold.

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[520] EA 10 (line 21) and EA 3 (line 15), respectively.

[521] EA 10 (lines 19-22): 20 MA.NA KÙ.GI *ša na-ša-a ul ma-li* ˹*ù*˺ *a-na ú-tu-ni iš-ku-nu* 5 MA.NA KÙ.GI *ul i-la-a* [KÙ.GI] ˹*ša*˺ *i-la-a i-na ṣa-la-mi pa-an ṭi-ki-ni* ˹*ša*˺-˹*ki*˺-*in* [KÙ.GI *im-ma-*]˹*ti*˺-*ma-a u*˺-*e-du-*[*ú*]-*š*[*i*].

[522] EA 3 (lines 13-17): *i-na-na a-na-ku* DUMU *ši-ip-ri ki aš-pu-ra-ak-ku* MU.6.KAM^{v} *ta-ak-ta-la-šu ù ša-a* MU 6-[K]AM^{v} 30 *ma-na* KÙ.GI *ša ki* KÙ.BABBAR *ep-šu a-na šu-ul-ma-ni-ia tu-ul-te-bi-la* KÙ.GI *ša-a-šu a-na pa-an* ^{I}KA-si-I DUMU *ši-ip-ri-ka uṣ-ṣi-id-du-ma i-ta-ma-ar*.

The information we draw from EA 10 is not limited to the colouration of the gold received. This passage offers evidence of the heat treatment applied. The Babylonian king claimed that after the testing (by fire) process of the 20 minas of gold received "not five minas came out" 5 MA.NA KÙ.GI *ul i-la-a*. This sort of observation generally means that there was a considerable loss of weight. What is more, the Babylonian king in the passage cited from the letter EA 3, said that the gold looked "like silver" even before it was put in the fire. This implies that the hue of silver was showing in the gold, without any need of a test by fire. This purity test would probably be performed in any case, even if the gold looked like actual gold, so as to verify the level of purity of the gold. This heat treatment will be discussed in more detail in Chapter 4.1.1.1.1.

Furthermore, there is the "gold tinged with red" *ša damu šūlû* – literally "with the colour of blood raised", as Frantz and Schorsch[523] have rendered Knudtzon's[524] original translation: "gold through which blood shines".[525] In the Amarna letters there are in total seven references to "gold with a reddish tinge", or "gold tinged with red", KÙ.GI *ša damu šūlû*.[526] The Akkadian word *šūlû* comes from the verb *elû*, which has the meaning of "bringing something to the surface", "raising", "bringing up".[527] These red-coloured gold objects were sent to Egypt from Mitanni and they seem to be part of polychrome creations. Taking into consideration that these references regard ready-made products and not raw materials, the possibility arises that the expression KÙ.GI *ša damu šūlû* actually describes gold artefacts, whose surfaces have been accordingly treated so as to reflect a reddish, blood-coloured hue.

Additionally, there is a letter sent from Šuwardata, the ruler of Gath, where "the gold and the red gold of the king, my lord" is mentioned.[528] Rainey[529] has most probably adopted and updated Knudtzon's[530] original transcription, where he read "… ù … *burruma*" and noted that the wedge seen there is the same as the one in EA 36 after the word for copper, URUDU/*wērium*, in line 7.[531] The word that is of interest here is *burruma*, which, as has been already mentioned, had the meaning of multi-coloured or speckled.[532] Thus, this adjective

[523] Frantz and Schorsch 1990, 147.
[524] Knudtzon 1915.
[525] Adler (1976) also translates it as "Gold, das Blut hervortreten läßt".
[526] Rainey (2015, 1280) understands "*'enhanced blood-red' i.e., 'reddish (gold)'*".
[527] CAD E, 114, especially pp. 131-33: 10. *šūlû*; Rainey 2015, 1280. See **Appendix 5**. The same Akkadian word was used in the passage cited above from EA 3 (line 20), concerning the silver that "came out" of the fire.
[528] EA 283 (lines 12-13): KÙ.GI!MEŠ! *ù* KÙ.GI!MEŠ! GÙN [I]*šàr-ri* EN-*ia*.
[529] Rainey 2015, 1096-97.
[530] Knudtzon 1915, 852.
[531] Knudtzon 1915, 853 n. g. It is Knudtzon's (1915, 1007) unclear sign no. 150 and it is indeed the same wedge as no. 56. See the wedge no. 56 drawn on the right side of the tablet in **Figure 6a**.
[532] CAD B, 331-32.

described a double-/multi-colouration of the gold that cannot be reduced to red. It could similarly signify the presence of a silvery hue on the gold. Unfortunately, the text does not provide us with more information, but polychromy achieved by the manipulation of the colour of gold is a valid possibility.

Regarding the second category, it comprises a series of characteristics that imply gold-working (or not). The specifications "molten", "solid cast" and "solid chased" gold concern statues that the Mitanni king requested from the Pharaoh Amenhotep IV. According to Ogden,[533] the gold-working tradition of Egypt and the Near East was of hammering out the gold, whether in sheet form or massive solid objects. Casting was employed usually in conjunction with working the gold by hand, like chasing. This involves "*hammering the metal down from the front to produce a low-relief design with linear margins*"[534] and an example of this treatment is found in the 22nd Dynasty gold figure of Amun, now in the Metropolitan Museum of Art in New York (MMA 26.7.1412).[535]

A link between the first and the second category of special references to gold can be found in the Mitanni correspondence and particularly in references to gold "that has not been worked". The king's foreign guests complained about the unworked state of the gold,[536] while the king repeatedly requested for "gold that has not been worked".[537] This obvious contradiction cannot be easily, or rationally, explained. The continuous, repeated in more than one letter, and pressing request for "very much" and even "very, very much" "gold that has not been worked" represents the true desire of the king of the Mitanni. On the other hand, the complaint is unequivocally made by the king's foreign guests, whose ethnicity eludes us, and it is distinctly separated from the king's words. It could be surmised that the Mitanni king wanted to acquire silver-containing gold, in order to mix it with iron and/or copper, and by doing so create the rare reddish-coloured gold discussed just above. If this was so, then it certainly was a conscious choice for this specific hue. Moreover, the fact that the foreign guests of the king lively criticised the unworked state and, thus, the colour of the gold sent from the Pharaoh, tells us that in their country such a gold was not beautiful and we could even say that it was considered almost unacceptable to high status dignitaries and the palace.

What is more, in EA 27, King Tušratta of the Mitanni is reminding to Amenhotep IV the good relationship he had with the Pharaoh's father. It reads:

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[533] Ogden 2000, 165.
[534] Moorey 1994, 216.
[535] Ogden 2000, 165.
[536] EA 20 (lines 49, 51): KÙ.GI *la ep-ša*.
[537] EA 19 (lines 42, 59, 66); EA 20 (line 71); EA 29 (lines 139, 163).

> It was your father (…) who recast them, fashioned them, finished them, purified them. And when the recasting took place, my envoys saw with their own eyes and when they were finished and they were purified, with their own eyes they saw.[538]

In this letter, the king refers to the matter of the golden statues, which Amenhotep III had prepared but not sent to him. The king maintained that the statues were recast, fashioned and purified in front of the eyes of his envoys and wonders why they have not been dispatched. Besides the interesting information regarding the diplomatic relations between the two kingdoms and kings, this passage is also a (probable) indication of the gold treatment abilities of the Egyptians.

3.2.2.2 Silver

As has already been stated, silver in the Amarna letters presents a lack of varieties. Only two tablets, EA 14 and EA 37, contain references to a variety of silver. In EA 14, Pharaoh Amenhotep IV offers to the Babylonian King Burna-Buriaš II a bride-price containing a box, a bed and a headrest of KÙ.BABBAR *zakuum* "clear silver": among a total of around 116 items of, or overlaid with, silver, only these three are of this variety.[539] On the other hand, the Alašiyan request for KÙ.BABBAR *ṣarpum* "refined silver", in EA 37, uses a word which denotes a heat treatment already discussed in Chapter 3.1.2.2 in relation to the OA "refined" silver.[540] It is believed that the Egyptians were acquiring silver from other kingdoms, such as the vassal states in Canaan, in the form of booty or tribute, as there is no local Egyptian silver source.[541]

3.2.2.3 Iron

The matter and understanding of *amūtum*, the rarest of the iron terms found in the Amarna letters, has been thoroughly discussed in Chapter 3.1.2.5.1. The second term used for

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[538] EA 27 (lines 24-27): *a-bu-˹ka˺-ma* (…) *a-na ši-ip-ki ut-te-e-er-šu-nu i-te-pu-us-sú-˹nu˺ ig-ta-mar-šu-nu ˹uz˺-ze-ek-ki-šu-nu ù ki-i a-na ši-ip-˹ki˺ tù-ur-ru* LÚ.DUMU.MEŠ.KIN-*[i]a ˹i˺-˹na˺ ˹IGI˺-˹šu˺-nu i-tam-ru ˹ù˺ ki-I gám-ru-ma za-ku₈-ú i-na* IGI.MEŠ-*šu-nu i-ta-am-ru*.

[539] EA 14 (II lines 57, 63). The mentioned objects include items like vessels and containers (large and small), an animal statue, a chest, ladles, pairs of sandals, a box, a bed, its headrest and mirrors of silver, plus another box and a throne overlaid with silver.

[540] CAD Ṣ, 102-4: *ṣarāpu*. Moran (1992, 110) translates "pure".

[541] Forbes 1950, 185; 1971, 212; Lucas and Harris 1962, 245-47; Aldred 1971, 32-3; Kassianidou 2009, 54. See also Gale and Stos-Gale 1981.

this metal, also found in the OA texts, is the Akkadian word *parzillum*.[542] Despite the fact that in the OA texts we read the phonetic spelling *parzillum*, in the Amarna letters we read the logogram AN.BAR instead.[543]

As far as the meaning of the term AN.BAR is concerned, the old belief that it meant "heaven-metal" or "star-metal", i.e. meteoric iron, has been withdrawn; scholars are now of the opinion that AN.BAR/*parzillum* denotes smelted iron.[544] Against the translation of AN.BAR/*parzillum* as "meteoric iron" the Hittite text KBo 1, 14, dating to the mid-13th century BC also bears witness. In lines 21-22 of this text, the "production" of AN.BAR is mentioned: (…) AN.BAR *a-na e-pé-ši* (…) AN.BAR *damqa*^{qá} *e-ip-pu-šu*. If this AN.BAR/*parzillum* means meteoric iron, then how can it be produced? The employed word for the verb "to produce" is *epēšum*, which according to the CAD has a number of meanings and uses. Among them are meanings such as "to make", "to build", "to fashion", "to manufacture", "to work", with *URUDU* (copper) it has been translated as "to mine (or smelt)", with all the traded metals [KÙ.BABBAR (silver), KÙ.GI (gold), URUDU (copper), etc.] as "to earn in commercial activities", with *parzillum* as "to smelt", and many more, among which some have a still obscure meaning.[545] Taking *epēšum* to mean "to smelt" iron, then AN.BAR cannot indeed be denoting iron coming from iron meteorites, which would have been the easiest and most probable source to have been exploited by the ancient Mesopotamians. Meteoric iron is not mined, but meteorites need to be found in the field and the iron needs to be extracted from the stony or stony-iron meteorites. A more thorough discussion on all this follows in Chapter 4.3 further below.

The word *ḫabalkinnum* has been identified as the Hittite word for iron and a few scholars have equated it with the logogram AN.BAR.[546] However, there is much discussion concerning the nature of this metal. From early on in the research into this word, it has been associated with *chalibikos*, meaning "of the tribe of Chalybes". The Chalybes lived on the coast of Pontus, in northern Anatolia, and are therefore connected with the production of the metal *χάλυψ*, meaning "steel".[547] In 1968, Hoffner proposed that this Hittite word "*may also occur in the toponym* ^{URU}*Ḫ̮A-WA-AL-KI-NA also spelled* ^{URU}*Ḫ̮A-WA-AR-KI-NA*".[548] The equation and

[542] Maxwell-Hyslop 1972, table on p. 162; Muhly *et al*. 1985, 74-5; Moorey 1994, 278-79; Yalçin 1998, table 4; Dercksen 2005, 27.
[543] See also: Hoffner 1968, 43; Reiter 1997, 361-67.
[544] Forbes 1950, 465; 1972, 229; Bjorkman 1973, 112, 114; Muhly *et al*. 1985, 74-5; Moorey 1994, 278-79; Reiter 1997, 392-93; Dercksen 2005, 27.
[545] CAD E, 191-235.
[546] Hoffner 1968, 42-3; Maxwell-Hyslop 1972, 161. See also: Bjorkman 1973, 114; Reiter 1997, 392-93.
[547] Forbes 1950, 268; Muhly *et al*. 1985, 76; Nieling 2009, 55-6. See also: Moorey 1994, 279; Puhvel 1996.
[548] Hoffner 1968, 43.

translation of this word as steel is, however, unfounded and it has been construed based on the fact that in EA 22 two dagger blades were said to be of *ḫabalkinnum*.[549] Whether this word can be connected to the steel-producing tribe of Chalybes or not, and if it denotes steel or not, cannot be deduced from the available texts from Amarna.[550] More texts need to be studied and especially those from the Iron Age, as this type of metal is mostly mentioned during those years. Until then, any discussion on the matter and any translation offered reside in the realm of hypothesis.

3.2.2.4 Copper

Both Alašiyan letters that mention "good" copper use the logogram DÙG, which means "good", "of good quality".[551] Apart from the difference in quality, there is evidence that this "good" copper was more highly valued and also rarer than the commonly found and traded copper from Alašiya. This claim is supported by the fact that the number of references and the amounts of "good" copper sent to Egypt are far less and smaller than those of regular copper. In the letter EA 33, we read about a shipment of 200 talents of regular copper and only 10 talents of the "good" variety. And in letter EA 40, the governor of Alašiya sends a greeting-gift to the governor of Egypt composed of five talents of copper and three talents of "good" copper.

Moreover, there is the single reference to "multi-coloured" copper, which the king of Alašiya sent to the Pharaoh, claiming that it would make his heart rejoice.[552] Back in 1915, Knudtzon[553] transcribed the last part of line 7 of tablet EA 36 as "*burrumi mat-ta-ḫ*[*i*]", *burrumi* being the word denoting the multi-coloured state of the copper. However, he left the sentence untranslated. The word *burrumum* is logographically written as TAR/DAR and it

549 Forbes 1950, 268; Maxwell-Hyslop 1974, 143 n. 15. See also Reiter 1997, 393.
550 Moorey 1994, 279. See also: Goetze 1940, 33; Tylecote 1981.
551 EA 33 and EA 40. CAD Ṭ, 19-42.
552 EA 36 (line 7).
553 Knudtzon 1915, 288 and n. k.

means multi-coloured, a mixture of two colours.[554] Moran[555] did not include this part of the tablet in his book and simply noted that the tablet is "*too fragmentary for translation*", providing only some information for the letter and pieces of transcribed lines. Cochavi-Rainey[556] and more recently Rainey[557] did include the tablet and the specific line in their works, thus restoring the "lost" transcription and translation of this letter. If this "multi-coloured" copper is indeed alloyed copper, then this passage is a testament to the transport of tin to the island and its addition to copper to create bronze, the most commonly found and used alloy of the LBA. Taking into consideration the fact that the search for copper, and better yet of "good" copper, was only in service of the bronze production, then the offer of 30 or more talents of bronze would indeed please the Pharaoh.

3.3 Compare and contrast

The diverse nature of the two text collections above analysed has a considerable impact on how we should perceive the information extracted from each of them. Elements such as the roughly 500-years gap, the fragmentary and "selective" character of the Amarna corpus, in contrast to the "complete" OA texts collection, and most importantly the fact that the latter concern common people and are mainly business letters, while the former are royal correspondences, must always be kept in mind while attempting to compare, contrast and draw conclusions.[558] Given that the OA traders dealt with raw materials and not finished goods, it is to be expected to find metals such as tin mentioned, which would be provided to metalsmiths for the production of bronze. For the same reason, finding a vast array of metal varieties is equally to be expected. Similarly, reading in the Amarna letters about the offer of great

[554] **CAD B, 331-32. It is Knudtzon's (1915, 1003) unclear sign no. 56 (see Figure** 6

a).

[555] Moran 1992, 109-10.

[556] Cochavi-Rainey 2003, 24.

[557] Rainey 2015, 345.

[558] "Selective", because the so-called Amarna letters represent those tablets which were deemed obsolete or unnecessary to the royal archive and were left behind. "Complete", because whole tablets were left and found, but unfortunately only a small proportion of the available tablets have been translated and published.

quantities in bronze objects is equally unsurprising, considering the nature of the correspondences recorded. Additionally, the received copper amounts from Alašiya should be regarded as trade commodities and not actual royal presents, although some of them could have been.

Despite the fact that the total amount of gold recorded in the OA texts, transported over a span of more than a century, is far less than that mentioned in the Amarna letters over a time period of only some 30 years – not to mention the certainty that much greater amounts would have been exchanged and recorded – gold seems to have constantly been the most desirable and (in its way) valuable metal of all. Furthermore, three gold varieties appear in both periods: silver-containing gold, red-coloured gold and gold of good quality.

The most wide-spread opinion is that the OA *pašallum* gold corresponds to the Amarna silver-like (pale) gold, about which many kings complain, and has been taken to denote electrum. Nevertheless, the word *pašallum* is quite often left untranslated, suggesting that its meaning is not as clear as we may think.[559] The OA text analysis led us to the conclusion that *pašallum* gold was a variety of good quality gold, which could be obtained after some kind of refinement process. The type of gold that can be related to the pale gold of the Amarna period is the "white" gold KÙ.GI *puṣium* and/or the gold that "turned into silver" (*ša ki* KU.BABBAR) after it was put in the fire. The complaints regarding the quality of this type of gold and the appeal to double-check the purity and, thus, the value of the gold received, reminds us of the often-read protests against the appearance and the purity of the gold that the Pharaoh sent to his fellow kings. In accordance with the gold-silver alloy's colouration scale (**Figure 10**), white gold contains a large proportion of silver, which gives this characteristic colour to the alloy. As a result, in the OA period and based on texts like FS Matouš 2, 125, it seems that this type of gold was considered to be of low quality and must have been less valuable than silver. Moreover, it is believed that in Egypt this white-coloured gold-silver alloy would simply be used as silver. Egyptians were very passionate about colours; since there were no silver but only silver-bearing gold sources in Egypt, this may have been the reason why this natural alloy may have been used instead of silver.

A second common variety of gold is the red-coloured one. In the OA texts, it is described as "red" and "blood-coloured" and in the Amarna letters, the Mitanni refer to gold "with the colour of blood raised". The high-value and price of red gold is evidenced in the OA

[559] Michel (1991; 2001) is the only person that has translated it as "extra-fin" and "pur" gold (KUG 5 and CCT 2, 46b, respectively).

text TC 3, 137, which reads as follows: "[Für das] rote [Gold(?)] beschafft [entweder geläutertes (Silber)] oder laßt (im Feuer) geprüftes (Silber) hereinkommen, und wo immer (welches) zu beschaffen ist, beschafft sie (die beiden Silbersorten)!".[560] In addition, text kt c/k 48 of the same period, documents the highest exchange ratio with silver recorded, at 8.5:1 or 9:1 for "good blood-coloured gold".[561] Similarly, in Kassite Babylon the gold-silver ratio for "red" gold was 8:1, while for "bright" gold it was 4:1.[562] As a result, the higher value and probably also purity of this variety of gold is further supported by its rarity both in the Amarna letters and in the OA texts. Balkan[563] noted that this blood-coloured gold, that we see in the OA texts as well as in the Amarna letters, is a highly valued variety of gold and speculated that it is gold-veined electrum. Furthermore, Forbes[564] maintained that it was considered as a superior variety of gold which, from the second half of the 18th and until the 20th Dynasty, appeared in an assortment of objects.[565] The question then arising is what exactly this red-coloured gold was. Was the red colouration fortuitous, or obtained through specific heat treatments? With the help of texts from Mari, we ascertained the possible addition of a mineral (salt?) for preparing (purifying?) gold. It appears probable that a heat treatment was performed in order to change the colour of the surface of the gold so as to resemble the hue of high purity gold. A mineral like common salt could have been mixed and fired with gold in a cupel, resulting in an actually purer gold. However, in spite of the fact that texts from Mari and Kaneš attest to the possibility of gold refinement, the texts from the 14th century BC Egypt do not reveal much and it seems like such a process was unknown or not used in this region. Nevertheless, "seems like" does not mean that it is so. The following chapter discusses the long-debated issue of the red hue of gold and whether it was due to the existence of iron or copper, or even a result of a purification or surface manipulation (depletion gilding) process. Still, the people of the ANE liked and valued the red hue on gold, and it would come as no surprise to find that it became a deliberately created colouration.

Closely related to gold is silver. Their association goes beyond the subject of the gold-silver alloy, electrum, which occurs both in the OA texts and in the Amarna letters. First, silver is always put second in value after gold and it was always used as currency. From the OA texts, we can understand that it was less valuable than gold. The Amarna letters, however, contain

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560 Sturm 1995, 499. TC 3, 137 (lines 1'-6'): *a-mì-im* […] *ep-ša* / *lu a-mu-ra-am ma-qí-ta-ma a-šar e-pa-ší-im ep-ša-šu-nu a-pu-tum*.
561 See Garelli 1963, 268-69.
562 Moorey 1994, 219.
563 Balkan 1965, 151.
564 Forbes 1971, 171-72.
565 Schorch 2001, 67-8. See also Ogden 1992b, 262-63.

another kind of proof. As has already been stated, there are two major categories of correspondence in the Amarna archive. On the one hand there is the royal correspondence, where kings ask for "much gold" from the Pharaoh and, on the other, there is the vassal correspondence and the trade negotiations between Alašiya and Egypt, where "much silver" is asked for instead. The latter category is the one that better informs us about the use of silver as currency.[566] If these letters were absent from the collection of tablets left behind we would not be in a position to recognise this metal as a standard of value, but simply as another precious metal used in the exact same way as gold or bronze. Moreover, according to the OA texts, "refined" silver was that variety most sought for, the most referred to and the most often transported, in general and in particular towards Aššur. In the Amarna letters, there is a sole reference to this variety of silver. It appears in the context of a request by the Alašiyan king and is unknown if it was satisfied.

Surprisingly enough, the Amarna letters include another variety of silver, one that appears only once in the OA texts. "Clear", i.e. pure, silver is offered by the Pharaoh, as a bride-price to the Babylonian king. This pure variety of the metal regards a box, three beds and a headrest, which are objects of no small size. Thus, the required amount of silver to make or overlay these objects must have been great. Maybe it was this variety of silver that the Alašiyan king was asking for as well. The current belief is that there was no silver source available to the Egyptians; instead they were using the locally available silver-loking gold. So, the Egyptian smiths cleverly combined the local gold-silver alloy with the imported silver to produce a purer (than the normally used) form of silver. However, the "clear" silver that was offered must have been imported in a refined and pure form, or purified by the Egyptian metalsmiths.[567]

The third metal mentioned is bronze, which is understood as the combination of copper and tin. The OA letters, which basically describe the circulation of raw materials, are rich with references of copper and tin shipments, but poor in mentioning bronze objects. The Amarna letters, on the other hand, involve a fitting number of bronze objects for the marriage contexts in which they are found and only a few exchanges of copper, or copper objects; the latter being in a striking minority. As far as recorded varieties of copper are concerned, the OA texts understandably contain an assortment of choices, while in the Amarna letters there is a distinctive differentiation between regular and good quality copper from Alašiya. In both textual evidence, "good" copper is more valuable than any other variety of this metal. To this

[566] See also Kassianidou 2009, 52, 55.
[567] Lucas and Harris 1962, 245-46; Forbes 1971, 212.

attest a number of factors. First, in the OA texts, it is the most commonly mentioned and the most often transported variety of the metal. Second, it is sent from Alašiya to Egypt in smaller quantities than regular copper. And third, it appears to be sent to Egypt instead of and as the equivalent of a much larger load of regular copper.

Furthermore, another very valuable metal during the 2nd millennium BC in the Near East was iron. The matter of this metal during the period of time under discussion is one of the most complicated and problematic. The debate regarding its terminology began in the 1950s and is still going on without definite conclusions being reached. This metal has been assigned to a number of Akkadian words and logograms, for some of which the relation is, at best, uncertain. According to the OA texts, all transport and exchange references regard KÙ.AN/*amūtum* and not *aši'um* or *parzillum*. Moreover, *amūtum* was to be exchanged only with gold and silver and no objects are mentioned.[568] In contrast, the Amarna letters refer to objects of *parzillum*, *ḫabalkinnum* and *amūtum*. Moreover, the trade-related texts of the OA period record varieties of KÙ.AN/*amūtum*, such as "good", "clear", "clear (and) in small pieces", "stones" and *kīšum*. Accordingly, the objects recorded in the Amarna letters do not mention specific characteristics of the metal and are separated into three distinct categories. There is jewellery (for example bracelets and finger-rings) and weapons (for instance a mace and a dagger blade) made of AN.BAR. There are also weapons (dagger blades and javelin tips) made of *ḫabalkinnum*. And there is a sole item, a horse-shaped vessel, made of *amūtum*.

In sort, the OA term *aši'um* was related to the terms *amūtum* and KÙ.AN, while the latter two were synonymous. *Amūtum* appears in OA texts but then disappears, only to make a sudden appearance in a letter sent to the Pharaoh from the Mitanni, in the 14th century BC. Moreover, AN.BAR and *parzillum* are taken to be synonymous as well. *Parzillum* is recorded in texts from Kaneš and Mari, as well as in Hittite texts from Ḫattuša. AN.BAR is documented in Sumerian texts of the end of the 3rd millennium BC, in Hittite texts from Ḫattuša, in a Middle Assyrian text from Aššur and in letters sent from the Mitanni during the Amarna period.[569] More importantly, both of these terms continue to appear in Mesopotamian and Anatolian texts during the first half of the 1st century BC.[570] Additionally, texts from Mari attest to the spelling *bar-zil-li*, recognised as an alternative spelling for *parzillum*. The aforementioned spelling corresponds with the Hebrew word *barzil* and the Ugaritic *brdl*, both of which denote iron.

[568] There is also a text that mentions *amūtum* being exchanged for copper with an exchange ratio of 2,618:1 (ICK 1, 39a, mentioned in Reiter 1997, 389).
[569] See Moorey 1994, 279.
[570] Maxwell-Hyslop 1972, table on p. 162; Yalçin 1998, table 4.

Finally, *ḫabalkinnum* (*ḫapalki*-) appears only in Hittite texts and also in letters sent from the Mitanni to Egypt during the Amarna period.

Furthermore, Hittite texts record AN.BAR GE_6, literally meaning "black iron". An example is a passage from KBo 4, 1 i 39: "they brought black iron of the sky from the sky", based on which the phrase AN.BAR GE_6 has also received the meaning of "meteoric iron".[571] "Black iron" has been related to Tylecote's[572] "black sands", which come from the black-coloured sands of the southern shores of the Black Sea. This area is related to the Chalybes, an iron and steel-producing tribe known from ancient Greek writers.[573] Moreover, the name of this tribe has been connected with the Hittite word *ḫapalki*- and Hoffner[574] has identified it in the toponym ^{URU}HA-WA-AL-KI-NA. Returning to the meaning of *parzillum* and AN.BAR, due to the fact that they are the only words, from those mentioned, that continue to appear into the 1st millennium BC, when iron production exists and iron weapons and tools are widely used, leads us to believe that they alone denote iron. The Hittite text KBo 1, 14, dating to the reign of Ḫatušiliš III (c. 1267-1237 BC), mentions AN.BAR in relation with daggers and armours produced in Anatolia. The passage reads as follows:

> As for the good iron which you wrote me about, good iron in Kizzuwatna in my seal-house is not available. That it is a bad time for producing iron I have written. (But) they will produce good iron; so far they will not have finished. When they will have finished, I shall send (it) to you. Today now I have an iron dagger blade brought on its way to you. [As for the a]rmor(?) which you sent me (saying): 'For this (armor) [send] blades [in return!'], so far they have not finished producing (them). [When they will have finished, I shall send] (them) to you. I have been made like you.[575]

Finally, as regards the Hittite word *ḫabalkinnum*, it appears in a Middle Assyrian text, which reads as follows:

> 4 daggers of bronze, 1 dagger of iron [AN.BAR], 1 lance of *ḫabalginnu*, (all of) which is (/was) the responsibility of Aššur-zuquppanni, Bābu-apla-uṣur has received; he has returned (it) to the 'bronze house'. [576]

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[571] KBo 4, 1 i 39: AN.BAR GE_6 *nebisas nebisaz uder*. Muhly *et al*. 1985, 74-5; Košak 1986, 125-26, 132-33.
[572] Tylecote 1981.
[573] Aeschylus (*Prometheus Bound*, lines 714-715) calls them *σιδηροτέκτονες Χάλυβες*, which can be translated as "Chalybes, workers in iron" (Sommerstein 2008, 520); Strabo, Geography xi 14.5.
[574] Hoffner 1968, 43.
[575] Goetze 1940, 29. KBo 1, 14 (lines 20-27): *a-na parzilli damqi*^{qi} *ša tàš-pu-ra-an-ni parzillu damqu i-na* ^{ál}*Ki-iz-zu-wa-at-na i-na bit* $^{aba\ n}$*kunukki-ia la-a-aš-šu parzillu a-na e-pé-ši li-mi-e-nu al-ta-pár parzilla damqa*^{qá} *e-ip-pu-šu a-di-ni la-a i-gám-ma-ru i-gám-ma-ru-ma ú-še-bi-la-ak-ku i-na-an-na a-nu-um-ma lišān paṭar parzilli* [*ul-te-b*]*il-ak-ku* [*a-na sa-*]*ri-ia-ma-a-ti ša tu-še-bi-la ma-a a-na an-na-a-ti lišānāti*^{meš} […………………] *a-na e-pá-ši a-di-ni la-a i-gám-ru* [*i-gám-ma-ru-ma ú-še-bi-l*]*a-ak-ku ki-I ku-a-ša-a šu-ta-a-ma-ku*. Zaccagnini 1970, 11; Forbes 1972, 266; Košak 1986, 133.
[576] Postgate 1973, 13 (lines 10-17): 4 GÍR *ša* ZABAR 1 GÍR *ša* AN.BAR 1 *ul-mu ša ḫa-bal-gi-ni ša i+na pi-ti* $^{m.d}$*a-šur-zu-qup-pa*$^{!}$*-ni* $^{m.d}$*ba-bu*-A.PAP *ma-ḫi-ir a-na* É ZABAR *ut-ta-er*.

Here, as well, the use of two completely different words to express the same metal is irregular and does not make sense. As a result, if *ḫabalkinnum* is indeed iron then it could be a Hittite word relating to a toponym, which could mean "iron from the area ^{URU}HA-WA-AL-KI-NA", as Hoffner suggested.[577]

If we are to agree with the now widely accepted opinion that *aši'um* denoted an iron ore and KÙ.AN/*amūtum* a bloom of (i.e. smelted) iron, the question that remains is why there would be a second word describing the same metal, i.e. *parzillum*. In my understanding, the Akkadian language used one word to express a range of literal and figurative meanings. Hence, having two or three words to denote practically the same metal seems illogical. Near Eastern metal tradition shows that from the point that a metal was produced, recognised as the now-known iron, it would continue to be referred to by the same and original word and only be accompanied by adjectives reflecting its quality, treatment (e.g. smelted etc.), colour etc. Reiter[578] made a great effort to collectively and comprehensively explore all opinions and possibilities regarding its nature and made the proposition that KÙ.AN denoted a tin-antimony alloy and not iron.[579] I cannot say that I agree with her translation on KÙ.AN, but for all intents and purposes the possibility remains that the aspect on which we base all our hypotheses – that *aši'um*, *amūtum*, KÙ.AN, *parzillum*, *ḫabalkinum* and AN.BAR are in one way or another synonymous to iron – may be a false one. Having said that, another possibility arises, which of course merits a more thorough and analytical investigation. This is that if KÙ.AN/*amūtum* did indeed refer to iron, then AN.BAR/*parzillum* and by extension *ḫabalkinnum* (if we accept the association of *ḫabalkinnum* with an Anatolian toponym and, thus, with the Chalybes) have the meaning of a more advanced iron product, for which north Anatolia was known and which later came to be known as steel. To prove such a statement and the conclusion that KÙ.AN/*amūtum* is a primary and lower quality-product of iron, more texts related to these words have to be found, read, translated, analysed and studied in conjunction with the rest of the references. Additionally, more chemical and structural analysis of iron samples from the 2nd as well as the beginnings of the 1st millennium BC in the Near East have to be performed, in order to find out when people actually started to experiment with iron. Also, to investigate if there was any technical progression in producing iron objects during the time of the earliest documentations of KÙ.AN/*amūtum*: if the answer is yes, then are these iron objects

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577 See Hoffner 1968, 43.
578 Reiter 1997, 353-91.
579 Reiter 1997, 353-57; see also p. 470, where she states that the identification of KÙ.AN with *amūtum* is not certain.

recognisably different from actual iron objects produced later, as for instance during the 14th century BC?

4 Archaeological finds and archaeometallurgical data

This chapter deals with the chemical and structural analyses that have been performed on metal objects by various researchers. The first part of this chapter (Chapter 4.1) regards gold and silver. These two metals are discussed *in tandem* because of their closely related nature and the fact that many gold objects would be better described as silver than golden. The decisive factor is their elevated silver content. This part is itself divided into the analysis and discussion of the gold finds (Subchapter 4.1.1) and that of the silver finds (Subchapter 4.1.2). The second part (Chapter 4.2) concerns all copper-based objects, whether they regard copper, arsenical copper, or tin bronze. This is further chronologically and spatially divided in MBA/OA samples from Anatolia and LBA objects from Egypt. The third part (Chapter 4.3) involves iron and it is spatially divided between Anatolian and Egyptian artefacts. Due to the complexity of the matter of iron, the analysis is concluded with a more detailed discussion about meteoric iron. The basis for this chapter is the chemical analyses performed on the various samples which, for reasons of space, are presented in Tables in **Appendix 6-Appendix 9**. The results of the analyses and the information derived from them are subsequently connected to the descriptions of the metals as read in the texts and discussed in the previous chapter.

4.1 Gold and silver

There is a plethora of studies on Egyptian gold, but a scarcity concerning gold in Anatolia. Only a few silver artefacts from Egypt have been analysed and the research performed on silver objects from Anatolia is even less. Therefore, Egypt and Egyptian artefacts will be the centre of discussion in this part of the chapter. Starting with gold, it has been noted that this metal is often characterised by its colour. There are two distinct colour variations of gold, one that "looked like silver/ashes" and one "with a reddish tinge", or "blood-coloured", which are to be found both in the OA as well as the Amarna texts. As regards Egypt, the former variety is tied to the local Egyptian gold, while the latter to artefacts sent from the Mitanni. The "like silver" or "like ashes" gold has always been associated with an alloy of gold and silver, called electrum. The term and the composition of this metal comes from Pliny.[580] According

[580] Plin., *NH* 33.23.

to his original and later also Lucas'[581] self-admittedly, "*entirely arbitrary*" division, a gold alloy containing more than 20% of silver is termed electrum, while its colour "shines more brightly than silver".[582] From this definition, there are two points to be discussed: a) the composition of the alloy and b) the colour of the alloy. What is more, the possible native occurrence of such an alloy in Egypt has to be reviewed.

Reflecting upon the matter of electrum and its occurrence in ancient Egypt, the matter of another ore must also be considered, the so-called aurian (or auriferous) silver. Lucas was the first to express the idea that there was no silver source in Egypt and that a local silver-rich ore was used instead.[583] Stos-Ferner and Gale put Lucas' opinion to the test and concluded that there are no local Egyptian silver-rich gold-silver alloys.[584] They also concluded that silver of a foreign origin was added to local Egyptian ores and that this foreign source may have been south Anatolia, with Canaan acting as an intermediary for Egypt.[585] In Egypt, the scarcity of silver, along with the abundance of gold, can easily explain the greater value of the former metal. During the New Kingdom, gold was half as valuable as silver.[586] At a later time, Gale and Stos-Gale[587] analysed a number of silver artefacts and came to the conclusion that "*a large part of Egyptian silver was, in fact, natural aurian silver or, put another way, a natural silver-rich ore probably coming from the same mines that provided Egypt with the majority of its gold*". Noteworthy is that the earliest Egyptian term for silver is *nbw ḥḏ*, which literally translates to "white gold" and points to a simple colour differentiation of the same ore.[588]

Geologically speaking, gold ores do not contain such high concentrations of silver as to be termed auriferous silver. The most silver-rich gold deposits are the subvolcanic ones. In these types of deposits, the ores contain more silver than gold, but the silver forms complex silver sulphosalts and not metallic phases. For this reason, they would not have been used in ancient times.[589] On the other hand, Nubian gold deposits are auriferous quartz veins, which normally have a silver content of about 20%, and placer deposits that can contain even less

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[581] Plin., *NH* 33.23; Lucas 1928, 315; Lucas and Harris 1962, 234-35. Troalen *et al*. 2009, 115. Forbes (1950, 153) sets a range between 22-55% silver. Ogden (1962a, 30; 1992b, 262) defines it as a gold alloy with more than 25% silver and Moorey (1994, 217) describes it as "*native argentiferous gold containing 20-50% silver*".
[582] Plin., *NH* 33.23: *electri natura est ad lucernarum lumina clarius argento splendere*. According to Mindat.org, the range of the silver content in electrum is 20-50% (Mindat.org, "Gold"); Moorey 1994, 217.
[583] Lucas 1928, 315.
[584] Stos-Ferner and Gale 1979. See also Gale and Stos-Gale 1981.
[585] Stos-Ferner and Gale 1979, 312; Gale and Stos-Gale 1981, 104; Stos-Gale and Gale 1981, 288-94. See also: Ogden 2000, 170; Shortland 2006, 659, 666.
[586] Lucas and Harris 1962, 247; Gale and Stos-Gale 1981, 103. See also Forbes 1950, 185.
[587] Gale and Stos-Gale 1981, 110-13. They (Gale and Stos-Gale 1981, 108) arbitrarily defined aurian silver as silver containing more than 5% gold.
[588] Forbes 1950, 175; Stos-Ferner and Gale 1979, 299; Gale and Stos-Gale 1981, 113.
[589] Philip and Rehren 1996, 139; Rehren *et al*. 1996, 6.

silver, as the gold nuggets are mechanically refined through the tumbling actions of the river.[590] The latter source is most commonly used from the late Second Intermediate Period (SIP) onwards and the Platinum Group Elements (PGE: platinum, palladium, rhodium, osmium, iridium, ruthenium) inclusions, found in several Egyptian gold artefacts, is proof of that statement.[591] Thus, alluvial gold should have a composition of <20 wt% Ag and <2 wt% Cu.[592]

Table 16. X-rays penetration depth for PIXE, XRF and SEM-EDS (modified table from Troalen *et al*. 2014, table 1). Depth measured in μm.

Au/Ag/Cu (wt%)	PIXE			XRF			SEM-EDS		
	Au L_a	Ag K_a	Cu K_a	Au L_a	Ag K_a	Cu K_a	Au L_a	Ag L_a	Cu K_a
95.8/4/0.2	7.4	11.1	5.1	12.7	27.8	7.9	0.5	0.5	0.5
86/12/2	7.9	12.1	5.5	13.5	32.4	8.7	0.5	0.5	0.5
68/30/2	8.8	14.0	6.2	15.2	43.1	9.8	0.6	0.6	0.5
50/48/2	9.6	15.8	6.8	17.0	59.9	10.8	0.6	0.6	0.6

A significant obstacle in analysing gold artefacts is the non-destruction clause operating among archaeologists and museums. The widely used analytical methods have the serious disadvantage of a rather small penetration depth (up to some tens of microns, in gold).[593] As a result, if one wants to analyse the core of the metal in comparison to the surface, these methods prove incapable of reaching the necessary depth.[594] **Table 16** is a modified version of a table from Troalen *et al*.,[595] showing the effective penetration depth values, measured in μm, from which 95% of the detected X-rays are produced. Despite the fact the X-Ray Fluorescence (XRF) beam has a deeper penetration depth than the Particle Induced X-Ray Emission (PIXE) and certainly deeper than the Scanning Electron Microscope coupled with Energy-Dispersive x-ray Spectrometer (SEM-EDS), it has been found that the corroded surface layers contribute

[590] Rehren *et al*. 1996, 6; Klemm and Klemm 2013, 21, 42-3. See also: Philip and Rehren 1996, 139-40; Klemm *et al*. 2001; 2002.
[591] Ogden 1977. See also: De Jesus 1977, 51-2; Meeks and Tite 1980; Botros 2004, 32; Troalen *et al.* 2009, 113; Troalen *et al*. 2014, 222-24.
[592] Ogden 2000, 162; Troalen *et al*. 2009, 115; 2014, 222; Miniaci *et al*. 2013, 58. Rehren *et al*. (1996, 7) state that silver and copper in native gold occur only as an impurity, while copper is almost absent in placer gold deposits.
[593] Tate 1986; Araújo *et al*. 1993, 452, table 2; Troalen *et al.* 2014, 221, table 1; Lemasson *et al.* 2015, 281, table 2. 10 μm (micron/micrometer) = 0.01 mm.
[594] See: Guerra 2008; Blakelock 2016.
[595] Troalen *et al*. 2014, table 1. See also Troalen and Guerra 2016, table 2.

to the measured signal, providing slightly lower silver concentrations in surface depleted artefacts and, thus, distorting the potential metal core concentrations.[596]

4.1.1 Gold artefacts

4.1.1.1 Egypt

The earliest Egyptian gold artefacts, for which exist metallurgical analysis, are objects of the 12th Dynasty (c. 1939-1760) of the Middle Kingdom (c. 1980-1760 BC).[597] The first gold artefacts of this dynasty that have been analysed were put under the microscope with the aim of examining the red, or purple, surface colouration. They were examined with an X-Ray Diffractometer (XRD) and SEM-EDS by Frantz and Schorsch, in 1990. Much later, Troalen *et al*.[598] included in their analysis of Egyptian gold artefacts a gold fish-shaped pendant of the same dynasty. This object was found in Tomb 72 of a young girl (in Cemetery A), in the site of el-Harāgeh (or simply Haraga) and dating to approximately 1875-1795 BC, along with other gold fish-shaped (catfish) pendants, gold beads and a steatite scarab with a golden rim.[599] The objects and their analytical data are presented in **Appendix 6**. The analysis provides valuable information on the matter of red gold, which will be discussed further below.

It is important to note that analytical methods, such as SEM-EDS, XRF and XRD, only reflect the composition of the surface of the objects and not of the core metal. They are affected by the phenomenon of surface depletion of copper and, to a lesser extent, silver, which result in the simultaneous enrichment of gold in the alloys.[600] Hence, the following analysis should be considered as semi-quantitative. It should also be noted that Frantz and Schorsch performed a SEM-EDS analysis both on surface samples, as well as cross sections of the objects. The results recorded in **Appendix 6** are those that refer to the cross sections.

The data from the 12th Dynasty gold objects present a great variety of compositions. Taking a closer look, three different composition types can be observed. Apropos the silver content, the first type is that with the greatest amount of this metal. To this category belongs the tail of the fish-shaped pendant (Sample No. 5b). Characteristic of this sample is that the silver content is greater than the gold content, reaching 51.7 wt% Ag. Moreover, a silver-rich

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[596] Blakelock 2016, 926.
[597] The Egyptian chronology follows Hornung *et al*. 2006.
[598] Troalen *et al*. 2009.
[599] Troalen *et al*. 2016, 75-6, table 1. The previously analysed pendant is sample no. 81 in Troalen *et al*. 2016 (Sample No. 5 in this research).
[600] Miniaci *et al*. 2013, 58.

composition can also be found in the gold beads and the scarab rim from the el-Harāgeh tomb. They contained silver ranging from 20 wt% to 40 wt% and copper from 2wt% to 6 wt%.[601] The second group is represented by items with a silver content of about 30-35 wt% and a gold content of about 60-70 wt%. To this group belong Sample Nos. 2-3, which come from gold funerary masks. The third type of composition observed is one with c. 10-20 wt% Ag and c. 78-90 wt% Au. The objects in this category are the leaves of gold from the coffins of Nephthys and Senebtisi (Sample Nos. 1 and 4) and the body of the fish-shaped pendant (Sample No. 5a). Others of this type of pendants were analysed by Troalen *et al*.[602] and were found to have been constructed from multiple parts with different compositions, just like Sample No. 5 listed in **Appendix 6**. The catfish pendant (with accession No. A.1914.1079) is made of a rather pure gold containing only about 7 wt% silver and less than 1 wt% copper. The body of another pendant (A.1914.1080) is made of gold with c. 20 wt% silver and c. 1.6 wt% copper, while its fins contain 22-23 wt% silver and its tail approximately 13 wt% silver. And a third sample, from pendant A.1914.1082 A&B, was composed of a silver-rich alloy, with c. 44 wt% silver and about 4 wt% copper. Furthermore, Ogden[603] refers to two more samples dating to this period. The first belongs to the "Dahshur Treasure" and contains 83-86% gold, less than 1% copper and silver. The second is a Middle Kingdom shell pendant, which is composed of less than 30% gold, approximately 66% silver and about 3% copper. The former sample from the "Dashur Treasure" is similar to the items of the third category listed in this research, while the latter reminds as the first category, which is characterised by the silver-rich tail of the fish-shaped pendant.

During the Old and Middle Kingdoms, gold in Egypt was mined from the auriferous quartz veins of the Eastern Desert (

Figure **7**). It is at the beginning of the Middle Kingdom, though, that the first recorded expedition to gain access to the gold sources of Nubia, by Pharaoh Senwosret (or Sesostris) I (c. 1920-1875 BC), is recorded.[604] Ogden[605] believes that there was no vein gold mining before

[601] Troalen *et al*. 2016, 81, fig. 7.
[602] Troalen *et al*. 2016, 81-2, fig. 8.
[603] Ogden 2000, 163-64.
[604] Klemm *et al*. 2001, 649; 2002, 216.
[605] Ogden 2000, 162.

the Middle Kingdom, but Klemm *et al*.[606] provide evidence of mines explored even since Predynastic times, i.e. before c. 2900 BC. The discovered mines of Pre- and Early Dynastic times are undeniably only a few, but they increase

in the Middle Kingdom.[607] Klemm *et al*.[608] also mention that the different geological settings of the Eastern Desert and Nubia, i.e. the north and the south, may explain the detected decrease of the silver content in gold deposits towards the south.[609] They analysed the gold and silver content in primary gold ores of certain mines of the Eastern Desert and Nubia (**Figures 7-8**). The Eastern Desert ores yielded concentrations from about 70% to a little less than 90% gold and from a little more than 10% to about 30% silver (**Figure 9**). It would also be worth mentioning that the mines from which they took these data are mines used in the Old and Middle Kingdoms. On the other hand, the Nubian gold ore samples, from mines used in the New Kingdom, presented somewhat higher gold concentrations. These ranged from about 80% to about 93% gold and from about 7% to about 20% silver.[610] What is more, Ogden[611] mentions an inscription on a wall in a tomb at Beni Hassan, belonging to the nomarch (provincial ruler) Ameni, which writes "I forced their (Nubian) chiefs to wash the gold", and he describes that we see depicted "*gold ore being sorted or washed, perhaps ground, while a vertical object is possibly some type of gravity washing table*". As a result, gold alloy artefacts with compositions of c. 70-95% gold and c. 5-30% silver are to be expected in the 12th Dynasty, when gold could have been used either as mined, or washed and hence be a little bit finer, from the Eastern Desert or Nubia.

On the basis of this information, the great variety observed in the analysed samples could be explained by the use of primary gold from different sources. Sample Nos. 1, 4 and 5a definitely fall inside the given range of compositions. Sample Nos. 2 and 3, on the other hand, fall a little bit below the minimum percentage of gold content, but this could be due to a number of reasons. One, they could have been produced from a source whose gold and silver contents have not been examined. Two, these gold leaves could be a product of recycled gold-alloy objects with varying original compositions. Furthermore, Sample No. 5b has a higher silver

[606] Klemm *et al*. 2001, 648-49.
[607] Klemm *et al*. 2001, fig. 9. The Early Dynastic period dates to c. 2900-2545 BC.
[608] Klemm and Klemm 2013, 42-4.
[609] See also: Klemm *et al*. 2001, 647; Botros 2004, especially pp. 15-6.
[610] Klemm and Klemm. 2013, fig. 4.1.
[611] Klemm *et al*. 2001, 649. See also Notton 1974, 53.

content and could, thus, be termed as a gold-rich silver artefact. It could have also been made by melting together gold-alloy and silver-alloy objects.

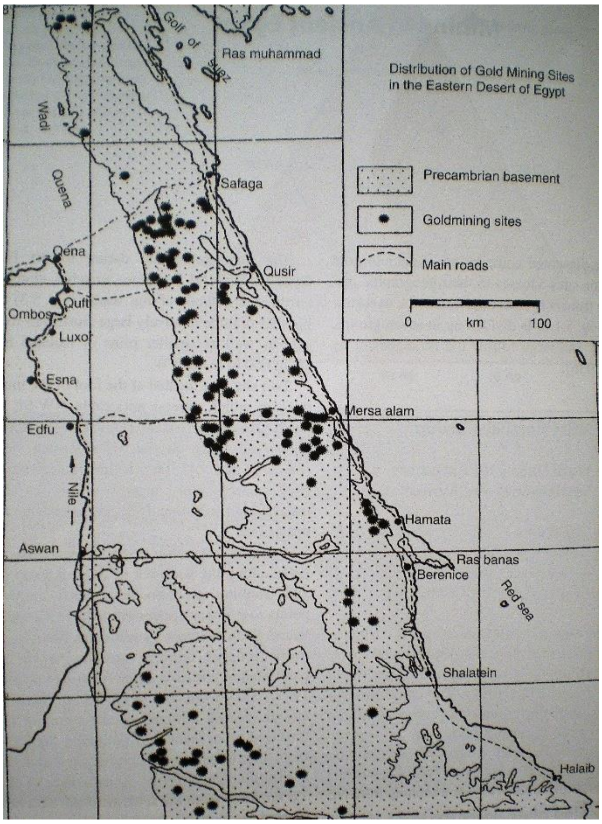

Figure 7. Gold mining sites in the Eastern Desert of Egypt (Klemm and Klemm 2013, fig. 5.1).

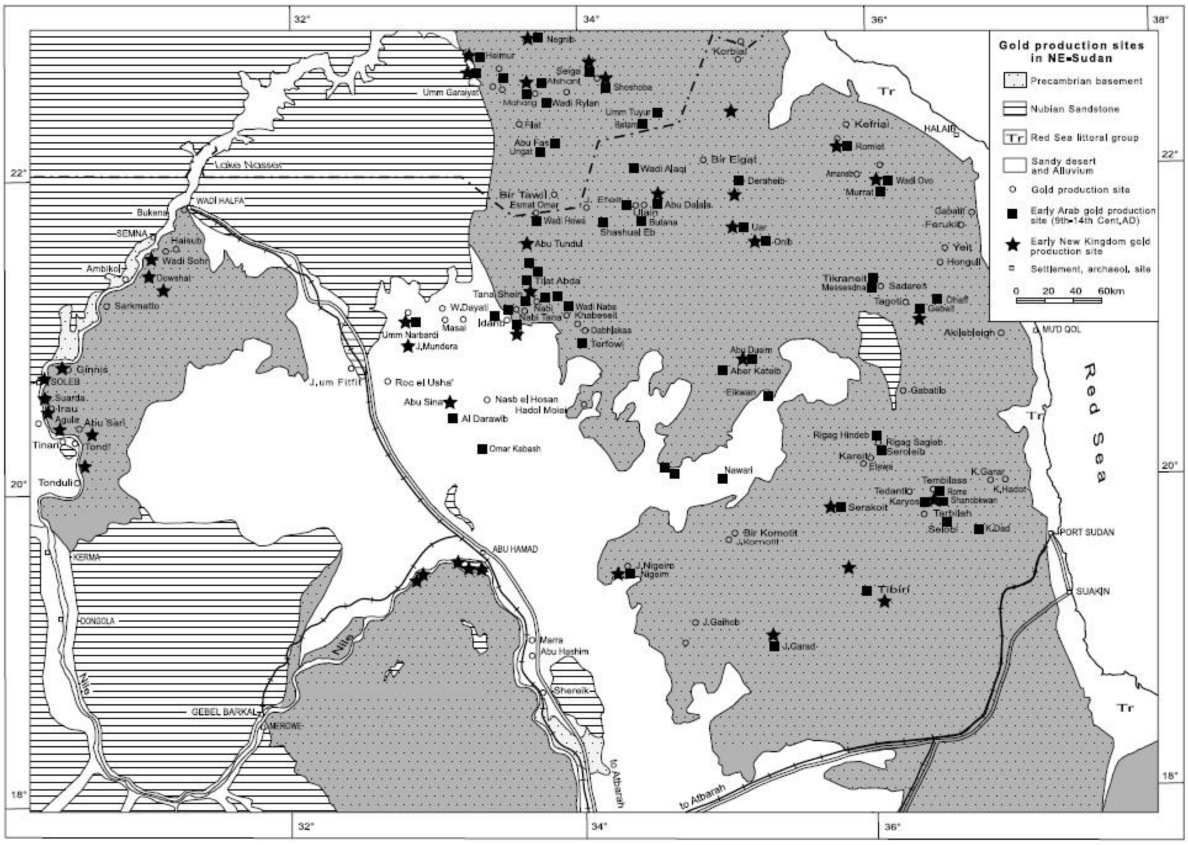

Figure 8. Early New Kingdom gold production sites in Nubia (Klemm *et al*. 2001, fig. 10).

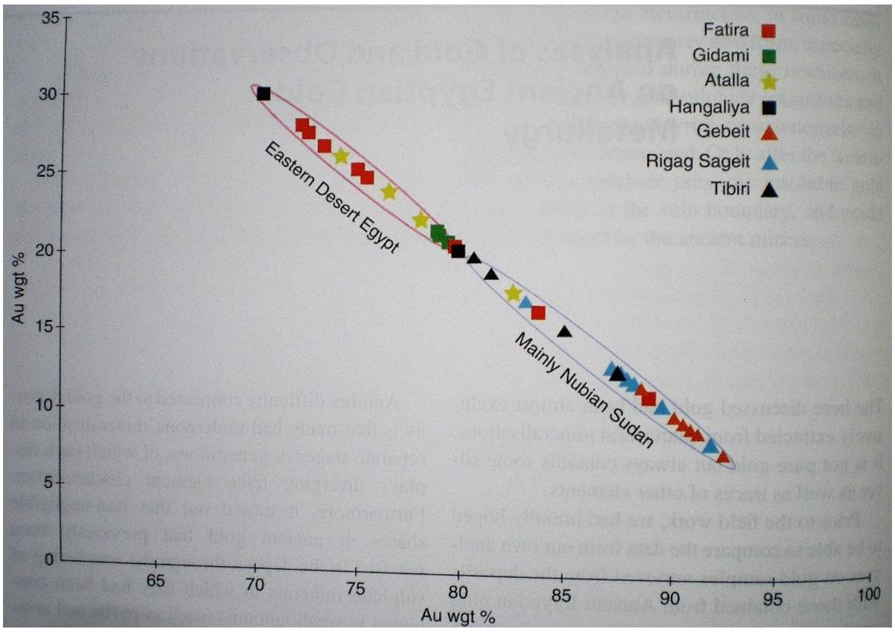

Figure 9. Gold vs. silver content analysis in primary gold (native gold) samples from Egyptian and Nubian deposits (Klemm and Klemm 2013, fig. 4.1; analyst: A. Murr).

The copper content of Sample Nos. 1 and 5b, as well as of the el-Harāgeh gold beads mentioned above, is higher than the normally found copper content in Egyptian gold ores, which is said to be normally less than 2%.[612] The addition of copper to silver and auriferous silver alloys had been a common practice since an early time. Its purpose was to lower the melting temperature, harden the alloy, increase its resistance to wear and create a hard solder.[613] Objects with more than 2% copper could have been made by either intentionally adding copper to primary gold, or melting together gold alloy artefacts with a solder made from copper minerals. The latter possibility was chosen as the most probable case for the analysed gold artefacts from Ebla (Royal Hypogea Tomb), dating to the MBA I (c. 1850-1750 BC) and II (c. 1750-1700 BC).[614] These gold artefacts from Ebla are synchronous with those of the 12th Dynasty in Egypt and present the same variation in composition. The samples from Ebla and their analytical data are presented in **Appendix 6**, as well. The analysis was performed with SEM-EDS, a semi-quantitative method, and four measurements were taken from each sample.[615]

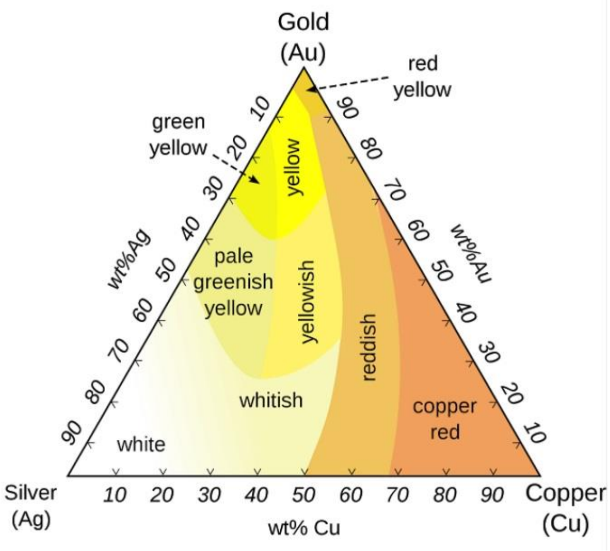

Figure 10.Ternary Au-Ag-Cu colour diagram (modified version from Rapson 1990, fig. 2; https://commons.wikimedia.org/wiki/File:Ag-Au-Cu-colours.png).

Apart from the chemical constituents of the gold artefacts from Egypt and their percentages, a very important aspect of this study is the colour of the metal artefacts and how they would look to anyone handling them. Most of the samples have a green-yellow or greenish-yellowish colour (**Figure 10**). The only piece offset towards a more yellow colour is

612 Ogden 1982, 18; 1992a, 30; 1992b, 262; 2000, 162.
613 Stos-Fertner and Gale 1979, 307; Gale and Stos-Gale 1981, 114; Philip and Rehren 1996, 141-42; Rehren *et al*. 1996, 8; Miniaci *et al*. 2013, 58; Troalen *et al*. 2014, 222.
614 Palmieri and Hauptmann 2000, 1266-267.
615 Palmieri and Hauptmann 2000, 1261, 1266-270, tables 3 and 4.

Sample No. 4. Moreover, there is a sample which has a pale greenish-yellowish colour, Sample No. 5b. Most interestingly, though, the two components creating the fish-shaped pendant (Sample Nos. 5a and b) have been created separately, with a doubtfully observable differentiation in colour. The fish's body was made from a gold alloy with around 16% silver, which would have a green-yellow colour, while its tail was made from a very gold-rich silver alloy (almost 1:1), which would look greenish-yellowish. The same differentiation in colouration can be seen in the two boxes of gold (and silver) leaf fragments from Senebtisi's coffin (Sample Nos. 4 and 62 (see below)), which were separated in the museum according to their appearance. The fragments in Box 1, i.e. Sample No. 62, appeared darker and greyer than those in Box 2, i.e. Sample No. 4, which had a red tint.[616] Their present surface colour is a result of corrosion and the formation of tarnish films and does not reflect the colour of the original metal. Nevertheless, the grouping of the fragments was rightly done, as Box 1's fragments reflected the whitish colour of a gold-rich silver alloy, which would pass as silver, while Box 2's seemed like pure (yellow) gold. These very clearly different compositions were intentionally created, so as to create a colouristic effect or, in the case of the fish-shaped pendant, to look like a real fish (Sample No. 5). In the same way, the two types of leaf fragments from Senebtisi's coffin must have been used to represent a specific colour, yellow-gold and whitish-silver. This would have created a colour variance in the different decorated parts of the coffin. It is no accident that these alloys have the exact compositions they need in order to show a specific colour.

The greater purity of Sample Nos. 4 and 5a is similar to the composition of gold alloy artefacts of the SIP (c. 1759-1539 BC) and more precisely of the 17th Dynasty.[617] Objects of this period were analysed by Miniaci *et al*.[618] with XRF and SEM-EDS (semi-quantitative results), and by Troalen *et al*.[619] with PIXE and XRF. The artefacts of this period and their respective analytical data are shown in **Appendix 6**. All samples from the 17th Dynasty were found to contain several PGE inclusions, verifying a provenance from an alluvial source.[620] Interestingly, this kind of inclusions were also detected in two gold beads and two fish-shaped pendants found in the tomb in el-Harāgeh of the 12th Dynasty.[621]

[616] Frantz and Schorsch 1990, 151.
[617] The chronology of the SIP is according to Hornung *et al*. 2006; Miniaci *et al*. (2013, 53) gave a date of c. 1800-1550 BC for this period. According to the NMS Collection's online site of the artefacts from Qurneh, the 17th Dynasty is dated to c. 1585-1545 BC.
[618] Miniaci *et al*. 2013.
[619] Troalen *et al*. 2009. See also Tate *et al*. 2009; Troalen *et al*. 2014.
[620] Ogden 1982, 21.
[621] Troalen *et al*. 2016, 81-2.

Alluvial deposits are a category of placer deposits, the other being beach placers.[622] When a water flow cuts away surface rock and reaches a mineral deposit, then the mineral, gold ore in this case, is broken off from the rock and is carried down the river or stream. During its journey, the ore is broken up into ever smaller pieces. Specific gravity and the flow of the river, or stream, will decide where the nuggets will be deposited.[623] Most importantly, the water flow will wash the gold ore and mechanically refine it and separate it from other metals, such as silver. For this reason, alluvial gold has a lower silver content than primary gold, even more so with increasing distance from the primary source.[624] The dry water courses, called wadis, dominating the Eastern Desert of Egypt are excellent sources of alluvial (placer) gold.[625]

The extraction of gold from alluvial deposits in the Eastern Desert, as well as washing, must have provided a finer gold, with lower silver content and a yellower colour. In addition to the fact that PGE inclusions were found in all 17th Dynasty samples, their compositions are less varying from those of the 12th Dynasty and the gold contents are distinctly higher. All three points could be taken as evidence of the introduction of a method to clean the gold of its impurities, or/and of some change regarding the sources from where gold was gathered or mined. The most probable goal of washing the gold would have been to purify it, in the sense of washing away any unwanted material. As there was no way to determine the exact composition of the alloy, its purity would be valued through the examination of its changing colour: refinement by washing may have made it look more yellow than green(ish)-yellow(ish). Nevertheless, almost all samples from the 17th Dynasty have a gold content above 80%, but rarely rising above 90% (only in Sample Nos. 11d and 15), and a silver content between 10% and 18%. According to Miniaci *et al*.,[626] this concentration of silver is "*typical of naturally occurring, unrefined alluvial gold*".

On rare occasions, we find artefacts containing more than 90% gold. From the here-listed objects, this exception is represented by Sample Nos. 11d and 15. The former is one of the gold legs of a lapis-lazuli scarab of a gold finger-ring (no solder measurement included). It is comprised of 91.3 wt% Au, 7.6 wt% Ag and 1.1 wt% Cu. The latter, a woman's earring from the Qurneh tomb, is made of even purer gold: 95.8 wt% Au, 4.1 wt% Ag, 0.2 wt% Cu.[627] Both of these samples contain less than 10% silver, which is the theoretical minimum silver content

[622] Botros 2004, 32.
[623] De Jesus 1977, 51-3.
[624] Rehren *et al*. 1996, 6.
[625] Botros 2004, 32.
[626] Miniaci *et al*. 2013, 58.
[627] Troalen and Guerra (2016, 209) believe that the higher purity of this earring suggests that gold from a distinct source was used for its manufacture.

of alluvial gold. The silver content of Sample No. 11d lies inside the limits of mainly Nubian primary gold, as found by Klemm and Klemm (**Figure 9**), but that of Sample No. 15 is just about outside the minimum limit. What is more, if both of these samples were to be plotted in the ternary Au-Ag-Cu diagram (**Figure 10**), then the former would appear on the edge of the yellow and the latter inside the red-yellow colour area.

Contrary to the homogeneous composition of the gold alloys of the samples studied by Miniaci *et al.*, the Qurneh burial presents some diversity. As far as the adult's jewellery is concerned, the bracelet and the necklace (Sample Nos. 14 and 16) are of quite the same typical, unrefined, alluvial gold composition. The penannular earring (Sample No. 15) has already been described and found to be of a finer gold. On the other hand, the adult's girdle beads contain slightly more silver than gold, with a high copper content. This composition reminds us of Sample No. 5b, the fish-shaped pendant's tail, of the 12th Dynasty. The beads of this girdle may have been manufactured from recycled scrap metal, resulting in a more whitish colour. Nevertheless, Troalen *et al.*[628] argue for a deliberate gold debasement. Similarly, the child's earrings have the typical gold and silver content of alluvial gold, but they contain more copper than traditionally contained in this type of gold. Is an intentional addition of copper to be inferred? Or were these made from recycled gold objects? The child's necklace seems to have been made from material of a different source, maybe coming from the Eastern Desert. It is composed of 68.6 wt% Au, 29.4 wt% Ag and 2 wt% Cu. This composition is not normally found in artefacts of alluvial gold. It is also possible that it was manufactured in an earlier period, meaning that it was an heirloom of some sort.

Figure 11. Woman's necklace, earring, bracelet and girdle from Qurneh (NMS Collection online, https://www.nms.ac.uk/explore-our-collections/collection-search-results/?item_id=299728).

[628] Troalen *et al.* 2009, 115; 2014, 222.

Moreover, despite the fact that the woman's bracelet and necklace should look yellow (Sample Nos. 14 and 16) and the earring red-yellow (Sample No. 15), judging by the picture in the NMS Collection online, they all look reddish-yellow; in contrast to the paler, yellowish to whitish girdle (Sample Nos. 17 and 18) (**Figure 11**).[629] The visual difference between the earrings and the bracelets and necklace is indistinguishable. The child's jewellery, on the other hand, has a green-yellow towards yellow (Sample Nos. 19 and 20) and a green-yellow (Sample No. 21) colour. These pieces seem to have been made from less fine alloys. The present colour of these items is characteristically less yellow than the adult's jewellery.[630] However, the question is why the child's jewellery was of lower quality and/or value. Was it because there was no need for a child to have jewellery of such a high-quality and value, because it was not fitting for a child to have such ostentatious jewellery, or was it a matter of chance?

The next dynasty, the 18th Dynasty of Egypt (c. 1539-1292 BC), is represented by a greater number of objects. These include Ahmose I's bracelet (c. 1539-1515 BC) (Sample No. 23), jewellery from the tomb of the scribe Beri (Sample Nos. 24-27), a series of penannular earrings, from a variety of sites dating to the reign of Tuthmose III (c. 1479-1425 BC) (Sample Nos. 25-38), an assortment of gold alloy artefacts from the tomb of the Three Wives of Tuthmose III (Sample Nos. 39-52), two groups of beads from Hathsepsut's temple (c. 1479-1458 BC) (Sample Nos. 56 and 57), three objects studied by Gale and Stos-Gale[631] that have been listed as "aurian silver" but their composition and probable colour encourages their listing as gold artefacts (Sample Nos. 53-55), two finger-rings of the Amarna period (reign of Amenhotep IV, c. 1353-1336 BC) (Sample Nos. 58 and 59) and Tutankhamun's funerary mask and throne (c. 1334-1325 BC) (Sample Nos. 60 and 61).[632] The compositions of the analysed artefacts are shown in **Appendix 6**.

Characteristic of this period is the higher purity of the gold alloys and the intentional addition of copper. All items analysed by Lemasson *et al.*[633] and Troalen and Guerra[634] were examined with PIXE and XRF. The analysis of the artefacts from the Three Wives of Tuthmose III was published by Lilyquist[635] and performed with SEM-EDS. The Hatshepsut beads were

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[629] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299728. See also Tate *et al*. 2012.
[630] Unfortunately, there is no picture of the child's necklace. The earrings are presented in the NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=597102.
[631] Gale and Stos-Gale 1981.
[632] The chronology of the reign of Tutankhamun follows Uda *et al*. (2007).
[633] Lemasson *et al*. 2015.
[634] Troalen and Guerra 2016.
[635] Lilyquist 2003.

examined by Frantz and Schorsch[636] with SEM-EDS, with the purpose of determining the composition of the surface layer responsible for the red tint. Once again, measurements were taken from both cross-sections and surface samples of the objects, but the results included in **Appendix 6** are those of the cross-sections. The Amarna finger-rings were examined by Troalen *et al*.[637] with XRF and SEM-EDS, while Tutankhamun's golden mask and throne were examined by Uda *et al*.[638] with a specially designed setup, an X-Ray Diffractometer equipped with x-ray Fluorescence spectrometer (XRDF).[639] All these methods produce semi-quantitative data.

The lowest gold content is present in Sample Nos. 28, 29, 51, 53, 54 and 55. Sample Nos. 28 and 29 are two penannular earrings from Riqqa, Sample No. 51 is an uraeus pendant from The Tomb of the Three Wives of Tuthmose III in Thebes, Sample No. 53 is a cowroid from the Tomb of Maket in Lahun, Sample No. 54 is a ring from a tomb in Abydos and sample No. 55 is a bead from Ehnasya. Except from Sample Nos. 51 and 54, all of the samples cited above have a gold concentration of about 50 wt% gold and just under 50 wt% silver. Sample No. 51 is an exception because it contains just under 50 wt% gold and about 50 wt% silver, instead, and Sample No. 54 because it is composed of almost 50 wt% gold with only about 35 wt% silver. This group of samples can be seen *in tandem* with Sample Nos. 17 and 18, the beads of the adult's girdle found in Qurneh. Such compositions create objects with a whitish, verging to greenish-yellowish, colouration (**Figure 10**). Even those objects from Qurneh could easily be mistaken for gold, despite the fact that they contain slightly more silver than gold (c. 52-53 wt% Ag with c. 42-43 wt% Au). All of the above-mentioned samples contain also some additional copper, usually more than about 3 wt%. Only Sample No. 54 reaches up to 8.4 wt% copper, while two more samples have a copper content below the 2% limit of naturally occurring alluvial gold (Sample Nos. 53 and 55). It is also noteworthy that these two samples in particular show an almost 50-50 balance between the two major components, gold and silver. It is a wonder how this alloy, on the very verge of whitish (silver-like looking) to pale greenish-yellowish (gold-like looking) hue, could be achieved. If the ultimate goal was a gold-looking object with the least gold spent, then this was an absolute success. In this case, the next question is why they would need to save gold and not silver, since gold can be found anywhere in the Eastern Desert and Nubia, but silver has to be imported. The answer may be found not in the

[636] Frantz and Schorsch 1990.
[637] Troalen *et al*. 2009.
[638] Uda *et al*. 2007; 2014.
[639] Uda *et al*. 2014, 159-63.

price of gold or silver, but in the general value, preciousness and use of gold in contrast to silver. However, a case of chance or fortuitous alloying is always possible.

Sample Nos. 25-38 are penannular earrings from Riqqa, Deir el-Medina and unknown provenances. Most of these items have compositions suggesting alluvial origin, while a few may have been made of recycled gold.[640] Most surprisingly though, none of these penannular earrings had the fine composition of the same type of earrings found in the Qurneh burial (Sample No. 15), dating to the previous Dynasty of Egypt.[641]

Moreover, in some of the items from the Tomb of the Three Wives of Tuthmose III, among which is also Sample No. 50, PGE inclusions have been detected.[642] Numerous of these inclusions were found in the two Amarna finger-rings as well. Sample No. 59 has the typical composition of unrefined, alluvial gold.[643] However, the other Amarna finger-ring, Sample No. 58, comprises two slightly different gold alloys, which must have come from different melts. The hoop of the ring (Sample No. 58a) is composed of a very pure gold alloy, while the two sets of its granules (Sample Nos. 58b and 58c) have been made by a fine gold alloy with the addition of copper. The hoop is composed of only about 1.7 wt% silver and 0.1 wt% copper, which means that it must have looked red-yellow in colour. The higher copper content detected in the granules was most probably added to lower the melting point of the gold and create a harder solder between the granules and the bezel of the ring.[644]

Finally, Tutankhamun's mask has been thoroughly examined by Uda *et al*.,[645] and was found to be made of a solid gold matrix of high purity gold (c. 97% Au) and thin layers (28-30 nm thick) (1 nm = 1^{-6} mm) of different compositions on the different parts of the mask. A spot between the two lips was chosen as typical of the white or light bluish gold, considered to be the least possible to have been stained or damaged. The 28 nm thick layer covering the solid gold matrix was composed of 76.8 wt% Au, 11.2 wt% Ag, and 12 wt% Cu. The bundle of the *nemes* on the back of the mask was chosen as characteristic of the golden, more reddish than pure, gold. The 30 nm in thickness layer of this part of the mask contained 93.8 wt% Au, 3.2 at% Ag, and 2.9 wt% Cu. These layers were so thin that they would give a different view of the inner solid gold matrix and would thus create the illusion of colour variation. The composition of the matrix, plotted in a ternary diagram, falls in the red-yellow colour area, as

[640] Sample Nos. 28, 29, 36, maybe 37, and 38. Troalen and Guerra 2016, 8-9.
[641] See also Troalen and Guerra 2016, 210, fig. 4.
[642] Lilyquist 2003, 180.
[643] Troalen *et al*. 2009, 114.
[644] Miniaci *et al*. 2013, 57.
[645] Uda *et al*. 2007; 2014.

is the *nemes*' surface layer; however, the lip's surface layer falls in the yellow colour area. Their thickness is, nonetheless, the key to creating the different colouring appearance. According to the authors, the addition of copper in order to reinforce the alloy to withstand heavy cold work is a plausible cause.[646] Nevertheless, most parts of the mask must have been "*devised to show golden gold*".[647] In the same way, the different coloured parts must have been "devised" to show the colour that the goldsmith wanted them to show.

From **Charts 31-32**, it is clear that a gold content of c. 80-90 wt% and silver content of c. 10-20 wt% is the most common among Egyptian artefacts. Admittedly, the 18th Dynasty objects are more than twice as many as the rest of the gold items listed here and their volume creates an imbalance which, in the case of the silver content, leads to a statistical bias. Nevertheless, disregarding actual numbers, the following charts offer a general appreciation of the existing trends. It is also noteworthy that purities higher than 90 wt% Au, with lower than 10 wt% Ag, have been found only in one item from the 17th and in artefacts dating to the 18th Dynasty. The one sample from Ebla with less than 5 wt% Ag is Sample No. 9, a rectangular sheet of gold from the tomb of "The Lord of the Goats". Its composition analysis, however, does not reach 100 wt% and, therefore, a question mark remains.[648] Unfortunately, not as many gold alloy objects from before the 18th Dynasty have been analysed. Thus, we cannot be sure if the observable variety of gold concentrations in gold alloy artefacts of this Dynasty is also a reality for gold alloys of previous periods, or if there were certain gold contents reflecting the origin of the alloy, i.e. smelted primary gold or recycled gold. **Charts 31-32**, definitely show this kind of differentiation between primary gold (80-90 wt% Au, 10-20 wt% Ag) and probably recycled gold-silver alloys (c. 60-70 wt% Au, 25-35 wt% Ag and 40-50 wt% Au, 50-60 wt% Ag). More analyses of objects dating to the first half of the 2nd millennium BC would provide an answer to this question.

[646] Uda *et al*. 2014, 152.
[647] Uda *et al*. 2014, 152.
[648] The given composition is 60 wt% Au, 5 wt% Ag, 4 wt% Cu (Palmieri and Hauptmann 2000, table 5).

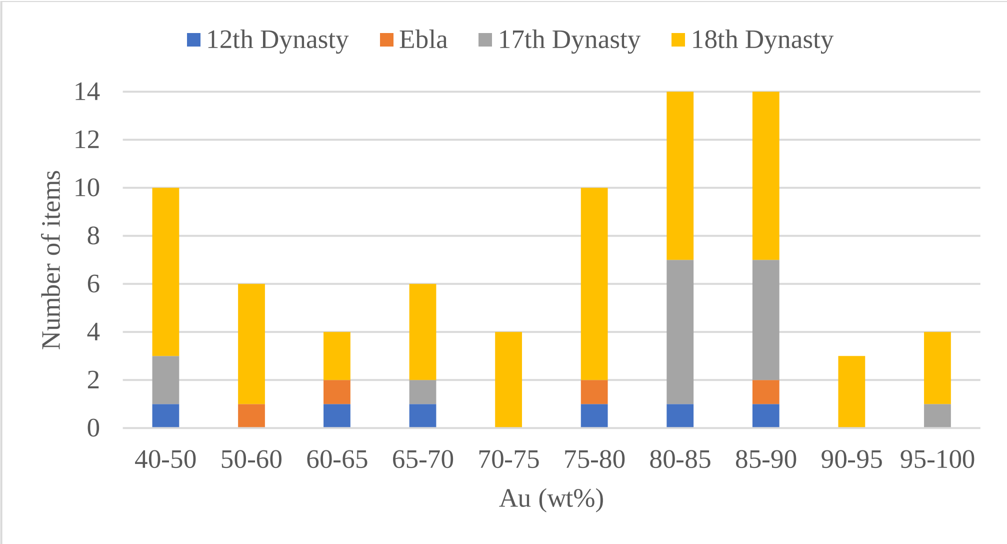

Chart 31. Au content in gold objects.

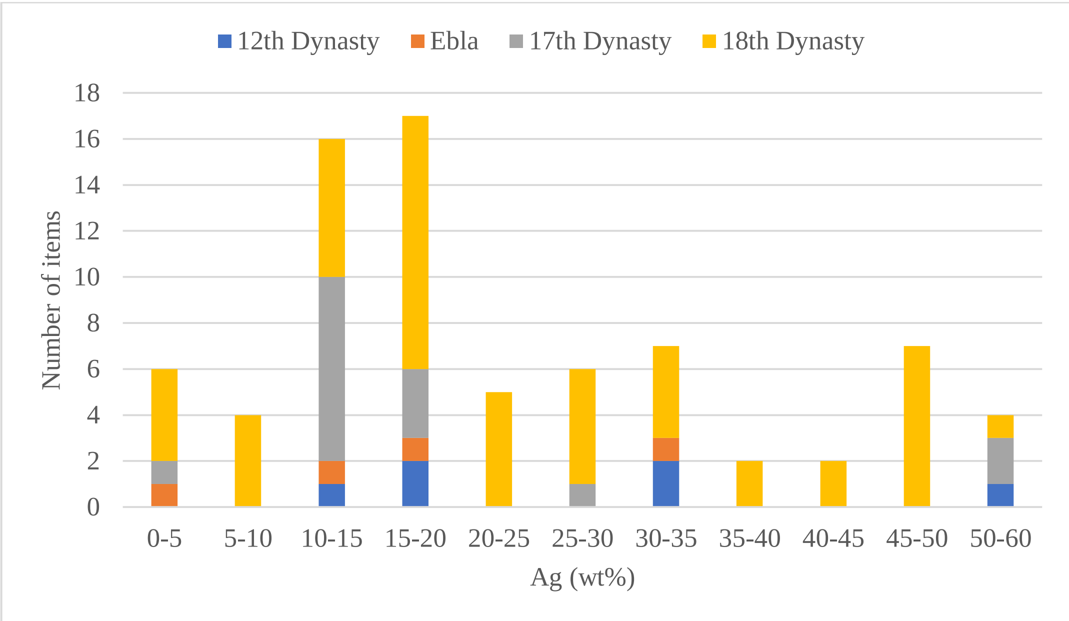

Chart 32. Ag content in gold objects.

Concerning the copper content of the here analysed gold objects (**Chart 33**), a trend roughly between 1-3 wt% Cu can be seen, with a second one forming at about 3.5-4 wt%. Once again, what matters is not so much the shown height of the bar in these charts, as the 18th Dynasty objects outnumber the rest of the samples included in this study, but the number of items belonging to each percentage range for each period of time, except from the 18th Dynasty, as well as which copper percentages occur in which periods. It has already been said that a copper content above c. 2 wt% is to be regarded as a deliberate addition. However, a copper content above 4 wt% is found only in 17th and 18th Dynasty objects, while items from the latter dynasty are the only ones that contain more than 5 wt% copper. Even if a 2-4 wt% copper content could be perceived as a result of recycling gold-alloy objects with copper-based solder, the much higher copper content of the 18th Dynasty artefacts is unmistakably a result of the deliberate addition to the alloy. In conclusion, it seems that by the 18th Dynasty Egyptian goldsmiths had the knowledge and capability to create any form of gold alloy they wished, by mixing specific amounts of gold, silver and copper, or by refining alluvial gold, even if that was limited to a surface treatment or used only for gold sheets and foils.

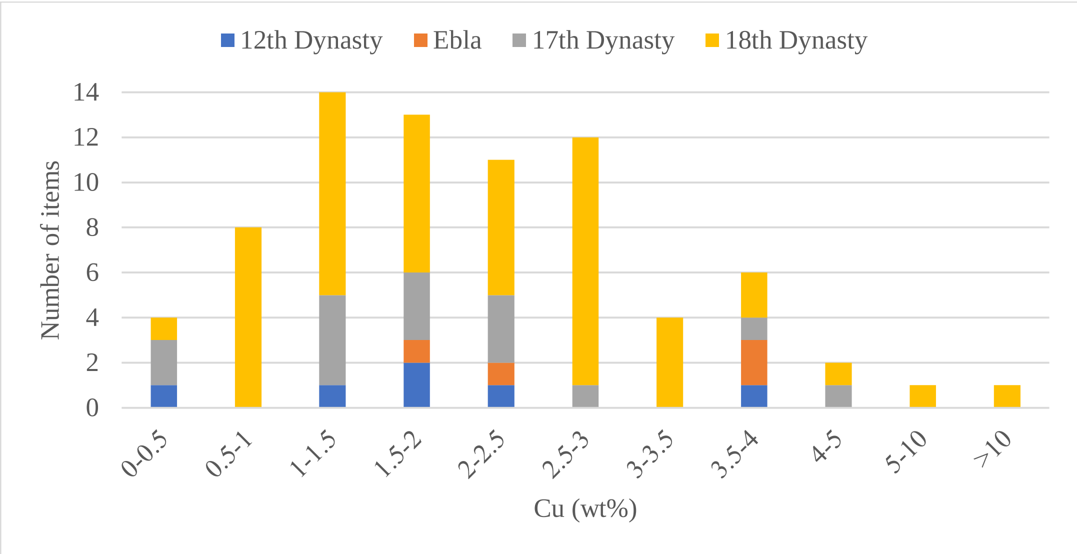

Chart 33. Cu content in gold objects.

4.1.1.1.1 Gold that looked like silver

As already noted, more than one Babylonian king complains that the gold he received from Egypt looked like silver, or that when it was put in the fire it turned into something that looked like ashes.[649] The constant explanation, right until today, is that Egypt's gold is actually the type of alloy we call electrum. This term was first mentioned by Pliny the Elder and has since then been used to describe an alloy of gold containing more than 20% silver. Scholars have maintained that the source of this alloy has long been depleted due to its extensive mining from the ancient Egyptians.[650] It is said that electrum containing much silver appears silvery-white and the metal could have actually been taken and used as silver by the ancient Egyptians.[651] Klemm and Klemm[652] examined a number of Egyptian gold ores and showed that

[649] EA 3 (line 15); EA 10 (line 21).
[650] Lucas and Harris 1962, 248.
[651] Forbes 1950, 175, 185; Lucas and Harris 1962, 234, 247. See also: Lucas 1928; Moorey 1994, 218.
[652] Klemm and Klemm 2013, fig. 4.1.

the silver content in the Eastern Desert and Nubia ranges between >5-30%.[653] This range of silver percentages contained in gold would produce artefacts with a colour falling right in the green-yellow area of the Au-Ag-Cu ternary diagram (**Figure 10**). A range of 5-30% silver in gold coincides with the composition of electrum defined by Pliny as well and, in fact, most Egyptian gold objects have a silver content between 10% and 20% (**Chart 31**).

Furthermore, Pliny wrote that "electrum under light shines brighter than silver" (*electri natura est ad lucernarum lumina clarius argento splendere*).[654] This means that it looks like silver, not gold, but shines brighter than silver. Having no way of completely understanding what Pliny meant by this description, we are reliant on our imaginations. Fortunately, on the online collection of the British Museum the photographs provided for the artefacts of the 17th Dynasty (Sample Nos. 10-13) present two different colour shades. In the first picture, the objects seem to have a yellow-gold colour, but in the second they appear paler, more silvery, more like electrum (

Figure **12**). In a personal communication with Dr. Gianluca Miniaci,[655] leading author of the article concerning the metallurgical analysis of these artefacts, it was conveyed to me that the

[653] Ramage and Craddock (2000a, 11) mention that it typically ranges between 5-40 wt%. See also Tissot *et al*. 2015, 78.
[654] Plin., *NH* 33.23.
[655] Miniaci, pers. com., May 19, 2017.

first picture (left-hand side) represents the "real" colour of the objects, while the second (right-hand side) is a result of the different type of light, under which the objects were placed. It is true that all of these items were made of alluvial gold containing less than 20 wt% silver, so they do not actually typify the composition of natural electrum, as defined by Pliny. Nevertheless, they are typical examples of gold Egyptian artefacts and, when they were put under light, they "looked like silver" – quoting the words of the Babylonian King in EA 3. Thus, it seems like the Babylonian king viewed the contents of the presents sent from Egypt in a hall illuminated with the type of light that would make the gold look more like silver (or electrum) and not yellow like gold.

Figure 12. 17th Dynasty gold objects under different lights.[656]

Specifically, in EA 10 the Babylonian king writes as follows:

[656] BM Collection online: left: http://www.britishmuseum.org/research/collection_online/collection_object_details/collection_image_gallery.aspx?partid=1&assetid=396528001&objectid=117804, right: http://www.britishmuseum.org/research/collection_online/collection_object_details/collection_image_gallery.aspx?partid=1&assetid=317361001&objectid=117804.

> The twenty minas of gold that were sent were not complete. And when they put them in the kiln, not five minas came out! [The gold] which did come out had the look of ashes when it turned dark (cooled). [As for the gold, wh]en did they ever verify it?[657]

And again, in EA 3:

> You have sent thirty minas of gold that looks like silver for my greeting gift. They melted down that gold in the presence of Kasî, your envoy and he witnessed (it).[658]

And in EA 7: "As for the forty minas of gold that they brought, when I ca[st] into the kiln, [fo]r sure [only *x* minas] came fort[h]."[659] Apart from the complaints about receiving gold that looked like silver, these three passages indicate one of two probable methods of testing the composition of a gold alloy. The first is fire assay and the other is a cupellation process. Fire assay is a way to determine the contents of a gold alloy by putting it into fire. If a gold alloy was placed inside a fire and came out having a whitish colour, then it contained silver. If, on the other hand, the surface was black and rough, then the alloy contained copper.[660] However, fire assay is a rather broad term, which envelops both cupellation and the parting methods. It is a qualitative way of determining the composition of the gold. A more quantitative determination would still require the application of either a cupellation (depleting the copper content and leaving a gold-silver alloy), or cementation (parting the silver from the gold) method.[661] Cupellation is a gold-refinement method, which entails a loss of weight of the original alloy. If gold is heated, the naturally contained copper will oxidise and be depleted, lowering the weight of the original metal by only a minuscule percent. This procedure, though, will have no effect on silver. In order to remove the silver from gold, it is necessary to include an element that will transform the silver into something else other than metal. The discussion on how this is done will be given in the subchapter that follows.

Line 20 of EA 10 mentions that after they melted the gold not even five minas of the metal came out of the kiln. This means that there was a 75% loss of weight. Despite the fact that this seems an illogical – metallurgically speaking – loss of weight after refinement, it corresponds perfectly to the expected exaggeration from the Babylonian king's part, participating in the game of power and supremacy among the kings of the ANE. Nevertheless,

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[657] EA 10 (lines 19-22): 20 MA.NA KÙ.GI *ša na-ša-a ul ma-li* ˹*ù*˺ *a-na ú-tu-ni ki-i iš-ku-nu* 5 MA.NA KÙ.GI *ul i-la-a* [KÙ.GI] ˹*ša*˺ *i-la-a i-na ṣa-la-mi pa-an ṭi-ki-ni* ˹*ša*˺-˹*ki*˺*-in* [KÙ.GI *im-ma-*]˹*ti*˺*-ma-a u*ʾ*-e-du-*[*ú*]*-š*[*i*].
[658] EA 3 (lines 15-17): 30 *ma-na* KÙ.GI *ša ki* KÙ.BABBAR *ep-šu a-na šu-il-ma-ni-ia tu-ul-te-bi-la* KÙ.GI *ša-a-šu a-na pa-an* [I]*Ka-si-i* DUMU *ši-ip-ri-ka uṣ-ṣi-id-du-ma i-ta-ma-ar*.
[659] EA 7 (lines 71-72): 40 *ma-na* KÙ.GI *ša na-šu-ni a-na ú-tu-ni ki-i aš-k*[*u-nu*] [*x mana š*]*a-ar-ru-um-ma ul i-la*[*-a*].
[660] Craddock 2000c, 246-47.
[661] Ramage and Craddock 2000a, 11-3; Craddock 2000c, 246.

the passage writes ˹*ù*˺ *a-na ú-tu-ni ki-i iš-ku-nu* 5 MA.NA KÙ.GI *ul i-la-a*, which essentially translates into "and when they put it into the kiln 5 minas did not appear". This could also be interpreted as five minas, out of the original 20 minas, were lost in the procedure. This would be a version more fitting to reality and the actual metallurgical process, but such a translation would lose the spirit of covert rivalry among kings, exhibited through these letters.

Based on the amount of weight lost during the testing by fire, a simple melting process should be eliminated as a possibility. There is a text from the OA period, which comments on a similar situation and writes:

> The 1/3 mina of gold which Puzur-Anna paid to me, the palace of Hahhum smelted it, and it turned into silver! …. However, please, please! the gold he pays out to you, put that in the fire twice! Be careful of the silver belonging to Aššur-bēl-awātim.[662]

Despite the fact that this passage does not come from Amarna, Egypt or even the same period of time, it does provide some information regarding the test by fire that every gold shipment should pass. In this OA text, the word used to talk about the re-(s)melting, the testing by fire, of the gold is the same that is used to describe "refined" silver in the OA texts, as well as in the Amarna letters. This is the Akkadian word *ṣarāpum*, which denotes a process of cleaning, of refining the metal. This also implies that the process described is one that would not affect silver and could be used for the treatment/refinement of silver as well. After all, the silver contained in the gold is what gives this ashy, greyish, appearance.

Ogden[663] states that "*certainly the colour of electrum would improve if it was repeatedly melted*". A simple melting process, however, would not result in such a great loss of weight. The only way that melting gold would result in a loss of weight of this magnitude is if the impurity that was driven out was a base metal and not silver. This would mean that the gold that Egypt sent was already processed in such way so as to appear more golden, when in fact it was not. As a result, when it was put in fire, copper (the necessary base metal) would be almost depleted, creating a significant loss of weight and make the gold look black and rough, due to the copper content – not silver-like. Nevertheless, the passage from EA 3 is to the contrary. The gold from Egypt looked like silver before it was even put in a kiln. Thus, it contained a considerable amount of silver (not copper), or at least enough to bother the Babylonian king and his foreign guests. Therefore, the only possible explanation is that the act of putting the gold in a kiln to test its purity implied a process that would lead to the depletion

[662] Larsen 2002, 138. OAA 1, 97 (lines 3-8, 20-24): *iṣ-ru-up-šu-ma a-na* KÙ.BABBAR*pí-ma i-tù-ar* … *a-pu-tum a-pu=tum* KÙ.GI *ša i-ša-qá=ku-ni a-na i-ša-tim šé-ni-šu ta-er-šu a-na* KÙ.BABBAR *ša A-šùr-be-el=a-wa-tim*.
[663] Ogden 1992, 263.

of some of the silver. As it will be shown below, a gold refinement process would not deplete the entirety of the silver in a single cycle. Even more so when the original metal contained a high amount of silver, as was most probably the case with the Egyptian gold. More cycles of refinement would be necessary to produce a good, yellowish, golden-looking gold.

4.1.1.1.2 Gold refinement – cementation – depletion gilding

When silver is parted from gold, a greater weight loss is observed than when copper leaves the metal. Probably the easiest method to achieve the depletion of silver in gold is by adding common salt (NaCl) into a crucible, along with the gold alloy, and heating it at about 800°C for several days. During this process, base metals get oxidised and silver reacts with the chloride (Cl) in the salt forming silver chloride, which is absorbed by the porous walls of the container. The result is (pure) gold with a greatly reduced silver content. By repeating this process, the gold alloy naturally becomes even purer.[664] A very interesting example of a find, possibly related to such a refinement method, is the crucible discovered in a workshop of the Balitshi-Dzedzvebi settlement, located near the Sakdrissi gold mines in southern Georgia dating to the end of the 4th millennium BC. Analysis of the crucible's inside crust revealed a slightly elevated level of silver, in comparison to that contained in the gold ore deposit analysed by the same team. Note that the copper content was not enriched in the crucible.[665] Could it be that the copper was oxidised and the silver was absorbed by the porous ceramic walls, leaving pure gold in the crucible? This discovery provides a hint of a far earlier knowledge and application of gold refinement techniques than previously thought.

It is generally believed that this salt cementation process for purifying gold was first invented in the 6th century BC by the Lydians, located in west Anatolia, when true coinage was for the first time introduced.[666] Back in 1974, Notton ran a series of experiments based on Agatharchides' description of gold refinement, as he observed it in 2nd century BC Egypt.[667] Notton used a white gold alloy (37.5% Au), silver and copper; to that he added salt and brick dust and heated it at a temperature of about 800°C for five days. The result was an alloy containing over 93% gold. In his experiment, he also found that including charcoal, tin or lead

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[664] Forbes 1950, 154-60; 1971, 180-81; De Jesus 1980, 86-7; Ogden 1982, 18-9; La Niece 1995, 45; Craddock 2000a, 32-8, see also pp. 38-50; Klemm and Klemm 2013, 45; Wunderlich *et al*. 2014, 362-63. See also: Ogden 1992b, 263; experiments done by Wunderlich *et al*. (2014); Pernicka 2017, 2.
[665] Stöllner and Gambashidze 2011, 195-98; Hauptmann *et al*. 2013.
[666] Lucas and Harris 1962, 229; Ogden 1992b, 263; 2000, 163-64; Bachmann 1999, 272; Craddock *et al*. 2005, 67-9, 73-6; cf. De Jesus 1980, 85.
[667] Notton (1974, 52) quotes Agatharchides' passage, based on which he performed his experiments (1974, 55-6).

to the mixture, the refining process was less successful, as these components prevented the completion of the necessary reaction to separate the gold from silver and base metals.[668] More recently, Wunderlich *et al*.[669] made their own experiments, which once again demonstrated that a single refining cycle with salt can yield a very pure gold alloy. Admittedly, they began with a rather pure alloy of gold, containing only about 17% silver and 0.3% copper (in addition to c. 0.3% zinc and 0.2% iron). Their first experiment followed the salt process, according to which they heated the mixture of gold alloy, salt and grog at 850°C for twelve hours. From the starting weight of 0.91 g, the end product had a weight of 0.522 g, which translates to approximately 43% weight loss. Additionally, the silver content was reduced to about 0.5%, while copper could not be detected anymore. By repeating the same procedure for a second time, the gold percentage was raised by 0.4%, reaching 99.9% purity, and the additional weight loss was around 4%.[670] From these experiments and their results, it is obvious that the greater the amount of silver in a gold alloy, the greater the weight loss during the purification procedure.

Taking into consideration the Babylonian complaints regarding the colour of the gold sent from Egypt and the treatment of the gold when received in Babylonia, we are led to the conclusion that in Babylonia a method of testing the gold composition through a trial by fire was performed. This resulted in a significant weight loss of the gold. Egypt was most probably sending gold in its as-mined form, which means that it contained silver at about 5-30% and had a yellow-green or yellowish-greenish colour. Consequently, Babylonia must have implemented a gold refinement process and not a simple fire assay.

The above-mentioned, analysed gold objects of the 18th Dynasty suggest that a gold-refinement method was known in Egypt as well. The Amarna gold finger-ring with the frog (Sample No. 58a) has a gold content reaching c. 98 wt%, while the matrix of Tutankhamun's golden mask has a gold content of about 97 wt% (Sample Nos. 60a and 60c). Furthermore, Tissot *et al*.[671] examined gold foils of gilded objects found in tombs 381 and 533 of the "North Cemetery" at Abydos, dating to the Middle Kingdom, and found compositions as fine as 99.7 wt% Au.[672] They explained these out-of-the-ordinary extremes as the result of a possible

[668] Notton 1974, 55-6.
[669] Wunderlich *et al*. 2014.
[670] Wunderlich *et al*. 2014, 355-58, table 1.
[671] Tissot *et al*. 2015.
[672] Tissot *et al*. 2015, table 2.

different gold source, referring to the Abu Marawat gold deposit in the central Eastern Desert of Egypt, which contained gold grains containing as low as 1.4 wt% Ag.[673]

A point against assuming a refined state for the 18th Dynasty samples is the detectable traces of copper, which were non-existent in the experiment by Wunderlich *et al*. after a single cementation cycle. Refined gold coins from Lydia, however, could yet provide some support for this claim. Gold *stater*s from Lydia, analysed with a combination of SEM-EDX and XRF from Cowell and Hyne,[674] were found to have a composition of 99% Au, 0.6-0.9% Ag and 0.2% Cu. Furthermore, gold Croeseid coins were analysed with Proton Activation Analysis (PAA) by Craddock *et al*.[675] and yielded a composition of 98-99.4% Au, 0.3-1.6% Ag and <0.03-0.3% Cu. The latter were certainly made of refined gold, but they still contained some copper. As a result, the possibility that the Amarna finger-ring and the funerary mask of Tutankhamun were made with refined gold cannot be excluded. Moreover, Klemm and Klemm[676] had the opportunity to study a sample of redundant gold foil from the lower part of Amenhotep IV's coffin by applying an Electron Probe Micro-Analysis (EPMA). The analysis revealed a 99% gold content, which further lead them to the decision to examine the sample more thoroughly under the SEM. The SEM showed that the foil "*was composed of several forged, porous plates*" on which twin lamellae and holes could be seen. The twin lamellae were created from the mechanical stress during forging, while the holes appear to have been the diffusion channels of the silver chloride formed during the cementation process. The image of this gold foil, with its holes and twin lamellae, was very similar to the image of a Lydian gold foil, dating to c. 550 BC, which was refined through the cementation process.[677] Klemm and Klemm[678] further maintain that other Egyptian, highly pure gold objects, even from the 16th century BC, may have been produced with a refining process. From their research and experimental results, they argue that the knowledge of cementation existed in the mid-2nd millennium BC Egypt, long before the Lydians. It is also noteworthy that on the surface of the golden matrix of Tutankhamun's burial mask very thin foils were applied, through which the colour of the matrix could be seen and supplemented in order to show a specific and desired colour hue. It seems that the Egyptian goldsmiths in due course had the ability to manipulate the composition of the alloy so as to create the colour (of gold) they wanted.

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[673] Tissot *et al*. 2015, 77-8, fig. 4; Zoheir and Akawy 2010, 314, table 3. See also Klemm and Klemm 2013, fig. 4.1.
[674] Cowell and Hyne 2000, 170-1, table 7.4.
[675] Craddock *et al*. 2005, table 4.
[676] Klemm and Klemm 2013, 45.
[677] Klemm and Klemm 2013, figs. 4.4-4.7.
[678] Klemm and Klemm 2013, 45-8.

Moreover, it has been determined that PGE inclusions, contained in alluvial gold, are a considerable nuisance for the goldsmith. These inclusions can actually withstand a cementation process, which operates at low temperatures, but cannot survive the high-temperature oxidation of the cupellation process (c. 1,100°C).[679] It has, thus, been surmised that foils of great purity and without PGE inclusions should have come from jewellery made from a gold recycled and refined through cupellation.[680] The Middle Kingdom gold foils from Abydos had to be examined with the newly developed D^2XRF, which has a much lower detection limit than any other non-destructive technique, in order to be able to detect the platinum inclusions.[681] From the here-listed gold objects, the finest compositions can be seen in the hoop of Sample No. 58 and the matrix of Tutankhamun's mask (Sample Nos. 60a and 60c). Even finer, however, are the gold foils from Abydos and from Amenhotep IV's coffin.[682] Unfortunately, the gold foil from Amenhotep IV's coffin, which has been examined and found to have been purified with a cementation process just like the gold foils from the refinery at Sardis, was not analysed with the intention to detect PGE inclusions and we, therefore, cannot be sure if the inclusions have been removed, whether deliberately or accidentally.[683] Nevertheless, the possibility that a high-temperature oxidising treatment, such as cupellation, was performed before going on with a process of parting silver from gold, cannot be ruled out. If both of these treatments were performed, then the PGE inclusions would have been removed during the first treatment, and together with the following purification of the gold would have made it suitable for the production of thin sheets. Thus, they would not be detectable in any analysis.

Craddock[684] has very sensibly noted that there was no reason for people of this early time to perceive the gold that came from the earth as impure; nor was there any motive, or actual reason, to get into the time-consuming process of gold refinement before the advent of coinage. The only likely reason for wanting to alter the composition of an object would be to change its colour and appearance. Depletion gilding was an alternative method to gold refinement for making an object *look* more golden. This technique is only applied on the surface of the object and is based on the same chemical reactions as the cementation process.[685] It is very important to mention that when we are talking about the surface of a metal, we refer to a

[679] Craddock 2000b, 242-43.
[680] Cowell and Hyne 2000, 173; Craddock 2000b, 242-43; Geçkinli *et al*. 2000, 185-86. See also: Pernicka 2017, 2; Wood *et al*. 2017, 2.
[681] Tissot *et al*. 2015, 78-9.
[682] See also Ogden 2010, 152.
[683] Klemm and Klemm 2013, 45.
[684] Craddock 2000a, 31. See also La Niece 1995, 44-5.
[685] Moorey 1994, 226; Bachmann 1999, 272-74. See also Blakelock 2016, 925.

very thin layer measuring some microns (1 μm = 0.001 mm), while on the other hand the body of the metal can be typically seen below a depth of 1 mm.[686]

Three gold chisels from the Early Dynastic III (c. 2600-2350 BC) grave of Queen Pu-abi at Ur (grave PG 800), along with a small chisel and a spearhead from grave PG 580, were analysed by Susan La Niece[687] and found to be the earliest examples of depletion gilding in the Near East.[688] A core sample was extracted from one of the chisels (U.10432) from the Queen's grave and analysed with XRF. It comprised 39% Au, 24% Ag and 37% Cu. A surface analysis was also performed with XRF and showed an enriched in gold alloy containing 85% Au, 11% Ag and 4% Cu. The surface analysis of the rest of the chisels revealed a similar composition, while further analysis performed on abraded surfaces of the same items produced somewhat similar results as the core sample of U.10432. The Queen's grave's chisels contained 44-45% Au, 11-13% Ag and 42-44% Cu and the small chisel from the tomb PG 580 consisted of 43% Au, 43% Ag and 13% Cu.[689]

One more sample, taken from a gilded object, was luckily made available to Müller-Karpe for analysis.[690] This was a very small sheet of gold, which had come off from the rim of a bowl or a beaker from the Royal Cemetery at Ur, dating to the Early Dynastic IIIb period (c. 2450-2350 BC) (**Figure 13**). SEM analysis on three points of the sample yielded different compositions depending on the distance from the outer surface. The total thickness of the sample is around 2 mm and on the outer side it has a burnished surface, from which the first measurement was taken (point 1 in **Figure 13**). The second measurement was taken from a narrow corrosion zone (point 2 in **Figure 13**), fractions of a millimetre from the external surface, and the third from the core of the sheet (point 3 in **Figure 13**), close to the inside wall. The composition of each point of measurement (from the outside to the inside of the sample, or from left to right in **Figure 13**) is: 41.3 – 39.1 – 23.4% Au, 40.7 – 47.8 – 51.9% Ag, 0.5 – 6.5 – 15.5% Cu, 17.1 – 6.4 – 8.5% O, 0.2 – 0.2 – 0.8% Cl. The artefact was depletion gilded to

[686] See Craddock 2000a, 28. The surface layers on Tutankhamun's mask were 28-30 nm thick, i.e. 0.028-0.03 μm.
[687] La Niece 1995.
[688] See also the eight small, golden-looking Chalcolithic (4th millennium BC) rings found in a burial cave at Nahal Qana (Israel), which have seemingly been depletion gilded in order to decrease the silver content, increase the gold content and, thus, appear more yellow (Gopher et al. 1990, 438-40; Philip and Rehren 1996, 140-41). According to Gopher *et al*.'s (1990, 439-40) metallographic examination, the rings were cast and lightly hammered, the surface was then exposed to an oxidative agent, such as an open-fire or salty sand, cleaned with an acidic substance, like fruit juice, and finally hammered to their final shape. In this way, the brightness of the now increased gold content was brought to the surface.
[689] La Niece 1995, 43-4, table 1.
[690] Bachmann 1999, 273, fig. 2, table 3.

look as from golden gold, due to its high copper content, to silver-white.[691] The reason behind such a decision seems quite perplexing to us, but we should not project present-day aesthetic predilection and values on those of the 3rd millennium BC in Mesopotamia.[692]

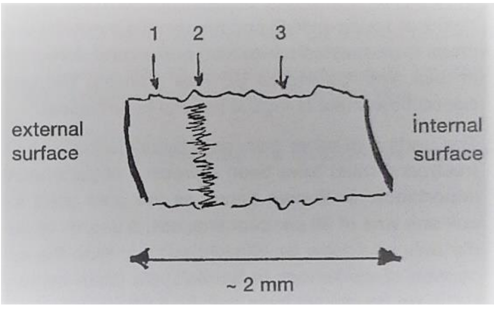

Figure 13. Schematic drawing of the rim of a gold beaker or bowl from the Royal tombs of Ur, 3rd millennium BC. Numbers indicate areas analysed by the SEM (Bachmann 1999, fig. 2).

La Niece[693] proposed a probable method of fire gilding by

> *immersing the sheet in aqueous pastes of ferric sulphate and salt or of ferric sulphate, salt and iron oxide at room temperature for two days. The black scale which formed on the surface was washed off with a hot strong salt solution, then burnished*.

Others have also successfully depletion gilded gold alloy samples, using a cementation method.[694] Bachmann[695] proposed heating the gold to oxidise the copper, then removing the copper oxides by organic acids, like vinegar, and finally burnishing and polishing the surface. Grimwade,[696] together with Teresa del Sol, performed a series of experiments, discovering that heating a ternary alloy sample in a boiling solution of alum (40 g of alum per 100 ml of distilled water) for two hours, produces a 2 μm compact depletion gilded layer with a "*good gold colour*".[697] Then, by performing a nine-cycle treatment of placing the sample in an alum paste with brick dust in an earthenware pot, heating it with a torch for three minutes and then washing it, they produced a good quality 8-10 μm thick layer.[698] This process has a significant advantage

[691] This is how Bachmann (1999, 273) describes the colour variation, although by plotting the gold, silver and copper percentages in the ternary Au-Ag-Cu colour diagram (**Figure 10**) the colour develops from a white-silvery (whitish) hue to a pale greenish-yellow one. The considerably high silver content of the inside of the rim would not appear more reddish with an addition of just 15% of copper. For such a result, much higher percentages of copper and/or gold are necessary (see the relative discussion in Chapter 4.1.2.1, below).
[692] See also the objects found in the Nahal Mishmar hoard, made by the lost wax casting method and being As-Sb-Cu alloys, looking greyish-silver despite of their copper content (Philip and Rehren 1996, 141).
[693] La Niece 1995, 45.
[694] La Niece 1995, 45-6. See also Craddock 2000a, 27-31.
[695] Bachmann 1999, 273-74. See also Lechtman 1988, 373; Sáenz-Samper and Martinón-Torres 2017, 1254.
[696] Grimwade 1999, 18-20.
[697] Grimwade 1999, fig. 11.
[698] Grimwade 1999, fig. 12.

over the cementation method, it is easier and faster.[699] The used ingredients, either by La Niece or Grimwade, were definitely known and widely used in ancient Egyptian pigment recipes.[700] Thus, it is only logical to assume that these chemical compounds could also be applied in goldsmithing and general metalworking. In addition, the relative ease with which silver could be removed from gold, using either salt or an iron-based corrosive compound, suggests that gold purification was within the limits of the technical capabilities of ancient Mesopotamian and Egyptian goldsmiths.[701]

4.1.1.1.3 Red gold

The first to have elaborated on this kind of gold was Lucas,[702] in Carter's second volume of *The Tomb of Tut-ankh-Amen*. He observed various shades of red, including reddish-brown, light-brick, blood-red, dull purple and rose-pink colours, for which he stated that are all fortuitous, except from the very last. According to him, the reddish-brown hue was a result of oxidised iron and copper that was found in the metal, the red or purple colouration was occasionally due to staining by organic matter and the rose-pink hue, particularly observed on a number of objects from Tutankhamun's tomb, was a result of iron oxide.[703] In contrast, the "gold tinged with red" that is recorded in the Amarna letters is a much different matter from the now-seen-as red gold on some gold Egyptian artefacts. This presently-seen-as-red hue is created by fortuitous corrosion. There are three distinct tones of red observed on the surface of gold alloy artefacts. These are reddish-purple, reddish-brown and rosy-pink or cherry red. Frantz and Schorsch[704] examined a few gold Egyptian objects of the 20th-19th and of the middle of the 15th centuries BC and found them to contain principally silver-gold sulphides with some copper. In a few instances, however, the colouration was due to iron. This was the predominant element on an assortment of Tuthmose III's foreign queens' gold rosettes.[705] Pink sequins from Tutankhamun's funerary robe were found to contain gold, silver, copper and

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699 The paste consisted of 10 g potassium nitrate (KNO_3), 9 g sodium chloride (common salt, NaCl), and 5 g potassium aluminium sulphate (alum). The experiment included a trial with an iron salt paste as well. It contained 10 g iron sulphate, 5 g sodium chloride and 5 g potassium nitrate. During the cementation experiments, both pastes produced good depletion gilded layers, but the process created blackened surfaces and grey patches (Grimware 1999, 18).
700 See Wood 1934, 64; Moorey 1994, 227; David *et al*. 2001.
701 See Craddock 2000a, 31.
702 Lucas 1927, 173-74; 1962, 233.
703 Lucas 1927, 173-74; 1962, 233-34; Aldred 1971, 32.
704 Frantz and Schorsch 1990.
705 Frantz and Schorsch 1990, 139-42.

0.85% iron, the last of which was the element that gave the pink colour to the sequins' surface.[706] Moreover, Ogden[707] notes that "*some Egyptian signet rings of the late Eighteenth Dynasty contain 50 per cent or more copper, which gave them an attractive reddish colour*".

The first colouration, and the one that has been rather extensively studied by Frantz and Schorsch,[708] is the reddish-purple one. This has been found on several Egyptian objects, among which are Sample Nos. 1-4 and 56. Initially, in 1927, Lucas claimed that this red-purple surface layer was caused by staining from organic matter "*since it was not soluble in either acids or in organic solvents, but could be readily removed by heating*".[709] During their examination of the Egyptian objects, Frantz and Schorsch discovered that the thickness and colour of the layer varied from sample to sample, as well as in different parts of a single sample, and that it was well bonded with the metal.[710] They also found that these layers were in fact silver-gold sulphide (AgAuS) occurrences, formed under the dry environmental conditions of the Egyptian tombs.[711] **Table 17** is a modified version of Table 1.A presented in Frantz and Schorsch's article; all measurements have been converted from at% to wt% by the author. It illustrates the relative increase or decrease of elements in respect to the depth from the surface of the sample. The operating voltages of SEM-EDS used for these measurements were 30 kV, 20 kV and 10 kV. The higher the electric tension used, the deeper into the surface of the sample we can see. For this reason, the results of the analysis are here presented in such a way so as to demonstrate the increase/decrease of the relative element detected with respect to decreasing depth. This means that seen from left to right in the table, measurements at 30 kV refer to points deeper in the surface of the sample, while those performed at 10 kV refer to the more superficial layers.

Table 17. SEM-EDS analysis of surface samples from presently red-coloured gold objects (Frantz and Schorsch 1990, table 1.A and p. 145 n. 8). All measurements have been converted from at% to wt%.

	Sample No. 1			**Sample No. 2**			**Sample No. 3**		
	30 kV	**20 kV**	**10 kV**	**30 kV**	**20 kV**	**10 kV**	**30 kV**	**20 kV**	**10 kV**
Au wt%	81.51	78.49	61.72	65.13	64.16	49.22	69.27	59.21	63.1
Ag wt%	16.81	19.82	33.13	33.4	33.69	44.08	29.37	34.81	32.25
Cu wt%	1.11	nd	nd	0.47	nd	nd	1.35	1.4	nd
S wt%	0.56	1.69	5.15	1	2.15	6.7	nd	4.58	4.66

[706] See also Wood 1934; Plenderleith and Werner 1971, 215-16.
[707] Ogden 1992a, 30; 1992b, 262-63.
[708] Frantz and Schorsch 1990; 2007.
[709] Lucas 1927, 172-73; Lucas and Harris 1962, 233.
[710] Frantz and Schorsch 1990, 136, 139; 2007.
[711] Frantz and Schorsch 1990, 142-44, 146, 148-49; 2007.

Cl wt%	-	-	-	-	-	-	-	-	-

	Sample No. 4			Sample No. 56			Sample No. 57		
	30 kV	**20 kV**	**10 kV**	**30 kV**	**20 kV**	**10 kV**	**30 kV**	**20 kV**	**10 kV**
Au wt%	91.44	88.55	65.7	53.99	43.96	30.99	90.89	92.51	90.81
Ag wt%	8.56	10.95	27.97	28.11	33.16	42.69	8.1	6.77	9.19
Cu wt%	nd	nd	nd	10.3	7.58	8	1.02	0.73	nd
S wt%	nd	0.51	6.34	2.42	3.86	4.97	nd	nd	nd
Cl wt%	-	-	-	9.13	11.44	13.35	-	-	-

The second tone of red is the reddish-brown one, which seems to be a result of the small amounts of copper and iron contained in the gold alloy, oxidising and slowly migrating to the surface of the object.[712] Not much has been written on this reddish hue but the general opinion is that, either deliberately or accidentally, iron-bearing compounds, such as iron oxides, are responsible.[713] Good examples of this type of red tinge are the polychrome daisies from the golden sandals of Tutankhamun (shoes no. 021f & g, **Figure 14**Error! Reference source not found.). Certain petal-shaped rosettes of the sandals were made from a different gold alloy and now a brownish corrosion layer has been formed (**Figures 15-16**).[714]

Figure 14. Artist's impression of open shoes 021f & g (Veldmeijer 2011, fig. 3.61).

[712] Lucas 1927, 173-74; Lucas and Harris 1962, 233; Ogden 1985, 73.
[713] Ogden (1982, 19) refers to the addition of haematite, as is described in Mesopotamian texts; Frantz and Schorsch (2007) mention lepidocrocite, a hydrated iron oxide, as an example of the causative substance; Ogden 2010, 153-55.
[714] Ogden 2010, 153-54.

Figure 15. The daisies on the strap of the right open shoe 021g (Veldmeijer 2011, fig. 3.63 j).

Figure 16. Detail of a daisy on right open shoe 021g (Veldmeijer 2011, fig. 3.63 k).

Finally, there is a rosy-pink tinge, that has also been described as "*transparent, cherry red*" and "*bright, translucent red*" by Frantz and Schorsch.[715] In the tomb of the Three Wives of Tuthmose III, red gold surfaces have also been noted. Specifically, gold rosettes from a wig covering was analysed by Frantz and Schorsch[716] and found to contain hydrated iron oxide (FeO(OH)), recognised as lepidocrocite.[717] However, it is uncertain if this thin film of iron oxides was an adventitious accretion deposited by groundwater during burial or, a deliberate or accidental addition of iron-bearing compounds to the gold. Judging by the location of the tomb, though, the former possibility is seen as more plausible.[718] The best representatives of the rosy-pink colouration are, nevertheless, the artefacts found in Tutankhamun's tomb. A good example is the hemispherical sheet-gold beads, which are believed to have been manufactured with a small addition of iron and are part of a chequerboard pattern created on a pair of sandals (shoes no. 021k & l, **Figures 17-18**).[719]

[715] Frantz and Schorsch 1990, 149; 2007.
[716] Frantz and Schorsch 1990, 141-42.
[717] Lilyquist 2003, 166-67, item no. 114 (MMA 26.8.117a), see also p. 124.
[718] Frantz and Schorsch 1990, 147, 149; 2007; Lilyquist 2003, 124. See also Ogden 1982, 19.
[719] Ogden 2010, 154-55.

Figure 17. Artist's impression of open shoes 021k & l (Veldmeijer 2011, fig. 3.66).

Figure 18. Beadwork of the outer part of the right sandal 021l (Veldmeijer 2011, fig. 3.68 b).

In 1934, Wood performed some experiments with a few small sequins, trying to understand the nature of the colouration. The thin surface film turned out to be homogeneous and possible to be peeled off, which proved that it was not an interference colouration.[720] His experiments led him to favour the possibility that (alluvial) gold containing traces of iron was melted, hammered into thin sheets and heated, but there was also the possibility that the gold was melted with orpiment (arsenic sulphide, As_2S_3) and then hammered into shape.[721] A further experiment was carried out by the British Museum and showed that when an Au-Ag-Cu alloy is fused together with iron pyrites (FeS_2) and soda (Na), then some of the silver and copper combines with the sulphur from the pyrites and rises to the surface as dross. This leaves the gold alloyed with iron which, given a hammering and heat treatment, develops a colouration like the one found on Tutankhamun's objects.[722] Hence, this rose-pink hue may have been produced by dipping the alloy into a solution of iron salt and then subjected to heating.[723] It would be worth mentioning that iron pyrites have a yellow colour similar to gold, and about the same melting point; this is the reason why they are also called "fool's gold". They may then have been (initially) accidentally mixed with gold.[724]

720 Wood 1934, 61-3.
721 Wood 1934, 63-4; Lucas and Harris 1962, 233-34. See also Ogden 2000, 164; cf. Schorsch 2001, 67.
722 Lucas and Harris 1962, 233-34.
723 Forbes 1950, 154; Lucas and Harris 1962, 233-34; Plenderleith and Werner 1971, 215-16.
724 Lucas and Harris 1962, 234; Plenderleith and Werner 1971, 215-16.

The fact that the passage in EA 22 and EA 25 states that the colour of blood was brought up on the surface of the gold, KÙ.GI *ša damu šūlû*, most probably means that the hue was achieved either by a) depletion gilding, creating a surface of pure(r) gold, i.e. of a red-yellow colour, b) the addition of some iron to the alloy, as a colouring constituent, or c) dipping the object into an iron-containing solution (sulphide, sulphate, or oxide), as has been described for the formation of the rosy-pink surface layer on gold alloys, followed by burnishing and washing.

Very pure gold, containing more than 95-96 wt% gold and less than c. 4 wt% silver, has a red-yellow colour. This colour could be achieved either by refining the gold or by depletion gilding. As has been described above, the process of depletion gilding can be achieved by dipping the gold alloy in a paste of alum (potassium aluminium sulphate, $KAl(SO_4)_2$, which can be found in minerals containing pyrites, FeS_2)[725] and brick dust, heating it and then washing it. Repeating the process nine times produces the desired 8-10 μm thick surface layer.[726] Another way would be to dip the alloy in a paste made of ferric sulphate ($Fe_2(SO_4)_3$) and salt (NaCl) (and iron oxide, such as haematite (Fe_2O_3)) for two days, washing and then heating it.[727] The latter method of depletion gilding seems to be quite similar to the method the British Museum used in their experiment of reproducing the rosy-pink surface colouration of Tutankhamun's gold objects. Key elements in both methods are iron pyrite and natrium, which cause the silver and copper to rise as dross on the surface of the alloy and as such be susceptible to washing and burnishing. By removing the dross, a gold-silver alloy with traces of iron is left behind. Whatever the method applied to achieve surface colour manipulation on gold alloys actually was, it certainly seems a reality. Ogden[728] draws our attention to the notable difference between the main outer part of the soles and the central shaped sections of sandals 021f & g (and 021k & l) from the tomb of Tutankhamun (**Figures 14 and 17**). There, the sheet gold was worked in a manner so as to represent woven rush and its greyish-brown colour appears to have been achieved with the application of some kind of "varnish."

Moreover, the colour of gold could appear red not only when it is very pure and it contains no more than about 2-3 wt% silver and copper, but also with the addition of copper (**Figure 10**). A number of signet-rings from the late 18th Dynasty have a distinct red colour,

[725] Anthony *et al*. 2004-2018, "Potassium alum"; Mindat.org, "Alum-(K)".
[726] Grimwade 1999, 18-20.
[727] La Niece 1995, 45. See also Anthony *et al*. 2004-2018, "Hematite"; Mindat.org, "Hematite".
[728] Ogden 2010, 155.

resulting from a high copper content (**Figures 19-20**).[729] Many of them are dated to Amenhotep IV's and Tutankhamun's reigns.[730] Ogden[731] carried out a qualitative analysis of one of the rings and found an Au:Cu:Ag ratio at about 2:2:1. He also examined these gold-copper alloy "stirrup" rings and realised that they were made by casting and not by hammering pieces together, as was the common practice for the more usual gold-silver alloys. The addition of copper to gold reduces the melting temperature of the alloy, considerably increases the ease with which the molten alloy will flow into a mould, gives the alloy increased strength and makes it less ductile and malleable.[732] All these characteristics and benefits of alloying gold with copper can definitely be considered a reason for doing so, but an aesthetic choice cannot be disregarded.[733]

Figure 19. Copper-gold ring of the Amarna period (Aldred 1971, pl. 69).

Figure 20. Signet-ring of Tuthmose III (Bulsink 2015, 166 Cat. 113).

A much earlier example of copper alloyed with gold has been found in gold objects from Poliochni, on the island of Lemnos located in the northeastern (NE) Aegean. These finds date to the Yellow Period of about 2400-2100 BC. The addition of copper to the original gold-silver alloys was presumably done in order to alter the colour of the metal.[734] Red gold made with the addition of copper was also attested in the New Hittite Kingdom (c. 1400-1200 BC) texts from Ḫattuša, synchronous with the above-mentioned 18th-19th Dynasty Pharaohs'

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[729] Lucas and Harris 1962, 229; Forbes 1971, 174; Ogden 1982, 18; 1992b, 262-63; 2010, 153; Schorsch 2001, 68. Stos-Fertner and Gale (1979, 306, fig. 5) note the existence of "*one strange Predynastic sample*" that contained 76% Au, 24% Cu and no silver. See also Stos-Fertner and Gale 1979, 305, fig. 3.
[730] Ogden 1977, 67, fig. 2; 1982, 18, pl. 2; 1992b, 263, fig. 2; MMA Collection online, http://www.metmuseum.org/art/collection/search/544679. See also Aldred 1971, pl. 69; Bulsink 2015, 166, pl. 29: for what appears to be a copper-rich signet-ring with the name of Amenhotep III.
[731] Ogden 1977, 67; 1982, 18; Schorsch 2001, 68-9.; cf. Ogden (1992b, 263) states that the ring contained about 20% copper. See also Ogden (1992a, 30), who writes that some signet-rings of this period contain 50% or more copper; Troalen *et al*. 2009, 115.
[732] Moorey 1994, 226; Rehren *et al*. 1996, 8; Ogden 2011, 152-53.
[733] See Ogden 2000, 163; 2011, 153.
[734] Pernicka *et al*. 2003, 149-50; Cultraro 2008, 456.

reigns.[735] KBo 18, 153 (CTH 242.2.B) mentions “gold alloyed with copper” GUŠKIN QADU URUDU and “gold without copper” GUŠKIN URUDU NU.GÁL, while KUB 42, 73 (CTH 24.2.B) records “good gold alloyed with copper” GUŠKIN SIG_5 QADU URUDU.[736] To my knowledge, there is no reference to gold alloyed with copper in texts predating the 14th century BC in Anatolia (or in Egypt), but there may be a text from Ur mentioning the addition of copper to gold in the making of earrings.[737] The question then arises, if “red” gold was reaching Ur via Dilmun, along with various precious stones, ivory, copper, and silver,[738] and was made with the addition of copper, then why would there be an intentional debasement of gold with substantial amounts of copper made in Ur itself? At this point, it would be very helpful if we were able to support one meaning over the other. But every argument that favours a purer gold variety seems to have another one against it, and vice versa. The only thing that can be said with absolute certainty is that colour was then, as it still is, a decisive factor in categorisation and differentiation. Thus, to the eyes of a non-metallurgist, i.e. to a scribe, messenger, or king, gold with a red hue would be “red”, whether this was of a purer and better quality of gold, or if it was made with the addition of copper.

4.1.1.1.4 Multi-coloured gold and the polychrome effect

Polychromy is a practice known in Egypt from the SIP, as the finds from the Qurneh burial show.[739] The best polychrome examples, though, come from objects of the 18th Dynasty. A necklace from the Tomb of Scribe Beri, Sample No. 24, was composed of beads with a green-yellow colour, a pendant and a scarab of steatite of a yellow colour, and a scarab of lapis lazuli and a terminal ring with a greenish-yellowish colour.[740] The greatest examples of polychromy used in a single object are Tutankhamun’s sandals and his rebus pendant. In the sandals 021f & g, the daisies were made up of petals of different colours and compositions (**Figures 14-16 and 21-22**); in sandals 021k & l, there is a chequerboard pattern composed of hemispherical and square beads of distinct alloys as well (**Figures 17-18**); and the rebus pendant had an electrum moon disc and golden sun discs.[741]

[735] On the chronology see Bryce 2005, xv.
[736] Košak 1982, 195; Siegelová 2005, 36; Siegelová and Tsumoto 2011, 277.
[737] Moorey 1994, 218.
[738] Moorey 1994, xxii.
[739] Troalen et al. 2014.
[740] See Troalen et al. 2016, 6-7.
[741] Ogden 1992b, 263; 2011, 153-55.

Figure 21. Detail of the triangular centre part with the daisies on the strap of right open shoe 021g (Veldmeijer 2011, fig. 3.63 l).

Figure 22. The construction of the daisies in shoes 021f & g (Ogden 2011, fig. 4.3).

Examples such as the daisies on the pair of shoes 021 f & g and the beadwork of the sandals provide visual proof of the possibility of the existence of "multi-coloured" gold. Most probably the difference between the colour of the beads and of the petals of the daisies was not so obvious at the time they were manufactured. Still, a variety of hues of gold, from yellow to silverish, to reddish, would produce the desired effect. Furthermore, this KÙ.GI GÙN "multi-coloured gold" of the Pharaoh, mentioned in EA 283, may not have referred to gold alone. This could have encompassed an entire object made primarily with gold but with the use of other materials as well, which would have created a polychrome, a multi-coloured effect. Once more, the pair of shoes 021 f & g provide a visual demonstration of the beauty of such a polychromy.

4.1.1.2 Anatolia

In contrast to the objects from Egypt and Ebla of the early 2nd millennium BC, gold artefacts from Kaneš and Kaman-Kalehöyük of the same period present a much higher purity. Gold objects from Kaneš, analysed by Masubuchi *et al*.,[742] were found to "*contain small amounts of silver and copper*". A very unusual and rather unique example of a gold cloisonné artefact (KL 10-1) depicting a "lion-dragon" was unearthed from Stratum IIIc at Kaman-Kalehöyük and upon analysis yielded the following compositions:[743]

Au wt%	Ag wt%	Cu wt%

[742] Masubuchi *et al*. 2004, 159-60.
[743] Paterakis *et al*. 2015. For the location of the site see **Figure 1**.

base plate:	94.8	2.5	2.2
foil:	93.5	4.0	1.8
cell walls:	93.2	3.9	2.2
rings:	87.9	9.2	1.7

The high purity of the gold used for the base plate would appear red-yellow. Similarly, the foil and cell walls would appear yellow towards red-yellow, closely resembling the colour of the base plate. The rings would look more yellow than the rest of the artefact, due to their lower gold and higher silver content.

Primary gold deposits are located in western/NW, northern Central and NE Anatolia (**Figures 23 and 39**). In NW Anatolia there are the epithermal gold-silver deposits of Kaymaz, located just west of Ankara, and Gümüsköy. Epithermal deposits form near the surface and metals are usually found in the form of veins. In northern Central Anatolia there is the mesothermal vein-type deposit of Gümüşhacıköy (also known as Gümüş), located in the vicinity of the proposed locations for Durhumit and Tišmurna. In these types of deposits gold and silver are usually found with copper, lead and zinc; the gold content might be relatively high. Additionally, in northern Anatolia there is the Küre mine, which is a volcanogenic massive sulphide deposit. In this type of deposits gold and silver occur only as by-products and can be found together with copper, lead and zinc. In NE Anatolia there are mesothermal vein-type as well as volcanogenic massive sulphide deposits, located on the southeastern (SE) coast of the Black Sea, in the area of Trabzon.[744]

[744] Bayburtoğlu and Yıldırım 2008, 46-9, fig. 1. See also Forbes 1950, 150-51; De Jesus 1977, 135-36; 1980, 82; Seelinger *et al*. 1985, 600-18: TG 159, TG 170, TG 171 (see **Figure 38**); Groves *et al*. 1998, 8-9, 18-20, figs. 1 and 2; Kaya 2009, table 1, fig. 1; Wilkinson 2014, 165-66, fig. 5.8. It has also been proposed that gold can also be found at the Kestel mine, which may have been initially used as a gold mine (Pernicka *et al*. 2003, 172).

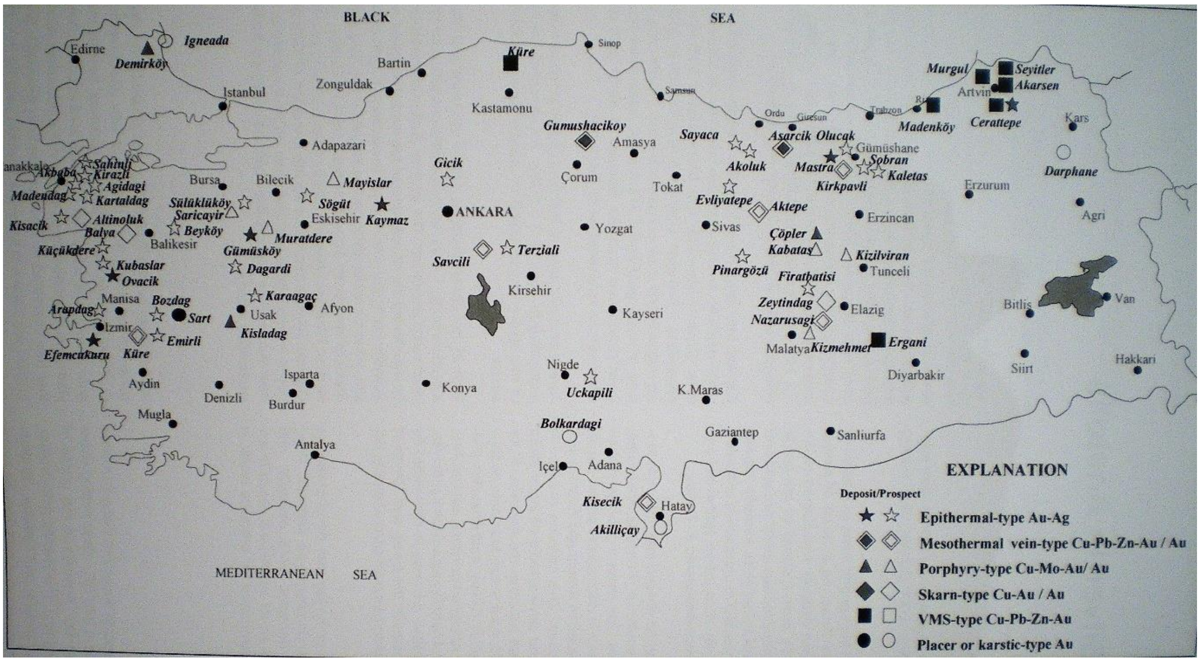

Figure 23. Gold and silver deposits in Turkey (Bayburtoğlu and Yıldırım 2008, fig. 1).

4.1.1.2.1 *Pašallum* gold

As already mentioned, this type of gold is commonly thought to represent the pale type of gold we call electrum, which is the usually found and widely used variety of gold in Egypt. However, evidence proves to the contrary here. The gold that the OA merchants described as *pašallum* most probably did not contain (that much) silver. This conclusion is based upon a variety of reasons.

First, *pašallum* gold can be obtained by a metallurgical process, expressed with the Akkadian word *bašālum*, better described as a melting and not as a smelting, or a cupellation, process. One of the reasons why this Akkadian verb does not denote a cupellation process has already been discussed in Chapter 3.1.2.1. Such a process better fits the Akkadian word *ṣarāpum*, which is used to denote "refined" silver and the separation of gold, as well as silver, from base metals.[745] However, the question of the definition of the word *bašālum* remains. Veenhof[746] has presented some evidence regarding the probable use of the word with a metaphorical meaning. According to him, the word might have the general meaning of "to cook", but as far as metal treatments are concerned, such a general definition creates only uncertainty. In a sense, the phrase "to cook" could be synonym to the phrase "to refine".

[745] *Ṣarāpum* is also used in relation to *amūtum*. This word perhaps describes a simple heat treatment, whereby metal or ore is put in a crucible and fired under oxidising conditions. In this way, refinement from impurities is achieved (see, for example: Moorey 1985, 177, 245; 1994, 217-18, 233, 282).
[746] Veenhof 2014, 413.

Nowadays, when we "cook" financial books, it means that we make financial statements appear something different, something "better". Much like cooking, we take the initial materials, mix them and create something else, something better. In a way, we refine the raw materials (or data in the case of financial books). On the same principle, the Akkadian word *bašālum* could have had the meaning of a refinement process.

Bašālum literally translates to "to boil". However, it is very improbable that the goldworkers would actually boil the gold. First and foremost because the temperature needed to actually boil this metal is too high for the capabilities of the smiths of the Bronze Age.[747] But also because there is no reason to do so. Gold needs only to be melted in order to be used. Thus, we can regard *bašālum* and *šabšulim* as references to the melting of gold. But its association with the production of a high quality of gold, i.e. *pašallum*, leads us to the conclusion that they do not refer to a simple melting process, but rather to a refinement one.[748] When we read KÙ.GI *sa'amum ša šabšulim* in FS Matouš 2, 125, it can be understood as red gold that has been refined. And in text Michel, Innaya II, 135ff. no. 100, when we read KÙ.GI SIG$_5$ *ù ša šabšulim*, we can understand that they talk about gold of good quality and gold that has been refined. The reference "das Silber läutere ich" KÙ.BABBAR *ù-ša-áb-ša-al* in text KTS 1, 2b is rather perplexing, as it is the only association (so far) of this word with silver.[749] It is, however, interesting that there is no reference to the act of refining the silver, but only to the final "refined silver" KÙ.BABBAR *ṣa-ru-pá-am*. The unique reference in KTS 1, 2b may have been accidental. Note, also, that there is no record of "refined", in reference to any metal, using the adjective of the word *bašālum*, in the same way that it is found in "refined silver" KÙ.BABBAR *ṣarpum*.

Second, in text kt 87/k 461 the writer sent an amount of 70 shekels of *pašallum* gold to the addressee and told him that "The (this) big (piece of) *pašallum* I obtained by refining it (*ú-ša-áb-ší-il$_5$-šu-ma*) inside the house, whereby I lost half of its weight, (but) it is of excellent quality". The writer then goes on saying that "I will produce gold of good quality by refining (*ú-ša-áb-ša-al-ma*) and send it to you".[750] From this passage, we learn that gold of good quality can be produced through the same process as *pašallum* gold, described with the term *bašālum*. What is more, the price recorded for the purchase of "*pašallum* gold of very good quality"

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747 Gold boils at c. 2.807 ºC.

748 It is possible that *pašallum* gold was *bašālum* gold (Barjamovic, pers. com.). In the same way that we would now describe that something that is "melted", "boiled", etc., is a result of a "melting", "boiling", etc. process.

749 Sturm 1995, 503. KTS 1, 2b (lines 14-16).

750 Veenhof 2014, 411-12, n. 66. Kt 87/k 461 (lines 15-19): *pašallum rabiam ina qarabbētim ú-ša-áb-ší-il$_5$-šu-ma mišlum imṭianni damiq watar;* (lines 29-30): GUŠKIN SIG$_5$ *ú-ša-áb-ša-al-ma ušebbalakkum*.

(KÙ.GI *pašallum damqum watrum* / SIG_5 DIRI), in texts AKT 6a, 166 and OrNS 50 no. 3, is 1 shekel of the gold for 10 shekels of silver, i.e. at a rate of 10:1.[751] This is the highest rate for the purchase of gold recorded in the OA texts. Moreover, in text kt c/k 48, which has to do with the purchase of gold of good quality and of a red/blood-like colour (KÙ.GI SIG_5 *ša damu*), a rate of 8.5-9:1 is recorded.[752] Accordingly, "gold of good quality" (KÙ.GI SIG_5) is sold at a rate of 8.7:1 in CCT 3, 22a.[753] Hence, based on the fact that "gold of good quality" records a slightly lower purchase rate than "*pašallum* gold of very good quality" and is directly associated with *pašallum* gold, we can draw the conclusion that the type of gold which is described with the word *pašallum* is of a good quality, rather valuable and expensive, and in no way what we call electrum.[754]

Third, in text OAA 1, 78 there is a unique record of "*pašallum* gold in ore" (KÙ.GI *pašallum ša abnišu* "*pašallum* gold of its stone").[755] At the same time, text FS Matouš 2, 126 refers to the purchase of "gold ore" (KÙ.GI *ša abnišu* "gold of its stone") at a rate of 8:1.[756] These two points of information lead us to the examination of the nature of the variety of gold under discussion and the available gold sources in Anatolia. Since *pašallum* gold can be obtained through a possible refinement process and also be found in the form of ore, we are led to two conclusions: a) the defining characteristic of *pašallum* gold was its appearance, i.e. its colour, and b) gold of good quality, one that did not contain many impurities, was probably indigenous in Anatolia and used by the Old Assyrians. Of course, not all gold ores were of a relatively pure gold. This is evident by the price of the gold ore mentioned in FS Matouš 2, 126 and of the fact that gold "of good quality" has to be produced.

4.1.1.2.2 Red gold

Based on the information that we have from Mesopotamia, the goldsmiths of the 2nd and possibly even of the late 3rd millennium BC appear to have mastered the technical skills of depletion gilding and maybe of gold purification as well.[757] Already in the Ur III period (c. 2112-2004 BC), texts from various cities mention different types of gold, which also have

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[751] AKT 6a, 166 (lines 5-9); OrNS 50 no. 3 (lines 9-10, 21-22).
[752] Kt c/k 48 (lines 35-37).
[753] CCT 3, 22a (lines 10-11).
[754] Contra Garelli 1963, 268. Dercksen (2005, 26) translates "nuggets".
[755] OAA 1, 78 (lines 4-5).
[756] FS Matouš 2, 126 (lines 8-9).
[757] Young 1979, 212-13; Waetzoldt 1985; Moorey 1994, 219. See also: Forbes 1950, 154-57; Powell 1990, 80-2; cf. Forbes 1971, 171-75. See also subchapters 4.1.1.1.2 and 4.1.1.1.3.

different prices. Waetzoldt[758] observed that the kind of gold that is described as HUŠ.A, meaning "red",[759] was the most expensive, reaching up to twenty times the price of silver.[760] OA texts from Kaneš attest to the higher price and rarity of "red" gold. In the thousands of OA texts translated up until now, there are only four which mention this variety of gold. KUG 25 records "rotes Gold" KÙ.GI HUŠ.A;[761] in CCT 4, 22b we also read about gold "rouge de très bonne qualité" HUŠ.A SIG_5;[762] FS Matouš 2, 125 contrarily uses the word *sa'amum* to describe "red" gold and reads "This is important: buy for the 16 minas of [*tiri*-]silver some red gold for smelting (KÙ.GI *sa'amum ša šabšulim*) and with your servant send it to me";[763] and in kt c/k 48 we find the only reference to "blood-coloured gold of good quality" KÙ.GI SIG_5 *ša damu*.[764] In particular, this last text mentions that:

> und in Kaniš 1 Mine oder 2 Minen gute Qualität Blut(farbenes Gold) (zu dem Preise) 8 ½ Schekel oder 9 Schekel (Silber für je 1 Schekel Gold) kauft für mich, aber wenn euch Waschgold in die Hände fällt kauft für mich 1 Mine Gold zweimal (den Betrag des Hochwertigen).[765]

Whether this red gold, which is twice as valuable as washed/alluvial gold, is pure by nature or purified cannot be determined.

The question is, however, what is the difference between "red" and "red of good quality" gold, if this red colour represents purity. What does this "good quality" refer to? According to the OA texts gold "of its water" *ša mā'ešu* (in the passage above translated as "Waschgold" = alluvial) is the cheapest, with an exchange rate of about 4.5:1 (kt c/k 48). Then comes *kuburšinnum* gold with a recorded price of 6.6:1 in TC 3, 43, followed by "blood-coloured" gold at 8.5-9:1.[766] The most expensive is "*pašallum* gold of very good quality", with an exchange ratio of 10:1. In texts from Mari, red gold was described with the Akkadian word *sa'amum*.[767] In one particular text, ARM 13, 6, a goldsmith received an amount of gold which

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758 Waetzoldt 1985, 4-6.
759 Landsberger (1967, 149-50) maintained that this word did not express a specific colour, but a glance expressed through words. See also Waetzoldt 1985, 9.
760 See also Reiter 1997, Anhang IV, 126*-27*.
761 KUG 25 (lines 9-10).
762 CCT 4, 22b (line 19).
763 Larsen 1978, 114-15. FS Matouš 2, 125 (lines 15-19): *a-put-um ša* 16 *ma-na* KÙ.BABBAR KÙ.GI *sà-ma-am ša ša-áb-šu-lim ša-a-ma ki ṣú-ha-ri-kà šé-bi₄-lam.*
764 Kt c/k 48 (line 35-36).
765 Balkan 1965, 151. Kt c/k 48 (lines 35-40): *ù i-na Kà-ni-is*[KI] GUŠKIN 1 MA.NA *ù* 2 MA.NA SIG_5 *ša da-me-e* 8 ½ GÍN.TA *ša-ma-nim ù šu-ma* GUŠKIN *ša ma-e-šu i-šé-ra-ku-nu-ti* 1 MA.NA GUŠKIN *a ší-ni-šu li-qi-a-nim*.
766 Unfortunately, there is no price ratio recorded for "simple" "red" gold. There is only a reference of a request to buy "some red gold for smelting" with *tiri*-silver (FS Matouš 2, 125).
767 See also Reiter 1997, Anhang IV, 128*-30*.

turned out not to be *sa'amum*.[768] According to the original interpretation, this "red" gold was one coloured with copper.[769] However, this interpretation was later amended by Durand,[770] who argued that this "red" colour represented the purity of the gold and was not gold made with the addition of copper.[771] Moreover, during the late Kassite period (c. 1595-1155 BC)[772] red gold (SA_5/*sa'amum*) appears to continue to be prised higher than any other type of gold.[773]

Regarding the references to "red" gold, a rather significant difference between the OA and the Mari texts of the 19th-18th centuries BC, on the one hand, and the texts from Amarna on the other, is that the former speak about raw materials, while the latter describe artefacts. So, when we read about "red gold that has been refined" KÙ.GI *sa'amum ša šabšulim* in the OA texts, very pure gold with a red-yellow and not a simply reddish colour is meant. The difference being that a red-yellow gold would be refined, have had its copper removed and would contain only a few percent of silver, while a reddish gold could contain a high amount of copper as well as silver (**Figure 10**).

4.1.1.2.3 Gold "of its water" (*ša mā'ešu*) – "of the sea" (*ša tiāmtim*)

The phrase *ša mā'ešu* means "of its water". In texts TC 1, 47 and kt c/k 48 the phrase KÙ.GI *ša mā'ešu* is realised as a reference to alluvial gold. In the present research, and in contrast to the translation offered by the original translators of the texts in which this variety of gold appears, it is argued that this KÙ.GI *ša mā'ešu* cannot be alluvial gold.

First, in Chapter 3.1.2.1 it was shown that the variety called "of the sea", expressed with the phrase *ša tiāmtim*, has about the same exchange rate as the variety of gold called *ša*

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[768] ARM 13, 6 (lines 5-17): "Sur les 4 mines d'or que mon seigneur m'avait fait porter pour (fabriquer) 2 ḪÚB.TIL.LÁ, il y a eu freinte, et j'ai dû pr[en]dre, [d'aut]re part, 4 sicles d'or, en vue(?) des 4 *kippu* (á fabriquer également). (Mais,) à cause de l['in]spection du stock, j'ai dû le mettre sous clé (avant d'y avoir suffisamment puisé), et sur les 4 sicles d'o[r] (qui m'étaient nécessaires), il manque (encore) ½ sicle, 10 grains d'or. (Aussi,) étant donné qu'il manque (en tout) 1 sicle, 25 grains, et que (, par suite,) l'orfèvre a déclaré: '(Cela) ne (peut donner de l'or) rouge!', l'or destiné aux ḪÚB.TIL.LÁ (à fabriquer par) Iašûb-Ašar, ne suffit (donc) point." *i-na 4 mané ḫurâṣim ša a-na* 2 HÚB[!].TIL.LÁ[!] *be-lí ú-ša-bi-lam im-ma-ri-iq-ma* 4 *šiqil ḫurâṣam i-na pa-an* 4 *ki-ip-pí* [*a-ḫ*]*u-ne-e él-t*[*e-e*]*q-qí-ma* [*aš-š*]*um sak-ku-ut-tim a-ma-ri-im ás-ki-ir-šu-ma i-na* 4 *šiqil ḫurâṣ*[*im*] ½ *šiqil* 10 *uṭṭet ḫurâṣum im-ṭì i-nu-ma* 1 *šiqil* 25 *uṭṭet im-ṭú-ú ù* (*awîl*)*kutimmum ki-a-am iq-bu-ú um-ma-a-mi ú-ul sa-am ḫurâṣ* HÚB.TIL.LÁ *ša* (*I*)*Ia-šu-ub-A-šar ú-ul ka-ši-id*. See also Reiter 1997, 43.

[769] Waetzoldt 1985, 9.

[770] Durand 1983, 129-30, n. 25: "« Sur les 4 mines d'or que mon seigneur m'a envoyées pour (faire) 2 GUR_7-ME, un prélèvement a été fait et (le technicien) a pris sur la surface des 4 lingots, l'un après l'autre, (en tout) 4 sicles d'or. J'ai mis cela au four pour pouvoir analyses ce qui resterait. Il y a eu une freinte de 100 grains sur les 4 sicles [= 720 grains]. Puisque donc la freinte est de 25 grains pour un sicle, et que l'orfèvre a déclaré : 'Ce n'est pas de l'or rouge', ce n'est donc pas de l'or (convenable) pour les GUR_7-ME de Yašûb-Ašar que l'on a reçu. … »."

[771] See also Waetzoldt 1985, 9.

[772] Chronology according to Aruz *et al*. 2008.

[773] Powell 1990, 80-1.

mā'ešu "of its water". Moreover, in text FS Matouš 2, 126 we read that gold *ša abnišu* "of its stone", has a higher exchange rate than both of the aforementioned varieties. This gold ore is to be sold at 8:1, while that "of the sea" and consequently also that "of its water" at only 6:1. These references demonstrate the lower value and most probably also quality and purity of gold *ša mā'ešu* "of its water" in comparison to gold "of its stone" *ša abnišu* or *pašallum* gold.

Second, alluvial gold is known for its lower silver content in comparison to vein gold ores, which is due to the mechanical washing (refinement) of the ore provided by the water's flow. From what we can understand from the OA texts, the traders of this time were greatly concerned for the purity of a metal. If we assume that by gold *ša mā'ešu* they meant alluvial gold, then we would normally expect it to be sold at a higher rate than vein-type gold ore. Gold ores can be of varying purity, but they generally contain more impurities than alluvial gold.

Third, alluvial gold in Anatolia can be found in the Tmolus Mountain, which is located in the western part of the country, far away from the area where the OA trade seems to have been conducted.[774] On the other hand, epithermal and mesothermal vein deposits, containing gold mixed with other metals, can be found rather close to the trading stations in NW Central Anatolia, northwest of the proposed location of Šalatuwar, and in northern Central Anatolia, close to the proposed locations of Durhumit and Tišmurna, where there are also many copper deposits.[775] It may be that the variety described as *ša tiāmtim* is different from the known gold ores that the OA traders were used to and that it was coming from a source near the sea, in this case the Black Sea. On the southern shores of the Black Sea there are several volcanogenic massive sulphide deposits which contain gold, especially in the Trabzon area in NE Anatolia (**Figure 23**).

Having shown that gold *ša mā'ešu* cannot be alluvial gold, another explanation for the term has to be sought. The phrase comes from the Akkadian word *mû*, denoting "water" or, in a wider sense, "fluid". The phrase "of its water" can be understood either as washed gold, i.e. cleaned with the use of water, or gold that comes from water. If gold is washed with water then the heavier particles of the gold will remain at the bottom, while the lighter particles will be washed away. This technique was applied by the Egyptians and could have resulted to a purer quality of gold. However, there is no evidence to support the use of such a washing technique in Anatolia during the OA period. In addition, the texts record that the end result of this process of cleaning still was of quite low quality and thus also purity. If this type of gold came from a

[774] See Rammage 2000, 18-20.
[775] See **Figure 39** and **Figure 23**.

body of water, then it would be alluvial gold, which means that it should be of rather pure quality. Both of these assumptions contradict the evidence at hand. If, on the other hand, the phrase *ša mā'ešu* is seen as a reference to the more general liquid state of a metal, then melted gold was possibly meant. When gold is put in fire and melted, base metals oxidise, leaving behind a gold-silver metal, with only traces of copper as an impurity. In case the original ore or metal contains a lot of silver, then this will not be affected by a simple melting process and the result will still be a gold-silver metal. This would be considered of low quality and value to the OA traders, who focused on purity. As a result, gold *ša mā'ešu* should be understood as gold that has been melted, i.e. cleaned by fire.

4.1.2 Silver artefacts

4.1.2.1 Egypt

The only available analyses of silver artefacts from Egypt have been published by Gale and Stos-Gale in 1981.[776] They performed XRF analysis on a series of objects from the Ashmolean Museum, dating from the Predynastic to the New Kingdom periods, separating them into silver and auriferous silver objects. Those that have been classified as auriferous silver have a higher than about 5 wt% gold content. **Appendix 7** lists the results of the analysed silver artefacts, including a sample from a series of silver leaf fragments published by Frantz and Schorsch.[777] This is Sample No. 65 and its analysis was performed on a cross-section of the object using a SEM-EDS. The chronologically oldest objects that are listed in the relative Appendix belong to the Middle Kingdom of Egypt (10th-12th Dynasties) and the youngest to the New Kingdom (18th Dynasty). In addition, there are two artefact samples from Ebla, Sample Nos. 81 and 82. The former dates to the MBA II period of Ebla (c. 1750-1700 BC), which is synchronous with the 12th Dynasty of Egypt.

During the first centuries of the 2nd millennium BC and until the time of the New Kingdom, silver was quite valuable in Egypt and was most probably imported from Anatolia, via its Canaanite neighbours.[778] The few silver artefact analyses that are available show a silver content ranging from c. 58 wt% to c. 96 wt%. Most samples contain between c. 85 wt% and c. 95 wt% silver, <10 wt% gold and <10 wt% copper (**Charts 34-39**).

[776] See also Lucas 1928.
[777] Frantz and Schorsch 1990.
[778] Stos-Ferner and Gale 1979, 312; Gale and Stos-Gale 1981, 104, 114.

As far as the silver content in silver artefacts of the Middle Kingdom is concerned, two distinct groups can be observed (**Chart 34**): one at about 60-65 wt% and one from 70 wt% silver and higher. The second group can be then separated in two subgroups: a) 70-80 wt% Ag and b) c. 85-95 wt% Ag. These groups correspond with the gold concentrations found in the silver objects from the Middle Kingdom in Egypt, the majority of which contain less than about 10 wt% gold and the minority between about 15% and 20 wt% gold (**Chart 35**). Interestingly enough, as varied as the silver and gold concentrations of the Middle Kingdom artefacts from Egypt may seem, they all belong to a whitish or white coloured alloy, most probably as indistinguishable as greenish-yellowish from green-yellow, or even green-yellow from yellow coloured gold alloys.

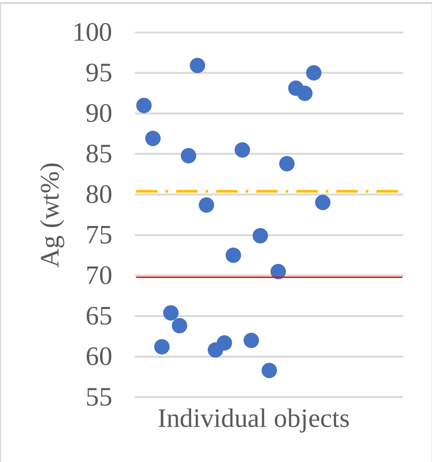

Chart 34. Silver content in Middle Kingdom silver objects.

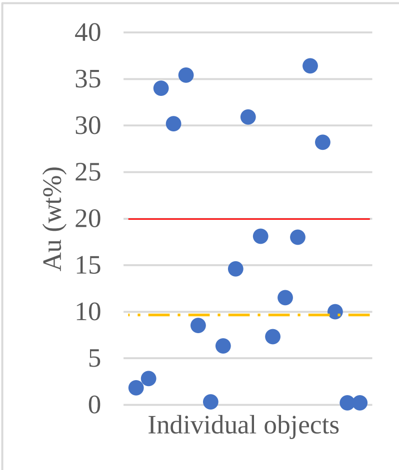

Chart 35. Gold content in Middle Kingdom silver objects.

As far as the SIP is concerned, there exists only a limited number of analysed artefacts and, as a result, they cannot be taken as representative of the period. Nevertheless, it is worth pointing out the higher silver content in the objects of this period than of the previous one, as well as the miniscule gold content (<1 wt% Au) and the rather low copper content (<3 wt% Cu) found in most objects. Sample Nos. 83, 85 and 86 are pure silver alloys. Sample No. 84 is formed by pure silver too, but with the addition of a significant amount of copper. Although the addition of around 10% of copper to pure silver does not have much effect on the alloy's colour and appearance, it does make it harder, i.e. able to withstand more elaborate working, and more resistant to corrosion.[779]

[779] Gale and Stos-Gale 1981, 114; Philip and Rehren 1996, 141-42; Rehren *et al*. 1996, 8. See also El Morr and Mödlinger 2014, 39-40.

Among the silver artefacts of the New Kingdom (c. 1539-1077 BC) there is also a sample published by Lilyquist[780] (Sample No. 88), analysed using SEM-EDS. Sample Nos. 89-90, despite some differences, have essentially the same composition. Moreover, the rings with a rectangular bezel from Lahun (Sample Nos. 92-93) have a very distinct composition, containing a rather significant amount of copper, which reaches 18 wt% Cu. The same kind of rings from Abydos (Sample Nos. 95-96) have a similar composition as well, but compared to the rings from Lahun they were constructed from high purity silver (approximately 95-96 wt% Ag), a little gold and a little copper. Another sample composed of high purity silver is sample No. 98, which is also a ring from Abydos, but with an openwork bezel. Most of the samples are grouped around 70-85 wt% Ag (**Chart 36**). Regarding the relative gold concentrations, a large group is formed in concentrations under about 11 wt% Au, while the rest of the samples are scattered around the plot area, forming three smaller groups: one at around 20 wt% Au, a second between 30 wt% and 35 wt% Au, and a third at about 43 wt% Au (**Chart 37**). Additionally, the vast majority of the New Kingdom silver objects contains less than c. 8 wt% Cu, which is approximately the same level of copper contained in silver objects of the Middle Kingdom (**Chart 39** compared with **Chart 38**).

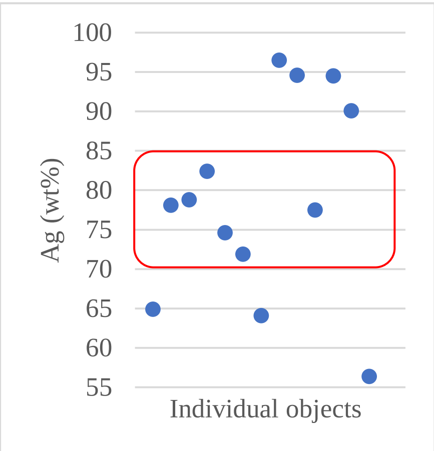

Chart 36. Silver content in New Kingdom silver artefacts.

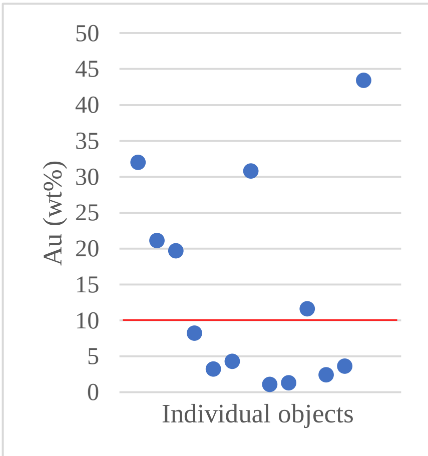

Chart 37. Gold content in New Kingdom silver artefacts.

The few silver objects from Egypt that have been analysed show that the imported silver has been arbitrarily and freely alloyed with gold from Egypt since an early time. Even the highest amounts of copper (about 25 wt% Cu in Sample Nos. 70 and 74 from the Middle Kingdom, **Chart 38**) observed would not have a major impact on the appearance of the object. This would still have had a silver-like, white to whitish colour. In order to change the colour

[780] Lilyquist 2003.

of silver enough gold must be added so that the silver content falls under the 50% level. From that point on, the alloy adopts a greenish-yellowish tinge, widely known in Egypt from gold alloy artefacts containing between 50-70% gold. The negative effect that the addition of gold has on the melting temperature of silver can be compensated for by the addition of copper, without any change in the resulting colour. In order to effectively change the colour of silver with the use of copper, an amount of more than 50% of this last metal has to be added. From around 25% of copper added to silver, and then on with increasing amounts of added metal, the alloy adopts a pale tinge that moves towards a reddish hue at approximately 50 wt% Cu (**Figure 10**). The purer a silver alloy is, the whiter it looks. However, in spite of the composition and gold or copper content, it is probable that any white or whitish-silverish alloy would be indistinguishable from another, provided of course that the silver content does not fall below a certain percentage.[781]

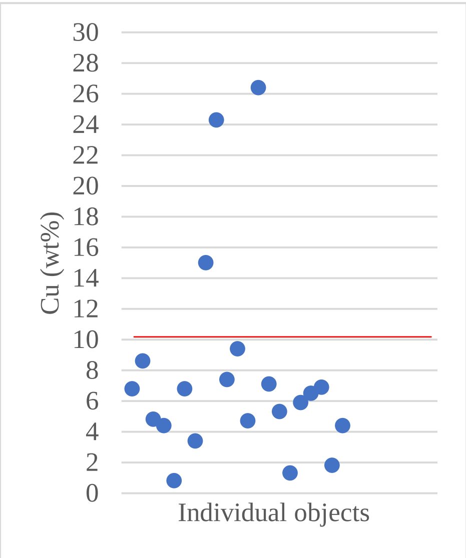

Chart 38. Copper content in Middle Kingdom silver objects.

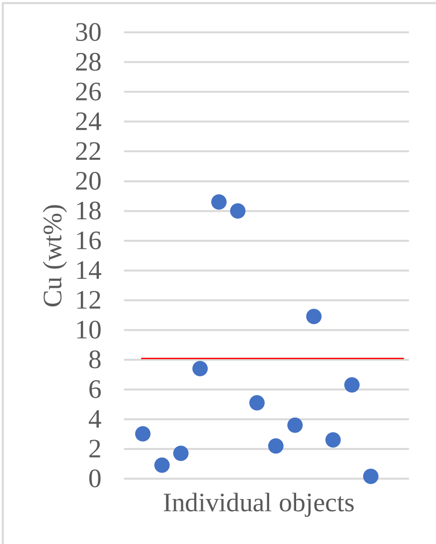

Chart 39. Copper content in New Kingdom silver objects.

Furthermore, Gale and Stos-Gale[782] write that

> *On present evidence silver derived from argentiferous galena will be characterized by gold contents from essentially zero up to about 0.5 per cent, lead contents between 0.05 per cent, and 2.5 per cent, copper contents less than 0.5 per cent, and bismuth contents generally between 0.01 and 1 per cent (rarely somewhat higher).*

This lead concentration only characterises and does not prove a silver derivation from argentiferous galena.[783] As it can be seen in **Chart 40**, most of the silver samples contain less

[781] Philip and Rehren 1996, 142; Rehren *et al*. 1996, 7-8; Palmieri and Hauptmann 2000, 1265.
[782] Gale and Stos-Gale 1981, 107. See also Moorey 1994, 233.
[783] Gale and Stos-Gale 1981, 107.

than 2 wt% Pb, which means that they could have been produced by the cupellation of argentiferous galena. Nevertheless, there are two objects containing more than 3 wt% Pb. These are Sample Nos. 92 and 93, which also contain more than 18 wt% copper, some gold and about 72-75 wt% silver (**Table 18**). It definitely cannot be asserted, nor yet excluded, that this higher concentration of lead came from the (also high amount of) copper, as there are samples which contain even more copper and they still have a lower than 1 wt% lead content (see Sample Nos. 70 and 74, as well as 84 and 97).[784] Even so, they do seem to have been created to a specific composition, one which is found only in these two rectangular bezel rings and in no other ring or jewel from the Tomb of Maket in Lahun.

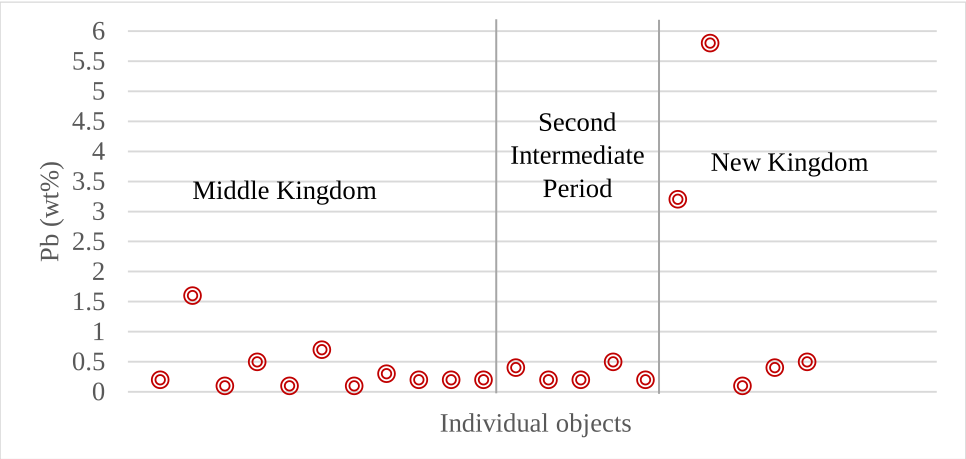

Chart 40. Lead content in silver samples.

Table 18. Lead content in silver samples.

Sample No.	Period	Ag wt%	Au wt%	Cu wt%	Pb wt%
62	Middle Kingdom	91.0	1.8	6.8	0.2
63	Middle Kingdom	86.9	2.8	8.6	1.6
67	Middle Kingdom	84.8	8.5	6.8	0.1
68	Middle Kingdom	95.9	0.3	3.4	0.5

[784] See also Cowell and Hyne 2000, 172, n. 32.

70	Middle Kingdom	60.8	14.6	24.3	0.1
73	Middle Kingdom	85.5	7.3	4.7	0.7
74	Middle Kingdom	62.0	11.5	26.4	0.1
78	Middle Kingdom	83.8	10.0	5.9	0.3
79	Middle Kingdom	93.1	0.2	6.5	0.2
80	Middle Kingdom	92.5	0.2	6.9	0.2
81	MBA II, Ebla	95.0	–	1.8	0.2
82	undated, Ebla	79.0 (?)	–	4.4	0.4
83	SIP	97.0	0.6	2.2	0.2
84	SIP	88.8	0.4	10.7	0.2
85	SIP	96.8	n.d.	2.7	0.5
86	SIP	96.5	0.3	2.9	0.2
92	New Kingdom	74.6	3.2	18.6	3.2
93	New Kingdom	71.9	4.3	18.0	5.8
95	New Kingdom	96.5	1.1	2.2	0.1
96	New Kingdom	94.6	1.3	3.6	0.4
98	New Kingdom	94.5	2.4	2.6	0.5

4.1.2.1.1 Pure/refined silver and the source of Egyptian silver

Through the millennia from Sargon I in the OA period to Pliny the Elder in the 3rd century AD, the Taurus Mountains were known as the “Silver Mountain”, providing silver to a range of lands from East to West and from North to South.[785] Though galena deposits exist in the Eastern Desert of Egypt, it is believed that they have not been used for the production of silver. Additionally, lead isotopic analysis of Egyptian artefacts does not match with the isotopic composition of these Egyptian sources. Thus, it has been suggested that Egypt imported its silver from somewhere else, a very prominent candidate being Anatolia via Syria.[786] This may have been the earliest source of silver for Egypt, but in the LBA of long-distance trade and trade-relations, when men from Crete (*Keftiu*) appear on the walls of Theban tombs carrying gifts of silver, Lavrion has appeared as another possible source for this metal.[787] Predynastic, Middle and New Kingdom Egyptian silver and lead artefacts, analysed by Stos-

[785] Forbes 1950, 190-91; 1971, 216-20; Moorey 1994, 235; Yener 2015, 3.
[786] Stos-Fertner and Gale 1979; Stos-Gale and Gale 1981. See also El Morr and Mödlinger 2014, 40.
[787] Forbes 1971, 212; Wachsmann 1987, 53; Stos-Gale *et al*. 1995, 127; Gill 2010, 25-30.

Fertner and Gale in 1979,[788] showed that three 18th Dynasty lead artefacts (two from Amarna and one from Abydos) fall inside the Lavrion field (**Charts 41-43**). It is worth pointing out that most of the Middle Kingdom and the sole Predynastic artefacts fall outside this aforementioned field. Moreover, a silver ingot from Amarna (No. 1925.568), analysed by Stos-Gale *et al*. in 1995,[789] was also found to lie inside the Lavrion field. Additionally, this specific artefact matches exactly with a Taurus 2B compatible artefact (No. AAN298), analysed and published by Yener *et al*.[790] The latter is a 3rd millennium BC silver headband found in Karataş, located in southwestern (SW) Anatolia just north of Kaş/Antalya (**Figure 1**).[791] Three more Middle Kingdom silver artefacts from Abydos (Nos. 1966.1066, E3293 and E3294) have isotopic compositions that fall in the near vicinity of Taurus 2A and one more (No. E2314) of Taurus 1B field.[792]

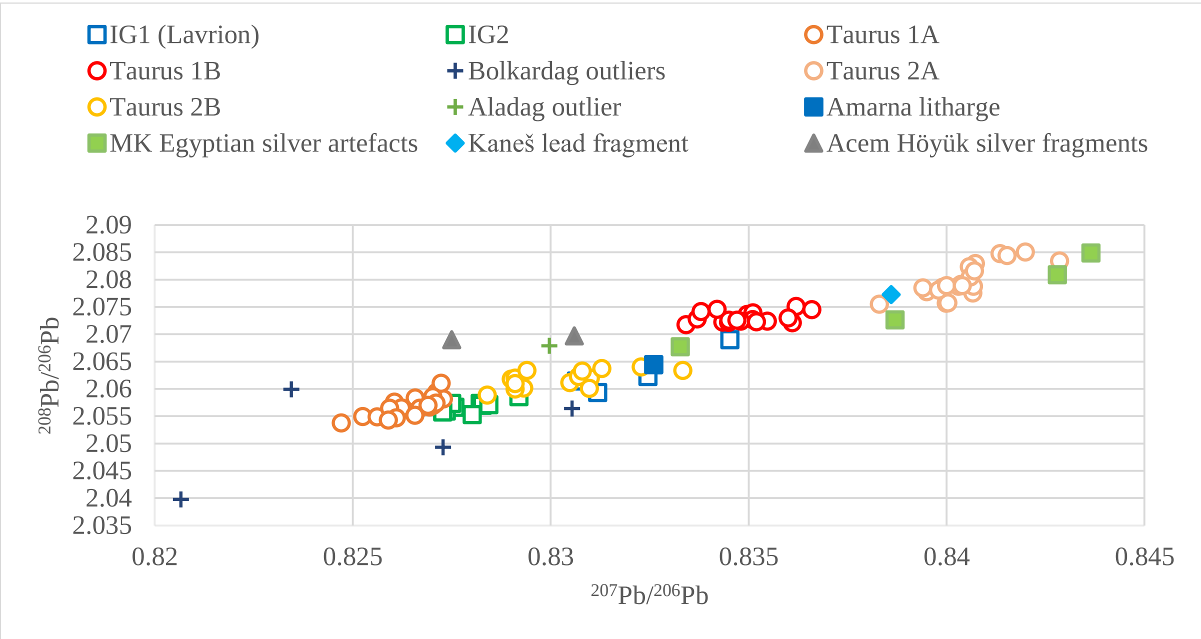

Chart 41. $^{207}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ lead isotope diagram.

[788] Stos-Fertner and Gale 1979, 311-12, fig. 9.
[789] Stos-Gale *et al*. 1995, 130, fig. 1.
[790] Yener *et al*. 1991, 561 table 2.
[791] Yener *et al*. 1991, 558.
[792] OXALID, "Near East artefacts (lead isotope and chemical data)".

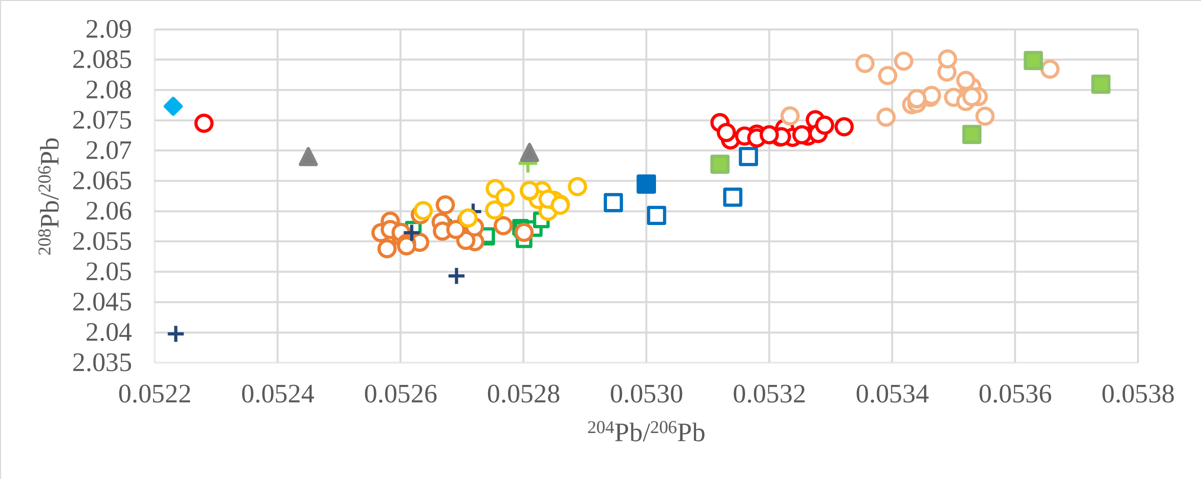

Chart 42. $^{204}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ lead isotope diagram.

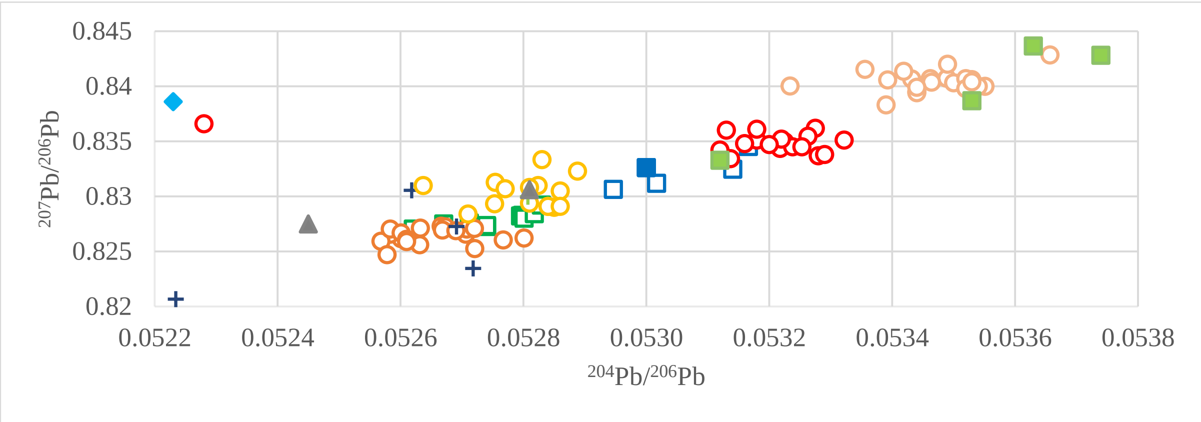

Chart 43. $^{204}Pb/^{206}Pb$ vs. $^{207}Pb/^{206}Pb$ lead isotope diagram.

Based on the increased demand for silver during the LBA, it is very probable that Egypt, as any other kingdom of the Near East, did not obtain silver from just one source. Hence, metals from Lavrion, as well as silver from the Taurus Mountains, would have reached and would have been used in Egypt. It is believed that the gold content in silver derived from argentiferous galena would not exceed the 0.5 wt% level, while the oxidised ores, such as cerussite, contain much more gold.[793] It is, however, unknown, or unspecified, where exactly does the higher limit of the gold content of these oxidised ores, or of the silver derived from them, lie. The Bolkardağ and Aladağ deposits contain between 1-100 ppm gold and Early Bronze Age (EBA) (c. 3000-2000 BC) silver ingots from Mahmatlar in southern Anatolia contain ≤0.268 wt% Au.[794] In general, objects from Anatolia and Mesopotamia have gold concentrations below 1 wt%, or even lower than 0.6 wt%, and from the Levant below 2 wt%, or even lower than 0.1

[793] Gale and Stos-Gale 1981, 107; Craddock 2014, 1085.
[794] Yener *et al*. 1991, 545, table 3.

wt% gold. Meanwhile, Aegean artefacts have an average gold content far below 1 wt%.[795] Correspondingly, the above-mentioned silver ingot from Amarna (No. 1925.568) comprises 96% silver with 0.57% gold and its exact isotopic match, compatible with Taurus 2B, is the silver head band from Karataş (No. AAN298) that contains 74.4 wt% silver with 0.0693 wt% gold. In contrast, the here-listed samples from the Middle Kingdom of Egypt contain an average of approximately 15 wt% gold and those from the New Kingdom a similar average of about 14 wt%.

The persistent problem with Egyptian silver is whether or not it was obtained from a local silver-rich deposit. It is a fact that rich silver ores containing gold are found only in young subvolcanic gold-silver veins. However, this type of vein does not occur in Egypt and its surrounding areas.[796] An alternative would be the procurement of silver from an outside source, as for instance Anatolia, and its mixture with local gold.[797] There are many Egyptian silver artefacts, listed in this research, which have a gold content (much) lower than 10 wt% and an accordingly low copper content. Simultaneously, there are as many silver artefacts with a rather, or even very, high gold content (reaching the 40% level). However, adding 20% or even 30% of gold to silver would not change the colour of the silver alloy. Nevertheless, at about 40% gold content the silver would start to take on the very well-known colour of electrum (**Figure 10**).[798] From the 39 silver samples listed here, only nine exceed the 30% gold level and most of them are dated to the Middle Kingdom of Egypt.[799] The majority of the silver artefacts contains only 14-15% gold. This percentage puts these alloys right inside the silver-whitish colour area of the Au-Ag-Cu colour diagram seen in **Figure 10**. Moreover, almost all objects have a lead content at, or below, 0.5 wt%, which could be interpreted as silver coming from cupelled argentiferous lead.[800] Being unable to determine the possible range of gold in a silver object derived from the cupellation of argentiferous cerussite, we cannot propose that silver coming from this type of ore, instead of argentiferous galena, was used for Egyptian silver artefacts of a specific composition. It is, however, quite feasible that some gold, and/or copper, was added to the imported silver to produce a still silver-looking object.

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[795] Rehren *et al*. 1996, 6.
[796] Lucas and Harris 1962, 245-46; Rehren *et al*. 1996, 6-7.
[797] See Gale and Stos-Gale 1981, 114; Rehren *et al*. 1996, 7.
[798] See also Rehren *et al*. 1996, 7-8.
[799] Sample Nos. 64, 65, 66, 71, 76 from Middle Kingdom, Sample No. 87 from the SIP and Sample Nos. 88, 94 and 100 from the New Kingdom.
[800] Gale and Stos-Gale (1981, 107) noted that an "*important characteristic of silver obtained by cupellation is that it will contain from 0.05 to 2.5 percent of lead*".

Considering that silver was rare in Egypt, in comparison to gold which was plentiful, it would be logical to infer that this imported white-coloured metal, called silver, would be a strong candidate for the practice of alloying. By alloying silver with silver-containing, not yellow-coloured, gold, an artefact with the same whitish hue would be produced. Aside from the fact that the lead isotope composition of the Egyptian silver artefacts does not match that of the argentiferous sources in Egypt, further support to the claim that silver was imported into Egypt can be provided both by the fact that we find silver artefacts made from rather pure silver (**Appendix 7**) and by the silver ingot found in Amarna, which contains less than 0.6 wt% gold and was found to fall inside the Lavrion isotopic field.[801] Stos-Gale and Gale[802] showed that the argentiferous galena deposits in Egypt were poor in silver and surmised that the Egyptians would have understood that it was not possible to produce silver from these galena sources. It is also noteworthy that the earliest Egyptian word for silver is "white gold". This implies that they did not initially recognise silver as a different metal but saw it as a different-coloured gold, which also means that they did not produce it themselves, otherwise they would have had a name for it and not a specification dependent on another metal.

Therefore, the conclusion is that Egypt was always in need of good refined silver. This was also the means of payment in the Amarna period and that is exactly what the king of Alašiya asks as payment for the lumber that he sends to Egypt. What is more, Amenhotep IV sends five somewhat large silver artefacts to King Burna-Buriaš II of Babylonia: "1 box of pure silver", "3 b[eds of pure silver?]; 1 headre[st], of pure silver".[803] These objects require a considerable amount of "pure" silver, which in all probability was imported to Egypt, and thus very precious.

4.1.2.2 Anatolia

Lacking chemical analyses on silver artefacts from a Near Eastern area other than Egypt, we have to rely on the lead isotope analysis results performed on some silver samples published by Yener[804] and the information they provide regarding the possible sources of silver. From these samples, of interest are a) a fragment of silver foil detected in the grooves of an

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801 Stos-Fertner and Gale 1979, 310-13, figs. 8-9; Stos-Gale *et al*. 1995, 130, fig. 1. See also Yener (2015, 4), who referred to a silver sample containing 1918 ppm gold, i.e. about 0.2%, as "quite pure".
802 Stos-Gale and Gale 1981, 286-94.
803 EA 14 (II line 57): 1 *tup-ni-nu ša* KÙ.BABBAR *za-ki-i*. EA 14 (II line 63): 3 GIŠ.[NÁ KÙ.BABBAR *za-ku-ú*] 1 *ša re-*˹*e*˺*-š*]*i* KÙ.BABBAR *za-ku-ú*.
804 Yener 2007; 2015.

ivory object from Alalakh, dated to the early 16th century BC, b) a silver bracelet from Grave 20 in Aššur, dated to the 19th-18th centuries BC, and c) a sample taken from a silver hoard of 210 pieces from the Sarıkaya palace at Acem Höyük, dated to the MBA.[805] According to the analytical results, the source of the silver for all of these objects can be found in the Taurus Mountains and particularly for the last two in the Aladağ mines (Taurus 2A, **Figure 24)**.[806] Moreover, the sample from the silver hoard was found to be of "*quite pure*" silver (71.8% Ag) with lead falling below the detection limit and gold reaching as high as 1918 ppm. According to Yener,[807] these results suggest an origin from native or very well refined silver. Many of the Central Taurus ores are rich in lead (10-30% Pb), also containing high levels of iron (often up to 40%), zinc (often up to 6-8%) and arsenic, and sometimes copper up to 1.5%, cobalt up to 3.3% and tin up to 1.5%.[808]

Apart from the Taurus Mountains' polymetallic deposits, other possible sources of silver for the OA trade network are located in northern and NW Central and NE Anatolia (**Figure 25**). As far as the northern Central and NE Anatolia is concerned, there are two important silver deposits in the Pontic Zone, namely Gümüş and Gümüşhane.[809] In NW Central Anatolia, there is a very important silver source located at Gümüşköy, west of Ankara and west of the assumed Purušhattum-Šalatuwar area.[810] After all, it is no chance that the Turkish word for silver is *gümüş*. All of the above-mentioned deposits contain galena, which in Gümüş is very rich in silver (up to 0.4%). Moreover, Gümüşhane contains the secondary argentiferous lead ore called cerussite, while in Gümüşköy pyrargyrite (Ag_3SbS_3), proustite (Ag_3AsS_3) and native silver can also be found.[811]

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805 For the silver foil fragment, see Yener 2007, 153-57; for the silver bracelet and the silver hoard, see Yener 2015, 2-4. Barjamovic (2011, 408-11) has identified the site of Acem Höyük with the ancient city of Ulama, mentioned in the OA texts. Acem Höyük lies north of the Central Taurus Mountains and southeast of Lake Tuz (Tuz Gölü) (**Figure 1**).
806 Yener 2015, 2-4. See also Yener *et al*. 1991.
807 Yener 2015, 4.
808 Yener *et al*. 1991, 546, 576-77.
809 TG 165 and TG 171 (Seelinger *et al*. 1985, 606-12, 616-18, fig. 1) (**Figure 38**).
810 TG 155 (Pernicka *et al*. 1984, 567, fig. 1) (**Figure 38**).
811 Pernicka *et al*. 1984, 567; Seelinger *et al*. 1985, 606-12, 616-18.

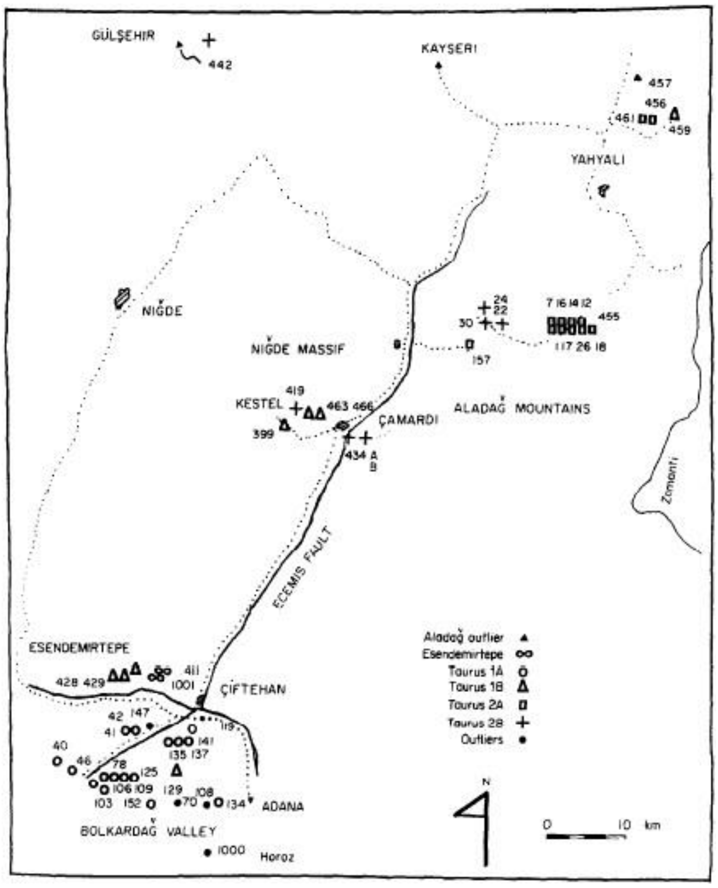

Figure 24. Geological specimen location map of the Central Taurus (Yener *et al*. 1991, fig. 2).

Figure 25. Locations of silver deposits in Central and NE Anatolia.

4.1.2.2.1 Refined silver

All of the above-mentioned ores contain one or more chemical elements that can be separated from silver by cupellation.[812] During this process, the lead (either contained in the ore or added to the mix) was heated in a strong oxidising environment at c. 1100°C, forming oxide compounds that can be absorbed by the cupel. In this way, the silver is left behind, refined by the loss of any base metal. In order to completely free silver from all impurities, though, more than one cycle of cupellation is needed. It is generally believed that argentiferous galena was the primary source of silver for the ancient world. This is most probably right for the Lavrion deposits in Attica, Greece. As far as Anatolia is concerned, it has been suggested that the secondary lead carbonate ores, found nearer to the surface than the primary lead sulphide ores, would be mostly used.[813] Cerussite (PbCO3) may be more difficult to find than galena (PbS), but it is more rewarding in the production of silver.[814]

4.2 Bronze

Broadly speaking, bronze is an alloy consisting predominantly of copper. The primary alloying elements used during the 2nd millennium BC are arsenic and tin. In order to avoid misinterpretations, the use of the term “bronze” will be limited to the copper-tin alloy and not to copper with the addition of arsenic, which will be better expressed by the term “arsenical copper”. From the mid-4th and until the mid-3rd millennium BC, arsenical copper was the preferred alloy in the Near East and Eastern Mediterranean. From 2500 BC onwards, tin started to slowly but steadily appear on the scene and become an important alloying element of copper, without ever fully superseding arsenic.[815]

A still unsolved problem is the definition of a lower limit for an intentionally produced alloy of copper with arsenic or tin. Many scholars put the lowest limit of added arsenic indicative of intentionally produced alloy at above 0.5 wt% As.[816] Regarding tin, the limit has been put at 0.5, 1 or even 2-3 wt%.[817] Hence, there is obviously no way of precisely differentiating between what is copper with impurities, what is an intentionally produced

[812] Tylecote 1980, 205-7; Moorey 1994, 233; Craddock 1995, 221-23; Dercksen 2005, 21, 23.
[813] Moorey 1994, 233; Skarpelis 2007, 245; Craddock 2014, 1085.
[814] Moorey 1994, 233.
[815] Eaton and McKerrel 1976; Maddin *et al*. 1977, 42; Gale *et al*. 1985; Moorey 1985, 15-20; 1994, 250-53; Muhly 2006, 163-74; Boscher 2016, 26-7. See also Lehner *et al*. 2015, 207-8.
[816] Charles 1967, 25; Lechtman 1996, 481. See also Moorey 1994, 242; cf. Eaton and McKerrell 1976, 169-70.
[817] Cleuziou and Berthoud 1982, 15; Moorey 1994, 242, 251; Lehner *et al*. 2015, 195.

arsenical copper or copper-tin alloy, and what is an in fact recycled copper artefact. For that reason, all copper-based objects will be examined together in this section.

Without wanting to define a lower limit of intentionally produced arsenic copper or bronze, for the purposes of this research a copper-based artefact containing <1 wt% tin or arsenic will be recognised as pure copper, a concentration of 1-2 wt% arsenic with below 1 wt% tin will be defining a low arsenical copper, any object containing more than 2 wt% arsenic will be characterised as arsenical copper and artefacts with more than c. 2 wt% tin will be recognised as bronze.

4.2.1 Anatolia (Middle Bronze Age I / Old Assyrian period)

Contrary to the paucity of gold and silver artefacts, the list of copper-based objects excavated and analysed from the site of Kaneš is rather extensive. In 1969, Esin published the spectral analysis of 85 bronze artefacts from this site, which many researchers have since then built upon. In **Appendix 8** only those objects which date to levels II and I of the MBA (Sample Nos. 101-160) are included. More recently, in 2012, Ercanlı published the analysis of 33 artefacts stored in the AMM at Ankara, performed with pXRF (Sample Nos. 161-193), and of 32 fragments from artefacts recovered in the excavations in Kaneš, performed with SEM-EDS (Sample Nos. 194-225).[818] In 2015, Lehner *et al*. presented the analysis of a further 28 objects from the same site, all dating to *kārum* Ib period, also performed with a pXRF (Sample Nos. 226-253). The results of the analyses are presented in **Appendix 8**. Ercanlı's analysis was performed on multiple points of each object from the AMM. These points are specified on figures 4.1-4.33 of his dissertation and correspond to letters *a* through *d* accompanying the Sample Nos. as given here.

The analytical results presented in this research have generated certain general conclusions regarding the metals used in combination with copper. First, pure copper that contains less than about 1 wt% Sn and/or less than about 1 wt% As, also contains less than about 0.5 wt% Fe. Second, with the arsenic content rising higher than c. 1-1.5 wt%, the iron content rises as well from around 0.5 wt% to about 2-2.5 wt%. On the other hand, with concentrations of iron higher than c. 1 wt%, the tin contained in the alloy is usually undetectable. Third, objects containing more than c. 4 wt% Sn do not contain more than c. 2-2.5 wt% As, or more than c. 1 wt% Fe. These conclusions can also be observed in **Chart 44**.

[818] See also Ercanlı 2015.

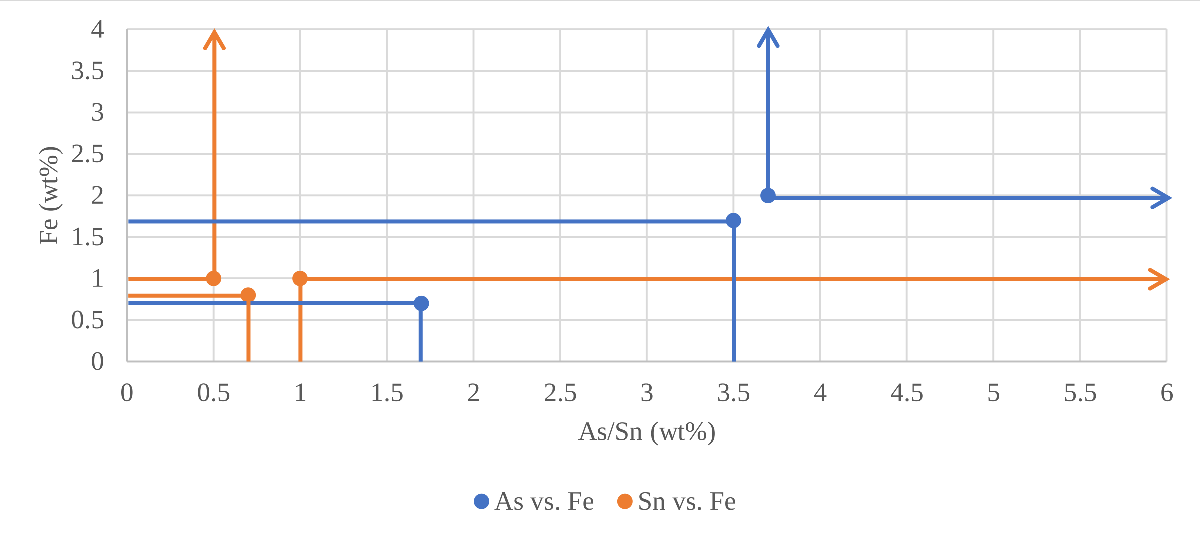

Chart 44. As and Sn vs. Fe concentrations in Kaneš copper-based artefacts.

From the analysed artefacts, there are more than a few that consist of 1-1.7 wt% As with less than c. 0.7 wt% Sn. The analysed ingots from Acem Höyük and the wrapped bars found in Kaneš, which will be further discussed below, contain up to c. 1.5 wt% As with <0.5 wt% Sn. Therefore, it can be surmised that such unrefined copper ingots may have been used for the manufacture of artefacts that show a similar composition. Furthermore, it has been observed that an addition of up to 2 wt% As does not offer much improvement over pure copper. From that percentage onwards, however, there is a proven noticeable increase in hardness. It is also worth mentioning that arsenical copper containing 5 wt% As has a tensile response just below that of a bronze containing 7 wt% Sn, and again an arsenical copper comprising 7 wt% As has the tensile equivalence to a bronze of 10 wt% Sn.[819] From these observations we can realise that pure copper was in circulation and that tin was preferably alloyed with rather pure copper, low in iron and arsenic content.

To these remarks there are, of course, some exceptions and a few noteworthy objects. There are a number of artefacts which are made of pure copper with the addition of c. 1-2 wt% Fe (a rivetted dagger: Sample No. 176, a ring: Sample No. 183, and two pins: Sample Nos. 221 and 243) and in one case of c. 2-3 wt% Fe (the small animal sculpture's legs: Sample Nos.

[819] Moorey 1994, 250; Lechtman 1996, 503; Boscher 2016, 42. According to Lechtman (1996, 197-98) "*Tensile testing is valuable because it provides a reliable measure not only of the strength of a material when subject to stress in tension, but also of the ductility of the material. Ductility refers to the extent to which a metal can be deformed without fracture, that is, the ability of the metal to flow plastically before fracture. A high ductility indicates that a material is 'forgiving' and likely to deform locally without cracking even under severe loads. Tensile ductility is thus a useful measure in the assessment of the quality of a metal or alloy*."

193b, 193c). These artefacts must have been overly brittle due to their high iron content.[820] The so-called "fired tube" (Sample No. 192) is an exceptional object. One sample (Sample No. 192a) was taken from the outside of the tube, while the second (Sample No. 192b) from the dross on the interior.[821] The sample from the outer surface seems to be of relatively pure copper, with about 1.6 wt% As. The dross of the inner side, however, shows a mixture of copper with c. 3 wt% Pb and about 8.2 wt% Fe. This is the only sample that contains such a high amount of iron. What is more, there are certain types of artefacts which may include examples of arsenical copper containing less than 0.5 wt% Fe. These are a spearhead (Sample No. 167) and two chisels (Sample Nos. 179, 196). Additionally, there is a notable case of a dagger (Sample No. 178) made of pure copper (no tin existent), whose blade (Sample No. 178a-b) contains arsenic in the 0.7 wt% level, iron at c. 0.5 wt% and c. 0.8 wt% respectively, and lead at 0.3 wt% and 2.65 wt% near the handle correspondingly. The handle-part of the blade (Sample No. 178c) contains no arsenic, 2 wt% Fe and 41 wt% Pb. Such a high lead content has not been noted in any other object analysed up until now.

Çukur and Kunç[822] published the analyses of a number of copper ingots found at the site of Acem Höyük (**Figure 26**), dating to the 20th-18th centuries BC. Their analytical results are presented in **Appendix 8**. The varying weight percentages of copper are due to heavy corrosion and the results presented in the Appendix are in wt% instead of ppm, as in the original publication.[823] The ingots are composed of "*fairly pure*" copper with less than 0.5 wt% Sn and As, except from an ingot (No. 15) that contains 1.25 wt% As and is interpreted as an indication that arsenic copper ore was used for its production.[824] What is more, these ingots most often contain less than 0.3 wt% Fe. However, there are three ingots composed of c. 0.7-1.1 wt% Fe (Nos. 13, 10 and 41) and one (No. 30) with 1.85 wt% Fe. The conclusion drawn by the authors was that the ingots were brought to this commercial centre as blister copper and transformed into artefacts without refining.[825] Based on the analysis of Sayre *et al*.[826] on various copper samples from this site, these ingots may have also come from Central Tauride or Central Anatolian deposits (**Figure 26**).

[820] See Boscher 2016, 303.
[821] Ercanlı 2012, fig. 4.32.
[822] Çukur and Kunç 1990.
[823] Çukur and Kunç 1990, 35, table 1.
[824] Çukur and Kunç 1990, 35.
[825] Çukur and Kunç 1990, 34; Dercksen 1996, 27, 29.
[826] Sayre *et al*. 2001, 110 table 9: samples AAN842, AAN843, AAN17095 and AAN17096; Lehner 2015, 76 fig. 76.

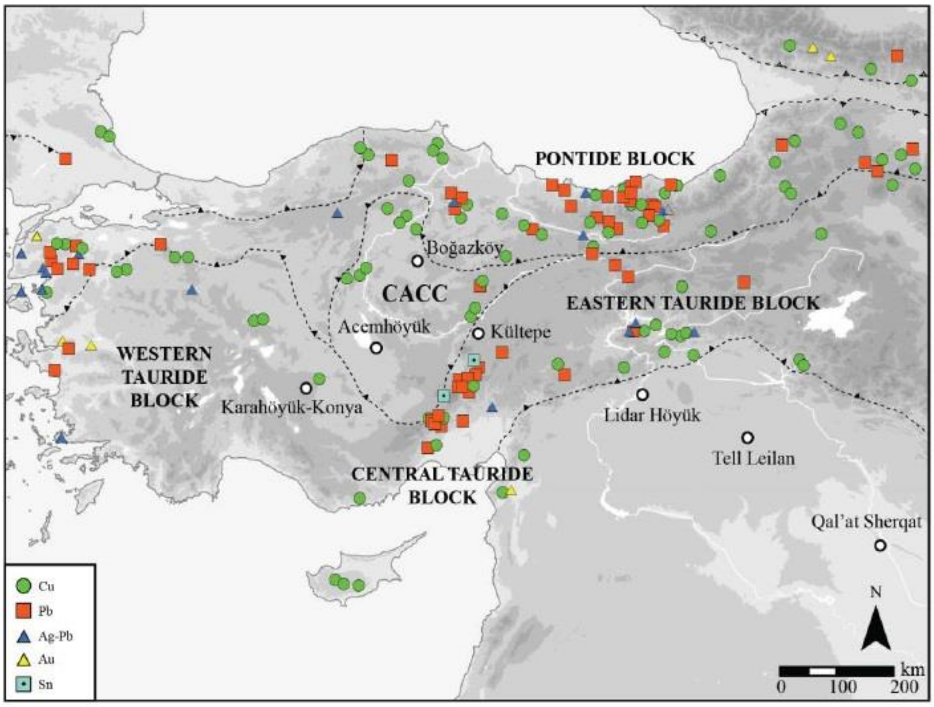

Figure 26. Distribution of known Anatolian metal-bearing regions (Lehner 2015, fig. 2.1).

Apart from the well-known form of an ingot (oblong or disc-shaped) as a fitting shape for the transportation and easy handling of metals, copper – as was also gold and silver – seems to have been transported and exchanged in other forms, too. Gold and silver were regularly traded and offered in ingots, bars or rods, rings and coils.[827] Copper was also handled in bars, ingots, torcs, sickles, or in the shape of rings, wrapped bars, coiled wires and anklets.[828] Lehner *et al*.[829] performed a pXRF analysis on seven wrapped bars (Sample Nos. 244-250) and three wire rings (Sample Nos. 251-253), that proved to have a very similar composition to that of the Acem Höyük ingots (**Charts 45-47**). Two of the wrapped bars (Sample Nos. 247 and 248) and two of the wire rings (Sample Nos. 251 and 252) are of 100% pure copper, while the third wire ring (Sample No. 253) contains c. 0.1 wt% Sn, c. 0.1 wt% As and c. 0.3 wt% Fe. Nevertheless, this too is considered to be of pure copper. Three of the wrapped bars (Sample Nos. 244-246) are of low arsenical copper, containing c. 1.1-1.6 wt% As, 0-0.3 wt% Sn and c. 0.8-1.2 wt% Fe. Furthermore, there are two wrapped bars which are of a rather perplexing composition. They are Sample Nos. 249 and 250 and they contain 2.5 wt% and 4.7 wt% Sn, about 3.3 wt%

[827] Powell 1996, 236, 238; Peyronel 2010, 931; Gestoso Singer 2013, 249; 2015, 89, 91. See also: Forbes 1950, 185; Klemm and Klemm 2013, 23; Gestoso Singer 2015, 105-6.
[828] Dercksen 2005, 57-9; 2010, 111.
[829] Lehner *et al*. 2015.

and 3.2 wt% As, c. 0.9 wt% and 1.4 wt% Fe and approximately 1.1 wt% and 2.1 wt% Pb, respectively.

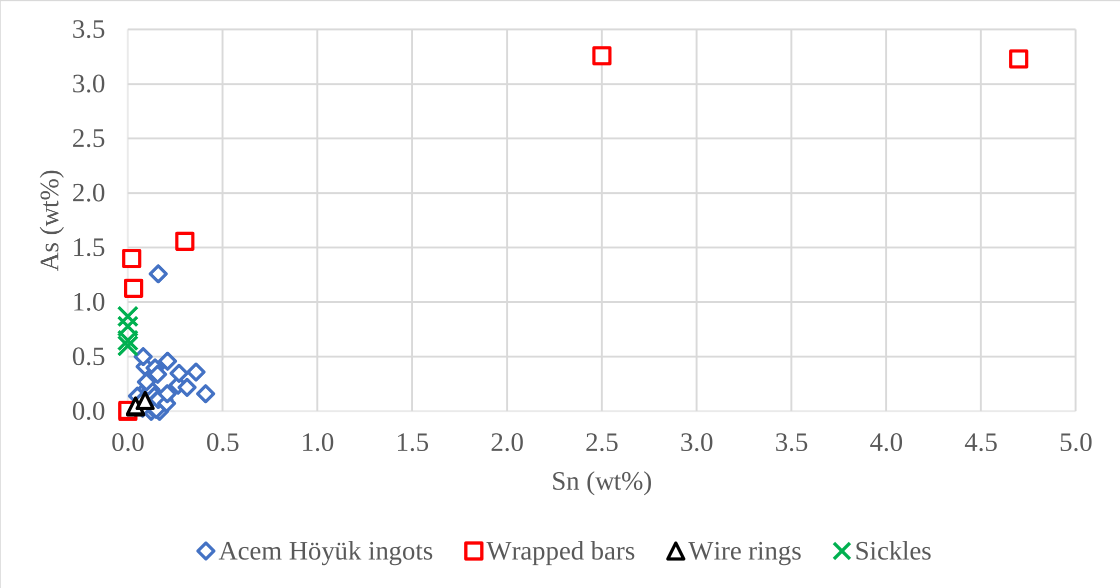

Chart 45. Comparison of tin and arsenic concentrations in the Acem Höyük ingots and wrapped bars, wire rings and sickles from Kaneš.

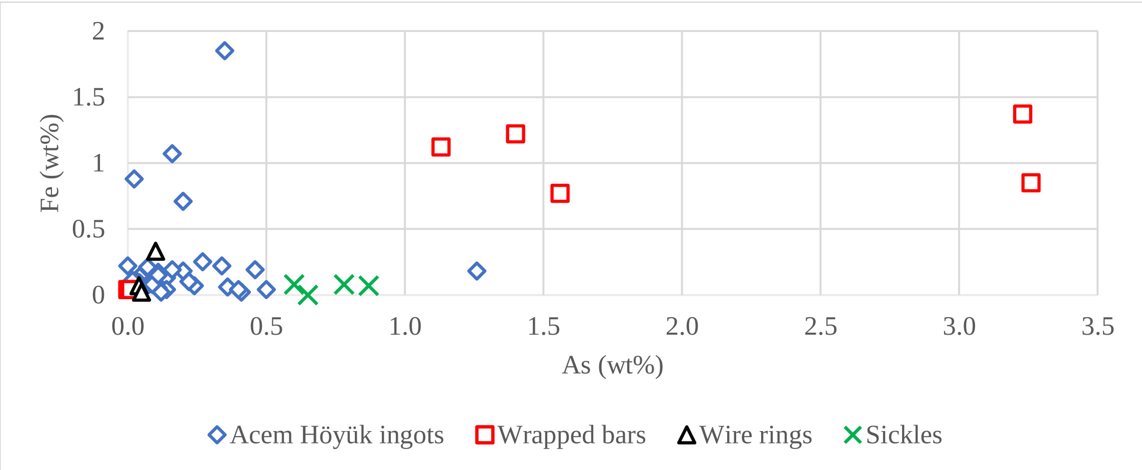

Chart 46. Comparison of arsenic and iron concentrations in the Acem Höyük ingots and wrapped bars, wire rings and sickles from Kaneš.

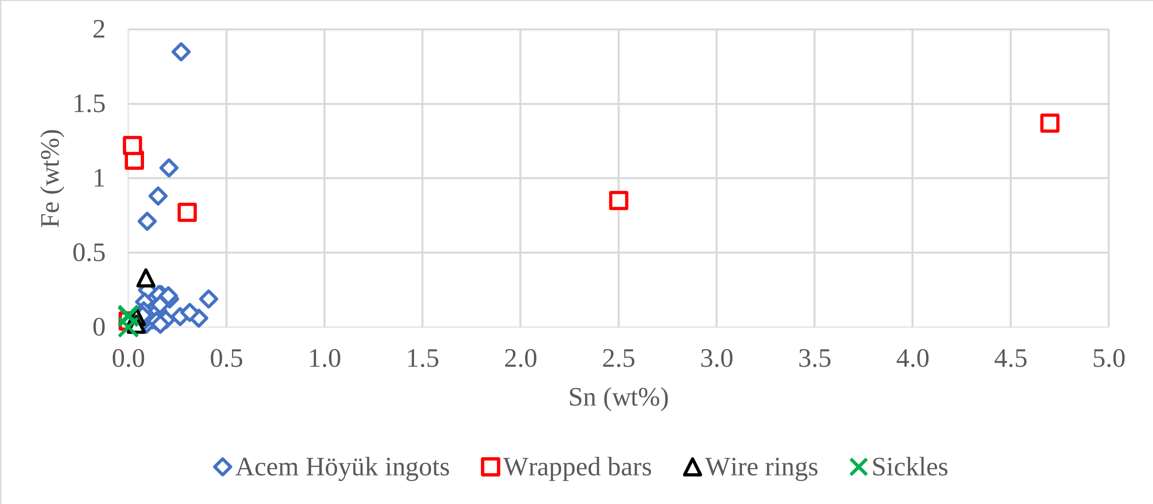

Chart 47. Comparison of tin and iron concentrations in the Acem Höyük ingots and wrapped bars, wire rings and sickles from Kaneš.

It must always be kept in mind that measurements taken with pXRF offer only semi-quantitative results, due to corrosion. Even surfaces that are cleaner from corrosion products can still present deceptive results and enhanced levels of elements such as tin, nickel and iron. What is more, higher iron percentages could also be a sign of contamination from the surrounding soil of their contexts.[830]

As far as copper deposits are concerned (**Figures 38-39**), northwest of where the town of Durhumit is believed to have been there is the Küre deposit (TG 162), which consists of pyrite (FeS_2), chalcopyrite ($CuFeS_2$), bornite (Cu_5FeS_4), chalcocite (Cu_2S), covellite (CuS), digenite (Cu_9S_5), sphalerite ((Zn,Fe)S), marcasite (FeS_2), tennantite ($(Cu,Ag,Zn,Fe)_{12}As_4S_{13}$) and some galena (PbS).[831] East of the same area there is another polymetallic, sulphide copper deposit, located in Tirebolu (TG 170), known as *Argyria*. It consists of pyrite, sphalerite, galena, chalcopyrite, bornite, tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$), bournonite ($PbCuSbS_3$), chalcocite, covellite, realgar, limonite ($FeO(OH){\cdot}nH_2O$), cerussite and secondary copper minerals (e.g. malachite etc.).[832] Moreover, there is the Gümüşhane deposit (TG 171), also known as *Argyropolis*, which is the most important lead-silver deposit of the eastern Pontic Zone, but also containing sulphide copper minerals like Tirebolu[833] and many more similar deposits in that area.[834] Another important deposit just east of the proposed location for

830 See Zimmermann *et al*. 2010, 227-28; Lehner 2014a, 134-35.
831 Seelinger *et al*. 1985, 603-5; Wagner and Öztunalı 2000, 40-1.
832 Seelinger *et al*. 1985, 614-16; Wagner and Öztunalı 2000, 42-3.
833 Seelinger *et al*. 1985, 616-18; Wagner and Öztunalı 2000, 43.
834 Seelinger *et al*. 1985, 618-20; Wagner and Öztunalı 2000, 44-5. See also Wagner and Öztunalı 2000, 46-8.

Durhumit is the Kozlu copper deposit (TG 275) consisting of sulphidic and secondary copper minerals.[835] In addition, southeast of this area, there are three more copper deposits: Madenköy (TG 276), Camili (TG 178) and Gölcük (TG 279), the last two of which must have been exploited for oxidic copper ores.[836] All of these sulphide copper deposits contained also iron, which is the main impurity in copper and the one that gives raw copper its characteristic black colour. Copper containing 1-5% Fe would have been very brittle and would have had inferior physical properties in comparison to those of pure copper. Thus, iron would have to be removed from the copper through refinement.[837]

A very puzzling subject and an important question is how tin in very low percentages got into copper in Anatolia, where, according to the Kaneš tablets, tin was being imported into Anatolia by Assyrian merchants and in its metallic form. Since it seems pointless for a smith to have added tin metal to copper in such a low percentage, the logical conclusion would be that the tin came either from using recycled copper which contained tin, or from the co-smelting of a tin-containing ore with copper. The tradition of recycling metals is very well known, but if we say that all of these artefacts (around 40%) that contain between >0% and ≤1.1% tin are made with recycled metal, then we must also accept that approximately 23.5% of the here-listed artefacts, which contain tin and arsenic between 0 and 1.1%, come from recycled copper as well. And what about those few objects that contain tin and arsenic in the 1-2% level? These latter examples are in fact representatives of an "unusual" group of ternary alloys of copper, tin and arsenic. Such objects have been found not only in MBA Kaneš, but also in EBA Kaneš, EBA and MBA Ḫattuša, and LBA Alalakh and Tarsus. The alternative explanation of them being a product of smelting locally-found, tin-containing, (polymetallic) ores has also been supported by Yazgan as well as Yener *et al*.[838]

The initial discovery of a tin deposit containing stannite (Cu_2FeSnS_4), at the Sulucadere region of Bolkardağ, and its use for the production of tin metal has been met with great scepticism.[839] Then came the discovery of cassiterite (SnO_2), the principal mineral of tin ore, at the Kestel mine located near Çamardı, Niğde, 40 km north of the Bolkardağ deposit, and its nearby processing site of Göltepe (**Figures 1 and 24**).[840] Most recently, at Hisarcık and Kıranardı, Kayseri, at the foothills of the Erciyes volcano, just 26 km south of Kaneš, an iron-

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[835] Wagner and Öztunalı 2000, 49.
[836] Wagner and Öztunalı 2000, 51-2. See also Wilkinson 2014, 158-62, fig. 5.1.
[837] Boscher 2016, 303.
[838] Yazgan 2015, 189-90; Yener *et al*. 2015, 608.
[839] Yener and Özbal 1987; Muhly 1993; Yener *et al*. 1993; Yener 2009, 145. See also Radivojević *et al*. 2013, online supplementary material.
[840] Yener *et al*. 1989; Yener and Vandiver 1993; Willies 1995; Yener 2009, 145. See also Earl and Özbal 1996.

tin-arsenic mineralisation has been observed (**Figure 27**).[841] The deposit bears cassiterite and the new mineral yazganite ($NaFe^{3+}_2(Mg,Mn)(AsO_4)_3 \cdot H_2O$) associated with haematite (Fe_2O_3), magnetite (Fe_3O_4), tridymite (SiO_2) and the secondary hydrothermal minerals orpiment (As_2S_3) and realgar (AsS).[842] Contrary to the vein-type deposit at Kestel, this polymetallic ore is easily extractable from the fumeroles, where it is deposited.[843] Yazgan supported the use of the Hisarcık polymetallic ore deposit for the production of ternary alloys of As, Sn and Cu, often found in EBA Kaneš, further proposing the addition of cassiterite and yazganite to copper as a possible method used by the ancient smelters for the production of such ternary alloys.[844] It is important to note that a fortified processing site, called Teknekayası Höyük, was found 2 km away from the mines and a preliminary surface survey in 2013 yielded pottery dating from the EBA II (c. 2700-2400 BC) all through to the Iron Age.[845] As a result, the possibility of this polymetallic ore deposit having been used during the OA period cannot be rejected.

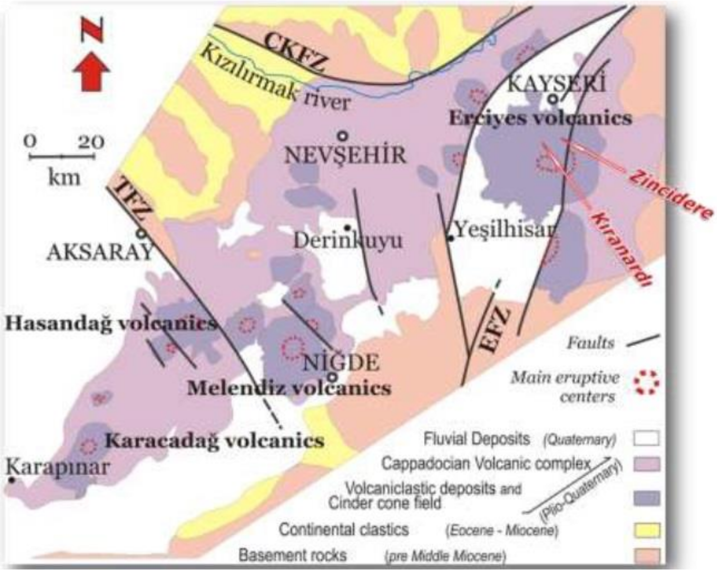

Figure 27. Simplified geological map of Cappadocian Volcanic Province (Yazgan 2015, fig. 1).

The existence of such polymetallic ores, containing tin, arsenic and iron, in the vicinity of Kaneš, can certainly explain the presence of "atypical" copper-based artefacts there, which consist of copper with just a little bit of arsenic and just a little bit of tin, but not in low enough concentrations to be termed "pure" and not high enough to be termed either "arsenical copper"

[841] Yener 2009, 145; Yener *et al*. 2015, 597-600. For the association between the aforementioned deposits and Kaneš, see **Figure 1** and Lehner 2015, fig. 3.3.
[842] Sarp and Černý 2005; Yazgan 2015, 185; Yener *et al*. 2015, 598-99, 602-4.
[843] Yener *et al*. 2015, 600.
[844] Yazgan 2015, 189-90. The mixed smelting of polymetallic ores with copper was also supported for the Balkans by Radivojević *et al*. (2013).
[845] Yener *et al*. 2015, 605-6.

or “bronze”.[846] Moreover, the fact that Anatolian copper, containing traces of tin, has been described as “pure”, further supports the co-existence and use of pollymetalic tin-containing copper minerals in Anatolia. Some of the Acem Höyük ingots are said to have been smelted and cast as blister copper and then transported to the site.[847] They contained c. 0.1-0.3 wt% Sn, up to c. 0.4 wt% As and c. 0.7-1.9 wt% Fe. This site is close to the Taurus Mountains and its polymetallic deposits. Therefore, these ingots could very well have been produced by co-smelting polymetallic ores with locally occurring copper minerals.[848]

4.2.1.1 Black copper – copper without haematite

The variety of copper characterised as *ṣalmum* “black” is recorded only seven times. The single text, however, that provides us with some further information is CMK 33. It reads that the deposited copper in Wahšušana is black and that “ici, il ne sera pas accepté. La totalité du cuivre (provient) de Durhumit”.[849] The passage reveals that “black” copper was of poor quality. Black, or blister, copper is the primary smelting product of copper and contains several impurities (most importantly iron) that can be slagged off or evaporated away with refinement or simple remelting.[850] Refinement would free the copper from its impurities, so gradually becoming reddish in colour as the quantity of these impurities decreases.[851]

If the Acem Höyük ingots were indeed cast as blister copper and then carried from the primary production site in the vicinity of the deposit to the secondary production site of Acem Höyük, where they would be re-melted and used for the production of metal, then they represent examples of the URUDU *ṣalmum* “black copper” of the OA texts. The only toponym accompanying “black” copper in the OA texts is the area of Durhumit. This is located in norther Anatolia, near the Pontic Zone, which is where the most important copper deposits are to be found. In the area of Kunanamit, black copper, i.e. smelted but unrefined, and copper of low quality could be found.[852] This area appears in one text along with copper from the land of Šawit/d, thus most probably placing these two areas in close proximity to each other.[853] The

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846 See also Lehner 2014b, 147.
847 Çukur and Kunç 1990, 34; Dercksen 1996, 27.
848 See Wagner and Öztunali 2000, 58-60, 66: TG 285, TG 287, TG 288 (**Figure 38**). See also Boscher 2016, 54-7.
849 Michel 2001, 91. CMK 33 (lines 10-14): *šu-uq-lá* URUDU *ša na-ad-ú ṣa-lá-am a-na-kam ú-lá i-ma-ḫar ku-lu* URUDU *ša Tur$_4$-ḫu-mì-it*.
850 Moorey 1994, 247; Craddock 1995, 204; Dercksen 1996, 19. See also De Jesus 1980, 27-9.
851 Dercksen 1996, 19.
852 See Dercksen 1996, 44; Barjamovic 2011, 284-85.
853 See Barjamovic 2011, 263, 387.

land of Šawit/d must have also been a mining area, as there is a reference to "clear", i.e. pure, copper from there and Dercksen[854] claims that copper from Kunanamit was exported from, or via, the land of Šawit/d. Hence, it has been suggested that copper was extracted from the mountain sources of the Pontic zone and from there sent to Durhumit, where it could be refined and turned into copper of good, or even superior, quality.[855] In this sense, "black" copper could very well be linked to URUDU *ša šaduišu* "copper of its stone", meaning copper coming straight from the deposit, i.e. raw copper.

Three copper slag samples found in Stratum IIIc (OA period) of Kaman Kalehöyük are consistent with the northern Central Anatolian copper-iron sulphidic ore deposits.[856] These slags were analysed with Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES). The results are presented in **Appendix 8.** According to Akanuma,[857] these slags must have been produced "*by the oxidative reaction of a copper-iron sulphide mixture*", such as chalcopyrite, and by using ores from different sources. Additionally, a small piece of slag related to copper production, or the conversion of matte to blister copper, has been found in Stratum IIIb-IId (c. 1700-800 BC) at the same site and is composed of crude copper, copper sulphide (chalcocite, Cu_2S) and iron oxide.[858]

There is a particular text from Kaneš, ICK 2, 54, which records a debt of "[x talent(s)] de cuivre de bonne qualité [de T]arita[r]; [x] talent(s) 30 mines de cuivre [q]ui ne contient pas d'hématite".[859] This separation between the two types of copper demonstrates the apparent differentiation between simply good quality copper and copper with no, or but little, haematite.[860] Haematite is an iron oxide that can be found in sulphuric copper ores such as chalcopyrite, or that could be used as a fluxing agent during the copper smelting process.[861] Regarding this matter, Muhly[862] maintains that this text implies that good quality copper contained haematite in its ore, which acted as a natural fluxing agent; a trait that the Old Assyrians knew, recognised and exploited. Dercksen,[863] on the other hand, states that copper was traded as metal and not in lumps of ore and, thus, copper that did not contain haematite

854 Dercksen 1996, 15, 44.
855 See Dercksen 1996, 154-55.
856 Akanuma 2007, 137-38.
857 Akanuma 2007, 137, n. 8.
858 Akanuma 2004, 170-71.
859 Ichisar 1981, 67-9. ICK 2, 54 (lines 1-5): [4 GÚ] URUDU SIG_5 [*ša T*]*a-ri-ta-a*[*r*] [2] GÚ 30 *ma-na* URUDU [*ša*] *ša-ad-wa-na-am la ú-kà-lu*.
860 Palache *et al*. 1944, 530.
861 Moorey 1994, 243-44; Dercksen 1996, 36.
862 Muhly 1980, 35-6.
863 Dercksen 1996, 39.

could not have been an ore. He also separates the two qualities in respect of origin: good quality copper from Taritar and copper with no haematite from an unknown source. Nevertheless, as we have seen, iron was the metal that gave the characteristic black colour to copper. Copper with the addition of iron, i.e. haematite, would have a black colour and would, thus, very easily be differentiated by other types of copper. Both "black" copper, meaning the primary smelting product of copper-iron sulphidic ores, and copper that contained haematite, which could have also been copper smelted with the help of iron as a fluxing agent, would be in the form of a rough ingot and they would both need to be refined in order to be efficiently used in bronze making and working.

4.2.1.2 Copper of its stone

If URUDU *ša šaduišu* "copper of its stone" is to be understood as native copper, in the present meaning of a naturally occurring pure copper (Cu) and not necessarily as a native-to-a-specific-place copper, then three Central Anatolian deposits located west of the proposed locations for Durhumit and Tišmurna are concerned; all of which contain native copper and cuprite (**Figures 38-39**). These are Derekütügün (TG 272), Üçoluk (TG 273) and Çağşak (TG 274).[864] It is important to note that at the Derekütügün and Üçoluk deposits there are nodules that consist not only of native copper (Cu) and cuprite (Cu_2O), but also malachite ($Cu_2CO_3(OH)_2$) and chrysocolla ($((Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O)$). They are found inside a sandy matrix, from which they are simply washed out after strong rains and can be, thus, easily picked up from the surface.[865] The third mineralisation, that of Çağşak, consists of iron-containing sulphidic minerals, such as chalcopyrite, bornite and limonite.[866] What is more, native copper can also be found in the southern Anatolian deposit of Alihoca (TG 287), which belongs to the Bolkardağ mining district. In this deposit, there is also found pentlandite ($(Fe,Ni)_9S_8$), pyrrhotite (Fe_7S_8), bornite, chalcopyrite, arsenopyrite (FeAsS), chalcocite, cuprite, secondary copper minerals and limonite.[867] As already mentioned, this mining district is about 40 km south of Niğde, where the polymetallic tin-containing ores have been discovered.

[864] Wagner and Öztunalı 2000, 50-1.
[865] Wagner and Öztunalı 2000, 50-1.
[866] Wagner and Öztunalı 2000, 51.
[867] Wagner and Öztunalı 2000, 58-9.

4.2.1.3 *Washed copper*

It must be very clear by now how abundant and widely used polymetallic, iron- and arsenic-containing, sulphidic ores were in Anatolia. The analysed artefacts from Kaneš have clearly shown that the imported tin was (preferably) alloyed with pure copper, meaning with copper containing less than 1 wt% As and less than 0.5 wt% iron. But there is evidence to support that the initially smelted copper was/could be the so-called blister or black copper, which means that one of its unwanted constituents was iron. Copper containing 1-5% iron would be too brittle and with physical properties inferior even to pure copper.[868] The copper ingots that came from the smelting sites into the cities had to be refined in order to be free from any unwanted elements which would make the metal uncooperative. The Acem Höyük ingots, which are said to have been produced as blister copper and transported to the site for further refinement and use, most often contain <0.5 wt% Fe, but there are also some containing around 1 wt% or around 2 wt% Fe. The objects analysed from the site, when compared to the ingots, have exactly the same compositions (**Appendix 8**), which means that those ingots were not further refined before they were melted to produce copper artefacts. These ingots might have actually been the type of "washed" copper so often mentioned in the OA texts. Further support for this claim can be provided by the fact that not only in Kaneš, but in Ebla and Ḫattuša as well, bronze objects normally contain less than c. 1 wt% As and less than c. 0.5 wt% Fe.[869] The refinement of copper is a rather simple process, as the only treatment that is required is re-melting under mildly oxidising conditions. In this way, metals that oxidise easily, such as iron, will be removed as dross, leaving the copper relatively clean from impurities.[870]

In 2000, Palmieri and Hauptmann published the analytical results of 70 copper-based artefacts from Ebla, performed with ICP-OES.[871] These are presented in **Appendix 8**, where Zn, Sb, Co, Ag and Bi concentrations have been converted from ppm of the original publication to wt%. 48 of the 70 samples are of interest to this research. From these, 19 artefacts are dated to the MBA I/II (c. 2000-1700 BC) (Sample Nos. 254-272), seven to the MBA I (c. 1850-1700 BC) (Sample Nos. 273-279), 21 to the MBA II (c. 1750-1700 BC) (Sample Nos. 280-300) and one last to the LBA (c. 1600-1200 BC) (Sample No. 301). In comparison to the compositions

[868] Craddock and Meeks 1987, 192; Catapotis and Bassiakos 2007, 79-80; Boscher 2016, 303.
[869] Palmieri and Hauptmann 2000; Lehner 2011, 2014b, 2015. Lehner (2015, 157) noted an alternative regarding the low concentration of iron existent in bronzes. He referred to the possibility that "*the alloying process itself drew iron out of the molten copper*". This possibility has to tested and is worth further examination through experimentation.
[870] See Pernicka 2014, 254-55.
[871] Palmieri and Hauptmann 2000, 1261-265, tables 1 and 2.

and the combinations of the metals (arsenic, tin and iron) that have been observed in the objects from Kaneš, the samples from Ebla present some differences as well as similarities. When the iron content is above c. 0.5 wt%, there is no more than c. 0.5 wt% Sn and/or more than c. 1 wt% As. In contrast, in the objects from Kaneš a linked increase of arsenic above 1 wt% and iron above 0.5 wt% is noted. Moreover, when an artefact contains more than c. 2 wt% Sn, then there is always less than c. 1 wt% As and less than 0.5 wt% Fe. In Kaneš, on the other hand, even when there is more than c. 2 wt% Sn, the arsenic can be as high as c. 3 wt% and the iron up to 1 wt%. Furthermore, in Ebla there are no irregular samples comprised of more than 1 wt% As with more than 1 wt% Sn. What is more, the arsenical copper objects do not exceed c. 3.2 wt% As, contrary to the Kaneš artefacts which reach up to c. 9.5 wt% As. Even so, the Ebla artefacts have a similar composition to the majority of the Kaneš ones.

To these broad observations, there are a few exceptions: sample No. 259, an MBA I/II pin containing c 2.2 wt% As and c. 1.1 wt% Fe, and Sample No. 261, an MBA I/II awl comprising c 2.8 wt% As with c. 2 wt% Fe. In addition, there is one more object which could be regarded as an exception. It is sample No. 282, an MBA II pin containing just above 1 wt% As (c. 1.2 wt% As) with >2 wt% Sn (c. 2.6 wt% Sn). More interestingly still, though, there is an artefact, an MBA I fenestrated axe (Sample No. 300), that consists of c. 2.9 wt% Sn, almost no As, c. 0.9 wt% Fe and 10.5 wt% Pb. Palmieri and Hauptmann[872] further note a sickle blade (Sample No. 273), dating to the MBA II, which contains c. 1 wt% As, c. 0.7 wt% Sn, c. 0.3 wt% Fe, c. 0.5 wt% Pb and 1.1 wt% Ni. According to the authors, such types of alloys are rare and found mainly in east Anatolia, in the Levant and in Mesopotamia.

As there are not many artefacts containing more than c. 1 wt% arsenic and the content of this metal does not go higher than c. 3.2 wt%, it can be assumed that arsenical copper was not an alloy of choice in Ebla, where purer copper seems to have been in use. It is also important to note that the 1 wt% As level is exceeded in only five samples, two of which contain just c. 1.2 wt% and c. 1.4 wt% As. On the other hand, bronze objects seem to have been produced with rather pure copper, containing only some arsenic and iron as impurities (<1% As, <0.5% Fe).[873] In contrast to Anatolian sites, where arsenical copper ores seem to have been widely used, in Ebla ores of purer copper seem to have been preferred. This is in agreement with the copper deposits of southern Anatolia, from where Mari's copper could also have come.[874]

[872] Palmieri and Hauptmann 2000, 1265.
[873] See Palmieri and Hauptmann 2000, 1262-263.
[874] See Chapter 3.1.2.4; Dercksen 1996, 30, 41-2.

4.2.1.4 Cupronickel

A great number of artefacts from the EBA until the LBA have been analysed by Lehner,[875] tracking the emergence, continuity and evolution of metal alloys and metal technology in Ḫattuša. Of interest to the present research is the great variety of alloys observed in the LBA, especially those rare alloys known as cupronickel, seen in the MBA II Kaneš and Ebla. However, it should always be kept in mind that a decisive factor in the noted diversity of alloys for the LBA can be attributed to the greater number of available objects, as well as chance.

This type of Cu-Ni alloy was also found in the site of Kaman-Kalehöyük, from where 363 copper-based pins were analysed and 15 were found to have a high nickel content. From those 15 pins, 8 belong to Stratum IIIb, i.e. the Old Hittite period (1730-1540 cal. BC/1700-1400 arch. BC).[876] The level of corrosion of the pins made measurements of the nickel rather difficult, but a range between 2 wt% and 18 wt% Ni was given and the authors attributed this as an impurity of the copper ore used for the manufacture of the pins.[877]

According to Lehner's research,[878] in LBA Ḫattuša copper-arsenic and copper-tin-arsenic alloys were the most common. In addition, there were copper-tin alloys, ternary and quaternary alloys with lead, and copper-nickel, copper-arsenic-nickel and copper-tin-nickel alloys. Concerning the copper-nickel alloys, there are low-nickel cupronickel alloys, containing c. 1-10 wt% Ni, and high-nickel cupronickel alloys, containing c. 10-20 wt% Ni.[879] Both types seem to be equally distributed among the nickel-containing assemblage analysed by Lehner.[880] Moreover, nickel seems to be more frequently present in pure copper and arsenical copper alloys, as most nickel-containing artefacts contain <1 wt% Sn and <1 wt% As. Nevertheless, there are two objects that additionally contain 2-3 wt% Sn, two that contain 20-22 wt% Sn, 10 containing 1-1.5 wt% As, two with 1.5-2 wt% As and three containing >2 wt% As. High-nickel Cu-Ni alloys give a silvery colour, which could have easily been mistaken for actual silver.[881] It is suggested that sulphidic polymetallic ores, such as chalcopyrites and

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[875] Lehner 2015; 2017. See also Lehner 2011; 2014a.
[876] The chronology is based on Omori and Nakamura's (2006) publication of the radiocarbon dating studies for this site. However, according to Schachner (2012, table 1), the Old Hittite period, i.e. MBA II, is dated to c. 1650-1530 BC.
[877] Masubuchi and Nakai 2003.
[878] Lehner 2011, 59; 2014a, 132; 2017.
[879] Lehner 2014a, 135; 2015, 159-63.
[880] Lehner 2015.
[881] Lehner 2011, 62-4. See also Lehner 2017, 251-54. However, Zimmermann *et al*. (2010, 228) note that a concentration of up to 40% Ni would be necessary for a colour alteration effect in copper. See also Pernicka 1990, 55.

arsenopyrites, or arsenic-rich speiss were smelted together with nickeliferous copper ores, such as pentlandite ($(Fe,Ni)_9S_8$) and siegenite ($(Ni,Co)_3S_4$).[882] Sources for these types of ores are located, among others, in Pancalı near Bitlis in eastern Anatolia (west of Lake Van), near Divriği, Sivas, in eastern Central Anatolia (NE of Kayseri) and in Alihoca (TG 287, Bolkardağ mining district) in southern Central Anatolia.[883]

High nickel concentration was also found in the chains of the bronze tablet, where the 13th century BC treaty between the Hittite King Tudḫaliya IV and King Kurunta of Tarḫuntašša was inscribed.[884] Despite the fact that the tablet itself contained very high amounts of tin (c. 36 wt% Sn), it did not contain any nickel. The chains, however, contained no tin and were made of copper with high amounts of nickel and iron (7.17 wt% and 6.49 wt% Ni, and 2.12 wt% and 2.69 wt% Fe, respectively).[885] The unusually high amounts of tin could alternatively be a thin coating and not tin alloyed with copper. But nickel in such an amount does not present any benefits to copper, neither in casting nor in colouration. According to the authors, this could have been an accidental Cu-Ni alloy, such as can occur in the easily found ophiolitic rocks of the Taurus Mountains, NE Anatolia, Cyprus and Oman.[886] Natural copper-nickel alloys occur as contaminations in copper-arsenic ores, which means that the alloy should also contain some (or a higher amount of) arsenic, an element which is absent from the two chains.[887] In this case, the use of meteoric iron for the production of the chains cannot be excluded.[888]

4.2.1.5 Arsenical copper and speiss

Arsenical copper objects (>1 wt% As) from Kaneš are believed to have been produced from the mixed- or co-smelting of copper with arsenic-containing minerals, or by melting together copper with copper arsenide, i.e. speiss.[889] The presence of a higher iron content in arsenical copper objects than in bronzes is notable in all Anatolian artefacts presented here, as well as in LBA Ḫattuša and surely at several other sites of the MBA and LBA.[890] This

[882] Lehner 2011, 64; 2014a, 135; 2015, 159-62.
[883] Wagner and Öztunalı 2000, 58-9; Lehner 2014a, 135; 2015, 162.
[884] Zimmermann *et al*. 2010.
[885] Zimmermann *et al*. 2010, 227-29, table 1.
[886] Begemann *et al*. 2010, 141-45; Zimmermann *et al*. 2010, 228. See also Wagner *et al*. 1989. Ophiolites are igneous rocks that originate from solidified magmas (Allen 2017, 13-4).
[887] Pernicka 1990, 55; Zimmermann *et al*. 2010. 228.
[888] Meteoric iron contains high amounts of nickel, ranging from 5% to 60% nickel and averaging around 8% nickel (Pernicka 1990, 62; Zimmermann *et al*. 2010, 228).
[889] Lehner 2014b, 147. See also Boscher 2016, 53-7, 59-60.
[890] See Lehner (2015, 158) for the analysis of artefacts from Ḫattuša.

observation leads to the association between the use of iron minerals with the arsenical copper production, as is seen in EBA Arisman in Iran (**Figure 28**).[891]

Generally speaking, arsenical copper could have been produced by co-smelting copper oxides with iron arsenides or sulpharsenides, such as arsenopyrite and löllingite ($FeAs_2$). This is achieved by adding arsenic-rich minerals to molten copper, or by smelting copper oxides together with speiss, or adding speiss to molten copper.[892] According to Boscher's[893] research on Çamlıbel Tarlası's metallurgical remains, dating to the mid-4th millennium BC (**Figure 1**), iron arsenate or arsenide mineral was added to molten copper "*where the arsenic dissolved and entered the metal through a process of cementation*."[894] Çamlıbel's findings are evidence of the conscious alloying of copper with arsenic before the observed production of speiss in Arisman. In order for the synthetic production of speiss, or more so for the mixing of molten copper with arsenic minerals, to be a perceived process, arsenic had to be recognised as a separate element and as a possible additive to copper. This would not have been possible if polymetallic deposits alone were being used.[895] The study of the here-listed artefacts has not divulged any specific information regarding the ores used, nor the way arsenical copper was produced. But the technological knowledge was already there and we cannot imagine that it has been lost. On the contrary, the wide variety of alloys seen, especially during the LBA, are indicative of experimentation with a range of ores and minerals found in Anatolia, giving rise to ever new alloys.[896] Furthermore, as Lechtman and Klein's[897] experiments in producing arsenical copper by co-smelting have shown, crucible smelting and furnace smelting yield different products in the matters of arsenic and iron retention.

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[891] Lehner 2014b, 147, 2015, 74-5. See also Rehren *et al*. 2012; Boscher 2016, 278-88.
[892] Boscher 2016, 55-60. See also Zwicker 1991; Lechtman and Klein 1999; Thornton *et al*. 2009, 308-10.
[893] Boscher 2016, 110-200, 271-77.
[894] Boscher 2016, 275. See also Schoop 2011, 62-4.
[895] Boscher 2016, 294.
[896] See also the interesting Cu-As-Sb and Cu-As-Ni alloy artefacts of the Nahal Mishmar hoard (Shalev and Northover 1993); Boscher 2016, 299.
[897] Lechtman and Klein 1999, 515-21.

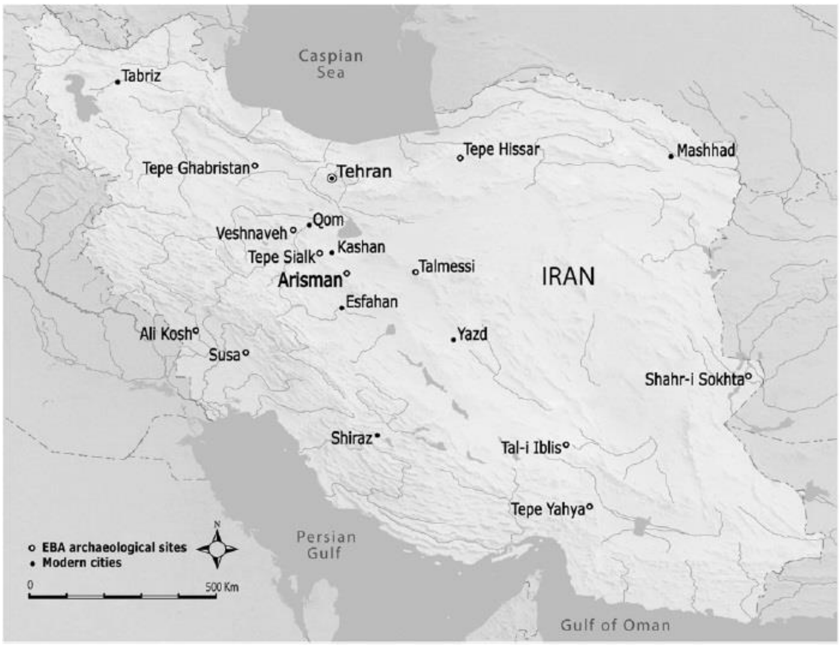

Figure 28. Map of Iran with EBA archaeometallurgical sites (Rehren et al. 2012, fig. 1).

Occurrences of ferrous speiss have been recorded from EBA Iran, Poros-Katsambas in northern-central and Chrysokamino in eastern Crete, EBA/MBA Jericho and LBA Ḫattuša, Kamid el-Loz in Lebanon and Tiryns in Greece.[898] In the early 3rd millennium BC, at Arslantepe in Anatolia, slag containing prills of Ni-As speiss was found, indicating a relationship with the speiss production also carried out in 3rd millennium BC Iran and a first attempt to smelt iron minerals.[899] Moreover, in the LBA and Roman Period western and central Europe, speiss was traded in ingot form.[900] Regarding the EBA production site of Chrysokamino in Crete, it has been said that ores from various sources were used, while arsenic minerals were imported from outside Crete.[901] However, whether or not speiss was also produced and traded (over long distances) during the OA period is unknown; an Akkadian word to describe such a metal has not been found (up until now). Furthermore, the extreme range of arsenic content (0-9.5 wt% As) found in the copper-based artefacts from Kaneš, in addition to the majority of them containing c. <1.5 wt% As, are contradictory to the stability of arsenic content expected in alloys produced by a controlled addition of speiss to copper.

[898] Muhly *et al*. 1985, 76-7; Zwicker 1991, 333; Bassiakos and Catapotis 2006, 340-44; Catapotis and Bassiakos 2007, 79-80; Thornton *et al*. 2009, 309; Rehren *et al*. 2012; Boscher 2016.
[899] Thornton *et al*. 2009, 314-15.
[900] Thornton *et al*. 2009, 309.
[901] Bassiakos and Catapotis 2006, 346-47; Catapotis and Bassiakos 2007, 72-4; Boscher 2016, 60.

4.2.1.6 Tin

As far as tin is concerned, the OA texts testify to the import of this metal from the Assyrian capital, Aššur. Its purchase in Aššur from traders coming from further east is also noted in the Kaneš tablets and supported by the Mari texts, which state that tin found its way there through Susa and Anshan in Elam (nowadays Iran) and Ešnunna.[902] The analysis of the copper-based artefacts, however, do not offer much on the matter. The only information that we can extract from the analysed artefacts is that there was no one specific recipe for bronze. The tin concentrations range from 0 wt% to c. 1 wt% Sn and from c. 3.5 wt% up to c. 17 wt% Sn, while most artefacts contain c. 4-11 wt% Sn (**Chart 48**).

Concerning the possible sources of tin for the Near East of the Bronze Age there has been much discussion, in which the mines of Karnab in Uzbekistan,[903] Mushiston in Tajikistan,[904] and Deh Hosein in Iran[905] have been the most prominent candidates; while Afghanistan[906] and Caucasia and Transcaucasia[907] have also been referred to.[908] However, the matter has not been solved; new mines and production sites are continuously coming to light. One thing that can certainly be said is that tin must have crossed the Zagros, and must have come from a variety of tin deposits and areas, not just one.[909] Moreover, without disregarding or diminishing the importance of the far eastern tin deposits in Uzbekistan and Tajikistan, it is my belief that at least during the MBA and LBA, Iranian tin deposits must have been the ones feeding this metal into the Near Eastern trade routes and its metal-producing industry.[910]

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[902] Muhly 1985, 282; Moorey 1994, 298; Reiter 1997, 213-51; Weisgerber and Cierny 2002, 179; Dercksen 2005, 19; Nezafati 2006, 79-80; Helwing 2009, 210-11.
[903] Boroffka *et al*. 2002, 143; Weisgerber and Cierny 2002, 181; Cierny and Weisgerber 2003, 24-7; Parzinger *et al*. 2003, 6-8; Helwing 2009, 211; Yalçin 2009, 102; Yener 2009, 148; Weisgerber 2009, 241-45; cf. Kaniuth 2007, 27-8, 33-4.
[904] Boroffka *et al*. 2002, 141; Weisgerber and Cierny 2002, 183-84; Cierny and Weisgerber 2003, 28-9; Parzinger *et al*. 2003, 6, 8-9; Yalçin 2009, 102; Yener 2009, 148; Weisgerber 2009, 245-47.
[905] Nezafati 2006, 85-7, 93-4; Nezafati *et al*. 2006; 2008a, 315-17; 2008b, 84; 2011; Helwing 2009, 211; Nezafati *et al*. 2009; Yalçin 2009, 103; Yener 2009, 149; Pigott 2012, 223. See also: Forbes 1972, 141; Moorey 1994, 299; Helwing 2009, 210-11.
[906] Parzinger *et al*. 2003, 4; Helwing 2009, 211.
[907] Forbes 1972, 141; Moorey 1994, 300.
[908] See also Dayton 1971; Crawford 1974; Cleuziou and Berthoud 1982; Parzinger *et al*. 2003, 9-13; Yener 2009, 144, 148-49; Frame 2010; Stöllner *et al*. 2011; Thornton and Giardino 2012, 254-55; Wilkinson 2014, 162-65; Cuénod *et al*. 2015; Boscher 2016, 33-4.
[909] See also Kaniuth 2007, 23-5.
[910] Cf. Jablonka 2014, 52-6.

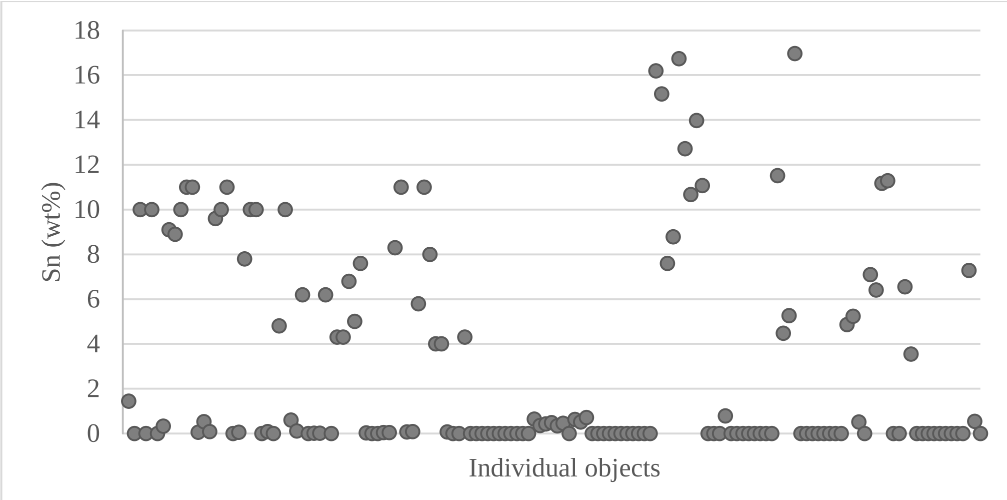

Chart 48. Tin concentrations in Kaneš artefacts.

4.2.2 Egypt (Late Bronze Age)

Unfortunately, not many copper-based Egyptian artefacts have been analysed, limiting our conclusions to an information-pool of only a few objects analysed by Stos-Gale *et al*. in 1995.[911] The information and the chemical analysis' data, performed with Neutron Activation Analysis (NAA) and Energy Dispersive X-Ray Fluorescence (EDXRF) for Pb measurements are presented in **Appendix 8**, where all metal amounts have been converted from ppm to wt%. The analysis was focused on the provenance of these copper-based artefacts and their lead isotope data. Thus, the objects were divided by Stos-Gale *et al*. in two groups. The first, IG1, has lead isotope ratios which are consistent with the Lavrion field. The second, IG2, forms a cluster with lower $^{207}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$, $^{204}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ and $^{204}Pb/^{206}Pb$ vs. $^{207}Pb/^{206}Pb$ ratios than IG1. However, the lead source of the IG2 could not be identified. According to Stos-Gale *et al*.'s research, the only ore samples which "*fall in the near vicinity of this group*" come from Ergani Maden in SE Anatolia.[912] Nevertheless, IG2's isotopic field corresponds also well with ores from the Taurus Mountains, especially Taurus 1A and Taurus 2B, as presented by Yener *et al*.[913] and Sayre *et al*.[914] (**Charts 49-51**).

[911] Stos-Gale *et al*. 1995.
[912] Stos-Gale *et al*. 1995, 130.
[913] Yener *et al*. 1991, 560-61 table 2.
[914] Sayre *et al*. 2001, 113 table 11.

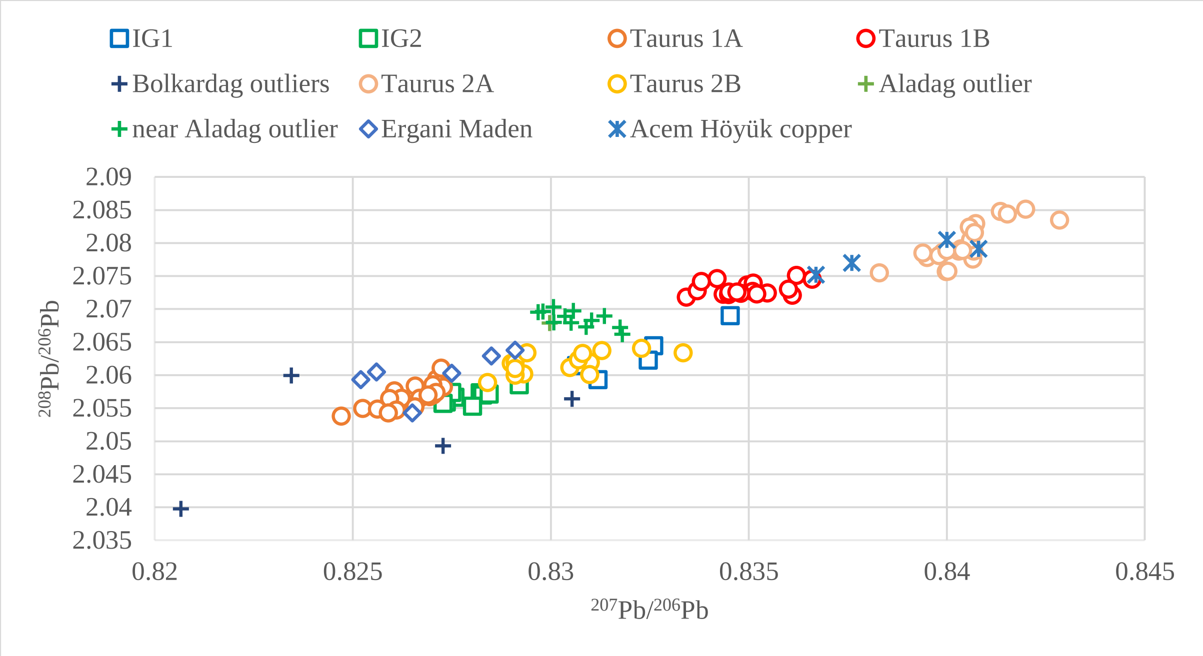

Chart 49. $^{207}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ lead isotope diagram.

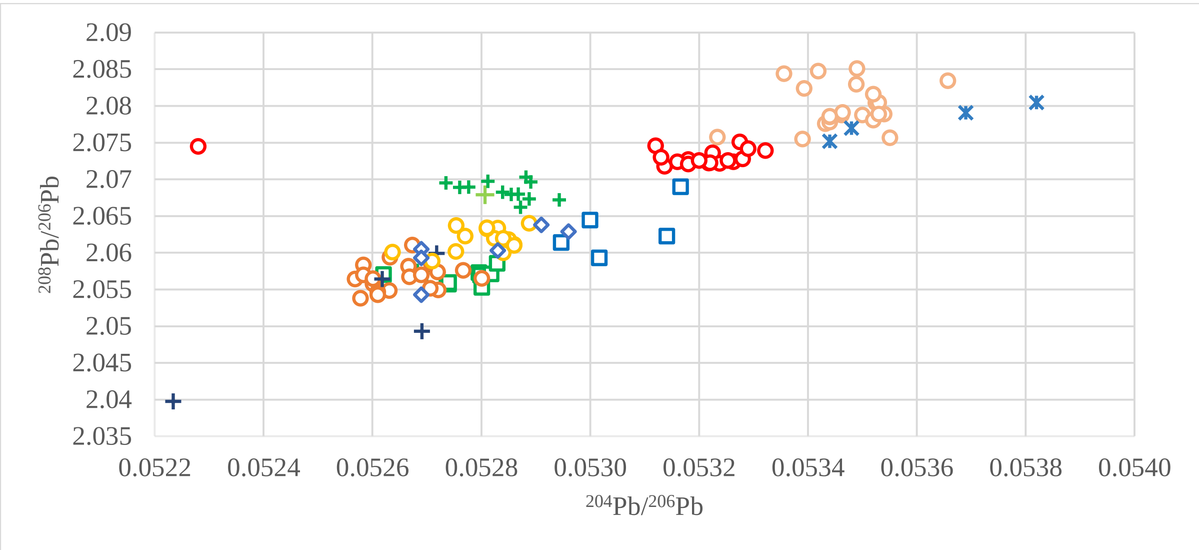

Chart 50. $^{204}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ lead isotope diagram.

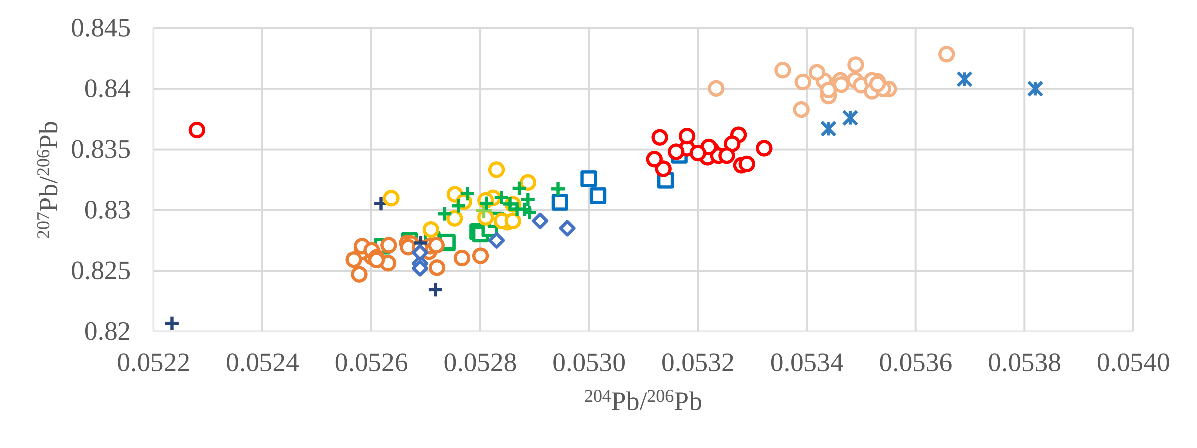

Chart 51. $^{204}Pb/^{206}Pb$ vs. $^{207}Pb/^{206}Pb$ lead isotope diagram.

The chemical analysis has shown that the objects belonging to the IG2 are high-Sn bronzes, made with rather pure copper containing c. 0.1-0.5 wt% As, less than c. 0.3 wt% Fe, less than c. 0.08 wt% Ni and less than c. 0.3 wt% Pb.[915] The only exception is a small knife (Sample No. 302) that contains only 2.74 wt% Sn. What was of particular interest to Stos-Gale *et al.* was the notably higher mean value of gold content found in the samples of the IG2 than in those of the IG1. These were 204.4 ppm and 17.4 ppm, respectively.[916] The average amount of gold in all five samples belonging to the IG1 is 73.5 ppm Au, admittedly much lower than the 204.4 ppm Au of the IG2 (**Chart 52** and **Table 19**).

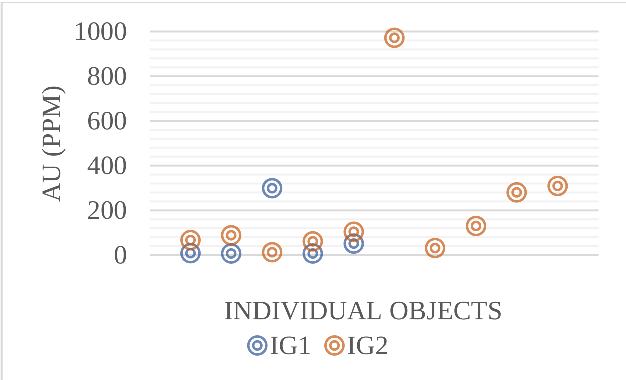

Chart 52. Gold content (in ppm) in Amarna bronzes of IG1 and IG2.

[915] Stos-Gale *et al.* 1995, 131.
[916] The mean value for IG1, 17.4 ppm, has been calculated using only four of the five samples' amounts, leaving outside Sample No. 307, which "*accepted at present as consistent with the Lavrion ores (1924.77), has a much higher gold and silver content than the other four (297 ppm and 284.5 ppm respectively), and its lead-isotope 208/206 ratio is somewhat higher*" (Stos-Gale *et al*. 1995, 131). However, re-calculating the average amount of gold of these same four samples a slightly different result turns up, i.e. 17.6 ppm instead of 17.4 ppm.

Table 19. Gold content in Amarna Bronzes of IG1 and IG2.

Sample No.	Ashmolean Museum No.	LI Group	Au ppm
302	1890.305	IG2	66.267
303	1921.1129	IG2	87.4
304	1921.1131	IG2	11.433
305	1921.1132	IG1	7.829
306	1921.1150	IG1	5.752
307	1924.77	IG1	297.453
308	1924.81	IG2	60.669
309	1924.82	IG2	102.510
310	1924.84	IG2	970.344
311	1925.413	IG2	29.556
312	1927.4104A	IG1	6.167
314	1931.487	IG2	128.548
315	1933.1209	IG2	279.363
316	1934.267	IG2	307.714
317	1935.595	IG1	50.470

The observation of the higher gold content in the IG2 objects led the authors to consider the possibility that either alluvial tin with a high gold content from the Eastern Desert of Egypt was used, that minerals or quartz-containing gold was used as flux, or that a small amount of gold was deliberately added to bronze.[917] The two latter theories were found improbable or impractical, leaving the first one as the most plausible.[918] Research and analysis done on samples from the Pi-Ramesse workshops, dating to about fifty years later than the Amarna period, yielded a large number of samples with "*striking similarity*" in matters of lead isotope ratios to the Amarna bronzes (**Charts 53-55**), as well as a rather high gold content pointing to a likelihood of this metal being a part of the tin used to produce bronze.[919] Taking into consideration that 1) unalloyed copper showed low amounts of gold in comparison to the amounts observed in the bronze samples, 2) there was no residual cassiterite found in the analysed samples and 3) there was a notable rarity of gold in crucible samples, as well as metals, an unintentional inclusion of gold through the direct combination of (alluvial?)

[917] Stos-Gale *et al*. 1995, 131-32. See also El Gemmizi (1985), in regard to the gold-containing cassiterite of the Eastern Desert.
[918] Stos-Gale *et al*. 1995, 132.
[919] Rademakers *et al*. 2017, 56, 60.

cassiterite with copper in a reducing atmosphere, i.e. a cementation process, was concluded.[920] However, the higher gold content of IG2 and the major group of samples from Pi-Ramesse could likely be a result of recycled scrap metal. This would explain the "unexplained" higher gold content and the inability to identify the ore source, creating a lead isotope ratio cluster close to known source fields but not exactly overlapping any of them.[921]

Nevertheless, by consulting **Table 19** and **Chart 52**, it becomes obviously possible that the two groups' difference in gold content is more a result of mathematical calculations and chance of sampling than a real difference. The gold content recorded in the samples belonging to IG1 ranges from 5.752 to 297.453 ppm, while that found in the samples of IG2 range from 11.433 to 307.714 and reaching up to 970.344 ppm. These ranges are also visible in **Chart 52**. Thus, the difference in the range of their recorded amounts is not so significant. Moreover, only five samples belong to IG1, while there are 13 of IG2. This "surplus" of samples belonging to IG2, in addition to the very small number of samples belonging to IG1 should also be something to keep in mind. Until more objects with an isotopic fingerprint corresponding to IG1 are sampled and analysed, we should remain cautious with our conclusions.

Concerning the origin of the copper used to produce copper-based and bronze artefacts in Egypt and with respect to the wide international connections that Egypt enjoyed during the New Kingdom, it comes as no surprise to find out that an assortment of international and local ore sources was used.[922] What has also always to be kept in mind is that, when ores from several different sources are used, mixed or not, the lead isotope analysis results and thus any effort to find the provenance of the metal, can be affected and misleading.[923] In addition, the isotopic fingerprints of all the metals contained in a sample, such as lead, copper, tin or arsenic can have an impact on lead isotope signatures.[924] Having said that, the cluster of IG2 does not match isotopically with any of the Uluburun ingots, which seem to come from Apliki in Cyprus,[925] but does have a slight overlap with ores from Kalavasos and most importantly with ores from Hala Sultan Teke in Cyprus.[926] Moreover, there is no connection with ores from Timna or

[920] Rademakers *et al*. 2017, 60, 67; 2018, 515-20. See also Erb-Satullo *et al*. 2015, 272-74.
[921] Rademakers *et al*. 2017, 68.
[922] See Rademakers *et al*. 2017, 55-64.
[923] Rademakers *et al*. 2017, 68-9.
[924] Liu *et al*. 2015, 499.
[925] Rademakers *et al*. 2017, 56, fig. 5. See also Rehren and Pusch 2012, 218.
[926] OXALID, "Cyprus: Cyprus – Ores" and "Cyprus: Cyprus – Artefacts LI". See also Pulak 2000, 147-50, figs. 14-15.

Faynan, Oman, Sinai, or the Eastern Desert, for which further research is needed in order to draw more secure conclusions, and there is no real overlap with the Anatolian ores.[927]

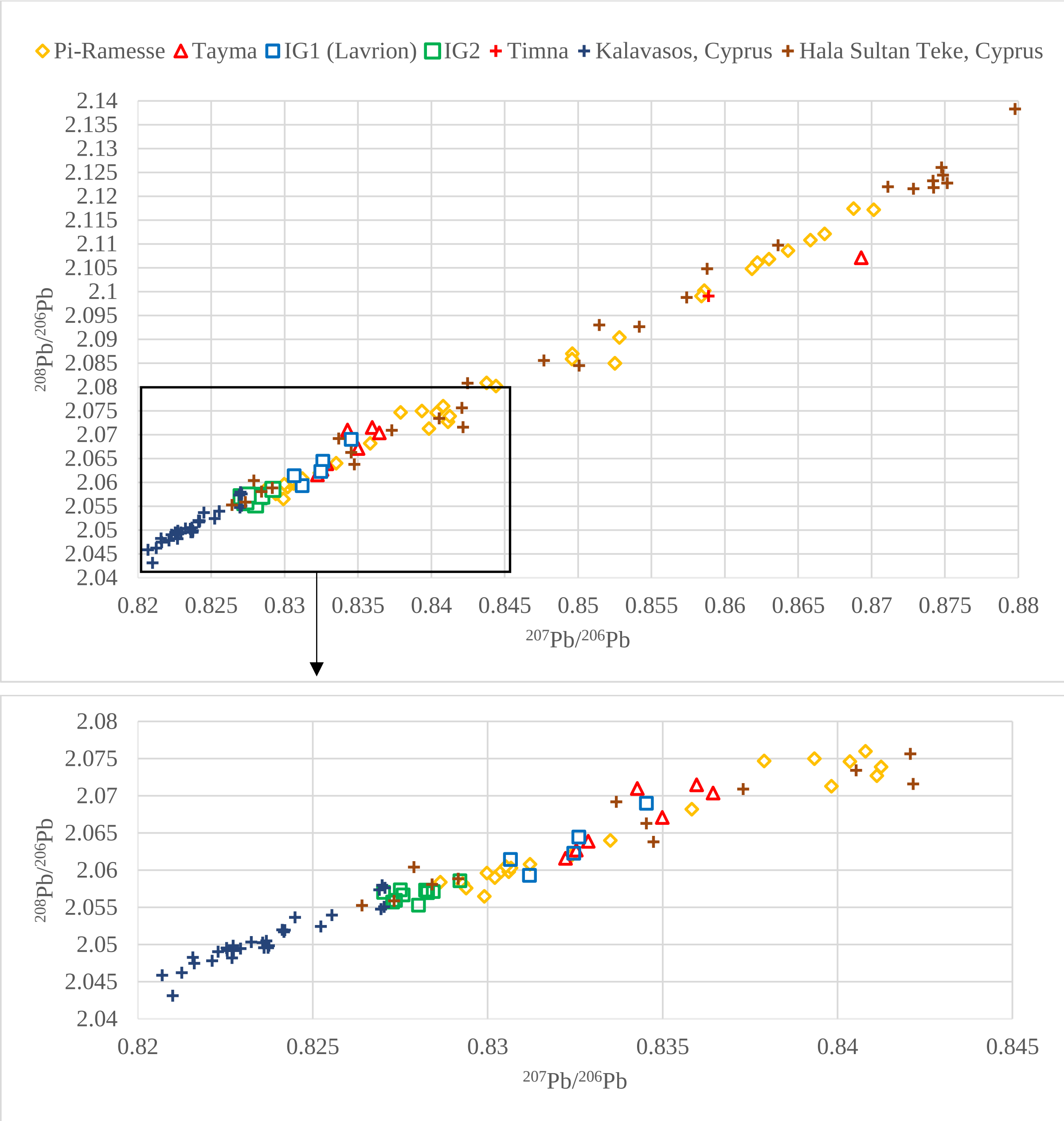

Chart 53. $^{207}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ lead isotope diagram.

[927] Rademakers *et al*. 2017, 56-60, figs. 5-7. See also Begemann *et al.* 2010, 153-56; Abdel-Motelib *et al.* 2012, fig. 32; Weeks 2007 (especially the lead isotope diagrams in fig. 2).

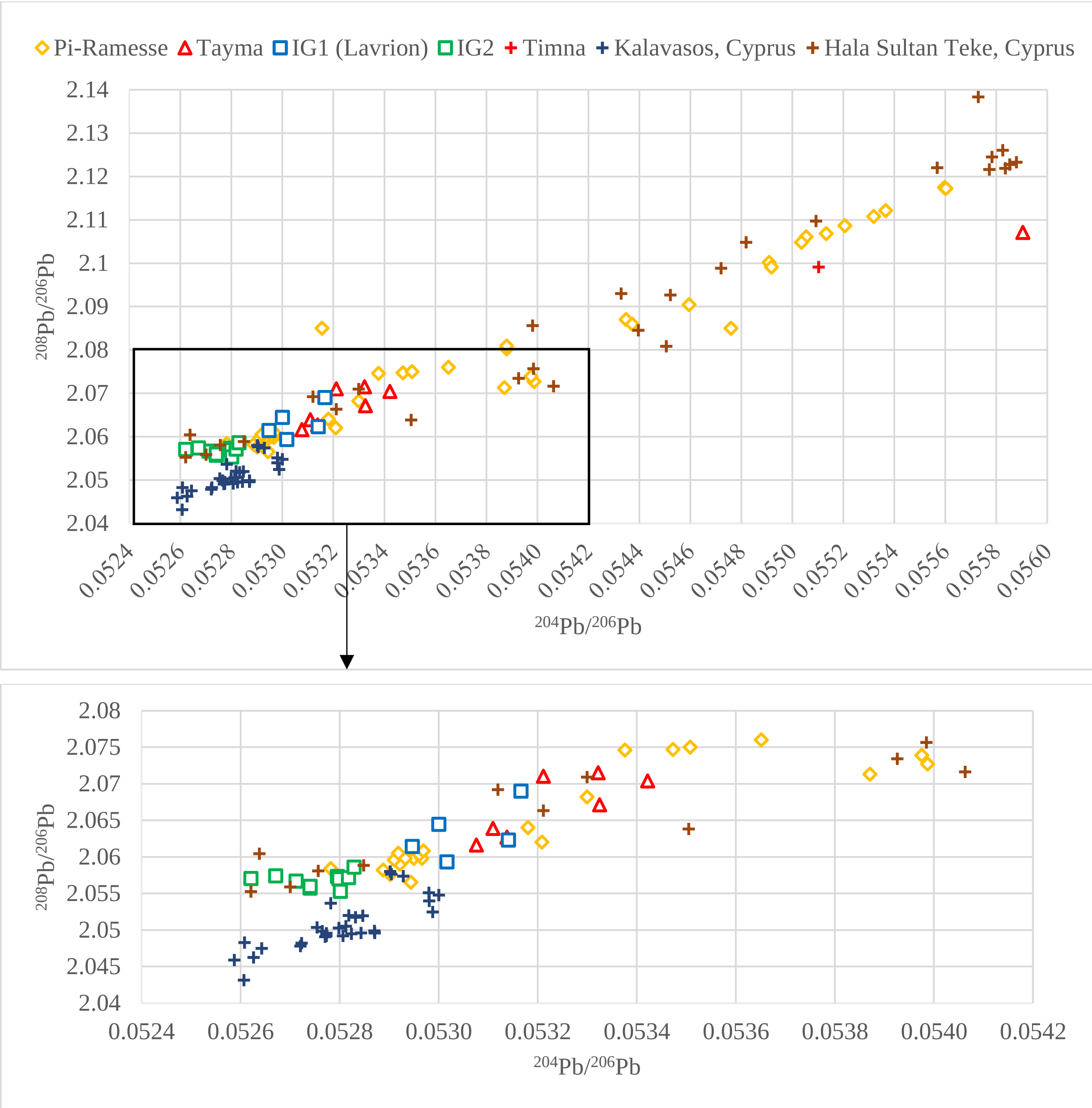

Chart 54. $^{204}Pb/^{206}Pb$ vs. $^{208}Pb/^{206}Pb$ lead isotope diagram.

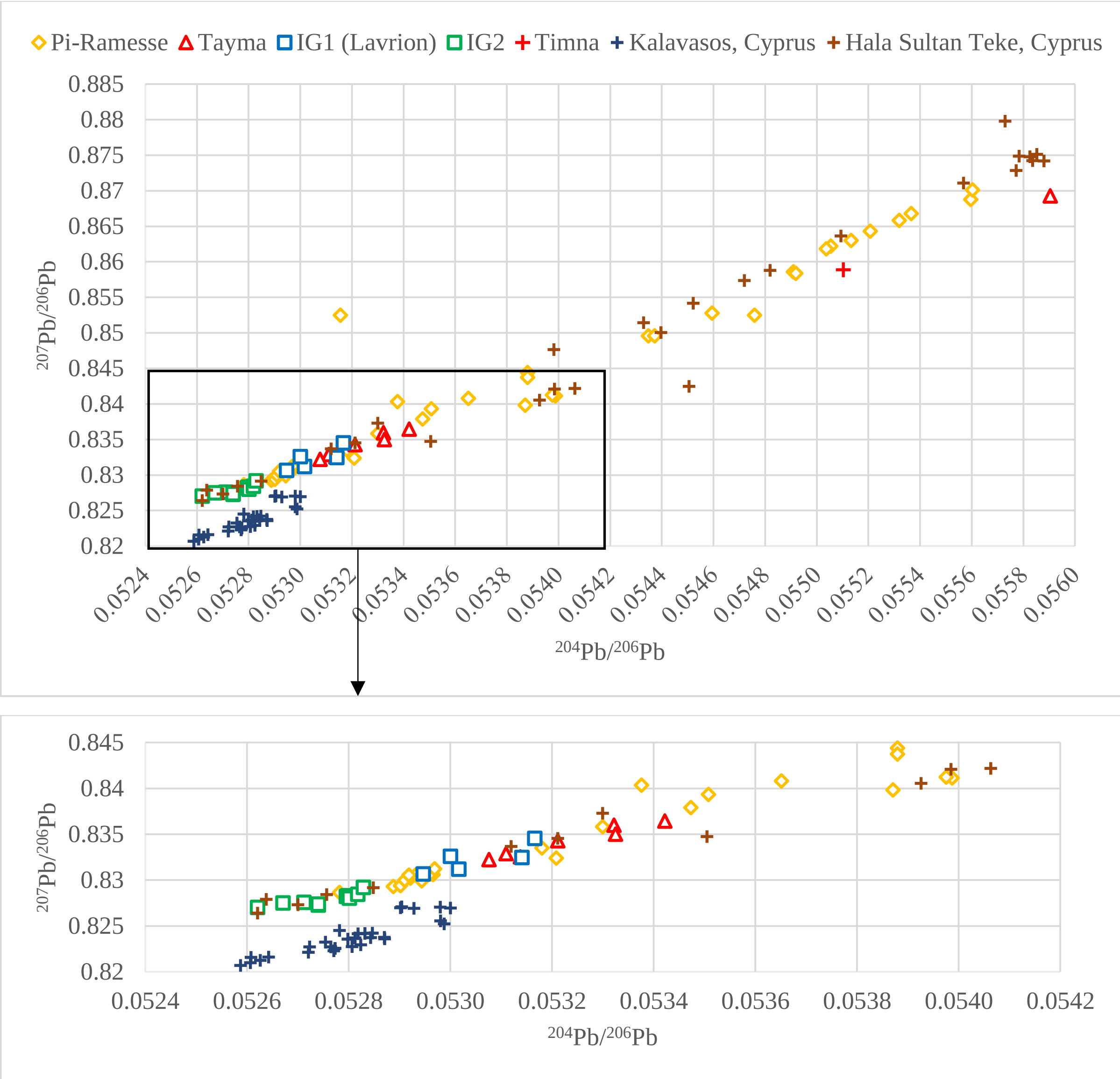

Chart 55. ^{204}Pb/^{206}Pb vs. ^{207}Pb/^{206}Pb lead isotope diagram.

4.3 Iron

Iron finds from the early 2nd millennium BC are very rare; not only due to the fact that there existed no true iron technology then, but most importantly because iron corrodes very quickly, reducing artefacts dating even to the 1st millennium BC to lumps of metal with no coherent shape, thus being very often disregarded in the field or in the museum warehouses.[928] Moreover, the corrosion layer formed can be so thick that it has "consumed" almost all the metal, leaving just a mere fragment of actual metal to be studied. Hence, from the few iron artefacts, or fragments of artefacts, found and the even fewer (fragments of) iron artefacts

[928] See also Stech-Wheeler *et al*. 1981, 246; Piaskowski and Wartke 1989, 89; Nieling 2009, 241-42.

analysed, the corrosion layer is what gets typically analysed, frequently leading to false data. Iron objects are very rarely allowed to be analysed due to their fragility and their rarity as archaeological findings, especially from such distant periods. A non-destructive analysis method, like the most common and most widely used – XRF, will unfortunately not reach the metal core of the metal and will, as a result, provide the researchers with data from the corrosion layer alone. Occasionally, the artefact is quite well-preserved, allowing for a good surface analysis by XRF, but this is most often not the case. Moreover, this method offers only an elemental analysis and does not show the structure of the object. At times, this is enough and can lead to a definite answer regarding the iron's origin. Sometimes, however, more conclusive methods are required. But they are, unfortunately, of a more destructive nature and are thus obviously precluded.[929]

When dealing with Bronze Age iron objects, the first question that arises is whether they are made of terrestrial or meteoric iron. The basic difference between the two is their nickel content. Iron meteorites contain considerable amounts of nickel, reaching up to 60% Ni, but usually it lies between 5 and 12% Ni; the distinction is usually made at around 5% Ni.[930] On the contrary, terrestrial iron comprises less than 0.2% Ni or, in the case of telluric (or native) iron, 1-4% Ni.[931] The latter is a rather rare occurrence of native iron in the form of metal and not as an ore, like magnetite, haematite or pyrite are. As opposed to what is widely believed, meteoric iron corrodes nearly as fast as wrought iron. This corrosion process leads to a significant loss of nickel in the outer corrosion layer, which means that an iron artefact of meteoric origin, if analysed only superficially, can appear as of non-meteoric origin due to a (seemingly) low nickel content.[932] A representative example of the effect of corrosion on the nickel content of a meteoric iron artefact are the Gerzeh beads, which have been analysed by three different teams and three different methods (see further below, Chapter 4.3.4). All methods were non-intrusive and have produced results according to the penetration depths reached. The least penetrative of the three (pXRF) yielded the lowest Ni content, while the method with the highest penetration depth showed a much higher Ni content.[933] For this reason, chemical analysis and nickel content determination are not sufficient to prove (or disprove) the meteoric origin of an iron object. Metallurgical analysis is also necessary, so that the

[929] See Jambon 2017, online supplementary material: A1.
[930] Buchwald 1975, 76-7; 2005, 25-6; Photos 1989, 404; Yalçin 1999, 180; Goldstein *et al*. 2009, 294; Rehren *et al*. 2013, 4787; Jambon 2017, online supplementary material: A1.
[931] Photos 1989, 405; Buchwald 2005, 35-7. See also Yalçin 1999, 180 n. 10.
[932] Buchwald 2005, 22-4, 29-34.
[933] Jambon 2017, online supplementary material: A1.

characteristic structure of meteorites can be identified. This includes the Widmanstätten texture and large crystal grains.[934]

4.3.1 Terrestrial iron

Terrestrial iron can be smelted from its ores at low temperatures (800-1300 °C) and in the solid state.[935] The end-product will be a bloom of iron, which is actually a lump of solid but spongy mixture of iron, slag and unburned charcoal. This method is known as the direct process. The smelting product of the direct process, i.e. the bloom, is malleable and can be immediately used or broken up into small pieces. However, consolidation and extraction of the slag from the metal by hammering at red heat (1000-1100 °C) is necessary.[936] Nevertheless, iron smelting, during this early stage of experimentation, could have resulted in the production of ferrite, containing less than 0.05% C, of steel (0.1-2% C), or even of cast iron with more than 4% C. This varying composition also occurred in the re-enactment of iron-smelting by a Mafa master in North Cameroon, in Africa. The differentiation in carbon content was a result of the inability to evenly control the temperature and the atmospheric conditions prevailing in the entire furnace.[937] If the end product desired is a high-carbon steel, or even cast iron, this has to be decarburised before it can be beaten to shape. The higher the carbon content in iron, the harder and more brittle it is.[938]

4.3.2 Meteoric iron

The most recent report on iron artefacts of the Bronze Age has introduced the idea, that all, or almost all, Bronze Age artefacts of the Near East derive from meteoric iron.[939] But what exactly is "meteoric iron"? For archaeologists, meteoric iron is that which comes from

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934 Muhly *et al*. 1985, 74; Photos 1989, 404-7; Yalçin 1999, 180 and n. 12; Rehren *et al*. 2013, 4787. See also: Photos 1989, 413-14; Johnson *et al*. 2013, 1003. Note that Widmanstätten structure can also appear in low-carbon steels (<0.3% C), under certain conditions (see Scott 1991, 20-1, 31-2; Todorov and Khristov 2004).

935 The melting point of pure iron is 1538 °C, although this can be lowered by additional carbon or phosphorous (David *et al*. 1989, 184; Serneels 2002; Buchwald 2005, 68; Charlton *et al*. 2010, 353).

936 Forbes 1972, 198, 206; Tylecote 1980, 209; Scott 1991, 138; Serneels 2002; Craddock 2003, 232. For an analysis of the smelting process and its varying outcomes, see: David *et al*. 1989, 183-4; Charlton *et al*. 2010, 353; Hamilton 2007. See also Buchwald 2005, 63-4; Yahalom-Mack 2015, 294-97.

937 David *et al*. 1989, 196. See also Forbes 1950, 411; 1972, 221-22.

938 Stech-Wheeler *et al*. 1981, 247 (see "martensite"); David *et al*. 1989, 184; Scott 1991, 31-3, 138; Serneels 2002. Note that in case sulphide iron ores (such as pyrite and pyrrhotite) are used, then "*the presence of sulfur from the ores has the potential to make any iron produced unworkable*." (Erb-Satullo 2014, 157) (see also Buchwald 2005, 149).

939 Jambon 2017, 6.

meteorites. This is a very vague "definition", though. (Almost) all meteorites contain a portion of nickel-iron metal in its elemental form. If we want to be more specific, and approach more effectively the question of iron and to understand more comprehensively what meteoric iron is, we first need to understand what exactly a meteorite is and then how could it have been identified during the period which we are studying.

We have all observed a "shooting star" in a clear night sky. This so-called "shooting star" is a meteoroid, a small piece of an asteroid or comet, entering our planet's atmosphere. This meteor makes its way through the atmosphere and if it survives entry and lands on the Earth's surface, then it is called a meteorite.[940] Meteorites are essentially stony objects which, if we follow the most basic typology and the easiest for non-specialists to understand, are classified into stones, stony-irons and irons. Stony meteorites are mainly composed of silicates (olivine and pyroxene), along with some nickel-iron metal.[941] They are the most common type of meteorites found, comprising a total of about 82.7% (in 1990) of the observed falls and found meteorites.[942] These are subdivided into chondrites and achondrites, the difference being the presence or not of chondrules, small grain-like inclusions. Chondrites contain around 19-30 wt% iron, not all of which is in its elemental state, i.e. not weathered. Moreover, they are the most common type of stony meteorites, accounting for approximately 85% of the found stony meteorites and observed meteorite falls.[943] On the other hand, achondrites do not contain iron and are essentially composed of silicon-based minerals.[944] Stony-iron meteorites, in contrast, consist of equal parts of silicon-based material and nickel-iron alloy. They represent the rarest type of meteorites found and falls observed (c. 1.5% in 1990).[945] Last but not least, iron meteorites are composed of almost exclusively iron-nickel metal (98%). Being formed in the core of large asteroids, iron meteorites are among the densest materials on earth and are significantly heavier than most rocks found on our planet.[946] Generally speaking, they represent about 28% of the total observed falls and found meteorites and they are more easily identified in the field, compared to stony meteorites.[947] The most beautiful characteristic of iron (and stony-iron) meteorites is the Widmanstätten structure, which can only be seen upon etching of a sliced piece. The structural composition of an iron meteorite includes crystals of kamacite (α-

[940] Norton and Chitwood 2008, 14, 43.
[941] Buchwald 1975, 61-3; Norton and Chitwood 2008, 75-8.
[942] Statistics reported in Buchwald 2005, table 1.3.
[943] Scott and Krot 2007, 2, 4-10, 34, 40-5; Norton and Chitwood 2008, 78-80.
[944] Norton and Chitwood 2008, 114-15, 192.
[945] Norton and Chitwood 2008, 167; see also pp. 168-73.
[946] Norton and Chitwood 2008, 149-50, 192; Goldstein *et al*. 2009, 320.
[947] Norton and Chitwood 2008, 192. Buchwald (2005, 23 table 1.3) reports that in 1990 only 15.8% of falls observed and meteorites found were of the iron class.

(Fe,Ni), ferrite) (lamellae), composed of c. >90% Fe and c. <10% Ni, interlocked with taenite (γ-(Ni,Fe), austenite), composed of c. 60-75% Fe and c. 25-40% Ni, which together form this striking pattern.[948]

Meteorites actually come in many forms and shapes: rectangular, flattened, conical, angular, ovoid, spherical, but typically irregular.[949] In a world without advanced analytical machines, which can see into a meteorite's very structure, other features and characteristics have to be sought in order to determine its celestial origin. These could be the colour and smoothness of an object, the presence of surface anomalies and its weight. A meteorite is very dense and much heavier that any terrestrially found rock. Its surface can be smooth, with regmaglypts (thumbprint-like indentations), which appear more striking on an iron meteorite, or with flow lines.[950] Freshly fallen stony meteorites have a dark brown to black fusion crust and iron meteorites have a black-blue crust, which "*looks like freshly welded steel*".[951] As iron meteorites fall through the earth's atmosphere an admittedly beautiful black and shiny fusion crust forms, but the longer they stay on the earth's surface, the more this fusion crust wears away and its place is taken by a brown iron oxide, i.e. rust (**Figure 29**).[952] This can make them look very much like terrestrial iron ores or simple rocks, as the elemental iron in the meteorite is converted into iron oxide, such like magnetite or goethite (**Figures 30-31**). It is important to note that the fraction-of-a-millimetre-thick fusion crust of an iron meteorite is very susceptible to rusting and it may take only a few centuries for it to completely disappear.[953] Achondrites (stony meteorites) also develop a shiny dark fusion crust (**Figure 32)**, but if they are to be gathered to smelt to produce iron, then the outcome will most certainly be a disappointment to the smelter, as this type of stony meteorite does not contain iron metal.

Figure 29. Iron meteorite found near Barringer Crater, northern Arizona, USA. Note the sharp edged regmaglypts and the shiny black fusion crust. The orange-coloured stains are areas which have been affected by weathering (Norton and Chitwood 2008, fig. 7.8).

[948] Buchwald 1975, 59-73, 76, 87-93; Norton and Chitwood 2008, 149-73; Goldstein *et al*. 2009, 294-95. See also Buchwald 1975, 94-113.
[949] Buchwald 1975, 45-9; Norton and Chitwood 2008, 58-62.
[950] Norton and Chitwood 2008, 59, figs. 3.21-3.28.
[951] Norton and Chitwood 2008, 53, 56.
[952] Norton and Chitwood 2008. 54-6, 68, 189-90, figs. 10.10-10.11.
[953] Norton and Chitwood 2008, 68.

Figure 30. Freshly fallen meteorite (chondrite) in Libya's desert (Norton and Chitwood 2008, fig. 10.10).

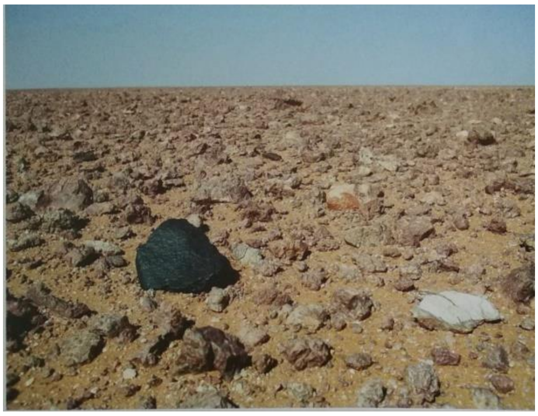
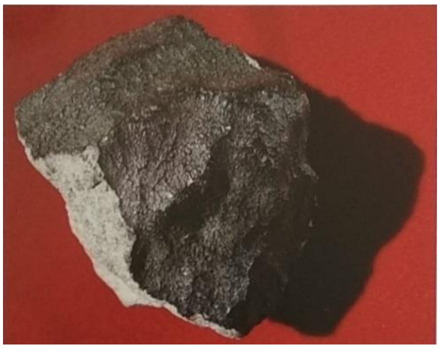


Figure 31. Stony meteorite weathering on the desert surface for c. 12,000 years (Norton and Chitwood 2008, fig. 10.11).

Figure 32. An achondrite (eucrite) stony meteorite with a shiny black fusion crust and a whitish interior (Norton and Chitwood 2008, fig. 5.9).



Moreover, this black colour does not exist only as a fusion crust on meteorites. Terrestrial rocks can also have such a dark surface (**Figures 33-34**). Many iron ores have a similar dark colouration with a light brown weathering product. Goethite has a black, brown to light brown colour and a dull metallic lustre. Apart from the fact that it is a very common weathering product of iron ores, it can also be found all over Anatolia. Most important among the sources of goethite is the area west-SW of Ankara, specifically the Eskişehir and Kütahya provinces, and the area south of the Kayseri, in particular the Niğde province. Additionally, this iron ore can also be found in Egypt and Israel.[954] Furthermore, siderite is another iron oxide

[954] Though it cannot be considered a complete map of localities and it is unknown which of those deposits were known and/or worked during the MBA and LBA, see the map in Mindat.org ("Goethite"), where goethite is recorded in western Central (province of Kütahya), southern Central (Niğde province), NE (Trabzon province), as well as northern Central Anatolia (Küre, Kastamonu province), the Egyptian Eastern Desert, Israel and possibly also Jordan.

($FeCO_3$), which has a yellowish-brown, brown colour with a vitreous lustre as well.[955] It is also found in many areas around Anatolia and more interestingly in the same areas where goethite can be found, in the Eastern Desert of Egypt, south of Aswan, as well as in Israel.[956] It is noteworthy that both goethite and siderite are said to exist in the Küre copper deposit, just north of Ankara, on the Black Sea. What is more, magnetite has already been mentioned as being associated with the newly found mineral, yazganite, in the Bolkardağ range. This is another iron oxide, of black colour and with a metallic (or dull metallic) lustre, which appears to be plentiful on the shores of the Black Sea, west of Trabzon.[957] Magnetite in Anatolia can also be found west of Ankara (Eskişehir province and Uludağ Mountain) and in the Kayseri province near Kültepe (Kaneš). It exists in eastern Israel, possibly in northern Jordan and northern Iraq, and in the Eastern Desert of Egypt.[958] Moreover, a lateritic deposit has been found in the eastern Taurus Mountains, south-SE of Yahyali in Kayseri (Buyukebelen). The mineral assemblage is composed of haematite and goethite in the weathering zone.[959]

Figure 33. Meteorwrong/rock (left) and meteorite (right) (Norton and Chitwood 2008, fig. 9.1).

Figure 34. A piece of terrestrial basalt (Norton and Chitwood 2008, fig. 5.11).

[955] Anthony *et al*. 2004-2018, "Siderite".
[956] See Mindat.org ("Siderite"), where siderite in Turkey is listed in western Central (Kütahya province), southern Central (Niğde and Adana provinces), NE Central (Tokat province), NE (Trabzon province), as well as northern Central Turkey (Küre, Kastamonu province). There is also a deposit in northern Iraq, on the borders with Turkey (Berzanik deposit, Sindi, Duhok province).
[957] Tylecote 1981; Anthony *et al*. 2004-2018, "Magnetite".
[958] See Mindat.org ("Magnetite"), by searching for a specific mineral in a specific region at the very bottom of the web page. A discussion regarding the most import and iron ores and deposits in the Near East can be found in Forbes (1972, 189-96).
[959] Kupeli and Arslan 1998.

Terrestrial iron ores and iron-containing meteorites can look very much the same and in the eyes of an untrained or unknowing eye exactly the same. The point is that they are basically the same, in the sense that they are "rocks that contain iron". Thus, if colour was the identifying element, then a differentiation between a terrestrial iron ore and a celestial iron rock would be very much impossible. Therefore, if we hypothesise that the people of the Bronze Age could in some way make the distinction, then another attribute should be looked for. As it has already been said, meteorites are denser and they have certain surface features that do not appear in earthly rocks. These are the regmaglypts and the flow lines that have formed during the passage of the meteorite through the Earth's atmosphere. During the OA period, or the entire Bronze Age for that matter, there is no indication that such a distinction was made. What we know is that the metal we call iron was recognised and used to manufacture a plethora of small, predominantly symbolic objects.

4.3.3 Anatolia

From Anatolia of the 2nd millennium BC there comes a very limited number of analysed iron samples, the vast majority of which come from the site of Kaman Kalehöyük and only (one or) two objects from Kaneš.[960] All samples were analysed by Akanuma throughout the years 2002-2008 with ICP-OES and are presented in **Appendix 9**.

The samples from Kaneš (Sample Nos. 324 and 325) belong to one or two artefacts. Sample No. 324 was taken from four restored fragments, while Sample No. 325 was taken from the corrosion layer of the two restored fragments. EPMA performed on the samples, in order to determine the mineral compositions of non-metallic inclusions, revealed impurities of sulphuric compounds and no steel structures. Furthermore, the former sample is composed mainly of copper and sulphur, while the latter is of iron and sulphur. However, they both contain high amounts of copper and cobalt, which must have derived from the ore used and not from the surrounding soil.[961]

[960] Omori and Nakamura (2006) have ^{14}C dated collected samples of bones, charcoal and charred grain, and provided the following calibrated dates: Stratum IIIc: 1910-1740 cal. BC (1930-1750 BC), Stratum IIIb: 1730-1540 cal. BC (1700-1400 BC), Stratum IId: 1410-900 cal. BC (1200-800 BC). The calibrated date given for Stratum IId shows a slight range difference, which cannot be further commented upon due to limited results (Omori and Nakamura 2006, 267).
[961] Akanuma 2003, 142, 145.

The analysed objects from Kaman Kalehöyük (listed here) span from 2200 BC (Stratum IVa) up to 800 BC (Stratum IId) and they comprise artefact fragments (Sample Nos. 318-323, 326-341), ore samples (Sample Nos. 342-346) and slag samples (Sample Nos. 347-348).[962] The analysed artefact fragments report the existence of steel during the 2nd millennium BC (the entire Stratum III) at the site, but they were almost certainly unintentional and accidental products.[963] The absence of evidence for actual iron production until (most probably) after 1400 BC, when slag has been reported and excavated ores have been related to either iron or copper production, speaks in favour of this conclusion.[964] The objects that have been found to contain carbon are presented in **Table 20**. The artefacts that have been identified as steel are admittedly very few, while most of them could have been of a much later date than the OA period, possibly dating after the 14th century BC.

The ores and slags that have been excavated and analysed, corresponding to all time-periods from which steel samples have been found, do not reveal a definite association with iron production. The red-brown lump of iron ore (Sample No. 342), excavated from Stratum IVa, has a chemical composition which matches that of haematite, with an additional amount of magnetite.[965] In the following stratum, Stratum IIIc, a small blackish-brown lump of iron slag was discovered (Sample No. 347).[966] In it, EPMA revealed areas of cementite, but the carbon content has not been recorded.[967] Of interest is the fact that this iron slag has been found in the near vicinity of several copper slags, whose main components are copper, iron oxide and sulphur, and a copper lump which is believed to "*originate from residual iron oxide or sulfuric compounds*".[968] The co-occurrence of these metal slags could be interpreted as their being parts of the same process, perhaps one of a copper production.

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[962] Any samples of uncertain dating, even approximate, are not included in this research.
[963] See Siegelová and Tsumoto 2011, 297.
[964] Akanuma (2003, 137) reports that "*In Stratum IIIa levels at Kaman-Kalehöyük (Hittite Empire Period), small lumps of slag, roughly the size of a thumb, were excavated along with fragments of iron artifacts with the composition of steel. The presence of slag indicates that some kind of iron production process was most likely carried out at the site at this time*.". Ores related to either iron or copper production are listed here as Sample Nos. 345 and 346. They are dated to Stratum IIIb-IId (c. 1700-800 BC) and are mainly composed of quartz and pyrite, and quartz and chalcopyrite, respectively (Akanuma 2004, 170).
[965] Akanuma 2008, 318.
[966] Akanuma (2007, 135) notes that "*according to Dr. Sachiro Omura, several pieces of iron slag were discovered from a structure dating to the Assyrian Colony Period during the 2007 excavation season*.".
[967] Akanuma 2007, 133-34, fig. 2.
[968] Akanuma 2007, 134.

Table 20. Carbon content and structure in samples from Kaman Kalehöyük.

Sample No.	**Level / Date**	**% C**
318	IVa (c. 2200-2030 BC)	0.1-0.3
320	IIIc (c. 1930-1750 BC)	0.1-0.3
321	IIIc (c. 1930-1750 BC)	0.2-0.3
323	IIIc (c. 1930-1750 BC)	0.1-0.2
330	III (c. 1930-1200 BC)	> 0.5
331	III (c. 1930-1200 BC)	> 0.5
332	III-IId (c. 1930-800 BC)	0.3-0.4
336	IIIa-IId (c. 1400-800 BC)	0.2-0.3
339	IIIa-IId (c. 1400-800 BC)	> 0.5
340	IIIa-IId (c. 1400-800 BC)	0.2-0.3

Furthermore, in Stratum IIIb a rather heavy lump of iron ore (Sample No. 343), weighing 413 g, has been found and analysed. This has been identified as a lump of haematite, containing a small amount of magnetite – just like the ore excavated from Stratum IVa. In view of the absence of any evidence of an iron production process, this item has been linked to the preparation of red-pigment for pottery.[969] Additionally, there are three more samples of ores, which have been dated to Stratums IIIb-IId, thus spanning the entire LBA and entering the Iron Age (Sample Nos. 344-346). Sample No. 344 is a small lump of iron ore, containing pyrite (FeS_2) and chalcopyrite ($CuFeS_2$), thus being identified as composed of limonite (associated to the mineral goethite) and haematite.[970] This too has preferentially been associated with a red-pigment-preparation process.[971] Sample Nos. 345 and 346 are two more small lumps of ore composed of possibly quartz and pyrite for the former, and possibly quartz, chalcopyrite and iron oxide the latter. Both of them have been related to copper or iron production.[972] Finally, in Stratum IIIa-IId, one more, small and dark brown iron slag piece was found.[973] Apart from its main components, which are iron oxide and silica, it also contains a small amount of copper (0.221 wt% Cu), which has been estimated to originate "*from the residual copper or copper compounds in the iron or iron corrosion*".[974]

[969] Akanuma 2006, 219.
[970] Akanuma 2004, 169.
[971] Akanuma 2004, 170.
[972] Akanuma 2004, 169-70.
[973] Akanuma 2003, 144.
[974] Akanuma 2003, 146.

As a result, the above-cited analysed samples from objects, ores and slags found in Kaman Kalehöyük do not offer any concrete evidence for the existence of iron production. Indeed, some accidental iron (steel) artefacts could have been produced in the process, but the overall picture is either of a preparation process of an iron-based pigment for pottery, or copper production. All ore and slag samples presented here could very well be related to the smelting of copper sulphide, or nickel-rich copper, ores.[975] Despite the prevailing notion of iron production having been in existence since the EBA at Kaman Kalehöyük,[976] the iron artefacts, ore and slag samples that have been found and analysed, along with all analysed copper slag samples, recall rather the slag samples found in the Late Chalcolithic site of Çamlıbel Tarlası (c. 3500-3100 BC), situated only 2.5 km west of the later established Ḫattuša, and the EBA site of Arisman in Iran (c. 3200-2300 BC) (**Figures 1** and **28**). Slags analysed by Boscher[977] from these two sites revealed that it would not be unexpected for small amounts of iron to be produced during the process of producing arsenical copper, using sulphuric compounds.[978]

To the importance of sulphuric compounds in copper production bear witness the two iron samples from Kaneš (Sample Nos. 324 and 325) as well. These contained a rather high amount of copper, reaching 5.34 wt% and 8.77 wt% Cu, as well as high cobalt amounts, 0.149 wt% and 0.192 wt% Co, respectively. Their structure consisted of Cu-S and Fe-S phases, many residual impurities composed of sulphuric compounds, but no steel structure.[979] Based on the fact that they were found in Kaneš, which was not a smelting site but one of secondary metal treatment, these samples cannot be related to a smelting process. However, they could be associated with a copper refining process.[980] It is worth mentioning that copper smelting slags from sites in western Georgia, ancient Colchis, were previously misinterpreted as iron smelting slags.[981]

Most of the early iron artefacts analysed come from the late 3rd millennium BC strata of Alaça Höyük.[982] A low nickel content, lower than 3 wt% Ni, was found in all iron objects

[975] See Akanuma 2007,137. See also: Lehner 2015, 158; Boscher 2016, 154-90, 221-49.
[976] See Akanuma 2007, 135-36; 2008, 320.
[977] Boscher 2016.
[978] See: Merkel and Barrett 2000, 65; Erb-Satullo *et al*. 2014, 157; Boscher 2016, 226, 303-5. See also Chapter 4.2.1.5.
[979] Akanuma 2003, 142.
[980] Cf. Akanuma 2005, 151.
[981] Erb-Satullo *et al*. 2014, 150. According to Erb-Satullo *et al.* (2014, 150), copper and iron smelting slags have a relatively similar bulk chemical composition, the latter commonly contain less than 0.02% Cu and the former 0.5-3% Cu. See also Nieling 2009, 267, 277-79.
[982] The Alaça Höyük iron finds were initially dated to the early 3rd millennium BC, but upon reconsideration they were placed in the late 3rd millennium BC (Lehner 2014b, 139). See: Yalçin 1999, 177-80; 2000b, 309; 2005b, 494-96. Yalçin (2005b, 493) also mentions a few Neolithic iron artefacts from Iraq and Iran that have been reported, but their dating is unclear due to uncertain stratification. For the location of the site, see **Figure 1**.

from this site. Yalçin[983] maintains that such artefacts are products of iron-nickel mixed ores smelting, such as can be found in ophiolitic deposits. An example of such a deposit is Tavşan Dağ (Mountain), which is located between Alaça Höyük and Amisos (present Samsun) (**Figure 1**).[984] Just west of Amisos there is the site of İkiztepe, where a silvery coloured and nickel-rich iron ingot was found, dating to the MBA.[985] Regarding the iron production in Amisos, an ancient Greek text, written by a pseudo-Aristotle, reads as follows:

> *Λέγεται δὲ ἰδιαιτάτην εἶναι γένεσιν σιδήρου τοῦ Χαλυβικοῦ καὶ τοῦ Ἀμισηνοῦ. συμφύεται γάρ, ὥς γε λέγουσιν, ἐκ τῆς ἄμμου τῆς καταφερομένης ἐκ τῶν ποταμῶν. ταύτην δ' οἱ μὲν ἁπλῶς φασὶ πλύναντας καμινεύειν, οἱ δὲ τὴν ὑπόστασιν τὴν γενομένην ἐκ τῆς πλύσεως πολλάκις πλυθεῖσαν συγκαίειν, παρεμβάλλειν δὲ τὸν πυρίμαχον καλούμενον λίθον· εἶναι δ' ἐν τῇ χώρᾳ πολύν. οὗτος δ' ὁ σίδηρος πολὺ τῶν ἄλλων γίνεται καλλίων. εἰ δὲ μὴ ἐν μιᾷ καμίνῳ ἐκαίετο, οὐδὲν ἔν, ὡς ἔοικε, διέφερε τἀργυρίου. μόνον δέ φασιν αὐτὸν ἀνίωτον εἶναι, οὐ πολὺν δὲ γίνεσθαι.*[986]

Which translates as:

> It is said that the production of the Chalybian and Amisenian iron is very peculiar; for it grows together, as at least they assert, from the sand that is carried down by the rivers. Some say that they simply wash this, and smelt it in a furnace; but others that, after frequently washing the deposit left by the first washing, they burn it, and insert what is called the fire-proof stone which is abundant in the country. This iron is far more beautiful that the other kinds. But if it were not burnt in the furnace it would not at all differ, as it appears, from silver. Now they say that it alone is not liable to rust, but that it is not very plentiful.[987]

This passage certainly reminds us of bog- and lake-iron. The former carries a lot of impurities, mainly phosphorus and manganese, and needs prolonged roasting before smelting. The latter, on the other hand, needs only washing and drying.[988] Bog iron is otherwise known as limonite, coming from the Greek word *λειμών* which means meadow; an obvious reference to its find-place. Limonite is usually found in the form of goethite (*a*-FeO(OH)), which is actually a common weathering product from a variety of iron-bearing minerals.[989]

In relation to the manganese content of the bog iron ore, the two lumps of manganese, iron-rich ore found in the "house of Perua" in Kaneš are worth mentioning.[990] Another

983 Yalçin 2005b, 495.
984 The deposit lies 100 km southwest of Amisos (Yalçin 2004, 223, map) and approximately 100 km north of Alaça Höyük (Yalçin 2005b, 495) (**Figure 1**).
985 Yalçin 2004, 223.
986 *Mir. ausc*. 833b.48.
987 Downdall 1909, 833b-834a. See also Forbes 1950, 404-5.
988 Forbes 1950, 405.
989 Anthony *et al*. 2004-2018, "Goethite".
990 Dercksen 2005, 28 and n. 48.

manganiferous ore, which contains a considerable amount of iron and whose surface can often be weathered to limonite, is haematite.[991] Haematite was recognised by the OA traders. Text ICK 2, 54 specifically mentions copper that does not contain haematite, referring to it with the word *šaduwānum*. Unfortunately, as Dercksen[992] also notes, the description of the lumps found in Kaneš is rather ambiguous and it is unknown whether a chemical analysis has been performed on them – certainly nothing published has been found. Whichever type of ore these lumps are, and based on the site where they were found, it is difficult to imagine them being related to a smelting process. However, this does not mean that haematite was not generally used in the smelting of copper, where it is recognised as a separate component.

What is more, bog iron ores, i.e. limonite (also known as brown haematite) and goethite, are also very often used as pigments.[993] Goethite (limonite) was known as brown/yellow ochre and haematite as red ochre and they were both used as pigments on a range of materials and surfaces.[994] An intriguing and recently discovered example of the use of goethite as pigment can be found in textiles from Gordion, linked to the mythical golden touch of King Midas. Gordion (modern Yassıhöyük) is located in Central Anatolia, close to the confluence of the Porsuk and Sakarya rivers, near to where Šalatuwar may have been (**Figures 1** and **39**). Its habitation begins from at least 2500 BC (EBA) and continues until modern times.[995] During the OA period, Gordion does not appear to represent any important trading post, but it does have ties with the Central Anatolia plateau and sites like Ḫattuša, Kaneš, Alişar Höyük and Alaça Höyük.[996] During the Middle Phrygian period (c. 800-540 BC) and at the beginning of Midas' reign (around 740 BC), Tumulus MM (also known as Midas Mound) was erected.[997] Inside this intact burial chamber no gold was found, despite the myth of King Midas' "golden touch". In an analysis of textile fragments found in the burial chamber, no fibres were found. What remained was a hollow core with an outer "*continuous golden yellow film*".[998] This surrounding film is composed of an inorganic material, containing 97 wt% Fe, which was found to be goethite. It seems like the shroud that covered the dead body had been "painted" with a

[991] Forbes 1950, 403.
[992] Dercksen 2005, 28.
[993] Allen 2017, 121. They were also both used for seals and weights (Moorey 1994, 75, 84).
[994] Moorey 1994, 139, 152-59, 327. See for example the publications by Perdikatsis (1998) and Kaplan *et al*. (2014) and note the use of manganiferous ores for black pigments and that of ferrous ores for red pigments.
[995] Barjamovic 2011, 354; Rose 2015, 13-4; The Gordion Archaeological Project 2015, "Archaeology: Overview" and "Archaeology: Chronology".
[996] The Gordion Archaeological Project 2015, "History: Bronze Age".
[997] Rose 2015, 15-6.
[998] Ballard 2012, 166.

film of goethite, thus making it look golden.[999] This newly discovered use of iron ores provides one more hint of the plethora of applications these, among other, ores had and to the ingenuity of the people of the Bronze Age. For this reason, finding an iron ore in an archaeological site should not be directly assumed to be connected to the production of iron. It is important to always keep in mind the archaeological context and the nature of the site and find-spot. It is a proven fact that such ores were used for a variety of purposes, many (if not most) of which are not related to the production of metals but to the decoration of a selection of surfaces.

Returning to the iron finds of Alaça Höyük, among the artefacts that date to the EBA II (c. 2800-2500 BC) there are also a necklace iron terminal (not analysed), an iron knife fragment (not analysed), a semi-lunate iron disc (with 2.4% Ni), two gold-headed iron pins (with 2.7 wt% Ni) and the well-known gold-handled dagger (low Ni content). Some iron fragments are also dated to c. 1800-1200 BC, but no performed analysis is mentioned.[1000] Moreover, a lump of iron from Tarsus, dating to the EBA III (c. 2400-2100 BC), some metal fragments from Kusura, dating to c. 1800-1600 BC, and the already mentioned pin from Alişar are reported, but none of them has been analysed.[1001] Furthermore, from the LBA, (pieces of) iron artefacts have been found in Ḫattuša (c. 1450-1200 BC) and Tell Açana (c. 1450-1200 BC).[1002] A lugged axe found in Ḫattuša appears to have been made of accidentally produced steel with an uneven carbon content: about 0.2% C in the handle and c. 0.6-0.7% C in the blade. Muhly *et al.*[1003] estimate that the carburisation of the axe was achieved by the necessary multiple annealing of the blade in order to properly work on it and give it its shape without breaking it.

Figure 35. Alaça Höyük iron dagger with gold handle (https://commons.wikimedia.org/wiki/File%3AAlaca_H%C3%BCy%C3%BCk_dagger.jpg).

[999] Ballard 2012, 166; Amrhein *et al*. 2015, 55. See also Ballard 2012, 167-70.
[1000] Muhly *et al*. 1985, 78-9; Yalçin 1999, 181, table 1. See also: Muhly *et al*. 1985, 71; Yalçin 2000b, 308-9.
[1001] Yalçin 1999, 178-81.
[1002] Yalçin 1999, 181-82, table 1.
[1003] Muhly *et al*. 1985, 78.

The gold-handled iron dagger from Alaça Höyük (**Figure 35**), dated to approximately 2500 BC, had a severely corroded blade and was initially found to contain a low percentage of nickel, which naturally deemed it as of a non-meteoric origin. The state of extreme corrosion, however, can greatly affect the nickel content of an artefact, thus "concealing" the true composition and origin of the iron, which upon anew examination could prove to be contradictory to the previous assessment.[1004] Nakai *et al*.[1005] have recently re-examined the dagger with a pXRF, discovering that the extensive corrosion has left no metal core in the iron blade. Their analysis showed that the dagger's blade is of meteoric iron, containing c. 2.4-6 wt% Ni. According to Jambon's research,[1006] the nickel content of an artefact is not enough to prove its meteoric, or not, origin, because irregular weathering can yield inconsistencies in the nickel content. Hence, multiple spots should be analysed and the more reliable Ni/Co vs. Ni/Fe ratio should be used. Jambon[1007] comments that "*because of the possible analytical bias the Co data were not considered*". Nakai *et al*. do not comment on the exact iron content of the dagger. However, they do offer the NiO and CoO contents of four analysed points, from which Jambon calculated the elements' contents. Thus, cobalt is found in the range of 0.16-0.24% in the metal, producing Fe/Co, Ni/Fe and Ni/Co ratios (calculated with any possible iron content from 10% to 90%) that place this artefact in the meteoric origin field. Based on Jambon's article, charts with a) the Ni:Fe:Co correlation and b) the Ni/Co vs. Ni/Fe ratios have been plotted (**Charts 56-57**). In the first (above-placed) charts the two different groups formed by the iron samples of terrestrial origin and those of meteoric origin are rather obvious, while at the same time, in the second (below-placed) charts the trend followed by the meteoric iron samples is evidently at a much different angle than that followed by the rest of the iron samples.

[1004] Yalçin 1999, 180.
[1005] Nakai *et al*. 2008.
[1006] Jambon 2017, 3.
[1007] Jambon 2017, online supplementary material: A4.1.

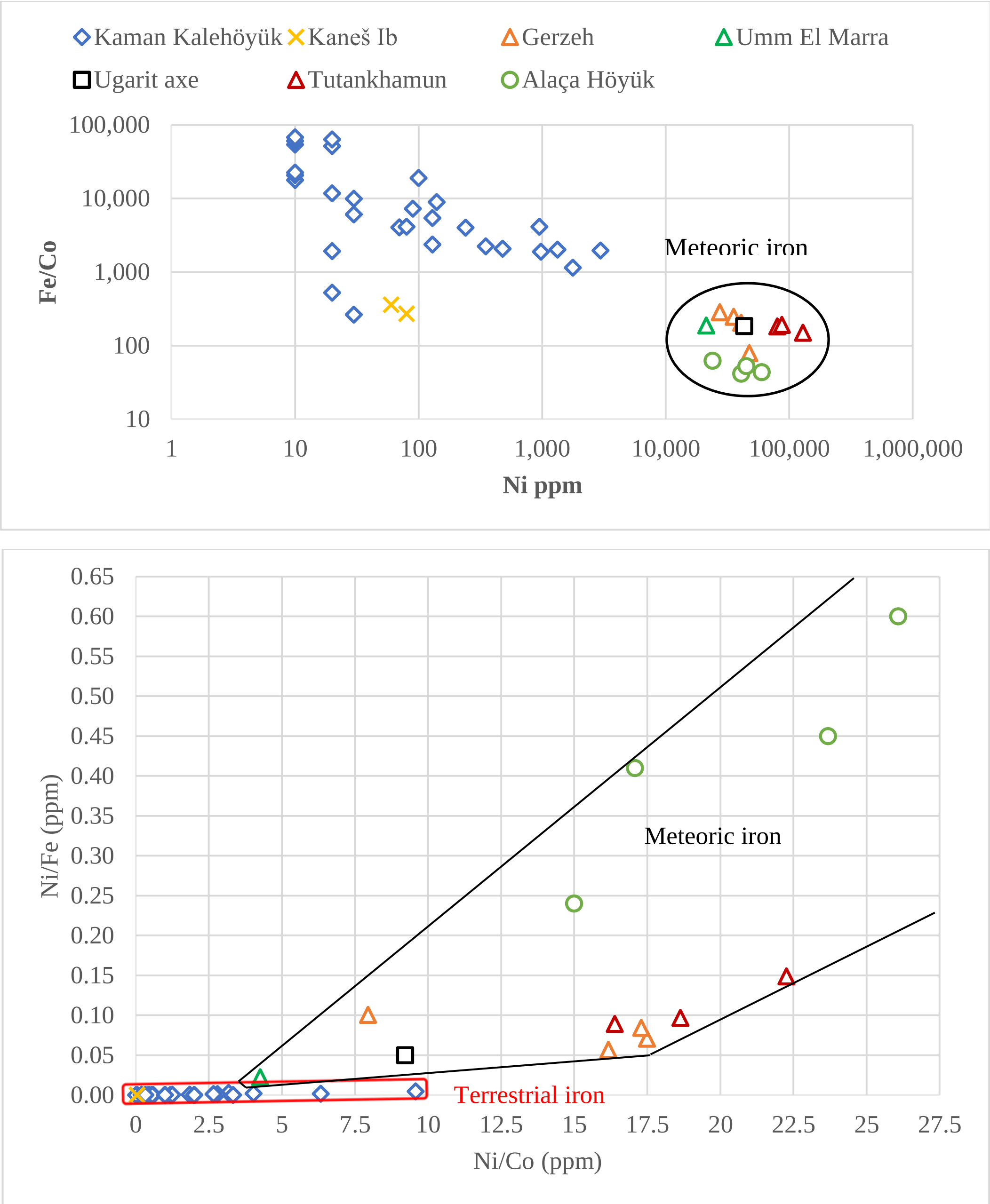

Chart 56. Ni:Fe:Co correlation of iron artefacts. Alaça Höyük dagger:10% Fe.

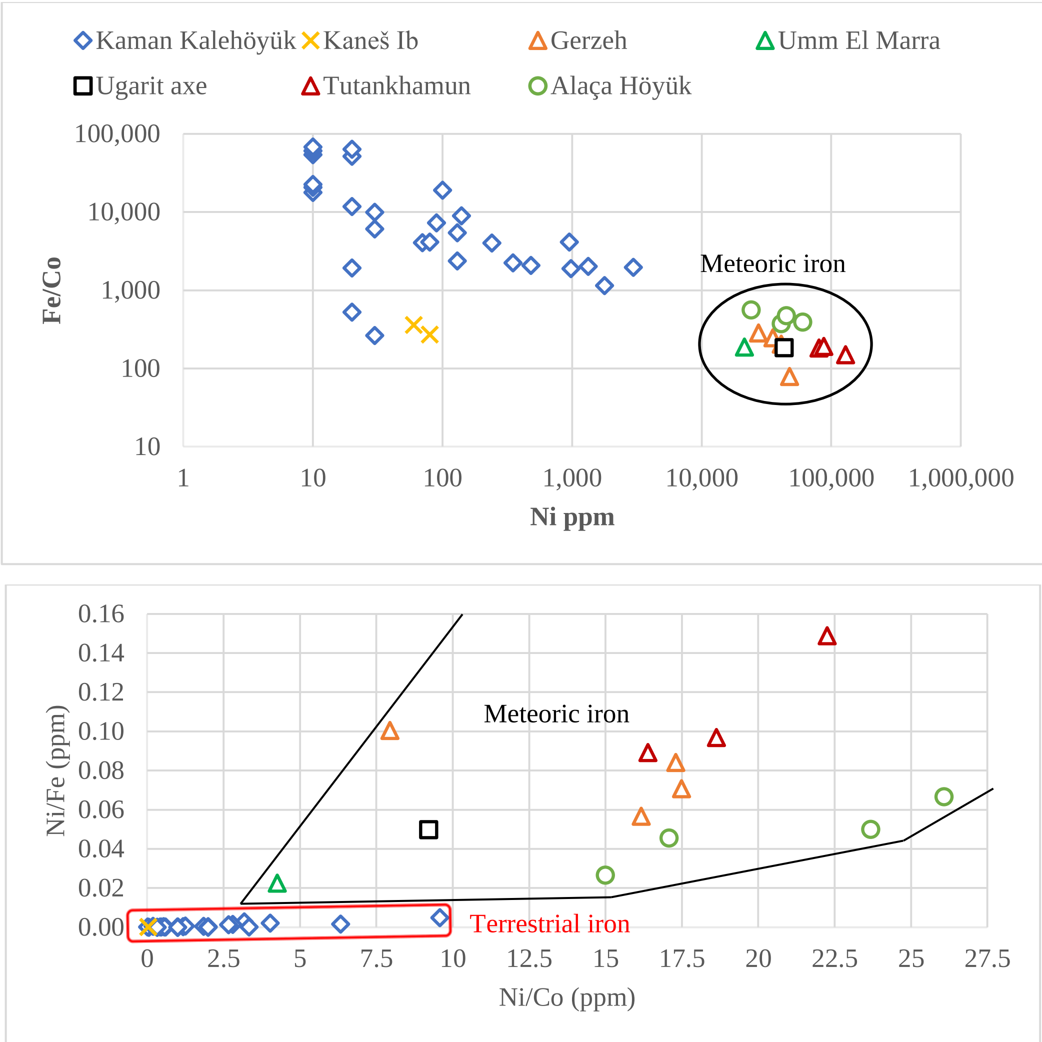

Chart 57. Ni:Fe:Co correlation of iron artefacts. Alaça Höyük dagger: 90% Fe.

Finally, the “Hittite” sword seen in **Figure 36,** published and analysed by Yalçin,[1008] is an example of LBA steel. It has a cast bronze haft and a steel blade, constructed from several pieces containing different levels of carbon (**Figure 37**).[1009] Unfortunately, it does not come from an excavated site but from the art market, so its provenance and exact date are uncertain. Initially, it was dated to the 14th/13th centuries BC. However, based on its haft’s shape it was later placed to the turn of the 2nd towards the 1st millennium BC. Its place of origin could be either NW Iran or eastern Anatolia.[1010] As a matter of fact, towards the 12th century BC and the beginning of the Iron Age, increasingly more true steel artefacts come to light, especially

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[1008] Yalçin *et al*. 2005b, 499, figs. 7-8; 2005a, fig. 223. The sword is in the Ruhr Museum, Essen, Germany (Inv. Nr. AS 70:293).
[1009] Yalçin *et al*. 2005b, 499, figs. 7-8.
[1010] Siegelová and Tsumoto 2011, 297 n. 89.

in the areas of Cyprus, Palestine and Transjordan.[1011] A discussion on this matter is, however, outside the scope of this research.

Figure 36. “Hittite” steel sword with bronze haft (Yalçin 2005a, fig. 223).

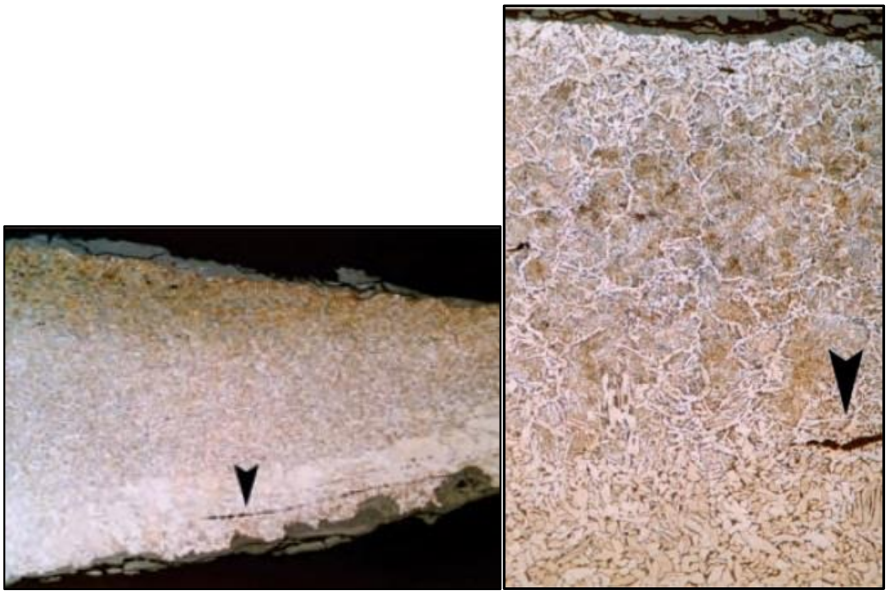

Figure 37. Microstructure of the “Hittite” steel sword. The arrow shows a not-so-well welded point/crack (Yalçin *et al*. 2005b, 499 fig. 8). The different grain size and structure of the different pieces is obvious.

4.3.4 Egypt

The oldest iron finds from Egypt come from an undisturbed tomb from the burial site in Gerzeh, dated to the late 4th millennium BC, and are made of meteoric iron.[1012] More specifically, they were a set of beads: carefully hammered thin sheets were then rolled into the

[1011] See: Pigott *et al*. 1982; Muhly *et al*. 1985, 80-1; Moorey 1994, 288-89; McGovern 1995, 30-3; Nieling 2009, 272-76; Yahalom-Mack and Eliyahu-Behar 2015, 285, 299-300. Smith *et al.* (1984, 234) refer to a small blade fragment from Pella, which has a martensitic structure, meaning that it was quickly cooled (quenched) possibly by plunging into water (see also Muhly *et al*. 1985, 80). This is a step towards a harder but more brittle steel. In order to relieve the metal of its brittleness, tempering is needed (see: Stech-Wheeler *et al*. 1981, 247; Scott 1991, 33; Yahalom-Mack and Eliyahu-Behar 2015, 297).
[1012] Rehren *et al*. 2013, 4785-786; Johnson *et al*. 2013, 997-98.

shape of a tube bead.[1013] The Gerzeh beads have previously been analysed and found to contain variable levels of nickel.[1014] Hence, further analysis with modern technology was in order. In 2013, Rehren *et al.* analysed three Gerzeh beads from the Petrie Museum of Egyptian Archaeology, University College of London. Meanwhile, Johnson *et al.*[1015] analysed another Gerzeh bead from the Manchester Museum. Rehren's *et al*.[1016] analysis was performed with Prompt Gamma Activation (PGAA), which is a non-destructive, quantitative analytical method. It is used for the determination of the elemental composition of an artefact and it works especially well when the analysed object is small, as neutrons can penetrate a few centimetres into the object. Johnson's *et al*.[1017] analysis was performed with SEM-EDS. From the EBA as well, around 2300-2000 BC, is a ball-shaped iron pendant from a tomb in Umm el-Marra, Syria, located just east of Aleppo.[1018] The pendant was analysed both by Bilal[1019] and by Jambon[1020] using a portable XRF device.

The chronologically next iron artefact is a (probably ceremonial) axe found in Ugarit (present-day Ras Shamra), dated to approximately 1450-1350 BC, i.e. the LBA. It consists of an iron blade, set in a copper-alloy socket with gold inlay.[1021] The analysis of this artefact was done with a pXRF as well.[1022] Regarding these last two objects (pendant and axe), the analytical results presented by Jambon differ only slightly from those presented by Bilal.[1023] Those of the latest publication are here employed. The most famous Egyptian iron artefact is Tutankhamun's iron dagger which, along with a miniature headrest and a bracelet, constitute the total of Tutankhamun's analysed iron funerary artefacts. The dagger has an iron blade and a decorated gold sheath, ending in a rock crystal pommel. The analysis of these objects was performed with pXRF by Comelli *et al.*[1024] and Ströbele *et al*.[1025] The artefacts and their elemental analyses are presented in **Appendix 9**.

[1013] Rehren *et al*. 2013, 4788, 4790-791; Johnson *et al*. 2013, 1000-2.
[1014] See Rehren *et al*. 2013, 4786; Johnson *et al*. 2013, 997-98; Jambon 2017, online supplementary material: A3.3, A4.1, table A4.
[1015] Johnson *et al*. 2013.
[1016] Rehren *et al*. 2013, 4787.
[1017] Johnson *et al*. 2013, 999.
[1018] See Schwartz *et al*. 2003, 325-26, 331, fig. 1. See also Bilal 2014, fig. 5.
[1019] Bilal 2014, 85, table 3.
[1020] Jambon 2017, online supplementary material: A4.1, table A4.
[1021] Muhly *et al*. 1985, 81; Aruz *et al*. 2008, 243-44; Nieling 2009, 243-44.
[1022] Bilal 2014, 85, table 2; Jambon 2017, 2, online supplementary material: table A4.
[1023] Jambon 2017, online supplementary material: table A4; Bilal 2014, 85-86 tables 2 and 3.
[1024] Comelli *et al*. 2016.
[1025] Ströbele *et al*. 2016. Due to my inability to find and study this article, its analytical results are here reproduced from Jambon (2017, online supplementary material: table A4).

Based on the conventional Ni-limit that characterises meteoric iron, most of the samples listed here should be described as of a non-meteoric origin. Nonetheless, further analysis of these objects showed that they are indeed all made of meteoric iron. The Gerzeh beads now consist of 99.9% corrosion with no metallic iron, thus a recalculation of the nickel content, factoring in the extreme state of corrosion, yields a 6-9% Ni content, which offers a good indication of a possible meteoric origin. Structural analysis and the germanium levels (measured with PIXE and found to be "*much higher than those detected in smelted iron*")[1026] of the beads gave further positive indications.[1027] The Umm el-Marra pendant is in an even more weathered state than the much older Gerzeh beads and has, consequently, yielded very low Ni levels.[1028] This iron sample is a good example of why the nickel content or the Ni/Fe ratio alone are not sufficient to prove the origin of an iron artefact. Excessive corrosion can produce varying Ni/Fe ratios, as the nickel content is diminished to a greater extent by weathering than is iron.[1029] For this reason, Jambon[1030] concluded that a Fe:Co:Ni abundance calculation for iron artefacts is necessary in order for their origin to be determined. With these calculations, the Umm el-Marra pendant is found to group together with meteoric iron samples and away from samples of terrestrial iron (**Charts 56-57**).[1031]

For LBA iron artefacts, there exist the axe from Ugarit and Tutankhamun's dagger, bracelet and miniature headrest. The blade of the Ugarit axe gave irregular nickel measurements, ranging from 1.7 wt% to 7.6 wt% Ni, and a mean value of 4.33 wt% Ni.[1032] The Ni/Fe vs. Ni/Co ratios place the axe in the same diagonal axis that is observed to be followed by all weathered meteoric iron objects, whence its identification as of meteoric origin came.[1033] Last but not least, Comelli *et al*.[1034] recently published an analysis of the iron dagger that was found on the right thigh of Tutankhamun's mummy. Their approach entailed a pXRF analysis of two spots on roughly the base of the blade and the calculation of the nickel content and of the Ni/Co ratio. The markedly high level of nickel (10.8 wt% Ni), as well as the high Ni/Co ratio (c. 18.6), are two important markers of the meteoric origin of the iron.[1035] What is more,

[1026] Rehren *et al*. 2013, 4790. See also Goldstein *et al*. 2009, 296-97.
[1027] Rehren *et al*. 2013, 4789-790; Johnson *et al.* 2013, 999-1000.
[1028] Jambon 2017, online supplementary material: A4.1.
[1029] Jambon 2017, 2-3, 5.
[1030] Jambon 2017, 3, 5-6.
[1031] See Jambon 2017, 3, figs. 3 and 4.
[1032] Bilal 2014, 85; Jambon 2017, online supplementary material: table A4. See also: Muhly *et al*. 1985, 81; Nieling 2009, 243-44.
[1033] See Jambon 2017, 2-3, figs. 2 and 3.
[1034] Comelli *et al*. 2016.
[1035] Comelli *et al.* 2016, 5-7.

by plotting the dagger's, as well as the bracelet's and the miniature headrest's Ni/Co vs. Ni/Fe ratios in a chart, they all fall well within the of-meteoric-origin field (**Charts 56-57**).[1036]

The analytical data provided by various researchers show that the generally-held hypothesis that all early iron artefacts were made from meteoric iron is true. Up until now, all evidence we have from actual iron artefacts from Anatolia of the MBA, as well as from Egypt of the EBA, MBA and LBA, point to the use of meteoric rather than terrestrial iron. The analysed samples from the site of Kaman Kalehöyük cannot be considered as actual artefacts and are taken as questionable evidence of iron production.

[1036] Jambon 2017, 3, fig. 3, online supplementary material: A4.1.

5 Discussion

The texts from the OA period, found in Kaneš, testify to the circulation and utilisation of a number of metals, primarily in their raw form and not as ready-made objects. These metals, KÙ.GI/*ḫurāṣum* “gold”, KÙ.BABBAR/*kaspum* “silver”, URUDU/*wērium* “copper”, AN.NA/*annakum* “tin”, *parzillum* “iron”, as well as KÙ.AN/*amūtum*/*aši’um*, are found to be accompanied by subjects or phrases that comment on their external appearance, i.e. form or shape (stone, dust, in small pieces, lumps, or bars) and colour, on their quality (good, poor, bad, or inferior) or purity (clear or refined), and their provenance. The references to the same metals in the Amarna letters, with the addition of AN.BAR/*parzillum* and *ḫabalkinnum* “iron”, exhibit some differences, but they always adhere to the same principal of a subject or phrase accompanying the metal, thus specifying an attribute of the raw metal or metal object. The Akkadian words that characterise a specific metal and for which there is no definite translation should also be understood as indicators of shape, colour or quality. It is possible that two of these factors could be encompassed by the same word. For example, the variety of gold known as *pašallum* from the Kaneš texts refers to the quality of the gold. This could have ultimately been realised by the colour of the metal. It may be that a metallurgical process led to this product. Thus, the sub-references of the process and the colour were included in the word *pašallum*, resulting in the meaning of a specific quality. The varieties of *šikkum* copper, “clear”, “good”, or “bad” gold, silver, copper and tin can also be treated and understood in the same way.

5.1 Old Assyrian trade routes and the Anatolian metal sources

The OA trade routes, trading colonies and stations in Anatolia facilitated the transportation of metals from their sources. By overlapping maps of Anatolia, where the (possible) locations of OA trading colonies and stations are presented (**Figure 39**), with maps of Anatolia, where the metal sources are shown (**Figure 38**), it becomes rather obvious that many of the major towns are (possibly) close to one or more metal sources. For example, Šalatuwar’s possible location has been placed in the near vicinity and to the southeast of the lead-silver deposit of Gümüşköy (TG 155), where copper ores are also to be found. The poroposed locations of Wahšušana and Tawiniya are in environs of a cluster of native copper sources (TG 272: Derekütügün, TG 273: Üçoluk and TG 274: Çağşak). If these deposits were exploited during the OA period, then the copper acquired could have been what the OA traders called “copper of its stone” URUDU *ša šaduišu*. Durhumit and Tišmurna are also thought to have been located in the neighbourhood of the copper-iron sulphidic deposit of Derealan (TG 164), the gold-silver-lead-zinc-iron polymetallic deposit of Gümüş or Gümüşhacıköy (TG 165), and the major copper and iron sulphidic, gold- and silver-bearing, deposits of Küre in the western Pontid (TG 162). Moreover, east of the area of the assumed location for Durhumit, there are more copper, iron, silver-lead and gold-bearing deposits, such as Kozlu (TG 275), Camili (TG 278), Gölcük (TG 279), Tirebolu (TG 170), Gümüşhane (TG 171) and Karadağ (TG 172). Furthermore, the central Taurus Mountains and the mining area of the Bolkardağ, in southern Central Anatolia, are rich in gold- and silver-bearing lead ores, as well as iron-nickel sulphides and iron and copper minerals and sulphidic ores (TG 236, TG 237, TG 287).

Unfortunately, recording the movements of the metals as read in the OA letters does not provide information regarding the sources of the metals. These tablets are letters written and sent from businessmen. The locations that they refer to do not necessarily coincide with the locations from where the metals could initially be acquired. With only a few exceptions, where we read about copper from a specific place of origin, such as from Habura(ta), Durhumit or Taritar, what we see in the texts is the movements of the metals based on, and in service of, trading transactions.

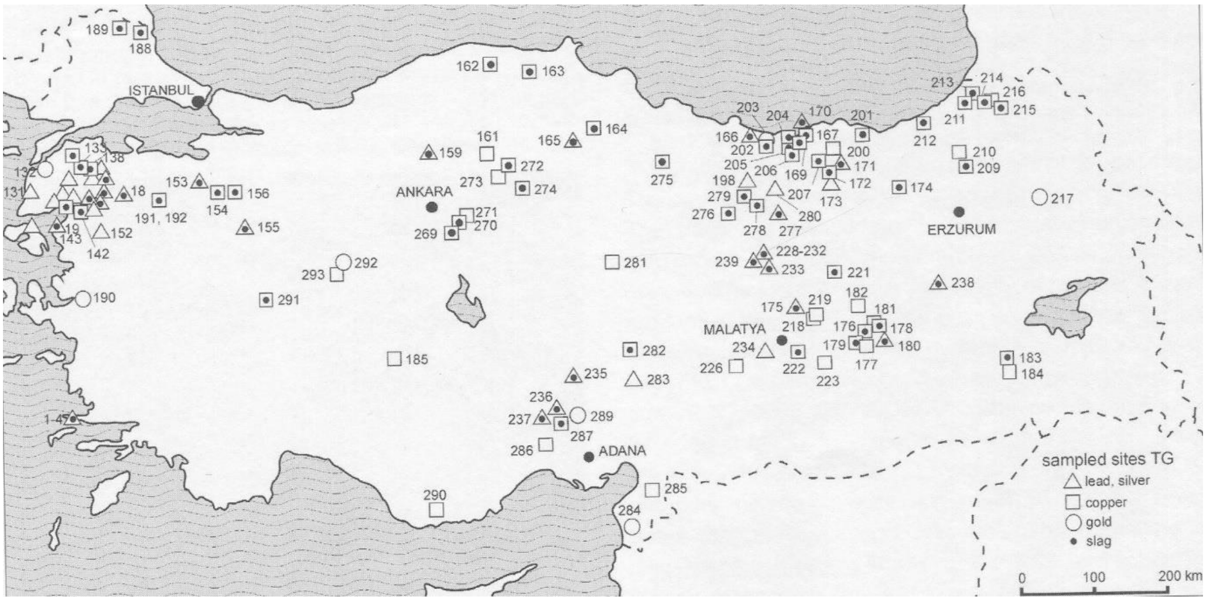

Figure 38. Map of Anatolia’s metal sources (TG nos.) (Wagner and Öztunalı 2000, fig. 1).

Cartography by Ivan d'Hostingue and Gojko Barjamovic 2010

Figure 39. Map of Anatolia c. 1880 BC (Barjamovic 2011, final map).

5.2 Gold

The Anatolian gold sources that would have been used by the OA traders are located primarily in the northern part of Central and NE Anatolia, close to the proposed locations of Durhumit, Tišmurna and Kuburnat, and in western Central Anatolia, close to the proposed areas of Purušhattum and Šalatuwar (**Figures 39** and **23**). These gold sources are gold-containing, polymetallic, vein type deposits. Most of them appear to be of the epithermal Au-Ag type, especially those located in western Anatolia and in the Pontic Zone. There are, however, Cu-Pb-Zn-Au deposits in northern Central Anatolia as well as in the Pontic Zone, on the southern shores of the Black Sea. This range of gold sources in Anatolia confers an assortment of qualities of gold ores. A fact that can be observed in the OA texts as well. Although we are lacking extensive geological and metallurgical information regarding the gold ore sources in Anatolia, it seems quite possible that copper-gold sources were used more often than silver-containing gold ones. The former have the advantage of a (significantly) lower silver content, which is the element that gives gold a paler, greenish-yellowish, or whitish colour. Such ores are much easier to clean from their impurities, as base metals oxidise when melted.

Based on the information that derives from the OA texts, gold is rarely found without specification of its colour, value, or quality. In a total of 77 tablets that record transport of this metal, 73 mention details regarding one of the aforementioned characteristics. The most commonly found variety is *pašallum* gold, being mentioned 39 times in 38 texts. Against what is widely believed, this term does not refer to the type of silver-containing gold we know as electrum. Electrum is arbitrarily defined as a naturally occurring alloy of gold containing more than 20% silver, which colour is pale, green(ish)-yellow(ish). However, such a poor quality of gold would not have been acceptable to the OA merchants, who preferred to deal with the highest qualities of metals. Not only in regard to gold, but also with silver as well as copper, the quality in favour is "good", or "refined". By understanding the word *pašallum* to refer not so much to a specifically treated gold but more to the colour of the gold, we can also realise that *pašallum* gold "of its stone" was a type of ore of gold of high quality and understandably of high purity. The fact that this variety does not refer to electrum, but to a purer variety of gold, is further supported by the OA texts, as well as the gold cloisonné artefact found in Kaman-Kalehöyük, which has a composition of c. 93-95 wt% Au, c. 2-4 wt% Ag and c. 2 wt% Cu. The texts refer to *pašallum* gold being obtained by a boiling/refinement process (*bašālum*), which resulted in loss of weight, and having a high exchange rate with silver. "*Pašallum* gold of very good quality" records the highest exchange rate, even higher than "gold of good quality".

The term that should be understood as referring to a silver-containing alloy of gold, is *puṣium*. This corresponds to "white" gold, which belongs among the varieties of the lowest quality and value. Another variety of gold of low-quality is that which is known as "of its water", written in the texts as KÙ.GI *ša mā'ešu* and which should not be misunderstood as alluvial gold. Alluvial gold in Anatolia exists in its western part, where the OA trade – as outlined by the Kaneš tablets – did not reach, and usually is rather purer than vein-type gold. Nevertheless, according to the OA texts, gold "of its stone" (*ša abnišu*) is purchased at a higher rate than gold "of its water" (*ša mā'ešu*). This means that the latter was of a lower quality and, thus, could not have been alluvial gold. Of a slightly higher quality and value is the so-called "gold of the sea" (KÙ.GI *ša tiāmtim*) and *kuburšinnum* gold. Of high(er) value is considered to have been "blood-coloured" (*ša damu*), "good" (SIG_5/*damqum*) and *pašallum* gold, while "red" (HUŠ.A) gold seems to have been of the highest possible quality and value.

Contrary to the situation in Anatolia, Egypt's gold sources appeared to have been very silver-rich. The Amarna corpus as well as archaeometallurgical analysis performed on a plethora of Egyptian artefacts from the beginning of the 2nd millennium BC until the 14th century BC give proof of that. The royal and international correspondence presents gold as the most valuable gift a king could offer to a fellow king. Here, we read about hundreds of talents of gold and hundreds of gold items being transferred. Simultaneously, we read several complaints regarding the colour and quality of the gold received from the Pharaoh. The Egyptian gold seems to have looked "like silver", or to have had the look "of ashes". This specific colour of the gold reflected its extant silver content, which was not welcome by the Great Kings of the ANE. Moreover, the vast majority of the analysed gold artefacts from Egypt are silver-rich and with a gold content extremely rarely rising above 90 wt%.

Since the late 3rd millennium BC in Mesopotamia, there are attestations of a red-coloured gold. The red colour of gold (HUŠ.A, *sa'amum* and *ša damu*) is also mentioned in a few OA texts, none of which references report a transport. However, since this early period of time, this type of gold was the most expensive one. In the OA text FS Matouš 2, 125 there is mention of "red gold" being produced through a refinement process, expressed with the word *bašālum*. The fact that this type of gold along with the other high-quality type of gold, *pašallum*, are being produced by this process, shows that the knowledge of gold refinement was already existent in the OA period. It may be that the already low silver content of the initial gold ore was advantageous to a possible refinement process, as silver is the element which is difficult to part from gold. Nevertheless, it is important to recognise that the Old Assyrians were in possession of gold of a most probably significantly high purity, appearing red-yellow or even reddish. Despite the traditional evidence against the use of a gold refinement process, the OA texts from Kaneš show that a similar process must have been (occasionally or only seldomly) used, since gold of a red colouration makes its appearance as a greatly valued and very rare variety of the metal. If colour was the clue to assessing the purity of the metal, then a superficial treatment would create the desired result. The OA tablets, however, do not speak about ready-made objects, where a depletion gilding treatment would make sense, but of raw materials. Thus, pure gold in its raw form must have existed. Its existence was a result of the low levels of silver contained in the gold alloy or of a gold refinement process. More metallurgical analysis of gold artefacts, as well as more prospections for and analysis of gold sources, are required in order to provide a more definite answer to this question.

Additionally, red gold also appears in the letters sent from the Mitanni king to the Pharaoh, but these references regard ready-made objects and not raw materials. These specific items sent from the Mitanni were of a kind of gold "with the colour of blood raised" (*ša damu šūlû*). Furthermore, the only occasions of true high-quality gold in Egypt are found in royal and pharaonic tombs of the 18th Dynasty. Artefacts from the tomb of Tutankhamun were created with gold that has been worked in an exceptional and specialised way. Yellow coloured gold, containing around 97 wt% of the metal, was used for the matrix of the Pharaoh's funerary mask and extremely thin layers of gold of varying compositions were applied on top of this matrix to deliberately present a specific colour and colour differentiation. The chemical analysis of these thin layers reminds us of the chemical composition of the gold cloisonné artefact from Kaman Kalehöyük, dating to the OA period. However, the resulting composition of the 14th century BC artefacts from Egypt was in no way a result of the purity of the gold ore. For the Egyptian objects of highly pure gold, there are two possibilities: a) they were refined, or b) they were depletion gilded. Experiments done by various researchers showed that gold refinement via salt cementation process was absolutely within the capabilities of the ancient Egyptian metallurgists. Furthermore, experiments of depletion gilding were likewise performed and proved that the materials needed were already known and used by the ancient Egyptians. Not to mention that examples of depletion gilding have been found in 3rd millennium BC Ur in Mesopotamia. In support of the claim that the Egyptian goldsmiths of the 18th Dynasty possessed the knowledge and ability to refine gold, even if it was only applied to the surface of the metal, is the fact that the golden foil from Amenhotep IV's coffin, when analysed, was seen to have a surface similar to the Lydian, refined by cementation, gold coins of the 6th century BC. This superficial refinement of gold could have been performed on the golden-with-reddish tinged objects that the Mitanni king offered to the Pharaoh. Another possibility would be that these Mitanni gold objects had their surfaces manipulated to appear reddish, not by depletion gilding (i.e. by removing the copper content on the surface, increasing the superficial gold content and simultaneously slightly decreasing the silver content), but rather by treating them with an iron-containing solution. The iron resting on the surface of the gold object would create a similar reddish hue.

The textual and the archaeometallurgical evidence from both OA Anatolia and LBA Egypt, combined with archaeometallurgical analysis of gold artefacts from Mesopotamia of the late 3rd millennium BC, show that a way to manipulate the external appearance of a golden artefact was indeed in existence. Depletion gilding was a reality from the late 3rd/early 2nd millennium BC and was probably perfected during the late 2nd millennium BC. It also appears that, since at least the OA period, there was a way to test the purity of the gold that was received. A simple test by fire would reveal the contents of the alloy and expose its impurities. However, this was not enough either for the OA traders or for the Amarna period kings. Gold had to be of good quality, it had to be pure, it should not contain silver. The evidence shows that a process that would deplete a part of the silver content in the gold was in use. This may have been a heat treatment similar to the salt cementation process, but according to the existing evidence it may be that the process was not yet perfected. Modern experiments of gold refinement via salt cementation produced gold metal with a greatly decreased silver content. This would mean that if a true cementation process was applied, then the Egyptian gold would not contain enough silver to look "like ashes". Indeed, gold refinement is a time-consuming and maybe also a rather unnecessary process. After all, if the ultimate goal was to alter only the metal's external appearance, this could also be achieved by depletion gilding. This was a much easier and faster process than gold refinement. If depletion gilding was applied to very thin sheets of gold, then the entirety of the object would be purified of its silver.

5.3 Silver

Since the OA period, silver was used as a currency and its acquisition was one of the ultimate goals of the OA traders. The intention of these merchants was to conduct their business in Anatolia, acquire as much silver (and gold) as possible and send it back to the city of Aššur. The merchants of the capital were then able to purchase tin, textiles and other commodities, as well as to pay for donkeys, caravan leaders and provisions for both animals and humans for the journey back to Anatolia. Similarly, during the LBA, silver is regarded as a precious metal, but its most important role was for purchases and payments of every kind.

Egypt's silver sources were most probably located in Anatolia, specifically in the Taurus Mountains, as well as in Lavrion in Greece. The silver ores of the Taurus Mountains are a possible source of silver for the Near East during the OA period as well. Other candidate sources of silver for the OA traders are located in north Central and NW Anatolia, situated in the vicinity of trading stations of that period. Purušhattum, Šalatuwar, Wašhušana and Durhumit are the trading colonies (*kārum*s) and trading stations (*wabartum*s) that are most commonly associated with the movement of silver towards Kaneš and Aššur. The first two are possibly located near the NW Anatolian, while the latter in the greater area of the northern Central Anatolian silver sources.

It is important to keep in mind that these trading stations and colonies were most probably established in order to facilitate the copper trade and the circulation of the imported tin. Silver functioned as a medium of exchange (currency) throughout the entire of the ANE, so references of towns in Anatolia and their potential position in regard to the silver sources should not be considered as directly associated with, or of great importance to, a study of trade. If we consider silver as currency, then tracking the movement of this metal unfailingly leads us to tracking the movements, the places of interest and the points of origin of the merchants. Silver moved along with the merchants. It was sent to Kaneš or any other trading station where there were trade goods available for purchase, or exchange. Finally, silver was sent to Aššur, where the home and "base of operations" for many traders were and from where new commodities for new ventures could be acquired.

Silver was extracted from its ores via the well-known cupellation process, through which silver was refined from base metals. "Refined" (*ṣarpum*) silver was in great demand by the OA traders and it seems that Alašiya, in its dealings for copper with Egypt, demanded payment in the same way as the traders of the OA period. Among the 297 tablets that refer to silver being transported for trade purposes, 41 (i.e. c. 13%) refer to "refined" and three (i.e. 1%) to "checked (in fire)" (*ammurum*) silver. It has been shown that both of these varieties must have referred to the same type and quality of silver. This means that approximately 14% of the transported silver was refined. The amount of refined silver transported for trade purposes, according to the OA texts, is about 23%. This may be explained by the fact that this specific quality of silver was mostly used to pay loans, debts, or other kinds of payments, which matters were not taken into account in the present research. Contrary to the situation of the OA texts, the Amarna corpus does not provide us with much information. The Amarna letters refer to gifts of silver being offered from one Great King to another, but there is only one such case where the specific quality and purity of the silver is mentioned. That text (EA 14) includes objects of "clear" (*zakuum*) silver, a term which is only once found in the OA texts. Nonetheless, there is an important similarity between the two corpora, namely the use of "refined" silver for payments. In the Amarna letters, the king of Alašiya requests payment in "refined" silver from the Pharaoh.

Unfortunately, there is a very limited sample of chemically analysed silver artefacts from Anatolia of the early 2nd millennium BC (silver hoard from MBA Acem Höyük). Yet, it shows that rather pure silver (c. 72 wt% Ag) was indeed in circulation. The same situation seems to be true for Egypt as well. The available analytical data from the 18th-14th centuries BC in Egypt, although still too limited to draw accurate conclusions, show that artefacts were mainly composed of more than 70 wt% Ag with less than 20 wt% Au and less than 10 wt% Cu. This picture does not undergo any observable changes from the Middle until the New Kingdom of Egypt.

5.4 Copper

Copper is the only metal for which many articles have been written and extensive studies have been made. Sources of copper in Anatolia have been thoroughly examined. Experiments of producing copper with a variety of types of ores and additives, as well as with different smelting techniques, have been conducted. A thorough linguistic and textual analysis of the varieties of copper during the OA period and based on Bronze Age texts has been made. As a result, there is little that can be added to the already existing knowledge regarding the copper and bronze production and the circulation during the 2nd millennium BC. The OA trade was generated because of, and for the realisation and facilitation of the trade in, tin. This metal seems to have lain at the heart of all this enterprise, which of course included many other commodities. This was also one of the two basic ingredients needed in order to make bronze. Smiths and metalworkers in the copper-rich lands of Anatolia needed tin to be imported from the southeast and delivered to them, in order to alloy it with copper and produce bronze.

Based on the copper sources available in Anatolia, the copper ores used seem to have been copper sulphides and/or oxides, copper-iron sulphides, or polymetallic. "Black" (*ṣalmum*) copper is the type of copper that still contains a number of impurities, the most important of which is iron. The copper-iron sulphidic ores of northern Central Anatolia correspond well with the origin of this type of copper from Durhumit. This impure (blister) copper travelled to melting sites in the cities, where it was refined and turned into a type of copper which was suitable for alloying with tin. “Washed” (*masium*) copper is the second most popular, after “good” (SIG_5/*damqum*) copper, and the most often transported and traded variety of this metal found in the OA texts. There are occasions, where these varieties are equated (kt a/k 579). In this sense, in the 190 tablets that refer to a variety of copper, there are 150 that mention “washed” or “good” copper, i.e. c. 79%. This shows that merchants preferred trading with copper that has been refined and is, thus, of good quality. Impurities that would lower the quality and value of the metal, such as iron, were unwelcome. A simple melting process, under mildly oxidising conditions, would cause the oxidation of metals such as iron and, thus, result in the refinement of copper. The archaeometallurgical analysis has shown that rather pure copper was preferably alloyed with tin, for the production of bronze. This is also supported by the OA texts, where we read about copper “of good quality” to be specifically asked for for the making of bronze (LB 1202), in addition to the fact that “washed” and “good” copper were most often circulated in a trade system that has been generated and was fuelled by the imported tin.

At the same time, recycled copper and bronze were re-melted for the production of new copper-based artefacts. For this reason, “scrap” (*hušā’ū*) metal from no longer usable bronze objects was often a part of the trading caravans. This recyclable metal was to be taken and sold most probably to smiths around Anatolia. The same treatment would apply to “broken” (*šabburum*) or “in small pieces” (*ṣaḫḫirum*) copper. The metallurgical analysis of copper-based objects from Anatolia of the 2nd millennium BC confirms the use of recycled material. If the arsenic content was high, then this metal was most commonly not alloyed with tin. Still, As-Sn-Cu alloys do exist, although they do not contain more than about 3 wt% As.

The subject of the origin of the Egyptian copper during the LBA is relatively simpler, as a major supplier of this metal is mentioned in the letters themselves. The metallurgical and isotopic evidence from Egyptian bronze objects shows that copper was imported from a variety of places and sources. The Taurus Mountains in Turkey, Lavrion in Greece, as well as Cyprus, are all possible candidates that may have provided Egypt with this much needed metal. In the Amarna letters, there are records of copper artefacts offered to a Great King, but the only cases where a specific variety of copper is mentioned are in the letters sent from the king of Alašiya (i.e. Cyprus). In these letters we read about “good” (DÙG) and “multi-coloured” (*burrumum*) copper, sent in rather small amounts in comparison to the rest of the copper sent to Egypt. This copper was then alloyed with tin, imported from the east, in order to make bronze. The importance and value of copper as a raw material for the Pharaoh can be understood by the status the Alašiyan king enjoys. Despite the fact that the relative correspondence does not follow the rules of etiquette that the rest of the Great Kings follow, he is recognised by the Pharaoh as a “brother”, i.e. as an equal, and not as a “son”, i.e. as vassal. Furthermore, in the late New Kingdom in Egypt, copper appears to have been also alloyed with gold for the production of a type of red-coloured gold for the manufacture of signet-rings. The addition of copper to gold may have facilitated the casting abilities and the durability and strength of such objects.

Judging by the analysed artefacts from Anatolia and the ANE, a rather astonishingly complex picture is revealed. These were people that used and experimented with an enormous variety of ores for the production of copper. Sulphidic and oxidic copper ores, iron arsenides and sulpharsenides, nickel-bearing ores and pure copper are some of the materials used throughout the MBA and LBA Near East. Any ore possible was put in a kiln and any usable metal was put in a crucible for the manufacture of new tools, weapons, etc.

5.4.1 Copper alloys and their colours

The tin-copper alloy, called bronze, was the new technology emerging in the 2nd millennium BC Near East; the OA trade provided it with its fuel. The amount of tin imported into Anatolia during the first centuries of the 2nd millennium BC accounts for more than 14.5 tons. This is, though, only a small part of the actual amount of tin that must have been transported by the OA merchants, since not all of the tablets excavated from Kaneš have been read and published. Despite the incredible amount of this metal being imported, only a small part of the copper-based artefacts in Kaneš were found to be made of bronze. The vast majority of them was made from arsenical copper or rather pure copper. On the other hand, all the analysed artefacts from LBA Amarna were manufactured from bronze.

Bronze never actually deposed arsenical copper from its position as the alloy in favour. It may be that arsenic was a volatile and uncontrollable element to alloy with copper and it is certain that the process needed in order to produce a high-arsenic arsenical copper was certainly time-consuming and difficult, but a total displacement of this alloy in favour of tin-bronze never actually occurred. Unfortunately, copper-based objects very often fall victims of recycling. As a result, we cannot be sure whether new arsenical copper artefacts were manufactured during the MBA or LBA in the Near East, or the old artefacts were (re-)used until their arsenic content was diminished. Judging by a diachronic study of metal use in Ḫattuša, both the arsenic content in copper-based artefacts and the use of arsenical copper seem to decrease from the MBA towards the LBA, the shift being more obvious still from the Early Iron Age onwards.[1037] Moreover, considering the importance of bronze tools, weapons and vessels, it is only logical to assume that these were never deliberately discarded. It is more probable that bronze, as well as arsenical copper, artefacts were continuously recycled and that what we find today (outside burials) is the result of sudden destruction, abandonment, or chance.

The advantages and disadvantages of arsenical copper vs. bronze are still debated. It is possible that we will never find a definite answer to the question why bronze was slowly "taking over", while arsenical copper continued being used. There is a multitude of factors to be considered: mechanical properties such as workability, castability, strength, hardness and wear resistance, but also external appearance, i.e. colour, and social, political and/or economic reasons. A discussion of which alloy is "better" will not be made here. The reader will simply be directed to an article recently published by Kuijpers,[1038] where he discusses the distinct types of copper-tin and copper-arsenic alloys, corresponding to certain ranges of content of the alloying element(s), based on their colour and mechanical properties. In contrast to the majority of research and analyses of archaeo-metals, which offer hard quantitative data on the mechanical properties of alloys, Kuijper's research is focused on the properties of the metals that were perceivable by the metalworkers of the past. The discussion that follows concentrates on the external appearance, meaning the colour of these alloys, with regard to the existing archaeometallurgical evidence from Anatolia and Egypt.

For a metalworker, his senses are his guide. Like in many crafts, seeing the colour and the texture of what you are making, smelling its odours and hearing the sounds that it is making are the most important aspects of assessing progess in the course of creation and a craftsman's guidelines. For a metalworker, the colour of the alloy that he has in front of him can give him some hints of what to expect on working with this metal. According to Kuijpers' typology,[1039] copper-based alloys containing less than c. 5 wt% Sn or less than c. 3 wt% As behave like copper and have the same colour as pure copper. These are Type I coppers with the characteristic red colour.[1040] Alloys containing between 3 wt% and 7 wt% As are listed as Type II coppers. They have the characteristic colour of orange, but their hue cannot be considered

[1037] Lehner 2014a, 132-33, fig. 60; 2015, 144-53, figs. 5.4, 5.6, 5.15.
[1038] Kuijpers 2017. See also Kuijpers 2012a; 2012b.
[1039] Kuijpers 2017, fig. 2.
[1040] In his research, when Kuijpers (2017) refers to the arsenic content, he also includes the metals nickel, antimony and silver, because these metals have similar effects in matters of colour and hardness on the copper alloy. The compositions of the copper-based alloy objects from Kaneš and Amarna contain only traces or minor amounts of these metals. For this reason, when we refer to arsenic content, we mean arsenic alone.

that different or easily distinguishable from the alloys that contain less than 3 wt% As and which have a reddish colour. Arsenic, however, will add a silvery-white sub-colouration to the metal. The only way to differentiate this alloy composition from the "as- copper" arsenic-copper alloy is by working with it. It is interesting here to cite the words of Kuijpers regarding this type of coppers. He notes as follows:

> *The behaviour of type II material might thus appear 'random' and, subsequently, difficult to appreciate from a craft perspective. Hence, despite the likelihood that the copper is positively affected by the presence of certain elements, this group of copper-compositions is best defined as an unpredictable, and accordingly risky material to work with.*[1041]

Tin-copper alloys containing 5-12 wt% Sn have the characteristic colour of yellow and are Kuijpers' Type III coppers. Their colour is that of what is conventionally identified as bronze and includes hues from orange-yellow to yellow-golden with the increasing amounts of tin. This type of alloy is recognised as having a good casting quality and good workability. With cold-hammering and frequent annealing it can become very hard, without risk of cracking or breaking.

The copper-alloy artefacts from Kaneš, that have been analysed and are here presented in **Appendix 8**, have arsenic contents ranging from 0 wt% to c. 6 wt% As (with two more comprising c. 8.6 wt% and 9.5 wt% As). By plotting the arsenic contents of the samples in a scatter chart, three relatively distinguishable categories are revealed (**Chart 58**). The first category ranges up to about 3 wt% As, while the dividing line between the second and the third categories can be drawn at about 7 wt% As. These groups agree perfectly with Kuijpers' Types I, II and V, respectively. Type V coppers are those containing more than 7 wt% As. They have a very distinct white-silvery colour and are considered as unpredictable as any other arsenic-containing copper alloy. It is also notable that most of the artefacts have such a low arsenic content that they belong to Kuijpers' Type I coppers. They must have had a reddish colour and they must have behaved like pure copper. Moreover, there are less and less samples with increasing levels of arsenic, especially from about 2 wt% As and up to c. 4.5 wt% As. According to Kuijpers' categorisation, as well Mödlinger's *et al*.[1042] quantitative analysis of the colours of copper-based alloys, and Radivojević's *et al*.[1043] experiment on producing a Cu-As-Sn ternary colour diagram and finally the data provided by the archaeometallurgical

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[1041] Kuijpers 2017.
[1042] Mödlinger *et al*. 2017.
[1043] Radivojević *et al*. 2018.

analysis of the arsenic-containing copper alloys from Kaneš, it appears that with an increasing amount of arsenic (from around 3 wt% As), the colour of the metal would slowly turn from reddish to reddish-yellow as the yellow hue starts to dominate the alloy's colour, and from around 4-5 wt% As it would slowly appear more silvery.[1044]

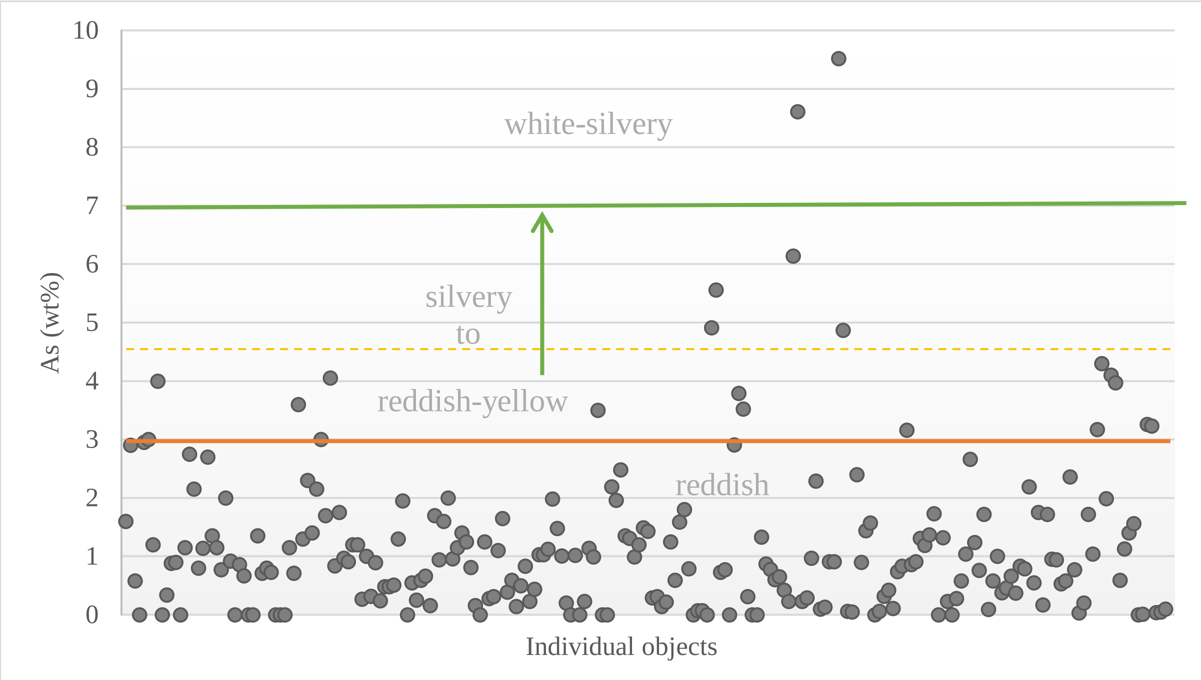

Chart 58. Arsenic concentrations in Kaneš artefacts.

Similarly, the tin contents in the copper artefacts from Kaneš reach up to c. 17 wt% Sn. By plotting the tin concentrations of these artefacts in a scatter chart, three distinguishable groups once more show up (**Chart 59**). The first group comprises two sub-groups and regards tin contents up to about 4 wt% Sn. One of the sub-groups comprises pure copper objects, while the other concerns objects containing about 1-4 wt% Sn. The second group has a range of tin contents from about 4 wt% to about 12 wt% Sn. And the third group includes those few high-tin bronzes that contain 12-17 wt% Sn. These groups of copper-tin alloys more or less correspond with Kuijpers' Types I, III and VI. As has already been said, most of the copper-based artefacts contain the sorts of amounts of arsenic and no, or only negligible, amounts of tin that they must have looked and behaved as pure copper.

There are a few objects containing from around 1 wt% to about 4 wt% Sn, increasing in numbers as one approaches the 5 wt% Sn level. Some of these samples could have been

[1044] See also the colours of the various copper alloys in Berger 2012, Abb. 6.

made from recycled material.[1045] From the 5 wt% Sn concentration up to 12 wt% Sn, the group coincides with Kuijpers' Type III yellow coppers. Regarding the samples falling inside the 1-5 wt% Sn field, by combining once again the information by Kuijpers', Mödlinger's *et al.*, Radivojević's *et al*. and Devogelaere's[1046] publications, it seems that when the tin content in these metals rose above about 1-2 wt%, the reddish colour of pure copper would slowly turn to red-yellowish and then yellow-reddish colourations, before it becomes the warm yellow colour of bronze proper.[1047] Objects made of recycled material, comprising c. 1-5 wt% Sn and up to about 3 wt% As, appear yellower than the binary alloys of just copper and tin. With rising tin contents, yellow becomes the dominant colour, making the alloy appear more silvery.[1048]

A considerable number of bronze samples contains about 5-12 wt% Sn. Their colour would have appeared from yellow to warm yellow or golden at about 9 wt% Sn. The dominating colour in bronzes is yellow, binary alloys of copper and tin tend towards a light red-golden at about 8 wt% Sn and a warm golden (described as reddish-yellow by Devogelaere) hue at about 10 wt% Sn. The yellow-golden colour of bronze reaches its peak and its warmest hue at around 11-13 wt% Sn. Those few artefacts that comprise >12 wt% Sn would have had a greyer colouration. These correspond with Kuijpers' Type IV gold coppers. From that point onwards, the colour of the alloy becomes more greyish and at about 16 wt% Sn it will appear paler and more like silver. In Kaneš, we have found artefacts that belong to every one of these colour-based categories. It may also be said that objects containing up to about 5-6 wt% Sn, no matter what their arsenic content, would have been only slightly and possibly unperceivably different from the reddish-yellow arsenical copper alloys in colour. The distinguishing line would be the yellow-golden looking alloys, consisting of copper with more than about 6 wt% tin.

1045 As for example, Sample Nos. 101, 127, 140, 159 and the two wrapped bars with Sample Nos. 249 and 250.
1046 Devogelaere 2017.
1047 See also the colours of the various copper alloys in Berger 2012, Abb. 6.
1048 Radivojević *et al*. 2018, 117.

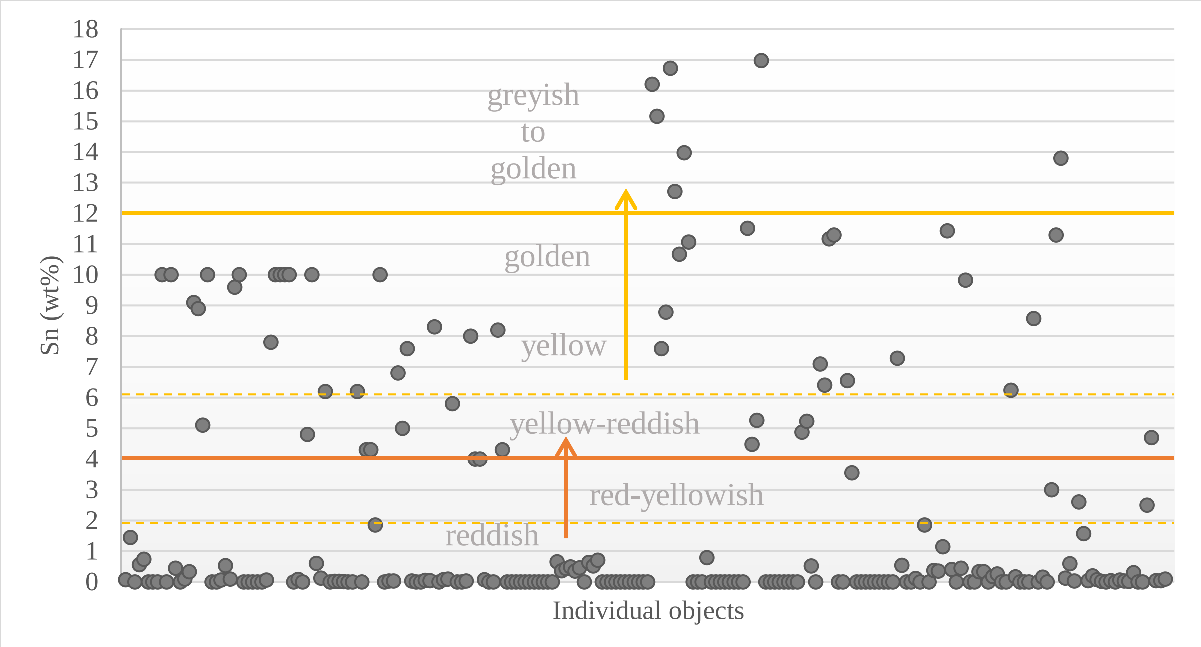

Chart 59. Tin concentrations in Kaneš artefacts.

As far as the very limited number of bronze artefacts analysed from Amarna is concerned, they all seem to have had a yellow-golden colour as they comprise c. 6-13 wt% Sn (**Chart 60**). In addition, there is a single object, a small knife (Sample No. 302), that contains less than about 3 wt% Sn and one more (Sample No. 306) that falls in the field of tin concentrations that create a more silvery than yellow-golden hue. This latter sample contains about 15 wt% Sn. It is unfortunate that there are no more bronze artefacts' analysis available. As a result, we cannot draw a definite conclusion as to whether this type of yellow-golden bronze was a deliberate choice and the metalworkers' objective, or if the idea given from these artefacts' samples, that a c. 6-12 wt% Sn was preferable and intended, is solely the result of chance from selecting these objects for analysis and not the reality.

Chart 60. Tin concentrations in Amarna artefacts.

5.5 Iron and the meaning of KÙ.AN/*amūtum/aši'um* and AN.BAR/*parzillum*

From the existing evidence, it seems that during the 2nd millennium BC meteoric iron was utilised in Anatolia and Egypt. The few iron artefacts from Anatolia of the early 2nd millennium BC, or from an even earlier period, have not undergone a metallurgical and chemical examination. As a result, we cannot say whether they were manufactured from meteoric iron or from terrestrial iron ores. The only analysed artefact from Anatolia, dated to an earlier time than the LBA or the Early Iron Age, is the Alaça Höyük dagger (**Figure 35**). This has been shown to have been made of meteoric iron, as were all the analysed artefacts from Egypt dating from the 4th millennium until the 14th century BC. As far as the iron objects found in Kaman Kalehöyük and Kaneš are concerned, it cannot be supported that these were produced as iron artefacts from iron ores; they may have only been accidental products.

The OA texts attest to a number of words which have essentially been associated with iron. The most common words during this period are KÙ.AN/*amūtum* and *aši'um*. If we assume that they were all referring to this metal then, based on the fact that the earliest use of the metal was in its meteoric form and that iron production from its ores was in its infantile stage, two possibilities arise. One, the words KÙ.AN/*amūtum* and *aši'um* referred to iron meteorites gathered in the field. And two, KÙ.AN/*amūtum* and *aši'um* referred to an iron ore. In the last case, these terms would be probably used to describe bog iron; this agrees with Dercksen's[1049] opinion. Bog iron is commonly found in Anatolia as the mineral goethite (limonite), with

[1049] Dercksen 2005, 28-9.

limonite being a weathering product of haematite, an iron ore known to the Assyrians at Kaneš and their local contemporaries.

However, if any of these cases is true, then we are faced with a paradox. During the same period of time, there are five different words (KÙ.AN/*amūtum*, AN.BAR/*parzillum* and *aši'um*), employed in the same geographical area, to express the same thing, i.e. iron. From early on in Mesopotamia, we find textual documentation of the logogram AN.BAR. Then, during the OA period in Anatolia, there are a few references to the logogram's Akkadian counterpart, i.e. *parzillum*, while the logogram itself does not appear until the end of this period.[1050] Both forms then continue to be used during the 1st millennium BC in the entire Near East. The fact that there are only sporadic finds of iron artefacts from periods earlier than the late LBA, in and after which the numbers constantly increase, when taken in correlation with the same observed increase in references to AN.BAR/*parzillum*, offers a hint of evidence towards the definite and only association of AN.BAR/*parzillum* with iron. Moreover, based on the fact that Mesopotamia is poor in metal sources, it is most probable that this word initially referred to the metal coming from iron meteorites. The characteristic regmaglypts and the increased density of an iron meteorite would be very striking and would, thus, make this celestial rock easy to distinguish from any common terrestrial rock. Plus, its shiny metallic surface would be immediately interpreted as metal-containing. Later, with the development of the production of iron from its ores, the word "expanded" its meaning and denoted the metal iron, disregarding the source. As a result, the much-commented phrase "black iron of the sky" should be understood as a meteorite freshly fallen from the sky, i.e. a rock that contains iron and which now has a black colour due to its existing, still not-rusted fusion crust.

Iron meteorites rust in the same way as terrestrial iron ores, developing a distinctive red-orange-brown colour. Thus, any weathered, iron-containing "rock" would have the same external appearance, in matters of colour, regardless of whether it was a meteorite or a terrestrial ore. The Akkadian word for iron, *parzillum*, admittedly appears scarcely in the OA tablets from Kaneš. Its very rare reference agrees with the undeveloped stage of manufacturing iron objects. Iron meteorites are not so easy to find and the production of iron from its ores was not yet known during the OA period. On the other hand, the words KÙ.AN/*amūtum* and *aši'um* also are admittedly rarely attested in the tablets from Kaneš, but they do appear more often than the word (AN.BAR/) *parzillum*. KÙ.AN/*amūtum*/*aši'um* in particular was a very highly valued

[1050] Up until now, the Akkadian form of the word can be found in only four texts out of the 107 texts that attest to any of the words that are associated with the metal iron. The much-anticipated publication from Erol will certainly offer much more information on this issue, as many unpublished texts will come to light.

commodity; it was worth ten times more than gold. It was worthy of extensive and strict measures of control, and a reason to imprison a man. Weirdly enough, KÙ.AN/*amūtum* and *aši'um* practically disappear after the OA period. The word *amūtum* appears once again in the Amarna letter EA 22, sent to the king of Egypt from the Mitanni king. It is a reference to a horse-shaped vessel, inlaid with gold and lapis-lazuli, which weighed about 2.5 kg (c. 300 shekels). This vessel of *amūtum* is a one-of-a-kind artefact in the entire Amarna correspondence.

If we assume that KÙ.AN/*amūtum* did indeed describe an iron ore, then we can only imagine that it was valued not for its beauty but solely as something new. Iron production from iron ores was not yet an established technology and a good product, meaning a successfully produced iron without many impurities, was difficult – if not impossible – to find. Disregarding the fact that simply smelted iron was not as beautiful or as long-lasting as other metals, still it would be something new, a technological innovation, which would have to be under the control of the authorities. And still there is the question, why there was yet another word describing basically the same metal. If AN.BAR/*parzillum* was already known, denoting what we call iron – the metal (coming from meteorites?) – then why would there be another word describing the same metal? Maybe the difference lay in the external appearance of the "rock". A non-weathered iron meteorite would appear as a shiny, with metallic lustre, metal. That may have been what the Sumerians called AN.BAR/*parzillum*.[1051] An iron ore, on the other hand, would have most commonly been found in its red-orange-brown colour. Still, the element iron, found in a number of iron ores, was already known and used in the service of copper smelting, both in Mesopotamia and in Anatolia. If we judge by the extensive knowledge and capabilities of the Bronze Age metallurgists to recognise the various ores and veins that contained copper, gold or silver, then we can also assume that the same proficiency applied to the recognition of the sources of iron, a metal which they used in order to promote slagging in the production of copper from its sulphide ores. Furthermore, if AN.BAR/*parzillum* meant meteoric iron and KÙ.AN/*amūtum* an iron ore, then why did the latter disappear during the period when it was just starting to be worked into something better, namely into steel?

The *amūtum*/KÙ.AN/*aši'um* triad remains a puzzle. As much as we would like to be able to say for certain that they refer to iron, we cannot. According to the CAD,[1052] "*the meaning suggested for aši'u is based on the assumption of it being a synonym of amūtu C*",

[1051] See also Puhvel 1996, 64-5.
[1052] CAD A(2), 442.

“*the tentative identification of both with ‘iron’ is supported by the very high prices attested for amūtu*”. However, the fact alone that KÙ.AN/*amūtum* and *aši’um* are highly valued does not necessarily mean that they denote iron. Furthermore, the words that describe a quality, form or treatment of KÙ.AN/*amūtum* do not strictly refer to metals. Veenhof,[1053] in his article regarding silver in the Old Assyrian trade, noted the use of some Akkadian words in the texts from Mari. One of these words is *ṣarāpum*. This is used to describe the treatment of *amūtum* in text CCT 4, 4 from Kaneš. In the texts from Mari, however, it is also used in association with materials other than metals, like ivory and precious stones. In such cases, it has the more general meaning of “to clean” and not “to refine”, or “to (re)smelt”. As a result, if we review references to KÙ.AN/*amūtum* (and *aši’um*) impartially, we may discover that they did not refer to iron, or even to a metal at all. The only thing that we know is that KÙ.AN/*amūtum* was circulated under authoritative control, that it was very expensive to procure and very hard to find, gathered and hoarded by the “City Hall” in Aššur, and that it became so rare so as to appear as a one-of-a-kind item among royal gifts from Mitanni to Egypt.

The evidence (and the lack of it) from texts from the ANE can support the idea that KÙ.AN/*amūtum* did not refer to iron in any way. The horse-shaped vessel that was offered to the king of Egypt was listed among a variety of prestigious gifts. If we regard *amūtum* to have meant a material related to iron, then we have to imagine that this “iron” was managed to be worked well enough in order to produce such a beautiful vessel, worthy of a royal gift. During the early 2nd millennium BC, metallurgists started experimenting with iron smelting and it appears that the successful production of iron objects was achieved around the 12th century BC. Thus, even in the 14th century BC, an object made from iron of good quality would unquestionably be a rarity, if it was even possible to have been made. Moreover, by the Amarna period, the word for iron was AN.BAR, as many references to this metal in the list of gifts sent from Mitanni also show. It may be that the initial recognition of this metal was in the form of iron meteorites, with a shiny metallic lustre but, in time, the weathered, red-orange-brown coloured form was definitely also identified as the same metal. In the Mitanni princess’ dowry, artefacts of AN.BAR, translated as of iron, and a vessel of *amūtum* are mentioned. If the latter was related to iron as well, which by this period is recognised as AN.BAR in all its forms, then why would there be a special reference to an object of *amūtum*? A possible reason would be that *amūtum* originally described an Anatolian product,[1054] which “disappeared” from

[1053] Veenhof 2014, 419.
[1054] See also Donbaz (1988, 50), who comments on the variety of gold and KÙ.AN described with the word *kīšum*, arguing that it refers to a native Anatolian product.

correspondences with the cessation of the OA trade around 1715 BC. This, however, does not provide any meaningful evidence of the word denoting a primary use or form of iron. It most probably leads to the contrary. In addition, there are more than one texts mentioning KÙ.AN/*amūtum* and *aši'um* travelling from Aššur to Anatolia, as well as evidence that *amūtum* arrived at Sippar, located on the banks of the Euphrates, along with *kutānum*-textiles and lapis lazuli. These were most probably coming from the southern Mesopotamian ports of trade, such as Babylon, as well as the eastern ones, such as Ešnuna and Susa.[1055]

5.6 The importance of colour and the perceivable characteristics of metals

The discussion regarding colour is a result of the analysis of the varieties of metals observed during this research. The need for such was created by the realisation that most of the terms that accompany metals in the Kaneš and the Amarna texts are descriptive of a colour or that they are indirectly referring to colour. Words that define colour, e.g. red, white, or black, do not need any further explanation as to how they relate to this subject. Those that indirectly refer to colour, however, do. They represent varieties of metals defined by a certain metal treatment, or characterise varieties of metals that are read in the texts from Kaneš, but have not yet received a proper or a definite translation in a modern language. The definition of the latter set remains enigmatic and is open to discussion.

Our senses are the way through which we understand the world that surrounds us. By touching and handling an object we can tell whether it is made of plastic, of metal, of fabric etc. By smelling, for instance, milk we can decide if it has gone bad and we should not drink it, or if it is still good. Another way would be to observe its consistency. All such are still matters that rely on our senses. These and many more examples where our senses are employed as testing-machines in our everyday life are a result of the connections we have made consciously, through trial and error, or subconsciously, through good or bad experiences. The same decision-making tools are used by metalworkers. They use their sight to see the colours of the fire, ores and metals they mix and the metals and alloys they produce. In this way, they recognise the heat of the fire, what types of ores or metals they have put in the fire and the mechanical characteristics of the alloys they produce. Similarly, they smell the fumes of the metals that they are (s)melting, thus appreciating some of their constituents. And they hear and feel the metal they work with on their anvil. This is the way that metallurgy "works".

[1055] Barjamovic 2011, 9; 2018, 147.

Metallurgy is an art and not a science. Metallurgists do not weigh specific amounts of metal *a* and metal *b*, being sure that they will get alloy *c* with certain mechanical and physical properties.[1056]

This appreciation of the role of the senses is the basis of the conclusion that even when the people that inscribed the tablets referred to the quality of a metal as being "good", "very good", "poor" or "bad", they were indirectly referring to the colour and/or maybe other physical characteristics of the material. "Good" gold was that which had a yellow or even reddish colour. Gold that contained silver and most probably looked like it, was not acceptable and was possibly considered to be of bad quality, although such a direct description is nowhere attested. The not yet translated word *pašallum,* that describes the most attested variety of gold, could have pointed to a characteristic hue. This specific hue could have also been recognised as pertaining to gold of good quality or gold that was clean from impurities. "Good" silver was one that had the characteristic lustre that we know that silver has. Poor or "bad" silver could have looked blackened, as a sign of weathering. "Good" copper should have looked reddish, just like the known colour of pure copper. "Good (but) bad" copper could have shown signs of oxidation, meaning the green colour of verdigris.

These direct attributions of quality are subsequently linked to indirect ones. The terms "boiled", "refined" and "washed", expressed with a variety of Akkadian words, is the most evident. If someone was not present for the actual process of refinement, then he could not possibly know that the metal had been so treated. One way to realise that a metal had been refined from its impurities, without having to put it into a fire and test it, is to observe its colour; provided that one already knows and recognises the colour of this metal in its pure(st) form. Accordingly, words that express a specific colour of the metal are indicators of the quality of the metal. Thus, "red" gold was an almost pure gold, while "white" gold was the exact opposite, i.e. gold that contained a considerable amount of silver. And "black" copper was the unrefined, primary product of copper smelting.

Following the same logic of naming and differentiating metals by their external physical characteristics, the ones that are perceivable by the human senses, the conclusions regarding the words said to describe iron have been drawn. According to this and based on this research, there is a significant possibility that the OA terms KÙ.AN/*amūtum* and *aši'um* did not refer to the metal we now call iron. This metal was expressed by the word AN.BAR/*parzillum*.

[1056] See Kuijpers 2012a, 145-46; 2017; Mödlinger *et al*. 2017, 14-5.

The only two metals that present a colour variation in the textual evidence are gold and copper. The amount of silver and copper present in gold and the amount of arsenic or tin in copper are the decisive factors for the colour variation. The different hues of a copper-arsenic or a copper-tin alloy have already been discussed. Artefacts of the early 2nd millennium BC appear to be of a red-yellowish or golden-yellow colour. Towards the end of the millennium, during the Amarna period, the available evidence shows that golden-yellow bronzes were preferred. A fact that may change with more analysed samples. The case of gold is somewhat different. The appearance of gold does not change based simply on an alloying element or the constituents alone: it is the amount that is critical. With increasing amounts of silver, the colour of gold would appear from red-yellow to yellow, to green-yellow, and then to silvery-white. With the addition of copper, gold could show a more reddish hue. However, it has been suggested that the Egyptians intentionally alloyed imported silver with their local silver-rich gold, in order to produce a metal that looked like silver, saving true silver metal in the process. It is also a matter of debate whether the red-coloured gold-copper alloy signet rings of the 18th Dynasty were an intentional product to facilitate the casting of the rings, or if they were a cheap alternative to pure red-coloured gold.

Apart from alloying gold with silver or copper, there was another way to change the appearance of gold. This was achieved by the process known as depletion gilding. In simple terms, this process entailed the removal of silver and copper from the surface of the gold, revealing its yellow colour. An example of the application of depletion gilding on a gold artefact has already been presented. It is a silver-gold-copper vessel from Ur, whose surface was treated to simultaneously increase the gold content and lower the silver and copper content of the outer layer. Of course, the result was that the original white-silvery colour was manipulated to appear more greenish-yellow, more like what we describe as electrum (**Figure 10**). From an ethnological perspective, it is interesting to note that gold Nahuange artefacts from Columbia in the northwest part of South America were at first treated according to the depletion gilding process to look more golden, and later meticulously polished, in order to reveal the pinkish colour of the bulk of the metal.[1057]

[1057] Sáenz-Samper and Martinón-Torres 2017.

5.6.1 Polychromy

The polychrome effect of metals was known and greatly appreciated by the Bronze Age people. Already from the early 2nd millennium BC in Egypt come examples of efforts to achieve polychromy in gold. However, during this early period it would be better to describe them as simple colour variations. These are the fish-shaped pendant (Sample No. 5) and the gold leaf fragments from Senebtisi's coffin (Sample Nos. 4 and 62). They both exhibit a minor diversification in colour with green-yellow combined with the colour of electrum and yellow combined with whitish. By the 18th Dynasty of Egypt, the different hues of gold multiply. Now, the range of white-green-yellow shades of gold expand to incorporate pink and red tinges as well.

The highpoint of colour variation in all mediums of art appears to be the 18th Dynasty in Egypt. This is demonstrated not only on artefacts but on mural paintings as well.[1058] During this period, we have many examples of objects that combine metals of variegated hues with materials of diverse colours. This is the time of true polychromy. For instance, we have already admired the multi-coloured shoes from the tomb of Tutankhamun (**Figures 14** and **17**). Stones of varying colours, such as blue, white, or red, were put together and side by side with yellow golden or reddish golden leaves and strings of gold. Moreover, the famous iron dagger of the same Pharaoh had an iron blade of probably bluish-black colour, a handle made of gold cloisonné filled with red turquoise and yellow glass, red jasper, green feldspar and blue lapis lazuli, topped with a clear-white rock-crystal knob (**Figure 40**).[1059]

Figure 40. Tutankhamun's iron dagger and gold sheath (Comelli *et al*. 2016, fig. 2).

The same polychrome effect can be found in copper-based alloy objects. The most characteristic examples are the Mycenaean daggers which display a polychrome effect based on a bluish-black coloured background with gold and silver inlaid decorative details. Analysed

[1058] Baines 1985, 286-88.
[1059] The Griffith Institute, "Carter No. 256k", http://www.griffith.ox.ac.uk/gri/carter/256k.html (JE 61585).

daggers from Mycenae, Prosymna and Pylos, in Greece, revealed that the bluish-black background for the inlay was a copper-tin alloy with gold and silver. This black bronze was the base on which the decorative motifs of gold, of varying hues, and of silver were laid (**Figures 41-42**).[1060] From Mycenaean sites there are also silver vessels that were decorated with gold and black inlays, which were of somewhat different composition. A silver vessel with gold and black inlay decorations, of apparent Mycenaean influence, was also found in a tomb in Enkomi, in Cyprus, dating towards the end of the 15th century BC (**Figure 43**). The black inlays of all these silver vessels were a copper-gold alloy, with no tin but with a small amount of silver.[1061] The blades of the daggers analysed by Demakopoulou *et al*.[1062] have a tin content over c. 5%, which would appear silvery in colour and would thus create a visible contrast with the black inlaid band and the golden and silver decorative inlays. Nevertheless, the silver colour would not be so intense as the colour of the silver vessel of Enkomi, as seen in **Figure 43**.

Figure 41. Bronze dagger from Pylos, Greece (NAM 8339) (NAM Collection online).

Figure 42. Bronze dagger from Grave Circle A in Mycenae, Greece (NAM Collection online).

[1060] Ogden 1993, 40-2; Demakopoulou *et al*. 1995. See also Aruz et al. 2008, 276 cat. no. 171; Cockrell 2009, 85-9; Benzonelli *et al*. 2017, 11-3.
[1061] Demakopoulou *et al*. 1995; Giumlia-Mair 2012, 107, 111-14.
[1062] Demakopoulou *et al*. 1995.

Figure 43. The silver cup from Enkomi, Cyprus (Talma 2018, fig. 4).

Objects made of black bronze appeared in Egypt long before the LBA and the Mycenaean period. Already from the Middle Kingdom of Egypt, i.e. from the first centuries of the 2nd millennium BC, there are artefacts made from, or decorated with, black bronze. These are a statuette of the crocodile god Sobek (**Figure 44**) and a kneeling statuette of Pharaoh Amenemhat III from el-Fayum and a scimitar found in Balata-Shechem (**Figure 45**). The composition of the black bronze on all three artefacts had the same composition as the much later dated Mycenaean daggers: a copper-tin alloy with gold and some silver.[1063] In particular, the crocodile and the scimitar were decorated with gold alloy inlays, thus providing a polychrome effect of yellowish (electrum) golden against the dark-coloured background.

Figure 44. Egyptian crocodile god Sobek made of black bronze (ḥmty km), found at el Fayum. Ägyptische Sammlung Munich, Inv. No. ÄS 6080 (Giumlia-Mair 2016, fig. 6).

[1063] Giumlia-Mair 1996; 2016, 126-31; Giumlia-Mair and Quirke 1997, 98-102.

Figure 45. Balata-Shechem scimitar (Talma 2018, fig. 2).

It is important to note that this black bronze has no connection to the "black copper" of the OA texts from Kaneš. The former was an artificial alloy of metals, employed for its ability to be used as a background for decorative reasons and as a medium of contrast in colours. The latter was a primary smelting product of copper, basically a raw material, which needed further treatment in order to be usable.

It appears that colours were of great importance to the Bronze Age people in the Near East and the eastern Mediterranean. Polychromy can be found in all possible mediums of art. Nonetheless, this polychromy does not appear to have been used by everybody. Only the elite had access to such luxurious multi-coloured artefacts of bronze or gold and to such richly-coloured decorative wall paintings. The fact that all the multi-coloured artefacts that have been discussed up until now were found in royal tombs supports this contention. Moreover, from ancient Egyptian art, it has been observed that the colour blue was reserved for elite use. The ceilings of royal tombs built during the New Kingdom of Egypt were painted dark blue as a simulation of the night sky.[1064] Furthermore, as regards the representation of metals on mural paintings, the colour blue was used to describe iron.[1065] In this way and despite the fact that in reality iron has a bluish-black colour, a connection can be discerned between the high value of this metal during the LBA and its colour representation in Egyptian art. The Egyptian artists

[1064] Baines 1995, 288.
[1065] Carpenter and Robertson 1930, 859.

painted iron as they saw it, but they also painted it with the colour that symbolised the heavens and the sky.[1066]

5.6.2 A matter of choice or chance?

There are various reasons for wanting to change the appearance of a metal. One may be a wish to make it look like something else. This is considered to be the reason for choosing to alloy copper with tin during the Chalcolithic period in the Balkans. The mid-5th millennium BC in the Balkans is the period that yields the well-known gold artefacts from the cemetery of Varna. The Varna cemetery belongs to the Vinča Culture, which slowly disappears around 4650-4600 BC. During the same period as these gold artefacts, or even some (hundred) years later, a number of bronze artefacts appears in the Balkans. Because of the yellow-golden colour of bronze, it is believed that this alloy was specifically selected for its colour, acting as a cheaper alternative to the rarer and more valuable gold. Moreover, the scarcity of gold and bronze artefacts in the Balkans led researchers to the belief that gold and its imitation in terms of colour, i.e. bronze, was an elite privilege.[1067] Regarding the choice of these people to produce bronze and not some other alloy of copper, it would be important to note that tin mineralisations are said to occur in western Serbia, but not close to the locations in Bulgaria, where most of the early bronze artefacts have been found. Interestingly, in the following periods of the EBA and MBA, arsenical copper became the alloy of preference; bronze becomes a more common alloy again only during the LBA (2nd millennium BC).

It appears that the people of the mid-5th millennium BC Balkans consciously chose to mix copper with tin, creating a golden-looking metal, which they could use instead of gold. However, the question remains: was that a deliberate choice of these people or was producing bronze their only (easily) available option? It would be interesting to see if arsenic-bearing copper ores existed in the vicinity of the sites, where bronze samples of such an early date in the Balkans have been found. The copper minerals chosen for the early production of copper in this area were of black and green colours and this includes the complex tin-copper ores that could have been used for the production of the golden-looking bronze objects of the mid-5th millennium BC. The only arsenic-rich copper artefact that was analysed by Radivojevič and

[1066] See Foroughi and Javadi 2017, 71-5, table 2.
[1067] Radivojević *et al*. 2013, 1039-42; 2018, 107. See also the debate between Šljivar and Borić (2015) and Radivojević *et al*. (2015). Regarding the Varna cemetery and its gold objects, see: Leusch *et al*. 2014. For the most recent dating of the cemetery, see: Higham *et al*. 2015.

Rehren[1068] is dated to a period up to 200 years after the disappearance of the Vinča Culture settlements. This was manufactured from a completely different copper ore, which probably was of a green-blue and red-black colouration.[1069] The relation between yellow-golden bronze and yellow-coloured gold cannot be denied,[1070] but availability of ores and/or knowledge and/or easiness to produce arsenical copper are factors that should be taken into consideration before deciding that a conscious choice to produce one alloy instead of another was made.

Concerning the reasons, or the incentives, towards a change in the production of copper-based alloy artefacts, an ethnological example, again from South America, will be given. In the lands around the Andes, there were two separate copper-alloy traditions in accordance with the local copper ores available. In the northwest, arsenic-bearing copper ores were abundant, while in the southwest, cassiterite ores were available. This means that the people of the former areas produced and used arsenical copper and those of the latter used tin as the alloying constituent with their copper. Pretty simple and straightforward. Upon the Inka expansion, during the late 15th-early 16th centuries AD, tin was introduced and, in a way, forced upon all lands, irrespective of the local ore deposits. The Inka state was in control of the only source of tin in the empire and in order to enforce its interests shut down all of the arsenic-bearing copper mines.[1071] Although this is a bit of an extreme example, it is a good one of how a leading community can create a change in the production, use and need of a certain metal.

In the ANE, despite the possibility that tin was already known and used before the beginning of the OA period and trade in Anatolia, this does not appear to have been (so intensively) used as an alloying element with copper. On the contrary, it appears that it was because of the OA trade in tin and the wide introduction of this metal to the coppersmiths that the change came about. Buying tin from the lands east of Zagros and selling it to the copper-rich lands of Anatolia, thus making a profit in silver and gold, as well as acquiring other valuable commodities from this land, was great business for the merchants and an increase in wealth for the city of Aššur.

With the passage of time and as coppersmiths started to get acquainted with the new alloying element, they "discovered" that when an increased amount of tin was thrown into the fire together with copper, then the end product was a more golden-looking alloy.

[1068] Radivojevič and Rehren 2015.
[1069] See also Radivojevič *et al*. 2013, 1040.
[1070] This conclusion does not apply to every culture and every period of time. Selection of tin bronze against another alloy of copper does not automatically mean that there was a desire to simulate the precious metal gold and its colour. Such a conclusion should be drawn based on the general cultural context of the area under discussion; cf. Kaniuth 2007, 32-3.
[1071] Lechtman 1996, 477-78.

Simultaneously, by the time of the LBA, silver was regarded not only as a medium of exchange, but also as currency. Everyday business transactions were made in silver. Gold, on the other hand, was a precious and expensive metal. And tin, the element that could create gold-looking objects, was an imported good and so it could not have been a very common commodity as well. Tin may have been much easier to control in alloying, but the (re)use of arsenical copper remained constant throughout the LBA. The colour of objects made with arsenical copper was either reddish-yellow, much like pure copper and low-tin bronzes, or silvery. The lavishly-made artefacts of the elite, especially of the LBA, involved the manipulation of gold, silver, bronze and precious stones and glasses. The choices that were made, in matters of metal selection, were based either on simple availability or on the colouristic result. When tools, weapons, everyday vessels and utensils were produced, then of more importance were the mechanical properties of the metals, as for instance their hardness and corrosion-resistance. But when symbolic, ceremonial and generally non-functional objects were to be created, then external appearance was of the highest significance. As a result, polymetallic and/or multi-material, multi-coloured artefacts were created with the purpose to create an effect of awe in the viewer.[1072]

Let us assume that all types of metals were available to the metalsmiths, leaving aside for the moment the matter of the price for the acquisition of each. The next question is, how was the choice for a specific metal or specific alloy for the production of a specific artefact made. For any object, utilitarian or not, the metalworker has to decide which qualities are needed for this specific object. If it is to be used by a commoner then more basic qualities are needed, without the need to pursue too far a pleasing external appearance. Things, however, start to get more complicated when objects are made for the elite. A sentence written by Gell[1073] describes the essence of the "problem": "*Art objects are produced in order to be displayed on those occasions when political power is being legitimized by association with various supernatural forces*." In Egypt, royalty was embodied in the Pharaoh, who was believed to be the mediator of the people with the Gods. Objects used by the Pharaohs had to be beautifully made with the best and most precious of materials. Gell continues by saying that "*Artistry is lavished on objects which are to be transacted in the most prestigious spheres of exchange, or which are intended to realize high prices at market*." Once again, the Amarna letters are

[1072] Gell 1992, 43-56; Radivojević and Rehren 2015, 202.
[1073] Gell 1992, 54.

representative of this truth. Only the most precious, the most highly valued and the most beautifully made artefacts were to be exchanged between the Great Kings of the Near East.

But who decides what is precious and what is not? What is beautiful and what is not? What is "a work of art" and what is not? The rarity and the difficulty of acquiring a commodity, or a metal in the current discussion, was an aspect of its preciousness. Beauty, however, is a more subjective issue. What is considered beautiful can change, based on the fashions particular to a certain period of time. And trends are influenced by the elite, by those who hold the power and by those who control the materials of creation. Of course, symbolism is another element that inspires and effects trends and art. But symbolism is more often than not instructed, if not created, by a political or a religious authority. Thus, the value of raw materials and by extension of technical skills is directed by the ones that hold the power. If the one selling a commodity someone else wants, or needs, decides to raise the price, then the other has to pay it in order to acquire the goods. If a person of political or religious power decides that a specific colour, fabric, or metal should be an exclusive elite privilege, then this will undoubtably be regarded as precious and as a symbol of wealth and power. If a specific colour was connected with a supernatural power, then any material use of this colour would be reserved for the accommodation of the divine.

In conclusion, colours act as symbols with a whole range of possible meanings. They are symbols of the elements present in an ore, in a metal, in an alloy. They are symbols of the heat of a fire and of the properties of a material. They are also symbols of specific materials. And they are symbols of the powers of nature, as they are also symbols of the greater powers. And finally, they are symbols of wealth, authority and power itself.

6 Conclusion

This research has set out to (re-)examine the modes of exchange and acquisition of metals in the 2nd millennium BC Near East and to further study the variety of raw materials and ready-made metal objects documented in the textual evidence. Its aim was to investigate how the textual evidence corresponded to actual raw materials and metal objects recovered from Anatolia, Egypt, Mesopotamia and Canaan, dating to c. 2000-1300 BC. The distribution, exchange and trade of metals are issues that have generally been approached from two principal, but isolated, perspectives: the written sources, on the one hand, and the archaeometallurgical and geological data, on the other. Most past studies focus on one of these two aspects and specifically on a particular metal, area or time-period. However, this research has taken a more holistic and multidisciplinary approach towards the study of the exchange and use of metals, by integrating information from written texts, archaeometallurgical analyses, experimental archaeology, geological studies of the pertinent areas and ethnoarchaeology.

The different exchange patterns of trade and of gift-exchanging have been fully analysed by numerous scholars and form the keystone for this research. The two main textual sources selected for this study are also representative of these two exchange patterns. First, there are the published tablets from Kaneš (Kültepe) in Anatolia, written by OA merchants. These illustrate trade, an enterprise which was followed by profit or loss. The OA merchants conducted their business by exchanging commodities with the ultimate goal of gaining as much silver and gold as possible. Gold would be sent back to Aššur, to be hoarded or used for special cases of purchases, while silver played the role of currency, which would be used in Aššur to buy more merchandise and hire new caravans to send back to Anatolia, where these goods would be sold. Second, there are the so-called Amarna letters, written during the mid-14th century BC in Egypt. They were exchanged between the kings of the Near East and correspond to gift-exchanges. The Amarna corpus shows us that this act had many purposes and could satisfy a variety of needs. Receiving luxurious commodities, acquiring wealth, forming political and military alliances, receiving acceptance as one of the Great Kings of the ANE, obtaining wealth, prestige, political status and power, are the many reasons and benefits of the royal and international gift-exchanging. The royal correspondence between Alašiya (Cyprus) and Egypt is the only example of trade negotiations we have from the Amarna corpus. Alašiya was a significant supplier of copper for Egypt and for this reason its king enjoyed the status of a Great King. In conclusion, these two diverse, in time and space, archives are products of two distinct social strata, common people and traders versus royalty and elite, as well as the two distinct aspects of the economy, the commercial versus the political.

At the start of this research, a thorough study of the movements of each metal was made. An additional objective here was to study the varieties of metals recorded in the ancient texts and see how they corresponded with existing metal objects. For this purpose, an understanding of the Akkadian language, an appreciation of the various available ores to the Bronze Age people of the Near East, the ability to comprehend the various metallurgical processes and treatments of each metal and a realisation of the mechanical and physical characteristics of each metal and of each alloy produced were all necessary.

The first level of the analysis of the texts from Kaneš included a list of the shipments of the OA merchants, regarding each metal separately, as well as a record of the exact amounts of metal transported for trading reasons. The second level was an examination of the varieties of metals appearing in the texts and, more specifically, of those varieties that qualified for transport and trade. By combining the information drawn from all three points of the analysis, we were able to extract conclusions regarding the circulation areas, the final destination, the importance and the preferable form and quality for the trade of each metal. Similarly, the first level of the analysis of the Amarna letters (**Appendix 2**) included an examination of the shipments and the amounts of raw metal and of metal objects mentioned. The second level was an analysis of the purpose, according to which each metal was transported, as for example as a dowry or a greeting-gift. The third and final level included a list of the varieties of each metal recorded in the letters, along with information regarding to who sent or received this specific variety of metal and in which letter it is found.

The accumulated information and data presented here offered the opportunity to prove or disprove existing theories related to the use and treatment of metals. The most valuable and precious metals were gold and silver. They had both an economic and an artistic value. According to the texts from Kaneš, gold was acquired in Anatolia, gathered in trading-colonies such as Kaneš and was then forwarded to Aššur (**Table 1**). **Chart 16** shows us how precious gold was; especially in comparison to tin and copper, which were the main trading commodities of the OA trade. In contrast, the preciousness of gold during the Amarna period is understood by the constant requests of the Great Kings to receive "much gold" from the Pharaoh, by the fact that it records the highest total amounts transferred and that it was especially offered in cases of international marriage (**Charts 29-30**). The preferably traded variety of gold in the OA trade was the one called *pašallum* (**Table 2** and **Chart 2**). This was a type of gold rather free from impurities, such as silver. On the other hand, important varieties of gold recorded in the international correspondence of the Amarna corpus are that which “looked like silver”, or “like ashes”, and that which had “the colour of blood”. The former was a silver-containing type of gold, while the latter could have been a descriptive of the hue showing on ready-made objects of gold, a hue which could have been artificial. “Red” gold also appears in the OA texts, but there it describes raw metal.

It is often debated whether silver acted as currency or if it would be better described as a means/mode of exchange/payment and/or a standard of value. A number of scholars agree on the assessment of silver as currency and this research provides further support to this notion. The analysis done here showed that gold and silver were more often sought after in a refined state. The Kaneš texts reveal that gold was also used as a medium of exchange, but this function of the metal is unfortunately not evidenced in the royal correspondence of the Amarna letters. Refined silver appears during both the MBA and the LBA as the countervalue required for every business transaction. This specific variety of silver is the most common found in the trade-related texts of the OA period, while it is also the kind of silver requested by Alašiya in the trade-related letters of the Amarna correspondence. As a trading commodity in the Kaneš texts, silver was forwarded to Aššur (**Table 3** and **Chart 4**), preferably in a refined state (**Table 4** and **Chart 6**).

At the same time, the most important metals were actually copper and tin, and by extension bronze. They had a primarily utilitarian and only secondarily artistic value of the sort that can be linked to the precious metals. Copper and tin were key elements of the OA trade. Tin was imported to Aššur from the east and then sold on in Anatolia (**Table 5**) and local copper circulated inside Anatolia (**Table 7**) and sold to coppersmiths, to be combined with the tin and to create bronze. The recorded amounts of both of these metals are far greater than any other metal mentioned in the texts from Kaneš (**Chart 16**). Apart from its role as a significant trading commodity, tin too seems to have been also used as a kind of currency in the trip from Aššur to Anatolia. Many tablets from Kaneš mention a variety of tin (“hand tin”) given to the caravan leaders that were leaving Aššur, which was to be used for *en route* expenses, such as tolls, lodging, food and fodder. Copper is defined by a variety of terms, most important of which are “washed” and “good” (**Table 8**, **Charts 11-12**). In the Amarna letters, there are many references to bronze exchanged as gifts among Great Kings, but only one to copper. Here, copper as a raw metal records the highest amount transferred, because it is part of the correspondence and trading negotiations between the Pharaoh and the king of Alašiya (**Charts 26-28**).

Other metals that are mentioned in the texts from Kaneš are possibly antimony, lead and iron. The last represents a very problematic issue for the OA period, since four different words have been equated with it. Similarly, there are three different words translated as iron in the Amarna letters. The OA texts record the logogram KÙ.AN and the Akkadian *amūtum* and *aši'um*, which are synonymous, and *parzillum*. Most textual references belong to the two former words, while the last one is mentioned only four times in all of the published texts from Kaneš (**Table 10**). Moreover, KÙ.AN/*amūtum* is most often transported and most often distinguished by a variety (**Table 11**). In the Amarna letters, we find the words AN.BAR, *ḫabalkinnum* and *amūtum* (**Table 15**). AN.BAR is the logographic equivalent of *parzillum*, which is to be understood as iron. *Ḫabalkinum* has been related to the tribe of Chalybes on northern Anatolia, where steel is said to have been produced. And *amūtum* is found in letter EA 22 describing the material from which a horse-shaped vessel was manufactured.

The second chapter of the analysis (Chapter 4) dealt with the chemical and structural analyses of various samples from the entire ANE of the 2nd millennium BC. The data collected from these analyses were combined with the textual information, offering the opportunity and the ability to expand on certain issues faced when examining the texts. Regarding gold, there was the matter of its purity, treatment and its possible refinement. This enquiry was also expanded to silver, its sources and purity. As far as copper was concerned, the plethora of information provided by the OA texts created questions regarding the ores used and, by extension, the final copper-based alloy product. Last but not least, there was the matter of iron, if and how it was used during the first centuries of the 2nd millennium BC and if all of the assigned words to this metal actually relate to it and how.

First, almost all of the analytical data for gold artefacts come from Egypt. The analysis shows that gold artefacts always contained a certain amount of silver, which ranged from c. 50 wt% to less than 5 wt% Ag, while most of the samples contained 10-20 wt% Ag. Purities higher than c. 90 wt% Au were observed only in the 17th and 18th Dynasties (**Charts 31-32**). The variety observed in the gold contents of the examined samples reflects the variety of ore sources exploited. Moreover, an examination of the gold ores of the Eastern Desert of Egypt and Nubia revealed silver contents ranging between 5-30% Ag. This range covers the most commonly observed composition in Egyptian gold artefacts (10-20 wt% Ag) as well as that of electrum, which is believed to be the definition of Egyptian gold (>20% Ag). Pliny's description of electrum was that it shines under light brighter than silver. Indeed, Egyptian gold artefacts with a composition of c. 80-85 wt% Au and c. 15-20 wt% Ag under a specific type of light appear a little brighter than silver (**Figure 12**). Although the most common variety of gold during the

OA period was *pašallum* gold, this was not the silver-containing type of gold that we find in Egypt but a refined form of this metal that did not reveal the white hue of silver. Furthermore, the high purity observed in gold objects of the 18th Dynasty, and the structural similarity between the analysed surface of a gold foil from Amenhotep IV's coffin and the refined gold coins from Lydia offer a hint towards an existing knowledge of gold refinement, or of depletion gilding. In the Amarna texts we read about "gold with the colour of blood raised", which most probably referred to objects, whose surface was treated with iron-bearing compounds to appear red. Red gold is also evident in the Kaneš texts, where it must have been highly pure. Against the beliefs of common opinion, a way to purify gold was already known from the early 2nd millennium BC. The technique was perhaps not yet perfected and due to the pointlessness of the process in a period when appearance mattered more than content, an alternative method was used in order to achieve the desired result. This was to apply a superficial treatment to the gold, called depletion gilding.

Second, silver was usually obtained by the cupellation of argentiferous galena. With this process, lead is absorbed by the porous walls of the cupel, leaving the silver refined. Lead isotope analyses of the silver-poor Egyptian silver sources were found not to correspond with the results from the analysed Egyptian artefacts. Moreover, the same analyses showed that possible matches for the silver used in Egypt are Lavrion in Greece and the Taurus Mountains in Anatolia (**Charts 41-43**). It is a known fact that ancient Egyptians did not recognise silver as a separate metal, but initially described it as "white gold". Furthermore, chemical analysis of silver artefacts from Egypt revealed compositions ranging from c. 55 wt% to c. 95 wt% Ag, with usually less than 10 wt% Au and less than 10 wt% Cu. These results show that the imported silver was often alloyed with silver-containing gold and/or copper. The addition of c. 10 wt% Cu to silver would not change its colour, but it would allow the object to withstand more elaborate working and would make it more corrosion resistant. Adding silver-containing gold to pure silver had the advantageous result of saving silver, which was an imported and not locally found metal, while still preserving the white colour of silver. Nevertheless, the most important role of silver in the 2nd millennium BC Near East was that of currency. This metal, and more specifically its "refined" variety (*ṣarpum*), was the ultimate goal of the OA traders and the means to buy trade-commodities and hire caravans in Aššur to travel towards Anatolia. Moreover, there exist a great number of tablets attesting to the use of this variety of silver for paying loans and debts. The use of silver for various types of payments is also found in the vassal correspondence of the Amarna corpus. In addition, there is a text from the king of

Alašiya, dealing with trade negotiations among Alašiya and Egypt, where the king requests from the Pharaoh payment with "refined" silver.

Third, chemically-analysed copper-based artefacts from Kaneš showed that the imported tin was preferably alloyed with pure copper and not with iron-containing, or arsenic-rich copper (**Chart 44**). However, Anatolian copper ores are mainly copper sulphides, copper oxides, or polymetallic, most of which contain iron as an impurity. The primary smelting product of this iron-containing copper is called blister copper and has a characteristic black colour, which we also read in the Kaneš texts. Black copper has to be refined before it can be used to manufacture bronze, as more than 1 wt% Fe makes the copper overly brittle. Ingots found in the site of Acem Höyük were found to have two different compositions, corresponding with the case before and after the refinement process. While some ingots contained >0.5 wt% Fe and are believed to have been blister copper brought to the site to be refined, most of them were composed of pure copper, which was then used for the manufacture of bronze. The same composition was observed in two wire rings and a similar composition in wrapped bars and sickles from Kaneš (**Charts 45-47**). Alongside the alloying of pure copper with tin to make bronze, arsenical copper was still being used during the OA period and was often recycled and mixed with tin creating ternary alloys of copper, arsenic and tin. Arsenical copper artefacts contained significantly higher amounts of iron than bronze ones did and this is observed not only in objects from Kaneš, but from Ḫattuša in the MBA and LBA as well. The few artefacts of the Amarna period from Egypt that have been analysed are also made of pure copper alloyed with tin. The tin, both in the MBA and the LBA, was coming from the lands east of the Zagros Mountains, the closest source of which is found in Iran (Deh Hosein). Contrary to the situation described in the Kaneš texts and revealed by the lead isotope analyses of copper-based objects from Anatolia, where copper was mined and circulated inside Anatolia during the LBA, the age of international relations, copper reached Egypt from a variety of sources, among which are Lavrion, the Taurus Mountains, as well as Cyprus (i.e. Alašiya), which also appears in the Amarna letters (**Charts 49-51 and 53-55**).

Fourth, nowadays we separate meteoric from terrestrial iron based on the nickel content found in the metal. If there is more than c. 5% Ni, the iron is deemed meteoric, and when there is less than that, it is terrestrial. Nevertheless, such a differentiation could not have been made by the people of the ANE. Meteoric iron can be found in meteorites that fall on the surface of the earth. The meteorites that contain the highest amounts of iron are iron meteorites and are also the easiest to find. They are distinguished by the regmaglypts, or flow lines, that have formed on their surface, their significant density and their black fusion crust when freshly fallen. However, if meteorites remain on the earth's surface for a sufficient amount of time, they acquire the light brown colour of iron oxides, i.e. weathered iron, such as magnetite and goethite. The latter two minerals are commonly found iron oxides in Anatolia, Egypt and Israel. Terrestrial iron ores can be smelted at low temperatures, producing a spongy mixture of iron, slag and unburned charcoal, called a bloom. This primary smelting product can be directly processed, but it is better to consolidate it and extract the slag from the metal. The analysed iron samples from Kaman Kalehöyük and Kaneš of the early 2nd millennium BC present a possible relation with the smelting of copper sulphide, or nickel-rich copper ores, or a preparation process to create red-pigment for pottery. No actual evidence of an iron production process has been discovered. The *communis opinio* that meteoric iron does not corrode was refuted by the chemical analyses of some iron beads from Gerzeh in Egypt, which showed that the nickel content had dicreased towards the surface of the object. In order to avoid the error of assuming that an iron artefact was of a non-meteoric origin, based on a rather superficial analysis, a correlation among iron, cobalt and nickel contents in the iron object has to be satisfied. Based on the analytical data and the correlation of these three constituents in the metal, the existing premise that all early iron artefacts were made of meteoric and not of terrestrial iron is valid and can be observed in **Charts 56-57**. Prior to the 13th century BC, all iron artefacts appear to have actually been made with meteoric iron.

Colour, as either directly or indirectly attested in the ANE texts, was the number-one identifier of the quality and the treatment applied to metals and metal objects. The significance of the physical properties of an object and/or a metal is recognised in this study. In matters of raw materials, these properties facilitated the identification of the suitable ores and presented metalworkers with essential information for treating the metal. In matters of ready-made objects, external appearance and most importantly colour were central in the manufacture of decorative, symbolic and/or royal artefacts. The colour and lustre of silver, the colour of copper, the various hues of gold along with the colour of bronze, were combined to form multi-coloured creations.

As far as gold is concerned, its colour was a decisive indicator for its purity, quality and, thus, price for the OA merchants. Gold that contained, and looked like, silver was easily recognisable by its pale, green(ish)-yellow(ish) colour and was never welcome. Neither by the merchants of the OA period, nor by the Great Kings of the LBA. The Kaneš texts make a clear distinction between "white" (*puṣium*) and *pašallum* gold. The former was silver-containing, while the latter was a variety of higher purity and quality. Therefore, its colour must have been quite different from what we recognise as electrum. The highest possible quality of gold contained less than c. 4 wt% Ag and had a red colouration. This red hue on gold had been highly valued since the late 3rd millennium BC in Mesopotamia. "Red" (HUŠ.A, *sa'amum* and *ša damu*) gold appears in the OA texts as the rarest and the most expensive type of gold. Gold "with the colour of blood raised" (*ša damu šūlû*) is mentioned in letters sent from the Mitanni king to the Pharaoh. These red-coloured gold objects were most probably superficially treated, either by depletion gilding or with an iron-containing solution, so as to show this hue.

During the OA trade, the amount of tin imported into Anatolia and recorded in the texts found in Kaneš is far too large to have produced the bronze objects found in the same site. The vast majority of copper-based artefacts are in fact of arsenical or rather pure copper. It is an undeniable fact that bronze is very often targeted for recycling and, as a result, is being continuously used and repurposed, and is so made less visible in the archaeological record. It is generally believed that bronze was a "better" alloy than arsenical copper and that is why the former replaced the latter. However, ancient metalworkers did not work based on hard quantitative data, but on empirical and perceivable qualities. Colour was a key factor to the copper-working process. A concentration of up to c. 3 wt% As, or up to c. 2 wt% Sn, would preserve the reddish hue of pure copper. Then the colouring created by the respective alloying elements begin to differ. From c. 3 wt% As on, the alloy starts acquiring a reddish-yellow hue, slowly turning towards silver at about 5 wt% As. Arsenical copper containing more than c. 7 wt% As has a distinctive white-silvery colouration. On the other hand, tin concentrations above c. 2 wt% Sn produce a red-yellowish hue, turning towards yellow-reddish at c. 4 wt% Sn. Then, as the tin content rises, the metal appears more and more yellow to golden, reaching its highest tone at approximately 12 wt% Sn. From that point on, the colour becomes increasingly more greyish (**Charts 58-59**). Each alloy colouration would have been appreciated by the metalworkers, who thus perceived the specific characteristics of the alloy to hand and how they would best be able to work with it. The analysed copper-based artefacts from Kaneš appear to have been concentrated in the reddish to reddish-yellow area (Cu and As-Cu alloys), and less in the yellow-golden area (Sn-Cu alloys). Meanwhile, the few analysed bronze artefacts from Amarna are mainly found in the yellow-golden colour margin (**Chart 60**).

A subject, which receives extensive discussion, is that of iron and its terminology during the OA and Amarna periods. The relative terms are KÙ.AN/*amūtum*, AN.BAR/*parzillum* and *aši'um*. AN.BAR/*parzillum* is rightfully understood as iron, as it is the only term that continues to appear in texts of the Iron Age, when iron production has begun. Furthermore, the logogram AN.BAR first appears in Mesopotamia, an area poor in metal sources. This means that this term initially referred to the metal coming from (iron) meteorites, which are rather easy to recognise from their regmaglypts, density and metallic lustre. With the later development of iron production from its ores, this term would have been expanded to denote iron, disregarding the source – terrestrial or meteoric. However, in the OA texts, this term appears only scarcely in its Akkadian form, while the terms KÙ.AN/*amūtum* are far more abundant. Moreover, the term *amūtum* is mentioned once again in an Amarna letter, where it describes a horse-shaped vessel. The disappearance of these terms in the period when iron production is starting to evolve, along with its reference as the raw material used for the manufacture of a horse-shaped vessel, leads to the conclusion that the association of the terms KÙ.AN/*amūtum* (and *aši'um*) with iron is doubtful and should be reconsidered.

Metallurgy is an art and not a science. The ancient metallurgists worked relying on their senses and experience. They did not mix specific amounts of two metals, knowing that they would get a specific alloy with specific mechanical and physical properties. Every word that was used in the ancient texts to describe the quality and/or purity of, or a treatment that has been performed on, a metal, was based on its external characteristics and most of all its colour and vice versa. For example, "good" gold would have a yellow colour, while "red" gold would be of very high purity, quality and value. Similarly, "good" copper would appear reddish, while "black" copper contained iron and was not of a good enough quality. Based on the same logic, iron would be first recognised as a black, maybe with metallic lustre, rock, while later it would have been recognised and used for the same purposes in its light-brown-looking form.

Moreover, colour had an important role in the lives of the ANE people. Since the early 2nd millennium BC, there are artefacts that were manufactured with materials of varying colours. The highpoint of polychromy appears to be the 18th Dynasty of Egypt. The greatest examples of polychromy are found among the funerary items of Tutankhamun, as well as in Mycenaean tombs in Greece. Black bronze, gold, silver and multi-coloured precious stones were put together to create a polychrome effect that was highly valued throughout the entire ANE. Moreover, the external appearance and more precisely the colour of a metal, or a metal artefact, was of great importance to all peoples, not only to the people of the ANE. Ethnological examples show us that certain copper-based alloys were chosen not only because of the local ores available, but also because of their external appearance and their resemblance to metals of greater value. Moreover, the use for which an object is designed plays a key-role on the materials that will be chosen. Luxurious, not functional, and symbolic items were works of art, which had to reflect their preciousness. For this reason, they were manufactured by the best artists, with the best quality of every material involved and with those colours that were regarded as precious and that would create the greatest admiration and wonder. This behaviour shows the significance of colour as a symbol of quality, value, wealth, authority and power.

In the multidisciplinary approach of this research, which offered a broadened perspective of the subject of the exchange and usage of metals from the earlier centuries of the 2nd millennium BC until about a century before the turn of the Iron Age, a variety of limitations were encountered and had to be, one way or another, overcome. First, the core of the textual evidence is still relatively limited. The presently translated and published texts from Kaneš may now have reached in the tens of thousands, but this is still only about 20% of the total number of tablets excavated. Forthcoming publications of archives from Kaneš are awaited and will most certainly offer much-needed additional information and missing details to the research. In particular, the forthcoming study of many unpublished texts, by Erol, will surely offer a deeper insight into the metal varieties.[1074] A second issue that had to be faced, was the lack of a standard weight system that could be used for the entire Near East. In order to overcome this issue, certain compromises had to be made and only one weight system chosen for each archive. This meant that for the Amarna letters some conversions were required. A third limitation regards the also limited number of samples available for analysis. The problem of not being allowed by Museums to extract samples from precious and valuable metal artefacts, or even sometimes not even being allowed to perform a simple pXRF analysis, is a well-known and oft-mentioned issue, which will not be further discussed here. Additionally, the non-destructive analytical methods usually used can only offer an image of the surface composition and not of the core of the object. Core sampling may lead to different conclusions regarding the artefact and its treatment. Despite these constraints, the broad spectrum of this research managed to combine information and data from diverse scientific sources, which were not obvious before due to the more focused traditional approach to the issue(s).

The need for more archaeometallurgical analysis is self-evident and the necessity for more geological studies concerning metals' sources becomes apparent. In regard to the subject of metal provenancing, the creation of a central, online database containing lead-isotopic and elemental analyses' data from all possible ore sources, extending from western Europe to the Far East, would be of great benefit to all researchers.[1075] This would offer an up-to-date access to the relative information and perhaps a better communication among researchers, which will possibly lead to the answering of unresolved questions.

[1074] Information provided by Erol (pers. com., December 19, 2017).

[1075] There exists already the OXALID, but it is limited to results provided by the Isotrace Laboratory at the University of Oxford.

Much has been written on the individual aspects that were included in this research. If the holistic and multidisciplinary approach followed in this study has offered answers to some since-long existing questions, it has equally created new ones. The study of the exchange of metals should not dwell overlong on the act *per se*. It should also expand to embrace an understanding and examination of what type of metal was transacted and for what purpose, why was one variety of a metal chosen over another and, last but not least, how were demand and preference formed.

Appendix 1. Old Assyrian texts from Kaneš

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
4. HethKongr. 112	-	-	kt 98/k 121	-	P361249	
AAA I/3, 5	-	Veenhof 2016, 27	-	WML 49.47.56	P360979	
AfO 35, 55	-	-	kt n/k 1919	-	-	
Akkadica 42, 7	-	FAOS 4, 372 no. 510	kt 84/k 3	-	P357331	
AKT 1, 17	CMK 237	OAA 1, 71	-	Ank. 2806	P360476	
AKT 1, 18	CMK 129	-	-	Ank. 2804	P360477	
AKT 1, 23	-	CMK 132	-	Ist. 12480	P360482	
AKT 1, 40	-	Michel, Innaya II, 409	kt a/k 462	AMM 109-128-64a+b	P360499	
AKT 1, 51	-	Sturm 1995, 496 no. 1	kt a/k 562b	AMM 109-218-64a+b	P360510	
AKT 1, 57	-	Michel, Innaya II, 410	kt a/k 501	AMM 109-165-64a+b	P360516	
AKT 1, 78	CMK 100	-	kt a/k 1165	AMM 109-639-64	P360537	
AKT 1, 82	CMK 147	-	kt y/k 14	AMM 116-13-71	P360541	
AKT 2, 12	-	Veenhof 2014, 409	kt n/k 594	AMM 165-594-64	P360554	
AKT 2, 22	CMK 8	-	kt n/k 604	-	P360565	
AKT 2, 39	-	OACT, 206f. no. 19	kt n/k 577	-	P360583	
AKT 3, 12	-	Sturm 1995, 496 no. 2	kt v/k 87	-	P360621	
AKT 3, 20	-	Sturm 1995, 496 no. 3	kt v/k 26	-	P360629	
AKT 3, 21	-	-	kt v/k 45	-	P360630	
AKT 3, 24	-	-	kt v/k 79	-	P360633	
AKT 3, 28	-	-	kt v/k 202	-	P360637	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 3, 30	-	-	kt v/k 75	-	P360639	
AKT 3, 33	-	-	kt v/k 189	-	P360642	
AKT 3, 34	-	-	kt v/k 103	-	P360643	
AKT 3, 44	-	-	kt v/k 84	-	P360653	
AKT 3, 45	-	Veenhof 2016, 19-20	kt v/k 16	-	P360654	
AKT 3, 52	-	-	kt v/k 11	-	P360661	
AKT 3, 56	-	-	kt v/k 13	-	P360665	
AKT 3, 57	-	-	kt v/k 106	-	P360666	
AKT 3, 61	-	-	kt v/k 133	-	P360670	
AKT 3, 64	-	-	kt v/k 72	-	P360673	
AKT 3, 65	-	-	kt v/k 138	-	P360674	
AKT 3, 66	-	-	kt v/k 73	-	P360675	
AKT 3, 67	-	-	kt v/k 36	-	P360676	
AKT 3, 68	-	-	kt v/k 99	-	P360677	
AKT 3, 70	-	-	kt v/k 81	-	P360679	
AKT 3, 72	-	-	kt v/k 10	-	P360681	
AKT 3, 73	-	-	kt v/k 50	-	P360682	
AKT 3, 74	-	-	kt v/k 90	-	P360683	
AKT 3, 75	-	-	kt v/k 22	-	P360684	
AKT 3, 76	-	-	kt v/k 21	-	P360685	
AKT 3, 78	-	-	kt v/k 18	-	P360687	
AKT 3, 82	-	-	kt v/k 39	-	P360691	
AKT 3, 90	-	-	kt v/k 74	-	P360699	
AKT 3, 91	-	-	kt v/k 62	-	P360700	
AKT 3, 93	-	-	kt v/k 31	-	P360702	
AKT 3, 95	-	-	kt v/k 68	-	P360704	
AKT 3, 101	-	-	kt v/k 126	-	P360710	
AKT 3, 102	-	-	kt v/k 114	-	P360711	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 3, 103	-	-	kt v/k 49	-	P360712	
AKT 3, 110	-	-	kt v/k 25	-	P360719	
AKT 3, 113	-	-	kt v/k 139	-	P360722	
AKT 5, 1	CMK 20	Belleten 61, 229-30	kt 92/k 221	-	P390599	
AKT 5, 2	CMK 21	Belleten 61, 225-27	kt 92/k 203	-	P390597	
AKT 5, 3	CMK 22	Belleten 61, 223-25	kt 92/k 200	-	-	
AKT 5, 6	-	-	kt 92/k 194	-	-	
AKT 5, 11	-	-	kt 92/k 233	-	-	
AKT 5, 16	-	-	kt 92/k 255	-	-	
AKT 5, 17	-	-	kt 92/k 236	-	-	
AKT 5, 25	-	-	kt 92/k 244	-	-	
AKT 5, 37	-	-	kt 92/k 220	-	-	
AKT 5, 41	-	-	kt 92/k 238	-	-	
AKT 5, 45	-	-	kt 92/k 202	-	-	
AKT 5, 46	-	-	kt 92/k 206	-	-	
AKT 5, 50	-	-	kt 92/k 195	-	-	
AKT 5, 51	-	-	kt 92/k 196	-	-	
AKT 5, 52	-	-	kt 92/k 198	-	-	
AKT 5, 57	-	-	kt 92/k 239	-	-	
AKT 5, 58A	-	-	kt 92/k 242	-	-	
AKT 5, 71	-	-	kt 92/k 234	-	-	
AKT 6a, 2	-	-	kt 94/k 1733	-	-	
AKT 6a, 3	-	-	kt 94/k 1746	-	-	
AKT 6a, 4	-	-	kt 94/k 1113	-	-	
AKT 6a, 8	-	-	kt 94/k 1211	-	-	
AKT 6a, 13	-	-	kt 94/k 1362	-	-	
AKT 6a, 25	-	-	kt 94/k 1050B	-	-	
AKT 6a, 27	-	-	kt 94/k 393	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6a, 46	-	-	kt 94/k 1144B	-	-	
AKT 6a, 74	-	-	kt 94/k 1136	-	-	
AKT 6a, 90	-	-	kt 94/k 1093	-	-	
AKT 6a, 91	-	-	kt 94/k 1097	-	-	
AKT 6a, 92	-	-	kt 94/k 1103	-	-	
AKT 6a, 93	-	-	kt 94/k 1104	-	-	
AKT 6a, 94	-	-	kt 94/k 1108	-	-	
AKT 6a, 95	-	-	kt 94/k 1110	-	-	
AKT 6a, 96	-	-	kt 94/k 1167	-	-	
AKT 6a, 97	-	-	kt 94/k 1191	-	-	
AKT 6a, 98	-	-	kt 94/k 1196	-	-	
AKT 6a, 99	-	-	kt 94/k 1199	-	-	
AKT 6a, 100	-	-	kt 94/k 1221	-	-	
AKT 6a, 101	-	-	kt 94/k 1233	-	-	
AKT 6a, 103	-	-	kt 94/k 1285	-	-	
AKT 6a, 120	-	-	kt 94/k 813	-	-	
AKT 6a, 125	-	-	kt 94/k 1444	-	-	
AKT 6a, 128	-	-	kt 94/k 1383	-	-	
AKT 6a, 129	-	-	kt 94/k 1756	-	-	
AKT 6a, 130	-	-	kt 94/k 1757	-	-	
AKT 6a, 143	-	-	kt 94/k 1318	-	-	
AKT 6a, 144	-	-	kt 94/k 1686	-	-	
AKT 6a, 145	-	-	kt 94/k 1687	-	-	
AKT 6a, 150	-	-	kt 94/k 1609	-	-	
AKT 6a, 162	-	-	kt 94/k 1750	-	-	
AKT 6a, 163	-	-	kt 94/k 1310	-	-	
AKT 6a, 164	-	-	kt 94/k 1744	-	-	
AKT 6a, 166	-	-	kt 94/k 1130	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6a, 167	-	-	kt 94/k 1736	-	-	
AKT 6a, 169	-	-	kt 94/k 1173	-	-	
AKT 6a, 173	-	-	kt 94/k 1470	-	-	
AKT 6a, 174	-	-	kt 94/k 850	-	-	
AKT 6a, 176	-	-	kt 94/k 1461	-	-	
AKT 6a, 177	-	-	kt 94/k 1020	-	-	
AKT 6a, 183	-	-	kt 94/k 1394	-	-	
AKT 6a, 184	-	-	kt 94/k 615	-	-	
AKT 6a, 185	-	-	kt 94/k 848	-	-	
AKT 6a, 188	-	-	kt 94/k 1382	-	-	
AKT 6a, 189	-	-	kt 94/k 1335	-	-	
AKT 6a, 194	-	-	kt 94/k 795	-	-	
AKT 6a, 203	-	-	kt 94/k 1755	-	-	
AKT 6a, 206	-	-	kt 94/k 1727	-	-	
AKT 6a, 208b	-	-	kt 94/k 1400	-	-	
AKT 6a, 216	-	-	kt 94/k 787	-	-	
AKT 6a, 224	-	-	kt 94/k 1688	-	-	
AKT 6a, 230	-	-	kt 94/k 1396	-	-	
AKT 6a, 246	-	-	kt 94/k 1669	-	-	
AKT 6a, 249	-	-	kt 94/k 590B	-	-	
AKT 6a, 250	-	-	kt 94/k 748	-	-	
AKT 6a, 251	-	-	kt 94/k 1023	-	-	
AKT 6a, 253	-	-	kt 94/k 613	-	-	
AKT 6a, 254	-	-	kt 94/k 619	-	-	
AKT 6a, 273	-	-	kt 94/k 1534	-	-	
AKT 6a, 276	-	-	kt 94/k 1111	-	-	
AKT 6a, 278a	-	-	kt 94/k 744	-	-	
AKT 6a, 282	-	-	kt 94/k 1214	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6a, 285	-	-	kt 94/k 1349	-	-	
AKT 6b, 300	-	-	kt 94/k 662	-	-	
AKT 6b, 301	-	-	kt 94/k 642	-	-	
AKT 6b, 303	-	-	kt 94/k 1668	-	-	
AKT 6b, 313	-	-	kt 94/k 1242	-	-	
AKT 6b, 316	-	-	kt 94/k 666	-	-	
AKT 6b, 317	-	-	kt 94/k 638	-	-	
AKT 6b, 318	-	-	kt 94/k 718	-	-	
AKT 6b, 322	-	-	kt 94/k 1401	-	-	
AKT 6b, 329	-	-	kt 94/k 1131	-	-	
AKT 6b, 332	-	-	kt 94/k 668	-	-	
AKT 6b, 333	-	-	kt 94/k 1373	-	-	
AKT 6b, 334	-	-	kt 94/k 1101	-	-	
AKT 6b, 335	-	-	kt 94/k 1245	-	-	
AKT 6b, 336	-	-	kt 94/k 788	-	-	
AKT 6b, 337b	-	-	kt 94/k 959	-	-	
AKT 6b, 340	-	-	kt 94/k 1387	-	-	
AKT 6b, 341	-	-	kt 94/k 771+780	-	-	
AKT 6b, 346	-	-	kt 94/k 790	-	-	
AKT 6b, 347	-	-	kt 94/k 789	-	-	
AKT 6b, 348	-	-	kt 94/k 1013	-	-	
AKT 6b, 350	-	-	kt 94/k 800	-	-	
AKT 6b, 352	-	-	kt 94/k 774	-	-	
AKT 6b, 353	-	-	kt 94/k 1252	-	-	
AKT 6b, 354	-	-	kt 94/k 941	-	-	
AKT 6b, 362	-	-	kt 94/k 974	-	-	
AKT 6b, 364	-	-	kt 94/k 856B	-	-	
AKT 6b, 367	-	-	kt 94/k 1376	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6b, 368	-	-	kt 94/k 952	-	-	
AKT 6b, 371	-	-	kt 94/k 824	-	-	
AKT 6b, 373	-	-	kt 94/k 1145B	-	-	
AKT 6b, 377	-	-	kt 94/k 601B	-	-	
AKT 6b, 378	-	-	kt 94/k 1384	-	-	
AKT 6b, 380	-	-	kt 94/k 847	-	-	
AKT 6b, 383	-	-	kt 94/k 1004	-	-	
AKT 6b, 384	-	-	kt 94/k 786	-	-	
AKT 6b, 385	-	-	kt 94/k 694	-	-	
AKT 6b, 399	-	-	kt 94/k 596B	-	-	
AKT 6b, 404	-	-	kt 94/k 1180B	-	-	
AKT 6b, 409	-	-	kt 94/k 727	-	-	
AKT 6b, 410	-	-	kt 94/k 1231	-	-	
AKT 6b, 411	-	-	kt 94/k 826	-	-	
AKT 6b, 416	-	-	kt 94/k 569	-	-	
AKT 6b, 417	-	-	kt 94/k 816	-	-	
AKT 6b, 427	-	-	kt 94/k 823	-	-	
AKT 6b, 438	-	-	kt 94/k 692	-	-	
AKT 6b, 443	-	-	kt 94/k 1316	-	-	
AKT 6b, 444	-	-	kt 94/k 1522	-	-	
AKT 6b, 446	-	-	kt 94/k 630	-	-	
AKT 6b, 447	-	-	kt 94/k 1219	-	-	
AKT 6b, 448	-	-	kt 94/k 627	-	-	
AKT 6b, 449	-	-	kt 94/k 1763	-	-	
AKT 6b, 452	-	-	kt 94/k 1616	-	-	
AKT 6b, 456	-	-	kt 94/k 853	-	-	
AKT 6b, 457	-	-	kt 94/k 798	-	-	
AKT 6b, 464	-	-	kt 94/k 1177	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6b, 466	-	-	kt 94/k 737	-	-	
AKT 6b, 467	-	-	kt 94/k 639	-	-	
AKT 6b, 468	-	-	kt 94/k 670	-	-	
AKT 6b, 469	-	-	kt 94/k 677	-	-	
AKT 6b, 476	-	-	kt 94/k 733	-	-	
AKT 6b, 477	-	-	kt 94/k 734	-	-	
AKT 6b, 478	-	-	kt 94/k 738	-	-	
AKT 6b, 481	-	-	kt 94/k 1700	-	-	
AKT 6b, 482	-	-	kt 94/k 1452	-	-	
AKT 6b, 483	-	-	kt 94/k 829	-	-	
AKT 6b, 485	-	-	kt 94/k 1005	-	-	
AKT 6b, 488	-	-	kt 94/k 1024	-	-	
AKT 6b, 489	-	-	kt 94/k 1129	-	-	
AKT 6b, 490	-	-	kt 94/k 1380	-	-	
AKT 6b, 491	-	-	kt 94/k 1605	-	-	
AKT 6b, 492	-	-	kt 94/k 703	-	-	
AKT 6b, 496	-	-	kt 94/k 768	-	-	
AKT 6b, 499	-	-	kt 94/k 1451	-	-	
AKT 6b, 505	-	-	kt 94/k 1328	-	-	
AKT 6b, 506	-	-	kt 94/k 1427	-	-	
AKT 6b, 507	-	-	kt 94/k 679	-	-	
AKT 6b, 514	-	-	kt 94/k 1270	-	-	
AKT 6b, 517	-	-	kt 94/k 911	-	-	
AKT 6b, 519	-	-	kt 94/k 755	-	-	
AKT 6c, 523	-	-	kt 94/k 830	-	-	
AKT 6c, 524	-	-	kt 94/k 1420B	-	-	
AKT 6c, 525	-	-	kt 94/k 775	-	-	
AKT 6c, 527	-	-	kt 94/k 937	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6c, 528	-	-	kt 94/k 845	-	-	
AKT 6c, 535	-	-	kt 94/k 1002	-	-	
AKT 6c, 536	-	-	kt 94/k 1423	-	-	
AKT 6c, 537	-	-	kt 94/k 966	-	-	
AKT 6c, 539	-	-	kt 94/k 663	-	-	
AKT 6c, 544	-	-	kt 94/k 1675	-	-	
AKT 6c, 547	-	-	kt 94/k 1611	-	-	
AKT 6c, 550	-	-	kt 94/k 843	-	-	
AKT 6c, 551	-	-	kt 94/k 1243	-	-	
AKT 6c, 554	-	-	kt 94/k 857B	-	-	
AKT 6c, 557	-	-	kt 94/k 1691	-	-	
AKT 6c, 559	-	-	kt 94/k 838	-	-	
AKT 6c, 560	-	-	kt 94/k 1352	-	-	
AKT 6c, 563	-	-	kt 94/k 671	-	-	
AKT 6c, 564	-	-	kt 94/k 656	-	-	
AKT 6c, 566	-	-	kt 94/k 575	-	-	
AKT 6c, 570	-	-	kt 94/k 759	-	-	
AKT 6c, 571	-	-	kt 94/k 808	-	-	
AKT 6c, 577	-	-	kt 94/k 809	-	-	
AKT 6c, 580	-	-	kt 94/k 888B	-	-	
AKT 6c, 592	-	-	kt 94/k 967	-	-	
AKT 6c, 598	-	-	kt 94/k 814	-	-	
AKT 6c, 599	-	-	kt 94/k 810	-	-	
AKT 6c, 601	-	-	kt 94/k 860B	-	-	
AKT 6c, 603	-	-	kt 94/k 859B	-	-	
AKT 6c, 606	-	-	kt 94/k 1353	-	-	
AKT 6c, 607	-	-	kt 94/k 623	-	-	
AKT 6c, 608	-	-	kt 94/k 1120	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6c, 610	-	-	kt 94/k 970	-	-	
AKT 6c, 613	-	-	kt 94/k 1393	-	-	
AKT 6c, 616	-	-	kt 94/k 1467	-	-	
AKT 6c, 617	-	-	kt 94/k 751	-	-	
AKT 6c, 618	-	-	kt 94/k 960	-	-	
AKT 6c, 621	-	-	kt 94/k 1012	-	-	
AKT 6c, 622	-	-	kt 94/k 1473	-	-	
AKT 6c, 625	-	-	kt 94/k 1151B	-	-	
AKT 6c, 626	-	-	kt 94/k 1082	-	-	
AKT 6c, 627	-	-	kt 94/k 756	-	-	
AKT 6c, 628	-	-	kt 94/k 1490	-	-	
AKT 6c, 630	-	-	kt 94/k 871B	-	-	
AKT 6c, 631	-	-	kt 94/k 685	-	-	
AKT 6c, 632	-	-	kt 94/k 1338	-	-	
AKT 6c, 636	-	-	kt 94/k 1398	-	-	
AKT 6c, 642	-	-	kt 94/k 1298	-	-	
AKT 6c, 647	-	-	kt 94/k 1441	-	-	
AKT 6c, 648	-	-	kt 94/k 1283	-	-	
AKT 6c, 649	-	-	kt 94/k 1471	-	-	
AKT 6c, 652	-	-	kt 94/k 1307	-	-	
AKT 6c, 655	-	-	kt 94/k 1348	-	-	
AKT 6c, 659	-	-	kt 94/k 1456	-	-	
AKT 6c, 666	-	-	kt 94/k 1299	-	-	
AKT 6c, 668	-	-	kt 94/k 834	-	-	
AKT 6c, 671	-	-	kt 94/k 858B	-	-	
AKT 6c, 677	-	-	kt 94/k 1457	-	-	
AKT 6c, 680	-	-	kt 94/k 978	-	-	
AKT 6c, 684	-	-	kt 94/k 579	-	-	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
AKT 6c, 685	-	-	kt 94/k 1360	-	-	
AKT 6c, 686	-	-	kt 94/k 1491	-	-	
AKT 6c, 688	-	-	kt 94/k 588B	-	-	
AKT 6c, 689	-	-	kt 94/k 812	-	-	
AKT 6c, 706	-	-	kt 94/k 740	-	-	
AKT 6c, 707	-	-	kt 94/k 1076	-	-	
AKT 6c, 721	-	-	kt 94/k 934	-	-	
AKT 6c, 723	-	-	kt 94/k 1092	-	-	
Anatolica 12, 131	-	-	-	Ka. 435	P361258	
Anatolica 12, 133	-	-	-	Ka. 276	P361259	
Anatolica 12, 138f.	-	-	-	Ka. 1004	P361261	
Anatolica 12, 143	-	-	-	Ka. 975	P361262	
Ank. 64	-	FAOS 4, 187 no. 194	-	-	-	
AnOr 6, 15	CMK 61	-	-	Ashm. 1914, 425	P361042	
AnOr 6, 18	CMK 175	-	-	Ashm. 1914, 433	P361045	
AnOr 6, 20	-	FAOS 4, 395f. no. 543	-	Ashm. 1914, 420	P368424	
ArAn 2, 25f.	CMK 93	-	kt 85/k 27	-	P361495	
ArAn 3, 160	-	-	kt 87/k 287	AMM 9-148-87	P360799	
ArAn 3, 294-297	-	Veenhof 2016, 24-26	kt 92/k 564b	-	P361322	
ATHE 10	-	FAOS 4, 188f. no. 196	-	-	P358342	
ATHE 17	-	FAOS 4, 62 no. 38	-	-	P358349	
ATHE 18	-	FAOS 4, 62f. no. 39	-	-	P358350	
ATHE 28	-	Ichisar, Imdilum 281f.	-	-	P358360	
ATHE 32	CMK 70	OACT, 201 no. 14; Sturm 1995, 496f. No. 4	-	-	P358364	
ATHE 37	-	OAA 1, 66	-	-	P358369	
ATHE 38	-	OrNS 36 no. 44	-	-	P358370	
ATHE 39	-	Dercksen 2005, 31 n. 45	-	-	P358371	

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ATHE 62	-	Ichisar, Imdilum 264-67	-	-	P358394	
ATHE 63	CMK 68	-	-	-	P358395	
Belleten 40, 182	-	Ichisar, Imdilum 211f.	-	Bursa 3776	P361603	
BibO 73, 20-21 no. B	-	-	kt m/k 71	AMM 164-71-64	-	
BibO 73, 22 no. C	-	-	kt m/k 93	AMM 164-93-64	-	
BibO 73, 22-23 no. D	-	-	-	private collection Struwe	-	
BIN 4, 1	-	van der Meer, Correspondance no. 1	-	NBC 1741	P293385	
BIN 4, 7	-	van der Meer, Correspondance no. 56	-	NBC 1702	P293383	
BIN 4, 13	-	OACP 87	-	NBC 1720	P292121	
BIN 4, 19	-	van der Meer, Correspondance no. 71	-	NBC 1666	P292109	
BIN 4, 24	-	OACP 89f.	-	NBC 1740	P292125	
BIN 4, 27	-	OACP 134f.; Ichisar, Imdilum 267-69	-	NBC 1687	P292117	
BIN 4, 29	-	OACP 136ff.	-	NBC 1692	P292119	
BIN 4, 30	CMK 142	Ichisar, Imdilum 364f.	-	NBC 1674	P292113	
BIN 4, 31	-	OACT, 190ff. no. 7	-	NBC 1901	P292129	
BIN 4, 35	-	OACT, 188ff. no. 6	-	NBC 1677	P293379	
BIN 4, 45	CMK 187	Michel, Innaya II, 160ff.	-	NBC 1664	P290537	
BIN 4, 50	CMK 181	-	-	NBC 1657	P290536	
BIN 4, 51	-	OAA 1, 64	-	NBC 1686	P290541	
BIN 4, 52	-	OAA 1, 62	-	NBC 1688	P290305	
BIN 4, 54	-	OAA 1, 119	-	NBC 1700	P290310	
BIN 4, 61	-	OACP 122ff.	-	NBC 1899	P290341	
BIN 4, 64	-	OAA 1, 114	-	NBC 1661	P290299	
BIN 4, 66	-	Ichisar, Imdilum 400f.	-	NBC 1696	P290308	

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BIN 4, 87	-	Michel, Innaya II, 247f. no. 180; Ichisar, Imdilum 401ff.; Sturm 1995, 497 no. 5	-	NBC 1893	P290339	
BIN 4, 88	-	OAA 1, 72	-	NBC 3914	P290353	
BIN 4, 92	-	OAA 1, 109	-	NBC 4008	P290355	
BIN 4, 115	-	Michel, Innaya II, 32 no. 16; FAOS 4, 387	-	NBC 1747	P290329	
BIN 4, 116	-	FAOS 4, 245 no. 272	-	NBC 1746	P290328	
BIN 4, 122	-	OACP 54f.	-	NBC 1750	P293860	
BIN 4, 124	-	FAOS 4, 459 no. 599; Nashef, TAVO B83, 47f.	-	NBC 3669	P293868	
BIN 4, 133	-	FAOS 4, 63 no. 40	-	NBC 3689	P293770	
BIN 4, 145	-	FAOS 4, 398f. no. 545	-	NBC 1709	P293853	
BIN 4, 146	-	Sturm 1995, 497 no. 6; FAOS 4, 546	-	NBC 1706	P293852	
BIN 4, 148	-	OAA 1, 161; FAOS 4, 67; OACT, 192f. no. 8	-	NBC 1690	P293851	
BIN 4, 149	-	Ichisar, Imdilum 139f.; FAOS 4, 5	-	NBC 1725	P293856	
BIN 4, 153	-	Ichisar, Imdilum 94; EL 75	-	NBC 1737	P293858	
BIN 4, 155	-	Ichisar, Imdilum 94f.; EL 133	-	NBC 1755	P293862	
BIN 4, 159	-	FAOS 4, 190f. no. 199	-	NBC 3867	P390673	
BIN 4, 160	-	OACT, 193ff. no. 9; FAOS 4, 547	-	NBC 1669	P293850	
BIN 4, 172	-	FAOS 4, 88f. no. 68	-	NBC 4001	P293723	
BIN 4, 173	-	Michel, Innaya II, 175ff. no. 126; EL 235	-	NBC 4016	P293731	
BIN 4, 184	-	FAOS 4, 40 no. 7; Ichisar, Imdilum 95f.	-	NBC 4051	P293753	
BIN 4, 193	-	FAOS 4, 458 no. 598	-	NBC 4066	P293766	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
BIN 4, 194	-	OACP 47f.; FAOS 4, 572	-	NBC 4052	P293754	
BIN 4, 198	-	FAOS 4, 405 no. 549; EL 232	-	NBC 4057	P293758	
BIN 4, 199	-	FAOS 4, 42 no. 9; EL II, 162a	-	NBC 4058	P293759	
BIN 4, 204	-	FAOS 4, 333 no. 407; EL 156	-	NBC 4032	P293745	
BIN 4, 217	-	Michel, Innaya II, 196 no. 145	-	NBC 3717	P293714	
BIN 4, 218	-	Michel, Innaya II, 222ff. no. 163	-	NBC 4006	P293725	
BIN 4, 226	-	van der Meer, Correspondance no. 4	-	NBC 3781	P293719	
BIN 4, 228	CMK 388	-	-	NBC 3869	P293722	
BIN 4, 233	CMK 277	Michel, Innaya II, 23ff.	-	NBC 3736	P293716	
BIN 6, 6	CMK 335	-	-	NBC 3815	P289567	
BIN 6, 12	-	Ichisar, Imdilum 292f.	-	NBC 1645	P292516	
BIN 6, 24	-	OrNS 36 no. 6	-	NBC 4074	P297495	
BIN 6, 31	-	OACP 71f.	-	NBC 03921	P297435	
BIN 6, 65	-	OACP 105	-	NBC 3952	P289588	
BIN 6, 74	-	Ichisar, Imdilum 208ff.	-	NBC 4000	P297479	
BIN 6, 75	-	Michel, Innaya II, 143f. no. 104	-	NBC 4045	P297489	
BIN 6, 76	-	OACT, 196f. no. 10; Ichisar, Imdilum 299ff.	-	NBC 6603	P298475	
BIN 6, 78	CMK 124	-	-	NBC 6606	P298478	
BIN 6, 79	CMK 138	Ichisar, Imdilum 269f.	-	NBC 6607	P298479	
BIN 6, 83	-	Michel, Innaya II, 302f. no. 243	-	NBC 3937	P297450	
BIN 6, 90	-	Michel, Innaya II, 11f.	-	NBC 3700	P297270	
BIN 6, 94	-	OACT, 34, 211, 217; TPAK 1, 112 note on line 7	-	NBC 3722	P297289	
BIN 6, 131	-	Michel, Innaya II, 116 no. 85	-	NBC 3768	P297327	
BIN 6, 133	-	Ichisar, Imdilum 210f.	-	NBC 3982	P289648	
BIN 6, 137	-	FAOS 4, 334 no. 410; Michel, Innaya II, 282	-	NBC 3662	P289553	

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BIN 6, 140	-	FAOS 4, 405f. no. 550	-	NBC 3664	P289555	
BIN 6, 148	-	FAOS 4, 167 no. 170	-	NBC 3704	P297274	
BIN 6, 165	-	FAOS 4, 64 no. 42	-	NBC 3728	P297295	
BIN 6, 175	-	FAOS 4, 167f. no. 171	-	NBC 4075	P297496	
BIN 6, 181	-	FAOS 4, 168f. no. 172	-	NBC 3911	P297427	
BIN 6, 185	-	FAOS 4, 206; Nashef, TAVO B83, 10	-	NBC 3855	P297379	
BIN 6, 186	-	OAA 1, 172; FAOS 4, 207	-	NBC 6598	P298470	
BIN 6, 189	-	FAOS 4, 197f. no. 208; Sturm 1995, 497 no. 7	-	NBC 1903	P297247	
BIN 6, 230	-	FAOS 4, 274f. no. 311; Ichisar, Imdilum 90f.	-	NBC 3777	P297336	
BIN 6, 231	-	BIN 4, 159; Nashef, TAVO B83, 11	-	NBC 3857	P293890	
BIN 6, 239	-	OACP 46f.	-	NBC 3864	P297388	
BIN 6, 245	-	Ichisar, Imdilum 96ff.	-	NBC 3788	P297342	
BIN 6, 252	-	Michel, Innaya II, 170f. no. 124	-	NBC 3859	P297383	
C 17	-	OAA 1, 23	-	C 17	-	
C 31	-	Veenhof 2014, 407	-	-	-	
C 33	-	DTCFD 5, 440 note 80; ArOr 18/1, 332 note 2; Anatolica 12, 145	-	Kalley Collection 1944/4	P361608	
CCT 1, 2	-	OACP 22f.	-	BM 113259	P358431	
CCT 1, 14a	-	FAOS 4, 65 no. 43; Ichisar, Imdilum 156f.	-	BM 113420	P358416	
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CCT 1, 16a	-	OACP 49; FAOS 4, 65 no. 46	-	BM 113530	P358421	
CCT 1, 19b	-	OAA 1, 159; FAOS 4, 438 no. 579	-	BM 113566	P358428	

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CCT 1, 20a	-	FAOS 4, 199f. no. 210	-	BM 113326	P358432	
CCT 1, 21c	-	FAOS 4, 338f. no. 422	-	BM 113628	P358436	
CCT 1, 22a	-	OAA 1, 158; FAOS 4, 439 no. 580	-	BM 113495	P358438	
CCT 1, 24a	-	FAOS 4, 407f. no. 552	-	BM 113348	P358441	
CCT 1, 24b	-	OAA 1, 162; FAOS 4, 436 no. 577	-	BM 113449	P358442	
CCT 1, 25	-	Ichisar, Imdilum 100ff.; EL 166	-	BM 113310	P358443	
CCT 1, 26c	-	fAOS 4, 44f. no. 13	-	BM 113619	P358446	
CCT 1, 28d	-	FAOS 4, 169f. no. 173	-	BM 113644	P358453	
CCT 1, 31b	-	FAOS 4, 340 no. 426	-	BM 113525	P358458	
CCT 1, 35	-	FAOS 4, 408f. no. 553	-	BM 113550	P358467	
CCT 1, 36a	-	FAOS 4, 170 no. 174	-	BM 113647	P358468	
CCT 1, 36b	-	FAOS 4, 341 no. 427	-	BM 113617	P358469	
CCT 1, 36c	-	FAOS 4, 202f. no. 214	-	BM 113534	P358470	
CCT 1, 37b	-	FAOS 4, 203f. no. 215	-	BM 113532	P358473	
CCT 1, 38a	-	FAOS 4, 249 no. 277	-	BM 113522	P358474	
CCT 1, 42a	-	Nashef, TAVO B83, 27; FAOS 4, 249 no. 278	-	BM 113375	P358485	
CCT 2, 2	-	OACP 117ff.; Sturm 1995, 497 no. 8	-	BM 113258	P358523	
CCT 2, 4a	-	OACP 80ff.	-	BM 113308	P358557	
CCT 2, 4b-5a	-	Sturm 1995, 497f. no. 9; van der Meer, Correspondance no. 27	-	BM 113421	P358558	
CCT 2, 8-10	-	Ichisar, Imdilum 219ff.; Michel, Innaya II, 315ff.	-	BM 115041	P358563	
CCT 2, 23	-	Ichisar, Imdilum 301ff.	-	BM 113299	P358528	
CCT 2, 26b	-	OAA 1, 120	-	BM 113473	P358532	
CCT 2, 29	-	OACT, 197f. no. 11	-	BM 113424	P358534	

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CCT 2, 32a	-	OACP 76; RA 24, no. 29	-	BM 113362	P358539	
CCT 2, 34	-	OACP 83f.	-	BM 113413	P358541	
CCT 2, 35	-	Ichisar, Imdilum 271ff.	-	BM 113266	P358542	
CCT 2, 36a	CMK 301	-	-	BM 113289	P358543	
CCT 2, 37b	CMK 188	-	-	BM 113453	P358545	
CCT 2, 40a	CMK 145	-	-	BM 113457	P358548	
CCT 2, 43	CMK 193	Michel, Innaya II, 86f.	-	BM 113490	P358551	
CCT 2, 46a	-	OACP 92f.	-	BM 113555	P358555	
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CCT 4, 11a	CMK 160	-	-	BM 115132	P358639	
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ICK 1, 30b	-	Ichisar, Imdilum 57f.	-	Ka. 923	P359428	
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ICK 1, 41b	-	Ichisar, Imdilum 59f.	-	Ka. 936	P359439	
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kt 87/k 462	-	Sturm 1995, 501 no. 25	kt 87/k 462	-	-	
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KTS 1, 53c	-	FAOS 4, 355 no. 465	-	Ka. 130	P360109	
KTS 1, 54d	-	FAOS 4, 355 no. 466	-	Ka. 62	P360113	
KTS 1, 55a	-	FAOS 4, 219f. no. 243	-	Ka. 138	P360116	
KTS 1, 57d	-	FAOS 4, 356f. no. 470	-	Ka. 59	P360126	
KTS 1, 59c	-	FAOS 4, 140f. no. 133	-	Ka. 7	P360135	
KTS 2, 7	AKT 1, 22	FAOS 4, 179ff. no. 184	-	Ka. 167	P360149	
KTS 2, 8	AKT 1, 28	Sturm 1995, 499 no. 14	-	Ka. 168	P360150	
KTS 2, 10	-	-	-	Ka. 170	P360152	AKT 1, 32 = KTS 2, 10
KTS 2, 11	AKT 1, 24	Sturm 1995, 499 no. 15	-	Ka. 171	P360153	
KTS 2, 22	-	-	-	Ka. 722	P360164	
KTS 2, 26	-	-	-	Ka. 788	P360168	
KTS 2, 27	-	-	-	Ka. 812	P360169	
KTS 2, 31	CMK 379	-	-	Ka. 995	P360173	
KTS 2, 33	-	Michel, Innaya II, 323f. no. 255	-	Ka. 998	P360175	
KTS 2, 34	-	-	-	Ka. 999	P360176	
KTS 2, 35	-	-	-	Ka. 1007	P360177	
KTS 2, 36	-	-	-	Ka. 1040	P360178	
KTS 2, 40	-	-	-	Ka. 1053	P360182	

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KTS 2, 53	-	FAOS 4, 454	-	Ka. 1103	P360195	
KTS 2, 56	-	FAOS 4, 357 no. 472	-	Ka. 1106	P360198	
KUG 5	-	Michel, Innaya II, 181f. no. 131; EL 138	-	[	P283862	
KUG 16	-	OAA 1, 140	-	-	P283873	
KUG 21	-	FAOS 4, 75 no. 55	-	-	P283878	Accession Number: Gi 3-15
KUG 22	-	FAOS 4, 259 no. 292	-	-	P283879	
KUG 24	-	FAOS 4, 259f. no. 293	-	-	P283881	
KUG 25	-	FAOS 4, 181 no. 185	-	-	P283882	Accession Number: Gi 3-06
KUG 26	-	FAOS 4, 423f. no. 566	-	-	P283883	
KUG 28	-	OAA 1, 38	-	-	P283885	
KUG 34	CMK 241	-	-	-	-	
KUG 37	-	Michel, Innaya II, 33f. no. 17	-	-	P283894	
KUG 49	-	Ichisar, Imdilum 337	-	-	P283906	
LB 1202	-	Ichisar, Imdilum 241f.	-	LB 1202	P361671	
LB 1231	-	OAA 1, 49	-	LB 1231	P389612	
LB 1275	-	Ichisar, Imdilum 337f.	-	LB 1275	P361672	
LB 1295	-	Ichisar, Imdilum 338f.	-	LB 1295	P361674	
LB 1296	-	Ichisar, Imdilum 339f.	-	LB 1296	P361675	
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OAA 1, 86	POAT 30	-	-	L 29-589	P361143	
OAA 1, 97	POAT 17	HUCA 39, 29f.	-	L 29-572	P361130	
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OAAS 4, 64f.	-	-	kt h/k 18	-	P498580	
OAAS 4, 69-70	-	-	-	-	P498600	
OAAS 4, 73-74	-	-	-	-	P498602	
OIP 27, 31	-	FAOS 4, 225, no. 249	-	Alisar d 2200m	P360754	
OIP 27, 54	-	FAOS 4, 260f. no. 294	-	A 12538	P360778	
OIP 27, 56	-	Ichisar, Imdilum 124ff.	-	A 6012	P332983	
OIP 27, 62	-	Ichisar, Imdilum, 386-88	-	Beloit College Art Hall No. 608	P360783	
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Orient 33, 80 no. 1	-	-	-	WML 49.47.61	P405529	
OrNS 36 no. 29	-	-	kt c/k 1087	-	P361532	
OrNS 50 no. 1	-	-	-	-	P361682	
OrNS 50 no. 2	CMK 347	-	-	-	P361683	
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RA 58, 60 Sch. 4	-	FAOS 4, 141f. no. 134	-	Sammlung Schaeffer 4	P361074	
RA 58, 64 Sch. 8	-	FAOS 4, 359f. no. 478	-	Sammlung Schaeffer 8	P361078	
RA 58, 66 Sch. 10	-	FAOS 4, 76 no. 57	-	Sammlung Schaeffer 10	P361079	
RA 58, 66 Sch. 11	-	FAOS 4, 360 no. 479	-	MS 1727	P361080	
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RA 59, 22 no. 2	-	-	-	MAH 16206	P390543	
RA 59, 25 no. 5	-	-	-	MAH 16204	P390546	
RA 59, 25 no. 6	-	-	-	MAH 16552	P390547	
RA 59, 29 no. 7	-	-	-	MAH 16591	P390548	
RA 59, 29 no. 8	-	-	-	MAH 19610	P390549	
RA 59, 29 no. 9	-	Ichisar, Imdilum 72f.	-	MAH 19603	P390550	
RA 59, 32 no. 10	-	-	-	MAH 19617	P390551	
RA 59, 32 no. 12	-	FAOS 4, 432f. no. 573	-	MAH 16468	P390553	
RA 59, 36 no. 13	-	-	-	MAH 16312	P390554	
RA 59, 36 no. 14	-	-	-	MAH 10824	P390555	
RA 59, 40 no. 16	-	FAOS 4, 425f. no. 567	-	MAH 16205	P390557	
RA 59, 40 no. 17	-	FAOS 4, 261 no. 295	-	MAH 16158	P390558	
RA 59, 44 no. 20	-	FAOS 4, 229 no. 254	-	MAH 16557	P390561	transcribed text does not match in CDLI
RA 59, 47 no. 21	-	-	-	MAH 19613	P390562	

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RA 59, 150 no. 23	-	Michel, Innaya II, 305f. no. 246	-	MAH 10823	P390564	
RA 59, 162 no. 26	-	-	-	MAH 19601	P390567 P390567	
RA 59, 165 no. 27	-	-	-	MAH 19611	P390568	
RA 59, 172 no. 32	-	Michel, Innaya II, 243ff. no. 178; Sturm 1995, 499 no. 16	-	MAH 19602	P390573	
RA 60, 106 no. 41	-	-	-	MAH 19618	P361088	
RA 60, 111 no. 42	CMK 159	-	-	MAH 19614	P361089	
RA 60, 111 no. 43	-	OAA 1, 82	-	MAH 19615	P361090	
RA 60, 115 no. 45	-	-	-	MAH 16466	P390641	
RA 60, 128	-	OAA 1, 154	-	AO 11216	P357892	
RA 60, 140 Bruce	-	OAA 1, 84	-	Bruce 001	P361101	
RA 60, 143	-	-	-	Dessalien 1	P390700	
RA 60, 95 no. 35	-	-	-	MAH 16357	P361104	
RA 81, 1	-	-	-	AO 22501	P357894	
RA 81, 3	-	-	-	AO 22506	P357896	
RA 81, 7	-	Michel, Innaya II, 123ff. no. 90	-	AO 29157	P357900	
RA 81, 8	-	Michel, Innaya II, 117ff. no. 89	-	AO 29158	P357901	
RA 81, 19	-	-	-	AO 29168	P357912	
RA 81, 20	-	-	-	AO 29169	P357913	
RA 81, 21	-	-	-	AO 29170	P357914	
RA 81, 49	-	-	-	AO 29197	P357942	
RA 81, 55	-	-	-	AO 29203	P357948	
RA 81, 60	-	FAOS 4, 230f. no. 256	-	AO 29206	P357953	
RA 81, 71	-	Michel, Innaya II, 333f. no. 264	-	AO 29268	P357964	
Šarnikzel 276-277	-	-	kt 99/k 139	-	P361340	
Sturm, FS Veenhof 487 IVa	-	-	kt 87/k 498	-	-	

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Sturm, FS Veenhof 487 IVb	-	-	-	-	-	
TC 1, 2	-	OAA 1, 47	-	AO 7051	P357337	
TC 1, 8	-	OAA 1, 24	-	AO 7057	P357343	
TC 1, 11	-	OAA 1, 107	-	AO 7060	P357346	
TC 1, 15	-	OACP 108	-	AO 7064	P357350	
TC 1, 20	-	Michel, Innaya II, 43ff. no. 26	-	AO 7069	P357355	
TC 1, 26	-	van der Meer, Correspondance no. 22	-	AO 7150	P357361	
TC 1, 39	CMK 92	-	-	AO 7323	P357374	
TC 1, 47	-	OAA 1, 42	-	AO 7458	P357382	
TC 1, 53	-	Ichisar, Imdilum 342f.	-	AO 7466	P357388	
TC 1, 72	-	FAOS 4, 78f. no. 60	-	AO 7469	P357407	
TC 1, 78	-	FAOS 4, 387 no. 534	-	AO 7079	P357413	
TC 1, 80	-	OAA 1, 167; FAOS 4, 232 no. 258	-	AO 7081	P357415	
TC 1, 81	-	FAOS 4, 105ff. no. 89	-	AO 7082	P357416	
TC 1, 92	-	FAOS 4, 361 no. 482	-	AO 7306	P357427	
TC 1, 108	-	FAOS 4, 79 no. 61	-	AO 7450	P357443	
TC 1, 109	-	FAOS 4, 144 no. 138	-	AO 7452	P357444	
TC 2, 2	-	van der Meer, Correspondance no. 30	-	AO 8672	P357492	
TC 2, 4	-	van der Meer, Correspondance no. 19	-	AO 8674	P357494	
TC 2, 6	-	OACP 111f.	-	AO 8676	P357496	
TC 2, 8	-	van der Meer, Correspondance no. 49	-	AO 8692	P357498	
TC 2, 9	CMK 183	-	-	AO 8693	P357499	
TC 2, 13	-	OACP 85f.	-	AO 8679	P357503	

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TC 2, 14	-	OACP 114f.	-	AO 8683	P357504	
TC 2, 17	-	OrNS 36 no. 7	-	AO 8684	P357507	
TC 2, 19	-	van der Meer, Correspondance no. 67	-	AO 8687	P357509	
TC 2, 22	-	Ichisar, Imdilum 388ff.; EL 2, 155b	-	AO 8680	P357512	
TC 2, 23	CMK 184	-	-	AO 8685	P357513	
TC 2, 29	CMK 216	Michel, Innaya II, 60	-	AO 8700	P357519	
TC 2, 33	-	OACT, 187f. no. 5	-	AO 8701	P357523	
TC 2, 36	-	Ichisar, Imdilum 343ff.	-	AO 8707	P357526	
TC 2, 54	-	FAOS 4, 80f. no. 62	-	AO 8738	P357544	
TC 2, 58	-	FAOS 4, 183f. no. 189	-	AO 8730	P357548	
TC 2, 62	-	FAOS 4, 145 no. 139	-	AO 8723	P357552	
TC 2, 70	-	OACP 45	-	AO 8742	P357560	
TC 3, 10	CMK 84	-	-	AO 9280	P357577	
TC 3, 18	CMK 125	-	-	AO 8237	P357585	
TC 3, 21	-	OACP 78f.	-	AO 8227	P357588	
TC 3, 22	CMK 230	-	-	AO 9296	P357589	
TC 3, 24	-	OACP 127ff.	-	AO 8629	P357590	
TC 3, 36	-	OACP 100f.	-	AO 8229	P357602	
TC 3, 41	CMK 276	Michel, Innaya II, 144f.; OrNS 36 no. 41	-	AO 8234	P357607	
TC 3, 43	CMK 128	OACP 98f.	-	AO 8264	P357609	
TC 3, 46	-	Ichisar, Imdilum 349ff.	-	AO 9291	P357612	
TC 3, 47	-	Ichisar, Imdilum 351f.	-	AO 9260	P357613	
TC 3, 50	-	Ichisar, Imdilum 355f.	-	AO 8236	P357616	
TC 3, 51	-	Ichisar, Imdilum 356ff.; Michel, Innaya II, 153ff. no. 110	-	AO 9266	P357617	
TC 3, 53	-	Ichisar, Imdilum 360f.	-	AO 7709	P357619	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
TC 3, 54	-	Ichisar, Imdilum 198f.	-	AO 9279	P357620	
TC 3, 58	-	Ichisar, Imdilum 253f.	-	AO 9270	P357624	
TC 3, 67	-	OACP 10f.	-	AO 7710	P357633	
TC 3, 69	-	OACP 74f.	-	AO 9297	P357635	
TC 3, 72	-	Michel, Innaya II, 47ff. no. 28	-	AO 8223	P357638	
TC 3, 77	-	Michel, Innaya II, 96 no. 67	-	AO 9248	P357643	
TC 3, 81	CMK 191	-	-	AO 9284	P357647	
TC 3, 85	CMK 90	-	-	AO 8257	P357651	
TC 3, 95	-	OAA 1, 6	-	AO 8242	P357661	
TC 3, 96	-	OAA 1, 112	-	AO 9253	P357662	
TC 3, 97	CMK 366	-	-	AO 9375	P357663	
TC 3, 106	CMK 386	-	-	AO 8259	P357672	
TC 3, 132	-	Sturm 1995, 499 no. 17	-	AO 9378	P357698	
TC 3, 137	-	Sturm 1995, 499 no. 18	-	AO 9376	P357703	
TC 3, 157	-	FAOS 4, 114 no. 95; Nashef, TAVO B83, 14	-	AO 8273	P357723	
TC 3, 166	-	OAA 1, 164; FAOS 4, no. 578	-	AO 8288	P357732	
TC 3, 171	-	FAOS 4, 184 no. 190	-	AO 8632	P357737	
TC 3, 178	-	FAOS 4, 443f. no. 586	-	AO 8289	P357744	
TC 3, 182	-	FAOS 4, 238f. no. 264	-	AO 8277	P357748	
TC 3, 186	-	FAOS 4, 60 no. 36	-	AO 937	P357752	
TC 3, 210	-	FAOS 4, 81ff. no. 63	-	AO 8293	P357776	
TC 3, 211	-	Ichisar, Imdilum 130ff.	-	AO 8271	P357777	
TC 3, 213	-	OACP 22	-	AO 8286	P357779	
TMH 1, 1a	CMK 47	-	-	HS 440	P358045	
TMH 1, 18c		-	-	HS 0434	P358163	
TMH 1, 24e	-	FAOS 4, 185 no. 191	-	HS 442	P358121	
TMH 1, 27a	-	FAOS 4, 239 no. 265	-	HS 436	P358136	

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TPAK 1, 3	-	-	kt 90/k 137	AMM 1-52-90	P360216	
TPAK 1, 4	-	-	kt 90/k 128	AMM 1-43-90	P360217	
TPAK 1, 8	-	-	kt 90/k 125	AMM 1-40-90	P360221	
TPAK 1, 20	-	-	kt 90/k 121	AMM 1-36-90	P360231	
TPAK 1, 21a	-	-	kt 90/k 324a	AMM 1-235-90a	P360435	
TPAK 1, 35	-	-	kt 90/k 173	AMM 1-88-90	P360245	
TPAK 1, 40	-	-	kt 90/k 2	AMM 1-2-90	P360250	
TPAK 1, 57	-	-	kt 90/k 237	AMM 1-148-90	P360267	
TPAK 1, 58	-	-	kt 90/k 225	AMM 1-136-90	P360268	
TPAK 1, 61	-	-	kt 90/k 343	AMM 1-254-90	P360271	
TPAK 1, 64	-	-	kt 90/k 150	AMM 1-65-90	P360274	
TPAK 1, 82	-	-	kt 90/k 335	AMM 1-246-90	P360292	
TPAK 1, 84	-	-	kt 90/k 177	AMM 1-92-90	P360294	
TPAK 1, 86	-	-	kt 90/k 96	AMM 1-13-90	P360296	
TPAK 1, 88	-	-	kt 90/k 221	AMM 1-132-90	P360298	
TPAK 1, 89	-	-	kt 90/k 246	AMM 1-157-90	P360299	
TPAK 1, 92	-	-	kt 90/k 160	AMM 1-75-90	P360302	
TPAK 1, 94	-	-	kt 90/k 227	AMM 1-138-90	P360304	
TPAK 1, 95	-	-	kt 90/k 109	AMM 1-26-90	P360305	
TPAK 1, 97	-	-	kt 90/k 230	AMM 1-141-90	P360307	
TPAK 1, 98	-	-	kt 90/k 251	AMM 1-162-90	P360308	
TPAK 1, 99	-	-	kt 90/k 162	AMM 1-77-90	P360309	
TPAK 1, 100	-	-	kt 90/k 212	AMM 1-123-90	P360310	
TPAK 1, 101a	-	-	kt 90/k 254a	AMM 1-165-90a	P360311	
TPAK 1, 102	-	-	kt 90/k 331	AMM 1-242-90	P360312	
TPAK 1, 103	-	-	kt 90/k 220	AMM 1-131-90	P360313	
TPAK 1, 107	-	-	kt 90/k 240	AMM 1-151-90	P360317	
TPAK 1, 110	-	-	kt 90/k 363	AMM 1-273-90	P360322	

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.	Notes
TPAK 1, 112	-	-	kt 90/k 344	AMM 1-255-90	P360324	
TPAK 1, 116	-	-	kt 90/k 161	AMM 1-76-90	P360328	
TPAK 1, 117	-	-	kt 90/k 107	AMM 1-24-90	P360329	
TPAK 1, 118	-	-	kt 90/k 266	AMM 1-177-90	P360330	
TPAK 1, 122	-	-	kt 90/k 185	AMM 1-100-90	P360334	
TPAK 1, 123	-	-	kt 90/k 241	AMM 1-152-90	P360335	
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TPAK 1, 141	-	-	kt 90/k 12	AMM 1-12-90	P360353	
TPAK 1, 142	-	-	kt 90/k 348	AMM 1-259-90	P360354	
TPAK 1, 143	-	-	kt 90/k 119	AMM 1-34-90	P360355	
TPAK 1, 149	-	-	kt 90/k 180	AMM 1-95-90	P360361	
TPAK 1, 150	-	-	kt 90/k 244	AMM 1-155-90	P360362	
TPAK 1, 151	-	-	kt 90/k 327	AMM 1-238-90	P360363	
TPAK 1, 155	-	-	kt 90/k 350	AMM 1-261-90	P360367	
TPAK 1, 160	-	-	kt 90/k 351	AMM 1-262-90	P360373	
TPAK 1, 170	-	-	kt 90/k 115	AMM 1-30-90	P360384	
TPAK 1, 181	-	-	kt 90/k 154	AMM 1-69-90	P360396	
TPAK 1, 190	-	-	kt 90/k 235	AMM 1-146-90	P360405	
TTC 14	-	OAA 1, 74; RA 80, 116-17	-	-	P357859	
TTC 16	-	FAOS 4, 391f. no. 541	-	-	P357861	
TTC 19	CMK 338	-	-	-	P357864	
VS 26, 6	-	OACT, 205f. no. 18	-	VAT 9255	P333928	
VS 26, 11	CMK 114	-	-	VAT 9213	P333883	
VS 26, 13	CMK 115	-	-	VAT 9218	P333887	
VS 26, 27	-	OACT, 34, 211; TPAK 1, 112 note on line 7	-	VAT 13548	P358200	
VS 26, 29	-	OAA 1, 79	-	VAT 9232	P333900	

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VS 26, 47	CMK 107	-	-	VAT 9219	P333888	
VS 26, 50	-	Sturm 1995, 499f. no. 19	-	VAT 13536	P358211	
VS 26, 58	CMK 137	-	-	VAT 9212	P333882	
VS 26, 61	CMK 185	-	-	VAT 13534	P358216	
VS 26, 69	-	Michel, Innaya II, 230ff. no. 169	-	VAT 13507	P358222	
VS 26, 73	CMK 12	-	-	VAT 9285	P358226	
VS 26, 99	-	Ichisar, Imdilum 91f.; EL 103	-	VAT 9268	P333941	
VS 26, 102	-	OACP 8f.	-	VAT 13519	P358248	
VS 26, 127	-	FAOS 4, 414 no. 558; EL 155	-	VAT 13480	P358266	
VS 26, 133	-	FAOS 4, 372 no. 511; EL II, 102a	-	VAT 9245	P333919	
VS 26, 145	-	FAOS 4, 242 no. 270	-	VAT 13479	P358278	
VS 26, 148	-	Nashef, TAVO B83, 53; FAOS 4, 267f. no. 302; VS 26, 29	-	VAT 9260	P333933	
VS 26, 149	-	FAOS 4, 149 no. 146	-	VAT 9256	P333929	
VS 26, 151	-	FAOS 4, 243	-	VAT 9211	P333881	
WZKM 86	-	-	kt 93/k 145	AMM 1-110-93	P390609	

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EA 1	Moran 1992, 1-5; Rainey 2015, 58-65	BM 29784	P270887	
EA 2	Moran 1992, 6; Rainey 2015, 66-7	VAT 148 + VAT 2706	P271034	
EA 3	Moran 1992, 7-8; Rainey 2015, 68-71	EMC 4743 (12210)	P270975	
EA 4	Moran 1992, 8-10; Rainey 2015, 72-5	VAT 1657	P271101	
EA 5	Moran 1992, 10-1; Rainey 2015, 76-9	BM 29787 + EMC (12195)	P270890	
EA 7	Moran 1992, 12-6; Rainey 2015, 82-7	VAT 150	P271036	
EA 9	Moran 1992, 18-9; Rainey 2015, 92-5	BM 29785	P270888	
EA 10	Moran 1992, 19-20; Rainey 2015, 96-9	BM 29786	P270889	
EA 11	Moran 1992, 21-3; Rainey 2015, 100-5	VAT 151 + VAT 1878	P271037	
EA 13	Moran 1992, 24-7; Rainey 2015, 108-11	VAT 1717	P271153	
EA 14	Moran 1992, 27-37; Rainey 2015, 112-27	Ashm 1893-1-41 (415) (+) VAT 1651 + VAT 2711	P271097	
EA 16	Moran 1992, 38-41; Rainey 2015, 130-33	EMC 4746 (12209)	P270976	
EA 17	Moran 1992, 41-2; Rainey 2015, 134-37	BM 29792	P270895	
EA 19	Moran 1992, 43-6; Rainey 2015, 140-47	BM 29791	P270894	
EA 20	Moran 1992, 47-50; Rainey 2015, 148-57	VAT 191	P271179	
EA 21	Moran 1992, 50; Rainey 2015, 156-59	VAT 190	P271178	
EA 22	Moran 1992, 51-61; Rainey 2015, 160-83	VAT 395	P271213	
EA 24	Moran 1992, 63-71; Rainey 2015, 188-241	VAT 422	P271214	Hurrian language text
EA 25	Moran 1992, 72-84; Rainey 2015, 242-75	VAT 340 (+) VAT 2191 + frag	P271202	

Primary publication No.	Secondary publications	Museum No.	CDLI No.	Notes
EA 26	Moran 1992, 84-6; Rainey 2015, 276-81	BM 29794 + A 9356	P270897	
EA 27	Moran 1992, 86-90; Rainey 2015, 282-95	VAT 00233 (+) VAT 02197bis + VAT 2193 ?	P271181	
EA 29	Moran 1992, 92-9; Rainey 2015, 300-23	VAT 271 + VAT 1600 + VAT 1618 + VAT 1619 + VAT 1620 + VAT 2192 + VAT 2194 + VAT 2195 + VAT 2196 + VAT 2197	P271184	
EA 31	Moran 1992, 101-3; Rainey 2015, 326-29	EMC 4741 (12208)	P270973	
EA 33	Moran 1992, 104-5; Rainey 2015, 332-35	VAT 1654	P271098	
EA 34	Moran 1992, 105-7; Rainey 2015, 336-39	BM 29789	P270892	
EA 35	Moran 1992, 107-9; Rainey 2015, 340-43	BM 29788	P270891	
EA 36	Moran 1992, 109-10; Rainey 2015, 344-47	EMC 4750 (12187)	P270980	
EA 37	Moran 1992, 110-11; Rainey 2015, 348-53	BM 29790	P270893	
EA 40	Moran 1992, 113; Rainey 2015, 356-57	EMC 4749 (12190)	P270979	
EA 41	Moran 1992, 114-17; Rainey 2015, 358-61	EMC 4747 (12207)	P270977	
EA 44	Moran 1992, 117; Rainey 2015, 368-69	VAT 1656	P271100	
EA 55	Moran 1992, 127-28; Rainey 2015, 400-5	BM 29819	P270921	
EA 77	Moran 1992, 147-48; Rainey 2015, 466-69	VAT 1635 + VAT 1700	P271082	
EA 91	Moran 1992, 164-65; Rainey 2015, 522-25	VAT 931	P271218	
EA 109	Moran 1992, 183-84; Rainey 2015, 588-91	VAT 1629	P271076	
EA 112	Moran 1992, 186-87; Rainey 2015, 598-601	VAT 1664	P271107	
EA 151	Moran 1992, 238-39; Rainey 2015, 762-67	BM 29813	P270915	
EA 265	Moran 1992, 314; Rainey 2015, 1058-59	VAT 1697	P271138	
EA 270	Moran 1992, 316-17; Rainey 2015, 1068-69	BM 29845	P270947	
EA 280	Moran 1992, 321-22; Rainey 2015, 1088-91	EMC 4772 (12213)	P271000	
EA 292	Moran 1992, 335-36; Rainey 2015, 1128-131	BM 037647	P270969	

Primary publication No.	Secondary publications	Museum No.	CDLI No.	Notes
EA 309	Moran 1992, 345; Rainey 2015, 1172-173	VAT 1874	P271168	
EA 313	Moran 1992, 346-47; Rainey 2015, 1180-181	EMC 4782 (12228)	P271009	
EA 369	Moran 1992, 366; Rainey 2015, 1250-251	MRAH E.6753	P271026	

Appendix 3. Supplementary texts

Primary publication No.	Secondary publication No.	Secondary publications	Excavation No.	Museum No.	CDLI No.
ARM 13, 6	LAPO 16, 108	-	-	NMSDez.	P351196
ARM 25, 313	-	-	-	NMSDez	P354052
KBo 1, 14	CTH 173	Goetze 1940; Zaccagnini 1970; Košak 1986, 133	Bo 7142-4	VAT 7430	P282480
KBo 4, 1	-	Košak 1986, 125-26, 132-33	Bo 2010	AMM 1177/v + Bo 2010	P434801
KBo 18, 153	CTH 242.2.B	Košak 1982, 195	-	AMM 235/d	P436140
KUB 42, 73	CTH 24.2.B	Košak 1982, 195	Bo 420	AMM Bo 420	P446245

Appendix 4. Old Assyrian metals varieties with bibliography

The following tables contain all the varieties of each metal used in this research.[1076]

Gold (KÙ.GI/*ḫurāṣum*)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
SIG5/*damqum*	(of) good (quality)	AKT 3, 90	Bilgiç & Günbatti 1995	gutes
		BIN 6, 181	Ulshöfer 1995	gutes
		BIN 6, 189	Ulshöfer 1995	gutes
		CCT 2, 46b	Michel 2001	de bonne qualité
		CCT 3, 18a	Michel 1991	de bonne qualité
		CCT 3, 22a	Larsen 1967	fine
		ICK 1, 84	Ichisar 1981	de bonne qualité
		kt 87/k 461	Veenhof 2014	of good quality
		Michel, Innaya II, 135ff. no. 100	Michel 1991	de bonne qualité
		TPAK 1, 58	Michel & Garelli 1997	de bonne qualité
SIG5 DIRI / *damqum watrum*	(of) very good (quality)	AKT 3, 12	Bilgiç & Günbatti 1995	gutes, ausgezeichnetes
		AKT 5, 50	Veenhof 2010b	of extremely good quality
HUŠ.A	red	KUG 25	Ulshöfer 1995	rotes
HUŠ.A SIG_5	red (of) good (quality)	CCT 4, 22b	Ichisar 1981	rouge de très bonne qualité
kiššum	-	AKT 5, 16	Veenhof 2010b	untranslated

[1076] The author holds sole responsibility of any discrepancies or omissions of the data.

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		kt c/k 440	Donbaz 1988a	untranslated
kiššum SIG$_5$	*kiššum* (of) good (quality)	kt 88/k 263	Donbaz 1988a	untranslated
kuburšinnum	-	BIN 6, 90	Michel 1991	untranslated
		ICK 1, 171	Ulshöfer 1995	Gold der *kupuršinnum*-Qualität
		ICK 2, 335	Balkan 1965	untranslated
		kt c/k 257	Balkan 1965	untranslated
		kt f/k 41	Balkan 1965	untranslated
		OLZ 60, 151	Ulshöfer 1995	untranslated
		TC 1, 47	Larsen 2002	untranslated
		TC 3, 43	Larsen 1967; Michel 2001	untranslated
SIG$_5$ *kuburšinnum*	good (quality) *kuburšinnum*	BIN 6, 137	Ulshöfer 1995	gutes Gold der *kupuršinnum*-Qualität
liqtum	-	Akkadica 42, 7	Ulshöfer 1995	UR.TUM-Gold
pašallum	-	AKT 3, 72	Bilgiç & Günbatti 1995	Blaßgold
		AKT 3, 90	Bilgiç & Günbatti 1995	Blaßgold
		AKT 5, 51	Veenhof 2010b	untranslated
		AKT 6a, 101	Larsen 2010	untranslated
		BIN 4, 66	Ichisar 1981	électron
		CCT 2, 8-10	Ichisar 1981	électron
		CCT 4, 6f	Larsen 2002	untranslated
		ICK 1, 165	Ulshöfer 1995	Blaßgold
		ICK 1, 167	Larsen 1967	untranslated
		ICK 2, 85	Larsen 1967	untranslated
		KKS 30	Matouš & Matoušová-Rajmová 1984	pale

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		KKS 35	Matouš & Matoušová-Rajmová 1984	pale
		kt 87/k 461	Veenhof 2014	untranslated
		kt c/k 257	Balkan 1965	untranslated
		kt c/k 263	Dercksen 1996	auriferous ore
		KTS 1, 53a	Ulshöfer 1995	Blaßgold
		RA 81, 19	Michel 1987	alliage d'or
		Sturm, FS Veenhof 487 IVa	Sturm 2001	untranslated
		Sturm, FS Veenhof 487 IVb	Sturm 2001	untranslated
		TC 1, 26	van der Meer 1931	électron
		TC 1, 47	Larsen 2002	untranslated
		TC 2, 2	van der Meer 1931	électron
		TC 2, 4	van der Meer 1931	électron
		TC 2, 22	Ichisar 1981	électron
		TC 3, 166	Larsen 2002	untranslated
		VS 26, 29	Larsen 2002	untranslated
pašallum SIG$_5$	*pašallum* (of) good (quality)	AKT 3, 64	Bilgiç & Günbatti 1995	gutes Blaßgold
		CCT 1, 16a	Larsen 1967	good *pašallu*
		CCT 5, 41b	Ichisar 1981	électron de bonne qualité
		KTS 2, 40	Donbaz 1989	gutes Blaßgold
pašallum SIG$_5$ DIRI	*pašallum* (of) very good (quality)	AKT 6a, 166	Larsen 2010	*pašallum* of extremely good quality

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		CCT 2, 46b	Michel 2001; Ichisar 1981	pur d'excellente qualité; électron d'excellente qualité
		CCT 6, 9a	Ichisar 1981	électron d'excellente qualité
		ICK 1, 30a	Ichisar 1981	*pašallum* d'excellente qualité
		ICK 1, 30b	Ichisar 1981	électron d'excellente qualité
		kt 87/k 461	Veenhof 2014	*pašallum* of excellent quality
		KUG 5	Michel 1991	extra-fin (et) d'excellente qualité
pašallum damqum watrum / DIRIG		OrNS 50 no. 3	Moren 1981	extrafine *pašallu*
pašallum ša abnišu	*pašallum* of its stone	OAA 1, 78	Larsen 2002	*pašallu* in ore
puṣium	white	FS Matouš 2, 125	Larsen 1978	white
		KTS 1, 52b	Ulshöfer 1995	Weißgold
ša abnišu	of its stone	AKT 6a, 203	Larsen 2010	ore
		AKT 6b, 336	Larsen 2013	dust
		AKT 6c, 626	Larsen 2014	dust
		BIN 6, 189	Ulshöfer 1995	Berggold
		CCT 2, 37b	Michel 2001	de minerai
		FAOS 4, 369 no. 502	Ulshöfer 1995	Steingold
		FS Matouš 2, 126	Larsen 1978	from ore
		ICK 2, 99	Balkan 1965	Berggold
		kt c/k 125	Balkan 1965	Berggold
		kt n/k 1686	Dercksen 2005	nuggets
		OLZ 60, 151	Ulshöfer 1995	Steingold
SIG_5 *ša abnišu*	good (quality) of its stone	kt c/k 98	Balkan 1965	[good] Berggold

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
ša šabšulim	that has been boiled	Michel, Innaya II, 135ff. no. 100	Michel 1991	ce qui est à fondre
SIG_5 *ša damu*	good (quality) blood-coloured	kt c/k 48	Balkan 1965	gute Qualität Blut(farbenes)
ša mā'ešu	of its water	kt c/k 48	Balkan 1965	Waschgold
		TC 1, 47	Larsen 2002	alluvial
sa'amum	red	FS Matouš 2, 125	Larsen 1978	red
sa'amum ša šabšulim	red boiled	FS Matouš 2, 125	Larsen 1978	red gold for smelting
ša tiāmtim	of (the) sea	FS Matouš 2, 126	Larsen 1978	sea-gold

Silver (KÙ.BABBAR/*kaspum*)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
ammurum	checked (in fire)	AKT 1, 51	Sturm 1995	(im Feuer) geprüftes
		AKT 3, 12	Bilgiç & Günbatti 1995; Sturm 1995	geprüftes; (im Feuer) geprüftes
		AKT 3, 20	Sturm 1995	(im Feuer) geprüftes
		AKT 6b, 333	Larsen 2013	checked
		AKT 6b, 373	Larsen 2013	checked
		AKT 6c, 688	Larsen 2014	checked
		ATHE 32	Michel 2001	untranslated
		BIN 4, 87	Michel 1991	amorrhéen
		BIN 4, 146	Sturm 1995	(im Feuer) geprüftes
		BIN 6, 189	Ulshöfer 1995	amurrisches
		CCT 2, 2	Larsen 1967	checked(?)
		CCT 2, 4b-5a	Sturm 1995	(im Feuer) geprüftes
		ICK 1, 10	Sturm 1995	(im Feuer) geprüftes
		ICK 1, 161	Sturm 1995	(im Feuer) geprüftes
		ICK 2, 95	Donbaz 1988b	Amurru
		ICK 2, 289	Sturm 1995	(im Feuer) geprüftes
		kt 87/k 445	Sturm 1995	(im Feuer) geprüftes
		kt 87/k 462	Sturm 1995	(im Feuer) geprüftes
		kt a/k 913	Sturm 1995	(im Feuer) geprüftes
		kt m/k 42	Sturm 1995	(im Feuer) geprüftes
		KTS 2, 8	Sturm 1995	(im Feuer) geprüftes
		KTS 2, 11	Sturm 1995	(im Feuer) geprüftes
		Prag 604	Sturm 1995	(im Feuer) geprüftes

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		RA 59, 172 no. 32	Michel 1991; Sturm 1995	(im Feuer) geprüftes
		TC 3, 132	Sturm 1995	(im Feuer) geprüftes
		TC 3, 137	Sturm 1995	(im Feuer) geprüftes
		VS 26, 50	Sturm 1995	(im Feuer) geprüftes
SIG_5/*damqum*	(of) good (quality)	AKT 6b, 488	Larsen 2013	good
		kt 94/k 1455	courtesy Larsen (2017)	good
		kt a/k 913	Sturm 1995	verfeinertes
hušā'ū	scrap	LB 1231	Larsen 2002	scrap
hušā'ū SIG_5	scrap (of) good (quality)	CCT 4, 2a	Larsen 2002	good quality scrap
lītum	-	AKT 1, 57	Michel 1991	alliage
		AKT 6b, 367	Larsen 2013	untranslated
		AKT 6b, 438	Larsen 2013	untranslated
lītum SIG_5	*lītum* (of) good (quality)	AKT 1, 57 (envelope)	Michel 1991	alliage de bonne qualité
		AKT 6b, 488	Larsen 2013	untranslated
		RA 59, 22 no. 2	Garelli 1965	*li*[*ti*] de bonne qualité
		TPAK 1, 84	Michel & Garelli 1997	*litu* de bonne qualité
		TPAK 1, 98	Michel & Garelli 1997	alliage-*litum* de bonne qualité
		TPAK 1, 160	Michel & Garelli 1997	alliage de bonne qualité
mussuḫum	(of) bad (quality)	AKT 6b, 371	Larsen 2013	of inferior quality
		ATHE 28	Ichisar 1981	gâté
		BIN 4, 30	Michel 2001	de mauvaise qualité
		ICK 1, 82	Ichisar 1981	de mauvaise qualité
		kt 91/k 487	Veenhof 2014	dirty
		kt c/k 257	Sturm 1995	von schlechter Qualität

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		kt c/k 513	Veenhof 2014	dirty
		kt c/k 820	Veenhof 2014	dirty
		kt n/k 119	Veenhof 2014	dirty
		kt n/k 1466	Veenhof 2014	dirty
		KTS 1, 29a	Balkan 1967	rotten
		OIP 27, 62	Gelb 1935	of poor quality
		TC 3, 41	Balkan 1967; Michel 2001	rotten; de mauvaise qualité
		TPAK 1, 8	Michel & Garelli 1997	de mauvaise qualité
		TTC 16	Ulshöfer 1995	minderwertiges
SAḪAR.BA	dust	AKT 5, 37	Veenhof 2010b	dust
		AKT 5, 41	Veenhof 2010b	dust
		AKT 5, 45	Veenhof 2010b	dust
saḫḫertum	in small pieces	KUG 21	Ulshöfer 1995	(an) Kleinkram
		RA 58, 64 Sch. 8	Ulshöfer 1995	Kleinkram
		RA 59, 47 no. 21	Garelli 1965	untranslated
ṣarpum	refined	4. HethKongr. 112	Donbaz 2001b	refined
		AfO 35, 55	Donbaz 1988b	no translation
		AKT 1, 40	Michel 1991	fin
		AKT 3, 12	Bilgiç & Günbatti 1995; Sturm 1995	geläutertes
		AKT 3, 20	Bilgiç & Günbatti 1995	geläutertes
		AKT 5, 52	Veenhof 2010b	refined
		AKT 6a, 2	Larsen 2010	refined
		AKT 6a, 3	Larsen 2010	refined
		AKT 6a, 8	Larsen 2010	refined

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		AKT 6a, 27	Larsen 2010	refined
		AKT 6a, 74	Larsen 2010	refined
		AKT 6a, 90	Larsen 2010	refined
		AKT 6a, 91	Larsen 2010	refined
		AKT 6a, 92	Larsen 2010	refined
		AKT 6a, 93	Larsen 2010	refined
		AKT 6a, 94	Larsen 2010	refined
		AKT 6a, 95	Larsen 2010	refined
		AKT 6a, 96	Larsen 2010	refined
		AKT 6a, 97	Larsen 2010	refined
		AKT 6a, 98	Larsen 2010	refined
		AKT 6a, 99	Larsen 2010	refined
		AKT 6a, 100	Larsen 2010	refined
		AKT 6a, 101	Larsen 2010	refined
		AKT 6a, 103	Larsen 2010	refined
		AKT 6a, 120	Larsen 2010	refined
		AKT 6a, 125	Larsen 2010	refined
		AKT 6a, 128	Larsen 2010	refined
		AKT 6a, 130	Larsen 2010	refined
		AKT 6a, 143	Larsen 2010	refined
		AKT 6a, 144	Larsen 2010	refined
		AKT 6a, 145	Larsen 2010	refined
		AKT 6a, 150	Larsen 2010	refined
		AKT 6a, 167	Larsen 2010	refined
		AKT 6a, 173	Larsen 2010	refined

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		AKT 6a, 188	Larsen 2010	refined
		AKT 6a, 203	Larsen 2010	refined
		AKT 6a, 278a	Larsen 2010	refined
		AKT 6b, 318	Larsen 2013	refined
		AKT 6b, 329	Larsen 2013	refined
		AKT 6b, 332	Larsen 2013	refined
		AKT 6b, 336	Larsen 2013	refined
		AKT 6b, 341	Larsen 2013	refined
		AKT 6b, 346	Larsen 2013	refined
		AKT 6b, 347	Larsen 2013	refined
		AKT 6b, 368	Larsen 2013	refined
		AKT 6b, 371	Larsen 2013	refined
		AKT 6b, 373	Larsen 2013	refined
		AKT 6b, 380	Larsen 2013	refined
		AKT 6b, 409	Larsen 2013	refined
		AKT 6b, 410	Larsen 2013	refined
		AKT 6b, 411	Larsen 2013	refined
		AKT 6b, 416	Larsen 2013	refined
		AKT 6b, 438	Larsen 2013	refined
		AKT 6b, 448	Larsen 2013	refined
		AKT 6b, 457	Larsen 2013	refined
		AKT 6b, 464	Larsen 2013	refined
		AKT 6b, 466	Larsen 2013	refined
		AKT 6b, 467	Larsen 2013	refined
		AKT 6b, 469	Larsen 2013	refined

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		AKT 6b, 478	Larsen 2013	refined
		AKT 6b, 481	Larsen 2013	refined
		AKT 6b, 482	Larsen 2013	refined
		AKT 6b, 485	Larsen 2013	refined
		AKT 6b, 489	Larsen 2013	refined
		AKT 6b, 490	Larsen 2013	refined
		AKT 6b, 491	Larsen 2013	refined
		AKT 6b, 499	Larsen 2013	refined
		AKT 6b, 505	Larsen 2013	refined
		AKT 6b, 517	Larsen 2013	refined
		AKT 6b, 519	Larsen 2013	refined
		AKT 6c, 544	Larsen 2014	refined
		AKT 6c, 625	Larsen 2014	refined
		AKT 6c, 636	Larsen 2014	refined
		AKT 6c, 666	Larsen 2014	refined
		AKT 6c, 688	Larsen 2014	refined
		AKT 6c, 707	Larsen 2014	refined
		Anatolica 12, 138	Donbaz & Veenhof 1985	refined
		ArAn 3, 160	Hecker 1997	geläutertes
		ATHE 28	Ichisar 1981	fin
		BIN 4, 19	van der Meer 1931	pur
		BIN 4, 27	Larsen 1967	refined
		BIN 4, 52	Larsen 2002	refined
		BIN 4, 61	Larsen 1967	refined
		BIN 4, 146	Sturm 1995	geläutertes

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		BIN 4, 149	Ichisar 1989	fin
		BIN 4, 153	Ichisar 1989	fin
		BIN 4, 198	Ulshöfer 1995	geläutertes
		BIN 6, 74	Ichisar 1981	fin
		BIN 6, 189	Ulshöfer 1995	geläutertes
		BIN 6, 239	Larsen 1967	refined
		BIN 6, 245	Ichisar 1981	fin
		C 17	Larsen 2002	refined
		CCT 1, 2	Larsen 1967	refined
		CCT 1, 26c	Ulshöfer 1995	geläutertes
		CCT 3, 21a	Ichisar 1981	fin
		CCT 4, 10a	Larsen 2002	refined
		CCT 4, 11a	Michel 2001	fin
		CCT 5, 41b	Ichisar 1981	fin
		CCT 6, 9a	Ichisar 1981	fin
		CTMMA 1, 92a	Spar 1988	refined
		FS Oelsner 481	Sturm 2000	refined
		FS Sachs 33ff.	Biggs 1988	refined
		Ichisar, Imdilum 240f.	Ichisar 1981	fin
		ICK 1, 41a	Ichisar 1981	fin
		ICK 1, 41b	Ichisar 1981	fin
		ICK 1, 84	Ichisar 1981	fin
		ICK 1, 116	Michel 1991	fin
		ICK 1, 117	Ichisar 1981	fin
		ICK 1, 122	Ichisar 1981	fin

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		ICK 1, 146	Ichisar 1981	fin
		ICK 1, 161	Sturm 1995	geläutertes
		ICK 1, 165	Ulshöfer 1995	geläutertes
		ICK 1, 167	Larsen 1967	refined
		ICK 1, 176	Michel 1991	fin
		ICK 1, 187	Ichisar 1981	fin
		ICK 1, 192	Michel 2001	fin
		ICK 2, 36	Ichisar 1981	fin
		ICK 2, 47	Ichisar 1981	fin
		ICK 2, 79	Ichisar 1981	fin
		ICK 2, 318	Ulshöfer 1995	geläutertes
		KTB 2	Larsen 2002	refined
		KTH 24	Lewy 1930	geläutertes
		KTH 26	Larsen 2002	refined
		KTP 6	Michel 2001	fin
		KTS 2, 8	Sturm 1995	geläutertes
		kt 87/k 462	Sturm 1995	geläutertes
		kt c/k 257	Sturm 1995	geläutertes
		KUG 16	Larsen 2002	refined
		LB 1296	Ichisar 1981	fin
		OAA 1, 78	Larsen 2002	refined
		OAA 1, 86	Larsen 2002	refined
		OIP 27, 56	Gelb 1935; Ichisar 1931	refined; fin
		OIP 27, 62	Gelb 1935	refined
		Orient 33, 80 no. 1	Kawasaki 1998	no translation

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		Prag 555	Matouš & Matoušová-Rajmová 1984	refined
		Prag 604	Sturm 1995	geläutertes
		Prag 733	Hecker 2004	geläutertes
		RA 58, 64 Sch. 8	Ulshöfer 1995	geläutertes
		RA 59, 29 no. 9	Ichisar 1981	fin
		RA 59, 36 no. 13	Garelli 1965	fin
		RA 59, 172 no. 32	Michel 1991; Sturm 1995	fin; geläutertes
		RA 60, 106 no. 41	Garelli 1966	fin
		RA 60, 140 Bruce	Larsen 2002	refined
		RA 81, 1	Michel 1987	fin
		RA 81, 55	Michel 1987	fin
		TC 1, 2	Larsen 2002	refined
		TC 1, 8	Larsen 2002	refined
		TC 1, 15	Larsen 1967	refined
		TC 2, 17	Balkan 1967	fine
		TC 2, 19	van der Meer 1931	pur
		TC 3, 47	Ichisar 1981; Michel 2001	fin
		TC 3, 166	Ulshöfer 1995; Larsen 2002	geläutertes; refined
		TC 3, 186	Ulshöfer 1995	geläutertes
		TC 3, 213	Larsen 1967	refined
		TMH 1, 18c	Hecker 1997	geläutertes
		TPAK 1, 82	Michel & Garelli 1997	fin
		TPAK 1, 86	Michel & Garelli 1997	fin
		TPAK 1, 88	Michel & Garelli 1997	fin
		TPAK 1, 89	Michel & Garelli 1997	fin

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		TPAK 1, 92	Michel & Garelli 1997	fin
		TPAK 1, 94	Michel & Garelli 1997	fin
		TPAK 1, 95	Michel & Garelli 1997	fin
		TPAK 1, 97	Michel & Garelli 1997	fin
		TPAK 1, 99	Michel & Garelli 1997	fin
		TPAK 1, 100	Michel & Garelli 1997	fin
		TPAK 1, 101a	Michel & Garelli 1997	fin
		TPAK 1, 102	Michel & Garelli 1997	fin
		TPAK 1, 107	Michel & Garelli 1997	fin
		TPAK 1, 112	Michel & Garelli 1997	fin
		TPAK 1, 116	Michel & Garelli 1997	fin
		TPAK 1, 117	Michel & Garelli 1997	fin
		TPAK 1, 118	Michel & Garelli 1997	fin
		TPAK 1, 122	Michel & Garelli 1997	fin
		TPAK 1, 123	Michel & Garelli 1997	fin
		TPAK 1, 125	Michel & Garelli 1997	fin
		TPAK 1, 140	Michel & Garelli 1997	fin
		TPAK 1, 143	Michel & Garelli 1997	fin
		TPAK 1, 155	Michel & Garelli 1997	fin
		TTC 14	Larsen 2002	refined
		VS 26, 29	Larsen 2002	refined
		VS 26, 50	Sturm 1995	geläutertes
		VS 26, 99	Ichisar 1981	fin
tirum	-	AKT 6b, 383	Larsen 2013	untranslated
		AKT 6b, 384	Larsen 2013	untranslated

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		FS Larsen 186	Donbaz 2004a	untranslated
		FS T. Özgüç 78-80	Donbaz 1989	untranslated
		FS Matouš 2, 125	Larsen 1978	untranslated
		KTS 1, 10	Larsen 1967	untranslated
		Neşr. C 1	Veenhof 1989; Michel 1991	untranslated
		OAAS 4, 52-53	Donbaz 2008	untranslated
		OAAS 4, 56	Donbaz 2008	untranslated
		Šarnikzel 276-277	Donbaz 2004b	untranslated
		TPAK 1, 110	Michel & Garelli 1997	argent pesé avec les poids officiels
zakuum	clear	kt 89/k 261	Veenhof 2016	pure

Tin (AN.NA/*annakum*)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
masīrum	-	AKT 6c, 655	Larsen 2014	untranslated
mussuḫum	(of) bad (quality)	Ka. 970	Donbaz 2015	impure
ša tamsium	(that has been) washed	TC 3, 50	Ichisar 1981	que tu as raffinées
SIG_5	(of) good (quality)	AKT 6b, 341	Larsen 2013	good
		BIN 6, 79	Michel 2001	de bonne qualité
		CCT 4, 34c	Michel 2001	de bonne qualité
		CCT 4, 40a	Michel 2001	de bonne qualité
		RA 81, 20	Michel 1987	de bonne qualité
		TC 1, 15	Larsen 1967	good
		TC 1, 26	van der Meer 1931	beau plomb
SIG_5 *watrum*	(of) very good (quality)	TC 1, 2	Larsen 2002	of extraordinary quality
zakuum	clear	Anatolica 12, 138	Donbaz & Veenhof 1985	pure

Copper (URUDU/*wērium*)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
SIG_5/*damqum*	(of) good (quality)	AKT 1, 17	Michel 2001; Larsen 2002	de bonne qualité; of good quality
		AKT 3, 30	Bilgiç & Günbatti 1995	gutes
		AKT 3, 52	Bilgiç & Günbatti 1995	gutes
		AKT 3, 66	Bilgiç & Günbatti 1995	gutes
		AKT 3, 72	Bilgiç & Günbatti 1995	gutes
		AKT 5, 51	Veenhof 2010b	refined
		AKT 5, 57	Veenhof 2010b	refined
		AKT 5, 58A	Veenhof 2010b	refined
		AKT 6a, 129	Larsen 2010	good
		AKT 6a, 184	Larsen 2010	good
		AKT 6a, 216	Larsen 2010	good
		AKT 6a, 224	Larsen 2010	good
		AKT 6a, 246	Larsen 2010	good
		AKT 6a, 250	Larsen 2010	good
		AKT 6a, 251	Larsen 2010	good
		AKT 6a, 253	Larsen 2010	good
		AKT 6a, 278a	Larsen 2010	good
		AKT 6a, 282	Larsen 2010	good
		AKT 6b, 313	Larsen 2013	good
		AKT 6b, 316	Larsen 2013	good
		AKT 6b, 333	Larsen 2013	good
		AKT 6b, 348	Larsen 2013	good
		AKT 6b, 352	Larsen 2013	good

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		AKT 6b, 354	Larsen 2013	good
		AKT 6b, 364	Larsen 2013	good
		AKT 6b, 377	Larsen 2013	good
		AKT 6b, 404	Larsen 2013	good
		AKT 6b, 416	Larsen 2013	good
		AKT 6b, 417	Larsen 2013	good
		AKT 6b, 443	Larsen 2013	good
		AKT 6b, 446	Larsen 2013	good
		AKT 6b, 447	Larsen 2013	good
		AKT 6b, 452	Larsen 2013	good
		AKT 6b, 464	Larsen 2013	good
		AKT 6b, 476	Larsen 2013	good
		AKT 6b, 499	Larsen 2013	good
		AKT 6b, 514	Larsen 2013	good
		AKT 6c, 523	Larsen 2014	(of) good (quality)
		AKT 6c, 535	Larsen 2014	(of) good (quality)
		AKT 6c, 550	Larsen 2014	(of) good (quality)
		AKT 6c, 551	Larsen 2014	(of) good (quality)
		AKT 6c, 610	Larsen 2014	(of) good (quality)
		AKT 6c, 613	Larsen 2014	(of) good (quality)
		AKT 6c, 621	Larsen 2014	(of) good (quality)
		AKT 6c, 632	Larsen 2014	(of) good (quality)
		AKT 6c, 636	Larsen 2014	(of) good (quality)
		AKT 6c, 668	Larsen 2014	(of) good (quality)
		AKT 6c, 686	Larsen 2014	(of) good (quality)

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		AKT 6c, 721	Larsen 2014	(of) good (quality)
		AKT 6c, 723	Larsen 2014	(of) good (quality)
		ArAn 2, 25f.	Michel 2001	de bonne qualité
		BIN 4, 35	Dercksen 1996	fine
		BIN 4, 54	Larsen 2002	(of) good (quality)
		BIN 4, 64	Larsen 2002	(of) good (quality)
		BIN 4, 148	Larsen 2002	(of) good (quality)
		BIN 4, 160	Dercksen 1996	fine
		BIN 4, 172	Ulshöfer 1995	gutes
		BIN 6, 76	Dercksen 1996	of good quality
		BIN 6, 133	Ichisar 1981	de bonne quali[té]
		CCT 2, 29	Dercksen 1996	fine
		CCT 2, 36a	Michel 2001	de bonne qualité
		CCT 2, 37b	Michel 2001	de bonne qualité
		CCT 3, 1	Ichisar 1981	bon
		CCT 3, 44b	Michel 2001	de bonne qualité
		CCT 4, 12b	Dercksen 1996	fine
		CCT 4, 27a	Ichisar 1981	bon
		CCT 4, 33b	Michel 1991	de bonne qualité
		CCT 4, 36b-37a	Michel 2001	de bonne qualité
		CCT 4, 47a	Ichisar 1981	de bonne qualité
		CCT 5, 13a	Michel 2001	de bonne qualité
		CCT 5, 28b	Ulshöfer 1995	gutes
		CCT 6, 37a	Ichisar 1981	bon
		CCT 6, 46b	Michel 1991	de bonne qualité

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		FS Oelsner 305 1	Müller & Marzahn 2000	good
		ICK 1, 55	Michel 2001	de bonne qualité
		ICK 2, 54	Ichisar 1981	de bonne qualité
		JCS 14, 11	Michel 1991	de bonne qualité
		kt 87/k 462	Sturm 1995	verfeinertes
		kt a/k 913	Sturm 1995	verfeinertes
		KTP 26	Ulshöfer 1995	gutes
		KTS 1, 18	Ichisar 1981	de bonne qualité
		KTS 1, 57d	Ulshöfer 1995	guter Qualität
		KTS 2, 8	Donbaz 1989	gutes
		KTS 2, 34	Donbaz 1989	gutes
		LB 1202	Ichisar 1981	de bonne qualité
		LB 1275	Ichisar 1981	en bonne qualité
		Neşr. C 43	Michel 1991	de bonne qualité
		OrNS 36 no. 29	Balkan 1967	of good quality
		RA 58, 132 (Gou 2)	Michel 2001	de bonne qualité
		RA 59, 36 no. 14	Garelli 1965	bon
		RA 60, 95 no. 35	Garelli 1966	de bonne qualité
		TC 1, 20	Michel 1991	de bonne qualité
		TC 1, 81	Ulshöfer 1995	gutes
		TC 2, 36	Ichisar 1981	bon
		TC 2, 54	Ulshöfer 1995	gutes
		TC 3, 97	Michel 2001	de bonne qualité
		TC 3, 182	Ulshöfer 1995	gutes
		TC 3, 210	Ulshöfer 1995	guten

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		TC 3, 211	Ichisar 1981	de bonne qualité
		TPAK 1, 4	Michel & Garelli 1997	de bonne qualité
		TPAK 1, 64	Michel & Garelli 1997	de bonne qualité
		TPAK 1, 103	Michel & Garelli 1997	de bonne qualité
		TPAK 1, 150	Michel & Garelli 1997	de bonne qualité
SIG_5 *watrum*	(of) very good (quality)	Anatolica 12, 133	Donbaz & Veenhof 1985	extremely good copper
hušā'ū	scrap	AKT 3, 20	Sturm 1995	(Kupfer)-Schrott
		BIN 4, 133	Ulshöfer 1995	(Kupfer)-Schrott
		BIN 6, 175	Ulshöfer 1995	(Kupfer)-Schrott
		CCT 1, 36a	Ulshöfer 1995	(Kupfer)-Schrott
		ICK 1, 55	Michel 2001	déchet (de cuivre)
		ICK 2, 321	Ulshöfer 1995	(Kupfer)-Schrott
		KTS 2, 8	Donbaz 1989	Schrott
		TC 1, 78	Ulshöfer 1995	(Kupfer)-Schrott
		TC 1, 108	Ulshöfer 1995	(Kupfer)-Schrott
		TC 3, 157	Ulshöfer 1995	(Kupfer)-Schrott
		VS 26, 148	Nashef 1987; Ulshöfer 1995	scrap; (Kupfer)-Schrott
lammunum	(of) poor (quality)	AKT 6a, 194	Larsen 2010	poor
		AKT 6a, 224	Larsen 2010	bad
		AKT 6a, 254	Larsen 2010	bad
		AKT 6b, 443	Larsen 2013	bad
		AKT 6b, 444	Larsen 2013	bad
		AKT 6c, 621	Larsen 2014	bad
		AKT 6c, 622	Larsen 2014	bad

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		BIN 4, 172	Ulshöfer 1995	schlechtes
		KUG 49	Ichisar 1981	de mauvaise qualité
		TC 2, 33	Dercksen 1996	poor
masium	washed	AKT 2, 39	Dercksen 1996	refined
		AKT 3, 74	Bilgiç & Günbatti 1995	gewaschenes
		AKT 3, 113	Bilgiç & Günbatti 1995	gewaschenes
		AKT 6a, 176	Larsen 2010	washed
		AKT 6a, 208b	Larsen 2010	washed
		AKT 6a, 230	Larsen 2010	washed
		AKT 6a, 254	Larsen 2010	washed
		AKT 6b, 313	Larsen 2013	washed
		AKT 6b, 336	Larsen 2013	washed
		AKT 6b, 348	Larsen 2013	washed
		AKT 6b, 353	Larsen 2013	washed
		AKT 6b, 385	Larsen 2013	washed
		AKT 6b, 399	Larsen 2013	washed
		AKT 6b, 444	Larsen 2013	washed
		AKT 6b, 447	Larsen 2013	washed
		AKT 6b, 456	Larsen 2013	washed
		AKT 6c, 617	Larsen 2014	washed
		AKT 6c, 618	Larsen 2014	washed
		AKT 6c, 627	Larsen 2014	washed
		AKT 6c, 689	Larsen 2014	washed
		BibO 73, 22 no. C	Veenhof 2016	refined
		BIN 4, 1	van der Meer 1931	plomb d’alliage

Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
		BIN 4, 31	Dercksen 1996	refined
		BIN 4, 160	Dercksen 1996	refined
		BIN 6, 94	Dercksen 1996	refined
		CCT 2, 40a	Michel 2001	affiné
		FS Larsen 179	Donbaz 2004a	refined
		ICK 1, 85	Ichisar 1981; Michel 1991	raffiné
		kt c/k 263	Dercksen 1996	refined
		KTH 1	Lewy 1930; Larsen 2002	gemischtes; washed
		KTH 38	Lewy 1930	verfeinertes
		KTS 1, 18	Ichisar 1981	raffiné
		RA 59, 25 no. 6	Garelli 1965	« lavé »
		TC 3, 10	Michel 2001	raffiné
		TC 3, 178	Ulshöfer 1995	geläutertes
		TMH 1, 1a	Michel 2001	affiné
		TPAK 1, 58	Michel & Garelli 1997	affiné
		TPAK 1, 112	Michel & Garelli 1997	affiné
		TPAK 1, 181	Michel & Garelli 1997	affiné
		VS 26, 27	Dercksen 1996	refined
masium SIG_5	washed (of) good (quality)	AKT 6b, 377	Larsen 2013	washed fine
		ICK 2, 99	Dercksen 1996	refined good
masium SIG_5/*damqum šabburum*	washed (of) good (quality) (and) broken	AKT 6b, 350	Larsen 2013	washed, good, broken
		OIP 27, 56	Gelb 1935; Ichisar 1981	mixed, purified, broken up; raffiné de bonne qualité, en petits morceaux

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
maṭium	inferior/inadequate	CCT 4, 36b-37a	Michel 2001	bien mauvais
mussuḫum	(of) bad (quality)	KTS 1, 57d	Ulshöfer 1995	minderwertiger Qaulität
SIG_5 *mussuḫum*	(of) good (but) bad (quality)	ATHE 38	Balkan 1967	of good (but) deteriorated quality
SIG_5 *šabburum*	(of) good (quality), broken	ATHE 37	Larsen 2002	good broken
šaduwānum la ukalu	that does not contain haematite	ICK 2, 54	Ichisar 1981	[q]ui ne contient pas d'hématite
ṣaḫḫirum	in small pieces	AKT 6a, 183	Larsen 2010	untranslated
		AKT 6a, 251	Larsen 2010	untranslated
		AKT 6a, 253	Larsen 2010	untranslated
		AKT 6b, 452	Larsen 2013	untranslated
		Anatolica 12, 131	Donbaz & Veenhof 1985	broken
		CCT 1, 35	Ulshöfer 1995	in sehr kleinen (Stücken?)
		CCT 2, 37b	Michel 2001	en morceaux
		TPAK 1, 64	Michel & Garelli 1997	en petits morceaux
ṣalmum	black	AKT 6a, 13	Larsen 2010	black
		AKT 6a, 251	Larsen 2010	black
		AKT 6c, 616	Larsen 2014	black
		AKT 6c, 721	Larsen 2014	black
		BIN 4, 31	Dercksen 1996	black
		CMK 33	Michel 2001	noir
		VS 26, 6	Dercksen 1996	black
ša šaduišu	of (its) stone	AKT 5, 25	Veenhof 2010b	of local origin / of its mountain
		AKT 5, 52	Veenhof 2010b	native
		kt a/k 265	Dercksen 1996	native

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		kt t/k 76 + kt t/k 79	Dercksen 1996	native
		OIP 27, 62	Gelb 1935; Ichisar 1981; Dercksen 1996	untranslated; à être payées comme sa taxe; native
šikkum	-	AKT 2, 39	Dercksen 1996	untranslated
		AKT 5, 45	Veenhof 2010b	untranslated
		AKT 5, 57	Veenhof 2010b	untranslated
		AKT 5, 58A	Veenhof 2010b	untranslated
		AKT 6a, 176	Larsen 2010	untranslated
		AKT 6a, 184	Larsen 2010	untranslated
		AKT 6a, 189	Larsen 2010	untranslated
		AKT 6a, 216	Larsen 2010	untranslated
		AKT 6b, 404	Larsen 2013	untranslated
		AKT 6b, 417	Larsen 2013	untranslated
		AKT 6b, 446	Larsen 2013	untranslated
		AKT 6b, 447	Larsen 2013	untranslated
		AKT 6b, 464	Larsen 2013	untranslated
		AKT 6b, 491	Larsen 2013	untranslated
		AKT 6b, 492	Larsen 2013	untranslated
		AKT 6b, 505	Larsen 2013	untranslated
		AKT 6b, 506	Larsen 2013	untranslated
		AKT 6c, 607	Larsen 2014	untranslated
		AKT 6c, 608	Larsen 2014	untranslated
		AKT 6c, 617	Larsen 2014	untranslated
		AKT 6c, 618	Larsen 2014	untranslated
		AKT 6c, 685	Larsen 2014	untranslated

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		AnOr 6, 20	Ulshöfer 1995	gestückeltes
		ATHE 18	Ulshöfer 1995	gestückeltes
		ATHE 38	Balkan 1967	of low quality
		BIN 4, 31	Dercksen 1996	untranslated
		BIN 4, 160	Dercksen 1996	untranslated
		BIN 4, 199	Ulshöfer 1995	gestückeltes
		BIN 6, 94	Dercksen 1996	untranslated
		CCT 5, 28b	Ulshöfer 1995	gestückeltes
		CCT 5, 31c	Ulshöfer 1995	gestückeltes
		CCT 6, 6d	Ulshöfer 1995	gestückeltes
		kt c/k 263	Dercksen 1996	untranslated
		KTP 40	Ulshöfer 1995	gestückeltes
		OIP 27, 54	Ulshöfer 1995	gestückeltes
		TC 1, 72	Ulshöfer 1995	gestückeltes
		TC 1, 109	Ulshöfer 1995	gestückeltes
		TC 2, 33	Dercksen 1996	untranslated
		TPAK 1, 190	Michel & Garelli 1997	en morceaux
zakuum	clear	AKT 3, 56	Bilgiç & Günbatti 1995	reines

<u>KÙ.AN/a*mūtum*, *aši'um* & *parzillum* (iron)</u>				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
KÙ.AN/*amūtum*	-	AAA I/3, 5	Veenhof 2016	iron
		AKT 3, 45	Bilgiç & Günbatti 1995	Meteoreisen
		AKT 5, 1	Veenhof 2010b	meteoric iron
		AKT 5, 2	Veenhof 2010b	meteoric iron
		AKT 5, 3	Veenhof 2010b	meteoric iron
		AKT 5, 6	Veenhof 2010b	meteoric iron
		AKT 5, 11	Veenhof 2010b	meteoric iron
		AKT 6a, 46	Larsen 2010	iron
		AKT 6a, 169	Larsen 2010	iron
		AKT 6a, 177	Larsen 2010	iron
		AKT 6b, 380	Larsen 2013	iron
		AKT 6b, 411	Larsen 2013	iron
		AKT 6c, 524	Larsen 2014	iron
		AKT 6c, 525	Larsen 2014	iron
		AKT 6c, 527	Larsen 2014	iron
		AKT 6c, 528	Larsen 2014	iron
		AKT 6c, 628	Larsen 2014	iron
		AKT 6c, 630	Larsen 2014	iron
		ArAn 2, 25f.	Michel 2001	fer-*amūtum*
		ArAn 3, 294-297	Sever 1997; Veenhof 2016	untranslated; iron
		ATHE 39	Dercksen 2005	untranslated
		BibO 73, 20-21 no. B	Veenhof 2016	iron
		BibO 73, 22 no. C	Veenhof 2016	iron / meteoric iron

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		BibO 73, 22-23 no. D	Veenhof 2016	meteoric iron
		BIN 4, 45	Michel 2001	fer-*amūtum*
		BIN 4, 50	Michel 2001	fer (KÙ.AN) / fer-*amūtum*
		BIN 4, 233	Michel 2001	fer-*amūtum*
		CCT 2, 37b	Michel 2001	fer-*amūtum*
		CCT 3, 17b	Michel 2001	fer-*amūtum*
		CCT 3, 36b	Michel 2001	fer-*amūtum*
		CCT 4, 4a	Michel 2001	fer-*amūtum* / fer de météorite-*amūtum*
		CCT 4, 34c	Michel 2001	fer-*amūtum*
		CCT 4, 38a	Veenhof 2016	iron
		CCT 5, 13a	Michel 2001	fer-*amūtum*
		CCT 6, 12a	Ichisar 1981	météo[rite]
		Cole 2	Michel 1991	fer de météorite
		CRRAI 34, 477	Donbaz 1989	iron?
		FS Garelli 239 = FT4	Larsen & Møller 1991	iron
		FS Matouš 2, 127-128	Larsen 1978	iron
		FS Sachs 33ff.	Biggs 1988	*amūtu*-metal
		FS Veenhof, Donbaz 83ff.	Donbaz 2001a; Donbaz 1988a	untranslated
		FS Veenhof, Donbaz 85ff.	Donbaz 2001a	untranslated
		ICK 1, 1	Michel 1991	fer de météorite
		ICK 1, 39b	Dercksen 2005	untranslated
		ICK 1, 55	Michel 2001	fer-*amūtum*
		ICK 2, 337	Ulshöfer 1995	Meteoreisen
		kt 87/k 387	Veenhof 2016	iron

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		kt 89/k 231	Veenhof 2016	iron
		kt 89/k 260	Veenhof 2016	untranslated
		kt 89/k 261	Veenhof 2016	iron
		kt 91/k 189	Veenhof 2016	iron
		kt 93/k 511	Veenhof 2016	iron
		kt 94/k 208	Veenhof 2016	iron
		kt a/k 1071	Çeçen 1997	untranslated
		kt a/k 1072	Çeçen 1997	untranslated
		kt b/k 211	Balkan 1965	Eisen
		kt b/k 229	Çeçen 1997	untranslated
		kt c/k 18	Çeçen 1997; Sever 1997	untranslated
		kt j/k 107	Çeçen 1997	untranslated
		kt n/k 88	Veenhof 2016	iron
		kt n/k 203	Veenhof 2016	untranslated
		kt n/k 510	Veenhof 2016	untranslated
		kt n/k 695	Veenhof 2016; Çeçen 1997	untranslated
		kt n/k 726	Çeçen 1997; Sever 1997	untranslated
		kt n/k 757	Çeçen 1997; Sever 1997; Dercksen 2005	untranslated
		kt n/k 1652	Çeçen 1997	untranslated
		kt n/k 1686	Çeçen 1997; Sever 1997; Sturm 2001; Dercksen 2005	untranslated; *amūtum*-Eisen; untranslated
		kt s/k 89	Çeçen 1997; Sever 1997	untranslated
		KTH 10	Lewy 1930	untranslated
		KTK 68	Ulshöfer 1995	Meteoreisen
		KTS 1, 30	Michel 2001	fer-*amūtum*

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		Michel, Innaya II, 324f. no. 256	Michel 1991	fer de météorite
		OAAS 4, 73-74	Kienast 2008	iron
		RA 81, 49	Michel 1987	fer (de météorite ?)
		TC 1, 20	Michel 1991	fer de météorite
		TC 2, 9	Michel 2001	fer-*amūtum*
		TPAK 1, 20	Michel & Garelli 1997	fer de météorite
		TPAK 1, 170	Michel & Garelli 1997	fer de météorite
		VS 26, 61	Michel 2001	fer-*amūtum*
		WZKM 86	Michel & Garelli 1996	fer de météorite
amūtum NA_4(/*abnum*)	stone	kt 87/k 387	Veenhof 2016	lump
KÙ.AN/*amūtum* SIG_5/*damqum*	(of) good (quality)	AKT 6a, 169	Larsen 2010	good
		BIN 4, 50	Michel 2001	d'excellente qualité
		kt 87/k 387	Veenhof 2016	good quality
amūtum SIG5/*damqum la watar*	(of) good (but) not very (good)	kt 87/k 387	Veenhof 2016	good, but not extremely good
amūtum kiṣrum	lump	CCT 4, 4a	Michel 2001	morceau
		KTS 1, 30	Michel 2001	(d'un seul) bloc
amūtum ṣahertum	in small pieces	FS Sachs 33ff.	Biggs 1988	in lumps(?)
		kt n/k 1686	Çeçen 1997; Sever 1997; Dercksen 2005	untranslated; crushed; small sized
		VS 26, 61	Michel 2001	en petits morceaux
amūtum ṣahertum zakuum	clear (and) in small pieces	CCT 4, 34c	Michel 2001	en petits morceaux purs
KÙ.AN *ša* KI.DIRI/*kīšum*	-	FS Veenhof, Donbaz 83ff.	Donbaz 2001a; Donbaz 1988a	untranslated

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		FS Veenhof, Donbaz 85ff.	Donbaz 2001a	untranslated
KÙ.AN/*amūtum zakuum*	clear	FS Veenhof, Donbaz 83ff.	Donbaz 2001a	pure
		ICK 1, 55	Michel 2001	pur
		kt a/k 1071	Çeçen 1997	untranslated
aši'um	-	AKT 1, 78	Michel 2001	fer-*aši'um*
		AKT 3, 45	Bilgiç & Günbatti 1995	iron
		AKT 5, 1	Veenhof 2010b	meteoric iron
		AKT 5, 17	Veenhof 2010b	meteoric iron / iron
		AKT 6a, 176	Larsen 2010	iron
		AKT 6b, 519	Larsen 2013	iron
		AKT 6c, 686	Larsen 2014	iron
		ATHE 62	Barjamovic 2011	*ašium*-metal
		BIN 4, 45	Michel 2001	fer-*aši'um*
		BIN 6, 181	Ulshöfer 1995	meteorisches Eisen
		CCT 2, 43	Michel 2001	fer-*aši'um*
		CCT 2, 48	Michel 2001	fer-*aši'um*
		CCT 3, 23b	Michel 1991	fer de météorite
		ICK 2, 145	Ichisar 1981	météorite
		kt 00/k 6	Günbatti 2004	untranslated
		kt 89/k 206	Veenhof 2016	untranslated
		kt 89/k 216	Veenhof 2016	untranslated
		kt 89/k 261	Veenhof 2016	untranslated
		kt 94/k 1455	Veenhof 2016	iron
		RA 59, 150 no. 23	Ichisar 1981; Michel 1991	
		TC 1, 39	Michel 2001	fer-*aši'um*

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
		TC 2, 23	Michel 2001	fer-*aši'um*
		TC 3, 81	Michel 2001	fer-*aši'um*
aši'um abnum	stone	kt 89/k 206	Veenhof 2016	big lump
aši'um urākum	bar	kt 89/k 206	Veenhof 2016	bar
ašiʾum zakuum ša šarrūtim	clear (and) of royal (quality)	kt 94/k 1455	Veenhof 2016; courtesy Larsen	good quality "of royal quality"; pure and of royal quality
parzillum	iron	Anatolica 12, 143	Donbaz & Veenhof 1985	iron
		C 33	Donbaz & Veenhof 1985; Larsen 2002	iron
		kt a/k 1260b	Çeçen 1997	iron
		kt n/k 1697	courtesy Erol (2017)	(parzillum iron)

Other metals				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
KÙ.GAN/*lulā'um*	antimony?	AKT 3, 52	Bilgiç & Günbatti 1995	Antimon
		AKT 6a, 216	Larsen 2010	antimony
		Ank. 64	Ulshöfer 1995	Antimon
		KTS 1, 7a	Veenhof 2014	antimony
UD.KA.BAR/*siparrum*	bronze	AKT 6a, 184	Larsen 2010	bronze
		AKT 6b, 335	Larsen 2013	bronze
		AKT 6b, 491	Larsen 2013	bronze
		AKT 6c, 535	Larsen 2014	bronze
		AKT 6c, 539	Larsen 2014	bronze
		AKT 6c, 547	Larsen 2014	bronze
		AKT 6c, 570	Larsen 2014	bronze
		AKT 6c, 571	Larsen 2014	bronze
		CCT 2, 36a	Michel 2001	bronze
		CCT 3, 20	Michel 2001	bronze
		CCT 4, 20a	Michel 2001	bronze
		Donbaz, FS N. Özgüç, 143-145	Donbaz 1993	bronze
		KTS 1, 12	Larsen 2002	bronze
		LB 1202	Ichisar 1981	bronze
		OOA 1, 102	Larsen 2002	bronze
		OAAS 4, 57-58	Donbaz 2008	bronze
		RA 60, 111 no. 42	Michel 2001	bronze
		RA 81, 55	Michel 1987	bronze
		TTC 16	Ulshöfer 1995	bronze

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
A.LÙ/A.BÁR/*abārum*	lead	AKT 6b, 300	Larsen 2013	lead

Appendix 5. Amarna metals varieties with bibliography

The following tables contain all the varieties of each metal used in this research in alphabetical order of Akkadian term.[1077]

		Gold (KÙ.GI/*ḫurāṣum*)		
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
banum	(of) good (quality)	EA 7	Moran 1992; Rainey 2015	fine; high quality
GÙN/*burrumum*	multi-coloured	EA 283	Moran 1992; Rainey 2015	no translation; red
SIG_5	(of) good (quality)	EA 31	Moran 1992; Rainey 2015	(of) excellent (quality); good-quality
epēqum	solid	EA 25	Moran 1992; Rainey 2015	solid
		EA 26	Moran 1992; Rainey 2015	solid
		EA 27	Moran 1992; Rainey 2015	solid
		EA 29	Moran 1992; Rainey 2015	solid
epēqum muššurum	solid chased	EA 29	Moran 1992; Rainey 2015	solid chased
la epēšu	not worked	EA 19	Moran 1992; Rainey 2015	that has not been worked
		EA 20	Moran 1992; Rainey 2015	that has not been worked; that has not been worked / unworked
		EA 29	Moran 1992; Rainey 2015	that has not been worked
Hurian: *nākkāša*	molten	EA 24	Moran 1992; Rainey 2015	molten
ša damu šūlû	(with the colour) of blood raised	EA 22	Moran 1992; Rainey 2015	with a *reddish tinge*
		EA 25	Moran 1992; Rainey 2015	with a *reddish tinge* / *tinged with red*
ša ki KÙ.BABBAR	(that looks) like silver	EA 3	Moran 1992; Rainey 2015	that *looked like silver*; that looks like silver

[1077] The author holds sole responsibility of any discrepancies or omissions of the data.

Logogram/ Akkadian word	Translation	Reference	Translator	Translated as
šapkum epēqum	solid cast	EA 26	Moran 1992; Rainey 2015	solid cast
		EA 27	Moran 1992; Rainey 2015	solid cast
ša ṭikmennu	(with the colour) of ashes	EA 10	Moran 1992; Rainey 2015	looked like *ashes*; had the look of ashes
zakuum	clear	EA 27	Moran 1992; Rainey 2015	pure; purified

Silver (KÙ.BABBAR/*kaspum*)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
zakuum	clear	EA 14	Moran 1992; Rainey 2015	pure
ṣarpum	refined	EA 37	Moran 1992; Rainey 2015	pure; refined

Copper (URUDU/*wērium*)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
DÙG	(of) good (quality)	EA 33	Moran 1992; Rainey 2015	*fine*; fine
		EA 40	Moran 1992; Rainey 2015	fine
TAR/*burrumum*	multi-coloured	EA 36	Moran 1992; Rainey 2015	no translation; multicolored (alloyed?)

AN.BAR, *ḫabalkinum*& a*mūtum* (iron)				
Logogram/ Akkadian word	**Translation**	**Reference**	**Translator**	**Translated as**
AN.BAR	iron	EA 22	Moran 1992; Rainey 2015	iron
		EA 25	Moran 1992; Rainey 2015	iron
ḫabalkinnum	-	EA 22	Moran 1992; Rainey 2015	iron
amūtum	-	EA 22	Moran 1992; Rainey 2015	*amutu*-metal

Appendix 6. Gold artefacts analysis

12th Dynasty gold artefacts analysis

Sample No.	Object No.	Reference	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
1	MMA 11.150.15b[1078]	Frantz and Schorsch 1990	Meir, tomb B3, pit 3	SEM-EDS	leaf from the face of the anthropoid coffin of Nephthys	78.6	19.1	2.4
2	MMA 12.182.132c[1079]	Frantz and Schorsch 1990	Meir	SEM-EDS	funerary mask of Ukhhotpe	62.8	35.3	1.9
3	LNP 600B	Frantz and Schorsch 1990	Lisht, North Cemetery, burial 600B	SEM-EDS	gold leaf fragments from funerary mask	69.0	30.1	0.9
4	LNP 763	Frantz and Schorsch 1990	Lisht, North Cemetery, shaft 763	SEM-EDS	box 2 of the gold leaf fragments from Senebtisi's coffin	85.8	13.6	0.6
5a	NMS A.1914.1081	Troalen et al. 2009	el-Harāgeh, cemetery A, tomb 72	XRF	fish-shaped pendant: body	82.6	16.3	1.1
5b	>>	>>	>>	>>	fish-shaped pendant: tail	45.0	51.7	3.3

1078 MMA Collection online, http://www.metmuseum.org/art/collection/search/558155.
1079 MMA Collection online, http://www.metmuseum.org/art/collection/search/558143?sortBy=Relevance&ft=12.182.132c&offset=0&rpp=20&pos=1.

MBA I-II Ebla gold artefacts analysis							
Sample No.	**Reference**	**Ref. No.**	**Site - Date**	**Description**	**Au wt%**	**Ag wt%**	**Cu wt%**
6	Palmieri and Hauptmann 2000	E58/1	Area P Sud MBA I/II, 1850-1800 BC	bronze boss cover: average on four measurements	77.3	19	3.8
7	Palmieri and Hauptmann 2000	E65/1	Royal Hypogea MBA I, 1850-1750 BC	8 fragments: average on four measurements	65	32.5	2.5
8	Palmieri and Hauptmann 2000	E66/1	Area P MBA II, 1750-1700 BC	2 fragments: average on four measurements	88	10.3	1.8
9	Palmieri and Hauptmann 2000	MQ136	Tomb of “The Lord of Goats” MBA II, 1750-1700 BC	rectangular sheet	60	5	4

				17th Dynasty gold artefacts analysis				
Sample No.	**Object No.**	**Reference**	**Site**	**Method**	**Description**	**Au wt%**	**Ag wt%**	**Cu wt%**
10a	BM EA7876[1080]	Miniaci *et al*. 2013	Qurneh	XRF	green jasper heart scarab of King Sobekemsaf II: corrugated strip around scarab	86.1	12.6	1.3
10b	>>	>>	>>	XRF	>>: top plate of plinth	86.2	12.6	1.3
10c	>>	>>	>>	SEM-EDS	>>: side wall of plinth	86.5	11.5	2.0
10d	>>	>>	>>	XRF	>>: base plate of plinth	86.8	12.3	0.9
10e	>>	>>	>>	XRF	>>: front left leg	86.1	12.6	1.3
10f	>>	>>	>>	SEM-EDS	>>: back right leg	85.4	13.1	1.5
10g	>>	>>	>>	SEM-EDS	>>: back left leg	87.5	11.3	1.2
11a	BM EA57698[1081]	Miniaci *et al*. 2013	Thebes?	XRF	gold finger-ring with lapis-lazuli scarab: hoop	85.0	14.0	1.0
11b	>>	>>	>>	XRF	>>: bezel plate	83.0	16.0	1.0
11c	>>	>>	>>	XRF	>>: coiled wire	84.0	15.0	1.0
11d	>>	>>	>>	SEM-EDS	>>: left leg	91.3	7.6	1.1
11e	>>	>>	>>	SEM-EDS	>>: right leg (including solder)	85.2	10.0	4.8
11f	>>	>>	>>	SEM-EDS	>>: collar	87.0	11.3	1.7

[1080] BM Collection online, http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?assetId=127856001&objectId=117804&partId=1.
[1081] BM Collection online, http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=117506&partId=1&searchText=lapis-lazuli+scarab&place=42209&object=22713+20569&matcult=16136&material=18413+18603&page=1.

Sample No.	Object No.	Reference	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
12a	BM EA57699[1082]	Miniaci *et al*. 2013	Edfu?	XRF	bracelet spacer bar decorated with cats: base plate	81.7	17.0	1.3
12b	>>	>>	>>	XRF	>>: end plate	81.1	16.8	2.1
12c	>>	>>	>>	XRF	>>: top plate	80.5	17.0	2.5
12d	>>	>>	>>	XRF	>>: cat 1 – body	88.0	11.0	1.0
12e	>>	>>	>>	XRF	>>: cat 2 – body	88.7	10.3	1.0
12f	>>	>>	>>	XRF	>>: cat 3 – body	88.9	10.1	1.0
12g	>>	>>	>>	XRF	>>: cat’s tail	82.4	16.3	1.3
12h	>>	>>	>>	XRF	>>: cat’s front leg	85.6	13.3	1.1
13a	BM EA57700[1083]	Miniaci *et al*. 2013	Edfu?	XRF	bracelet spacer bar decorated with cats: base plate	81.1	17.4	1.5
13b	>>	>>	>>	XRF	>>: end plate	81.3	17.0	1.7
13c	>>	>>	>>	XRF	>>: top plate	79.1	17.5	3.4
13d	>>	>>	>>	XRF	>>: cat 1 – body	87.8	11.0	1.2
13e	>>	>>	>>	XRF	>>: cat 2 – body	87.5	11.2	1.3
13f	>>	>>	>>	XRF	>>: cat 3 – body	86.6	11.8	1.6
13g	>>	>>	>>	XRF	>>: cat’s tail	84.4	13.4	2.2

[1082] BM Collection online, http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=111504&partId=1&object=22713+20569&material=18413+18603&museumno=1924,1215.2&page=1.

[1083] BM Collection online, http://www.britishmuseum.org/research/collection_online/collection_object_details.aspx?objectId=111503&partId=1&object=22713+20569&material=18413+18603&museumno=1924,1215.3&page=1.

Sample No.	Object No.	Reference	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
13h	>>	>>	>>	XRF	>>: cat’s front leg	85.6	12.7	1.7
14	NMS A.1909.527.16[1084]	Troalen *et al.* 2014[1085]	Qurneh (Sheikh Abd el-Qurna)	PIXE	adult’s bracelet	88.1	11.6	0.3
15	NMS 1909.527.18[1086]	Troalen *et al.* 2014[1087]	Qurneh (Sheikh Abd el-Qurna)	μPIXE	adult’s pennanular earring	95.6	4.0	0.4
16	NMS A.1909.527.19[1088]	Troalen *et al.* 2009	Qurneh (Sheikh Abd el-Qurna)	PIXE	adult’s necklace: average on three rings	87.8	10.4	1.8
17	NMS A.1909.527.17[1089]	Troalen *et al.* 2009	Qurneh (Sheikh Abd el-Qurna)	PIXE	adult’s girdle: average on 26 wallet beads	43.8	52.5	3.7
18	NMS A.1909.527.17	Troalen *et al.* 2009	Qurneh (Sheikh Abd el-Qurna)	PIXE	adult’s girdle: average on 10 barrel beads	42.1	53.1	4.8

[1084] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299724.
[1085] See also Tate *et al*. 2009; Troalen *et al*. 2009.
[1086] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299729.
[1087] See also Troalen *et al*. 2009; Troalen and Guerra 2016.
[1088] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299731.
[1089] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299728.

Sample No.	Object No.	Reference	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
19	NMS A.1909.527.43[1090]	Troalen *et al*. 2009	Qurneh (Sheikh Abd el-Qurna)	PIXE	child's earring A	82.5	14.6	2.9
20	NMS A.1909.527.43	Troalen *et al*. 2009	Qurneh (Sheikh Abd el-Qurna)	PIXE	child's earring B	83.7	14.2	2.1
21	NMS A.1909.527.11[1091]	Troalen *et al*. 2009	Qurneh (Sheikh Abd el-Qurna)	PIXE	child's necklace: average on two rings	68.6	29.4	2.0
22	Louvre E3297	Lemasson *et al*. 2015	Unknown	PIXE	Queen Ahhotep's ring	82.3	15.7	1.2

[1090] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=597102.
[1091] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299721.

18th Dynasty gold artefacts analysis

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
23a	-	Lemasson *et al.* 2015	-	-	PIXE	Ahmose's I bracelet: cartouche	63.8	31.3	2.8
23b	-	>>	-	-	>>	>>: lion	70.4	26.9	1.2
24a	NMS A.1913.388[1092]	Troalen and Guerra 2016	-	Riqqa, Tomb 296 of Scribe Beri	XRF, PIXE	Riqqa necklace: average of beads[1093]	80.4	18.2	1.4
24b	>>	>>	-	>>	>>	>>: rectangular pendant	87.7	11.6	0.7
24c	>>	>>	-	>>	>>	>>: steatite scarab	86.5	11.7	1.7
24d	>>	>>	-	>>	>>	>>: lapis lazuli scarab	59.9	37.1	3.0
24e	>>	>>	-	>>	>>	>>: terminal ring	66.9	31.0	2.1
25	NMS A.1913.389[1094]	Troalen and Guerra 2016	-	Riqqa, Tomb 296 of Scribe Beri	XRF	penannular earring: average on four hoops	88.4	10.1	1.0
26	NMS A.1913.390[1095]	Troalen and Guerra 2016	-	Riqqa, Tomb 296 of Scribe Beri	XRF	penannular earring: average on two hoops	86.3	12.7	0.9
27	NMS A.1913.391[1096]	Troalen and Guerra 2016	-	Riqqa, Tomb 296 of Scribe Beri	XRF, PIXE	penannular earring: average on four hoops	89.3	9.6	1.2
28a	Petrie Museum UC31416	Troalen and Guerra 2016	-	Riqqa, Cemetery C	pXRF	penannular earring: average on 2 hoops	49.0	47.9	3.2
28b	>>	>>	-	>>	>>	>>: closing plate	49.7	46.3	4.0

[1092] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299708.
[1093] Flat lenticular beads, ball beads, small ball beads, and terminal small oval bead (Troalen and Guerra 2016, 5, table 3).
[1094] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299909.
[1095] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299910.
[1096] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=302256.

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
29a	Manchester Museum 6146[1097]	Troalen and Guerra 2016	-	Riqqa	pXRF	penannular earring: average on four hoops	49.6	46.8	3.6
29b	>>	>>	-	>>	>>	>>: plate closing hoop	51.9	45.2	2.9
30	Louvre Museum E 14435B	Troalen and Guerra 2016[1098]	-	Deir el-Medina	PIXE	penannular earring: average on four hoops	77.8	18.8	3.5
31	Louvre Museum E 14435C	Troalen and Guerra 2016	-	Deir el-Medina	PIXE	penannular earring: average on four hoops	79.4	18.7	2.0
32	Louvre Museum E 14435D	Troalen and Guerra 2016[1099]	-	Deir el-Medina	PIXE	penannular earring: average on four hoops	80.4	18.0	1.7
33	NMS A.1937.691[1100]	Troalen and Guerra 2016	-	-	PIXE	earring: average on four hoops	80.6	18.4	1.0
34a	NMS A.1928.160[1101]	Troalen and Guerra 2016	-	-	PIXE	penannular earring: average on four hoops	80.5	17.2	2.3
34b	>>	>>	-	-	>>	>>: closing plate	88.5	9.0	2.5
35	NMS A.1965.368[1102]	Troalen and Guerra 2016	-	-	PIXE	penannular earring: average on four hoops	83.2	15.8	1.1
36	Louvre Museum AF2444	Lemasson *et al.* 2015	-	-	PIXE	penannular earring	54.3	42.4	2.5

1097 The University of Manchester: Manchester Museum Collection online, http://harbour.man.ac.uk/mmcustom/Display.php?irn=104830&QueryPage=%2Fmmcustom%2FEgyptQuery.php.
1098 See also Lemasson *et al*. 2015.
1099 See also Lemasson *et al*. 2015.
1100 NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=302268.
1101 NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299913.
1102 NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299934.

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
37	Louvre Museum N1855B	Lemasson *et al.* 2015	-	-	PIXE	penannular earring	73.7	25.5	0.8
38	Louvre Museum N2084	Troalen and Guerra 2016[1103]	-	-	PIXE	penannular earring: average on four hoops	56.7	40.6	2.8
39	MMA 26.8.94b	Lilyquist 2003[1104]	110	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	glass-inlaid penannular earring: average on three measurements	69.3	25.7	5.0
40a	22658	Lemasson e*t al*. 2015	-	-	PIXE	necklace: bead with hard-solder	82.3	15.7	1.2
40b	>>	>>	-	-	>>	>>: average on six beads	87.3	11.6	1.1
41	MMA 26.8.101	Lilyquist 2003	24	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	falcon collar	75.3	22.5	2.2
42	MMA 26.8.104	Lilyquist 2003	25	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	vulture breastplate	75.0	22.4	2.6

[1103] See also Lemasson *et al*. 2015.
[1104] Published also in Troalen and Guerra 2016.

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
43	MMA 26.8.107	Lilyquist 2003	26	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	folded cloth amulet	74.0	23.4	2.6
44	MMA 26.8.102[1105]	Lilyquist 2003	27	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	falcon collar	78.6	19.5	1.9
45	MMA 26.8.105[1106]	Lilyquist 2003	28	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	vulture breastplate	78.4	19.8	1.8
46	MMA 26.8.108[1107]	Lilyquist 2003	29	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	folded cloth amulet	77.6	21.0	1.4
47a	MMA 26.8.99[1108]	Lilyquist 2003	108	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	gazelle diadem: average on band and post	60.3	36.5	3.2

[1105] MMA Collection online, http://www.metmuseum.org/art/collection/search/548449?sortBy=Relevance&ft=26.8.105&offset=0&rpp=20&pos=2.
[1106] MMA Collection online, http://www.metmuseum.org/art/collection/search/548450?sortBy=Relevance&ft=26.8.105&offset=0&rpp=20&pos=1.
[1107] MMA Collection online, http://www.metmuseum.org/art/collection/search/561061?sortBy=Relevance&ft=26.8.108&offset=0&rpp=20&pos=1.
[1108] MMA Collection online, http://www.metmuseum.org/art/collection/search/553269?sortBy=Relevance&ft=26.8.99&offset=0&rpp=20&pos=1.

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
47b	>>	>>	>>	>>	SEM-EDS	>>: average on rosette and rosette bezel	60.5	36.7	2.8
47c	>>	>>	>>	>>	SEM-EDS	>>: average on gazelles	60.0	37.3	2.8
47d	>>	>>	>>	>>	SEM-EDS	>>: average on gazelles' neck rings, small flat ring, small rounded ring	57.8	38.0	3.4
48	MMA 1988.17	Lilyquist 2003	133	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	drop-shaped element	69.4	28.8	1.8
49a	MMA 26.8.124d[1109]	Lilyquist 2003	138	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	lion armlet: bottom of cat spacer	69.8	27.9	2.2
49b	>>	>>	>>	>>	>>	>>: surface of spacer bead	80.1	18.6	1.3
50	MMA 26.8.129[1110]	Lilyquist 2003	141	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	hinged bracelet (inner surface)	75.4	21.8	2.8

[1109] MMA Collection online, http://www.metmuseum.org/art/collection/search/548683?sortBy=Relevance&ft=26.8.124&offset=0&rpp=20&pos=1.
[1110] MMA Collection online, http://www.metmuseum.org/art/collection/search/547644?sortBy=Relevance&ft=26.8.129&offset=0&rpp=20&pos=1.

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
51	MMA 26.8.81[1111]	Lilyquist 2003	223	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	uraeus pendant	46.0	51.0	3.0
52	MMA 26.8.118g	Lilyquist 2003	216	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	SEM-EDS	loop-and-pin clasp	63.9	33.2	2.9
53	Ashm. 1890.781	Gale and Stos-Gale 1981	-	Lahun, Tomb of Maket	XRF	cowroid	49.3	49.3	1.5
54	Ashm. E.2580(2)	Gale and Stos-Gale 1981	-	Abydos E269	XRF	ring	49.5	34.7	8.4
55	Ashm. EE.499(1)	Gale and Stos-Gale 1981	-	Ehnasya 19B	XRF	bead	49.3	49.3	1.3
56	MMA 27.3.444[1112]	Frantz and Schorsch 1990	-	Thebes, Deir el-Bahri, Temple of Hatshepsut, foundation deposits 7-9	SEM-EDS	Hatshepsut tubular beads ("red")	51.5	45.8	2.8
57	MMA 27.3.444	Frantz and Schorsch 1990	-	Thebes, Deir el-Bahri, Temple of Hatshepsut, foundation deposits 7-9	SEM-EDS	Hatshepsut tubular beads ("non red")	91.7	7.4	0.9

[1111] MMA Collection online, http://www.metmuseum.org/art/collection/search/549891?sortBy=Relevance&ft=26.8.81&offset=0&rpp=20&pos=1.
[1112] MMA Collection online, http://www.metmuseum.org/art/collection/search/549114?sortBy=Relevance&when=2000-1000+B.C.&where=Egypt%7cThebes&what=Beads%7cGold&ft=*&offset=0&rpp=20&pos=2.

Sample No.	Object No.	Reference	Ref. No.	Site	Method	Description	Au wt%	Ag wt%	Cu wt%
58a	NMS A.1883.49.2[1113]	Troalen *et al.* 2009	-	Amarna, probably the Royal Tomb	XRF	gold finger-ring with frog: hoop	98.2	1.7	0.1
58b	>>	>>	-	>>	SEM-EDS	>>: low row granules	89.4	7.9	2.8
58c	>>	>>	-	>>	SEM-EDS	>>: upper row granules	94.0	3.3	2.7
59	NMS A.1883.49.8[1114]	Troalen *et al.* 2009	-	Amarna, probably the Royal Tomb	XRF	gold finger-ring with bezel	81.1	18.1	0.8
60a	EMC JE60672	Uda *et al*. 2007	-	Thebes, Valley of the Kings, Tomb KV62	XRDF	Tutankhamun's golden mask: lip matrix	96.6	1.0	2.4
60b	>>	>>	-	>>	XRDF	>>: lip surface	76.8	11.2	12.0
60c	>>	>>	-	>>	XRDF	>>: *nemes* matrix	97.8	1.4	0.8
60d	>>	>>	-	>>	XRDF	>>: *nemes* surface	93.8	3.2	2.9
61	EMC JE62028	Uda *et al*. 2014	-	Thebes, Valley of the Kings, Tomb KV62	XRDF	Tutankhamun's golden throne	95.1	3.9	1.0

[1113] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299865.
[1114] NMS Collection online, http://www.nms.ac.uk/explore/collection-search-results/?item_id=299866.

Appendix 7. Silver artefacts analysis

n.d. = not detected.

Sample No.	Object No.	Reference	Ref. No.	Site	Dynasty/ Date	Method	Description	Ag wt%	Au wt%	Cu wt%	Pb wt%	Bi wt%
Middle Kingdom silver artefacts analysis												
62	Ashm. E.1745	Gale and Stos-Gale 1981	-	Dendera	-	XRF	necklet	91.0	1.8	6.8	0.2	0.18
63	Ashm. E.1963	Gale and Stos-Gale 1981	-	Dendera	10th	XRF	ring	86.9	2.8	8.6	1.6	-
64	Ashm. 1925.438	Gale and Stos-Gale 1981	-	Fayum, Qasr es-Sapha	11th-12th	XRF	fragment on core	61.2	34.0	4.8	n.d.	-
65	LNP 763	Frantz and Schorsch 1990	-	Lisht, North Cemetery, shaft 763	-	SEM-EDS	box 1 of the gold leaf fragments from Senebtisi's coffin	65.4	30.2	4.4	-	-
66	Ashm. EE.486	Gale and Stos-Gale 1981	-	El-Kab 299	12th	XRF	bead	63.8	35.4	0.8	n.d.	-
67	Ashm. E.1962	Gale and Stos-Gale 1981	-	Dendera 543	12th	XRF	fragment of bracelet	84.8	8.5	6.8	0.1	-
68	Ashm. E.2652	Gale and Stos-Gale 1981	-	Abydos	-	XRF	finger-ring	95.9	0.3	3.4	0.5	-

Sample No.	Object No.	Reference	Ref. No.	Site	Dynasty/ Date	Method	Description	Ag wt%	Au wt%	Cu wt%	Pb wt%	Bi wt%
69	Ashm. EE.633(1)	Gale and Stos-Gale 1981	-	Abydos 416	12th	XRF	“gold leaf”	78.7	6.3	15.0	n.d.	-
70	Ashm. E.3294	Gale and Stos-Gale 1981	-	Abydos 416	12th	XRF	necklet fragment	60.8	14.6	24.3	0.1	-
71	Ashm. EE.627(1)	Gale and Stos-Gale 1981	-	Abydos 416	12th	XRF	cap on bead	61.7	30.9	7.4	n.d.	-
72	Ashm. EE.627(2)	Gale and Stos-Gale 1981	-	Abydos 416	12th	XRF	cap on bead	72.5	18.1	9.4	n.d.	-
74	Ashm. 1913.406(1)	Gale and Stos-Gale 1981	-	Abydos D166, Grave 13	-	XRF	scarab with silver mount and hoop	62.0	11.5	26.4	0.1	-
75	Ashm. 1913.406(2)	Gale and Stos-Gale 1981	-	Abydos D166	-	XRF	scarab with silver mount and hoop	74.9	18.0	7.1	n.d.	-
76	Ashm. 1913.407	Gale and Stos-Gale 1981	-	Abydos D166	-	XRF	shell pendant	58.3	36.4	5.3	n.d.	-
77	Ashm. E.2210	Gale and Stos-Gale 1981	-	Abydos E284	-	XRF	disc	70.5	28.2	1.3	n.d.	-
78	Ashm. E.2314	Gale and Stos-Gale 1981	-	Abydos E303	12th – 13th	XRF	earrings	83.8	10.0	5.9	0.3	-
79	Ashm. Fortnum R.7	Gale and Stos-Gale 1981	-	-	-	XRF	Scarab with silver mount and hoop	93.1	0.2	6.5	0.2	0.19
80	Ashm. E.2220	Gale and Stos-Gale 1981	-	-	-	XRF	sleeve on kohl-stick	92.5	0.2	6.9	0.2	-

Sample No.	Object No.	Reference	Ref. No.	Site	Dynasty/ Date	Method	Description	Ag wt%	Au wt%	Cu wt%	Pb wt%	Bi wt%
81[1115]	-	Palmieri and Hauptmann 2000	MG214	Ebla, Sep. D.7, qu.EflV9iV; L.3702	1750-1700 BC	SEM-EDS	ingot	95.0	-	1.8	0.2	0.05
82[1116]	-	Palmieri and Hauptmann 2000	E27	Ebla	not dated	SEM-EDS	bracelet	79.0(?)	-	4.4	0.4	0.05

[1115] Also contained 0.2 wt% Sn and 0.7 wt% Fe (Palmieri and Hauptmann 2000, table 2).
[1116] Also contained 0.1 wt% Sn and 0.3 wt% Fe (Palmieri and Hauptmann 2000, table 2).

Second Intermediate Period silver artefacts analysis										
Sample No.	**Object No.**	**Reference**	**Site**	**Method**	**Description**	**Ag wt%**	**Au wt%**	**Cu wt%**	**Pb wt%**	**Bi wt%**
83	Ashm. 1930.495(1)	Gale and Stos-Gale 1981	Mostagedda 3170	XRF	necklet	97.0	0.6	2.2	0.2	-
84	Ashm. 1930.495(2)	Gale and Stos-Gale 1981	Mostagedda 3170	XRF	necklet	88.8	0.4	10.7	0.2	-
85	Ashm. 1925.494	Gale and Stos-Gale 1981	Badari 5478	XRF	bead	96.8	n.d.	2.7	0.5	0.19
86	Ashm. 1925.496	Gale and Stos-Gale 1981	Badari 5478	XRF	coiled ring	96.5	0.3	2.9	0.2	0.19
87	Ashm. 1923.571	Gale and Stos-Gale 1981	Qau 1300	XRF	ring on string of beads	58.0	37.7	4.3	n.d.	-

Sample No.	Object No.	Reference	Ref. No.	Site	Dynasty	Description	Ag wt%	Au wt%	Cu wt%	Pb wt%	Bi wt%
New Kingdom silver artefacts analysis											
88	MMA 26.8.72	Lilyquist 2003	181	Thebes, Wadi Gabbanat el-Qurud, Wadi D, Tomb of the Three Wives of Tuthmose III	18th	bivalve shell and loop	64.9	32.0	3.0	-	-
89	Ashm. 1890.762(1)	Gale and Stos-Gale 1981	-	Lahun, Tomb of Maket	18th	ring	78.1	21.1	0.9	n.d.	-
90	Ashm. 1890.762(2)	Gale and Stos-Gale 1981	-	Lahun, Tomb of Maket	18th	ring	78.8	19.7	1.7	n.d.	-
91	Ashm. 1890.762(3)	Gale and Stos-Gale 1981	-	Lahun, Tomb of Maket	18th	ring	82.4	8.2	7.4	n.d.	-
92	Ashm. 1890.763(1)	Gale and Stos-Gale 1981	-	Lahun, Tomb of Maket	18th	ring with rectangular bezel	74.6	3.2	18.6	3.2	-
93	Ashm. 1890.763(2)	Gale and Stos-Gale 1981	-	Lahun, Tomb of Maket	18th	ring with rectangular bezel	71.9	4.3	18.0	5.8	-
94	Ashm. EE.520	Gale and Stos-Gale 1981	-	Abydos E143	18th	bead	64.1	30.8	5.1	n.d.	-
95	Ashm. E.4300(1)	Gale and Stos-Gale 1981	-	Abydos E178	18th	ring with rectangular bezel	96.5	1.1	2.2	0.1	-
96	Ashm. E.4300(2)	Gale and Stos-Gale 1981	-	Abydos E178	18th	ring with rectangular bezel	94.6	1.3	3.6	0.4	-
97	Ashm. EE.570	Gale and Stos-Gale 1981	-	Abydos E269	18th	bead	77.5	11.6	10.9	n.d.	-

Sample No.	Object No.	Reference	Ref. No.	Site	Dynasty	Description	Ag wt%	Au wt%	Cu wt%	Pb wt%	Bi wt%
98	Ashm. E.2580(1)	Gale and Stos-Gale 1981	-	Abydos (E269?)[1117]	-	ring with openwork bezel	94.5	2.4	2.6	0.5	-
99	Ashm. 1965.1746(2)	Gale and Stos-Gale 1981	-	-	18th	fragment of inlay	90.1	3.6	6.3	-	-
100	1965.174b(1)[1118]	Gale and Stos-Gale 1981	-	-	-	fragment of inlay	56.4	43.4	0.2	n.d.	-

[1117] In Gale and Stos-Gale (1981, table 1), there are no more details as to the exact location in Abydos, from where this sample comes.
[1118] Item nos. are written as in Gale and Stos-Gale (1981, tables 1 and 2). Most probably Sample Nos. 99 and 100 have the same item no., but in Gale and Stos-Gale (1981, tables 1 and 2) it is once as 1965.1746 and once as 1965.174b written. The final digit of the item no. can equally be either 6 or b.

Appendix 8. Copper-based artefacts analysis

tr. = traces.

Kaneš copper-based artefacts analysis																	
Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
101	6789	kt i/k 25	McKerrel 1977; Dercksen 1996	-	bracelet	-	2.9	1.45	0.053	0.34	0.15	tr	tr	tr	tr	0	0.36
102	6794	-	McKerrel 1977	-	awl	-	1.2	0	0.096	tr	0.26	0	0	0	tr	0	0.36
103	6796	kt a/k 381	McKerrel 1977; Dercksen 1996	-	dagger	-	tr	10.0	tr	0.94	tr	0	tr	0	0.04	0	0.068
104	6797	kt a/k 674	McKerrel 1977; Dercksen 1996	-	spearhead	-	0.34	0	>0.5	0.074	0.29	0	0	0.038	0.011	0	0.045

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
105	6798	kt a/k 183 or 381	McKerrell 1977; Dercksen 1996	-	nail	-	0.88	10.0	>0.5	tr	0.25	0	0	tr	0.11	tr	0.07
106	6800	-	McKerrell 1996	-	dagger	-	tr	0	0.05	0	tr	0	0	0	0	0	tr
107	6802	kt b/k 46	McKerrell 1977; Dercksen 1996	-	dagger	-	2.75	0.33	>0.5	0.13	0.38	0	0	0	0.012	0	0.044
108	6803	-	McKerrell 1977	-	round ingot	-	2.15	9.1	0.31	0.72	0.073	0	0	0	tr	0	<0.01
109	6804	kt a/k ?	McKerrell 1977; Dercksen 1996	-	awl	-	0.8	8.9	>0.5	0.17	0.072	0	0	0	tr	0	<0.01
110	6806	kt c/k 199	McKerrell 1977; Dercksen 1996	-	shaft-hole axe	-	2.7	10.0	>0.5	0.25	tr	0.059	0	0	0.026	0	0.045

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
111	6807	kt c/k 182	McKerrell 1977; Dercksen 1996	-	chain? ring	-	1.35	>10.0	0.088	0.57	0.044	0.11	tr	0	0	0	0.057
112	6808	kt c/k 183	McKerrell 1977; Dercksen 1996	-	chain? ring	-	1.15	>10.0	0.33	0.49	0.039	0	0	0	tr	0	0.038
113	6809	-	McKerrell 1977	-	bracelet	-	0.77	0.06	>0.5	0.074	0.04	0.078	0	0	0.009	0	0.03
114	6810	kt c/k 197	McKerrell 1977; Dercksen 1996	-	bracelet	-	2.0	0.53	>0.5	0.15	0.056	0	0	0	0.009	0	0.043
115	6811	kt c/k 165	McKerrell 1977; Dercksen 1996	-	awl	-	0.92	0.092	0.5	0.1	0.082	0	tr	0	0.008	0	0.063
116	6812	kt b/k 63	McKerrell 1977; Dercksen 1996	-	damaged blade	-	tr	9.6	tr	0.12	0.11	0	tr	0	0	0	tr

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
117	6813	kt h!/k 170	McKerrell 1977; Dercksen 1996	-	handle	-	0.86	10.0	tr	0.5	0.072	tr	0	0	0	0	0.06
118	6814	kt c/k 164	Dercksen 1996	-	pin	-	0.67	>10.0	0.17	0.11	1.67	0.088	0	0	0	0	tr
119	6815	kt h?/k 192	Dercksen 1996	-	arrowhead	-	tr	0	>0.5	tr	0.31	0.43	0	0	0.02	0	0.04
120	6819	kt b/k 243	Dercksen 1996	-	knife	-	0.8	0.055	>0.5	0.096	0.12	tr	0	0	0.011	0	0.048
121	6820	-	Dercksen 1996-	-	spearhead	-	0.73	7.8	0.3	tr	tr	0.17	0	0	tr	0	0.06
122	6821	-	Dercksen 1996	-	Annitta's dagger	-	tr	10.0	0.04	0	tr	0	0	0	0	0	0.015
123	6824	kt e/k 3	Dercksen 1996	-	dagger	-	1.15	10.0	0.16	tr	0	0	0	0	0	0	0.024
124	6825	-	Dercksen 1996	-	dagger	-	0.71	tr	>0.5	tr	tr	0	0	0	0.009	0	0.039
125	6826	kt e/k 52	Dercksen 1996	-	awl	-	3.6	0.079	0.022	0.21	0.13	0	tr	0	tr	0	0.047
126	6827	kt e/k 102	Dercksen 1996	-	awl	-	1.3	tr	>0.5	tr	0.1	0	0	tr	0.013	0	0.029

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
127	6828	kt a/k 156?	Dercksen 1996	-	pin	-	2.3	4.8	>0.5	0.52	0.085	0	0	0	0.029	0	0.049
128	6829	kt e/k 6	Dercksen 1996	-	macehead	-	1.4	10.0	>0.5	0.47	tr	0	0	0	0.035	0	0.052
129	6830	kt e/k 101	Dercksen 1996	-	dagger	-	2.15	0.6	>0.5	0.3	0.13	0	0	0	0.024	0	0.061
130	6831	kt e/k 157	Dercksen 1996	-	dagger	-	3.0	0.12	>0.5	0.16	0.27	0	0	tr	0.023	0	tr
131	6832	kt b/k 97	Dercksen 1996	-	hook	-	1.7	6.2	0.036	1.22	0.066	0	0	0	0	0	0.048
132	6833	kt e/k 234	Dercksen 1996	-	awl	-	4.05	tr	>0.5	0.86	0.11	0	tr	+	0.018	0	0.062
133	17637	kt h/k 130	Dercksen 1996	-	frying pan	-	0.84	0.02	+	0.01	0.39	0	tr	0.04	0	0	0.04
134	17639	kt b/k 104	Dercksen 1996	-	lugged axe	-	0.97	0.01	++	0.03	0.01	0	tr	0	0.01	0	0.05
135	17642	kt h/k 131	Dercksen 1996	-	handle	-	1.2	6.2	++	1.4	0.26	tr	tr	0	0.013	0	0.05
136	17643	kt h/k 190	Dercksen 1996	-	sickle	-	0.27	0	++	0.05	0.07	0	tr	0	0	0	0.04
137	17644	kt h/k 132	Dercksen 1996	-	bracelet	-	1.0	4.3	++	1.45	0.29	0	tr	0.3	0.015	0	0.07
138	17645	-	-	-	pedestal container	-	0.32	4.3	+	0.13	0.02	0	0	0	0	0	0.01

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
139	17651	kt h/k 26	Dercksen 1996	-	pin	-	1.3	6.8	++	2.8	0.05	0	tr	0	0.014	0	0.06
140	17652	kt h/k 29	Dercksen 1996	-	pin	-	1.95	5.0	++	0.9	0.82	0	tr	0	0.007	0	0.04
141	17653	kt h/k 90	Dercksen 1996	-	pin	-	0.0	7.6	++	0.75	0.24	0	0	0	0	0	0.01
142	17654	kt h/k 215	Dercksen 1996	-	dagger	-	0.55	0.03	++	0.04	0.01	0	0	0	0	0	0.05
143	17655	kt a/k 71	Dercksen 1996	-	scraper	-	0.25	0	++	0.02	0.04	0	0	0	0	0	0.03
144	17656	-	Dercksen 1996	-	sickle	-	0.59	0	++	1.75	0.21	0	0	0	0	0	0.22
145	17657	kt h/k 30	Dercksen 1996	-	sickle	-	0.66	0.05	++	0.2	0.1	0	tr	0	0	0	<0.01
146	17658	kt h/k 162	Dercksen 1996	-	stamp seal	-	0.16	0.04	++	0.02	0.58	0	0	0	0	0	0.01
147	17659	-	Dercksen 1996	-	knife	-	1.7	8.3	++	0.71	0.09	0	tr	0	0.016	0	0.18
148	17660	-	-	-	blade fragment	-	0.94	>10.0	+	0.15	0.32	0	0	0	tr	0	0.02
149	17661	kt h/k 22	Dercksen 1996	-	bracelet	-	1.6	0.07	++	0.08	0.03	0	0.07	0	0.013	0	0.03
150	17662	kt h/k 23	Dercksen 1996	-	bracelet	-	2.0	0.09	++	0.1	0.02	0	0.08	0	0.014	0	0.03

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
151	17663	kt h/k 27	Dercksen 1996	-	pin	-	0.96	5.8	+	3.0	0.05	0	0	0	0.015	0	0.04
152	17664	kt h/k 68	Dercksen 1996	-	bracelet	-	1.15	>10.0	+	0.04	0	0	0	0	0	0	0.02
153	17729	kt h/k 69	Dercksen 1996	-	bracelet	-	0.81	8.0	++	0.04	0	0	0	0	0	0	0.04
154	17730	kt h/k 91	Dercksen 1996	-	bracelet	-	0.16	4.0	++	0.04	0.02	0	0	0	0	0	0.05
155	17731	kt h/k 92	Dercksen 1996	-	bracelet	-	tr	4.0	++	0.04	0.02	0	0	0	0	0	0.05
156	17732	kt h/k 28	Dercksen 1996	-	pin	-	1.25	0.07	++	0.17	0.01	0.04	tr	0	0	0	0.03
157	17733	kt h/k 67	Dercksen 1996	-	bracelet	-	0.28	tr	++	tr	<0.01	tr	0	0	0	0	0.02
158	17734	kt h/k 66	Dercksen 1996	-	bracelet	-	0.31	tr	++	<0.01	<0.01	0.03	0	0	0	0	0.02
159	17736	-	Dercksen 1996	-	pin	-	1.65	4.3	+	1.2	0.49	0	0.08	0	0.012	0	0.06
160	17737	-	Dercksen 1996	-	sickle-shaped hand-weapon	-	0.39	0	++	0.01	0.02	0	0	0	0.006	0	tr

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
161a	-	AMM 126-57-64	Ercanlı 2012	Kt-01	spearhead	99.03	0.59	-	0.21	0.17	-	-	-	-	-	-	-
161b	-	>>	>>	>>	>>	99.72	0.14	-	-	0.14	-	-	-	-	-	-	-
161c	-	>>	>>	>>	>>	99.17	0.5	-	0.21	0.12	-	-	-	-	-	-	-
162a	-	AMM 126-61-64	Ercanlı 2012	Kt-02	spearhead	98.70	0.83	-	0.32	0.14	-	-	-	-	-	-	-
162b	-	>>	>>	>>	>>	99.49	0.23	-	0.08	0.19	-	-	-	-	-	-	-
162c	-	>>	>>	>>	>>	99.32	0.44	-	0.12	0.13	-	-	-	-	-	-	-
163a	-	AMM 125-8-64	Ercanlı 2012	Kt-03	spearhead	97.91	1.03	-	0.50	0.09	-	0.46	-	-	-	-	-
163b	-	>>	>>	>>	>>	97.76	1.03	-	0.47	0.20	-	0.53	-	-	-	-	-
163c	-	>>	>>	>>	>>	97.40	1.12	-	0.54	0.18	-	0.76	-	-	-	-	-
164a	-	AMM 125-25-64	Ercanlı 2012	Kt-04	spearhead	95.78	1.98	-	1.72	0.20	-	0.32	-	-	-	-	-
164b	-	>>	>>	>>	>>	96.74	1.48	0.65	0.48	0.32	-	0.32	-	-	-	-	-
164c	-	>>	>>	>>	>>	97.51	1.01	0.36	0.36	0.18	-	0.59	-	-	-	-	-
165a	-	AMM 122-45-64	Ercanlı 2012	Kt-05	spearhead	98.43	0.20	0.43	0.13	0.32	-	0.48	-	-	-	-	-
165b	-	>>	>>	>>	>>	98.00	-	0.49	0.08	0.38	-	1.04	-	-	-	-	-

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
165c	-	>>	>>	>>	>>	97.89	1.02	0.35	0.07	0.24	-	0.42	-	-	-	-	-
166a	-	AMM 123-16-64	Ercanlı 2012	Kt-06	spearhead	99.05	-	0.46	0.25	0.23	-	-	-	-	-	-	-
166b	-	>>	>>	>>	>>	99.12	0.23	-	0.22	-	0.20	-	-	-	-	-	-
167a	-	AMM 122-23-64	Ercanlı 2012	Kt-07	spearhead	97.39	1.14	0.63	0.23	0.61	-	-	-	-	-	-	-
167b	-	>>	>>	>>	>>	97.37	0.99	0.52	0.23	0.90	-	-	-	-	-	-	-
167c	-	>>	>>	>>	>>	94.92	3.5	0.71	0.40	0.30	0.17	-	-	-	-	-	-
168a	-	AMM 130-81-64	Ercanlı 2012	Kt-08	spearhead	95.37	-	-	0.65	3.48	-	-	-	-	-	-	-
168b	-	>>	>>	>>	>>	90.74	-	-	0.31	8.92	-	-	-	-	-	-	-
169a	-	AMM 125-55-64	Ercanlı 2012	Kt-09	spearhead	95.64	2.19	-	1.66	0.34	0.18	0.52	-	-	-	-	-
169b	-	>>	>>	>>	>>	96.82	1.96	-	0.62	0.42	0.18	-	-	-	-	-	-
169c	-	>>	>>	>>	>>	95.50	2.48	-	0.76	0.55	0.18	-	-	-	-	-	-
170a	-	AMM 94-55-64	Ercanlı 2012	Kt-10	flat axe	97.91	1.35	-	0.53	0.21	-	-	-	-	-	-	-
170b	-	>>	>>	>>	>>	97.86	1.31	-	0.61	0.23	-	-	-	-	-	-	-

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
171a	-	AMM 117-94-64	Ercanlı 2012	Kt-11	chisel[1119]	98.51	0.99	-	0.37	0.13	-	-	-	-	-	-	-
171b	-	>>	>>	>>	>>	98.33	1.20	-	0.30	0.10	-	-	-	-	-	-	-
172a	-	AMM 123-19-64	Ercanlı 2012	Kt-12	shaft-hole axe	97.75	1.49	-	0.56	0.19	-	-	-	-	-	-	-
172b	-	>>	>>	>>	>>	97.84	1.43	-	0.50	0.23	-	-	-	-	-	-	-
173a	-	AMM 1-40-95	Ercanlı 2012	Kt-13	shaft-hole axe	83.20	0.29	16.20	0.15	0.17	-	-	-	-	-	-	-
173b	-	>>	>>	>>	>>	84.25	0.31	15.16	0.18	0.09	-	-	-	-	-	-	-
173c	-	>>	>>	>>	>>	92.20	0.14	7.60	-	0.06	-	-	-	-	-	-	-
173d	-	>>	>>	>>	>>	90.94	0.22	8.78	-	0.06	-	-	-	-	-	-	-
174a	-	AMM 1-47-2000	Ercanlı 2012	Kt-14	shaft-hole axe	78.66	1.25	16.73	0.54	2.53	0.30	-	-	-	-	-	-
174b	-	>>	>>	>>	>>	83.23	0.59	12.71	0.33	2.89	0.25	-	-	-	-	-	-
175a	-	AMM 94-55-64	Ercanlı 2012	Kt-15	flat axe	86.04	1.59	10.67	0.92	0.77	-	-	-	-	-	-	-
175b	-	>>	>>	>>	>>	83.38	1.8	13.97	0.39	0.45	-	-	-	-	-	-	-
175c	-	>>	>>	>>	>>	97.22	0.79	11.07	0.21	0.70	-	-	-	-	-	-	-

[1119] This object is described as a flat axe (Ercanlı 2012, fig. 4.11), but actually looks more like a chisel.

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
176a	-	AMM 131-3-64	Ercanlı 2012	Kt-16	rivetted dagger	97.92	-	-	2.08	-	-	-	-	-	-	-	-
176b	-	>>	>>	>>	>>	98.32	0.07	-	1.60	-	-	-	-	-	-	-	-
176c	-	>>	>>	>>	>>	98.74	0.07	-	1.19	-	-	-	-	-	-	-	-
176d	-	>>	>>	>>	>>	98.22	-	0.79	0.90	0.10	-	-	-	-	-	-	-
177a	-	AMM 71-2-66	Ercanlı 2012	Kt-17	dagger	92.81	4.91	-	1.97	0.31	-	-	-	-	-	-	-
177b	-	>>	>>	>>	>>	92.94	5.56	-	1.20	0.30	-	-	-	-	-	-	-
178a	-	AMM 71-9-60	Ercanlı 2012	Kt-18	dagger	98.51	0.73	-	0.46	0.30	-	-	-	-	-	-	-
178b	-	>>	>>	>>	>>	95.77	0.77	-	0.82	2.65	-	-	-	-	-	-	-
178c	-	>>	>>	>>	>>	56.88	-	-	2.07	41.05	-	-	-	-	-	-	-
179a	-	AMM 94-71-64	Ercanlı 2012	Kt-19	chisel	96.69	2.91	-	0.16	0.25	-	-	-	-	-	-	-
179b	-	>>	>>	>>	>>	95.65	3.79	-	0.16	0.26	0.14	-	-	-	-	-	-
179c	-	>>	>>	>>	>>	96.12	3.52	-	0.16	0.19	-	-	-	-	-	-	-
180a	-	AMM 177-16-74	Ercanlı 2012	Kt-20	fork weapon	84.33	0.31	11.51	0.16	3.69	-	-	-	-	-	-	-
180b	-	>>	>>	>>	>>	93.48	-	4.48	-	1.68	-	-	-	-	-	-	-
180c	-	>>	>>	>>	>>	93.27	-	5.26	-	1.46	-	-	-	-	-	-	-
180d	-	>>	>>	>>	>>	78.48	1.33	16.97	0.44	2.77	-	-	-	-	-	-	-

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
181a	-	AMM 94-33-64	Ercanlı 2012	Kt-21	sickle blade	98.98	0.87	-	0.07	0.08	-	-	-	-	-	-	-
181b	-	>>	>>	>>	>>	99.06	0.78	-	0.08	0.09	-	-	-	-	-	-	-
182a	-	AMM 126-23-04	Ercanlı 2012	Kt-22	sickle blade part	98.73	0.60	-	0.08	0.41	0.18	-	-	-	-	-	-
182b	-	>>	>>	>>	>>	98.59	0.65	-	-	0.53	0.23	-	-	-	-	-	-
183a	-	kt n/k 132	Ercanlı 2012	Kt-23	ring	97.09	0.42	-	1.49	1.00	-	-	-	-	-	-	-
183b	-	>>	>>	>>	>>	97.19	0.23	-	1.97	0.61	-	-	-	-	-	-	-
184a	-	kt 01/k 98	Ercanlı 2012	Kt-24	ring	90.34	6.14	-	2.21	1.31	-	-	-	-	-	-	-
184b	-	>>	>>	>>	>>	88.88	8.61	-	1.90	0.61	-	-	-	-	-	-	-
185a	-	AMM 126-46-64	Ercanlı 2012	Kt-25	bracelet	92.95	0.23	4.87	0.46	0.10	-	0.43	-	-	-	-	-
185b	-	>>	>>	>>	>>	93.62	0.29	5.23	0.37	0.11	-	0.37	-	-	-	-	-
186a	-	AMM 1-27-99	Ercanlı 2012	Kt-26	finger cymbal	97.84	0.97	0.52	0.10	0.57	-	-	-	-	-	-	-
186b	-	>>	>>	>>	>>	96.87	2.29	-	0.43	0.41	-	-	-	-	-	-	-
187a	-	kt 97/k 478	Ercanlı 2012	Kt-27	drinking cup	92.46	0.10	7.09	0.35	-	-	-	-	-	-	-	-
187b	-	>>	>>	>>	>>	92.80	0.13	6.41	0.65	-	-	-	-	-	-	-	-

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
188a	-	AMM 126-90-64	Ercanlı 2012	Kt-28	drinking cup	84.77	0.91	11.17	0.49	0.79	-	0.93	0.94	-	-	-	-
188b	-	>>	>>	>>	>>	85.35	0.91	11.29	0.21	0.78	-	0.65	0.81	-	-	-	-
189a	-	kt 01/k 23	Ercanlı 2012	Kt-29	drinking cup	88.25	9.52	-	1.74	0.49	-	-	-	-	-	-	-
189b	-	>>	>>	>>	>>	94.13	4.87	-	0.57	0.43	-	-	-	-	-	-	-
190a	-	AMM 01-07-93	Ercanlı 2012	Kt-30	small bowl	93.40	0.06	6.55	-	-	-	-	-	-	-	-	-
190b	-	>>	>>	>>	>>	96.40	0.05	3.55	-	-	-	-	-	-	-	-	-
191a	-	AMM 1-107-03	Ercanlı 2012	Kt-31	small shovel	95.72	2.40	-	0.76	0.61	-	0.30	-	-	-	-	-
191b	-	>>	>>	>>	>>	98.46	0.90	-	0.28	0.36	-	-	-	-	-	-	-
191c	-	>>	>>	>>	>>	97.73	1.44	-	0.33	0.50	-	-	-	-	-	-	-
192a	-	AMM 127-23-04	Ercanlı 2012	Kt-32	fired tubed piece	97.10	1.57	-	0.57	0.37	-	0.39	-	-	-	-	-
192b	-	>>	>>	>>	>>	88.18	-	-	8.19	2.98	-	-	-	-	-	-	-
193a	-	AMM 127-22-61	Ercanlı 2012	Kt-33	small animal sculpture	98.89	0.06	-	-	0.07	-	-	-	-	-	-	-
193b	-	>>	>>	>>	>>	95.27	0.32	-	3.18	0.36	0.25	0.62	-	-	-	-	-

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
193c	-	>>	>>	>>	>>	95.94	0.42	-	1.87	0.39	-	1.39	-	-	-	-	-
193d	-	>>	>>	>>	>>	99.77	0.11	-	-	0.12	-	-	-	-	-	-	-
194	-	-	Ercanlı 2012	Kt-34	chisel fragment	90.70	0.74	7.28	0.09	-	-	-	-	-	-	1.04	-
195	-	-	Ercanlı 2012	Kt-35	pin fragment	97.64	0.83	0.54	0.41	-	-	-	0.40	-	-	-	-
196	-	-	Ercanlı 2012	Kt-36	chisel fragment	94.38	3.16	-	0.20	-	-	-	-	-	-	-	-
197	-	-	Ercanlı 2012	Kt-37	plate fragment	98.32	0.86	-	0.05	0.07	-	-	-	-	-	0.47	0.14
198	-	-	Ercanlı 2012	Kt-38	pin fragment	97.61	0.91	0.11	0.15	-	-	-	-	-	-	-	0.15
199	-	-	Ercanlı 2012	Kt-39	pin fragment	97.20	1.31	-	0.57	-	-	-	-	-	-	-	0.07
200	-	-	Ercanlı 2012	Kt-40	chisel fragment	93.10	1.19	1.85	0.27	0.29	-	-	0.52	-	-	-	0.10
201	-	-	Ercanlı 2012	Kt-41	pin fragment	96.34	1.37	-	1.19	-	-	-	0.06	-	-	0.65	-
202	-	-	Ercanlı 2012	Kt-42	pin fragment	95.71	1.73	0.37	0.40	0.25	-	-	0.04	-	-	-	-
203	-	-	Ercanlı 2012	Kt-43	pin fragment	89.19	-	0.35	0.48	-	-	-	0.33	-	-	-	-
204	-	-	Ercanlı 2012	Kt-44	pin fragment	93.82	1.32	1.14	0.77	-	-	-	0.55	-	-	-	0.56

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
205	-	-	Ercanlı 2012	Kt-45	bowl fragment	86.15	0.23	11.43	-	-	-	-	0.63	-	-	-	-
206	-	-	Ercanlı 2012	Kt-46	pin fragment	96.18	-	0.40	0.10	0.58	-	-	-	-	-	-	-
207	-	-	Ercanlı 2012	Kt-47	pin fragment	99.03	0.28	-	-	-	-	-	0.26	-	-	-	0.25
208	-	-	Ercanlı 2012	Kt-48	chisel fragment	97.36	0.58	0.45	0.08	-	-	-	-	-	-	0.60	0.24
209	-	-	Ercanlı 2012	Kt-49	chisel fragment	86.59	1.04	9.83	0.41	0.42	-	-	-	-	-	1.41	-
210	-	-	Ercanlı 2012	Kt-50	ring fragment	93.90	2.66	-	0.79	0.79	-	-	-	-	-	0.52	-
211	-	-	Ercanlı 2012	Kt-51	pin fragment	98.15	1.24	-	0.45	0.16	-	-	-	-	-	-	-
212	-	-	Ercanlı 2012	Kt-52	pin fragment	97.09	0.76	0.33	0.67	-	-	-	0.03	-	-	0.62	0.42
213	-	-	Ercanlı 2012	Kt-53	pin fragment	96.06	1.72	0.33	0.62	-	-	-	0.50	-	-	0.67	-
214	-	-	Ercanlı 2012	Kt-54	chisel fragment	97.43	0.09	-	0.24	0.82	-	-	-	-	-	-	-
215	-	-	Ercanlı 2012	Kt-55	pin fragment	96.76	0.58	0.17	0.55	-	-	-	0.12	-	-	-	0.34
216	-	-	Ercanlı 2012	Kt-56	pin fragment	97.23	1.00	0.26	0.61	0.03	-	-	0.13	-	-	-	0.04

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
217	-	-	Ercanlı 2012	Kt-57	pin fragment	97.94	0.38	-	0.05	0.11	-	-	1.09	-	-	-	0.25
218	-	-	Ercanlı 2012	Kt-58	chisel fragment	98.41	0.46	-	-	0.66	-	-	0.39	-	-	-	-
219	-	-	Ercanlı 2012	Kt-59	chisel fragment	92.10	0.66	6.24	0.17	0.43	-	-	-	-	-	-	-
220	-	-	Ercanlı 2012	Kt-60	pin fragment	98.78	0.37	0.16	0.28	-	-	-	-	-	-	-	0.27
221	-	-	Ercanlı 2012	Kt-61	pin fragment	96.73	0.83	-	1.12	0.29	-	-	0.70	-	-	-	0.23
222	-	-	Ercanlı 2012	Kt-62	pin fragment	97.79	0.79	-	0.23	-	-	-	-	-	-	1.04	-
223	-	-	Ercanlı 2012	Kt-63	pin fragment	95.77	2.19	-	1.14	0.62	-	-	-	-	-	-	0.04
224	-	-	Ercanlı 2012	Kt-64	chisel fragment	89.70	0.55	8.57	0.25	0.23	-	-	0.42	-	-	0.05	-
225	-	-	Ercanlı 2012	Kt-65	pin fragment	96.06	1.75	-	1.37	0.33	-	-	0.16	-	-	-	0.15
226	-	kt 13-1865	Lehner *et al.* 2015	KT 20	needle	99.00	0.17	0.15	0.22	0.03	-	0.08	-	-	-	-	0.02
227	-	kt 11-1865	Lehner *et al.* 2015	KT 29	pin shaft, unid.	97.00	1.72	-	0.97	0.53	0.04	0.12	0.07	-	-	-	0.02
228	-	kt 13-430	Lehner *et al.* 2015	KT 62	sheet	93.00	0.95	3.00	0.50	1.61	0.09	0.09	0.20	0.01	-	-	0.06

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
229	-	kt 13-1744	Lehner *et al*. 2015	KT 74	attachment tool	86.00	0.94	11.30	0.26	0.82	0.08	0.05	-	0.02	-	-	0.07
230	-	kt 13-1746	Lehner *et al*. 2015	KT 75	attachment tool	83.00	0.97	13.80	0.97	1.80	0.04	0.06	-	-	-	-	0.02
231	-	kt 13-1446	Lehner *et al*. 2015	KT 76	awl	99.00	0.58	0.12	0.26	0.23	0.03	-	-	0.01	-	-	0.05
232	-	kt 13-1423	Lehner *et al*. 2015	KT 77	awl	94.00	2.36	0.59	0.58	2.1	0.02	-	0.15	0.01	-	-	0.02
233	-	kt 13-1424	Lehner *et al*. 2015	KT 78	blade	98.00	0.77	0.03	0.43	0.07	0.75	-	0.01	0.06	-	-	0.01
234	-	kt 13-1233	Lehner *et al*. 2015	KT 79	cymbal	97.00	0.03	2.60	0.33	0.20	-	0.09	-	-	-	-	-
235	-	kt 13-1234	Lehner *et al*. 2015	KT 80	cymbal	98.00	0.20	1.57	0.08	0.35	0.02	0.06	-	-	-	-	-
236	-	kt 13-1537	Lehner *et al*. 2015	KT 81	pin shaft	96.00	1.72	0.04	1.10	1.48	0.02	0.08	-	-	-	-	0.03
237	-	kt 13-1653	Lehner *et al*. 2015	KT 82	pin shaft	97.00	1.04	0.20	1.45	0.16	0.12	0.05	-	0.02	-	-	0.02
238	-	kt 13-1389	Lehner *et al*. 2015	KT 83	pin shaft	96.00	3.17	0.07	0.53	0.38	0.03	-	0.05	0.01	-	-	0.08
239	-	kt 13-1720	Lehner *et al*. 2015	KT 84	pin, rosette head	91.00	4.30	0.02	2.40	1.75	0.27	0.14	0.06	-	-	-	0.01

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
240	-	kt 13-1805	Lehner *et al*. 2015	KT 85	pin, trapezoid head	96.00	1.99	-	1.33	0.42	0.03	-	-	0.01	-	-	0.05
241	-	kt 13-1761	Lehner *et al*. 2015	KT 86	pin, round head	95.00	4.10	0.04	0.71	0.43	0.03	-	0.10	0.01	-	-	0.03
242	-	kt 13-1763	Lehner *et al*. 2015	KT 87	pin, round head	95.00	3.97	-	0.66	0.18	0.02	-	0.05	-	-	-	0.06
243	-	kt 13-1767	Lehner *et al*. 2015	KT 88	pin, stone head	97.00	0.59	0.06	1.77	0.26	0.02	0.19	-	-	-	-	0.05
244	-	kt 13-1509	Lehner et al. 2015	KT 89	wrapped bar	97.00	1.13	0.03	1.12	0.59	0.02	0.07	0.05	-	-	-	0.04
245	-	kt 13-1510	Lehner *et al*. 2015	KT 90	wrapped bar	97.00	1.40	0.02	1.22	0.67	0.03	0.07	0.02	0.01	-	-	0.03
246	-	kt 13-1711	Lehner *et al*. 2015	KT 91	wrapped hammered bar	97.00	1.56	0.30	0.77	0.22	0.19	-	0.12	-	-	-	0.03
247	-	kt 13-1238	Lehner *et al*. 2015	KT 92	wrapped bar	100	-	-	0.04	0.01	-	-	-	-	-	-	0.05
248	-	kt 13-1239	Lehner *et al*. 2015	KT 93	wrapped bar	100	0.01	-	0.04	0.02	-	-	-	-	-	-	0.07
249	-	kt 13-1751	Lehner *et al*. 2015	KT 94	wrapped bar	92.00	3.26	2.50	0.85	1.07	0.09	-	-	-	-	-	0.03
250	-	kt 13-1752	Lehner *et al*. 2015	KT 95	wrapped bar	88.00	3.23	4.70	1.37	2.10	0.06	0.08	0.03	-	-	-	0.04

Sample No.	Esin No.	Object No.	Reference	Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Bi wt%	Au wt%	Ag wt%
251	-	kt 13-1511	Lehner *et al*. 2015	KT 96	wire ring	100	0.04	0.04	0.07	0.04	0.04	0.07	-	-	-	-	0.02
252	-	kt 13-1753	Lehner *et al*. 2015	KT 97	wire ring	100	0.05	0.04	0.02	0.04	0.03	-	-	-	-	-	0.02
253	-	kt 13-227	Lehner *et al.* 2015	KT 98	wire ring	99.00	0.10	0.09	0.33	0.06	0.01	0.34	-	-	-	-	-

Acem Höyük copper artefacts and ingots analysis									
Ref. No.	**Description**	**Cu wt%**	**As wt%**	**Sn wt%**	**Fe wt%**	**Pb wt%**	**Ni wt%**	**Zn wt%**	**Sb wt%**
1	artefact	93.17	0.19	0.15	0.48	0.02	0.05	0.08	0.01
2	artefact	59.71	0.11	0.18	0.22	0.03	0.03	0.02	0.02
3	artefact	68.19	0.15	0.70	0.47	0.86	0.08	0.23	0.07
4	artefact	63.68	0.07	0.12	0.07	0.01	0.07	0.02	0.01
5	artefact	68.46	0.60	0.13	0.03	0.11	0.23	-	0.01
6	artefact	101.92	0.50	0.16	0.49	0.02	0.03	0.03	0.02
7	artefact	36.20	0.35	0.02	0.06	0.09	0.21	0.01	0.01
8	artefact	78.09	0.20	0.23	0.24	0.02	0.04	0.01	0.02
9	ingot	60.78	0.36	0.36	0.06	0.04	0.17	0.01	0.04
10	ingot	37.09	0.02	0.15	0.88	0.02	0.67	0.02	0.02
11	ingot	97.40	0.04	0.11	0.14	0.02	0.48	-	0.01
12	ingot	68.81	-	0.12	0.05	0.06	0.05	0.03	-
13	ingot	74.25	0.20	0.10	0.71	0.02	0.04	0.02	0.01
14	ingot	75.24	0.41	0.09	0.02	0.01	0.06	0.02	0.01
15	ingot	52.50	1.26	0.16	0.18	0.02	0.04	0.03	0.02
16	ingot	65.81	0.50	0.08	0.04	0.01	0.11	-	0.04
17	ingot	53.06	0.20	0.12	0.18	0.02	0.03	0.01	0.01
18	ingot	69.35	0.11	0.08	0.07	0.01	0.02	-	0.01
19	ingot	65.84	0.04	0.08	0.09	0.01	0.33	-	0.01
20	ingot	73.51	0.08	0.13	0.08	0.01	0.45	-	0.01
21	ingot	66.00	0.27	0.10	0.25	0.01	0.02	0.05	0.01
22	ingot	59.76	0.11	0.08	0.17	0.01	0.03	-	0.01
23	ingot	64.39	-	0.17	0.22	0.02	0.04	0.01	0.02

Ref. No.	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%
24	ingot	65.64	0.03	0.14	0.07	0.01	0.25	-	0.01
25	ingot	60.62	0.14	0.14	0.13	0.01	0.09	-	0.01
26	ingot	61.91	0.03	0.08	0.11	0.01	0.34	-	0.01
27	ingot	72.44	0.02	0.15	0.11	0.02	0.43	-	0.02
28	ingot	79.06	0.24	0.26	0.07	0.03	0.08	-	0.03
29	ingot	66.06	0.46	0.21	0.19	0.02	0.01	0.01	-
30	ingot	78.18	0.35	0.27	1.85	0.03	0.04	0.01	0.03
31	ingot	69.13	0.40	0.14	0.04	0.01	0.04	-	0.01
32	ingot	70.15	0.14	0.05	0.04	0.01	0.11	-	0.01
33	ingot	64.43	0.11	0.19	0.05	0.01	0.10	-	0.02
34	ingot	73.40	0.09	0.07	0.08	0.01	0.35	-	0.01
35	ingot	60.52	0.34	0.16	0.22	0.02	0.02	-	0.02
36	ingot	79.01	0.12	0.16	0.02	0.02	0.11	-	0.02
37	ingot	39.62	0.16	0.41	0.19	0.04	0.28	-	0.04
38	ingot	77.79	0.11	0.16	0.15	0.02	0.69	-	0.02
39	ingot	68.09	0.22	0.31	0.10	0.03	0.26	0.07	0.03
40	ingot	69.17	0.07	0.20	0.21	0.02	0.01	0.10	0.08
41	ingot	70.03	0.16	0.21	1.07	0.02	0.02	0.15	0.02

Kaman Kalehöyük copper slags analysis																		
Reference	**Ref. No.**	**Description**	**Fe wt%**	**Cu wt%**	**Ni wt%**	**Co wt%**	**Mn wt%**	**P wt%**	**Ti wt%**	**Si wt%**	**Ca wt%**	**Al wt%**	**Mg wt%**	**Pb wt%**	**As wt%**	**Sb wt%**	**Bi wt%**	**S wt%**
Akanuma 2007, table 4	2007_6	lump	4.06	87.4	0.064	0.031	<0.001	-	<0.001	-	-	0.008	-	0.913	0.75	0.36	<0.01	1.17
Akanuma 2007, table 7	2007_7	slag	27.55	44.8	0.021	0.088	0.002	<0.01	0.028	3.31	<0.01	0.289	0.083	0.069	0.65	0.03	<0.01	2.31
Akanuma 2007, table 7	2007_8	slag	22.51	56.1	0.03	0.03	0.008	<0.01	0.009	0.12	0.085	0.074	0.04	0.179	5.38	0.16	<0.01	1.17
Akanuma 2007, table 7	2007_9	slag	26.65	50.3	0.04	0.07	0.006	<0.01	0.006	0.22	0.082	0.051	0.025	0.068	0.51	0.01	<0.01	2.37
Akanuma 2004, table 3	2004_6	slag	27.88	39.5	0.025	0.101	0.001	<0.01	0.015	1.43	0.058	0.237	0.027	0.04	1.43	0.05	<0.01	2.95

Ebla copper-based artefacts analysis															
Sample No.	**Inv. No. Rome**	**Arch. Inv. No.**	**Date**	**Description**	**Cu wt%**	**As wt%**	**Sn wt%**	**Fe wt%**	**Pb wt%**	**Ni wt%**	**Zn wt%**	**Sb wt%**	**Co wt%**	**Ag wt%**	**Bi wt%**
254	E20	TM.83.G234	2000-1600	pin	88	0.39	4.29	0.15	1.01	0.05	<0.001	<0.01	0.01	<0.008	0.03
255	E21	TM.83.G223	2000-1600	pin	94	0.64	0.30	0.51	0.81	0.09	<0.001	0.01	0.01	<0.008	0.04
256	E23	TM.83.G270	2000-1600	pin	83	0.95	5.57	0.10	1.73	0.05	<0.001	<0.01	0.01	<0.008	<0.03
257	E29	TM.83.G158	2000-1600	pin	85	3.24	0.14	0.54	1.05	0.64	<0.001	0.15	0.02	0.50	<0.03
258	E30	TM.83.G285	2000-1600	pin	92	0.20	4.91	0.08	1.98	0.04	<0.001	<0.01	0.01	0.43	<0.03
259	E31	TM.83.G211	2000-1600	pin	79	2.15	0.37	1.09	0.04	0.21	0.01	0.03	0.00	<0.008	<0.03
260	E40	TM.92.P1	2000-1600	pin	88	0.75	0.38	1.26	0.04	0.75	<0.001	0.07	0.01	0.10	<0.03
261	E41	TM.92.P92	2000-1600	awl	90	2.81	0.50	1.99	0.06	0.18	<0.001	0.85	0.01	0.06	<0.03
262	E42	TM.92.T275	2000-1600	pin	77	0.60	0.13	0.41	1.88	0.04	0.01	0.10	0.02	<0.008	<0.03
263	E47	TM.P264	2000-1600	pin	93	0.87	0.20	0.69	0.04	0.45	<0.001	0.05	0.00	0.01	<0.03
264	E48	TM.P539	2000-1600	pin	86	0.44	5.75	0.13	0.62	0.05	0.01	<0.01	0.00	0.05	0.03

Sample No.	Inv. No. Rome	Arch. Inv. No.	Date	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Ag wt%	Bi wt%
265	E18	TM.83.4 G9	1800-1600	axe	92	0.58	4.26	0.04	0.05	0.05	<0.001	0.01	0.03	<0.008	<0.03
266	E19	TM.83.G.269	1800-1600	sickle	91	0.96	0.73	0.31	0.52	1.10	0.01	0.06	0.02	<0.008	<0.03
267	E24	TM.83.G.217	1800-1600	sickle	85	0.96	0.54	0.22	0.03	0.04	<0.001	0.03	0.05	<0.008	<0.03
268	E38	TM.92.T226	1800-1600	chisel	94	1.35	0.28	0.23	0.38	0.57	<0.001	0.16	0.09	0.05	<0.03
269	E39	TM.P.536	1800-1600	spiral	72	0.96	2.83	0.33	0.04	0.24	<0.001	0.11	0.01	0.06	<0.03
270	E43	TM.92.T276	1800-1600	needle	97	0.88	<0.008	0.05	0.08	0.12	0.56	0.05	0.16	<0.008	<0.03
271	E49	TM.95.V635	1800-1600	axe	91	0.70	0.32	0.50	0.06	0.22	0.00	0.05	0.07	0.03	<0.03
272	MM842	TM.71.M.842	1800-1600	spearhead	67	0.22	7.76	0.20	0.17	0.07	0.02	<0.01	<0.001	0.13	0.04
273	E1	-	1850-1700	bowl	82	0.13	9.51	0.20	0.05	0.05	<0.001	<0.01	0.01	0.16	<0.03
274	E2	-	1850-1700	pin	96	0.29	0.15	0.47	0.57	0.04	0.01	0.02	0.01	<0.008	<0.03
275	E3	TM.78.Q505	1850-1700	spearhead	62	0.11	2.33	0.13	0.04	0.01	0.01	<0.01	<0.001	0.01	<0.03
276	E5	TM.78.Q517	1850-1700	spearhead	62	0.15	2.26	0.13	0.08	0.02	0.01	<0.01	0.00	0.32	0.05

Sample No.	Inv. No. Rome	Arch. Inv. No.	Date	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Ag wt%	Bi wt%
277	E6	TM.78.Q504	1850-1700	spearhead	64	1.01	0.25	0.57	0.06	0.00	<0.001	<0.01	0.01	0.15	<0.03
278	E34	TM.88.P	1850-1700	head	95	0.80	3.50	0.98	0.18	0.07	<0.001	0.03	0.01	0.14	<0.03
279	E35	TM.76.G846	1850-1700	sickle	64	0.09	4.47	0.10	0.04	0.12	<0.001	<0.01	0.01	0.07	<0.03
280	E4	TM.78.Q.IC	1750-1700	spearhead	99	0.63	0.25	0.62	0.20	0.03	0.01	0.11	0.00	0.08	0.04
281	E7	TM.78.Q.IC	1750-1700	spearhead	61	0.20	5.49	0.10	0.04	0.01	<0.001	<0.01	0.22	0.01	<0.03
282	E8	TM.79.Q.IA78	1750-1700	pin	86	1.18	2.62	0.17	0.15	0.05	<0.001	<0.01	0.01	0.72	<0.03
283	E9	TM.78	1750-1700	spearhead?	51	0.12	4.83	0.04	0.05	0.03	0.02	<0.01	<0.001	0.86	<0.03
284	E10	TM.78.Q.IC	1750-1700	axe	62	0.04	5.73	0.02	0.07	0.01	0.01	<0.01	0.00	0.01	<0.03
285	E11	TM.78.Q.IC	1750-1700	spearhead	84	0.33	9.75	0.16	0.56	0.01	<0.001	<0.01	0.01	0.03	0.04
286	E12	TM.79.Q.IA	1750-1700	spearhead	67	0.07	2.67	0.06	0.02	0.01	<0.001	0.02	0.01	0.02	<0.03
287	E13	TM.78.Q.IC	1750-1700	chisel	90	0.38	8.79	0.25	0.16	0.02	<0.001	<0.01	0.01	0.09	<0.03
288	E14	TM.79.Q.IC.78	1750-1700	spearhead	60	0.20	5.01	0.05	0.03	0.21	0.01	<0.01	0.00	0.01	<0.03

Sample No.	Inv. No. Rome	Arch. Inv. No.	Date	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Ag wt%	Bi wt%
289	E15	TM.78.Q	1750-1700	spearhead	85	0.48	11.10	0.21	0.10	0.03	<0.001	<0.01	0.01	0.06	<0.03
290	E16	TM.78.Q.IC	1750-1700	spearhead	84	0.41	10.80	0.15	0.09	0.07	<0.001	<0.01	0.01	0.01	<0.03
291	E17	TM.79.Q.IA2	1750-1700	dagger	75	0.05	1.30	0.09	0.24	0.06	0.01	<0.01	0.00	0.01	<0.03
292	E33	TM.79.Q.188	1750-1700	handle	83	0.31	8.85	0.21	0.36	0.03	<0.001	<0.01	0.01	0.31	<0.03
293	E36	TM.79.Q.IC	1750-1700	spearhead	84	0.88	8.28	0.35	0.09	0.04	<0.001	<0.01	0.01	0.11	<0.03
294	E37	TM.88.R.463	1750-1700	pan	80	0.38	9.17	0.21	0.09	0.13	<0.001	0.02	0.01	0.04	<0.03
295	MQ446	TM.78.Q.446	1750-1700	goat head	58	<0.02	0.45	0.15	0.12	0.02	0.01	<0.01	0.00	1.54	0.03
296	MQ473	TM.78.Q.473	1750-1700	bell	34	<0.02	<0.008	1.07	0.43	0.03	0.03	<0.01	<0.001	0.71	0.03
297	MQ477	TM.78.Q.477	1750-1700	spearhead	61	<0.02	<0.008	0.14	0.02	0.02	0.01	0.01	<0.001	<0.008	0.05
298	MQ481	TM.78.Q.481	1750-1700	fenestrated axe	54	0.44	13.10	0.16	1.34	0.05	0.01	0.11	<0.001	0.14	<0.03
299	MQ516	TM.78.Q.516	1750-1700	forniture	56	0.29	0.86	0.09	0.10	0.01	0.01	0.01	<0.001	<0.008	<0.03
300	M79Q343	TM.79.Q.343	1750-1700	fenestrated axe	66	0.10	2.86	0.85	10.50	0.05	0.03	<0.01	0.01	<0.008	0.09

Sample No.	Inv. No. Rome	Arch. Inv. No.	Date	Description	Cu wt%	As wt%	Sn wt%	Fe wt%	Pb wt%	Ni wt%	Zn wt%	Sb wt%	Co wt%	Ag wt%	Bi wt%
301	MQ343	TM.85.Q.343	1600-1200	dagger	72	0.32	4.96	0.15	0.07	0.04	0.01	0.00	0.01	0.03	<0.03

Amarna copper-based artefacts analysis												
Sample No.	**Ashmolean Museum No.**	**Description**	**Cu wt%**	**As wt%**	**Sn wt%**	**Fe wt%**	**Ni wt%**	**Zn wt%**	**Sb wt%**	**Co wt%**	**Au wt%**	**Ag wt%**
302	1890.305	small knife	96	0.22	2.74	0.26	0.03	-	0.001	0.005	0.007	0.005
303	1921.1129	axe with binding	91	0.43	8.53	0.12	0.07	-	0.027	0.008	0.009	0.011
304	1921.1131	hoe	87	0.33	12.71	0.11	0.03	-	0.013	0.006	0.001	0.007
305	1921.1132	awl	89	0.31	10.45	0.13	0.06	-	0.019	0.043	0.001	0.011
306	1921.1150	stud	84	0.23	15.16	-	0.03	-	0.018	0.009	0.001	0.004
307	1924.77	knife (dagger)	88	0.12	11.43	0.11	0.02	-	0.004	0.004	0.029	0.028
308	1924.81	small chisel	93	0.49	6.25	0.18	0.08	-	0.039	0.004	0.006	0.021
309	1924.82	awl/chisel	93	0.49	6.94	0.17	0.03	0.004	0.026	0.006	0.010	0.013
310	1924.84	tongs with hands	92	0.39	7.51	0.19	0.05	-	0.025	0.008	0.097	0.072
311	1925.413	hook (bent awl?)	90	0.53	8.78	-	0.05	-	0.036	0.008	0.003	0.034
312	1927.4104A	situla fragments	89	0.26	10.63	0.28	0.02	-	0.015	0.005	0.001	0.003
313	1927.4104B	situla fragments	88	0.22	11.23	0.24	0.02	0.002	0.007	0.011	0.001	0.003
314	1931.487	knife	90	0.33	9.21	0.23	0.04	-	0.020	0.012	0.013	0.012
315	1933.1209	horse bit	91	0.49	7.68	-	0.08	-	0.022	0.008	0.028	0.030
316	1934.267	small knife	90	0.54	9.34	0.15	0.05	0.004	0.038	0.008	0.031	0.037
317	1935.595	chisel	87	0.22	12.91	0.32	0.04	-	0.023	0.005	0.005	0.011

Appendix 9. Iron artefacts analysis

Kaman Kalehöyük and Kaneš iron artefacts, ores and slags

Sample No.	Reference	Ref. No.	Site	Level / Date	Method	Descrption	State
318	Akanuma 2008, table 2	2008_1Sa1	Kaman Kalehöyük	IVa (c. 2200-2030 BC)	ICP-OES	Fragment from a bar-shaped object	Corrosion
319	Akanuma 2002, table 2; Akanuma 2003, table 2; Akanuma 2007, table 2	2002_16; 2003_2; 2007_2Sa1	Kaman Kalehöyük	IIIc (c. 1930-1750 BC)	ICP-OES	Fragment	Corrosion
320	Akanuma 2002, table 2; Akanuma 2003, table 2; Akanuma 2005, table 3; Akanuma 2007, table 2	2002_17; 2003_3; 2005_Rf1; 2007_3Sa1	Kaman Kalehöyük	IIIc (c. 1930-1750 BC)	ICP-OES	Fragment	Corrosion
321	Akanuma 2002, table 2; Akanuma 2003, table 2; Akanuma 2005, table 3; Akanuma 2007, table 2	2002_18; 2003_4; 2005_Rf2; 2007_4Sa1	Kaman Kalehöyük	IIIc (c. 1930-1750 BC)	ICP-OES	Fragment	Corrosion
322	Akanuma 2002, table 2	2002_19	Kaman Kalehöyük	IIIc (c. 1930-1750 BC)	ICP-OES	Fragment	Corrosion
323	Akanuma 2005, table 2; Akanuma 2007, table 2	2005_2; 2007_1Sa1	Kaman Kalehöyük	IIIc (c. 1930-1750 BC)	ICP-OES	Fragment from a cutting-tool-shaped object	Corrosion
324	Akanuma 2003, table 2; Akanuma 2005, table 3	2003_1Sa1; 2005_Rf3Sa1	Kaneš	Ib (c. 1837-1715 BC)	ICP-OES	Fragment	Corrosion

Sample No.	Reference	Ref. No.	Site	Level / Date	Method	Descrption	State
325	Akanuma 2003, table 2; Akanuma 2005, table 3	2003_1Sa2; 2005_Rf3Sa2	Kaneš	Ib (c. 1837-1715 BC)	ICP-OES	Fragment	Corrosion
326	Akanuma 2005, table 2	2005_1	Kaman Kalehöyük	IIIb (c. 1700-1400 BC)	ICP-OES	Fragment from a nail-like object	Corrosion
327	Akanuma 2005, table 2	2005_3	Kaman Kalehöyük	IIIb (c. 1700-1400 BC)	ICP-OES	Fragment from a bar-shaped object	Corrosion
328	Akanuma 2003, table 2; Akanuma 2005, table 3	2003_15; 2005_Rf5	Kaman Kalehöyük	III (c. 1930-1200 BC)	ICP-OES	Fragment	Corrosion
329	Akanuma 2003, table 2	2003_16	Kaman Kalehöyük	III (c. 1930-1200 BC)	ICP-OES	Fragment	Corrosion
330	Akanuma 2005, table 3	2005_Rf4Sa1	Kaman Kalehöyük	III (c. 1930-1200 BC)	ICP-OES	Knife	Corrosion
331	Akanuma 2005, table 3	2005_Rf4Sa2	Kaman Kalehöyük	III (c. 1930-1200 BC)	ICP-OES	Knife	Corrosion
332	Akanuma 2005, table 2	2005_4	Kaman Kalehöyük	III-IId (c. 1930-800 BC)	ICP-OES	Fragment	Corrosion
333	Akanuma 2004, table 2	2004_2	Kaman Kalehöyük	IIIb-IId (c. 1700-800 BC)	ICP-OES	Fragment	Corrosion
334	Akanuma 2004, table 2	2004_5	Kaman Kalehöyük	IIIb-IId (c. 1700-800 BC)	ICP-OES	Fragment	Corrosion
335	Akanuma 2003, table 2	2003_6	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Fragment	Corrosion
336	Akanuma 2003, table 2	2003_8	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Fragment	Corrosion
337	Akanuma 2003, table 2	2003_9	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Fragment	Corrosion
338	Akanuma 2003, table 2	2003_10	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Fragment	Corrosion
339	Akanuma 2003, table 2; Akanuma 2005, table 3	2003_17; 2005_Rf6	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Fragment of a bar-shaped implement	Corrosion
340	Akanuma 2005, table 2	2005_5	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Fragment from a spit-like object	Corrosion
341	Akanuma 2005, table 2	2005_6	Kaman Kalehöyük	IId (c. 1200-800 BC)	ICP-OES	Fragment from a knife-like object	Corrosion

Sample No.	Reference	Ref. No.	Site	Level / Date	Method	Descrption	State
342	Akanuma 2008, table 5	2008_2Sa1	Kaman Kalehöyük	IVa (c. 2200-2030 BC)	ICP-OES	Iron ore	-
343	Akanuma 2006, table 3	2006_1Sa1	Kaman Kalehöyük	IIIb (c. 1700-1400 BC)	ICP-OES	Iron ore	-
344	Akanuma 2004, table 3; Akanuma 2006, table 3	2004_1; 2006_Rf18	Kaman Kalehöyük	IIIb-IId (c. 1700-800 BC)	ICP-OES	Iron ore	-
345	Akanuma 2004, table 3	2004_3	Kaman Kalehöyük	IIIb-IId (c. 1700-800 BC)	ICP-OES	Ore	-
346	Akanuma 2004, table 3	2004_4	Kaman Kalehöyük	IIIb-IId (c. 1700-800 BC)	ICP-OES	Ore	-
347	Akanuma 2007, table 3	2007_5Sa1	Kaman Kalehöyük	IIIc (1930-1750 BC)	ICP-OES	Iron slag	-
348	Akanuma 2003, table 3	2003_13	Kaman Kalehöyük	IIIa-IId (c. 1400-800 BC)	ICP-OES	Slag	Corrosion

Kaman Kalehöyük and Kaneš iron artefacts, ores and slags analysis

Sample No.	Fe wt%	Cu wt%	Ni wt%	Co wt%	Mn wt%	P wt%	Ti wt%	Si wt%	Ca wt%	Al wt%	Mg wt%	As wt%	Sb wt%	Sn wt%	Pb wt%	Zn wt%	Bi wt%	Au wt%	S wt%
318	63.85	0.02	0.002	0.0001	0.017	0.12	0.343	2.51	0.555	0.992	0.145	0.01	<0.01	-	-	-	-	-	-
319	51.47	0.002	0.002	0.001	0.01	0.21	0.099	4.55	0.445	1.32	0.24	-	-	-	-	-	-	-	-
320	70.52	0.082	0.002	0.006	0.004	0.06	0.003	0.76	0.052	0.067	0.03	-	-	-	-	-	-	-	-
321	69.36	0.041	0.003	0.007	0.007	0.11	0.004	0.83	0.337	0.104	0.049	>0.1	-	-	-	-	-	-	-
322	62.16	0.33	0.095	0.015	0.002	0.08	0.003	0.73	0.78	0.041	0.140	-	-	-	-	-	-	-	-
323	59.54	0.062	0.013	0.011	0.013	0.036	0.013	1.35	0.493	0.128	0.168	>0.1	-	-	-	-	-	-	-
324	53.94	5.34	0.006	0.149	<0.001	<0.01	<0.001	1.08	0.60	0.031	0.044	-	-	-	-	-	-	-	-
325	52.19	8.77	0.008	0.192	<0.001	<0.01	<0.001	0.65	0.137	0.003	0.061	-	-	-	-	-	-	-	-
326	30.30	0.011	0.003	0.005	0.255	0.262	0.172	14.1	4.97	3.07	0.541	-	-	-	-	-	-	-	-
327	62.77	0.002	0.035	0.028	0.004	0.056	0.007	0..26	1.1	0.007	0.153	-	-	-	-	-	-	-	-
328	66.60	0.362	0.133	0.033	0.002	<0.01	<0.001	0.83	0.392	0.015	0.059	-	-	-	-	-	-	-	-
329	65.48	0.068	0.009	0.009	0.004	0.16	0.001	1.49	0.282	0.078	0.102	-	-	-	-	-	-	-	-
330	61.05	0.023	0.007	0.015	0.004	0.056	0.007	0.75	0.397	-	-	-	-	-	-	-	-	-	-
331	57.74	0.017	0.008	0.014	0.005	0.081	0.007	1.11	0.326	-	-	-	-	-	-	-	-	-	-
332	62.40	0.07	0.014	0.007	0.004	0.015	0.004	0.22	0.226	0.022	0.028	-	-	-	-	-	-	-	-
333	60.53	<0.001	<0.001	<0.001	0.029	0.21	0.004	1.42	0.423	0.237	0.097	-	-	-	-	-	-	-	-
334	20.75	0.002	<0.001	<0.001	0.018	0.18	0.261	12.8	0.349	3.09	0.119	-	-	-	-	-	-	-	-
335	52.17	0.004	0.024	0.013	0.020	1.07	0.050	3.68	0.701	0.900	0.233	-	-	-	-	-	-	-	-
336	64.18	0.004	0.178	0.056	0.012	0.17	0.003	0.92	0.810	0.060	0.129	-	-	-	-	-	-	-	-
337	66.15	0.076	0.098	0.035	0.006	0.32	0.001	0.62	0.177	0.059	0.065	-	-	-	-	-	-	-	-
338	69.70	0.045	0.002	0.036	0.003	<0.01	<0.001	0.36	0.026	0.037	0.018	-	-	-	-	-	-	-	-
339	54.13	0.033	0.001	0.001	0.018	0.75	0.050	3.64	1.24	0.807	0.278	-	-	-	-	-	-	-	-
340	60.90	0.095	0.297	0.031	0.005	0.105	0.043	2.28	0.247	0.466	0.116	-	-	-	-	-	-	-	-

Sample No.	Fe wt%	Cu wt%	Ni wt%	Co wt%	Mn wt%	P wt%	Ti wt%	Si wt%	Ca wt%	Al wt%	Mg wt%	As wt%	Sb wt%	Sn wt%	Pb wt%	Zn wt%	Bi wt%	Au wt%	S wt%
341	57.18	0.038	0.01	0.003	0.004	0.049	0.006	0.80	0.137	0.134	0.074	-	-	-	-	-	-	-	-
342	67.58	0.004	0.001	<0.001	0.004	0.04	0.127	0.61	0.051	0.455	0.023	<0.01	<0.01	-	-	-	-	-	-
343	67.61	0.004	<0.001	0.003	0.019	0.05	0.011	0.82	0.118	0.164	0.037	0.01	<0.01	-	-	-	-	-	-
344	51.81	0.772	0.003	0.196	0.003	<0.01	0.004	3.16	0.603	0.241	0.346	0.23	<0.01	<0.01	<0.01	0.003	<0.01	<0.01	0.081
345	17.83	0.001	0.001	0.001	0.008	0.32	0.09	23.8	0.566	1.8	0.096	0.06	<0.01	<0.01	<0.01	<0.001	<0.01	<0.01	1.49
346	5.24	5.18	0.002	0.01	0.006	<0.01	<0.001	34.8	0.429	0.128	0.229	0.06	<0.01	<0.01	0.01	0.025	0.25	<0.01	-
347	37.52	<0.001	0.048	0.018	0.099	0.41	0.057	5.65	4.22	0.938	0.642	-	-	-	-	-	-	-	-
348	56.91	0.221	0.013	0.024	0.020	0.37	0.036	3.90	0.636	0.634	0.277	-	-	-	-	-	-	-	-

			Egyptian and Syrian iron artefacts			
Sample No.	**Object No.**	**Reference**	**Site**	**Date**	**Method**	**Description**
349	Petrie Museum UC10738	Rehren *et al*. 2013	Gerzeh, Egypt	late 4th mill. BC	PGAA	bead
350	Petrie Museum UC10739	Rehren *et al.* 2013	Gerzeh, Egypt	late 4th mill. BC	PGAA	bead
351	Petrie Museum UC10740	Rehren *et al*. 2013	Gerzeh, Egypt	late 4th mill. BC	PGAA	bead
352	Manchester Museum 5303	Johnson et al. 2013	Gerzeh, Egypt	late 4th mill. BC	SEM-EDS	bead: average on three measurements
353	-	Bilal 2014; Jambon 2017	Umm el-Marra, Syria	2300-2000 BC	pXRF	pendant: average on nine measurements
354	National Museum of Aleppo M10127	Bilal 2014; Jambon 2017	Ugarit, Syria	1450-1350 BC	pXRF	axe blade: average on ten measurements
355	EMC JE61585	Comelli *et al.* 2016	Thebes, Egypt	1334-1325 BC	pXRF	dagger blade
356	EMC JE62385	Ströbele *et al*. 2016	Thebes, Egypt	1334-1325 BC	pXRF	bracelet
357	EMC JE61869	Ströbele *et al*. 2016	Thebes, Egypt	1334-1325 BC	pXRF	miniature headrest

Egyptian and Syrian iron artefacts analysis														
Sample No.	**Fe wt%**	**Ni wt%**	**Co wt%**	**Na wt%**	**Mg wt%**	**Al wt%**	**Si wt%**	**P wt%**	**S wt%**	**Cl wt%**	**K wt%**	**Ca wt%**	**Ti wt%**	**Mn wt%**
349	50.2	3.55	0.203	0.13	0.66	0.18	1.5	0.8	0.2	0.709	0.028	0.48	0.016	0.023
350	48.7	4.1	0.237	0.23	<0.2	0.31	3.0	0.6	0.2	0.625	0.077	0.55	0.047	0.016
351	48.5	2.75	0.17	0.2	0.46	0.1	1.3	1.0	0.2	0.806	0.08	0.67	0.009	0.05
352	47.5	4.77	0.6	0.5	0.5	0.1	0.8	0.5	0.2	1.0	-	0.6	-	-
353	94.5	2.13	0.5	-	-	-	-	-	-	-	-	-	-	-
354	86.82	4.33	0.47	-	-	-	-	-	-	-	-	-	-	-
355	88.57	10.8	0.58	-	-	-	-	-	-	-	-	-	-	-
356	90.03	8.03	0.49	-	-	-	-	-	-	-	-	-	-	-
357	90.51	8.76	0.47	-	-	-	-	-	-	-	-	-	-	-

Chronology

This chronological table uses the Middle Chronology of the Near East.

Egyptian chronology follows Hornung *et al.* 2006.

Anatolian chronology is according to Schachner 2012.

Mesopotamian chronology follows Van de Mieroop 2004 and Aruz *et al*. 2008.

Periods and kings listed are only those relative to this research.

Egypt		**Mesopotamia**		**Anatolia**		**Ugarit**
Early Dynastic	c. 2900-2545 BC					
Old Kingdom	c. 2543-2120 BC	Early Dynastic III	c. 2600-2350 BC			
First Intermediate Period	c. 2118-1980 BC	Ur III	c. 2112-2004 BC			
		MBA	c. 2000-1600 BC	MBA I	c. 2000-1720/00 BC	
Middle Kingdom	c. 1980-1760 BC	Old Assyrian Period	c. 1920-1740 BC	*kārum* Kaneš II	- c. 1840 BC	
12th Dynasty	c. 1939-1760 BC			*kārum* Kaneš Ib	- c. 1715 BC	
		Old Babylonian Period	c. 1894-1595 BC			
Second Intermediate Period	c. 1759-1539 BC			MBA II	c. 1650-1530 BC	

Egypt		**Mesopotamia**		**Anatolia**		**Ugarit**	
New Kingdom	c. 1539-1077 BC	LBA	c. 1600-1200 BC	LBA	c. 1530-1180 BC		
18th Dynasty	c. 1539-1292 BC	Kassite Period	c. 1595-1155 BC				
Ahmose I	c. 1539-1515 BC						
Tuthmose III	c. 1479-1425 BC						
Hathsepsut	c. 1479-1458 BC						
Amenhotep III	c. 1390-1353 BC	Kadašman-Enlil I (Babylonia)	c. 1370-1359 BC				
Amenhotep IV (Akhenaten)	c. 1353-1336 BC	Burna-Buriaš II (Babylonia)	c. 1359-1333 BC	Šuppiluliuma I	c. 1344-1322 BC	Niqmaddu II	c. 1353-1318 BC
		Tušratta (Mitanni)	c. 1365-1330? BC				
Smenkhkare	c. 1336-1334 BC						
Tutankhamun	? - 1324 BC						

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