Univerzita Karlova, Filozofická fakulta, Český egyptologický ústav

Disertační práce

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Společenský kontext mědi ve starověkém Egyptě do konce Střední říše

The social context of copper in Ancient Egypt down to the end of Middle Kingdom

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Školitel: Prof. Mgr. Miroslav Bárta, Dr.

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Prohlášení

Prohlašuji, že jsem disertační práci vypracoval samostatně, že jsem řádně citoval všechny použité prameny a literaturu a že práce nebyla využita v rámci jiného vysokoškolského studia či k získání jiného nebo stejného titulu.

Martin Odler

Abstrakt

Předmětem doktorské práce je rekonstrukce *chaîne opératoire* mědi ve starověkém Egyptě od počátků výskytu ve 4. tisíciletí před Kr. do konce Střední říše. Měď byla kovem nejčastěji používaným ve staroegyptské společnosti, její studium nabízí statistická „velká data“, jinak často nedostupná pro starověké kultury. V práci jsou postupně analyzovány tři velké skupiny historických pramenů: písemné a ikonografické prameny, archeologické prameny (materiální kultura, tj. artefakty) a archeometalurgické prameny, rozděleny do několika následných fází *chaîne opératoire*.

Měď se ve studovaných obdobích nazývala *bjꜣ*, výslovnost [byr], zatímco pro tzv. asijskou měď a *ḥsmn* je navržena interpretace jako arsenová měď s nízkým, resp. vysokým obsahem arsenu. Ve Střední říši začal termín *ḥsmn* označovat také cínový bronz. Slovo pro tavící tyglík bylo *bḏ*(*.t*) a řemeslnou specializaci metalurga i kováře označoval pojem *bḏ.ty*. Pro sledovaná období neexistuje podstatný důkaz pro současné egyptologické čtení mědi jako *ḥm.t* a metalurga a kováře jako *ḥm.ty*; obě tato čtení jsou chybná.

Měděné artefakty jsou v práci pojednány jako pramen sériové povahy, u něhož lze studovat pravidelnost tvarů. 2253 archeologických kontextů bylo do studie zahrnuto a některé artefakty jsou výjimečně početné: 1597 čepelí dlát, 1231 čepelí seker, 1097 nádob, 1025 čepelí teslic, 611 zrcadel. Srovnání rozměrů artefaktů se známými staroegyptskými délkovými mírami nicméně ukazuje neočekávaný přístup k regularizaci rozměrů, protože zjištěné rozměry jsou většinou kratší než tyto míry. Toto pozorování se týká nejen artefaktů, které se prakticky užívaly a používáním postupně zkracovaly (dláta, teslice, sekery, pilky), ale i artefaktů, jež si zachovaly své původní rozměry od momentu vytvoření (zrcadla, nádoby).

Ze sledovaných období bylo analyzováno celkem 962 artefaktů a zlomků rudy, některé z nich opakovaně; ukazujeme ovšem, že uvedený počet představuje pouze zlomek celkově známých artefaktů. I tento zlomek však poskytuje statisticky významný vzorek, jenž prokazuje užívání arsenové mědi jako hlavní slitiny pro praktické nástroje a zbraně ve sledovaných obdobích, v době Střední říše s postupným příchodem cínového bronzu, který se v této době používal zároveň s arsenovou mědí (i když staří Egypťané znali cínový bronz již dříve – používal se na výrobu nádob). Měděná ruda pocházela zejména z Východní pouště a Sinaje, v řídkých případech pak i z jiných oblastí (Feinán, Anatolie). Za uvedení cínového bronzu do Egypta nejsou odpovědní pouze tzv. „Hyksósové“; zdá se, že kyperské zdroje hrály důležitou úlohu již ve střední době bronzové. Jako hlavní problém současného stavu bádání je identifikován nedostatek analýz izotopů olova týkající se rud i artefaktů a rovněž nedostatek

analýz artefaktů samotných, které by se zaměřovaly nejenom na původ rud a chemické složení, ale také na způsoby jejich výroby.

Klíčová slova: měď, arsenová měď, cínový bronz, starověký Egypt, starověká Núbie; chaîne opératoire, egyptologie, egyptská archeologie, archeometalurgie, raná doba bronzová, střední doba bronzová

Abstract

The subject of the doctoral thesis is a reconstruction of the *chaîne opératoire* of copper in ancient Egypt from its earliest occurrence in the fourth millennium BC until the end of the Middle Kingdom. As copper was the metal most widely used in ancient Egyptian society, its study can offer statistical "big data" otherwise rarely available for ancient cultures. Three large groups of sources are discussed successively: written and iconographic sources, archaeological sources (material culture, i.e. artefacts), and archaeometallurgical sources, divided into several consecutive stages of the *chaîne opératoire*.

Copper was named *bjꜣ* and read [byr] in the periods under study, while an interpretation as arsenical copper with a low and high content of arsenic, respectively, is proposed for so-called Asian copper and *ḥsmn*. In the Middle Kingdom, the term *ḥsmn* begun to be used also for tin bronze. The word for crucible was *bḏ*(*.t*) and the word for metalworker (incorporating both metallurgists and smiths) was *bḏ.ty*. There is no substantial Egyptian evidence from the periods under study for the current Egyptological reading of copper as *ḥm.t* and metalworker as *ḥm.ty*, which are both mistaken.

Copper artefacts are treated as a source of a serial nature in the thesis, demonstrating regularization of their shapes. 2,253 archaeological contexts were included in the study. Some of the artefact categories are quite numerous: 1,597 chisel blades; 1,231 axe blades; 1,097 vessels; 1,025 adze blades, 611 mirror discs. A comparison of the dimensions of the artefacts to known ancient Egyptian measures of length shows an unexpected regularization of these measures, with dimensions being usually shorter than the expected ancient Egyptian value. This is true not only of artefacts that were practically used and gradually shortened by use (chisels, adzes, axes, saws) but also of artefacts that presumably retained their original size from the moment of production (mirrors, vessels). Although 962 artefacts and ore pieces have been analysed from the periods under study, some of them repeatedly, it is shown that this is only a fraction of the total counts of the objects. Yet even this fraction gives a statistically significant sample of the analyses, establishing the use of arsenical copper as the main alloy for practically used tools and weapons in the periods under study, with the gradual advent of tin bronze, used side by side with arsenical copper, during the Middle Kingdom (although ancient Egyptians had known tin bronze before and used it for the production of vessels). The material was coming predominantly from Eastern Desert and Sinaitic mining regions, and seldom from elsewhere (Feynan, Anatolia). The so-called “Hyksos” are not solely responsible for the introduction of tin bronze in Egypt; it seems that Cypriot sources played an important role already in the Middle Bronze Age. The lack of a significant number of lead isotope analyses of ores and artefacts and the lack of a significant number of analyses of the artefacts themselves going beyond the present-day focus solely on the provenance and chemical composition are identified as the main problems of the current state of research.

Keywords: copper, arsenical copper, tin bronze, ancient Egypt, ancient Nubia; chaîne opératoire, Egyptology, Egyptian archaeology, archaeometallurgy, Early Bronze Age, Middle Bronze

Contents

0. Introduction

Once, at a conference about early copper metallurgy, someone in the informal discussion summarized the current opinion of archaeometallurgical specialists on the research of ancient Egyptian metallurgy: "Egypt is a black hole".[1] I cannot think of a better dictum for this work, with its aim to virtually break this spell and show the possibilities of a contextual study of metals in ancient Egypt on the example of copper. The objective of the thesis is to present a narrative, a synchronic and diachronic reconstruction of the development and changes of the *chaîne opératoire* of copper or copper alloy artefacts based on the preserved evidence. The means to that end include various sources – textual, iconographic and palaeographic, archaeological (i.e. material culture) and scientific (analyses of ores and artefacts). By their collection and analysis using the methods of relevant subdisciplines of Egyptology and Egyptian archaeology, a synthesis of the current state of knowledge will be pieced together in the conclusion of this thesis. Prospects of further research will be delineated, and open questions posed. What is new here is an ordering of the text based on the principle of the *chaîne opératoire*, of the inevitable processing of copper as a material, inside the chapters divided by the categories of sources (textual, with iconographic and palaeographic; archaeological, i.e. material culture; and scientific). Although ancient Egyptians included all ores and semiprecious stones in the category of *ꜥꜣ.t*, they knew what they needed to do to the ore in practice in order to produce the metal. By organizing our work according to the principle of the *chaîne opératoire*, we can identify what the sources tell us and what they do not.

The chronology of the thesis is delimited on the one side by the earliest occurrence of copper artefacts in the Badarian culture and on the other by Dynasty 13, in order to examine Egyptian and Nubian copper or copper alloy material culture before the impact of the so-called "Hyksos" material culture. The chorological limits are set by the extent of the ancient Egyptian and ancient Nubian predynastic and dynastic cultures in the defined period. Previous attempts are either largely outdated or based only on a selected part of the evidence.[2] A complete picture of copper extraction, production, use and reuse is lacking. This long period of time can be perceived as an era of a single technology characterized by several common

[1] This was indeed expressed in print as well: "Egypt and Nubia are thus black holes in the archaeometallurgical universe." (Killick 2013, 540).
[2] Outdated, but still useful is (Lucas and Harris 1962). Monographs on particular pieces of evidence are e.g. expedition graffiti in (Eichler 1993) or the Pyramid Texts in (Lalouette 1979). There are many omissions also in (Ogden 2000).

traits such as the use of arsenical copper for practical purposes, the use of so-called small crucibles with a volume of c. 1 litre and, generally, a rather small scale of the craft.

The thesis consists of two main components: the text itself and appendices (maps, charts, tables). The subject is defined in detail in Chapter 1; Chapter 2 presents a "toolbox" of analytical terms used further in the thesis. Chapter 3 presents the bibliographical essay with a summary of previous research and also a gazetteer of the sites important as the original context of the examined evidence. Open questions are dealt with in the three successive chapters, dealing with written and iconographic sources (Chapter 4), copper artefacts themselves (Chapter 5) and the archaeometallurgy of copper in the periods under study (Chapter 6). Chapter 7 presents a synthesis, organized chronologically and with references to the previous chapters. Chapter 8 compares the obtained knowledge of Egyptian metallurgy with neighbouring regions. The appendices gather and compare the evidence, while their content is discussed in the text.

If we try to examine the frequency of the word and its derivatives in the written sources, copper should be considered a marginal raw material down to the end of the Middle Kingdom. The ancient Egyptian economy was for the most part based on crop cultivation and processing, with "payments" provided mostly by in bread and beer. Crop processing required an independent "bureau" of administration – the "Granary". All other materials, including precious and base metals, were administered by another institution, the White House/Treasury – *pr ḥḏ*. According to the written sources, the main concern of ancient Egyptians in the Afterlife was to avoid hunger and thirst and to be clothed well. Yet in the same periods, there are hundreds of archaeological contexts containing complete or fragmentarily preserved copper artefacts. Interdisciplinary research combining approaches of archaeology with traditional methods of Egyptology is inevitable in order to properly understand the social role of copper in the periods under study.

Every bit of copper ore had to be brought to the Nile Valley; each metal object found within the historical boundaries of the Egyptian nomes was made from imported material. Copper was always "foreign", yet the demands of the culture forced Egyptians to gain it, mine it and use it on a large scale. The period of more than five millennia of documented use and reuse of copper is among the longest in the history of humankind. We can see how original ancient Egyptian technological solutions were implemented in practice and how, from time to time, foreign influence reshaped the material culture of Egypt. Ancient Egyptians were peculiar regarding their observation of material culture and its reflection in two-dimensional and three-dimensional art, including hieroglyphs. This peculiarity has no exact parallels in contemporary cultures. On the other hand, cuneiform texts provide far better information on the crafts and the handling of material culture than ancient Egyptian written sources. The most important evidence from ancient Egypt is visual; there is a wealth of sources dealing with the "techniques of the body" and the use of artefacts. From this clearly follows the importance of archaeometric analyses as a corrigendum of visual information with its interpretative limits. Yet this area is understudied in ancient Egyptian archaeology, the subject of case studies rather than bigger projects (this, of course, depends on the funding, but projects of a broader scope are desperately needed).

The blame for the lack of metal studies lays for the greatest part on the Egyptologists. Even the latest excavation reports from Egypt contain uncleaned corroded "lumps" of objects, and they are published as such. Archaeometallurgical investigation of the excavated artefacts is very rare. Other problems lie in communication: Egyptology retains a kind of pluralistic language approach. The recent important works on ancient Egyptian metallurgy and metal artefacts have been published in French and German.[3] English is only one of several important languages in Egyptology, not the sole one. In order to synthesize the knowledge, one cannot ignore literature published in other languages besides English.

The intended audience of this thesis could be divided into two groups. The first is comprised of Egyptologists and Egyptian archaeologists. A study of metal artefacts is one of the most underdeveloped fields in Egyptology. Most Egyptologists are not aware of the possibilities and limits of the study of metals (including copper) for a better understanding of ancient Egyptian economy and society in general. This thesis is designed as a case study, as a survey of these possibilities and limits, in order to show the archaeological and scientific side of research problems of the artefactual evidence which was deemed „*lückenhaft*"[4] and even too poor and meagre to be studied in detail in comparison with the written and iconographic sources.

In the second group are non-Egyptologist archaeologists and archaeometallurgists. Ancient Egyptian written sources may not offer such breath-taking detail about the *chaîne opératoire* of the metallurgy as ancient Mesopotamian written sources,[5] but detailed and complex study of ancient Egyptian sources could address several pertinent research questions of archaeology and archaeometallurgy in general, including the relationship between the written, iconographic and artefactual evidence, the emic and etic definitions of the artefacts,

[3] (Abd El-Raziq et al. 2011; Petschel 2011).
[4] (Eichler 1993, 15).
[5] (Limet 1960; Rouault 1977).

the (attached) craft specialization, the handling of material culture in early civilizations and the emic value of the materials (the value as perceived and expressed by material culture in the past societies, rather than by the archaeologists of the present). The possibilities and limits of the work with ancient Egyptian sources will be explained. In this regard, ancient Egypt has yet to offer many new insights into old problems.

1. Definition of the subject, contents, and limits of the thesis

1.1. Copper as a chemical element and raw material

Only the basic definition of copper is given herein, as a more detailed archaeometallurgical discussion is reserved for Chapter 6. Copper (Latin *cuprum*, chemical symbol Cu) is the chemical element with atomic number 29 in the periodic table of elements, relative atomic mass 63.546(3). It melts at 1084.62°C and has a density of 8960 kg/m^3. The colour is yellowish-reddish, a bright metallic lustre slowly tarnishes to a dull film in the moist air. Copper is otherwise resistant to atmospheric corrosion. It is included among precious metals, has a high thermal and electrical conductivity. Copper and its alloys are characterized by good malleability in a hot and cold state, weldability.[6]

Copper occurs in nature also in a pure state, as an aggregate. More frequently, copper is contained in dozens of minerals.[7] The two main groups of copper minerals are oxidic and sulphidic, the main difference being the chemical elements to which copper is bound in the chemical compounds – oxygen in oxidic minerals and sulphur in sulphides. Oxides were easier to reduce to metal using ancient technology. It was previously assumed that sulphidic ores were processed only in later periods, but the latest research shows that Chalcolithic and Early Bronze Age metallurgists of (not only) Eastern Mediterranean were able to obtain metal also from sulphidic ores.[8] The most important ancient mineral seems to be oxidic: malachite, chemical compound $CuCO_3$ $Cu(OH)_2$, it is a mineral of emerald green to dark green colour.[9] Malachite was the main source of copper ore and green pigment in the Antiquity but by no means the only one.

The copper deposits known at present are not identical with the sources used in the Antiquity. Many of them were depleted in the past, predominantly those containing ore with a higher percentage of copper. Ores with less and less copper are mined over the course of time, but the expenses are lower as well.[10] Globally, the five largest copper exporters in 2017 were Chile, Peru, Australia, Indonesia and Canada, and the importers were China, Germany, United States, Italy and Taiwan.[11]

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[6] (Bowen and Gunatilaka 1977, 1; Cardarelli 2008, 179–187).
[7] (Bowen and Gunatilaka 1977, passim, detailed list on pp. 345-351; Arndt and Ganino 2012, 21–23).
[8] (Bourgarit 2007; Killick 2014).
[9] (Bowen and Gunatilaka 1977, 350).
[10] (Bowen and Gunatilaka 1977, 1–2).
[11](Arndt and Ganino 2012, 19–42, Fig. 2.2c). Data for 2017, http://www.worldsrichestcountries.com/top-copper-importers.html for importers and http://www.worldstopexports.com/copper-ore-exports-by-country/ for exporters, pages last accessed on 8th May 2019.

One of the greatest errors done in the past and sometimes even at present (not only) in the field of Egyptology and Egyptian archaeology is an assumption that the type of copper alloy – copper with impurities, arsenical copper, tin bronze or some peculiar alloy such as arsenical copper with nickel – can be distinguished by naked eye. The literature of the past two hundred years is full of baseless claims about the material, which are only gradually being corrected by analyses. Data from past literature therefore have to be cited with this in mind and corrected if later analyses have proved the use of other materials.[12]

1.2. Society and social context

The term "society" seems to be self-explanatory: if it occurs in the title of an article, it does not have to be explained in the text.[13] Ancient Egyptian society in the periods defined below could be described and defined, at least for the Middle Kingdom, either in the words of the Loyalist teaching, or on the background of the experience described (or imagined?) the Tale of Sinuhe.[14] The ideas presented in those texts, formulated based on long experience, are valid also for the notions of Egyptian social and cosmic order.[15] The subject of the present research is rather a controlled effort of the elite aimed at the creation of this identity; the non-elite is non-existent beyond archaeology, and even archaeology rather focuses on the elite representation(s).[16] It seems that in the periods under study, anyone who lived in the land of Egypt was able to communicate in Egyptian and accepted Egyptian habits could be a member of "society". Egyptian self-identity was also perceived in contact with foreign people who sometimes lived in Egypt in those times.[17]

Ancient Nubian society is mostly perceived through the prism of Egyptian sources, even the iconographic evidence from A-Group Sayala or Qustul is doubted as a representation of the Nubian perception. Leaving aside this question of art history, A-Group and C-Group are clearly discernible, and the Nubians can be distinguished as such in Egyptian iconographic and written sources.[18] Moreover, the "Kerman" – Kushite (*kꜣš*, as named by Egyptians) identity, apparently differing from both Egyptian and C-Group (Lower) Nubian, was created at least in the Middle Kingdom. While Kerman material culture, including copper, can be distinguished, A-Group and C-Group copper objects were almost usually labelled as imports.

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[12] As in the study of the objects in KHM (Odler et al. 2018).
[13] As in (Baines and Lacovara 2002).
[14] (Parkinson 2009, 21–53, 235–245).
[15] (Baines and Yoffee 1998; Lehner 2000, 318–321).
[16] (Kemp 1991, 1–107).
[17] (Valbelle 1990b).
[18] (Zibelius-Chen 1988; Raue 2019).

One of the aims of this thesis is to reassess this problem, returning to the items themselves and their scant analyses.

The "return to things" movement in the social sciences and humanities, including archaeology, can be followed at least since 1986.[19] The rather conservative term "social context" is preferred in the title of the thesis, as it is more comprehensible in modern Egyptology and Egyptian archaeology. The term "social context(s)" is used also in contemporary archaeological literature, as a relational embedding and networking of things and materials in society.[20] The popular use of the term "biography" of objects rather neglects the archaeometallurgical side of the problem, the need for thorough scientific examination of the artefact. I am also aware of the concept of entanglement,[21] but I prefer to use the older and more widely understandable term. Entanglement as a recent concept is not yet frequently used in Egyptian archaeology (see below).

1.3. Chorology and chronology

The geographical areas under study are Egypt and Nubia in their ancient borders.[22] In justified cases, evidence out of these traditional borders is also included, predominantly from the Eastern Desert and Sinai (which were not considered parts of Egypt by ancient Egyptians themselves) but also from more distant regions of the ancient Near East.

The periods examined in this work include the Badarian and Naqada cultures (with the doubtful existence of the Maadi/Buto culture[23]) and the following historical periods: Early Dynastic, Old Kingdom, First Intermediate and Middle Kingdom (Figure 1.1). Middle Kingdom is included until the Dynasty 13, thus the site most affected is Tell el-Dab^{c}a, where 132 contexts are included, down to the stratum E/3, while others, from the Hyksos rule itself are omitted.[24] Similar split is applied to omitted Theban and Abydene graves of the Dynasty 17, clearly out of the scope herein. The author realizes that often the dating is only preliminary and will be subject to further revisions.[25]

For Nubia, the contemporary archaeological cultures are A-Group, C-Group and in justified cases the so-called pre-Kerma and Kerma culture. Since Kerman material culture was demonstrably different from the ancient Egyptian metalwork, some artefacts in the Kerman

[19] (Appadurai (Ed) 1986).
[20] E.g. (Hodder 2012, 3, 33).
[21] (Hodder 2012, 2016).
[22] As presented e.g in the atlas of ancient Egypt and Nubia: (Baines and Málek 1996). For Nubia itself, see also (Hofmann 1967).
[23] (Köhler 2014b).
[24] (Philip 2006).
[25] On the questions of chronology e.g. (Müller 2018).

contexts can be identified as Egyptian “imports”. Second comparative group included in the scope are Kerman objects that were analysed for their chemical composition and lead isotopes. As an “out-group” comparison, they help to assess the results of the analyses of contemporary Egyptian copper artefacts.

1.4. Thesis in the context of archaeological theory

The thesis aims predominantly at a complex description of the use of copper by ancient Egyptians and Nubians with an objective to better understand the emic perspective of the past society and people. Useful analytical tools the archaeological theory provides will be used throughout, but I wonder what ancient people would think about some of these approaches and whether sometimes the researchers may purposefully tweak the evidence to suit the analytical tools.

I would include the thesis in the period of “postmodern synthesis” when no school is unequivocally prevailing.[26] Nonetheless, I must define affinities. The first is a negative one: like others, I find it difficult to use any of the modern approaches that are called “materiality” in British archaeological literature.[27] Likewise, Egyptological attempt of application of the “Actor-Network-Theory” claims that many pieces of evidence that will be examined in the analytical chapters, and directly speak about ancient Egyptian knowledge of the use of copper and its context, simply do not exist.[28]

The concept of the entanglement of humans and things is important in this thesis for two notions:[29]: the human society depends also on the time and existence of things, including the processing of metals. These activities represent a delayed return of an investment of time and effort, and only a strong social structure enables large-scale procurement and processing of metal (it is up to the evidence to show whether this was based on a permanent or temporary specialization). In this respect, ancient Egyptian society was very “modern”. Moreover, there is hardly any way back: the Egyptians needed copper and metals also in the intermediate periods of their history, which means that new ways of acquisition had to be tried if the expeditions were not possible. In the eras of unity and prosperity, arsenical copper and flint use were among the entanglements enabling the construction of pyramids. In the second work, I. Hodder widens the definition of “things” to involve also ideas, thoughts and institutions.[30]

[26] (Trigger 2009).
[27] As well as (Roberts and Thornton (Eds) 2014, 6).
[28] (Hawary 2018).
[29] (Hodder 2012).
[30] (Hodder 2016).

Nevertheless, even this approach might not bridge the great divide between the social and natural sciences.

Likewise, I cannot hide an affinity to evolutionary archaeology, as it focuses on the long-term change, which can be documented quite well and in detail on ancient Egyptian example.[31] However, as I perceive this thesis as a preparatory stage for a fully evolutionary study of particular artefact categories and classes, I will refrain from lengthier discussions of the issues connected with the evolution of material culture.

I would like to argue in this thesis that there is one overarching problem more important than the theoretical embedding of its approach: it is the manner in which we create and analyse data, the “anything goes” attitude that is frequently encountered in contemporary archaeology, which seriously hinders any meaningful synthesis of “big data” about the past. It does not matter if we label this data “Wild West” as social context, entaglement or object biographies, if we cannot pursue any meaningful statistics or comparison on large scale.

1.5. Categories of sources used

Textual sources represent texts written in hieroglyphic and hieratic scripts in the periods under study. The texts *per se* are also sources of iconography, as hieroglyphs depicted material culture. Very often, the texts are accompanied by iconographic depictions, two- and three-dimensional representations of past reality. Although all these sources are also present in material reality, after the publication of text, they often lose their material character in further Egyptological work. Archaeological sources are herein defined as material culture itself, objects that produced or bore the texts and produced other objects.[32] Sources provided by natural sciences are examined as additional layers of meaning and contextualizing, by means of analyses of the chemical composition and other properties of objects and materials.

1.6. Organization of the text

Ancient Egyptian material culture serves in the literature as evidence supporting or merely illustrating the written sources. This order is reversed in the thesis – written sources will be used to provide information on the handling of material culture in ancient Egypt, as only one of the sources important for the reconstruction of the *chaîne opératoire*. I will proceed from the traditional Egyptological evidence, i.e. texts, iconography, and palaeography. A text-based approach is typical of Egyptology.[33] However, it can be shown on the example of texts what

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[31] (O’Brien and Lyman 2000; Hodder 2012, 138–178).

[32] For the definition in Egyptological literature, see (Ikram 2014).

[33] As e.g. craft scenes of the Middle Kingdom, “they have hardly ever been studied making full use of the available spectrum of information, i.e., taking into account the pictorial as well as the textual levels of representation.” (Jurman 2018, 101). Material culture is then marginally mentioned, archaeometry is not at all.

kind of information they do not provide. Expedition inscriptions inform about the organization and participants of the expeditions. Mostly, they do not inform about the amount of the material gathered and the primary processing of the ore. None of the preserved texts deals with the metallurgical process itself, with the smelting, melting and the production of objects, with the exact processes of the *chaîne opératoire*. We must assume that the expertise on these processes was passed down from father to son in the craft. This practical knowledge was most probably outside the scope of the written culture of ancient Egypt. However, Emperor Diocletian allegedly commanded destruction of ancient Egyptian books on production of gold and silver in 290 AD, therefore some technical descriptions of metallurgy by ancient Egyptians must have existed.[34]

The archaeological chapter will be focused on archaeology *sensu stricto*, rather than on archaeology perceived as a part of art history. Archaeology thus means here the study of past material remains, i.e. material culture, not always intentionally produced. The biggest advances have been made in the research of the mining areas in the Eastern Desert, Sinai and Wadi Arabah. The thesis offers scope only for a compilation of recently published information regarding this research. However, the potential of these advances is yet to be shown to the Egyptologists in general. More attention is thus paid to the use and reuse of copper artefacts, to the latter part of the *chaîne opératoire*.

After that, I shall proceed to the evidence provided by the methods of archaeometallurgy, the study of the production and use of metals, in our case copper. The research has been hindered on one hand by a lack of the understanding of archaeometallurgical aspects of metals research by Egyptologists, on the other hand by a lack of understanding of particular and peculiar Egyptian evidence by archaeometallurgical specialists. Each bit of copper ore needed to be brought to the Nile Valley, each metal object found in the historical boundaries of Egyptian nomes was made from imported material. The potential concealed in this fact is clear: if all the objects found were analysed, it would be possible to identify all sources entering Egypt and describe their circulation within the system. The scientific methods speak their own scientific languages and Egyptologists need to understand the limits and possibilities of their approaches.

The data produced by natural sciences tend to be marginalized in the reconstruction of ancient Egyptian history, yet they offer largely unexplored datasets, revealing information not recorded in the written or iconographic sources. Rather surprisingly, almost each great past

[34] The reason behind the destruction was to impede the financing of uprisings against Roman rule (Schneider 1996, 168).

excavator (e.g. W. M. Flinders Petrie, J. Garstang, G. A. Reisner, G. Steindorff) was interested in the composition of metal finds and submitted at least one object for examination. What has changed since then mostly is the required size of sample diminished and the spectrum of methods is wider, as well as the spectrum of the questions that can be answered.

Natural sciences are not considered as "better" or "more scientific" in comparison with the approach of humanities, more specifically Egyptology or Egyptian archaeology. Natural sciences provide data that are interpreted in the current framework of the knowledge of the respective science; final historical interpretation needs to be done in a dialogue and mutual understanding with other sources, being it written, iconographic or material culture. Wealth of ancient Egyptian sources has a potential to explore the history in great detail, regardless of the most common paradigm of interpretation in current archaeological literature. Thus natural sciences and Egyptology can mutually benefit from cooperation, challenging current views based largely on traditionally used sources.

1.7. Organization of the appendices

The appendices contain figures, comprising tables, drawings, photographs, charts, plots, and maps. These appendices accompany the text and either provide or combine the evidence used in the analysis within the thesis, organized according to the stages of the *chaîne opératoire*, all sources used for the analysis are cited either in the text or in the appendices. The catalogue is not part of the printed version of the thesis, as it has several thousand entries for the contexts of the sources and particular artefacts. The catalogue of the thesis is based on two separately built databases in the proprietary software FileMaker, one containing archaeological and archaeometallurgical sources, the other comprising textual and iconographic sources. The structure of the catalogue was in detail described elsewhere.[35] The most important analytical units are the location of the source, and its chronological position. Geographical coordinates are very important part of the catalogue, as they enable mapping of the phenomena and they are also assessed in the regional framework (described in detail in Chapter 3).

1.8. Contents of the thesis in relation to author's previous research

I completed and defended my MA thesis at the Czech Institute of Egyptology in 2012.[36] Besides the material from Abusir excavations, the thesis was based only on information available in the literature, and the focus was on the Early Dynastic, Old Kingdom and First Intermediate Period, i.e. the third millennium BC. I was aware of the limits of this approach and in 2012–2014, I received funding for a documentation project of unpublished finds in

[35] (Odler 2016, 23–28).
[36] (Odler 2012).

European and American museums. Old Kingdom finds were by far the largest documented corpus in this project; its output was published as a monograph, much updated compared to the thesis text.[37] The two following projects aimed at a targeted study of the assemblages in ÄMUL and KHM. The information already published is cited whenever necessary, yet I endeavour to address some of the published issues anew in the present thesis.

I consciously avoid detailed discussion of issues that were already discussed in the master's thesis and the monograph. A new mathematical and statistical interpretation of data from the monograph is offered herein, in much broader context. I cannot claim to have deep expertise in archaeometallurgy; nevertheless, as Egyptologists, we need to understand the possibilities and limits of such studies, or we cannot engage in meaningful discussions with specialists in the relevant disciplines.

Leaving out topics covered in the previous texts, there are still unexplored possibilities of deepened understanding of ancient Egyptian use of copper. I am especially focusing on answering several "big" questions of the use of copper in ancient Egypt. In case of written sources what was the name of copper and its relation to practically used alloys, and its relation to the term for metalworker. In case of material culture, what were the metrological properties of objects. In case of the archaeometallurgy, it is important to gather the published information and assess what is for now missing in the available data.

[37] (Odler 2016).

2. General concepts and misconceptions

This thesis aims to get beyond the boundaries of Egyptology in the directions of archaeology, archaeometallurgy and the natural sciences. Some recurring problems will reappear in the handling of the evidence. These general problems need to be conceptualized and discussed in advance. This chapter aims to define a "toolkit" or "toolbox" of analytical approaches used to understand and explain the evidence.

The problems that arise in the communication are in two temporal directions: in communication with the past and in communication among contemporary specialists. First, archaeology is a sort of communication with a past culture, yet our knowledge of the past society is limited by the available sources, and the means of communication are limited as well. Luckily, we are able to perceive many aspects of ancient Egyptian culture in their own terms. Secondly, communication among contemporary disciplines is often difficult due to the existence of independent research traditions and specific research terms and concepts used to present research results. The chemical and physical reality of the ancient Egyptian world was not vastly different from the world we live in; metals and other substances have not changed since.

2.1. Data in Egyptian archaeology

It is almost obligatory for each work in Egyptian archaeology to warn of the selective preservation of ancient Egyptian culture and objects.[38] There are no standards concerning the data structure and contents published in Egyptology and especially in Egyptian archaeology. Even in the field of ancient Egyptian ceramology, in which researchers communicate new information efficiently, there are no set standards for each aspect and detail of a drawing and the archaeological data. This might seem impossible, and the general guidelines have to be specific concerning the information provided but not each particular detail.

Logical fallacies originating in the limited evidence have been pointed out: the "fallacy of negative proof" – the absence of evidence, the "elimination of evidence", the "fallacy of the lonely fact", and "canonized guesswork".[39] However, this exact article by Gee gives problematic reasoning about the wide availability of the afterlife before the end of the Old Kingdom, listing as first three proofs servant burials, sets for the Opening of the Mouth and offering lists, arguably approaches characteristic of the elite funerary equipment.

[38] E.g. (Ikram 2014, 178).
[39](Gee 2010).

In the thesis, I attempt to gather and count the available pieces of evidence and to gauge from these figures how well the past is represented and how well it has been studied. The structure of the data and database was described previously.[40]

2.2. Chaîne opératoire

The interest into the human production processes originated in the French anthropology with the observation of the body movements and their societal connotations and transmission through learning, by Marcel Mauss.[41] His pupil, archaeologist and ethnologist André Leroi-Gourhan, coined a term *chaîne opératoire*, initially applied to the relation of the technology and language.[42] The concept denotes the inevitable steps that are needed when working with materials, in order to produce artefacts, as also Leroi-Gourhan widened his definition later.[43]

In the case of copper, these steps would involve everything from the procurement of the ore to the use and reuse of objects made of that ore (Figure 2.1). These steps were inevitable; without them, the objects would not exist. This looks like a truism, but many Egyptologists just assume that the occurrence of ancient Egyptian objects is self-evident and apply contemporary measures of importance to ancient culture, deciding what is valuable and what is not. In that regard, we often ignore the perspective of ancient Egyptians on what is and is not important and what is interesting and remarkable in the material culture, even though it can often be inferred from the written and iconographic sources.

Earlier French approach distinguished between reflective knowledge (*connaissance*) and skills (*savoir faire*). It has been criticized because of the focus solely on the practical steps of the operations, disregarding their social context.[44] This was reflected in later French scholarship, with the assertion that technological choices might not be based on the material properties of objects or logical choices.[45] This is arguably one of the gravest reasons for the divide between archaeology and natural science. "Objectively" observed technological properties might not have been perceived by ancient Egyptian craftsmen.

More recent approaches distinguish knowledge (the mental representation), ideational know-how (the practical sequence of production, material comparison) and motor know-how

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[40] Odler (2016).
[41] (Mauss 1973), originally published in 1935.
[42] (Leroi-Gourhan 1964, 164): „La technique est à la fois geste et outil, organisés en chaîne par un véritable syntaxe qui donne aux séries opératoires à la fois leur fixité et leur souplesse. La syntaxe opératoire est proposée par la mémoire et naît entre le cerveau et le milieu matériel. Si l'on poursuit le parallèle avec le langage, le même processus est toujours présent. On peut, par conséquent, fonder sur la connaissance des techniques depuis la pebble-culture jusqu'à l'Acheuléen l'hypothèse d'un langage dont le degré de complexité et la richesse de concepts soient sensiblement les mêmes que pour les techniques."
[43] (Leroi-Gourhan (Ed) 1988, 1030).
[44] (Skibo and Schiffer 2008; Hodder 2012, 53–54).
[45] (Lemonnier 1986, 154–156).

(intuitive operations).[46] The *chaîne opératoire* approach is updated with the so-called behavioural chains, involving also actions that might not be inferred from the physical or chemical properties of the material.[47] It is also argued that while the *chaîne opératoire* ended with the completion of the artefact, "behavioural chains" include all phases of its life cycle.[48] B. Ottaway even included to the process the generation of the archaeological information and knowledge (Figure 2.2).[49]

Another result of the *chaîne opératoire* is the path-dependency of the previous decisions.[50] Ancient Egyptians knew tin bronze alongside arsenical copper, yet they preferred the latter. This particular strategy prevailed, and the evolution of material culture was historically embedded in the past decisions the Egyptians made based on the existing variability.

In Egyptology, S. Quirke called for an "analytical description of the relevant chain of production", but this task was being left to the "historians of technology."[51] I think it is also a research question for Egyptology itself and we cannot shun from the technological aspects of the production of materials. For the purposes of this thesis, the life cycle of an artefact is understood broadly from the procurement of the ore to its final deposition or recycling of scrap metal, depending on the use of the tools and hardware. Four main stages, as defined for thesis, are procurement, initial processing and transport of ore; storage of copper, revenues and transactions with it without a specification; melting and production of copper objects, in connection with metalworkers; and, finally, use and reuse of the copper artefacts themselves.

2.3. Ancient Egyptian and modern categories

Categorization is an inevitable process for all neural beings, especially humans. "… our bodies and brains determine that we will categorize; they also determine what kinds of categories we will have and what their structure will be".[52] The currently used categories may, however, be very different from the categories used in antiquity, specifically in ancient Egypt. And even in the past, they might have changed through time. "Thought is *embodied* … the core of our conceptual systems is directly grounded in perception, body movement, and

[46] (Pelegrin 1990; Wynn 1994).
[47] (Skibo and Schiffer 2008; Hodder 2012, 54–58).
[48] (Nørgard 2018, 247–248).
[49] (Ottaway 2001).
[50] (Hodder 2012, 105, 2016, 23–24).
[51] (Quirke 2009, 121–122).
[52] (Lakoff and Johnson 1999, 18).

experience of a physical and social character."[53] It is extremely difficult to translate the ancient experience, and Egyptologists find themselves in the roles of translators.

The problems start on the level of word translations, as ancient Egyptian cognitive categories were not identical with the cognitive categories of modern languages. It is not always possible to translate one word of an ancient language with one word of a modern language and assume that the scientific definition of this element was identical with ancient Egyptian perception as well.[54] Ancient words were not scientific definitions. An example that is central to the present thesis: there was no single and singular word that denoted copper in the periods under study; the words and their contents changed in the course of time. The interpretation presented in this thesis is also tentative and open to further discussions. Ancient Egyptian categories were successfully studied in connection to the determinatives.[55] These studies were also applied on copper determinative, engaging also categorization theory of G. Lakoff.[56] Herein, some new interpretations are proposed.

We have to bear in mind also that the expertise of ancient Egyptian metallurgists was not identical to the knowledge of the authors of ancient Egyptian texts.[57] We can observe only a marginal presence of the specific language of craftsmen in the sources; what was the general level of understanding of materials and technologies can only be guessed. With some exceptions, the language of the craftsmen is lost, and only scientific methods can approach the differences in technologies applied.

2.4. Complementary logic of ancient Egyptians

Ancient Egyptian thinking enabled complementary explanations of phenomena.[58] The modern explanation expects a singular "logical" explanation. Multiple explanations are considered superfluous and improbable. This approach would be not understandable in ancient Egyptian culture and especially religion, where multiple, even contradictory explanations of a single phenomenon are existing. In archaeology, this means that the explanation of artefacts need not be singular, and they can enter several possible contexts of the use and understanding. The above-mentioned conclusion that technological choices might be based on a set of assumptions which is seemingly illogical was also drawn in the study of technology.[59] In

[53] (Lakoff 1990, xiv).
[54] Regarding similar case of the ancient and modern terms of colour, cf. (Quirke 2001).
[55] (Goldwasser 2002).
[56] (Herslund 2011, 2015).
[57] Cf. (Harris 1961, 63–64).
[58] (Hornung 1982).
[59] (Lemonnier 1986, 179–180). For copper metallurgy see (Kuijpers 2018a).

ancient Egypt, we might have an apt society in which those "illogical" choices might be explained.

2.5. Weight of reasoning

Understandably, the published information depends on the current state of research. Traditional textual and iconographic sources are legitimate but incomplete. The connections and contacts between cultures have been examined on the level of the typology of artefacts.

The reasoning corroborated by the analyses of the elemental and isotopic composition needs to be taken into account, and such conclusions might have more argumentative weight. For example, it is difficult to argue that ancient Egyptians mined only turquoise on Sinai, as is written in the sources, in view of the demonstrable presence of Sinaitic copper ore in artefacts on the basis of isotopic ratios. Another example is the copper preserved from Maadi. E. Baumgartel in educated guess argued that it came from Sinai,[60] but analyses by E. Pernicka and A. Hauptmann followed by the lead isotopes have shown which particular fragments might have come from Sinai and which from other regions (such as Anatolia).[61]

2.6. Bottleneck preservation of evidence

As we continue further into the past, the amount of evidence is decreasing, which is described metaphorically as the "bottleneck effect".[62] This is true of some periods of ancient Egypt, although it does not follow the simple chronological trajectory: the preservation of Old Kingdom tombs is often better than of Middle Kingdom ones, and much more Old Kingdom tombs are published sufficiently. However, a tendency to explain Old Kingdom phenomena with more complex New Kingdom evidence can be observed in general syntheses, although most frequently in popularizing works. Much of what was created in the Old Kingdom would have been impossible without a functioning system that was somewhat different from other Egyptian periods. And for an outsider to Egyptology, it seems that ancient Egypt was fundamentally the "same" throughout time, while Egyptologists can pinpoint the differences between the main periods. Even those periods lasted for several hundred years and for several generations of people. While the technological framework of the periods under study is comparable (use of similar crucibles and furnaces), the societal and institutional frameworks changed significantly. The "bottlenecks effects" hinder the sufficient understanding of each period under study.

2.7. Egyptian exceptionalism

[60] (Baumgartel 1960, 23).
[61] (Pernicka and Hauptmann 1989; Abdel-Motelib et al. 2012, 48–50).
[62] (Kaufman 2018, 6–7).

When reading the works of archaeologists focusing on (early) Egypt, one feels that Egypt is often considered an exceptional civilization.[63] Yet, as will be demonstrated in this work, many aspects of Egyptian material culture made of copper and its social context are similar to phenomena that have been documented elsewhere in the broader region of the Eastern Mediterranean. It is attempted to assess, whether these are coincidences or connections.

2.8. Idea of progress

Often unexplained undercurrent of the Egyptological thinking and interpretation are certain rudimentary ideas about the development of society and material culture. It is often presumed that occurrence of metal objects meant the abandonment of the stone tools. On the contrary, stone tools were used quite frequently even in the dynastic Egypt. And this is valid for the Eastern Mediterranean Bronze Age, where stone tools were undoubtedly used alongside metal ones, for specific tasks. Most recently, Manclossi et al. attempted to propose a framework, in which we ought to consider the technological development from the stone tools to metal ones.[64]

Egyptians had access to high quality stone material, rather than to metal, and they were able to produce both the lithics and the groundstone polished tools. Many tasks could have been performed by the so called *ad hoc* flint industry, ubiquitous at the sites from the periods under study.[65] Heavy building tools at the sites were rather made of stone.[66] But also finer tools could have been made of chert and flint, rather than metal. For the Old Kingdom, example of such site is settlement refuse from Giza, containing numerous big and small lithic tools, clearly practically used by Dynasty-4 pyramid builders.[67] Later example is Middle Kingdom fortress at Kubban, with 5 lugged axe blades, 16 adze blades, all made of polished stone.[68] Metals must have been processed here as two weighing stones with numbers were found as well.[69] Hammers made of hard stones have been tools supposed to be used in the quarrying of meta greywacke in Wadi Hammamat and only stone tools were found and presumed to be used at Middle Kingdom carnelian mining site at Stela Ridge.[70] A number of stone tools was also uncovered at Middle Kingdom Kahun in Fayum.[71]

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63 Most recently (Morris 2019). "Egyptian exceptionalism" was also refuted by (Moreno Garcia 2019).
64 (Manclossi,Rosen and Boëda 2019).
65 E.g at Abusir (Svoboda 1993).
66 (Eger 1994).
67 (Kromer 1978).
68 (Emery and Kirwan 1935, 45–46, Figs. 24A, 24B).
69 (Emery and Kirwan 1935, 48, Fig. 28).
70 (Nieto 2014, 55; Bloxam 2006, 290).
71 (Petrie et al. 1891, Pl. VII).

Another unspoken assumption is that the technologically "better" solutions will eventually succeed. As we will see in case of ancient Egyptians, although they were in contact with the easier solutions of e.g. joining blades to the wooden hafts by socket eyes, they retained their traditional approaches of attaching handles and hafts.

2.9. Sources of "decorum" and idiosyncratic sources

The frequently used term "decorum" denotes spoken and unspoken rules that were applied in ancient Egyptian culture to "doing things" *comme il faut*.[72] Statistically, these sources are among the most represented, and although they look alike for laymen, they are never the same for Egyptologists, nor were they for ancient Egyptians. And then, there is often a single, idiosyncratic source containing explanations lacking in the sources that tightly follow the "decorum", such as either the Theban stela of Khety, describing in detail the course of the expedition to Sinai, or the fragmentarily preserved annals of Amenemhat II.

2.10. "Metallschock"

This term was introduced in archaeology by Austrian classical archaeologist Fritz Schachermeyr;[73] in recent literature, it was used by Toby C. Wilkinson.[74] Other word used for this phenomenon, especially in the Classical Antiquity, is skeuomorphism.[75] It describes the effect that the introduction of metal vessels had on the production of ceramics in Chalcolithic and Early Bronze Age Aegean and neighbouring regions. Ceramic forms started to imitate metal vessels by some properties, most of all a vessel surface with "metallic" appearance. A similar phenomenon was described in ancient Egyptian material culture e.g. by G. A. Reisner and A. Radwan.[76]

2.11. Material boundaries

One of the gravest problems of the study of ancient Egyptian material culture are the boundaries of material. Most of specialists study their material, categorized on the basis of matter of which they were produced.[77] Ancient Egyptian craftsmen were crossing these material boundaries, not only because metalworkers could be specialized in copper as well as gold and silver. Copper tools had their templates in the flint artefacts of Neolithic and

[72] (Baines 1990).
[73].(Schachermeyr 1955, 128–129).
[74] (Wilkinson 2014, passim).
[75] In north-eastern Africa e.g. (Manzo 2012).
[76] (Reisner 1931, 146; Radwan 1983, 35).
[77] Artefacts can be defined on the basis of material, what was the thought of (Clarke 1968, 193) for him was the material first choice of the type definition with 100% common trait. However, ethnoarchaeological research shows how for the production of one artefact, wide array of tools and materials were used, as in the production of bronze statuettes in Tamilnadu (Levy et al. 2008, 51–60, Fig. 23).

Chalcolithic period. Concerning tool kits, it is impossible to deal within this thesis with the full scope of the objects used in the different tool kits.[78]

[78] As was e.g. done for the Minoan crafts by (Evely 1993).

3. Copper in ancient Egypt – history of research, models of the development of metallurgy, available data

This chapter is a bibliographical essay examining the history of the research of the use of copper in ancient Egypt, based on the source categories accessible, and the theoretical concepts and models behind the research questions. The history of the discoveries exceeds the scope of the chapter. An overview of the regions, sites and contexts is provided as well, as it is important for the contextual understanding of the examined evidence.

3.1. Copper metallurgy and production in periods under study: history of research

3.1.1. Written and iconographic sources

As these categories of sources, fundamental for Egyptology, have received the most attention, the research of them has reached in some respects the limits of what can be learned using this type of sources alone.

Concerning general works, the discussion is still in broad terms shaped by the monograph on ancient Egyptian minerals by J. R. Harris.[79] A later synthesis of the same topic by S. Aufrère is cited less frequently.[80] The prestige character and connections of the ancient Egyptian economy, with attention paid also to copper and other metals, were discussed by S. Morenz, who introduced the term "conspicuous consumption" in Egyptology.[81] On the opposite side stands "peasant society", in which the largest part of the ancient Egyptian population lived.[82]

As for particular studies of words, even the ancient Egyptian name of copper was not established unequivocally. The interest started with K. L. Lepsius, and earlier discussions were summarized by J. R. Harris.[83] While the word *ḥm.t* is used to transcribe copper and the word *ḥm.ty* to name the copper/metal worker, the basis for doing so is rather weak. Discussions were also led astray by Gardiner's identification of sign N34 as a metal ingot, even though already J.-F. Champollion had determined it correctly as a crucible.[84] The latest discussion of the subject is by O. Herslund.[85]

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[79] (Harris 1961).
[80] (Aufrère 1991).
[81] (Morenz 1969).
[82] (Janssen 1981).
[83] (Lepsius 1872; Harris 1961, 50–62).
[84] Early discussions in (Davey 1985, 146–148).
[85] In his PhD thesis and article (Herslund 2011, 2015).

Some of the terms connected with metallurgy have attracted more attention in the literature, e.g. the word for metalworker[86] and the problems connected with the comprehension and translation of the term *bjꜣ* into modern languages.[87] Earlier studies were re-examined and summarized by John R. Harris.[88] Harris discussed the terms used for copper, tin bronze and iron in his monograph, and his interpretations are widely accepted to this day, with an additional discussion of the term *bjꜣ* and its derivatives in the dissertation of E. Graefe.[89] Graefe has identified two semantic fields of the root *bjꜣ*: the first one is connected with the division, distraction, subtraction, etc., while the second means "treasure", "a precious thing".[90] A. Nibbi pointed out a wider psychologic and cognitive aspect.[91] The metal is something new made from differing substances during metallurgical activity, and thus these two semantic fields could have been connected in ancient Egyptian culture.

The translation of *bjꜣ* as copper alone before the end of the Middle Kingdom was seldom expressed in the literature.[92] *Bjꜣ* was translated as "iron" by R. O. Faulkner in his edition of the Pyramid Texts, in accordance with Harris's interpretation. Allen avoided such straightforward interpretation and translated the word as "metal".[93] The word *ḥsmn* is traditionally translated as "tin bronze" in Egyptian sources.[94] However, already Harris assumed that the distinction between copper and tin bronze might not be perceived clearly in the Middle Kingdom.[95] In Chapter 4.1.1, I will propose a more logical interpretation and translation of this word in connection with metal.

Broader textual units are the texts themselves, often combined with iconography. From the viewpoint of metallurgy, some text categories received more attention than others. The most important source for copper metallurgy terminology are the inscriptions in workshop scenes. [96] R. Drenkhahn and B. Scheel offered detailed discussions of the subject.[97] The preserved terminology is interpreted by Scheel as a record of the special technical language of the metallurgists, often with difficult translations. The latest attempt was

[86] (Junker 1956; Schott 1973; Drenkhahn 1976).
[87] (Harris 1961; Graefe 1971).
[88] (Harris 1961, 50–-64).
[89] (Graefe 1971).
[90] Cited after (Nibbi 1977, 59).
[91] (Nibbi 1977, 59).
[92] E.g. by (Chassinat 1968, 462–476).
[93] (Allen 2005).
[94] (Parkinson 2009).
[95] (Harris 1961, 63–64).
[96] (Klebs 1915, 84–86; Montet 1925, 275–288).
[97] (Drenkhahn 1976; Scheel 1985, 1986).

undertaken by C. J. Davey, proposing "technical" interpretation of the scenes.[98] The arts and crafts terminology in general was analysed by R. Drenkhahn.[99] Recent art-historical approach is defined by M. Hampson's articles.[100]

Information on the use of copper is only marginally present in other texts. As for the initial procurement and storage, the mentions are scarce. Until recently, the expeditions were mostly studied only based on inscriptional evidence found either in the areas themselves or, to a lesser extent, referring to the areas. Among the first editions of the rock inscriptions are those from the Eastern Desert.[101] The first extensive corpus for Sinai was published in the 1950s.[102] Old Kingdom evidence was gathered by E. Eichler,[103] while the standard work for the Middle Kingdom is by K.-J. Seyfried.[104] Recent French discoveries in the Eastern Desert and Sinai make it possible to assess the range of Predynastic and Early Dynastic expeditions and add inscriptions also from the Old and Middle Kingdoms, resulting most recently in a new synthesis of the expeditions to the Sinai Peninsula.[105] Several case studies were written by A. Diego Espinel.[106] Much less is known about Nubia, although there is a prosopography and an edition of the rock inscriptions.[107] A corpus of Old Kingdom sealings from Buhen was never published *in extenso*, only in selection.[108] The Middle Kingdom corpus was recently enriched with a publication of sealings from Mirgissa.[109]

Back in Egypt, the presumed storage facility for copper and other non-edible materials was the so-called Treasury, recently examined in depth by S. Desplancques.[110] Direct evidence of the storage and use of unspecified copper is meagre; in the context of the Old Kingdom exchange, those mentions were incorporated in a broader framework.[111] Copper and other metals were controlled by weighing; apart from weighing stones, other pieces of evidence were seldom discussed in the literature.[112] The scant sources listing copper as a subject of taxation include Coptos Decrees B, C and D from late Dynasty 6.[113] First

98 Davey (2012).
99 (Drenkhahn 1976).
100 (Hampson 2010, 2012, 2014).
101 (Couyat and Montet 1912; Goyon 1957).
102 (Gardiner,Peet and Černý 1952).
103 (Eichler 1993).
104 (Seyfried 1981).
105 (Abd El-Raziq et al. 2002; Tallet 2015, 2012, 2018; Tallet and Mahfouz 2012).
106 (Diego Espinel 2002, 2015).
107 (Gratien 1991; Hintze and Reineke 1989).
108 (Kaplony 1981).
109 (Gratien 2019).
110 (Desplancques 2006).
111 (Müller-Wollermann 1985).
112 (Altenmüller 1986; Cour-Marty 1985, 1994, 1991, 1990, 1997).
113 (Goedicke 1967).

Intermediate Period evidence can prove the use and storage of copper also in these times.[114] Indispensable pieces of evidence in this regard are the stelae of the officials Khety and Tjetji who were in charge of the procurement and storage of copper.[115] Royal procurement of raw materials was described in the fragmentary annals of Amenemhat II.[116] Middle Kingdom sources, especially the so-called Heqanakht papyri, confirm the use of copper in private transactions.[117]

Copper was processed by metalworkers in Egypt, and a peculiar type of textual source is used frequently to infer information about the society and the crafts: the titles of persons occurring on their funerary monuments, false doors and other tomb inscriptions but also in other documents. Their modern study began with W. Helck, and several authors elaborated especially on members of the elite.[118] Special attention to craft titles was paid by R. Drenkhahn; the most recent studies on the Middle Kingdom are by S. Quirke.[119] Several related crafts, such as shipbuilding and sculpting, were studied subsequently.[120] A contemporary repertory of official titles from the third millennium BC was compiled by D. Jones.[121] It is an extremely useful compendium, but due to the broadness its of scope, it needs to be used with caution. Similar works for the Middle Kingdom were produced by W. Ward and H. G. Fischer, and later authors.[122]

An introduction to ancient Egyptian administration in general is provided in the edited volume by Moreno García.[123] The only sufficiently published administrative document dealing with the use and reuse of copper tool blades from the periods under study is the so-called papyrus Reisner II, the work log of a metallurgical workshop in a dockyard at This from the reign of Senusret I.[124] The volume had an unusually high number of reviews, and its study continues further.[125] A fragment of the Middle Kingdom Lahun papyri indicates that this was a common form of documents related to copper and that such documents must have existed already in the third millennium BC, in the Early Dynastic Period and the Old Kingdom. Unfortunately, they are not preserved.

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114 (Fischer 1964b, 1968; Padró 1999).
115 (Gardiner 1917; Blackman 1931).
116 (Altenmüller and Moussa 1991; Altenmüller 2015).
117 (Edel 1987; Allen 2002).
118 (Helck 1954; Baer 1960; Martin-Pardey 1976; Kanawati 1977; Strudwick 1985). Cf. (Martin-Pardey 1989) for the possibilities and limits of such approach.
119 (Drenkhahn 1976, 1995; Quirke 2003, 2009, 2018).
120 (Dürring 1995; Eaton-Krauss 1984).
121 (Jones 2000).
122 (Ward 1982; Fischer 1997; Doxey 1998; Stefanović 2006).
123 (Moreno García (Ed) 2013).
124 (Simpson 1965).
125 (Goedicke 1966; Spaull 1966; Wilson 1967; Wente 1967; Berlev 1969; Andrássy 2009).

The evidence must be pieced together from several types of documents. Early Dynastic texts were published by the sustained effort of P. Kaplony; as he also incorporated doubtful examples in the case of inscriptions on copper objects, however, some of his determinations require caution in use.[126] All Dynasty-3 documents including administrative ones were published in a single volume.[127] A recent edition of the Helwan slab stelae with photographs and drawings of all the stelae is an example of how a modern edition of a text should look like.[128] In the Old Kingdom, texts are either royal or private.[129] Mortuary temples archives provide data on copper objects stored in the temples.[130] Texts connected with the social context of the craft deserve special attention.[131]

As the number of tombs that have been published from the Middle Kingdom is much lower, one particular category of evidence is of high importance: Middle Kingdom funerary stelae that contain prosopographical information on contemporary individuals. Most of these stelae were found at Abydos; their original archaeological contexts were established by W. K. Simpson. Prosopographical studies were done e.g. by O. Berlev and D. Franke.[132] Particular workshops producing the stelae were established, and the objects are being examined on this basis as coming from different parts of ancient Egypt, mostly to Abydos.[133]

The first floruit of ancient Egyptian “literary” works is dated to the Middle Kingdom.[134] Works of ancient Egyptian literature provide a framework for social interpretation of copper artefacts, although they were present only marginally in such texts. The information from literary works can be used to perceive the value of materials and artefacts in contemporary society. Specific editions and sources will be cited in Chapter 4. The so-called Teaching of Khety, also known as the Satire of Trades, needs to be mentioned as a satire on the well-organized and idealistic metalworking scenes in the tombs.[135] Copper was also used in ancient Egyptian medicine.[136]

Religious texts offer information on the connotations of metals and metal objects in the spheres of the cult and the ritual. For the Old Kingdom, transliterations and translations of the Pyramid Texts are largely based on the edition of K. Sethe; only in the cases of the Texts

[126] (Kaplony 1963a, 1963b, 1964, 1966, 1965).
[127] (Kahl,Kloth and Zimmermann 1995).
[128] (Köhler and Jones 2009).
[129] (Goedicke 1967, 1970).
[130] (Posener-Kriéger 1969, 1976, 2004; Posener-Kriéger,Verner and Vymazalová 2006).
[131] (Smith 1946; Wilson 1947; Müller-Wollermann 1985).
[132] (Simpson 1974; Berlev 1978; Franke and Mareé 2013).
[133] (Ilin-Tomich 2015, 2017, s.d.).
[134] (Parkinson 2009).
[135] (Helck 1970; Verly 2017).
[136] (Matiegková 1960; Weser 2005).

of the Pyramid of Wenis and Texts of the Pyramid of Pepy I, the forms of the signs could be checked together with photographs of the texts.[137] Indispensable aid now for the study of the Pyramid Texts is the concordance published by J. P. Allen and his translation of the texts.[138] Unfortunately, the latest edition of the Pyramid Texts of Merenra was published too late to be fully considered here.[139] C. Lalouette dealt particularly with the topic of copper in the Pyramid Texts.[140] The offering lists, very important especially in private contexts, seldom contained also copper objects.[141] Middle Kingdom funerary religious texts were written on wooden coffins of the elite. Their edition was prepared by A. de Buck; a dictionary of the texts where copper objects occurred is more suitable for the purpose of our study.[142] The Coffin Texts were translated into English, but the translation is sometimes not precise, regarding the copper-related subjects.[143]

Iconographic sources can be divided into two main groups according to their spatial characteristics: two-dimensional and three-dimensional sources. Two-dimensional sources – reliefs, paintings and drawings – were more frequent in the periods under study, along with signs of the hieroglyphic and hieratic script (i.e., the palaeographic evidence). They have been studied by several authors.[144] Regrettably, the decoration of royal mortuary complexes is preserved only fragmentarily, even though it most probably served as a general model for the reliefs and paintings later used in the private context.[145] Apart from studies on metalworking scenes and scenes of other crafts (as mentioned above), there are also specific studies of e.g. fishing tools.[146]

In the First Intermediate Period and the Middle Kingdom, funerary offerings including tools with copper blades were depicted on the inner sides of coffins, forming so-called object friezes.[147] Not all Middle Kingdom sarcophagi have been published in sufficient detail.[148] The corpus was recently brought up to date by H. Willems.[149]

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[137] (Piankoff and Husson 1968; Leclant 2001).
[138] (Allen 2005, 2015, 2013a, 2013b, 2013c, 2013d, 2013e, 2013f)
[139] (Pierre-Croisiau 2019).
[140] (Lalouette 1979). (Ségalas 2017, 2019) must be mentioned as a rather problematic recent attempt to deal with the religious aspects of copper. Regarding his hypothesis, it must be stated that there is no evidence supporting a connection between the decay of the copper objects in the burial equipment and a concept of rebirth.
[141] (Barta 1963; Morales 2015).
[142] (Molen 2000; Buck 1935, 1938, 1947, 1951, 1954, 1956, 1961).
[143] (Faulkner 2004).
[144] (Klebs 1915; Montet 1925, 275–288; Drenkhahn 1976; Scheel 1985, 1986; Davey 2012).
[145] (Goedicke 1971; Ćwiek 2003).
[146] (Soria-Trastoy 2012; Odler and Peterková Hlouchová 2017).
[147] (Jéquier 1921; Willems 1988).
[148] (Lacau 1904, 1906; Freed *et al.* (Eds) 2009; Lapp 1993; Willems 1997).
[149] (Willems 2014).

Except for the unique case of an Old Kingdom statuette of a metalworker,[150] most of three-dimensional sources had the form of wooden models of workshop scenes from the First Intermediate Period and the Middle Kingdom, down to the reign of Senusret II.[151] To the metallurgical scenes need to be added also scenes of other crafts, which make it possible to study the use of the tools in various craft activities in great detail. These are mostly the scenes of carpentry, statue making, boat and ship making, leatherworking and jewellery production. Ancient Egyptian workshop scenes represent some of the most peculiar and most important creations of ancient Egyptian culture. They are widely used and referred to also outside Egyptological literature, in the treatises dealing with the crafts of other Bronze Age civilizations.[152] The reason is that other Bronze Age cultures lack comparable two-dimensional and three-dimensional iconographic sources of evidence dealing with the crafts, in terms of both the total number and the available detail; only classical Antiquity has analogous Greek and Roman sources. The "self-representation" of metalworkers in statuary in the periods under study can be defined based on existing funerary evidence that will be discussed in detail in the following chapter.[153]

Early Dynastic palaeography was examined recently in great detail by I. Regulski.[154] While the palaeography of Dynasty 4 was synthesized,[155] the palaeography of Dynasties 5 and 6 is available only for singular tombs or smaller regions.[156] Photographs of the texts are necessary in this regard, as typified hieroglyphic inscriptions cannot render the diversity of Old Kingdom hieroglyphic script. The script became rather standardized in the First Intermediate Period and the Middle Kingdom.

3.1.2. Artefacts

Material aspects of the above-mentioned texts and iconographic sources tend to be less stressed in the literature. Therefore, material culture in the narrow sense of the word is represented only by artefacts made of copper. Since they were subject of my recently published work and many aspects were already covered, especially of the Old Kingdom, a

[150] (Davey 2009).
[151] (Winlock 1955; Tooley 1995).
[152] (Evely 1993, passim).
[153] Examples published e.g. by (Borchardt 1911; Spencer 1980; Fay 2003).
[154] Regulski (2010).
[155] (Schweitzer 2005).
[156] For tomb of Mereruka, see (Collombert 2010), for regional studies also with focus on the palaeography, e.g. (Fischer 1964b, 1968).

slightly different selective approach is preferred in the presentation of the current state of research.[157]

The archaeological evidence is biased by the post-depositional history and further recycling of the material, but we have to think about the original situation, also on what was not preserved, not only on the basis of preserved written sources. An analysis of archaeological sources (material culture) is often avoided in the Egyptological literature. It is argued that most metal objects were taken either from the burial equipment or from other archaeological contexts, then recycled or discarded, and that remaining archaeological contexts are to scarce to draw any conclusions.[158] The interpretation of the material culture is thus mostly based on written and iconographic sources. It is then surprising how on this basis the production of copper tools and weapons is considered in some literature as marginal, compared to the production of the temple equipment and royal gifts for officials. The economy is then interpreted as aimed at the festival/conspicuous consumption of the expedition products.[159] The situation must have been quite opposite, considering the extensive monuments of the ancient Egyptian stone architecture in the periods under study and physical properties of the various materials.[160]

Among the recent outputs is a chapter from the monograph by Karin Sowada.[161] She concluded that "[a]ccess to the metal was not restricted to elites, meaning that large quantities of copper ore were required for the mass production of many items". I have already presented arguments on why this interpretation of the Old Kingdom evidence is misleading.[162] Also more recently, C. Mazé presented an overview of the geographically restricted mining areas, while copper itself "circulated through society."[163] In an overview of the materials available for "richer and poorer classes" in other article, copper is conspicuously missing from either categories.[164]

Eichler likewise assumed a richness of natural and human resources in ancient Egyptian society and thus no need for an "economizing" approach to their procurement.[165] There is plenty of written evidence against this assumption, however. Documents such as the

[157] (Odler 2016).
[158] (Eichler 1993, 15, 324). And especially (Eichler 1993, 21): „… viele Ansätze, die erfolgreich in der ethnologischen Feldforschung angewand wurden, kommen aufgrund des lückenhaft und züfallig überlieferten Materials aus dem Alten Ägypten nicht in Frage."
[159] (Eichler 1993, 320–321).
[160] (Stocks 2003).
[161] (Sowada 2009, 45–48, 185–188).
[162] (Odler 2016, 29–30)
[163] (Mazé 2018, 119).
[164] (Miniaci 2018, 141, Figure 1).
[165] (Eichler 1993, 14).

papyri Reisner II prove the control of the amount of copper. The temple inventory was also subjected to meticulous control. It is rather safer to assume that some resources were indeed plentiful (local limestone, mud for pottery and mudbricks), while the acquisition of other resources required some effort.

Paradoxically, metal artefacts were hardly present on the sites of the procurement of copper, as most of the tools used in copper mining were of stone, wood or pottery (crucibles). Nevertheless, they also deserve attention. Since these sites comprised mining as well as primary processing of the ore, they offered evidence for several stages of the *chaîne opératoire*. The only site from the periods under study with the complete excavation report published is Middle Kingdom Ayn Soukhna.[166] The project there continues, and more data will be available later. Preliminary reports from the Eastern Desert were published by the IFAO on the sites of el-Urf/Mongul South [167] and sites in Wadi Arabah.[168] The British survey identified another concentration of sites with copper processing in Wadi Abu Had.[169] Excavations took place on the sites of Wadi Dara and Wadi Um Balad, but only preliminary reports are available.[170] Many sites were discovered and revisited by a survey of R. and D. Klemm.[171]

On Sinai, the first excavator interested in metallurgical remains was Flinders Petrie.[172] Later, however, J. Černý complained about the condition in which Petrie left the sites he had excavated on Sinai. Israeli archaeologists paid attention to metallurgical sites.[173] When Sinai again became part of the Arab Republic of Egypt, the Swiss survey mapped the remains of miner settlements.[174] The Old Kingdom mining site of Seh Nasb was discovered by the French mission.[175] Preliminary information was also published on several Middle Kingdom copper mining galleries.[176]

Buhen in Nubia was presumed to be a bustling Old Kingdom metallurgical centre, but a revision of the excavation records has corrected this picture to rather scant evidence of copper processing.[177] The Middle Kingdom evidence at Buhen is not numerous, either.[178]

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166 (Abd El-Raziq et al. 2011).
167 (Tawab et al. 1990; Pouit and Castel 1994; Castel and Pouit 1997).
168 (Tristant 2012).
169 (Bomann and Young 1994; Bomann 1994, 1995, 1999).
170 (Castel et al. 1992, 1995, 1998).
171 (Klemm and Klemm 2013).
172 (Petrie 1906).
173 (Beit-Arieh 2003).
174 (Chartier-Raymond 1988; Chartier-Raymond et al. 1994).
175 (Tallet,Castel and Fluzin 2011).
176 (Tallet 2018).
177 (Emery 1963; O'Connor 2014).

More third millennium BC copper mining sites were identified by the surveys of R. and D. Klemm, along with evidence of gold mining.[179]

Inland Egyptian copper processing facilities have been identified at several sites. The earliest one is from Dynasty 2 el-Kab.[180] Old Kingdom workshops were identified at Giza.[181] In the First Intermediate Period, a copper workshop was identified at Balat.[182]

Archaeological evidence concerning the storage of copper and copper artefacts is meagre, a treasury was identified only in the Middle Kingdom fortress at Buhen. Existing evidence concerning metalworkers has been discussed above; without texts, we would not know that these were the tombs of metalworkers, as they were similar to other tombs. Only at Old Kingdom Giza (East Field, Russian concession), First Intermediate Period Badari and Middle Kingdom Ayn Soukhna have been identified graves of simple metalworkers, with a burial equipment consisting of a crucible in Badari and hammerstones at Giza and Ayn Soukhna.[183]

Copper artefacts have not been found in the Neolithic cultures of Fayum, Merimda and al-Omari. They are known from the Badarian culture, together with the earliest glazed artefacts.[184] The earliest extensive surveys of Predynastic copper artefacts were provided by Flinders Petrie.[185] The counting of the number and diversity of copper artefacts in the predynastic cultures might originate from the assumption of Childe that metallurgy is a trait of developed cultures.[186] The interpretation has shifted and earliest metal artefacts are explained rather as status symbols with no practical use and purpose. In the case of copper, this might have changed with the first occurrence of arsenical copper in the Naqada culture. This copper alloy is supposed to be hard enough to provide useful material for the production of tools for working soft stone and wood. Stocks assumes that a hollow copper tube was invented as a drilling tool for the production of stone vessels in this period.[187]

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[178] (Emery et al. 1979).
[179] (Klemm and Klemm 2013).
[180] (Claes and Huyge 2016; Claes,Davey and Hendrickx 2020).
[181] (Saleh 1974; Lehner 2007, 33–35, Fig. 1.24).
[182] (Jeuthe 2012).
[183] Giza: M. Lebedev (pers. comm.); Badari: (Brunton 1927, 36, 67, Pl. XLI: 25); Ayn Soukhna: (Abd El-Raziq et al. 2011, 15, 17, Figs. 62, 73–78).
[184] (Brunton and Caton-Thompson 1928; Horn 2015).
[185] (Petrie 1901a, 24–25, Pl. IV, 1920, 1925, 25–27).
[186] Copper artefacts were discussed in the syntheses of Egyptian prehistory, e. g. by (Trigger 1983; Midant-Reynes 2000b, 2000a; Wengrow 2006).
[187] (Stocks 2003, 13).

Copper artefacts became more frequent in Phase II of the Naqada culture.[188] Gradual increase of their use was documented in Naqada by J. C. Payne.[189] W. Davis assumed that already in this period, one could connect the occurrence of copper tools with the crafts using stone, ivory and wood.[190] The products were the results of attached craft specialization.[191] Copper is studied among the status symbols of predynastic and Early Dynastic cemeteries.[192] The occurrence of copper artefacts is assumed to be connected with the social change (or restructuring of society) in Levant and Egypt.[193] According to Takamiya, social prestige of copper was connected with its practical properties as well.[194]

Fragments of copper sheets, ingots and ore were found also at Maadi.[195] The evidence of metallurgy is not certain according to some authors,[196] while others interpret them as certain;[197] Maadi was even considered to be the place where metallurgy originated or was brought to Egypt.[198] A different interpretation sees Maadi only as an exchange centre between Egypt, Sinai and Levant.[199] Midant-Reynes compared early Naqada copper artefacts with objects found at Maadi and found some similarities in the two cultures.[200]

Copper in predynastic Nubia was first surveyed by C. M. Firth.[201] A-Group metallurgy has been discussed several times;[202] copper artefacts were usually interpreted as imports and large objects as markers of high social status.[203] The most important were the studies by I. Hofmann, who collected all A-Group objects known at the time; an updated version of known A-Group copper objects was provided by J. Roy, who assumed in her monograph that these were all imports from Egypt.[204]

The most important material for the Early Dynastic Period, defined here as Dynasties 1–3, was found in royal tombs, their enclosures and the burials around them at Abydos, and in

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188 Lists of types in (Trigger 1983, 33–34; Vercoutter 1992, 154; Midant-Reynes 2000b, 195–196).
189 (Payne 1992).
190 (Davis 1983, 25).
191 (Earle 1987).
192 E g. (Payne 1992; Delrue 2001; Takamiya 2003; Rowland 2014; Kroeper 1992).
193 (Klimscha 2011, 201).
194 (Takamiya 2003, 492).
195 (Rizkana and Seeher 1989, 13–18).
196 (Golden 2002, 232; Wengrow 2006, 84–85; Bard 2017, 7).
197 (Way 1997, 54).
198 (Vercoutter 1992, 149).
199 (Trigger 1983, 26; Hofmann 1991, 200–214).
200 (Midant-Reynes 2000b, 181).
201 (Firth 1927, 14).
202 E. g. (Nordström 1972, 123–124; Tadmor 2002, 248–249; Anfinset 2010).
203 (Bard 2017, 14).
204 (Hofmann 1967, 103–108; Roy 2011).

the tombs of high officials and their subsidiary graves at Saqqara.[205] The most important Dynasty 3 finds come from Saqqara again – the royal complex of King Netjerykhet – and from the provincial tombs of high officials at Bet Khallaf.[206] Perhaps the only author who tried to define a separate chronological group of Early Dynastic copper tools was W. B. Emery;[207] in the case of weapons, it was G. P. Gilbert.[208] K. Piquette dealt with the tool traces of (presumably predominantly used) copper tools on bone, wood and ivory labels.[209]

Old Kingdom copper tools and other objects were discussed elsewhere recently.[210] Although the occurrence of new types of weapons was presumed to begin in the First Intermediate Period, battle axe epsilon blades had occurred at least in the iconographic sources already in the Old Kingdom. Other types of weapons have dubious dating of the first occurrence, but it might be rather in the First Intermediate Period or the early Middle Kingdom.[211]

Early Middle Kingdom copper objects were preserved at the provincial cemeteries south of Asiut and in the tombs of the governors of Asiut itself.[212] Objects from royal contexts were found in the mortuary temple of Mentuhotep II; it was during his reign that the deposition of copper model tool blades in the so-called foundation deposits started.[213] Generally, Old Kingdom burial customs continued, with a changed typology of the tool blades used. A collection of undisturbed Middle Kingdom burial assemblages was gathered by J.-L. Podvin, followed by a detailed study of female burials by W. Grajetzki.[214] Settlement contexts were represented by Kahun, although not all objects presented as coming from the Middle Kingdom were of that dating.[215] The material published from Tell el-Dab^ca is crucial for the late Middle Kingdom and the Second Intermediate Period.[216]

Several broad categories of copper artefacts can be defined: tools, cosmetic implements, vessels, regalia, statuary, jewellery and hardware. Only a few works have

[205] Abydos: (Amélinau 1899, 1902, 1904, 1905; Petrie 1900c, 1901c, 1901b, 1925). Saqqara: (Emery 1939, 1949, 1954, 1958).
[206] Saqqara: (Firth and Quibell 1935; Lauer 1936, 1939), Bet Khallaf: (Garstang 1903).
[207] (Emery 1961, 216–222).
[208] (Gilbert 2004).
[209] (Piquette 2010, 2018).
[210] (Odler 2016).
[211] (Davies 1987, 30–42; Herold 2008).
[212] (Chassinat and Palanque 1911; Brunton 1927, 1937, 1948; Seidlmayer 1990; Zitman 2010).
[213] (Weinstein 1974; Arnold and Arnold 1981).
[214] (Podvin 2000; Grajetzki 2014).
[215] (Petrie,Griffith and Newberry 1890; Petrie et al. 1891; Griffith 1910).
[216] (Bietak 1996; Czerny 1999; Hein and Jánosi 2004; Forstner-Müller 2008; Schiestl 2009; Philip 2006).

attempted to cover the whole spectrum of objects produced of metal.[217] Most of these categories could occur in a full-size and functional version as well as in a miniaturized version, as models or miniatures. Moreover, the evidence is highly distorted, with funerary objects represented more than objects from settlements. The problem is also that not everything found in a funerary context is a model or miniature. The known tool kits of metal objects form several groups, which vary in the attention paid to them by researchers. The tool kits included also objects made of other materials, but those are out of the scope of this thesis. The first is the artisan tool kit, consisting of chisels, adzes, axes, saws, and drills. Although chisels were most important in the production of fine two- and three-dimensional works that we admire at present, they have received less attention, with crucial studies by W. M. Flinders Petrie, D. Stocks and M. Odler.[218] Adzes were mostly studied by W. M. Flinders Petrie and M. Odler.[219] Two standard monographs by E. Kühnert-Eggebrecht and V. W. Davies focused on axes, with additional lexicographical information presented by E. Edel.[220] The typology of saws is the most problematic, as they have been often mistaken for knives, but a distinct class of saws has been established in a recent publication.[221] Drills are studied through the traces they leave in other materials and experiments because their copper remains are non-existent.[222] The cosmetic tool kit consists of razors, mirrors, tweezers, hair curlers, cosmetic spatulas and kohl-sticks. Besides a corpus publication from the Louvre, more attention has been paid only to mirrors.[223] Although a distinct class of razors was confirmed by Montet, they are still mistaken for knives or axe blades.[224] The textile and leatherwork tool kit includes needles, knives, awls and pins, which are sometimes difficult to be distinguished from other thin pointed objects. Leatherwork was discussed in a recently published dissertation; other tools, such as needles, were studied infrequently.[225] So-called awls had a special meaning in A-Group, where they were convincingly used as tattooing implements.[226] The hunting and food processing tool kit contains a low number of copper classes: fish-hooks,

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[217] (Petrie 1917, 1927, 1937; Radwan 1983; Odler 2016). Most recent attempt to deal with the Predynastic and Early Dynastic material culture made of copper is (Ségalas 2019).
[218] (Petrie 1917, 19–22, Pls. XXI-XXIII; Stocks 2003; Odler 2016).
[219] (Petrie 1917, 16–17, Pls. XV-XVII; Odler 2015a, 2016).
[220] (Kühnert-Eggebrecht 1969; Edel 1986; Davies 1987).
[221] (Laroze and Garric 2013; Odler 2016).
[222] (Rieth 1958; Hartenberg and Schmidt 1969; Stocks 2003; Saraydar 2012).
[223] (Vandier d'Abbadie 1972; Bénédite 1907; Petrie 1927, 28–33, Pls. XXIV-XXIX; Lilyquist 1979; Odler 2016, 181–193).
[224] (Montet 1933).
[225] (Schwarz 2000; Vogelsang-Eastwood 1995, 35–37; Nunn and Rowling 2001).
[226] (Nordström 2002).

harpoons and knives.[227] Weaponry in the periods under study comprises arrowheads, spearheads, daggers. Comparatively more attention was focused on weaponry and after Petrie, two monographs from 1926 remain valid contributions to subject to this day.[228] Later works have offered limited new information about the subject.[229] Notable contributions to the subject are works on Early Dynastic weaponry and metal weapons in general.[230] Most information on daggers can be found in a recent monograph, although some critical points need to be raised.[231] Arrowheads and spearheads from the Early Dynastic Period were examined by G. P. Gilbert and in a typological paper by T. Huret and others, but they would deserve more attention.[232] Vessels are also specific "tools" of the performed rituals, predominantly of that of the funerary repast. Since the publication of the latest corpus work in 1983, the number of uncovered vessels has increased along with the understanding of the rituals in which they were used.[233] Copper was also used in the finishing of ancient Egyptian furniture and in other cases of use of the hardware, but it has not been studied in detail in the literature.[234] Peculiar types of use include the regalia of ancient Egyptian kings,[235] statues and statuettes of the deities, kings and non-royal persons or barques made of copper.[236]

Several museums have published their copper artefacts in catalogues, led by the British Museum[237] and followed by the Louvre,[238] the Ashmolean Museum, Oxford,[239] the Royal Museum of Art and History, Brussels,[240] the Neues Museum, Berlin,[241] the National Museum, Warsaw,[242] or the Brooklyn Museum.[243] The catalogues of copper and bronze objects of the Egyptian Museum, Cairo, were published more than a century ago.[244] More museum material was included in the corpora of individual artefact categories, such as vessels

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227 (Brewer and Friedman 1990, 21–31; Soria-Trastoy 2012; Odler and Peterková Hlouchová 2017; Czarnowicz 2018; Ikram 1995, 62–70, Fig. 14).
228 (Petrie 1917; Bonnet 1926; Wolf 1926).
229 (Shaw 1991; McDermott 2004).
230 (Gilbert 2004; Boatright 2010).
231 (Petschel 2011; Odler 2013).
232 (Gilbert 2004; Clark,Phillips and Staley 1974; Huret 1990).
233 (Bissing 1901; Petrie 1937; Radwan 1983; Lapp 1986; Odler 2017b).
234 For instance, copper pieces of furniture were published from the burial equipment of Queen Hetepheres: (Reisner and Smith 1955).
235 For crowns, see most recently (Ertman 2019).
236 Copper statues are discussed in (Eckmann et al. 2005; Hill 2004; Hill and Tourna 2007).
237 (James 1961; Spencer 1980; Davies 1987).
238 (Vandier d'Abbadie 1972). A catalogue of ancient Egyptian weaponry in the Louvre is being prepared by Nathalie Couton-Perche (pers. comm.).
239 (Payne 1993).
240 (Rademakers et al. 2018).
241 (Roeder 1937).
242 (Stępniak 2006).
243 (Needler 1984).
244 (Bissing 1901; Bénédite 1907).

or Old Kingdom tools.[245] Many museums have detailed information on their collections accessible online, but there is still a long way to the proper federated synthesis of the data accessible online, as each museum has its own approach to their online portals. The museums' policies concerning the curation of artefacts represent the decisive factor in the last major topic in the history of research, archaeometallurgy of ancient Egyptian copper, and the subject of the following subchapter.

3.1.3. Archaeometallurgy

The earliest analyses of the ancient Egyptian copper base artefacts were performed just few years after the decipherment of hieroglyphs, on the objects in the Passalacqua collection in Trieste (now incorporated in the collection of the Neues Museum, Berlin). The analytical work was done by Professor Louis Nicholas Vauquelin, discoverer of beryllium and chromium.[246] Moreover, also minerals, pigments and other substances were studied in the collection, being thus the first truly interdisciplinary project of Egyptian archaeology.[247] Less attention was paid to the archaeological context, and thus there is not often enough information to date the objects. Other early analyses were listed by J. Riederer.[248]

The first programme, involving a number of artefacts, was developed and published by eminent French chemist Marcellin Berthelot.[249] For the periods under study, the most interesting are results from Dahshur.[250] By the scope of the analyses cited, already the excavation reports from the late nineteenth and early twentieth centuries were truly interdisciplinary, with metals being only some of the interesting materials to be analysed.[251] The results of older analyses of ancient Egyptian copper artefacts were collected by several authors.[252] The first synthesis of the results was contained in the work by Lucas and Harris.[253] Contrary to the widely held opinion of the completeness of references to earlier analyses in Lucas and Harris, the book lacks some of them. A reference to metal objects analysed by Beni Hassan is missing, as well as a reference to some early analyses of metal vessels.[254]

[245] (Radwan 1983; Odler 2016).
[246] (Vauquelin 1826).
[247] (Brongniart 1826; Le Baillif 1826; Mérimée 1826).
[248] (Riederer 1982, 6–7).
[249] (Pollard and Heron 2008, 6).
[250] (Berthelot 1895).
[251] (Gladstone 1890, 1892; Petrie 1892, 1900c; Quibell 1898, 1913; Flight 1882).
[252] (Riederer 1978b; Kaczmarczyk and Hedges 1983; Wuttmann 1986).
[253] (Lucas and Harris 1962, 483–492).
[254] (Garstang 1907b, 196), carried out by dr. Alfred Theophile de Mouilpied, (assistant) lecturer in chemistry at the University of Liverpool and later professor of Science (unestablished) at the Royal Military Academy, Woolwich. Analyses of vessels by (Lucas 1900).

The first author interested in the metallography of the objects was Herbert Garland in the early twentieth century, although in a fragment from the tomb of Hesyra, he only found traces of the original metal core.[255] The gravest problem of these analyses lies in the geochemical diversity of the ore deposits and reduction of the amount of chemical compounds and elements in the artefacts during and after the metallurgical activity.[256] Reisner discussed this issue in the interwar period with Professor Richards of Harvard University and concluded that the analyses could not always find the exact composition of the original artefacts.[257] This served as an excuse for the omission of composition analyses from the publication of artefacts from the mortuary temple of Menkaura. The number of analyses, not always reliable, increased in the early decades of the twentieth century.[258]

New methods were discovered throughout the last century, most importantly the neutron activation analysis (NAA) and the atomic absorption spectroscopy (AAS); the latter was used more frequently on Egyptian objects. The use of the methods is sometimes not well justified, such as the use of X-ray diffraction for the analysis of an Old Kingdom mirror.[259]

Another useful method is X-ray fluorescence (XRF); the first substantial study of Egyptian objects was based on this method. E. R. Eaton and H. McKerrel used XRF analysis to analyse a large collection of Egyptian and Near Eastern artefacts.[260] They have confirmed that the occurrence of tin bronzes increased and the occurrence of arsenical copper decreased in the period between the Old and the New Kingdom. The analyses of the artefacts are presented in general terms; the results for each artefact are stored in the archive of the Ashmolean Museum in Oxford, but they have not been published in full until now, with the exception of Predynastic material.[261] XRF analyses might not be as precise as the analyses that are done at present, yet they enable to distinguish between artefacts made of copper with impurities, arsenical copper and tin or leaded tin bronzes.

A synthesis of the knowledge was attempted by J. Ogden in what is probably the most frequently cited recent article on ancient Egyptian metals.[262] It offers a good overview of the

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[255] (Quibell 1913, 40).
[256] (Hauptmann 2007, 27–31).
[257] (Reisner 1931, 232).
[258] (Rathgen 1909; Borchardt 1910; Phillips 1922, 1924; Sebelien 1924; Hall 1929; Desch 1928, 1933; Garland and Bannister 1927; Bannister 1937; Carpenter 1931, 1932; Coghlan and Voce 1950; Bisson de la Roque 1950).
[259] (Saleh 1983).
[260] (Eaton and McKerrell 1976; McKerrell 1971, 1993).
[261] I would like to thank here to the curator of the Egyptian collection in the Ashmolean Museum, Oxford, L. McNamara, for enabling me to study the results of McKerrell's analyses.
[262] (Ogden 2000).

then state of the research, unfortunately with the omission of some important articles and also some ancient Egyptian written sources.[263]

The published analyses of ancient Egyptian copper artefacts can be categorized into several groups. Analyses of the same object classes in the diachronic perspective are useful; the best known examples are XRF, AAS and metallography analyses of the axes in the collection of the British Museum, with an addition of some selected artefacts from the collections of Petrie Museum UCL and Ashmolean Museum in Oxford.[264] Less known are the studies of tools and weapons, and of 40 mirrors, both corpora in the Louvre collection, the latter accompanying the catalogue of toilet utensils in the Louvre, but not in the same volume.[265] Analyses by Josef Riederer on the artefacts in the collections of museums in West Germany (Berlin, Hildesheim, Hannover, Munich and other museums with smaller collections) were focused predominantly on later material and offer mostly analyses of Late Period bronzes, but also a few earlier artefacts, analyses by Mommsen et al., of the material from Bonn, included also two earlier objects.[266] A study of the ancient Eastern Mediterranean copper and bronze artefacts in the Museum of Mediterranean and Near Eastern Antiquities in Stockholm is not often cited.[267] Analyses of the objects from the American museums are not published frequently.[268] A recent study has added more data points to objects from Hannover, but its methodology of Late Period bronze objects was criticized due to the disregard of lead separation. Since this problem does not influence earlier objects analysed in the project, the results given for objects from the Early Dynastic Period and the Old Kingdom are correct.[269] Earlier statuary was not analysed often.[270] Hopefully, the amount of the analyses of objects in the Egyptian museums will rise.[271]

The fundamental problem of the research of ancient Egyptian metallurgy is the lack of data concerning ore sources. A joint Egyptian-German project has brought first results for Eastern Desert ores recently; the data for Sinai are slightly more numerous,[272] but we know almost nothing about copper ore sources from Nubia.[273] Some presume that copper from Wadi Arabah in Israel and Jordan, from the sites of Feynan, Timna and Wadi Amram, was

263 E.g. (Hours and Michel 1974; Michel 1972; Wuttmann 1986, 1992; Gilmore 1986b; McKerrell 1993).
264 (Davies 1987).
265 (Hours and Michel 1974; Michel 1972; Vandier d'Abbadie 1972).
266 (Riederer 1978b, 1982, 1983, 1984, 1988, 1992, 1978a; Mommsen et al. 1979).
267 (Oldeberg 1976, 130–131).
268 (Kopp 1934; Garenne-Marot 1984; Maddin et al. 1984; Brovarski 2013).
269 (Schulze and Lehmann 2014; Masson-Berghoff et al. 2018, 319).
270 (Giumlía-Mair 1997; Rehren 2005; Mathis et al. 2009; Giumlía-Mair and Quirke 1997).
271 (Gharib Abd Allah and Maher 2018).
272 (Abdel-Motelib et al. 2012; Pfeiffer 2013; Segal,Ilani and Rosenfeld 2000).
273 (Gayar and Jones 1989; el-Gayar and Jones 1989).

used in ancient Egypt as well. Although the ore sources are well described, the evidence for the use of this ore in Egypt is only indirect.[274] The exception so far seems to be the presumed connection between Tell Hujayrat al-Ghuzlan and Maadi in the Chalcolithic.[275] Targeted studies of the datable mineral remains are also scarce.[276]

Even less than about ore sources is known for the periods under study about metallurgical remains such as crucibles and slags. A study of some crucibles from the First Intermediate Period and the Middle Kingdom was carried out by C. J. Davey in the Petrie Museum UCL.[277] Although complete evidence for Middle Kingdom metallurgy was found at Ayn Soukhna, the published research focused on the experimental reconstruction of the process.[278]

Analyses targeted on chronologically and chorologically narrower assemblages, mostly from a single site and period, are more frequent. For the Predynastic Period, analyses of artefacts and other copper and ore fragments are available from the Lower Egyptian sites of Buto,[279] Kafr Hassan Dawood,[280] Maadi,[281] and Tell el-Farkha.[282] Artefacts from Naqada have been analysed by H. McKerrell and the results included in the catalogue by J. Crowfoot-Payne.[283] Lead isotopes and trace elements for three A-Group objects, now deposited in Sweden, were published by N. Anfinset.[284] Analyses of Early Dynastic metal objects in the British Museum with the use of AAS and XRF were published by A. J. Spencer.[285] Five artefacts from Dynasty 1 and 2 royal tombs at Abydos were analysed by J. Golden using the PIXE technique.[286]

Analyses of arsenical copper fragments from the uncovering of the first boat pit of King Khufu are not frequently cited.[287] A study of Dynasty 6 objects from Giza did not find immediate followers, either.[288] The first substantial lead isotope datasets for third millennium BC Egypt were published in 2018, by teams from Brussels and Prague (using material from

274 (Ben-Yosef et al. 2016).
275 (Klimscha 2011; Pernicka and Hauptmann 1989; Hauptmann,Begemann and Schmitt-Strecker 1999).
276 (Gale and Stos-Gale 1981; Hassan and Hassan 1981; Shortland 2006).
277 (Davey 1985).
278 (Abd El-Raziq et al. 2011). Some XRF analyses of artefacts were published in (Abd El-Raziq,Castel and Tallet 2016).
279 (Pernicka and Schleiter 1997).
280 (Hassan et al. 2015).
281 (Pernicka and Hauptmann 1989).
282 (Rehren and Pernicka 2014).
283 (McKerrell 1993).
284 (Anfinset 2010, 163–165, Figs. 6.49–6.50).
285 (Spencer 1980, 88).
286 (Golden 2002).
287 (Iskander 1960).
288 (Maddin et al. 1984).

the Egyptian Museum of Leipzig University).[289] The methodology of both approaches, presenting a hierarchical model of interpretation of lead isotope data, was commented upon.[290] A few more data points representing objects analysed in the Kunsthistorisches Museum Wien were added recently.[291]

NAA analyses of Middle Kingdom artefacts from Kahun were carried out by Gilmore.[292] Middle Kingdom axe blades, most of them without secure provenance, were published in the British Museum catalogue, a few more Middle Kingdom artefacts were analysed recently in Vienna; otherwise, however, Middle Kingdom material is the most understudied out of the periods.[293] In the late Middle Kingdom and the Second Intermediate Period, objects from Tell el-Dab^ca represent the only corpus of a significant size to have been analysed.[294] As for contemporary Nubia, C-Group objects analysed include two mirrors currently stored in Vienna and several more artefacts from Leipzig, so far published only with XRF results, and a single earlier analysis from Semna fortress.[295] Since the Kerman Kingdom was partially supplied with copper from the north, also few published results of the Kerman objects are included herein.[296]

Apart from the lack of data concerning the ores used, this field of study faces another important problem. Provenance studies are a “hot” topic at present, along with trace element analyses. Methods that require the taking of small samples, such as metallography and subsequent Vickers micro-hardness testing, are not popular among museum curators. They are, however, inevitable for assessing the physical properties of the objects and distinguishing between full-size, functional objects and models.[297] Thoughtful comparison of existing data can help, hopefully, but more data are needed to properly describe the abilities and limits of ancient Egyptian metalworkers.

3.2. Analytical units of regions

Before the discussion of source categories, it is inevitable to discuss briefly the state of the data available for the specific sites, organized according to their geographical position and then according to types: workshops, settlements and, by far the most numerous, cemeteries (Figure 3.1). Mining sites are reserved for a separate discussion in Chapter 5. The

289 (Rademakers et al. 2018; Kmošek et al. 2018).
290 (Ben-Yosef 2018).
291 (Odler et al. 2018).
292 (Gilmore 1986b, 1986a; David 1988).
293 (Odler et al. 2018).
294 (Philip and Cowell 2006).
295 (Kmošek et al. 2018, 2016b; Žabkar and Žabkar 1982).
296 (Dunham 1943b, 1943a; Vercoutter,Thomas-Gooriecckx and Lefève 1960; Bonnet (Ed) 1990; Young 1996).
297 Arguments presented in (Kmošek et al. 2016a, 2018).

understanding of the structure and preservation of data is vital for the comprehension of the evidence: what and how is preserved.[298]

3.2.1. Sites in Upper Egypt

3.2.1.1. From Elephantine to el-Kab

The region around the first cataract was a contact zone between the Naqada and Egyptian population coming from the north and Nubian cultures coming from the south. Their mutual relations were recently examined in depth.[299]

The island of Elephantine was inhabited since the Naqada culture. The Naqada III settlement at Elephantine provided a corpus of 81 copper tools and fragments.[300] Later finds were published in the form of preliminary reports.[301] Only a limited number of the finds has been until now included in the final reports of some parts of the site.[302] Although some burials were discovered on the island itself, the main cemetery is located north of it, at Qubbet el-Hawa.[303] Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts.[304] Middle Kingdom material culture is being brought to light by the Spanish mission.[305]

The cemeteries of Nubian cultures, from A-Group to the Middle Kingdom, with a low number of important copper artefacts, were located north of the Aswan area, at Kubbaniya and Kubbaniya North.[306] The blade was the only heavy metal tool found at Kubbaniya. There was also a copper needle in Grave P.114, a disturbed A Group grave with three skulls, remains of the burial equipment, pottery and stone vessels; moreover, a fish-hook was the only find in Grave 24.g.10.[307] Other needles, pins and awls found were made of bone and ivory. Grave 23.h.10 contained a tiny copper alloy rectangle packed in linen, besides an ivory pin and small fragments of malachite together with two cosmetic grinders and shell beads from a necklace.[308] Copper beads were found in two graves, and a copper armlet in one grave.[309] Many graves have been disturbed and plundered, and the remaining metal objects are very scarce. Their occurrence in the mentioned graves and in the grave described below

[298] In order to facilitate machine readability, not all letters have been retained in ancient Egyptian or Arabic transcriptions of the site names.
[299] (Raue 2019).
[300] (Kopp 2006, 84–86, Taf. 37).
[301] (Kaiser et al. 1980, 1982, 1984, 1987, 1995, 1997).
[302] (Dreyer 1986; Pätznick 2005; Dorn 2015; Kopp 2018, 2019).
[303] Earlier excavations published in (Edel,Seyfried and Vieler 2008).
[304] (Odler 2016, 53, 88–89).
[305] A dagger found recently *in situ* (Jiménez Serrano et al. 2014, 19–23).
[306] (Junker 1919, 1920).
[307] (Junker 1919, 1919, 117–118, 127, Taf. XXXIX).
[308] (Junker 1919, 121, 145).
[309] (Junker 1919, 97, 103).

was rather associated to the 'rich' graves with luxurious items. Raw copper, malachite (and also brochantite) were quite frequent;[310] they were present in altogether 53 graves, although sometimes only in very small fragments. They were packed in linen, leather and also stored in three miniature woven baskets. The find context next to palettes and grinders indicates the use for the green cosmetic paint.[311] Other tools present were stone axeheads and pounders/hammerstones in three graves. The find category of "flint knives", coined by Junker, contained diverse tool blades made of flint, for example with retouched blades, serrated blades and scrapers; they were found in more than 60 graves of the cemetery.[312]

Old Kingdom and First Intermediate Period occupation was recently confirmed in Kom Ombo, but the information has not yet been published. It seems, however, that the capital of the first Upper Egyptian nome might have been located there rather than on Elephantine.

Important funerary material was uncovered at Edfu, the capital of the second Upper Egyptian nome, by the joint French-Polish mission, although the excavation methodology and subsequent publication obfuscate the use of data.[313] Old Kingdom archaeological evidence was discussed elsewhere.[314] Evidence of copper processing and a connection between the Old Kingdom profession of "prospectors" and copper was recently identified in a newly found Old Kingdom town from the reign of Djedkara Isesi.[315]

3.2.1.2. Between el-Kab and Thebes

One of the early centres of the Egyptian state was situated in Hierakonpolis (Nekhen), later the capital of the third Upper Egyptian nome, but the number of copper finds is rather low, possibly also due to later looting. The most important is a pair of copper statues of King Pepy I and his son.[316] Opposite Hierakonpolis on the east bank is el-Kab with a number of Early Dynastic and Old Kingdom settlements and funerary finds.[317] Old Kingdom archaeological evidence was discussed elsewhere.[318] Predynastic and Early Dynastic settlements in the area, Adaima and es-Siba´iya, add to the evidence.[319]

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310 As determined by Prof. Berwerth, mentioned in Junker (1919, 90).
311 Junker (1919, 90–91).
312 Junker (1919, 115–117, Taf. XXXVIII).
313 (Alliot 1933, 1935; Bruyère et al. 1937; Michałowski et al. 1950; Stępniak 2006).
314 (Odler 2016, 87–88).
315 (Moeller and Marouard 2018).
316 (Quibell 1900; Garstang 1907a; Adams 1995; Eckmann et al. 2005).
317 (Quibell 1898; Sayce and Clarke 1906; Limme,Hendrickx and Huyge 1997; Limme 2008; Hendrickx and Eyckerman 2009; Claes and Huyge 2016).
318 (Odler 2016, 90).
319 (Needler 1984, 282).

Another important concentration is in the south of the fourth Upper Egyptian nome, although the publication of the evidence is uneven. A Predynastic and Early Dynastic cemetery was published from Armant.[320] Another site with origins in the Predynastic Period is Gebelein; most of the finds, of both archaeological and iconographic nature, remain unpublished, but they are at least on display in the Egyptian Museum in Turin. Old Kingdom archaeological evidence was discussed elsewhere.[321] Important iconographic and written evidence was found at another site, Moalla, in the tomb of the First Intermediate Period nomarch Ankhtify.[322] A hoard of Aegean silver was discovered at el-Tod; there are differing opinions concerning its dating, although the objects were deposited in two heavy copper caskets with cartouches of Amenemhat II.[323]

3.2.1.3. Theban area

The use of copper in the Theban area, the centre of the fourth Upper Egyptian nome, can be confirmed from the third millennium BC. Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts.[324] More important are, however, objects from the early Middle Kingdom, with the earliest use of copper model tool blades for the foundation deposits at Deir el-Bahari by Mentuhotep II, and the best preserved carpenter workshop, including a model of a metallurgical furnace.[325] Theban coffins contained tools and weapons in the object friezes.

3.2.1.4. Between Thebes and Abydos

Coptos was the capital of the fifth Upper Egyptian nome and the departure point for expeditions to the Eastern Desert. Unfortunately, the archaeology of the periods under study is not well known, crucial evidence is represented by the written documents, the Coptos decrees and the inventory of the temple of Min.[326]

An earlier centre was located near the cemeteries at Naqada and Ballas. Naqada is the most important site for fourth millennium Egypt with the highest amount of preserved material culture. The concentration of sites also includes the cemetery at Ballas.[327] The ancient name of the settlement was Nubt, i.e. "Golden (town)" and the extent of the cemeteries is an indirect reference to the wealth of inhabitants, based on the sources of gold

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[320] (Mond et al. 1937).
[321] (Odler 2016, 90).
[322] (Vandier,Khafaga and Vandier-d'Abbadie 1950).
[323] (Bisson de la Roque 1937, 1950; Kemp and Merrillees 1980).
[324] (Odler 2016, 53, 92).
[325] (Arnold and Arnold 1981; Winlock 1955).
[326] (Goedicke 1967, 1994).
[327] (Petrie and Quibell 1895; Baumgartel 1970; Payne 1993).

(and possibly copper) accessible from there in the Eastern Desert. Late Old Kingdom tombs were situated at the site of Khozam.[328]

Dendera was the capital of the sixth Upper Egyptian nome, with recently confirmed habitation since the Naqada culture.[329] Old Kingdom archaeological evidence was discussed elsewhere.[330] Old Kingdom, First Intermediate and early Middle Kingdom cemetery was superficially excavated by Petrie, but at least the material was published. Nothing is known on C. Rosher excavations and later work of C. S. Fisher was meticulous, but it is until now unpublished in detail.[331] Latest work on the cemetery is being done by French mission. However, there is discrepancy between published data. Slater claimed that 21 mirrors and 4 axes were found at Dendera, database of this work includes from the site 27 mirrors and 21 axe blades.[332] Rather peculiar in whole contemporary Egypt is the attention focused on the possession of copper in late Old Kingdom and First Intermediate Period inscriptions.[333]

Only the cemetery of nomarchs at Hamra Dom is known from the capital of the seventh Upper Egyptian nome. Burials began there in the Early Dynastic Period; concerning copper, there is limited material culture and important written and iconographic sources.[334] More important was the publication of Predynastic cemetery at Diospolis Parva.[335] Old Kingdom archaeological evidence of continuing burial activity was discussed elsewhere.[336] The cemetery contained also Middle Kingdom burials.[337]

3.2.1.5. Abydos

Abydos is one of the most important sites of Egyptian history. Its importance for the Early Dynastic Period together with the excavation reports have been cited above. A revision of the earlier excavations is being conducted at the cemetery of early kings by the German Archaeological Institute, contributing also new copper finds.[338] Vast cemeteries of Abydos were excavated in numerous campaigns, especially by the archaeologists of the Egypt

[328] (Fischer 1964b).
[329] (Moeller and Marouard 2018).
[330] (Odler 2016, 86).
[331] (Petrie 1900a, 1900b; Slater 1970, 1974). Only some mirrors were published anew by (Lilyquist 1979).
[332] (Slater 1974, 264–265).
[333] (Henry George Fischer 1961; 1968; Musacchio 2006).
[334] (Quibell 1904; Säve-Söderbergh 1994).
[335] (Petrie 1901a).
[336] (Odler 2016, 87).
[337] (Bourriau 2009).
[338] (Dreyer,Hartung and Pumpenmeier 1993; Dreyer et al. 1996, 1998b, 2000, 2003, 2006, 2017).

Exploration Fund. The quality of the publications themselves is uneven and until the present day, there is lack of a reliable map of the whole area with all the cemeteries included.[339]

The importance of Beit Khallaf for Dynasty 3 has also been mentioned above. Old Kingdom contexts were already discussed, together with a burial at Sinki.[340] Abydos continued to be an important source of written documents in the Middle Kingdom. Somewhere in the area of the capital of the eighth Upper Egyptian nome, This, was located a copper workshop as part of the royal dockyard, the origin of the papyrus Reisner II.[341]

The predynastic and Early Dynastic cemeteries at Mahasna and Reqaqna were published in the early 1900s.[342] Old Kingdom archaeological evidence was discussed elsewhere.[343] Reports on the Predynastic and Early Dynastic cemeteries at Naga ed-Deir were more detailed.[344] Old Kingdom archaeological evidence was discussed elsewhere.[345] Other, smaller cemeteries in the region, Sheikh Farag, Mesheikh and Mesaid, have not been published yet; the material from them is accessible in the online collection of the Museum of Fine Arts, Boston.[346]

3.2.1.6. Between Abydos and Asiut

Akhmim was the capital of the ninth Upper Egyptian nome. Its necropolis in the periods under study was el-Hawawish. Both provided iconographic and written sources but no copper material culture.[347]

Asiut was the capital of the thirteenth nome of Upper Egypt and the cemetery of the nomarchs.[348] Cemeteries south of Asiut provided evidence of material culture in the periods under study from the Badarian culture until the Middle Kingdom. On the west bank, there are the sites of (Deir) Rifa and Zarabi, on the east bank Matmar, Mostagedda, Badari, Hammamiya and Kau.[349] For the fourth millennium BC, the earliest copper in Egypt was found at Badari and a later copper axe is known from Matmar.[350] Old Kingdom archaeological and iconographic evidence from the cemeteries (Badari, Hammamiya,

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339 (Peet and Loat 1913; Peet 1914; Naville 1914; Loat 1923; Ayrton and Loat 1908; Ayrton,Currelly and Weigall 1904; Frankfort 1930; Sowada 2010; Adams 2015; Garstang 1901).
340 (Odler 2016, 83–85).
341 (Simpson 1965).
342 (Garstang 1904, 1903).
343 (Odler 2016, 91).
344 (Mace 1909).
345 (Odler 2016, 92).
346 https://www.mfa.org/collections/search For preliminary report on Mesaid, see (Onstine 2005).
347 (Kanawati 1980b, 1983, 1987, 1992).
348 (Chassinat and Palanque 1911; Zitman 2010).
349 (Petrie 1907; Brunton 1927, 1937, 1948; Khouli and Kanawati 1990; Grajetzki 2009).
350 (Brunton and Caton-Thompson 1928; Brunton 1948, 16, Pl. XVI: 40).

Matmar, Mostagedda) was discussed elsewhere.[351] The cemeteries Balabish, (Deir) Rifa and Zarabi can rather be dated to the First Intermediate Period and the Middle Kingdom.[352]

Assemblages in Mostagedda analogical to the grave with the analysed objects have been found in eight cases, dated to Phases IIC (Tomb 5112), and predominantly IIIB (Tombs 721 with a full-size lugged axe blade and 1814 with an epsilon battle axe; 1621, 1658, 1690, 1693 with a model tool assemblage).[353] The model tools included artisan tools, axes, adzes, chisels and saws, many with preserved handles or lashing; a model mirror (1693), model battle epsilon axe blades (1690, 1658) and model spearheads (1621, 1658, 1681, 1690) were occasionally present. From the find of a copper alloy mast in 1690, Brunton assumed that the tombs at Mostagedda had also contained wooden models of workshops and ships, although they were eaten by white ants.[354]

Full-size metal weapon blades were at Mostagedda rare; besides the battle axe from Grave 5118, there were similar axe blades from Graves 1690 and 1814 and a full-size spearhead from Grave 1920. Brunton assumed that all the burials with weapons were male.[355]

3.2.1.7. Between Asiut and Amarna

The twelfth Upper Egyptian nome with its capital of Deir el-Gebrawi was situated on the west bank of the Nile.[356] Old Kingdom iconographic evidence was discussed elsewhere.[357]

The centre of the fourteenth Upper Egyptian nome was Meir. Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts.[358] In the late Old Kingdom and First Intermediate Period, the focus of burial activity shifted to Dara.[359] Old Kingdom archaeological evidence was discussed elsewhere.[360] Old Kingdom archaeological evidence was discussed elsewhere.[361] Later on, evidence of the iconography of copper objects comes from Middle Kingdom coffins from Meir.

3.2.1.8. Between Amarna and Beni Hasan

Sheikh Said was the Old Kingdom cemetery of the nomarchs of fifteenth Upper Egyptian nome. The iconographic evidence was discussed elsewhere.[362] Dynasty 12 nomarchs moved

[351] (Odler 2016, 52, 85–86).
[352] (Odler 2016, 92).
[353] Seidlmayer (1990, 133–139).
[354] Brunton (1937, 102–103).
[355] Brunton (1937, 108).
[356] (Davies 1902a, 1902b; Kanawati 2005, 2013).
[357] (Odler 2016, 52).
[358] (Odler 2016, 52–53, 91).
[359] (Weill 1958, 195).
[360] (Weill 1958, 195).
[361] (Odler 2016, 86).
[362] (Odler 2016, 52).

their tombs north to the site of Deir el-Bersha, with all categories of evidence preserved but not all of them sufficiently published.[363] Burials there, nevertheless, reach back to the Old Kingdom, including a mirror and copper pieces of jewellery.[364] A single First Intermediate period mirror was allegedly found at the site of Antinoe.[365]

3.2.1.9. Fayum and sites down to Beni Hasan

Old Kingdom nomarchs of the sixteenth Upper Egyptian nome were buried at Zawiyet el-Mayitin.[366] Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts.[367] The main focus of the burial activity then shifted to Beni Hasan. The beginning of the burial activity can be dated to the Old Kingdom. Of the five parts of the necropolis,[368] two provide evidence for funerary use of copper in both iconography and objects. Iconographic evidence was documented from the upper necropolis of nomarch tombs,[369] iconographic evidence from coffins and material culture was found at the lower necropolis of First Intermediate Period and Middle Kingdom shaft tombs.[370] The original report on the lower necropolis is incomplete in the presentation of data, and the field documentation is almost non-existent. A rather numerous set of objects was subjected to the chemical composition analysis.[371] Only a limited amount of the artefacts can be traced to their contemporary museum location.[372] The available evidence on copper can be dated predominantly to the Middle Kingdom, although New Kingdom objects occurred there as well from later burial contexts. After Garstang, the contexts were redated by S. Seidlmayer and S. Orel.[373]

The site of Tehna was located in the seventeenth Upper Egyptian nome. Old Kingdom iconographic evidence was discussed elsewhere.[374]

The Dynasty-6 nomarchs of the twentieth Upper Egyptian nome were buried at Deshasha. Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts.[375]

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[363] (Freed *et al.* (Eds) 2009; Willems 2014)
[364] (Vereecken et al. 2009).
[365] Context Ant1: (Lilyquist 1979, 18). (Rademakers et al. 2016) do not have any finds from this site on the map of artefacts from Brussels.
[366] (Varille 1938; Piacentini 1993).
[367] (Odler 2016, 52, 92–93).
[368] (Bommas 2012, 44–46).
[369] (Newberry et al. 1893a, 1893b, 1896, 1893c).
[370] (Garstang 1907b).
[371] (Garstang 1907b, 196).
[372] (Orel 1993); not all of the objects were tracked down, e.g. model tools from Tomb 116, now apparently in the Egyptian Museum, Cairo or model tool blades, handles and hafts from Tomb 186, now in the World Museum, Liverpool; (Bommas 2012).
[373] (Seidlmayer 1990, 216–230; Orel 1993).
[374] (Odler 2016, 52).

The entrance region to the Fayum oasis has preserved archaeological contexts from the Predynastic Period up to the Middle Kingdom. The Predynastic and Early Dynastic cemetery at Abusir el-Meleq was excavated in the early twentieth century, with a few copper finds.[376] Early Dynastic assemblages were found at Lahun.[377] Old Kingdom archaeological evidence was discussed elsewhere.[378]

Centre of the First Intermediate period state was near Heracleopolis Magna, as well as the tombs of the state officials.[379] First Intermediate and early Middle Kingdom graves were identified at Sedment.[380] Site of two first pyramids of Dynasty 12 was Lisht and meagre amount of archaeological and iconographic evidence was found here, although larger part of the material is unpublished.[381] Middle Kingdom cemeteries were also at Ghurab and Haraga.[382] Latter site is presumed to be a cemetery of the pyramid town of the Senusret II, where few pieces of evidence about the use of copper were found in the Kahun papyri.[383]

3.2.2. Sites around Memphis

The broader Memphite region includes all sites from Meidum up to Heliopolis. The sites there provide the richest evidence for all aspects of copper research, especially in the third and early second millennia BC.

The earliest Predynastic copper object was found at Gerza; the cemeteries at Tarkhan are slightly later but continue to the Early Dynastic Period, with several important contexts.[384] The Maadi site is a specific case from the fourth millennium BC, with clear connections to the east and north-east of Egypt.[385] Regrettably, the early excavations did not follow the stratification of the site and the finds therefore cannot be assigned to any finer chronological unit.

The publications for the crucial Early Dynastic site of Saqqara have been listed above. In addition to Saqqara, several cemeteries of people with a slightly lower social status were uncovered, each with a presence of copper objects: Abu Rawash, Abusir South – Bonnet

375 (Odler 2016, 52, 86).
376 (Scharff and Möller 1926).
377 (Petrie,Brunton and Murray 1923).
378 (Odler 2016, 91).
379 (Padró 1999).
380 (Petrie and Brunton 1924).
381 (Hayes 1937; Goedicke 1971).
382 (Petrie,Griffith and Newberry 1890; Petrie et al. 1891; Loat 1904; Engelbach 1923; Brunton and Engelbach 1927).
383 (Collier and Quirke 2006).
384 (Stevenson 2009b; Petrie,Wainwright and Gardiner 1913; Petrie 1914; Grajetzki 2004; Mawdsley 2012).
385 (Rizkana and Seeher 1989; Pernicka and Hauptmann 1989; Abdel-Motelib et al. 2012).

Cemetery, Giza, Helwan and Tura, with one find from Batn el-Baqara.[386] In this work, Dynasty 3 is included in the Early Dynastic Period and Saqqara royal pyramids were already mentioned. Otherwise, Dynasty-3 material is rare in the Memphite region: some objects were found at Saqqara, some fragments at Abusir, in the tomb of Hetepi.[387]

Metal finds were scarce at the cemetery of Tura, with ca. 10 objects preserved. [388] Besides the analysed adze blade and spearhead, the 583 explored graves only contained one other spearhead,[389] another adze, much smaller than the analysed specimen (Grave 19.f.1), a harpoon (Grave 19.i.2), two small bowls (Graves 15.h.2 and 15.h.5), one ring from the southern part and three armbands, one decorated, in Grave 18.k.1. A deposit of five metal vessels was entombed in the eastern part of the necropolis. As Junker aptly remarks, the vessels were made of more metal than all other copper alloy finds from Tura.[390] The deposit was found in a shaft tomb near the large Tomb 27.w.1 with a combination of stairs and a shaft built most probably in Dynasty 3; this could also be the date of the neighbouring structure, but later, early Old Kingdom dating cannot be ruled out, either.[391] The occurrence of tools made of stone, i.e. flint blades (arrowheads, rectangular, so-called razor blades and knives) was also rather scarce at Tura.[392]

The Old Kingdom saw an immense building and burying activity in the vicinity of Memphis. Royal pyramids were built at the sites of Dahshur, Giza, Abu Rawash, Zawiyet el-Aryan, Abusir and Saqqara; copper coming from royal contexts is meagre; the figures are slightly higher for persons around the king, predominantly queens, princes and princesses.[393]

Old Kingdom archaeology itself is defined on the pyramids and other tombs at Giza. After Lepsius,[394] substantial work was done by several missions, led by G. Steindorff,[395] H. Junker,[396] G. A. Reisner,[397] and S. Hassan,[398] several other tombs were excavated by other

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[386] (Petrie 1907; Bonnet 1928; Montet 1938, 1946; Saad 1948, 1951, 1957; Klasens 1957, 1958, 1959, 1960, 1961; Saad 1969; Radwan 1983, 8, Taf. 3: 20; Köhler 2005; Tristant 2008; Köhler and Jones 2009; Köhler 2014a; Köhler et al. 2017). The author of the thesis will be publishing old finds of Montet and new finds from Abu Rawash in a monograph in preparation (see poster (Odler 2017a).
[387] (Quibell 1923; Bárta,Coppens and Vymazalová 2010).
[388] Junker (1912, 54–56).
[389] Junker (1912, 55, Abb. 74).
[390] (Junker 1912, 55–56, Abb. 75–76).
[391] Junker (1912, 25–26, Abb. 35).
[392] Junker (1912, 59–60, Abb. 83).
[393] (Bergdoll 2016; Callender 2008; Krejčí 2008c, 2008b, 2008a; Valloggia 2011; Krejčí 2013; Krejčí,Arias Kytnarová and Odler 2015; Krejčí 2016; Leclant and Clerc 1997).
[394] (Lepsius 1849).
[395] (Steindorff,Hölscher and Grimm 1991; Spiekermann and Kampp-Seyfried 2003).
[396] (Junker 1929, 1934, 1938, 1940, 1941, 1943, 1944, 1947, 1950, 1951, 1953).
[397] (Reisner 1931, 1942; Reisner and Smith 1955).
[398] (Hassan 1936, 1941, 1943, 1950, 1953).

researchers.[399] Unpublished tombs documented by Harvard mission are being published in the series Giza Mastabas,[400] some tombs were recently republished.[401] Settlement and iconographic evidence from Giza was discussed elsewhere, along with the archaeological contexts.[402] Generally, it can be estimated that the data published in later volumes bear more detailed information. Tombs in contemporary Giza continue to be excavated by the Egyptian and Russian missions.

Arguably the most important Old Kingdom burial site was Saqqara, but the tombs there, including metalworker tombs, were initially explored with the aim of procuring written and iconographic material.[403] Only from the early 1900s did the excavation started to focus also on the burial chambers of the tombs. Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts.[404] Works by J. E. Quibell, C. M. Firth and J.-P. Lauer are important in this regard.[405] Recently, the Egyptian missions, and foreign, Australian,[406] French,[407] Polish,[408] Swiss-French missions are working in the area and have excavated either iconographic or copper material culture.

Just north of Saqqara is located Abusir, where L. Borchardt uncovered many tombs at the royal necropolis.[409] The Czech Institute of Egyptology continues at the royal necropolis since 1960 and at Abusir South since 1991. Most written and iconographic sources come from Dynasty 5,[410] with copper finds coming from the whole course of the Dynasty 3 to Dynasty 6 burial activity at the site.[411] A sun temple of King Nyuserra was built at the site Abu Ghurab north of Abusir. A report on it contains information about the scarce metal finds and an inscription fragment mentioning copper objects.[412]Old Kingdom archaeological contexts were already discussed, together with iconographic and textual evidence.[413]

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399 (Fakhry 1935; Abu-Bakr 1953).
400 (Dunham and Simpson 1974; Simpson et al. 1976, 1978; Simpson 1980; Weeks 1994; Brovarski 2001; Manuelian 2009).
401 (Kanawati 2001).
402 (Odler 2016, 38–51, 65–77).
403 (Hamernik 1985; Mariette 1889).
404 (Odler 2016, 38–51, 81–82).
405 (Quibell 1913, 1923; Firth 1926; Drioton and Lauer 1958).
406 (Kanawati and Hassan 1997; Kanawati and Abder-Raziq 1998; Kanawati,Abder-Raziq and McFarlane 2003; Kanawati 2006).
407 (Dobrev,Laville and Onézime 2006).
408 (Kowalska 2013; Weker 2013).
409 (Borchardt 1907).
410 (Verner 1986; Bárta 2001; Vachala 2004).
411 (Bárta et al. 2009; Odler 2015b, 2017b; Odler et al. 2019).
412 (Borchardt and Bissing 1905).
413 (Odler 2016, 38–51, 55–65).

The northernmost Old Kingdom cemetery was Abu Rawash.[414] Old Kingdom contexts were already discussed, involving funerary and settlement finds as well as a possible foundation deposit.[415]

The first Dynasty-4 pyramid was built at Meidum, and although Petrie assumed Dynasty 4 dating for the whole necropolis,[416] the funerary activity continued here until the end of the Old Kingdom.[417] Old Kingdom iconographic evidence was discussed elsewhere, along with the archaeological contexts, all probably from early Dynasty 4.[418]

The scarce iconographic evidence coming from Dahshur, together with an almost total absence of Old Kingdom material culture, was already discussed.[419]

First Intermediate and Middle Kingdom burials with all types of sources were found at Abusir and Saqqara.[420] Dahshur becomes a crucial site because of the preservation of the burial equipment of Middle Kingdom princesses, with daggers and copper model tool blades as well as foundation deposits.[421]

Lesser cemeteries in the area were situated in Heliopolis; Old Kingdom archaeological evidence was discussed elsewhere.[422] Some of the finds have been made at Mit Rahina, others further south, at Kafr Ammar, near Tarkhan. [423] Another site is Riqqa.[424]

3.2.3. Sites in Lower Egypt and Wadi Tumilat

Several important sites in the Delta and Wadi Tumilat can be dated to the fourth millennium BC. In the western Delta, the settlement site of Buto brought to light copper finds from the fourth and third millennia BC.

In the eastern Delta, 38 copper artefacts were found at Tell el-Farkha, seven of them were from burials, one prill fragment possibly a remnant of metallurgical activity.[425] Other copper finds were uncovered at the nearby site of Tell el-Murra. Another important site of the eastern Delta is Minshat Abu Omar, a Predynastic and Early Dynastic cemetery with

[414] (Bisson de la Roque 1924, 1925).
[415] (Odler 2016, 55).
[416] (Petrie 1892).
[417] (Rzeuska 2011).
[418] (Odler 2016, 38, 80–81).
[419] (Odler 2016, 38, 65).
[420] (Schäfer 1908; Firth 1926; Quibell and Hayter 1927).
[421] (Alexanian et al. 2006; Morgan 1895, 1903; Grajetzki 2014).
[422] (Odler 2016, 77–80).
[423] (Odler 2016, 80).
[424] (Engelbach et al. 1915).
[425] (Czarnowicz 2012, 2018).

archaeological evidence.[426] One copper object is known also from the temple site of Tell Ibrahim Awad.

752 burials were excavated at the site of Kafr Hassan Dawood in Wadi Tumilat with the highest number of copper artefacts among Predynastic sites.[427] The earliest occurrence of copper artefacts was in Phase KHD IV (Naqada IIIB), with prevailing working tool classes: adzes, chisels, harpoons, a knife and a bangle. Most copper artefacts are datable to Phase KHD Va (Naqada IIIC1), with 10 adzes, 8 chisels and 7 harpoons besides less frequent artefacts. The finds become considerably less numerous in the following Phases KHD Vb (Naqada IIIC2) and KHD VI (Naqada IIIC3–D) and disappear altogether in KHD VII (Naqada IIID).[428] Rowland links the high frequency of tools with increased stone- and woodworking activity.[429] An interesting point is that adzes did not occur in the largest graves; harpoons occur only in four burials.[430] Copper artefacts are mostly single in the graves; among the multiple occurrences is idiosyncratic Grave 371 with 20 artefacts. Broken adzes represent a specific feature of the graves.

Old Kingdom contexts with archaeological and iconographic evidence were found at Mendes.[431] Old Kingdom iconographic evidence was discussed elsewhere, along with the period's archaeological evidence.[432]

Old Kingdom archaeological evidence for the site of Tell Basta was discussed elsewhere.[433] Burials continued at Tell Basta in the Middle Kingdom.

Tell el-Dab^ca is an important site for the late Middle Kingdom and the Second Intermediate Period, as its material culture is "foreign" to the Egyptians, even though it is situated on the Egyptian soil. Most of the material was found in funerary contexts;[434] other finds were from the settlement.[435]

In western part of delta, Kom el-Barnougi is a site with two Middle Kingdom tombs with decorated burial chambers and a mirror.[436] Most important cemetery of western Delta was excavated at Kom el-Hisn, the capital of the third Lower Egyptian nome, but it has been only preliminarily published. Selected archaeological contexts were described in the

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[426] (Kroeper 1992; Kroeper and Wildung 1994, 2000).
[427] (Rowland 2014).
[428] (Rowland 2014, Figs. 10–15).
[429] (Rowland 2014, 291).
[430] (Rowland 2014, 285, 287).
[431] (Hansen 1967; Soghor 1967; Redford 2010).
[432] (Odler 2016, 51, 54).
[433] (Odler 2016, 54).
[434] (Philip 2006; Forstner-Müller 2008; Schiestl 2009).
[435] (Czerny 1999; Hein and Jánosi 2004).
[436] (Lilyquist 1979, 14).

preliminary reports.[437] The museum inventory numbers of artefacts are listed, although this piece of information cannot be always matched with the actual grave.[438] Another contested issue is the dating of the cemetery, while it has been dated only to the late First Intermediate Period and Dynasty 11 by G. Brunton and S. Orel, there are contexts with mirrors and daggers datable to the later parts of the Middle Kingdom.[439]

3.2.4. Sites in Nubia

Lower Nubia spans between the first and second Nile cataracts. The landscape was explored in the first and second salvage campaigns connected to the building of Asuan dam, with the focus on cemeteries. First survey in the early 1900s covered area from Shelal, south of Asuan, to Gebel Abu Simbela.[440] Second survey between Wadi es-Sebua and Adindan took place in 1929–1931.[441]

The most important sites were discovered at the entrance to Wadi Allaqi, Nubia's gold-bearing region: the fortress of Kubban with proved Middle Kingdom habitation and a presumed, albeit not proved Old Kingdom presence. The cemeteries of Sayala and Naga Wadi count among the richest A-Group sites comparable only with Qustul (see below).

The key site in the middle part of Lower Nubia is Aniba, with the largest C-Group cemetery providing the backbone of its chronology. Habitation here reaches back to A-Group and there is even one grave with a copper assemblage than can be interpreted as an import of an Old Kingdom Egyptian tool kit. The Egyptians built a Middle Kingdom fortress there. Most copper objects are datable to C-Group or even later.[442] The area was presumably the centre of the whole C-Group; the cemeteries around Aniba have been subject of several salvage campaigns, mostly contributing C-Group copper material culture.[443] Copper finds were scarce at C-Group settlements.[444]

The region north of the second cataract interested archaeologists already around the time of the first Nubian salvage campaigns in the early half of the twentieth century. Excavated copper objects, predominantly from A-Group Faras, were published only insufficiently and then some of them in museum catalogues.[445] Later work of the Oriental

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[437] (Hamada and Amir 1947; Hamada and Farid 1947, 1948, 1950).
[438] Information on the particular graves are in the register of the Egyptian Museum in Cairo, although sometimes it differs from the published graves (Orel 2000).
[439] (Brunton 1947; Lilyquist 1979; Orel 2000; Petschel 2011). This important cemetery would deserve a detailed publication, all excavated conserved material is presumably deposited in the Egyptian Museum, Cairo.
[440] (Reisner 1910; Firth 1912, 1915, 1927).
[441] (Emery and Kirwan 1935).
[442] (Steindorff 1935, 1937; Bietak 1968).
[443] (Junker 1926; Emery and Kirwan 1935).
[444] Wadi el-Arab settlement, context WeA1: (Emery and Kirwan 1935, 106–107, Fig. 85).
[445] (Griffith 1921, 1922, 1924; Spencer 1980, 84, 86; Rademakers et al. 2018).

Institute, University of Chicago, uncovered presumed A-Group "royal" tombs at Qustul; other copper objects of A-Group and Old Kingdom dating were found on smaller cemeteries.[446]

The second cataract had a strong presence of Nubian cultures since prehistory, from the periods under study in A-Group and C-Group but Pan Grave and Kerma graves can occasionally be found as well. Material from the salvage campaign of the Scandinavian Joint Expedition was published in several detailed volumes, including copper finds.[447] A string of Middle Kingdom fortresses was located in the area around the second cataract, from south to north Semna South, Semna, Kumma, Uronarti, Shalfak, Askut, Mirgissa, and Buhen. The earliest Egyptian settlement was present at Buhen: an Old Kingdom town from Dynasties 4 and 5. Material excavated from the sites was published in the form of preliminary and some final excavation reports, concerning material culture but also written evidence.[448] One of the major issues of the research is only preliminary publication of sealings from Buhen. Besides the typology, we do not know much more about the copper objects produced in the region.

The capital of the Upper Nubia region was Kerma. Some copper artefacts are interpreted as Egyptian imports.[449] The Kerma culture had, however, also distinct types of weaponry (so-called Kerma daggers, peculiar axe blades) and other objects (e.g. razors).[450] Although copper was assumed to be imported from Egypt, the Kermans had their own production of copper items, which is beyond the scope of this thesis.[451]

3.2.5. Sites in Western Desert

Old Kingdom archaeological evidence from Balat was discussed elsewhere.[452] A sequence of the governors' tombs brought material of late Dynasty 6, the reign of Pepy II, and of the First Intermediate Period.[453] Additional finds were from the ka sanctuaries of the governors and from a First Intermediate Period workshop.[454]

3.2.6. Sites in Eastern Desert

The region along the Red Sea was perceived as a single geographical unit by ancient Egyptians. Several copper procuring sites and early gold mines were identified in the Eastern

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446 (Williams 1986, 1989).
447 (Nordström 1972; Säve-Söderbergh 1989).
448 (Dunham,Janssen and Reisner 1960; Žabkar and Žabkar 1982; Dunham,Reisner and Wheeler 1967; Vercoutter et al. 1975; Vercoutter 1977; Gratien 2019; Emery 1963; Emery et al. 1979; O'Connor 2014; Smith 1991).
449 (Valbelle 1990a).
450 (Vercoutter,Thomas-Gooriecckx and Lefève 1960; Young 1996; Hafsaas-Tsakos 2013; Manzo 2016).
451 A copper workshop from Kerma published in (Bonnet 1986). Kerma copper metallurgy is a subject of contemporary study by F. Rademakers (KU Leuven) and G. Verly (RMAH Brussels) (pers. comm.).
452 Odler (2016,93–97).
453 (Valloggia 1986; Minault-Gout and Deleuze 1992; Valloggia 1998; Cherpion,Castel and Pantalacci 2001).
454 (Soukiassian,Wuttmann and Pantalacci 2002; Jeuthe 2012).

Desert, some of them have been excavated: Abu Mureiwat, Atalla, Barramiya, Bir Umm el-Fawakhir, Daghbag, el-Urf, Hamash-North, Higalig (also known as Hagalik), Kasr Girgis, Samut, Umm Eleiga, Umm Esh el-Zarqa, Umm Had-South, Umm Soleimat, Wadi Abu el-Maysa, Wadi Abu Had, Wadi Bokari, Wadi Dara, Wadi el-Sid, Wadi Sagia, Wadi Semna, Wadi Um Balad. Expedition inscriptions were preserved in Wadi Dungash. The gold mines of Abu Siha, Duweishat and Sokar are situated south of the second cataract, with possible traces of early mining; one of those sites, Umm Fahm, contains evidence of copper mining.[455]

Three harbour installations were found on the shore of the Red Sea: Wadi el-Jarf from early Dynasty 4, Ayn Soukhna from the Old Kingdom and the early Middle Kingdom (its Old Kingdom name was *Bꜥt*, in the district of *Jn.t*),[456] Marsa Gawasis from the Middle Kingdom.

3.2.7. Sites on Sinai Peninsula

Sinai is an example of a geographical entity that was long perceived in Egyptological literature on the basis of texts and inscriptional evidence, which were the main focus of the research. Existing and newly discovered inscriptional evidence was recently synthesized by P. Tallet; the texts on Sinai in the thesis discuss mainly his but also previous interpretations.[457] Sinai was never completely in Egyptian hands, local inhabitants with different habits and material culture lived on its largest part. Egyptian presence was most frequent in the centre of the peninsula, in the wadis north and west of the coastal Markha Plain.

Predynastic and Early Dynastic inscriptions are concentrated north of the plain, at the sites of Faras Um el-Zuebin, Wadi Ameyra and Wadi el-Homr.[458] East of the plain were sites with Early Dynastic and Old Kingdom presence, predominantly in the area of Wadi Maghara (the ancient Egyptian name Terraces of Turquoise, *ḫtjw fkꜣt*),[459] with many inscriptions, some of them documented in the nineteenth century but later destroyed.[460] Another important Old Kingdom area were the sites at Bir Nasib, Seh Nasib and Wadi Kharig, with evidence of copper mining and processing.[461] A fortress at Tell Ras Budran with a circular ground plan was built on the Markha Plain in early Dynasty 4.

After a hiatus in the First Intermediate Period, Middle Kingdom ore mining and processing is to be found at Gebel Hazbar and other sites.[462] A temple precinct was built and

[455] (Klemm and Klemm 2013).
[456] Tallet (2018, 27–28).
[457] (Tallet 2012, 2018).
[458] (Tallet 2012, 2015).
[459] Tallet (2018, 15–20).
[460] Gardiner – Peet – Černý (1955); Eichler (1993); Tallet (2018).
[461] Until now, they are published only in the form of preliminary reports (e.g. Tallet et al. 2011).
[462] Again, only preliminary information is available on these sites.

enlarged at Serabit el-Khadim,[463] designated as Mining Area (*Bjꜣw*) in ancient Egyptian.[464] The main material mined here was turquoise, but there is also scant evidence of copper mining and processing.

Egyptian presence on these sites was restricted both temporally and spatially. This was not part of the proper ancient Egyptian territory. Wadi Tar, an assumed source of arsenical copper for both Levant and Egypt, is situated out of this area, in south-eastern Sinai.

Generally, inscriptional evidence has been published, sometimes in several editions. Rather meagre information is available on the copper mining and processing sites, and ancient Egyptian copper finds are also rather scant on Sinai.

3.2.8. Sites out of north-eastern Africa

The city of Byblos on the Lebanese coast was in contact with ancient Egyptians at least from the early Old Kingdom.[465] An axe found nearby Byblos was discussed elsewhere.[466] Middle Bronze Age metal artefacts from Byblos with the Egyptian parallels were studied recently.[467]

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[463] (Valbelle and Bonnet 1996).
[464] Tallet (2018, 24–27).
[465] (Ward 1964; Saghieh 1983; Diego Espinel 2002).
[466] (Odler 2016, 97).
[467] (Kopetzky 2018).

4. Textual, iconographic and palaeographic sources

Let us begin the discussion of Egyptological sources with the most traditional ones, textual and iconographic.[468] As iconographic sources were often accompanied by inscriptions, it is logical to discuss both categories at once. Even though their absolute numbers are the lowest compared to the preserved artefacts and the potentially infinite number of scientific material analyses, these sources provide an irreplaceable framework for the interpretation of archaeological and scientific sources. It must be noted that the "traditional" Egyptological approach works in Positivist tradition with "positive" evidence, directly informing about an issue, in this case including "copper" or "metalwork" in the texts or iconography. Thorough study of the sources reveals that inferences about the procurement, processing and use of copper can be made also about the titles and institutions that nominally do not involve "copper". Proper study would therefore include almost all major parts of the Old Kingdom society and it is difficult to undertake such study individually. On the other hand, these sources are not scientific, therefore the identification of materials is often not secure and can be contested.

We will proceed from the basic lexicographical units, words of the ancient Egyptian connected with metallurgy, and discuss their original context and permissible translation(s) into English. Building on this fundamental vocabulary of terms, we will analyse the textual and iconographic sources dealing with copper from the periods under study. Each source has to be examined on the basis of its particular purpose in ancient Egyptian society. The information about the social context of copper can be inferred from the texts, but only if we are able to understand their social context(s). The evidence itself, within chronological units, is organised in a different manner, based on the *chaîne opératoire*, on the assumed stages of the procurement, use and discard of copper in ancient society.

As it is clearly visible on the regional distribution of the sources (Figure 4.1), most of these, one third, has a provenance in Memphite region. In cases of Thebes and Abydos, many tombs and contexts are until now unpublished. Many other regions are represented by a share below 10% and 5%. Sources from Delta are almost absent. The temporal and regional distribution (Figure 4.2) demonstrates absence of secure sources from the Predynastic, and a prevalence of the sources from the periods of centralized state and unhindered production of the tombs, images and texts. While the Old Kingdom sources are clearly skewed towards Memphis, Middle Kingdom sources are well distributed over Egypt and many of its regions.

[468] With the subcategory of palaeography as a specific iconographic source in its own right.

4.1. Main lexicographical units in periods under study

4.1.1. Minerals and copper ores

In many instances, the identifications of J. R. Harris of minerals and ores must be followed.[469] A hierarchy of ancient Egyptian words can be perceived, with the word *ꜥꜣ.t* covering all minerals, including ores, and similar natural phenomena (e.g. fossilized wood). Thus, there was not a single word only for "mineral/ore" in ancient Egyptian. For Harris, the earlier explanations of the term were not clear, and he concluded: "*ꜥꜣt* is to be regarded as a word for mineral, with perhaps certain implications of value and rarity, the distinction between *ꜥꜣt* and *ỉnr* becomes clear, since the latter refers principally to stones which were quarried in large quantities."[470] Closeness in writing and probably also sound with the ancient Egyptian term for "donkey" might not be coincidental. Etymologically, this word might be connected to the word for *ꜥꜣ*, donkey, being the "donkey (load)". The etymology is in agreement with what is known about the means of transport of minerals in this period.[471]

Malachite is the best-known source of the copper. Its most often used ancient Egyptian name was *šsmt*. Another word, *wꜣḏ,* had several possible translations, besides malachite including also other green semi-precious stones.[472]

4.1.2. Copper

The answer to the quite simple question of what the ancient Egyptian name for copper was is complex and difficult. The following paragraphs represent yet another attempt, following O. Herslund's conclusions in several respects[473] while newly incorporating evidence on the wide use of arsenical copper and adding also new interpretations (Figures 4.3–4.11).

The main problem is with the way metal is written down in ancient Egyptian sources, noted by logographic signs, scarcely accompanied by phonetic complements and their regional and temporal diversity was taken into account less frequently. However, several sources offered writings, in which the term is written partially phonetically. Thus, we are presenting a case for the identification of "copper" with the word *bjꜣ*. Reading of copper as *ḥm.t* and metalworker as *ḥm.ty* in the periods under study is mistaken and not correct in the periods under study. The word *bjꜣ*, however, meant also things completely different from metals. This makes it very difficult to determine what is denoted in many contexts.

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469 (Harris 1961).
470 (Harris 1961, discussion on pp. 21–22, quote on p. 22).
471 Creation of nouns by feminine endings is a feature of early Egyptian language (Loprieno 1995, 52–54).
472 (Harris 1961, 132, 102–104).
473 (Herslund 2011, 2015).

Even the contemporary pronounciation is misguiding. According to the historical phonological reconstruction, phoneme j was a sound representing Semitic [y], while phoneme *ꜣ* is the most "controversial" of Egyptian phonemes and the interpretations differ. Two main stances on the pronounciation in the Old Egyptian are either as [r]/[l] or as [']. [474] The word for copper is conventionally pronounced by Egyptologists as [bia] nowadays. Etymological parallels in many Semitic languages speak rather for the pronounciation of [byr]. [475]

Many meanings of *bjꜣ* were dissected by E. Graefe. [476] Etymologically, it seems that the original meaning of *bjꜣ* was "hole in the ground", thus also "mine" and materials mined in the ground. G. Takács makes the distinction between the words for "mine" and "metal", both written *bjꜣ* in Egyptological transcription, arguing that these were two different words. [477] The distinction is corroborated by the etymological parallels of the both words. The word *bjꜣ* as a mine denoted originally any "hole in the ground", including e.g. wells, and the word is often determined by a sign of "well" or "a hole filled with water", in Gardiner's Sign List N41. [478] This sign is, however, used also for the denotation of the *bjꜣ* as a material (as we can see on the examples on Figures 4.7–4.8, 4.10), and not only this sign. Already in the Old Kingdom, these words were probably closely converging in pronunciation, thus we are finding examples of the confused writing, where N41 is changed with the several copper-related signs.

Two hieroglyphic signs denoted copper-related subjects most frequently, the first resembles a "drop", the second is a crucible or a doubled crucible (Figures 4.3–4.11). [479] The former is used as a determinative of material and is discussed here, the crucible in the subchapter on the name of metalworker. According to Herslund, "drop" represents a crucible packed in charcoal. In some cases, the drop shape is completed with a tiny stroke on the bottom. Also other occurrences of the sign in the context of the name of material *bjꜣ* do not resemble the "hole with the water" sign N41, but a square to drop-shaped sign with a dot in the middle. Could this be a frontal view of a crucible, little stroke denoting the liquid metal poured out? Another form of sign has the rounded shape on the bottom and projections upwards and sideways, denoting most probably crucible on a fire. This sign developed also into the lozenge-shaped "diamond" sign, often written in a *bjꜣ* group.

Significant evidence of the convergence of pronunciation are writings in the Pyramid Texts, where in the many writings of *bjꜣ* sign group is used both the sign N41 for "well", but

[474] (Takács 1999, 50–92, 273–275).
[475] (Takács 2001, 123).
[476] (Graefe 1971).
[477] (Takács 2001, 122–126).
[478] Early variants of this sign are discussed in (Graefe 1971, 84–85).
[479] Latest detailed analysis of their occurrences in (Herslund 2011, 62–65, 2015).

also "drop"-shaped or "diamond" shaped sign, denoting crucible. Graefe thought that this could be "Meteorstücke", but it is quite well visible that these are different forms of the "crucible" sign (Figures 4.7–4.8).

O. Herslund omitted several sources, and a few new ones were published recently. However, all of these are understandable in the framework of this interpretation of sign connections. Scribes of the papyrus archive of Raneferef used several forms of the N41 sign, if written with initial b, read as *bjꜣ*, in one rare case even as a droplet sign with a projection, rather unique in the hieratic (on Figure 4.5, Pl. 43H). In two cases, the N41 sign was read as *ḥm*, in the title of *ḥm.tjw*, "craftsmen".[480] Two forms of writing show royal inscriptions, an inscription of Nyuserra at Ayn Sokhna, with N41, but clearly read as *bjꜣ* (Figure 4.5, Ayn Sokhna, Gallery G5), and an inscription of Mentuhotep II, with group of signs resembling the groups from offering lists, but also adding a "diamond" sign with projections (Figure 4.10, CCIS 218). The temple inventory from Coptos uses throughout "drop"-shaped sign for copper.

Of these many forms of copper sign (and we cannot forget that these are only scant remains of several centuries of writing development), a single form prevailed in the Middle Kingdom, sign N34 for a single crucible, denoting both the material processed in the crucible, copper, and the craft specialization dealing with it. The cursive form of this sign is used in both meanings throughout the papyrus Reisner II. Nevertheless, even in the Middle Kingdom occurred also signs in form of double crucible, e.g. on the stela of Khety and in the annals of Amenemhat II.

Moreover, I would like to also propose another connection of the "drop" sign. The "drop" shape begun to denote a "fire" and it became identical with a top part of the hieroglyphic sign U28, read as *ḏꜣ*. The lower part became a "fireplace" / "cauldron", similar to the sign N26. Gardiner interpreted the combination as a "fire-drill" and this word is known from the periods under study only from the Tale of shipwrecked sailor.[481] An interpretation of the sign U28 as a depiction of "fire" is more probable, and even in some metalworking scenes, such feature is complemented by a crucible, as in the tomb of Antef in Thebes.[482] One of the many ancient Egyptian terms for fire or "burnt" (things) is also *ḏꜣf*, although with rather late appearance in the sources.[483] We can observe a development of the signs. A drop-shaped sign, although "flattened" denoting copper as a material is known since the Early Dynastic

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480 (Posener-Kriéger,Verner and Vymazalová 2006, Pls. 7, 7A, 50, 50A).
481 TLA, lemma no. 181490, later mentioned in pBrooklyn 47.218.84.
482 The main determinative for fire being, nevertheless, the sign Q7 (Cannuyer 1990).
483 TLA, lemmas no. 182120, 182130. Cf. (Cannuyer 1990, 104: 28).

Period.[484] On the other hand, sign U29 of the same time started as two strokes, one horizontal and another one vertical, becoming in the Dynasty 2 a "flame" shaped feature, still on a vertical "platform".[485] Original form probably reflects early hieratic sign. More than thousand years later, similar sign, a horizontal and a vertical stroke, denotes copper in the entries of papyrus Reisner II. This connected group of signs might be called "pyrotechnological", as these signs clearly were perceived by ancient Egyptians as a similar emic category.[486]

Copper is often read by Egyptologists as *ḥmt* and metalworker as *ḥmty*, based on the analysis by J. R. Harris.[487] The term *ḥmt* was supposed to be distinguished from *bjꜣ*, translated as "(meteoric) iron". The former term was interpreted as being the closest to our perception of the word "copper" and its physical and semantic properties.[488] As we have seen, whole confusion can be explained by the several meanings of the word *bjꜣ*, one of them being "copper", and uses of several differing signs, N41 read both as *bjꜣ* and *ḥm*, N34 read as *bjꜣ* and *bḏ*(*t.*). Although Harris claimed that "none of the words of the *bi-* or *biꜣ-* roots is ever written with N34 ideogram",[489] it was demonstrated that these instances are, in fact, many, although they are more often connected with the "drop-shaped" sign and its derivatives (see Figures 4.3–4.11). Already C. Lalouette convincingly refuted the reading *ḥmt* and proposed term *bjꜣ* also for copper.[490] Herslund claimed that no sources of phonetic value *ḥm.t* were from the "Pharaonic Period".[491] Before Coptic, similar word occurred only in the texts from the temple at Edfu, where *ẖmt*/*ẖms* names the lance of Horus.[492] Harris listed two more instances from Edfu.[493] In Coptic, the word in question is **ϩⲟⲙⲛⲧ/ϩⲟⲙⲧ**, meaning copper, and **ϩⲏ**, meaning "mine, quarry".[494] Before these uses, there is almost no evidence indicating this reading of the sign "copper", but a definitive discussion would need to include the sources of the New Kingdom and later ones, which are out of the scope of this thesis.

An exception of a material, close philologically, but also practically, might be a term *ḥmwt* found in the periods under study in the annals of Amenemhat II.[495] It was written with

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484 (Kahl 2004, 308–309).
485 The only exception being a „club"-shaped sign from the reign of Ninetjer (Regulski 2010, 197–198, 660–661).
486 Fire as a phenomenon was denoted by many words in ancient Egyptian (Cannuyer 1990).
487 (Harris 1961, 50–62). That "drop"-shaped hieroglyph and bjA were two distinct words was also an opinion of (Posener-Kriéger 1969, 424–425).
488 Later followed e.g. by (Altenmüller 2015, 208).
489 (Harris 1961, 61).
490 (Lalouette 1979, 333–334).
491 (Herslund 2011, 38).
492 (Harris 1961, 51).
493 (Harris 1961, 62, footnote 2).
494 (Černý 1976, 271, 283–284).
495 (Altenmüller 2015, 198–199).

the sign U24, for the stone-drill, and determined with pellets-sign of a mineral. It was translated as "green frit", but it might as well mean copper dust (or possibly dust of other green-coloured minerals as well), needed for the production of faience as a colourant.[496] In papyrus Ebers, this material is used for the healing of wounds, and copper indeed has antimicrobial properties that might be helpful.[497] Here might be seen the precursor of the later term for copper in Coptic.

4.1.3. Asian copper and other adjectives

The term copper often occurs from the Old Kingdom either with the "adjective" *sṯt,* which is usually translated as "Asiatic" or standing on its own as "Asiatic" (copper). Current, more correct form would be "Asian". The word is derived from *sṯt*, traditionally translated as "Asia" (Figure 4.9). According to the latest analysis by A.-L. Mourad, the term denoted neighbours of Egypt to the north-east, predominantly Sinai and southern Levant, possibly also parts of eastern delta. Once in the Old Kingdom, the people living in *sṯt* were denoted as *mntw*. But often was this term used as *topos*, not denoting a concrete region, just presumably the area to the north-east of Egypt. In other instances, the word had determinatives of crenelated fortified settlements, the nearest being those in southern Levant.[498] For Tallet, the general name of the area east and north of Egypt is *sṯt* even until the New Kingdom.[499] The term is written down by a specific hieroglyph, interpreted as a pack-saddle for donkey or a shoulder knot.[500] In addition to the name of *ꜥꜣ.t*, this might be another donkey-related term, connected also with the import of materials foreign to Egypt and Egyptians.

A. Nibbi included in the territory also Eastern Desert and this material term therefore described copper from the Eastern Desert and Sinai. [501]. The latest discussion by Sowada proposed that the term *sṯtj* could have meant either copper from Feynan or tin bronze from northern Syria.[502] In the latter case, Old Kingdom Egyptians would rather use the term copper from *Rṯnw*/*kbn* – land of Retjenu/Byblos.[503] The word *sṯt* was used by Sahura on Sinai and thus this term for material most probably included material coming from the peninsula.

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496 (Tite et al. 1998).
497 (Matiegková 1960; Weser 2005).
498 (Mourad 2017).
499 Tallet (2018, 15). According to (Saretta 2016, 20–21), *styw*, Middle Kingdom version of *sṯt*, overlaps with the term *ꜥꜣmw*, "Asians".
500 Saddle-pack interpretation in (Nibbi 1977, 60, 1978), shoulder knot in (Redford 1986, 125).
501 (Nibbi 1977, 60, 1978).
502 (Sowada 2009, 185–188) The explanation of the term is problematized by Golden, who lists earlier opinions of A. Nibbi and J. Černý that copper in the Eastern Desert was also mined by Asians (Golden 2002, 232).
503 For *Rṯnw* see (Saretta 2016, 20).

The explanation of the origin seems to be based on the fact that some kind of copper was coming from “Asia”, being different from a “usual” copper known to ancient Egyptians, most probably from Eastern Desert. That was an area where they first encountered copper ore and copper. As this material must have been different from “ordinary” copper, an interpretation either as arsenical copper or, rather improbably, tin bronze can be proposed. Apparently, there is no need for a new substantive, but an adjective is added to the word *bjꜣ*. This could mean that the material is not that different from the commonly used copper as e.g. *ḥsmn*, requiring completely different word. Could this be a denotation of the copper with low arsenic, which is not significantly different from copper by its appearance, but by its physical properties? It was harder and the outer appearance was similar to “normal” copper and did not instigated the use of a different word. Slight difference from the “normal” copper could have been the olfactory sense of the garlic-like smell of arsenic. The term can thus denote material coming from Sinai and possibly also southern Levant, which is in compliance with the perception of the both regions as part of a geographical entity different from Egypt, named *sṯt*.

Ancient Egyptians used also other adjectives motivated by the geographical origin of the ore, although these are less frequent. Three of these were mentioned in a stela of Khety. One of these ores, ore of *Jhwjw*, occurs again in the annals of Amenemhat II as the material for production of vessels, but with a different orthography of *j*(*w*)*ḥw*.[504] On the stela of Khety, it is described as *psḏ*, “shining”.[505] It occurs also later in the New Kingom, but early differing orthography might indicate that in the Middle Kingdom it was relatively new source of material, also for the scribes. Altenmüller is most probably correct with the opinion that this is a specific alloy, but it does not have to be a “sheet” as he proposes. Statistically relevant analyses of the cultic equipment might point to the possible source of this alloy.

Stela of Khety names the sources as “new” and this is an expression also found in the annals of Amenemhat II, in the booty from the towns *jwꜣj* and *jꜣsjj*. Among the captured objects are 646 debens of *bjꜣ swꜣ*, i.e. “broken copper” or copper scrap, and 125 debens of *bjꜣ mꜣ* “new copper”.[506] Egyptian administrators here made a difference between a material prepared for recycling and a material that was probably freshly captured from a workshop/workshops. The ratio is already in the early Middle Kingdom strongly in favour of the recycled copper.

[504] (Altenmüller 2015, 211).
[505] TLA, lemma no. 62420.
[506] (Altenmüller 2015, 76–77).

As an import from Sinai is in the annals of Amenemhat II for the first time mentioned *bjꜣ-kjs*, i.e. “copper of Cusae” (M13). According to Harris, this was originally magnetite and then also confused with hematite.[507] For Altenmüller, this word might already here represent hematite, and Tallet presumes as well that it might be either this mineral or magnetite.[508] It might have been used for the production of jewellery, but it was also important as fluxing agent in the smelting of copper.

The word *bjꜣ rwḏ* in a Middle Kingdom text in one of the Lahun papyri, translated by Harris as “hard copper”, might have denoted “arsenical copper” or it is an early attempt of naming a tin bronze object.[509]

4.1.4. Alloyed copper: arsenical copper and tin bronze

Metals and elements other than copper are seldom mentioned, with the exception of gold and silver. The word *ḥsmn* is usually translated as tin bronze.[510] It is most probably true for the New Kingdom, when this was the most frequent alloy used by ancient Egyptians. Before this era, tin bronze was marginally present in Egypt, but arsenical copper must have been the most widely used alloy in the times preceding the Second Intermediate Period and the New Kingdom for practically used metal artefacts.

Thus, a more logical interpretation offers itself based on existing evidence. J. R. Harris could not consider the occurrence of arsenical copper. Yet, to my knowledge, there are almost no discussions about the possible term for arsenical copper in ancient Egyptian. One of the few was by archaeologists Eaton and McKerrell, proposing the translation of the word *ḏꜥm* as arsenical copper.[511] From the contexts of the uses of *ḏꜥm*, however, the usual interpretation as “electrum” ought to be followed.[512]

Therefore, I propose reading *ḥsmn* as arsenical copper, with higher contents of arsenic, thus observable as different material also by a naked eye in uncorroded state. In the Middle Kingdom, this material begun to be mistaken also for tin bronze, as it started to be used for the production of practically used artefacts, being imported to Egypt from abroad and, consecutively, produced from the recycled material also in Egypt itself. The details of the process are elaborated in the following chapters.

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507 (Harris 1961, 170).
508 (Altenmüller 2015, 193–194; Tallet 2018, 66).
509 (Harris 1961, 58).
510 (Harris 1961, 63–64; Altenmüller 2015, 206–208).
511 (Eaton and McKerrell 1976).
512(Harris 1961, 44–50; Parkinson 2009).

Another frequent translation of this word in other contexts is a natron. The closeness of the words was most probably due to the fact that the appearance of arsenical copper with c. 10% was rather whitish-grey. Its translation is most probably copper with high arsenic. Again, as in the case of copper = *bjꜣ*, this claim will be supported throughout this thesis by separate categories of evidence. However, to complicate the matter further, the same name was allotted also to the mineral amethyst.[513] As a purple variety of quartz, it can have different hues, ranging from white to purple. Significantly, the streak of the mineral (powder that is produced from the mineral) is white.[514] The closeness of these words can be thus justified by the "white" colour of some of their occurrences.

The reason why I am trying to explain the change in the lexical subject of the word is that I find difficult to explain a connection among tin bronze, natron, and amethyst. The connection between natron and amethyst can be substantiated by the white colour of some of their forms, but the hue of the tin bronze is well-known until present day and it has nothing to do with the white colour, neither is the colour of tin minerals, especially cassiterite, which is grey or black. If the word originally denoted copper with high contents of arsenic, having a cool, whitish-grey hue, lexical connection among these three seemingly unrelated words can be explained by referring to some of their perceptible properties. Unfortunately, we cannot verify the perception of ancient Egyptians of different eras on these materials.

The information on the particular smell of metallurgists ("metalworkers stinking more than roe") in the *Teaching of Khety* might be evidence of the use of arsenic (4–8).[515] The text was composed in the period when one of the most frequent copper alloys was so-called arsenical copper. Arsenic is a toxic element with a distinct smell slightly similar to garlic – the verse might be a reference to the use of arsenic in metallurgical processes.

Other metals were discussed by Harris and then seldom by other authors. The word *ḏḥ.t* is usually translated as a lead, but it could have been also confused with tin.[516] Rather low numbers of the ingots listed in the annals of Thutmose III might allow consideration of translating this material as tin in some cases.[517] Since the properties of the alloys, using either tin or lead, differ markedly, this metal was most probably not confused by the metalworking specialists using the ores.

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513 (Altenmüller 2015, 200).
514 Amethyst, see Web resources in the bibliography.
515 Other proposed interpretation is that it is connected to the use of mud as a protective material against heat, cf. (Verly 2017).
516 (Harris 1961, 67–68)
517 (Altenmüller 2015, 310–311).

Another assumed name for tin from the Middle Kingdom is *sšw*, mentioned on the stela of Sahathor from the reign of Amenemhat II.[518] Being present also in the annals of Amenemhat II, it was translated by Altenmüller as "white lead".[519]

4.1.5. Crucible and metalworkers

This subchapter discusses the main term translated as "metalworker" in contemporary texts (Figures 4.12–4.15). The category includes both smelters/melters and smiths for ancient Egyptians. It is argued here that the word for crucible was *bḏ.t* and the word for the metalworker was *bḏ.ty*. Alternatives, existing in Egyptological literature, of *ḥm.t* and *ḥm.ty* are mistakes.

The hieroglyph N34 depicts a ceramic crucible used for the melting of metal; this interpretation, corroborated by iconographic, palaeographic, archaeological sources, was proposed already by J.-F. Champollion.[520] It is not an ingot, as was supposed by Gardiner. This sign almost always stands alone, without phonetic complements, like in the case of copper, which complicates its interpretation. The term for a crucible (*bḏ.t*) is written in full in several texts. The earliest is on the statue of Ankhua (Figure 4.12, EA171).

An alternative form of the sign (W13) represents two crucibles side by side. This co-occurrence might be read as a *nisbe* of the word *bḏ.*(*t*), i.e. *bḏ.ty* – creating also a pun on the name of a metalworker, "person of the crucible"/"crucible operator", i. e. a metalworker.[521] On this basis, *bḏ.ty* can be defined as the only legitimate reading of the name of a metalworker in ancient Egyptian in the periods under study.[522] As was stated in the subchapter on copper above, the signs N34 and W13 were also used for the writing of the material itself, processed by metalworkers. In the Old Kingdom, Dynasty 5, e.g. in the tombs of Iymery and Wepemnefret, both signs occurred in the same scenes, W13 denoting the profession and "drop" sign denoting the material (Figure 4.13, G 8882; Figure 4.35e, G 6020). Both signs occurred in the unique title of a certain Neferseres, "metalworker of copper" (Figure 4.13, Tomb of Nikaukhnum). In the Middle Kingdom N34 became the only used form for both the material and the profession.

The phoneme *ḏ* was most probably pronounced as [dj], Semitic [*g]..[523] A lemma *bḏ* common both for crucible, *bḏ.t*, and a bread mould, *bḏꜣ*, points most probably to the similar

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518 Tallet (2018, 25).
519 (Altenmüller 2015, 201–202).
520 Harris (1961, 51); Nibbi (1977, 60-62). Followed e.g. by (Davey 1985; Franke and Mareé 2013, 109).
521 For nisbe see (Allen 2010, 61–68). For the creation of nouns with nisbe ending (Loprieno 1995, 57–58).
522 As already proposed by (Drenkhahn 1976); followed e.g. by (Franke and Mareé 2013, 109). Later on, the crucible in Coptic was called ⲃⲓⲛⲓ, and the smith ⲃⲉⲥⲛⲏⲧ (Černý 1976, 24, 27).
523 (Takács 1999, 249–262).

mental concepts of both artefacts.[524] Current Egyptological pronunciation is again incorrect, instead of [bedja], the word needs to be pronounced as [bedjer], having e.g. clear Akkadian parallel in a name of vessel, "bugurru".[525] The vessels themselves were made of similar material, Nile mud with a lot of temper and after firing rather porous sherd. Moreover, there is evidence of the use of bread moulds as copper processing vessels (see Chapter 5).

The craftsmen working more often with gold were named as "goldworkers", although down to Middle Kingdom, the sources are clear in informing us that these specialist were working both with gold and copper, in production of jewellery. In the Old Kingdom, the title of the gold worker is a combined expression *bḏ.ty nbw*, "metalworker of gold". Then, in the Middle Kingdom, the title changed into later *nb.y*, "goldworker", "goldsmith".[526] Therefore, the Old Kingdom occurrences of the title can contribute also to the palaeography of the sign N34, Middle Kingdom titles are written only with the sign of a collar.

The only early exception to this reading and writing were documented in Elephantine, where the title *ḥm.tj* is inscribed by the groups of signs interpreted by Pätznick as the title "metalworker" (Figure 4.12). One case can be explained as this title, another must be something else (see chapter 4.4.2 for arguments).

Lastly, several titles interpreted as metalworkers, can be translated otherwise. In the early Dynasty 11, a rock inscription of Ipi, son of Ipi, from the reign of Mentuhotep II, lists several of his titles, among these *jmy-r ḥm.tjw ḳs.tjw, ḥr(.j)-ḥr(.j)w m ꜥꜣ.t nb, ḥm.tjw ꜥꜣt nb*.[527] The context indicates rather a translation overseer of craftsmen and sculptors, superior of the superiors in all minerals, craftsman of all minerals, although a translation to "metalworker" was proposed.[528] Similarly, an inscription from the late Dynasty 11 features probably a cursive version of the stone-drill hieroglyphic sign and ought to be translated as "overseer of craftsmen".[529]

As the early sources are extremely laconic, the reconstruction of the specific vocabulary of early Egyptian metalwork can be only tentative, working with almost singular pieces of evidence. The actions of metal smelting and casting was denoted by the verb *nb(j)* and the specific name of such fire was *nbj(.t)*.[530]

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[524] *bḏ*, and *bḏꜣ* resp. as crucible and mould – TLA lemmas 58540, 58550; TLA *bḏꜣ* as bread mould – TLA lemma no. 58570.
[525] (Takács 2001, 366–367).
[526] (Jones 2000, 416, title no. 1533; Quirke 2003, 90, 92).
[527] (Couyat and Montet 1912, 46–47).
[528] A. Ilin-Tomich, pers. comm.
[529] (Goyon 1957, 79, Pl. XIX, inscription no. 57). Again, according to A. Ilin-Tomich (pers. comm.), the sign in question ought to be translated as "metalworker ".
[530] (Cannuyer 1990, 110).

4.2. Expeditions: procurement, initial processing, and transport of ore

The initial steps of the *chaîne opératoire* were the procurement of the ore, its assumed preliminary processing, sealing and transport to Egypt herself. As all areas with the occurrence of copper ore were situated outside the core area of the country incorporated in the nome structure, an effort was needed to reach these areas. The textual evidence is irreplaceable with the information on the societal and institutional involvement in the organization of expeditions.

Let us now examine existing textual evidence, which begins to occur on Sinai in the late Predynastic Period and then continues there and also in other areas. Despite that, most inscriptions lack direct information or even hints at the processing of the copper ore, as this was not the focus of the texts (Figures 4.21–4.26). While limiting ourselves to sources listed in the database, we will observe how the official scribes change their practice, how inscriptions successively provide more complex information, including mentions of metalworkers and copper. If the inscriptions were present, they have begun gradually to mention cultic activity, offerings, and various deities. An important topic was successful return home, rewards for the people who would read offering formulae and (afterlife) repercussions for those, who would damage the inscriptions.[531] The areas, where the Egyptians mined the resources, were perceived as the lands of the "otherness", specific divine presence, thus also priests were participating on expeditions, and the procurement of materials was possible only because of the divine "assistance".[532]

The total number of expedition inscriptions gave rise to rather modest estimates of the frequency of the expeditions, counting on 15 years between expeditions for all expeditions in the Old Kingdom, 35 years in Wadi Hammamat until the end of Dynasty 30 and 17 years for Wadi el-Hudi.[533] But did each expedition initiate an inscription? We need to bear in mind and try to answer the most important question: why some of the areas of ancient Egyptian activity were worthy of inscribed commemorations of the expeditions (such as Sinai and Nubia, or the Western Desert without copper sources), while other areas with the mining presence are almost without inscriptional evidence (the Eastern Desert areas with copper mines). Informal procurement of some materials, outside of the control of state, is deliberated by several authors, although the direct evidence is meagre. Such procurement could have been taking

531 (Eichler 1994).
532 (Lloyd 2013).
533 (Gundlach 1977, 58; Eichler 1993, 151).

place only on sites well accessible from Nile valley, e.g. Eastern Desert, but hardly at Sinai Peninsula.[534]

Ore procurement was not easy and a well-known ancient Egyptian metaphor touches upon the subject. In the Middle Kingdom Teaching of Vizier Ptahhotep, a verse hints at the observation that "*Perfect speech is more hidden than malachite, …*" (pPrisse, 50 (P 5.8). The malachite might have been an allusion to the difficulty of finding the ore. The metaphor was referring to the reality known to the reader. The context of the claim did not seem to be ironic or subversive; it is an assertion of the scarcity of some type of resources, both human and natural. It can therefore be inferred that by the time of the Middle Kingdom at least, it was difficult to find suitable copper ore, as easily reachable deposits had been depleted. However, it must be noted that for Harris, translation of this word as "malachite" seemed "inappropriate" and supposed that this must refer to a rarer type of stone.[535]

4.2.1. Late Predynastic and Early Dynastic Period

From the beginning, corpus of inscriptions is uneven. While inscriptional evidence from Sinai occurs in the Predynastic and then increases, documented inscriptions from several copper mining areas in the Eastern Desert are rather rare.

4.2.1.1. Sinai

The assumption that King Netjerykhet (Djoser) was the first ruler to organise an expedition to Sinai is untenable in view of recent discoveries. Inscriptions identifying early rulers but not directly referring to the procurement of resources were documented at Wadi Ameyra and Faras Um al-Zuebin, probably in connection with Naqada IIIA King Scorpion,[536] certainly with Naqada IIIB Kings Iry-Hor, Ka?, and Narmer, Naqada IIIC, Dynasty 1 Kings Djer, Djet?, and Den and Naqada IIID, Dynasty 2 King Nebra. They are interpreted as being inscribed in the vicinity of an as yet unidentified mining area.[537] Even though the evidence is indirect, it can be assumed that the presence of the Egyptians meant also the exploitation of its mineral resources, starting in the Predynastic Period. And although Tallet assumes a land route for these expeditions,[538] boats prominent in these Predynastic and Early Dynastic inscriptions might point to them at least as complementary means of transport to Sinai even in these remote times. The occasional mentions of a royal carpenter (or shipwright indeed)

[534] (Bloxam 2006; Mazé 2018, 119–121; Kemp 1991, 246–248).
[535] (Harris 1961, 103).
[536] Based on the analogy of rock inscription in the tomb of U-j, sometimes ascribed to King Scorpion I (Tallet and Laisney 2012, 383–384, Fig. 7).
[537] Tallet and Laisney (2012); Tallet (2018, 86–96, 122–125).
[538] Tallet (2018, Fig. 14).

during the reigns of Djer and Netjerykeht represent another indication of the use of boats on the royal expeditions.

A series of events was inscribed on the year labels of King Den (Figure 4.21a). Thanks to two complete specimens referring to the king's sed festival, the events can be set in the thirtieth year of his reign. Because of the discovery of the king's inscriptions on Sinai, in Wadi Humur, P. Tallet interprets both year labels and the Sinai inscriptions in connection with each other.[539] The year labels, found in the Tomb of Den at Abydos and currently in the collection of the Louvre, the British Museum and the Oriental Institute Chicago, render several actions in one register.[540] They are read and interpreted as destroying the walled settlement *ꜥꜣ ꜥn* (Beautiful Gate), massacring the people Iuntiu (people of the bow) and bringing malachite (*jn.t šśm.t*). The last element of the table is a feathered figure with a striding leg, holding a harpoon or spear in the front hand and another object on the opposite shoulder. This image is most frequently interpreted as one of the earliest images of the god Sopdu[541] or of the deity Ash, later merged with Sopdu.[542] P. Tallet identifies the settlement mentioned with the site of Ayn Fogeya, the largest known Early Bronze Age settlement on Sinai.[543] If the interpretation is correct, this is a clear example of how ore sources might have been gained by military action. The register combines the conquest of a town, the killing of its inhabitants and the receiving of booty in the form of malachite. As the reference is to the copper ore, it can be assumed that it was processed in the Egyptian state itself. The two year labels referred to similar events.[544] Although the triangular sign on the larger fragment was interpreted by Herslund as copper,[545] it is rather a rendering of the group of signs "malachite" as on the year labels from the preceding series.

The bringing of unspecified tribute or offering by a foreigner kneeling in front of Horus on a serekh is also the subject of a rock drawing from the reign of Djer.[546] In Dynasty 3, the inscription from the reign of Netjerykhet is partly damaged, the supposed enumeration of the products brought from Sinai is missing (Figure 4.21b).[547] The administration of Sinai in Dynasty 3 was most probably led by the official *ꜥḏ-mr ẖꜣs.t*, who is present in the Sinai

[539] Ibrahim and Tallet (2008; 2009); Tallet (2010).
[540] The British Museum: EA32650, EA15466; Louvre: E 25268; the Oriental Institute, University of Chicago: E6215, E6126.
[541] (Godron 1990, 58–59).
[542] (Tallet 2018, 47–49).
[543] Tallet (2010, 102–103).
[544] Godron (1990, Pl. VIII: 15, 16).
[545] Herslund (2015, 111. Figs. 8–9).
[546] CCIS 207: Tallet (2018, 91, 200).
[547] Eichler (1993, 29, No. 2).

inscriptions.[548] At the lower left end of the inscription of this official is possibly written the word *bjꜣ*, but the context is unclear.

4.2.2. Old Kingdom

The expedition practice of Dynasties 3–6 was documented in increasingly detailed expedition inscriptions.[549] While the inscriptions indicate consecutive expeditions, not all of these might have initiated a textual recording. And many might be lost because of erosion.

The ore procurement happened under the auspices of some Old Kingdom deities. This idea was well expressed by A. B Lloyd: "natural products or attributes of these lands belong to the gods and, if the Egyptians get their hands on them, they do so because the gods allow this to happen."[550] The deity *par excellence* in this regard is Horus, personified by the reigning king[551] and by his Horus name. Another such deity is *ḏḥw.tj nb ḫꜣs.wt*, Thoth, the lord of the foreign lands.[552] The king is also a beloved one of the Lord of Coptos – the god Min.[553] Min was one of the main deities of the Eastern desert. Even the highest of gods could have been involved in the mineral procurement. In Year 6 of Djedkara, writings (*sš*) of Ra in his sun temple Nekhen Ra informed about a place of finding turquoise. This is probably "the first recorded example of a divine oracular indication that success would be achieved on such a mission, in this case to extract semi-precious stones, especially turquoise, from Sinai".[554]

Officials with the title *ḫtm.ty-nṯr* were usually interpreted as the leaders of the expeditions,[555] but other opinions are also presented in the literature .[556] These officials were appointed to tasks requiring military participation and/or organized workforce, and the royal commissioning of these tasks was emphasised in the title.[557] The missions required sealing – meaning the control of amount of procured materials, and even the overseeing of bringing a dwarf to the court of Pepy II.[558] An increased number of holders of the title was buried in the provinces in Dynasty 6, pointing to the decentralised organisation of the expeditions and probably also of other tasks of officials.[559]

[548] Eichler (1993, 37, Nos. 23, 24).
[549] (Eichler 1993).
[550] (Lloyd 2013, 365).
[551] E. g. Sinai expedition inscriptions Eichler 1993, 29-32).
[552] (Eichler 1993, 31-32, No. 10).
[553] (Eichler 1993, 71, No. 124).
[554] (Baines and Parkinson 1997; Strudwick 2005, 137).
[555] (Eichler 1993, 234-254).
[556] (Kuraszkiewicz 2006, 200).
[557] The claim that "the title of god's sealer in itself does not express in any way the functions of its holder" is thus incorrect (Kuraszkiewicz 2006, 195).
[558] The "civil" duties of the sealers in the Old Kingdom sources are described in (Kuraszkiewicz 2006).
[559] (Eichler 1993, 250-254).

The evidence will be discussed below. However, what is absent in the inscriptions is e.g. the information about the tools used. We can only estimate which titles could have been used in the connection with the use of tools with copper blades. The most likely specialized group working with copper tools on expeditions was *ḥmw.tjw*, "craftsmen".[560] The work of masons on expeditions was directed by *jmy-r šj* – „overseer of the stonework",[561] *jmy-r ḳdw*.[562]

4.2.2.1. Eastern Desert

Again it is needed to reiterate that this area was not considered as ancient Egypt proper by Egyptians. The inhabitants of Eastern Desert were different from Egyptians. A chain of fortresses probably existed along the border with the Eastern Desert in the Old Kingdom.[563] The Old Kingdom title *jmy-r mnww*, overseer of the fortresses, most probably referred to these military installations, which could also serve to protect the transported material including the ore.

Coptos was a departure point for expeditions to Wadi Hammamat, but it obviously concentrated also specialists for the expeditions to Nubia. Titles occurring on monuments from the Coptite nome refer to the organization of expeditions to the Eastern Desert and Nubia and to the sealing of some material. There are also at least three monuments to men who took part in Old Kingdom expeditions with their usual titulary from Naqada and Zawayda.[564]

A specialized group of prospectors (*smn.tjw*) with usual Old Kingdom organizational structure (from plain *smn.tjw* to *jmy-r smn.tjw*) is found inscribed in Eastern Desert expedition inscriptions.[565] The evidence is interpreted by Eichler: the prospectors had higher status than plain craftsmen and were specialized in the prospection of gold (and silver as proposed by him) in the Eastern Desert. Their practical *modus operandi* is visible at the sites in the Eastern Desert; it clearly shows that they must have been looking also for copper and malachite, but there was hardly any silver present.[566] Archaeological evidence thus complements the written sources. Newly found written and archaeological evidence from Old Kingdom Edfu corroborates that these prospectors were targeting also copper ore sources.[567]

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560 (Eichler 1993, 185-187).
561 (Eichler 1993, 171-172).
562 (Eichler 1993, 74, No. 132).
563 (Eichler 1993, 202-204).
564 Fischer (1964, 30-34).
565 (Yoyotte 1975; Seyfried 1976; Eichler 1993, 188–192; Diego Espinel 2014). It was argued in the literature that this might be also a "kin group" (Bloxam 2006, 295).
566 Klemm and Klemm (2013).
567 (Moeller and Marouard 2018).

4.2.2.2. Nubia

A settlement hiatus was presumed in Nubia between Dynasty 1 and Dynasty 4. Except for an inscription of Nynetjer near Korosko, this hiatus was purportedly demonstrated also by the absence of Egyptian written sources.[568] The inscriptions from Khor el-Aquiba testify to a military expedition. The dating of the inscriptions is unclear, as well as whether they can be connected to an incursion to Nubia in the reign of Snofru.[569] Besides gold, also copper might be presumed as one of the immaterial targets of these incursions.[570]

Sealings from the Old Kingdom town at Buhen indicate the chronological framework for the settlement. The site was settled from the reign of Khafra to the reign of Nyuserra, then probably abandoned. Besides sealings and allegedly ostraca, no other Old Kingdom inscriptional evidence is known from the site. But even the sealings were not fully published yet.[571]

Fragmentary evidence of importing gold from Nubia, *nbw* and *ḏꜥm,* was reflected slightly later in an inscription from the decoration of Djedkara's mortuary complex, naming three sites from which gold and electrum were coming.[572] This could also mean that the role of Buhen was overtaken by another site in the region.

The inscriptions in Dakke of three *jmy-r smn.tjw* were found south of Buhen.[573] The prospectors could seek there for gold as well as copper ore. Nubian products are denoted as "*jnn.w nb.w nfr*(*.w*)" – "all good brought products".[574] Old Kingdom inscriptions reach as far as the Third Cataract, however; some Old Kingdom textual evidence was reused even in Kerma and its original location is unknown.[575] Clearly, the Egyptians attempted to reach sources of materials anywhere possible, just as the regional and supra-regional powers use to do anywhere in the world.

4.2.2.3. Sinai

Compared to the frequency of Middle Kingdom inscriptions on Sinai, Old Kingdom inscriptions are fewer in number. This can be explained by the assumption that a monumental inscription might have been necessary only during the first expedition in the respective

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568 (Raue 2019, 102–103).
569 (Eichler 1993, 112–113, Nos. 260–264; Raue 2019, 117–119).
570 Gold and copper among other materials as mined in Nubia by Egyptians are presumed e.g. by (Török 2009, 58).
571 According to M. Torcia, sealings of Early Dynastic kings were identified among the material. There was also an information about a tribute of gold on sealing UC21888. The paper was presented at the 14th International Conference for Nubian Studies in Paris, on 11th September 2018.
572 (Grimm 1988).
573 Eichler (1993, 117, Nos. 278-280).
574 Eichler (1993, 114, No. 265).
575 (Valbelle 1990a; Raue 2019, 133–139).

reign.[576] The fact that turquoise is mentioned as material from Sinai led some authors to doubt copper ore mining in the Old Kingdom,[577] while others are convinced about copper ore mining in Wadi Maghara.[578]

The most frequent motif of monumental inscriptions (15 times) in the third millennium is a scene of a king smiting a kneeling enemy, who is depicted with a pointed beard of an "Asian" man.[579] From Den to Khufu,[580] the population is called *Ꞽwn.tjw*, "bowmen", and *Mn.ṯyw* from Dynasty 5. Since these names co-occur in Old Kingdom sources, they are most probably ethnonyms of the local populations the Egyptians encountered on Sinai.[581] The north of Sinai, down to the vicinity of Suez was inhabited by "sand dwellers", *ḥryw-š*.[582]

A particular inscription from the reign of Sahura informs about the subjugation of Asia (*sṯ.t*).[583] The preferred, more frequent written version of such inscriptions informed, even only on Sinai, about the subjection of all foreign lands.[584] These images and inscriptions confirm that Old Kingdom Egyptians perceived Sinai as a foreign territory where apotropaic measures (monumental images and inscriptions) needed to be taken to protect the expedition participants.

There is a lacuna in the preservation of Sinai expedition inscriptions between the reigns of Khufu and Nyuserra, with the exception of Sahura.[585] This period of absence of inscriptions coincides with the presence of ancient Egyptians in Nubia, with the main habitation and production period of Buhen, datable on the basis of sealings to the reigns from Khafra to Nyuserra. Nevertheless, pottery from the metallurgical installations can be allegedly dated to Dynasty 5, and this lacuna might only be a coincidence.

Since Nyuserra, expedition inscriptions on Sinai started to be more detailed, listing the members of the expeditions and other information.[586] Unfortunately, 16 columns of an inscription from his reign at Ayn Soukhna were badly damaged and the first Old Kingdom mention of copper in this context is unclear (Figure 4.21d). The earliest mention of metalworkers comes from the reign of Djedkara (Figure 4.21e). The inscription from year 6 contains the scribe of metalworkers and the controller of metalworkers – *sš bḏ.tyw* and *śḥḏ*

[576] As (Tallet 2018, 115) assumes.
[577] (Giveon 1978, 51).
[578] (Wengrow 2006, 147; Sowada 2009, 185–186; Gourdon 2016, 169).
[579] Inscriptions collected in Eichler (1993, 29-38), further analysis with additions in Tallet (2018, 33–34, Fig. 8).
[580] Eichler (1993, 30–31 – No. 7, the reign of Khufu).
[581] Tallet (2018, 34).
[582] Tallet (2018,34–37).
[583] Eichler (1993, 38 – No. 26, the reign of Sahura, Wadi Kharig).
[584] E. g. Eichler (1993, 30-33).
[585] Eichler (1993, 130).
[586] Tallet (2018, 106).

bḏ.tyw.[587] The text has been frequently interpreted as mentioning "copper",[588] but the transcription *bḏ*(*.tyw*), "metalworkers" is more likely in this case, as the double crucible is used here.[589] Baines and Parkinson suggest that these officials could have been in charge of the reparation of metal tools used to extract turquoise, not necessarily indicating a connection to copper mining on Sinai.[590] Two similarly detailed Sinai inscriptions from the reigns of Pepy I and Pepy II did not contain metalworker titles.[591]

4.2.2.4. Wadi Arabah

There is no Old Kingdom textual evidence on the imports of copper ore or ingots from Wadi Arabah in contemporary Jordan and Israel to Egypt. The only possible evidence of an incursion into this territory might be a biographical inscription of Weni from mid-Dynasty 6.[592]

4.2.2.5. Byblos

Scribe of the royal carpenters Neferseshemra was named on a fragment of a travertine offering table found in the so-called foundation deposits of the Byblos temple.[593] It was originally dated to Dynasty 3 by Montet, as the same title was held by Hesyra.[594] Ward would rather date the individual to Dynasty 4.[595] Further written evidence of Dynasty 4 or 5 is an inscribed axe, found near the brook Nahr Ibrahim.[596]

Only the publication of the biography of Iny from Dynasty 6, however, provides us with a written source describing the course of some expeditions in detail.[597] In his office of the sealer of King of Lower Egypt, *ẖtm.ty-bj.ty*, Iny brought silver, possibly during the reign of Pepy I (Figure 4.23). Under the reign of Merenra, he was sent to Byblos and brought back three ships with lapis lazuli, lead/tin (*dḥt*), silver and *sfṯ*-oil. The authors prefer the interpretation of the word *dḥt* as tin because lead was accessible in the Eastern Desert. Iny was rewarded for his services with gold. The lesser biography of Iny says directly: "I brought (back) one Byblos-ship and several cargo-ships loaded with silver, Aamu-men and Aamu-women." Iny is interpreted as the central figure of the expeditions in the inscriptions; in his office of *ẖtm.ty-bj.ty*, he was able to lead the expedition and seal and oversee the amount of

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587 (Gardiner,Peet and Černý 1952, 60–61). Translation in Strudwick (2005, 137-138).
588 E. g. Sowada (2009, 186).
589 As transcribed by Tallet (2018, 107–108).
590 (Baines and Parkinson 1997, 15).
591 (Eichler 1993, 34–35, Nos. 16, 17; Gourdon 2016, 168–171).
592 (Miroschedji 2012).
593 On the context (Diego Espinel 2002, 108–110).
594 (Montet 1938, 84–85).
595 (Ward 1964).
596 (Odler 2016, 34, Fig. 19).
597 (Marcolin and Diego Espinel 2011).

materials imported to Egypt. Although copper was not within Iny's sphere of activity, the practice used in the expeditions to the copper-mining regions of the Eastern Desert and Sinai could have been the same or similar.

The silver might have been coming to Byblos through Ebla, although Old Kingdom Egyptians were not aware of this or at least did not mention the fact in their written sources.[598]

4.2.2.6. Punt

An entry on a Palermo Stone from the reign of Sahura denotes bringing of material from two areas, Punt and Sinai (Figure 4.21c). The reading of this *locus* is uncertain, however; the signs are worn and difficult to read. First column lists turquoise or names (terraces of) turquoise,[599] then lists probably 6,000 units of copper. Two other columns are inscribed over with the name of Punt. Below Punt are listed in second column incense and electrum, then in the last column 2,900 measures of malachite. If the reading is correct, this locus shows that the raw material was imported into Egypt in the case of Punt and the following steps of the *chaîne opératoire* took place in Egypt. The locus about Sinai is less clear: it may describe the transport into Egypt of the raw material (pure copper) or of the smelted product. Nevertheless, the entry on the Palermo Stone is accepted with caution. D. Raue proposed that in this case, Punt is merged with Sinai in the inscription.[600]

4.2.3. Middle Kingdom

At the very end of the Old Kingdom, expedition activity must be yet supposed. A false door found at Khozam near Naqada belonged to Dynasty 8 overseer of Upper Egypt, overseer of foreign lands and overseer of eastern and western foreign lands named Weser.[601] According to Fischer, the titles were connected to expeditions to Wadi Hammamat and oases in the Western Desert. First Intermediate Period sources are almost silent about expeditions.

In the Middle Kingdom, using evidence from Wadi el-Hudi, Sinai and Wadi Hammamat, K.-J. Seyfried counted at least 67 expeditions for a period of c. 220 years, meaning that there was an expedition once in every three years.[602] However, the figures are highly distorted by the more numerous expeditions of Amenemhat III, having clearly higher frequency – or just higher rate of the making and preservation of the expedition inscriptions, and this can serve as a good example of incorrect usage of the counting of mean. Regarding time, expedition inscriptions did not often give the complete information. An expedition to the

[598] (Gourdon 2016, 198–199).
[599] (Wilkinson 2000, 168–171).
[600] (Raue 2019, 131).
[601] (Fischer 1964b, 43–47).
[602] (Seyfried 1981, 1–5).

area of Wadi Hammamat could take, according to Middle Kingdom sources, at least two months.[603]

Middle Kingdom literature asserts that the king initiated the expeditions. The main character of the Tale of the Shipwrecked Sailor mentioned twice that he was on the sovereign's expedition to the Mining Region (20–30 and 80–90).[604] In contrast to the Old Kingdom, Treasury officials played the main part in the practical organization of expeditions in the Middle Kingdom, e.g. to Sinai and Wadi el-Hudi.[605] This institution was only included in the title strings of the highest officials in the early Middle Kingdom. Overseers of Both Treasuries organized expeditions to Punt in Dynasty 11 and later to the granite quarries near Elephantine and to Nubia. A Dynasty 11 document from Year 8 of the reign of Mentuhotep III mentions an expedition returning from Punt, led by Henu, the overseer of Both Treasuries and overseer of sealed things of gold (among other titles), but his stated mission is to bring stones for the statues and buildings.[606] Overseers of sealed things, as the officials of Treasury, initiated expeditions more often but rarely participated in them.[607] On the spot, the expeditions were most often led by the great chamberlain of the Treasury (*jmy-rꜥ ꜥḫnw.tỉ wr n pr-ḥḏ*) and the lower positioned chamberlain of the Treasury (*jmy-rꜥ ꜥḫnw.tỉ n pr-ḥḏ*). Great chamberlain of the Treasury Khenmesu from the reign of Amenemhat III says directly that his task was to bring turquoise and copper.[608] The exception is Wadi Hammamat, where expeditions with other highest officials headed as well.[609] Late Middle Kingdom "Duties of the Vizier" preserved in Section 11 an evidence that reports from the mining areas were subjected to the inspection of the highest official in the state after the king, a vizier, who was required to obtain a written "petition" (as translated by Boorn, in Egyptian *sšw*).[610]

The Treasury officials at the residence were different than on expeditions, including a "scribe of the Treasury" (*sš pr-ḥḏ*), a "chamber keeper of the Treasury" (*ỉry-ꜥ.t pr-ḥḏ*) and a "steward of the Treasury" (*jmy-rꜥ pr n pr-ḥḏ*). The Treasury possessed its own fleet and its own craftsmen, including metalworkers.[611] The Treasury issued "sandals, myrrh and

[603] (Nieto 2014, 36–37).
[604] (Goedicke 1974). Moreover, the tale is set in the framework of the return of an expedition from Nubia and the official to whom the story is narrated had to report its unsuccessful result. The adventures happening to the narrator add to an impression that unreal things and phenomena could happen outside of Egypt.
[605] (Seyfried 1981).
[606] (Desplancques 2006, 327).
[607] (Desplancques 2006, 305–306, 324).
[608] (Tallet 2018, 155–157, 323).
[609] (Nieto 2014).
[610] (Lorton 1994, 154–155; Boorn 1988, 193–201).
[611] (Desplancques 2006, 389–398).

everything that is necessary for the works ... for the expedition's workmen".[612] This must have included also metal tools.

We have more detailed information on the "practical" staff of the expedition in this period. The metalworkers were named in the inscriptions and they are listed in the Sinai subchapter. Phyles of quarrymen (*ẖrty.w-nṯr*) and stonemasons (*jky.w*) took part in the expeditions, former hewing the stones from the bedrock, the latter further shaping them into the preliminary shapes. These specialists in work in the quarries were numbered in tens, up to a hundred.[613] Thousand(s) of common workers transported the quarried stones.[614]

Already for the Old Kingdom expedition to Eastern Desert and Sinai was suspected that the local inhabitants either took part in the operations or might have been threatening them. Middle Kingdom expedition inscriptions provide specific, unequivocal evidence of the presence of Asians (*ꜥꜣm.w*) – people of Retjenu in the missions. Undoubted mentions of them exist for 13 out of the 42 expeditions on Sinai. At least one group came from a town named *ḥꜥmj*, assumed to be located in the region near Arad.[615] The evidence on the local population participating on the mining is also being interpreted as indications of the "bottom-up" approach going against the monopolization of material procurement, using Hathor as a deity to be venerated by both sides of the process.[616] However, the Asians might have participated on the state expeditions as well, as the written sources speak about in the Middle Kingdom.

From a religious perspective, Hathor, the consort of Ra and the mother of Horus, became a mining deity *par excellence* in the Middle Kingdom.[617] A temple was devoted to her in her function of the goddess of miners at Serabit el-Khadim on the Sinai Peninsula. It was possibly from there that her cult spread also to the Eastern Desert.

4.2.3.1. Stela of Khety

An idionsyncratic source must be pinpointed, as it describes the course of the expeditions from the point of view of its leader. A crucial document dealing with the practice of the raw material import is the rear part of a limestone stela of a certain Khety (Figure 4.25), datable only generally to late Dynasty 11 or early Dynasty 12.[618] The stela is unique in describing the process of the procurement of ores. On its example, we can observe how a person without a direct mention of metal or metalwork in his titulary could take part in the *chaîne opératoire* of

[612] (Nieto 2014, 53–54).
[613] (Kóthay 2007).
[614] (Nieto 2014, 55).
[615] Tallet (2018, 38–42).
[616] (Bloxam 2006).
[617] (Allam 1963; Valbelle and Bonnet 1996; Cauville 2016).
[618] Recently, it was translated and studied by (Landgráfová 2011, 56–58; Tallet 2018, 10–12).

the handling of copper. Khety's main title was *jmy-r š*, translated as "sea-captain" by Gardiner and later as "overseer of the workplace" by Landgráfová. The interpretations of the term *š* in the literature differ widely.[619] He took part in several activities of the palace, suggesting that he was a person with direct access to the king and courtiers. The first stela depicted Khety at the offering table during the funerary repast.

The second stela rendered twelve lines of biographical inscription of utmost importance for the description of the events unfolding on the expeditions. On the rear part, Khety listed his titles of royal sealer, sole companion and overseer of the workplace. One of the duties of the royal sealer was to make foreign countries powerless. He described his mission: "When I was in the mining region, I inspected it, traversing the foreign lands of Tjenhet. When I was in the houses of the Northerner, I sealed up his treasuries on that mountain of the house of the Horus of the Terrace of turquoise, [having taken (?)] turquoise thence from the mine of the house of Shema. I repeated the carrying from another mine, called The Mine of Horu[s] of [...]tn[...], as that which had come into being for Horus himself." The sealing (*ḫtm.n*(=*j*) is an act of the control of raw materials, in this case turquoise and possibly also copper, and two mines (galleries?) were opened by Khety. Military activity might have been part of the expedition duties: "I punished for <him> Asians in their foreign lands."

The ultimate end of the expedition is clear: "I returned in peace to his palace, and I brought to him the best of the foreign lands, consisting of new ore of Bat, shining ore of Ihuiu, hard ore from Menkau, (and consisting) of turquoise <of> Hererwetet, lapis lazuli of Tefreret, (and consisting) of sahret-stone, which is upon the mountains, silicified wood from the mountain of Hestiu, rentjetj-Mineral from the hill of the desert, (and consisting) of staffs of Rashaawt and black eye-paint of Kehebu." Instead of the translation "ore" by Landgráfová and two options métal/cuivre by Tallet, I would prefer to translate all three occurrences as "copper".[620] Khety brought three types of copper ore from three different localities and many other materials, which might have been either booty or more probably goods gained by exchange in the foreign lands. For all three sites of origin of the copper ore, these are the only attestations in an ancient Egyptian text. The latest attempt to identify them was made by P. Tallet. Bat was most probably the name of Ayn Soukhna,[621] Ihuiu might be a place name on or in the vicinity of Sinai, as a similar name *Jww* is known from the reign of Hatshepsut,

[619] (Franke 1984, 111; Jones 2000, 243–244).
[620] (Landgráfová 2011, 58; Tallet 2018, 12).
[621] (Tallet 2018, 27–28). A recently published fragment of text from the reign of Sahura is not against this determination, either: (Awady 2011).

named right after Sinai.[622] Menkau seems to be similar to the names of Kings Menkaura and Menkauhor, and an inscription of Menkauhor is known from Wadi Maghara.[623] We can observe the cognitive category of *ꜥꜣ.t* – semiprecious stones, including metal ore – in action here, as all the listed materials could be included under one general descriptive unit. And we can also observe that Khety moved around the areas of Eastern desert and Sinai together, thus they are discussed in a single subchapter.

4.2.3.2. Eastern Desert and Sinai

Copper mining on Sinai in the early Middle Kingdom was confirmed by the inscriptional evidence from the reign of Mentuhotep IV at Ayn Sokhna, where the last clause of the inscriptions informed about the task of *r jnt mfkꜣ.t bjꜣ jnw nb nfr n ḫꜣs.t* – to bring turquoise, copper and all good products of the hills (Figure 4.21f).[624] The term *bjꜣ* has several determinatives,[625] but all of them with reasonable parallels in other sources. Mentuhotep is clearly attempting to continue within the tradition of his Old Kingdom predecessors.

What was happening on Sinai was best described on the above-mentioned stela of Khety. Furthermore, Middle Kingdom inscriptional evidence is the most detailed on Sinai from ancient Egyptians. They initiated a building of a temple at Serabit el-Khadim, dedicated to Hathor.[626] On the other hand, Egyptians were feeling on Sinai as in the “land of the others”, as in Dynasty 12 wrote certain Ptahwer on a stela from Serabit el-Khadim.[627]

An expedition to the area of Ayn Soukhna in early Dynasty 12 was organised by overseer of sealed things Ipy.[628] This official’s presence is recorded also in the copper processing site of Wadi Um Balad.[629] We can see how the officials with the expedition duties moved around the area.

The presence of metalworkers in Middle Kingdom expeditions to Sinai was more frequent according to the expedition inscriptions than in the Old Kingdom: three metalworkers in year 11 of the reign of Amenemhat II,[630] two metalworkers in year 4 of Amenemhat III,[631] three metalworkers in year 40 of Amenemhat III,[632] two metalworkers and

[622] Tallet (2018, 30), but even Tallet himself expressed doubts.
[623] Tallet (2018, 30).
[624] Tallet (2012, 199-200, doc. 218).
[625] As was already supposed by (Tallet 2018, 66).
[626] (Valbelle and Bonnet 1996).
[627] (Morenz 2019, 58).
[628] (Desplancques 2006, 240)
[629] (Mathieu 1998).
[630] Seyfried (1981, 156).
[631] Seyfried (1981, 160).
[632] Seyfried (1981, 172).

two carpenters in an unknown year of Amenemhat III,[633] and sixteen metalworkes in year 9 of Amenemhat IV (Figure 4.22).[634] Their tasks were probably smelting the mined ore and repairing broken tools. For Tallet, the number seems to be rather low, indicating that the copper procurement and processing was not the main task of the expeditions.[635] Middle Kingdom expeditions contained also sculptors, such as the overseer of sculptors Ameni from the reign of Amenemhat I.[636] Among other specialist that could have used copper tools were carpenters, quarrymen, and prospectors/jewel workers (*ms-ꜥꜣ.t*).[637] Moreover, P. Saretta proposed interpretation of the term *jmnw* as a transcribed loanword for Semitic craftsmen, these persons known from five Sinai stelae and also from Lisht documents.[638]

4.2.3.3. Western desert

Surprisingly, a metalworker and a ("police") official Renseneb, left his inscription west of the Nile valley, on the recently discovered Gebel Tjauti. The dating of the inscription is late Middle Kingdom, and since metal mining is impossible in the area, a care for weaponry of warriors stationed on a nearby hill Gebel Roma is supposed by J. C. Darnell.[639]

4.2.3.4. Nubia

Nubians were present in Egypt in the First Intermediate Period; it is possible that some raw materials were accessible via informal ways from Nubia.[640] As for Middle Kingdom procurement of copper in Nubia, the evidence is mostly indirect. Hostility against Nubia is perceptible in the sources since Dynasty 11 and especially in Dynasty 12. The fortresses at Kubban, Aniba, Ikkur, Buhen and Kor were founded during the reign of Senusret I. The most important raw material mentioned in the sources is gold, although 120 deben of malachite were sent from Nubia in the reign of Amenemhat II (see below). Nubia saw five new military campaigns during the reign of Senusret III, along with the extension of existing fortresses and the construction of new ones in the newly annexed territory.[641]

Overseer of prospectors and prospectors left inscriptions and sealings also in the Middle Kingdom Nubia.[642] Overseer of gold workers left his title but not his name at Tomas.[643] Thus the Egyptians were not only using the earlier knowledge of the terrain, they

[633] Seyfried (1981, 178).
[634] Seyfried (1981, 182).
[635] (Tallet 2018, 217–218).
[636] Tallet (2012, 209, doc. 230).
[637] (Tallet 2018, 217).
[638] (Saretta 2016, 131–136).
[639] (Darnell and Darnell 2002, 58).
[640] (Raue 2019, 139–140, 174–175).
[641] (Raue 2019, 176–186).
[642] (Gratien 2019, 132).
[643] (Gratien 2019, 133).

were exploring new mining sites. Rather surprising is the occurrence of a Middle Kingdom inscription of the painter and sculptor Renseneb in the vicinity of the Semna fortress.[644] Worker of precious stones (*ꜥꜣ.t*) and a stone cutter were mentioned in the inscriptions at Toshka and el-Malki.[645]

Egyptians left the Nubia roughly in the middle of Dynasty 13 and Kerman garrisons were located in the fortresses of Buhen and Mirgissa.[646] Nevertheless, written sources postulate that remaining Egyptians were serving Kerman ruler, especially for the exchange of goods.

4.2.3.5. Tribute from abroad in the annals of Amenemhat II

The extent of the activities of Middle Kingdom kings is documented by the fragmentary annals of King Amenemhat II.[647] The original location of the reused inscription might have been either in Heliopolis or in the mortuary temple of the king in Dahshur.[648] The largest fragment of annals, so called "Farag fragment", is currently being dated to the Year 30 and 31 of the reign of Amenemhat II, while the smaller, much more damaged "Petrie fragment" might not be from the same period.[649] In case of the material procurement, fragmentary texts represents the most extensive evidence of tribute containing metals brought in Egypt from the era before the New Kingdom. The numbers listed in the annals are generally low compared to the data provided on the Palermo Stone; they most probably reflected actual deeds written down during the reign of the king.

By far the largest amount was brought from Lebanon. Two ships sent to the expedition to Lebanon (*ḫntj-š*) returned with 1,676.5 deben of silver and an unknown amount of gold, 4,822 deben of arsenical copper/tin bronze (*ḥsmn*), 15,961 deben of copper (*bjꜣ*) and 1,410 deben of white lead (*sšw*) (M19).[650] Rich was also the booty captured at two towns, *Jwꜣj* and *Jꜥsjj* (M17–M18), included 1,734 deben of malachite. If the location of the towns to Ura in Cilicia and the second one on Cyprus is correct, these "pooled" looted goods might mean use of malachite and copper from Anatolia and Cyprus in the reign of Amenemhat II.[651]

Much smaller tributes (*bꜣk.wt*) from Nubia (*kꜣš* and *Wbꜣ.t-spꜣ.t*) included 1 and ¾ deben of electrum and 120 deben of malachite (column M11; Figure 4.26–4.27). The term

[644] (Hintze and Reineke 1989, 160, Inschrift Nr. 528, Taf. 221).
[645] (Gratien 2019, 131–132).
[646] (Török 2009, 104–105).
[647](Altenmüller and Moussa 1991; Altenmüller 2015).
[648] (Altenmüller 2015, 281–283; Willems 2017, 474).
[649] (Altenmüller 2015, 281–296).
[650] (Altenmüller 2015, 82–86).
[651] On their location, see (Altenmüller 2015, 297–306).

b3k.wt was used for levies that meant subservient relation of Nubians to the king.[652] The gifts brought from Asia (*sṯt*) by children of the ruler included 220 deben of silver and an unknown amount of gold, 6 deben of lead/tin (*ḏḥ.t*) and 55 deben of white lead (*sšw*) (M 13).[653] The following two columns are supposed to list material imported from Sinai, from the Terraces of turquoise, including 9 and ¾ deben of silver (M14), a rather unusual material for Sinai. Turquoise is listed, alongside fossilized wood, hematite and another mineral. Remarkable is absence of any mention of copper or malachite.[654] Nomads from the country *ṯmp3w* brought 234 and ¼ of deben of lead/tin (*ḏḥt.j*) (M15). The discussion about the location of the land Tjempau is ongoing with no definitive answers yet.[655] If the tribute is lead, it might be coming e.g. from Eastern Desert, if it could be tin, then the closest sources to Egypt are again in the Eastern Desert or in Anatolia. The researchers usually tend to interpret this as a mention of the lead tribute.

Lines M21-23 listed materials brought to the palace (*stp-z3*) as a tribute that was coming most probably from within Egyptian "customs", i.e. materials captured at the borders of the Egyptian territory (*g3.wt*).[656] It included 32 deben of raw silver and, 920 deben in the form of "new copper" and 25 deben in the form of bronze "rings" or lumps (*nws*).[657] In fact, the second term might denoted very well copper prills that are semi-product of the metallurgical workshops, used for the further processing of the metal after initial smelting.[658] Such prills can be also by-products of smelting, and they might have been intentionally collected in workshops, as they contain metal, which can be later used. Furthermore, the inner land tribute included *ḥmwt*, probably "copper dust" in 6 *m3m3* vessels.[659]

Also a comparative chart with the deben of the raw materials shows that the trade with Lebanon operated in much higher numbers than all other means of the acquisition and requisition of raw materials (Figure 4.26, 4.27). Tributes from neighbouring areas had only a symbolic, diplomatic role.[660] However, they were taken into Egypt and clearly inform us that the mixing of copper from various sources might have been possible in the Middle Kingdom Egypt.

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652 (Müller-Wollermann 1983, 90; Kubisch 2007, 83; Altenmüller 2015, 37).
653 (Altenmüller 2015, 45–49).
654 (Altenmüller 2015, 49–52).
655 Overview in (Altenmüller 2015, 307–312).
656 The word *g3.wt* means also bundle and thus probably refers to the form of the tribute (TLA, lemma no. 166280). On the interpretation (Altenmüller 2015, 95–96).
657 (Altenmüller 2015, 93–98).
658 Experimentally produced at Ayn Sokhna, cf. (Abd El-Raziq et al. 2011, Pl. 10: 5, 6, 11: 7, 8).
659 (Altenmüller 2015, 100).
660 (Bárta 2003, 115–116).

4.2.3.6. Tributes and high officials

Middle Kingdom sources speak also about the activity of high officials, especially nomarchs, in the procurement of raw materials. In his autobiographical inscription, nomarch Amenemhat I of Beni Hasan claimed that he went to South, to Coptos, to fetch *bjꜣ.w/bjꜣ.w n nbw* for the ruler.[661] We do not know whether copper was included among those "miracles"/"wonderful things", but it can be assumed. In this regard, it is important to mention that nomarch Sarenput I of Qubbet el-Hawa was in charge of *gꜣ.wt* tribute from foreign countries for royal treasures (*ẖkr.t*); he also reports on *jnw* products and *bꜣk.w* tributes.[662]

Famous scene of the processions of Asians in the tomb of Khnumhotep II at Beni Hasan had a material procurement purpose named in the inscription (Figure 4.120). 37 Asians, armed also with spears, were bringing galena and Khnumhotep "brought" the people. Since the whole inscription is introduced by dating to the Year 6 of Senusret II, galena might have eventually reached the court. It was also interpreted in the literature as the possible evidence of informal, small scale mining in Eastern Desert.[663]

4.3. Copper storage, revenues, and transactions

After mining and (optional) initial processing, the copper ore had to be transported to Egypt and stored for further use. There are almost no written sources speaking directly about the transport of the mined ore or semi-processed products (ingots?) from the mining sites to the administration centres and their storage in the periods under study. The exceptions are already mentioned stelae of Iny and Khety and other mentions of the material procurement being a task of the high officials. The task and the material are important, the means of transport or the means of later storage not as much, as these were most probably self-evident for the readers of the texts.

Copper in this semi-processed state might have circulated inside Egypt, but the sources are silent of what was happening between the return of expeditions or import of the material and its use for manifold purposes. Exceptional are mentions of unspecified copper as the subject of revenues for the royal administration and temples which are discussed in this chapter as well. The sources are also clear that copper was part of personal property and transactions with it, in the form of rewards ("payment") for craftsmen's work. Once again, its form is almost never specified. There are indications that metals were used as a value

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661 (Kanawati and Evans 2016).
662 (Desplancques 2006, 410).
663 (Bloxam 2006, 295–296).

equivalent already in the Old Kingdom, with beginnings of these ideas in the Early Dynastic period or even before; the reasons are stated below.

In broader terms of the materials' circulation, the control of the goods and their procurement for the administration were a vital part of the activities of early states. However, the closest we can get is the evidence of "sealing things", the control of the movement of material resources by the administration, and the seals and sealings themselves. The bearers of the title "sealer" were arguably often important persons, and the overseeing of the movement of materials was an important aspect of the elite actions. The sources provide some information, alas not detailed, concerning the movement of "things". Supposedly, these sources merge information about semi-processed metalworking products and finished, usable artefacts.

4.3.1. Administration of resources in the Early Dynastic period

Already in the Early Dynastic Period, there is evidence of *pr-ḥḏ* – the Treasury, from the reigns of Merneith and Den of Dynasty 1 and Sekhemib and Peribsen of Dynasty 2.[664] However, the original institutions in the Early Dynastic Period might have been *pr-dšr*, the "Red House", and *pr-ḥḏ*, the "White House", linked to the symbolic colours of the Egyptian crowns and the two lands. The correct literal translation for the Early Dynastic Period would therefore be the "White House", rather than the "Silver House", as it was also interpreted in the past.[665] T. Wilkinson proposed how these institutions could have interchanged through the Early Dynastic Period, depending on whether the "centre" was considered to be in Upper or Lower Egypt.[666] The evidence on the officials of the institution is meagre as well.[667] Since Dynasty 3 Sekhemkhet, we know about the doubled, "state" level institution (*pr.wy ḥḏ*).[668] The dual is usually interpreted as the "state" level of institution combining both parts of Egypt.

Wilkinson also suggested that the leading figures of the Treasury were denoted by the title "sealer of Lower Egypt/chancellor".[669] It is highly plausible, due to the closeness of the sealing and the storage of materials, but it needs to be proved by the evidence. Some of these bearers were powerful individuals, including Hemaka and Imhotep.

No evidence connects Early Dynastic Treasury with the storage of metals and metal objects, and we can only infer that metals were also stored by the "White House" or "Red

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[664] (Wilkinson 1999, 125–133; Desplancques 2006, 15–16).
[665] In agreement with (Eichler 1993, 282).
[666] (Wilkinson 1999, 125–128).
[667] (Wilkinson 1999, 131–133).
[668] (Kahl,Kloth and Zimmermann 1995, 130–131).
[669] (Wilkinson 1999, 131–132, Fig. 4.6).

House" and that the situation might have been similar to the Old Kingdom. The expected association of metals and weighing is, however, evident in the paintings from the Tomb of Hesyra at Saqqara, where three boxes with tools are stored next to two other boxes apparently containing weighing stones (Figures 4.55–4.56). The decoration displayed the property of Hesyra, either in life or for the Afterlife. Similar nature of the use of metals later on, and more detailed sources, enable us to presume that the aspects of the use of metals observable then were present in rudimentary forms in Early Dynastic Period or even earlier.

After the publication by Wilkinson, the simple title *ḫtm.w* – sealer was published from Elephantine; however, it cannot be inferred from the title what he actually sealed[670] and whether even there, far in the south, he might have been connected with the Treasury. Moreover, early Egyptian sources inform also about the existence of "sealers of gold" and "sealers of electrum".[671]

Recently, traditional interpretation was challenged, with the updated list of Early Dynastic sources and proposed translation of *pr-ḥḏ* as the "House of the stone vessels", focused on oil and fragrant substances, and *pr-dšr* as the "House of ceramic vessels", especially wine stored in them.[672] Fritschy unfortunately downplays the evidence that the former storage centre contained also flint tools, as well as the archaeological evidence of the use of silver already in the Predynastic period.

4.3.2. Administration of resources in the Old Kingdom

Direct evidence concerning the storage and distribution of copper is meagre, although unpublished clay tablets from Balat and papyri from Wadi el-Jarf will most probably enrich our knowledge in this respect. The handling of copper ore, ingots and products might have been included under other administrative units, particularly the Treasury and the overseeing of royal works. While several Egyptologists argued that titles with the component of "sealer" (*ḫtm.ty*) were honorific, I will argue that this was, on the contrary, one of the most important practical functions and aspects of elite power. Sealing enabled controlled movement of the semi-processed materials, including copper.

4.3.2.1. Storage: *pr-ḥḏ* – the Treasury and metals

[670] (Bussmann 2010, 447).
[671] (Jones 2000, 766).
[672] (Fritschy 2019).

The "Treasury" remained the main storage centre in the Old Kingdom, written in the dual, *pr.wy ḥḏ*, on the state level.[673] It was one of the main branches of Old Kingdom administration.[674] Its Old Kingdom counterpart is in fact the Granary, the institution storing edible goods, whereas the Treasury's domain was non-edible raw materials and finished products. Since Both Houses of Gold frequently co-occurred with the Treasury in Old Kingdom administration, the perception of the name of the institution might have changed to the "House of Silver". The word *ḥḏ* enables both translations.

There is no direct Old Kingdom evidence of storing copper in the Treasury.[675] Since Both Golden Houses were part of the institution, it can be inferred that other metals including copper were also stored there. The issuance of various products from the Treasury was recorded: clothing and textile, sarcophagi, oils, perfume, incense and even mud bricks, possibly also wine.[676] More objects were presumably included under the general term *ḫtm.t* – sealed things (translated in some contexts as funerary equipment),[677] including textile, oils and – in the tomb of Meryteti, son of Mereruka – also gold.[678] Some researchers assume that gold in private contexts came from the royal Treasury.[679] Copper was possibly too mundane to be specifically mentioned in such inscriptions.

Three sources of the procurement of goods for the Treasury were the provinces, the expeditions and other departments of the administration,[680] although the evidence of Treasury officials in the expeditions is almost non-existent in the Old Kingdom.[681] The revenues were most probably collected by agents of the Treasury sent from the state's centre; only in Dynasty 6 there is evidence of three provincial nomarchs holding also the titles of overseers of the Treasury or of Both Treasuries and also of the Granary, which means that they supervised the collection of both edible and non-edible goods.[682] The evidence indirectly demonstrates that Old Kingdom Treasury was an institution for passive storage of either the materials or finished objects that might have been royal property. This was a place where the

[673] (Strudwick 1985, 284; Eichler 1993, 281–284; Desplancques 2006). If its Early Dynastic counterpart had a completely different name, storage of the materials and products in the "Treasury" is certain in the Old Kingdom.
[674] The Early Dynastic counterpart, *pr-dšr,* is mentioned only scarcely; in the tomb of Nyankhkhnum and Khnumhotep, *pr-dšr* is a storage place for wine and fruits (Moussa and Altenmüller 1977, 101–105, Taf. 34-35, Abb.13).
[675] Indirect evidence was mentioned by (Strudwick 1985, 284).
[676] (Desplancques 2006, 202–206).
[677] Or as "treasure, portable wealth" by (Fischer 1964a, 26).
[678] Desplancques (2006, 206-208).
[679] (Lapp 1986, 268; Eichler 1993, 317).
[680] (Desplancques 2006, 209–210).
[681] The closest person to the expeditions who also most probably held the title of *ḫrp pr-ḥḏ* is Kaaper, who was buried at Abusir South (Bárta 2001).
[682] (Kanawati 1980a, 74).

materials were passively stored as either ingots or finished objects. Certainly, the Treasury also took care of the regalia, defined broadly by lesser titles as oils, textiles, etc., but also of metal objects connected with the royal office. Work with the materials was the duty of either the royal workshops or *kꜣ.t* – the work branch of the administration (see below).

A magazine or magazines existed as subordinate units of the *pr-ḥḏ* with the name *wḏꜣ,* as reflected in the Old Kingdom title of its intendant.[683] Using the analogy with gold again, copper might have been stored similarly, as a title of the keeper of the magazine of gold is known from the Old Kingdom.[684]

A detailed discussion of the Treasury is necessary for comparison with the metalworkers' organizational structure, which was very similar in lower ranks. The upper levels enable us to perceive how the "state level" of the administration was expressed. As summarized by Desplancques, the highest officials of the institution were *jmy-r pr-ḥḏ, jmy-r pr.wy-ḥḏ, jmy-r pr.wy nbw* and *jmy-r ẖtm.t*.[685] The title *jmy-r pr-ḥḏ*, rare after Dynasty 5, referred to the actual management of the office.[686] Indirect reference to metal objects lies in its holder's responsibility to oversee the regalia. A special derivation of the title with the names of mortuary temples proves that a treasury was also incorporated in royal funerary monuments. Bearers of this title were unlikely to attain the status of vizier.[687]

On the contrary, bearers of the title *jmy-r pr.wy-ḥḏ* were often viziers.[688] The dual refers to the state level, but it is unlikely that these officials managed Both Treasuries on day-to-day basis. Desplancques assumes this for non-vizieral holders of the title in Dynasty 6 after the older, singular title diminished in importance. They were also responsible for the regalia. Textile is brought to the funerary cult from Both Treasuries, which means that it was an actually existing institution.[689] Bearers of this title frequently were also overseers of Both Golden Houses, *jmy-r pr.wy nbw.*[690] Gold is treated separately in Old Kingdom titulary, and we can assume with confidence that this term denotes the institution storing gold. A singular "House of Gold" is almost absent from Old Kingdom evidence,[691] which means that gold was amassed only on the state level; the title is likewise absent from provincial cemeteries. The

[683] (Desplancques 2006, 199).
[684] (Jones 2000, 314, title no. 1153).
[685] (Desplancques 2006, 127–191).
[686] (Desplancques 2006, 130–143).
[687] Only one provincial official happened to be also vizier: Pepyankh called Black Heni.
[688] (Desplancques 2006, 143–151).
[689] (Desplancques 2006, 149).
[690] (Desplancques 2006, 151–158).
[691] However, *ḥwt-nbw* was mentioned in the reign of Pepy II, in a text about production of a statue. It is questionable whether both institutions are identical (Schott 1974).

title bearers tend to have also the title of the Overseer of Both Workshops. While Desplancques argues in favour of a link between Both Golden Houses and the workshops including craftsmen and metalworkers, I would rather consider this as evidence of another branch of administration, overseeing the works.[692] Moreover, 19 bearers of the highest treasury titles were also engaged as overseers of works, although 17 of these were also viziers.[693]

The fourth title, *jmy-r ḫtm.t,* belonged only to Khentika (*Ḫntj-kꜣ*) at Saqqara. This was the topmost title of Middle Kingdom Treasury, and Khentika seems to be the first precursor.[694] In the Old Kingdom, however, this title might be rather interpreted as expressing control of the sending of sealed things for the funerary equipment.

Desplancques distinguishes between two main categories of subordinated officials, the intermediary level and the agents of the institution.[695] The higher category included overseers, controllers, inspectors and adjuncts/assistants (*jmy-r*, *ḫrp*, *sḥḏ*, *jmy-ḫt*). A title referring to a magazine (*jry wḏꜣ*) gives only a glimpse of the actual structure of the institution, although it might be assumed that this was the actual “quartermaster” of the Treasury’s magazine(s). Some of these officials were subordinate also in the office of overseeing the regalia. The most frequent agents of the Treasury were the scribes. These were also depicted in the tombs as bringing textile and other objects from the Treasury, once even in the context of *pr-ḏ.t*, in the tomb of Kaemankh.[696]

Outside the realm of lengthy written documents, Old Kingdom archaeological contexts have provided many objects with royal names, interpreted as royal gifts within the burial equipment. In some cases, Old Kingdom heirlooms, which were deposited only in the First Intermediate Period and were found on the cemeteries near sites without clear royal involvement (but the absence of evidence does not mean that there was not any involvement of the court, e.g. at cemeteries south of Asiut).[697] Sealings of various goods often represented the royal aspect as well. Both these categories most probably came from the Treasury. The offerings from royal or temple institutions were presumably denoted by the word *wḏb* and their use was performed with the ritual 2b as defined by Lapp.[698] S. Seidlmayer attempted to

[692] (Desplancques 2006, 155–157).
[693] (Krejčí 2000, 70–71)
[694] (James 1953; Desplancques 2006, 158–160).
[695] (Desplancques 2006, 162–191).
[696] (Desplancques 2006, 187).
[697] (Eichler 1993, 312–316; Mazé 2018, 123–126). The occurrence of objects with the royal name of Snofru seems to be different case, as these objects were found in later royal mortuary temples, meaning that the ancestor was thus venerated in later cult (Kuhn 2014).
[698] (Lapp 1986, 177–180).

define broader categories of material culture that might have been distributed centrally to the provinces, including copper and gold objects.[699]

Summing up, the leadership of the Treasury in the Old Kingdom underwent some changes, berating not a rigid structure, but gradually developing institution. On its practical level, instead of changes, a stability of some titles can be observed. The object from "Tresury" can be met predominantly in the burial equipment, but this might be connected to the prevalent written sources.

4.3.2.2. Sealing of goods and metals

While the overseeing and sealing of goods might have been one of the main duties of the Treasury, this activity was not limited to a single institution.[700] Direct evidence of the use of the Treasury seal is meagre.[701] The most important sealer titles in the Old Kingdom were *ẖtm.ty-bj.ty*, sealer of the King of Lower Egypt,[702] and already mentioned *ẖtm.ty-nṯr*, expedition leader.[703] Extant Old Kingdom evidence suggests that the title *ẖtm.ty*(*-bỉty*) had a role in the overseeing of the amount and movement of the material – "sealing" of the material. Mentions of other Old Kingdom sealers were collected by Desplancques.[704] They include royal sealers, *ẖtm.w nsw*, on the state level and sealers, *ẖtm.w,* on the private level.[705]

Like with the magazine, the only metal treated separately in the case of sealing is gold, albeit scarcely. In Dynasty 4, the sealer of gold of the workshop of King of Upper and Lower Egypt Khufu appeared once.[706] The context itself is unusual, the burial of Queen Hetepheres at Giza; we can observe direct issuance from the workshop, without mentioning the Treasury (at least on the preserved seal imprints). From Dynasty 6 Gozeriya, the cemetery opposite Dendera, we know overseer of gold (*jmy-r nbw*), together with the title of sealer of god (*ẖtm.ty-nṯr*), although the name is not preserved.[707]

Copper was not mentioned; most probably, it was understood to be among other sealed things. Copper could have been stored in several types of receptacles, all of them equally probable, in the periods under study: sacks, baskets, coffers, boxes and caskets; they all could

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699 (Seidlmayer 2007).
700 For a brief overview of the subject, see (Boochs 1982). Besides materials, documents were also sealed, for instance, but that is outside the scope of this thesis.
701 Pehernefer from early Dynasty 4 had a title authorising him to use the seal of the Treasury (Desplancques 2006, 190–191).
702 Jones (2000, 763-764).
703 Eichler (1993, 234-254); Jones (2000, 767); (Kuraszkiewicz 2006).
704 (Desplancques 2006, 160–161).
705 Also (Boochs 1982, 64–65).
706 The authors themselves, however, interpreted the evidence as an indication of the existence of a gold seal of King Khufu with which all the seal imprints were made (Reisner and Smith 1955, 49, Fig. 47; Jones 2000, 766).
707 (Fischer 1968, 55; Eichler 1993, 250). Cf. also (Jones 2000, 153).

be sealed. The doors of the magazines were sealed as well, in both royal and private property.[708]

Where published in sufficient numbers, evidence from the provinces demonstrates that sealer was among the most important titles held by the provincial elites even into the First Intermediate Period. Figure 4.31 shows that the title of the sealer remained one of the most important titles up until Dynasty 8 and the First Intermediate Period in Old Kingdom Akhmim, with sufficiently extensive prosopographical evidence. Titles dealing with the control of materials were preserved also at Naqada, albeit in lesser numbers. The title of *ḫtm.ty bj.ty* was found in nine inscriptions; three Dynasty 6 holders of this title were buried at Naqada.[709]

4.3.2.3. Weighing and its units

While direct evidence connecting copper with Treasury or sealing of materials is missing in the Old Kingdom, it can be presumed. Action directly involving presumed copper ingots and finished copper objects is weighing. It can be again well presumed in the royal sphere, but the existing evidence is coming mainly from the "private" tombs, although usually of high officials of royal and provincial administration.

Metalworking scenes are the only Old Kingdom scenes where weighing of material is displayed.[710] Weighing can be both the initial and the final stage of metal production: the processed ore or semi-finished product (ingot?) is weighed at the beginning of the process, and finished products are weighed before the artefacts are delivered to the superior official, and eventually to the tomb owner. These are the actions that enable us to observe what was happening to the material brough into Egypt by expeditions or tribute. The context is rather non-royal/private, as the overseeing officials were either stewards (*jmy-r pr*) or overseers of the metalworkers of the funerary domain (*jmy-r bḏ.tyw* (*n*) *pr ḏ.t*). The only well-preserved scene from the royal mortuary complex, from the causeway of King Wenis was preserved incompletely; the only complete caption in the weighing scene refers only to the use of a balance.

Fourteen of the preserved metalworking scenes include weighing (Figure 4.35–4.39); the figure might be higher if all scenes were preserved in their entirety. Even as it is, the number represents almost half of all Old Kingdom metalworking scenes. The preservation of the scenes enables us to define two main types of balances, larger ones standing on a separate

[708] (Boochs 1982, 18–19, 32–41).
[709] (Fischer 1964b, 13).
[710] As noted by (Eyre 1987, 13).

support for heavier objects, and smaller ones held in one hand. The former was named "stand balance" by E. Brovarski.[711] In most occurrences, both types of balances were of simple structure with two receptacles hanging on a fulcrum; in the stand balance, this structure was attached to a fixed pole with a support. The objects being weighed are not preserved in all cases. Vessels represent the most frequent finished objects; the only undisputed case of weighing of tool blades is from the Tomb of Kaemrehu.[712]

Textual evidence of the Old Kingdom weighing units is meagre; the two existing units are *šˁ.t* and *dbn*. Although the evidence has been dismissed as too scattered, we cannot ignore it; moreover, we need to bear in mind that most of Old Kingdom written sources are not preserved. The value unit of *šˁ.t* occurred already in Old Kingdom texts, but it is uncertain whether the meaning of the word was the same as in later texts.[713] The document of "House-selling" found at the valley temple of Rakhef (Figure 4.32) listed three objects valued 10 *šˁt* altogether: a piece of four-measure cloth, a wooden bed and a piece of two-measure cloth. The word in the document had a clear determinative of a copper "droplet" with a projection, analogical to other occurrences of this sign. Thus, we can conclude that a copper unit of value was meant here.

The word *šˁ.t* was also mentioned in the tomb of Nyankhkhnum and Khnumhotep, to the right of the door area on the northern wall, in the last register of the market scene. A textile is sold for the value of 10 *šˁ.t*.[714] The determinative of the word had a rectangular shape, but it is unclear and does not resemble the determinative used in the house selling document. According to the authors, it is similar to the mollusc shell and can be interpreted as evidence of the use of mollusc shells as an equivalent of value. In fact, it might be informal version of a crucible sign, denoting copper.

Moreover, another scene from the tomb of Nyankhkhnum and Khnumhotep in Saqqara probably depicted the exchange of a *dbn*-weight, used for metal weighing, for a vessel with inclining sides.[715] One of the participants in the transaction – the buyer – was titled *ḥmw.ty dbn* – "craftsman of deben(-production?)";[716] the object he is holding in his right hand is interpreted as a *dbn*-weight while in the left hand, he is holding a vessel similar to the offered

[711] (Brovarski 2001, 147–148, Fig. 117).
[712] (Odler 2016, Fig. 11).
[713] For later use see below and (Wente 1965, 196).
[714] (Moussa and Altenmüller 1977, 85, Abb. 10).
[715] (Moussa and Altenmüller 1977, 83, Abb. 10).
[716] Cf. (Jones 2000, 596).

vessels. The person who sells the vessels is saying: *mk jsw, dbn=k jpn* – “the exchange value for this is a deben”.

The fact that the apparently rectangular weighing stones depicted in metalworking scenes are not named does not deny their existence in the Old Kingdom. From the above mentioned, *dbn* can be inferred as the name for the stones. As often, the archaeological evidence of the weighing stones is more prolific; we will discuss it in the Chapter 5.

4.3.2.4. Copper in the private transactions and tomb building

Some Old Kingdom “private” tomb owners have provided information concerning the construction of the tomb and the rewards for it or for lesser craft works.[717] Copper was one of the possible means of payment for work, but not very frequent. Müller-Wollermann collected eighteen Old Kingdom examples of reward for the tomb or tomb furnishing, five of them listing also the material of the reward.[718] Altogether sixteen inscriptions concern the reward for the tomb (nos. 1–10, 12–17), two inscriptions the making of a statue (no. 11) and a single for a false door (no. 18). The other rewards included in the most complete text bread, beer, linen, *mrḥ.t*-oil, barley, and emmer; bread and beer were mentioned three times more, linen twice.

The biography from the Dynasty 6 tomb of Metjetji in Saqqara mentioned copper, together with textile and bread provided by the tomb owner for the workers from the tomb owner’s funerary estate. The clause was read by Goedicke: *jrw nf kꜣt jm=f m bjꜣ ẖrj-ꜥ(=j)* [*n*] *pr-ḏt* and translated “Die jene Arbeit in ihm machten mit Kupfer(-werkzeug) unter (meiner) Aufsicht des Stiftungsgutes”.[719] The key noun or preposition *ẖrj-ꜥ* might have different meanings in this part of the text, e.g. “with help” or “under the”. Rather than the materials in which the payment for the construction of the tomb was made, copper might have been a material used to build the tomb.[720] Metjetji’s main title of overseer of the department of tenant-land holders of the Great House[721] does not link him to any possible overseeing of copper procurement or production.

The text from the late Dynasty 6 (Merenra or Pepy II) tomb of Akhetmehu in Giza (G 2375) mentions that the owner of the tomb provided the workers with bread and beer and

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[717] (Volten 1931; Wilson 1947; Müller-Wollermann 1985).
[718] (Müller-Wollermann 1985, 142–144).
[719] (Goedicke 1958, 24).
[720] Especially Metjetji’s text does not corroborate the claim: “Man rechnet in Kupfer (Kupfergewichten) ab, die ein festes Gewicht und einen festen Wert haben. … Die Bezahlung kann auch in Naturalien erfolgen, deren Wert an der Kupferwährung gemessen wird.”[720] (Kaplony 1976, 27–31, Nr. 6). Old Kingdom evidence together does justify such conclusion.
[721] (Jones 2000, 241).

moreover with “clothing, *mrḥ.t*-oil, copper and grain in great quantity.”[722] It is worth noting that Akhetmehu’s “career” was in the legal branch of the administration and the only vague connection with the distribution of materials is in his title of the master of reversion-offerings.[723]

We can conclude with Müller-Wollermann that copper is listed among natural rewards for work on the tomb, but the exact form – the raw material, finished tools or ingots – is unknown.[724] Possibly, there was a difference between copper provided for the construction of the tomb and copper as “a reward/payment” to the builder, like the difference between the texts of Akhetmehu (more probably reward) and Metjetji (rather furnishing during the construction). According to the preserved titles, neither Akhetmehu, nor Metjejti, were involved in the processing and use of copper. This means that copper could have been redistributed also by powerful people outside of the Treasury and the overseeing of the works; this is exactly the case of Metjetji and Akhetmehu.

A form of reward could have been the craft scenes in large decorated tombs, where the craftsmen participating at the production of funerary equipment were depicted, and seldom also named. Smaller tombs did not offer space for these, but the tomb owner mentioned craftsmen as Akhetmehu and Metjetji did.

In addition, it must be mentioned that in some Old Kingdom tombs, rewards of the female weavers with the gold jewellery (possibly with copper core?) was depicted, with a complete list compiled by H. Küllmer.[725] If not far-fetched in the representation, this is clear evidence of the distribution of metal further down the social pyramid, beyond the spheres of the king and high officials. The latter functioned as the pinnacles of their own small social pyramids, distributing allegedly precious gifts, in order to reinforce the social relations.

4.3.2.5. Revenues for overseer of Upper Egypt: Coptos decrees B, C and D

The Coptos decrees, a corpus of royal decrees from Dynasties 6 and 8, provide marginal but valuable information on the administrative control of copper, and finally in the context of royal administration (Figure 4.33). From the legal point of view, decrees B and C exempted the temple of Min from compulsory work for the royal administration. Coptos D protected an

[722] (Edel 1953, 328, B 1.2; Herslund 2015, 112–113, Fig. 9).

[723] Titles on the pillars: *s3b smsw h3jt r nḫn wḏꜥ-mdw št3 n ḥwt wrt ḥrj-sšt3 ḥm-nṯr m3ꜥt ḥrj-wḏbw* – judge, elder of the court, mouth of Nekhen, judge of secret matters of the Great Court, secretary, priest of Maat, master of reversion-offerings; on the architrave: *s3b r nḫn smsw h3jt ḥrj-tp mdw n wḏꜥ-mdw št3w n ḥwt wrt ḥm-nṯr m3ꜥt ḥrj-sšt3 n wḏꜥ-mdw r nḫn* – judge, mouth of Nekhen, elder of the court, overlord of the words of secret judgements of the Great Court, priest of Maat, secretary of judgements, mouth of Nekhen. Digital Giza, last accessed on 20th January 2020: http://giza.fas.harvard.edu/ancientpeople/609/full/.

[724] (Müller-Wollermann 1985, 147).

[725] (Fischer 2000, 20, Fig. 17; Mazé 2018, 126; Küllmer 2017).

estate named "Min strengthens Neferirkara" belonging to the *pr šnꜥ* estate. Coptos decrees C and D inform about the control of copper by the overseer of Upper Egypt, the highest-ranking administrator of the southern part of the country besides the southern vizier in Dynasty 6. The rights of the overseer of Upper Egypt are mentioned in general terms in Coptos decree B from the year after the eleventh cattle count; this official's "levy" is denoted with the term *srw*.[726]

Coptos decree C is dated to the year after the 22nd cattle count in the reign of Pepy II. It is an updated version of Coptos decree B from the year after the eleventh count. The general term for the works required by the overseer of Upper Egypt in this document is *hꜣ*(*w*), which Goedicke interprets as arranging ("Zuweisung") the work rather than the actual work, named as *kꜣt*.[727] One of the changes concerned a short list of items under control of the overseer of Upper Egypt: gold, copper and jewellery.

Coptos decree D reiterates some of the exemptions, but only for the estate "Min strengthens Neferirkara"; this includes the requirements of the overseer of Upper Egypt, listing only gold and copper. The general heading for the levies of the overseer of Upper Egypt was not preserved on the fragments of Coptos D. What was preserved in this document is a possible reference to the Residence (*ẖnw*) as the final destination of the overseer's requirements.[728] This brings to mind the general description of the duties of overseer of Upper Egypt as presented in the biography of Weni: "carrying out every task; assessing everything which was assessed for the Residence in this Upper Egypt on two occasions and every regular duty which was assessed for the Residence in this Upper Egypt on two occasions; performing the office of a magistrate so as to make my reputation in this Upper Egypt".[729] This short description might have included the assessment of the amount of gold and copper for the Residence. Based on the Coptos decrees among other sources, Kanawati assumed that there was a division of responsibility of the viziers for the revenues and for the royal works in the provinces: the former category might include copper ingots in the revenue, the latter possibly used copper tools in carpentry and masonry works.[730]

The crucial term for the interpretation of both *loci, mꜣꜥw*, is translated as levies "Erzeugnisse (Fremdländer), Geschenke, Tribute".[731] Goedicke commented on levies in gold and on "metal" as a specific levy of Upper Egypt.[732] The latest study by Brovarski is focused

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[726] (Goedicke 1967, 99–100).
[727] (Goedicke 1967, 119–120).
[728] (Goedicke 1967, 245).
[729] (Strudwick 2005, 355–356).
[730] (Kanawati 1980a, 27).
[731] (Hannig 2003, 503).
[732] (Goedicke 1967, 127).

on the prosopography and an overview of the known holders from the Old Kingdom up to the Middle Kingdom.[733] In a thesis by Clarke, the requirements for copper and gold are interpreted as unclear.[734] We can conclude from both decrees that at least these revenues came at least in part from inside ancient Egypt. These levies were apparently existing also before the Dynasty 6, the evidence was excavated recently at Abusir South. A Dynasty-4 official Nyankhseshat was among other duties a controller of the levies of gold.[735] On the other hand, Nubian products listed in the biography of Harkhuf are generally named by the same term.[736] Thus we have to be cautious and not overinterpret Old Kingdom terminology, as the "levies" could have been from inside, but also outside Egypt.

The vicinity of the Eastern Desert might have caused higher concentrations of metals in Upper Egypt. The form of the "requirements" – whether the metals were collected by the bureau of the overseer as the ore, semi-processed products or the products of workshops – is not known or discernible from the Coptos decrees. On the other hand, they provide the information that both the temple of Min and the estate protected by the king owned gold and copper that could be, were it not for the royal protection, "confiscated" by the overseer of Upper Egypt. The terminology of the documents is not unified. It is possible that the evidence pieced together from different sources reveals *ad hoc* solutions of the needs encountered in the administrative practice rather than an underlying structure of the administration.

What can be inferred from the Coptos decrees is that institutions in Upper Egypt (temples and estates of temples) procured or produced copper, gold and jewellery and that these materials were subject to "taxation" by the overseer of Upper Egypt with the final destination in the Residence. This information goes against the tendency to interpret the procurement of materials as an activity organised exclusively by the royal administration and might be added to the recent attempts of deconstruct the "state monopoly" on material procurement.[737] Due to the lack of comparable evidence, it is difficult to find out whether this was characteristic of late Dynasty 6 or it was the original type of action presumed to be within the powers the overseer of Upper Egypt since the creation of this "office" after the middle of Dynasty 5.

[733] Omitting e.g. Ptahshepses Junior from Abusir –(Bárta 2000). See (Brovarski 2013, 2014).
[734] (Clarke 2009, 129, 136).
[735] *ḫrp mꜣꜥ.w nbw.w*, although with a different orthography of three "sickle" hieroglyphic signs (Odler et al. 2019). In early hieroglyphic script a "sickle" sign was also used to write down the three-consonantal *mꜣꜥ* (Kahl 2003, 169–173).
[736] (Kubisch 2007, 70).
[737] For the Middle Kingdom, see (Bloxam 2006).

The practical consequences of the control over the flow of materials can be traced in the fragmentary inscription of the overseer of Upper Egypt Idu I from Dendera, from the late Dynasty 6. He claimed in his funerary inscription that he possessed, in the translation of N. Strudwick, "... everything excellent and splendid: oxen, herds, copper ....".[738] It seems that the overseers were taking some of the revenues destined to be used in the centre of the state, which empowered the regions and weakened the centre. Significantly, but not surprisingly, tomb of Idu I was the largest on the Old Kingdom cemetery.[739]

4.3.3. Administration of resources in the First Intermediate Period

Dynasty 8 is sometimes included in the Old Kingdom, but there is not enough evidence to say how the state was functioning.[740] A mention of 40 turquoise pieces in the endowment of vessels and other products (some made of copper, see below) to the temple of Min at Coptos is important as an indication that this material, coming from Sinai, was available in Upper Egypt in Dynasty 8, albeit in the form of pieces.[741]

Later, after the disintegration of Egypt, at least two smaller royal courts existed during the First Intermediate Period: one in Heracleopolis Magna (Dynasty 9 and 10) and another in Thebes (early Dynasty 11). Evidence of the overseeing of the circulation of materials is preserved from both of them, indicating that on the smaller scale, it was "business as usual". Unusual is, however, that many inscriptions, e.g. from Dendera, but also from other sites, stressed the importance of copper in the personal property, which was an issue ignored in the Old and Middle Kingdom inscriptions.

Judging from the decoration of his tomb, Sehu might have been one of the most powerful officials at Heracleopolis. He was sealer of the King of Lower Egypt (*ḫtm.ty-bj.ty*), overseer of sealed things (*jmy-rꜥ ḫtm.t*), sole companion, controller of all works (*pḏ-ḥr ḥr k3.t nbt*) and inspector of inspectors (of craftsmen) (*sḥḏ sḥḏ.w* [*ḥmw.tyw*], a reconstructed title). A fragment of his biographical inscription indicates involvement in building projects.[742] He even had a metalworking scene in his tomb (Figure 4.40a). It can be observed that while some titles continue from the Old Kingdom, others underwent certain changes. Overseeing of potentially the whole *chaîne opératoire* is in the hands of a single person at the Heracleopolitan court. The tomb of Sehu was systematically destroyed, very little survived, but this approach to the organization of material procurement, storage and use continued in the Middle Kingdom. Not

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738 (Fischer 1961, 61, 1968, 93–100). This particular piece of relief is 98.1038 in the Museum of Fine Arts, Boston.
739 (Kanawati 1977, Graph VIII).
740 (Baud 2006).
741 (Goedicke 1994).
742 (Padró 1999, 126–146).

all the sealers were specialised in this manner, as another sealer of the King of Lower Egypt from Heracleopolis Magna demonstrates: Kaywy was rather focused on the territorial control.[743] On a lesser scale, certain Hetepy from the Memphite area, most probably under Heracleopolitan rule, was a scribe of the Treasury of the pyramid town of King Merykara, indicating a specific smaller institution for this town continuing in the Old Kingdom practice.[744]

In the south, the titles of "sealer of the King of Lower Egypt" were popular also in the First Intermediate Period. The evidence from Thebes is most detailed. The titles of "sealers" (*ḫtm.w*) and "overseers of sealed things" (*jmy-rꜥ ḫtm.t*) were found on First Intermediate Period stelae from the Theban area.[745] The most important of them is the stela of Tjetji from the early Dynasty 11 reigns of Antef II and Antef III, which informs us in detail (absent in either the Old Kingdom or the Middle Kingdom) about the duties of the overseer of sealed things; it is idiosyncratic in this respect (Figure 4.24). Tjetji emphasised he was appointed to this office by that king. "He made me great, he promoted me, he placed me in the place of his heart's desire in his palace of solitude. The treasury was in my hand and under my seal, consisting of the choicest of all good things which were brought to the Majesty of my lord from Upper and Lower Egypt, of every matter pleasing the heart, as a tribute of this entire land for the fear of him throughout this land, (and) which were brought to the Majesty of my lord from the rulers and chieftains of the desert, because of the fear of him pervading the foreign countries."[746] This official had to control the goods brought to the Residence both from Egypt and from abroad defined as tribute using the Old Kingdom phraseology, as applied also in expedition inscriptions, for instance. As the word for tribute is used ubiquitous *jnw*.[747]

Sealers are known also from other Upper Egyptian sites: Dendera, Naqada, Coptos and Khozam (mentioned above in connection with evidence on the expeditions). These might be also the points of departure for expeditions to the Eastern Desert and its copper ore and gold bearing areas. A fragment of an architrave from Dendera bearing the names and titles of Seneni has been dated by Fischer to late Dynasty 6 or even later.[748] He was *ḫtm.ty bj.ty*, overseer of the storerooms and also carpenter of Nekhen (see below).[749] Another official of

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743 The false door was not fully published, preliminary information in (Pérez Die 2005, 241).
744 (Desplancques 2006, 188).
745 Grajetzki (2013, 219).
746 (Blackman 1931; Landgráfová 2011, 10–14).
747 (Kubisch 2007, 71).
748 (Fischer 1968, 119).
749 (Fischer 1968, 123–127).

the same name dated to Dynasty 9 bore the titles *mḏḥ nśwt* and *ḫtm.ty bj.ty*.[750] Three sealers are known from Naqada: Iqer with the titles of *ḫtm.ty-bj.ty*, sole companion and overseer of the department of stores (*pr šnꜥ*), Sen with the same titles, and Shemai, who was *ḫtmtj bj.ty* as well but only steward of the department of stores.[751] These titles clearly indicate a link between the storing and sealing of the materials. A fragmentary stela from Coptos is evidence of at least one official with this title in the provincial capital.[752]

Even further south, Governor Ankhtify, an independent figure in First Intermediate Period Egypt, built a tomb of a peculiar style at Moalla. In his biographical inscription, he claimed: “I have obtained this coffin and burial equipment with my own copper” (III, 7–8; Figure 4.34a). In nearby Gebelein, Heqaib also boasts of the plentiful copper, unequal to his peers (8-9; Figure 4.34d).[753]

Further down the social ladder, sole companion Hornekhet from Dendera writes on an architrave from his tomb about the positive deeds that he made during his life. The phrases of the supplying of the people of his town start with the traditional: “I gave bread to one who came hungry, and I gave sandals to one who came barefoot…”, but continues unusually with “… I gave copper to one who asked for copper. I gave yarn and I gave linen flax. I never took it from them. Moreover, I gave female children to husbands. People were born because of it: …”.[754] Such statements must be taken with caution, but at least Hornekhet describes the possibility of giving away copper for a person in its need, and presumably of a lower social status that Hornekhet himself.

The evidence enables a conclusion based on both iconographic and written sources that the use of copper was not restricted in the highest echelons of the First Intermediate Period society. The loss of complexity was on the state level, but provincial “kingdoms” repeated the administration model of the Memphite centre, with some newly added features. Small, local “states” needed copper as well. The remarkable absence of expedition inscriptions indicates that smaller administration units, the “states”, probably turned upon the already available or recyclable sources. Incursions into the Eastern Desert cannot be ruled out.

4.3.4. Administration of resources in the Middle Kingdom

The main difference perceptible between the Old and the Middle Kingdoms was that in the latter period, the whole *chaîne opératoire* of (not only) copper could have been organised by

750 (Fischer 1968, 195).
751 (Fischer 1964b, 76, 90, 99).
752 (Fischer 1964b, 101–102).
753 The text published by (Polotsky 1930), reinterpreted by (Edel 1981, 198).
754 (Musacchio 2006, 76–77, D 3128 (JdE 46048)).

the Treasury. Its highest official (the overseer of sealed things – *jmy-r ḫtm.t*) organized expeditions to obtain raw materials including copper, the institution possessed its own craftsmen including metalworkers, and this office was also in charge of the organisation of construction projects. Thus, what had been split into the bureaux of the Treasury and the overseeing of the royal work in the Old Kingdom became unified.

The necessity of storing goods is listed in the negative in the Dialogue of Ipuur as one of the phenomena that had happened in the past but were no longer happening at the "overturned" time of the composition of the work.[755] The negative description captures the things that were "usually done" in the delayed return economy of ancient Egypt. The Dialogue of Ipuur and the Lord of All is dated in the period between the reign of Senusret III and the end of the Second Intermediate Period. No product of all works (*kꜣ.t nb.t*) was stored according to the text (3.6-10). Further, the royal provisions' quarter/storehouse (*šnʿ n-nsw*) was robbed and the royal house (*pr nsw*) was without its revenues (*ḫm.t-bꜣk.w=f*) (10.3–10.6). The former income of the royal house, i.e. the palace, is listed, including wheat, emmer, poultry, fish, white and fine linen, oil and copper. According to Enmarch, oil and copper are named in a single verse (their only occurrence in ancient Egyptian literature) because they were important in cosmetics.[756] Also from the Middle Kingdom is a female offering bearer of Khnumhotep I at Beni Hasan, holding a mirror and an ointment jar, cooccurring in the iconography.[757]

Surprising is that loci from the Dialogue of Ipuur do not mention the Treasury directly, only its provisions' quarter (*šnʿ*)[758] and the higher unit of the Palace – the royal house. Contrary to the Old Kingdom, in the Middle Kingdom evidence of copper produced and used in Treasury exists.

4.3.4.1. Treasury and the vizier

The Middle Kingdom Treasury was a more complex institution than before, since it had subsumed the duties of several Old Kingdom offices. As for copper, it means that from the mining until the final use, the metal might have formally moved within the branches of a single institution. The Treasury's involvement in the expeditions has been discussed above.

The leadership of the institution in Egypt was divided among several officials. The highest officials were *jmy-r prwy ḥḏ, jmy-r prwy nbw* and *jmy-r ḫtmt*.[759] The overseer of both

[755] Enmarch (2008).
[756] (Enmarch 2008, 162–164).
[757] (Lashien and Mourad 2019, 32, Pl. 72).
[758] In the Heqanakht letters, *šnʿ* is translated as "workshop" (Allen 2002, 18).
[759] (Vernus 1994; Desplancques 2006, 221–223; Grajetzki 2013, 238–239).

treasuries (*jmy-rʿ pr.wj ḥḏ*) can be found in the evidence in Egypt itself; of its more than ten bearers, only two were viziers. They organized construction of royal buildings (thus performing the duties of Old Kingdom overseer of works). The function of the overseer of Both Golden Houses, an institution storing gold on the state level, continues from the Old Kingdom, with eight known bearers including Vizier Dagi.[760] Khety, another bearer of these titles from Dynasty 11, has also the title of the overseer of silver and gold.[761] These two titles disappeared after Dynasty 12. A document preserved in the early New Kingdom tomb of Rekhmira, renamed The Duties of the Vizier by J. H. Breasted, can be dated to the late Middle Kingdom.[762] The text describes that the vizier had to collect deliveries from the workshops and open the Golden-House (*pr-nbw*), together with the overseer of the Treasury.[763]

While both above-mentioned titles belonged to high officials, the first of them most probably to the "director" of the Treasury, the overseer of sealed things (*jmy-rʿ ẖtm.w*) became by far the most frequent title among high officials of the state as well as among overseers on lower levels of administration.[764] On the highest state level, altogether 28 bearers of the title are known until the Second Intermediate Period, including powerful Dynasty 11 official Meketra. Eight of them were also *ẖtm.ty bj.ty*, and three were viziers as well.[765] In accordance with its name, the title is quite frequent on Middle Kingdom seals and sealings (contrasting with the absence of the previous two high titles). There is evidence of its bearers' involvement in construction projects, the overseeing of the tributes and the initiation of expeditions, although these officials rarely participated in them. In the late Middle Kingdom, sealings of overseers of sealed things and their subordinated officials occurred in the Hyksos territory and in Palestine, probably indicating a relationship between the procurement of material and persons of foreign origin.[766]

A changed role of the Treasury is perceptible also on the lower level, with mentions of chamberlains leading the expeditions and of other officials explicitly controlling craftsmen. Lower ranking officials worked in the "provision quarter" - *šnʿ*[767] and Abydos stelae are the main source for its organization. Provision quarters contained "chambers" – *ʿ.t*, such as the

760 (Desplancques 2006, 297–311).
761 *jmy-r ḥḏ ḥnʿ nbw* (Desplancques 2006, 353).
762 (Boorn 1988; Quirke 2004). Arguments for dating into the late Middle Kingdom presented by J.-M. Kruchten and (Quirke 2009, 113–114).
763 (Boorn 1988, 42–55, 284–285).
764 It occurs down after the end of the Late Period (Vernus 1994).
765 (Desplancques 2006, 311–328).
766 (Desplancques 2006, 407–408).
767 (ibid., 240-247).

chamber of the collar.[768] Officials responsible for the Treasury chambers were often present in expeditions.[769] Lower-standing scribes of the Treasury were most probably in charge of the detailed noting down of the mined material.[770] The Treasury also had its own metalworkers (see below). A title expressing responsibility for silver and gold counts is part of the titulary of the official Sehetepibra, the right-hand man of the overseer of sealed things. A rock inscription from Wadi el-Hudi complements this title with a clause "who seals for production in the workshop".[771] Kay, assistant of the overseer of sealed things, was sent to control the craftsmen at the direct request of the king.[772]

Nomarch Sarenput I explained in his biography that the craftsmen were called to service by him, but the tomb building was praised by the king, equipped by things from the Royal palace and also Treasury.[773] Reciprocally, he received *gꜣw.t* levies and *bꜣk.w* production from the foreign lands, which were then *ẖkr.t nswt*, regalia/wealth of king.[774]

4.3.4.2. Treasuries in Nubia

Smaller treasuries are known from Middle Kingdom fortresses in Nubia, based on inscriptional evidence. The sealings were uncovered from the fortresses of Semna South, Uronarti, Askut, Iken/Mirgissa, Bigga, and Menu Mehty.[775] No indication is given about separate rooms or spaces destined to be used for copper. Although precious metals are rather supposed to be stored there, copper cannot be excluded.

A type of storage space was probably *ẖtm*, "sealed (space?)"present on sealings from Mirgissa.[776] Seals of magazines (*wḏꜣ*), which were probably smaller in size, are known from Semna South, Shalfak and Iken. Sealings with this inscription are coming from the packages, but also doors, and the magazines could have been located out of the fortress.[777] The material stored herein was both edible and nonedible.[778] Possibly, they were lesser parts of the treasuries, but the information rather demonstrates generic use as a term for "magazine". On one of the tomb paintings in Beni Hasan, a box ("tresor") is denoted by an inscription *wḏꜣ-ḥtp n nb*w – "box for gold", thus probably depicting such smaller storage units (Figure 4.40d).

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768 Grajetzki (2013, 244).
769 (Desplancques 2006, 374–380).
770 (Desplancques 2006, 384–388).
771 *Jry n ḥḏ ḥnꜥ nbw ẖtm r ḳmꜣ.t m st-ḥwt* (Desplancques 2006, 353).
772 *Jn=j r ẖrp ḥm.wt ẖr ḥm=f* (Desplancques 2006, 356).
773 (Desplancques 2006, 372). Text translated by R. Landgráfová, accessible in "Thesaurus Linguae Aegyptiae, Grab des Sarenput I. (Qubbet el-Hawa 36), Grabfassade, Biographie, 8–11", last accessed on 10th January 2020: http://aaew.bbaw.de/tla/servlet/GetCtxt?u=guest&f=0&l=0&tc=1367&db=0&ws=0&mv=1.
774 (Kubisch 2007, 73).
775 (Gratien 1994, 188–190, 2019, 79).
776 (Gratien 2019, 79).
777 (Gratien 2019, 80).
778 (Gratien 1994, 194–195, 2019, 112–113).

Overseers of sealed things are known from Nubia, on sealings and on displaced Egyptian objects found at Kerma.[779] Evidence of the sealings of other responsible officials of the Treasury chambers was also found in the fortresses of Kumma, Wekhu, Nebpu, Sery and Askut.[780] Although Treasury officials were present in Nubia, their presence was most probably only temporary.[781]

A singular sealing from Mirgissa denotes very importantly an "overseer of the house of counting copper Neb...", thus a specific official destined to be the counter of copper (Figure 4.15, photograph 3-97). Traditionally, this would be interpreted as an introduction of a new title in Nubia, previously unknown. I am rather of an opinion that the evidence of such officials in other contexts was not yet, unfortunately, preserved. On the other hand, inscription might be also instead translated as "overseer of the house of counting, metalworker Neb...".

4.3.4.3. Weighing of copper

Weighing of copper was also depicted in the Middle Kingdom scenes of metalworking. Far less scenes were completely and sufficiently published, and they are all from Beni Hasan (Figures 4.40, 4.59). Nevertheless, the composition and actions, together with devices depicted were significantly different between tombs. Most of the preserved structures are weights standing on separately built broad support, from which a fulcrum with a beam and weighing bowls is hanging.

From our perspective, the most interesting is scene from tomb of Amenemhat, where on both bowls of balance are being weighed tool blades (Figure 4.40g). Oblong chisel on both bowls, more chisels (or weighing stones), and a mirror blade on the left bowl, on the right is also an adze blade and a lugged axe blade. Below the bowl is most probably a toolbox, and on both sides of balance are kneeling workers, holding the balance bowls. Here we can observe how various products of the metallurgical workshop could have been weighed at once, in a single bowl of balance. If this is not an indented complementary depiction of all possibilities or even a joke of ancient craftsmen (in Old Kingdom scene of Kaemrehu only single type of adze blades is weighed), it must be a depiction of past actions. On the right end of whole register, a scribe is delivered with a papyrus, clearly inscribed by numerals (84 or 85 debens?), denoting weighing operation at left.[782]

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[779] (Desplancques 2006, 324–326; Gratien 2019, 103–108).
[780] (Desplancques 2006, 376).
[781] (Gratien 2019, 106).
[782] This new discussion is possible only after the new publication of the whole tomb, as in the early publication, these details were rather blurred (Kanawati and Evans 2016).

From other scenes, gold working scene from tomb of Baket III is depicting a balance with both persons standing around it, although the bowls are much smaller (Figure 4.40d). A caption above the scene is denoting "bringing of copper and gold" and "scribe of gold". Scene might be interpreted as cooccurring weighing of both metals in the practice of jewellers. In another, fragmentarily preserved scene also from the tomb of Baket III, uncomplete caption reads probably *wdn bjꜣ* – copper is heavy(?)", with another caption is preserved even less well (Figure 4.40e).

Tomb of Khnumotep II provides architectural setting for a weighing scene of unclear metal (Figure 4.40i). It looks as if taking place outside, under a light roof supported by three columns with bases. Three persons are present at weighing, including overseer of sealed things, a scribe and an operator of the scale, without a title.

4.3.4.4. Copper in the private transactions

Unequivocal evidence of transactions with copper and copper tools is preserved only from Dynasty 11. E. Edel first published a text from Qubbet el-Hawa, found in Tomb 30b and written in hieratic on the inner side of a semi-circular bowl.[783] Edel dated the text to the late Old Kingdom. He interpreted it as a list of burial goods for the father of a certain Sebekhotep.[784] The text was later reinterpreted by Goedicke as a document dealing with a transaction,[785] the payment for the burial of Sobekhotep's father within the tomb. The valuables listed were grain, fruit, textile and a copper axe. Finally, Seidlmayer corroborated Goedicke's conclusion and dated the vessel to Dynasty 11 based on analogies from other sites and Qubbet el-Hawwa.[786] The vessel thus provides a *terminus post quem* for the text. According to Seidlmayer, the material from the tomb did not include any Dynasty 12 material. Dating of the text in Dynasty 11 has to be followed, yet the bowl is dated to early Dynasty 12 in the publication of tomb.[787]

Another piece of evidence datable to Dynasty 11 confirms that copper was used in private transactions of early Middle Kingdom Egyptians. It is one of the closing sentences of the Letter II written by Heqanakht (Figure 4.34c):[788] "Now look, I have had 24 copper deben for the lease of land brought to you (all) by Sihathor. Now, have 2 *dꜥr* of land cultivated for us on lease in Perhaa beside Hau Jr., by copper, by cloth, by full barley, [by] any[thing], but only when you will have (first) collected the value of oil or of anything (else) there. Mind you, be

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[783] (Edel 1987).
[784] The dating to the Old Kingdom is followed e.g. by (Strudwick 2005, 426).
[785] (Goedicke 1988).
[786] (Seidlmayer 2006).
[787] (Edel,Seyfried and Vieler 2008, 414–415).
[788] Translation by (Allen 2002, 17, vo. 1–4).

especially diligent. Be watchful, and [farm] good watered land of Khepshyt." Sihathor brought from Heqanakht 24 copper deben for the lease of land. We can see how non-royal individuals without direct access to the king might have used the deben in private transactions.

Several mentions of the lemma *šnꜥ* appeared in Heqanakht's correspondence as well, translated as a verb "value" (*šnꜥ*) and a noun "value" (*šnꜥw*, *šnꜥt*). In none of these cases was indicated connection of the word to copper. In a letter I, Heqanakht orders to his household (I, 3–9, selection): "Arrange to have Heti's son Nakht and Sinebniut go down to Perhaa to cultivate for [us] a dar. of land on lease. They should take its lease from that sheet to be woven there (with you). If, however, they will have collected the equivalent **value** of that emmer that is (owed me) in Perhaa, they should use it there as well. Should you have nothing more than that sheet I said to weave, they should take it **valued** from Sidder Grove and lease land for its **value**." All three occurrences have a determinative of abstract concepts, a scroll, twice is present also determinative Aa2 of "counting" matters.[789] The word value with the same determinative was also written down in the Letter II, cited in the last paragraph.[790]

Copper was also listed among private possessions in two Middle Kingdom stelae from Armant and Thebes (Figure 4.34e).[791]Concluding this subchapter, a mention must be made of Dynasty-17 stela of a soldier Haankhef from Edfu.[792] He claims on the stela that he obtained (*jnj.n=j*) gold, 26 units, most probably deben, which was a cost of a female servant. Thus, before the beginning of the New Kingdom, also gold is confirmed as an expression of value, moreover, used in private transaction. Then, in the New Kingdom, written sources include transactions with gold and even silver. E.g. annual tax of an official in charge of natron in Fayum was 91 kg of gold, fishermen paid their taxes in silver.[793]

4.4. Metalworkers, melting and production of copper objects

Having clarified the procurement, storage, and unspecified operations with copper, let us focus on the performers of the craft themselves, the metalworkers. In contrast to prehistoric cultures and similarly to other early cultures with writing, we are provided with the names and other information on metalworkers in Egypt.

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789 (Allen 2002, 15, Pl. 26–27), MMA 22.3.516.

790 (Allen 2002, 17, Pl. 32–33), MMA 22.3.517.

791 EA1164: Clère and Vandier (1948, No. 4, Column 6); Fischer (1961, 63–64); CG 20011: Lange and Schäfer (1902, 10–11, Taf. II: 20011); Clère and Vandier (1948, No. 33, Line 2); Fischer (1961, 63–64).

792 (Kubisch 2008, 227–230).

793 (Moreno García 2013, 94–96).

The metalworkers can be approached using several categories of sources. First, albeit not frequently, funerary monuments and tombs of metalworkers are preserved. The overview of the monuments of metalworkers will contain also their official titles used in Egyptological studies to gain insight into the social status and structure of society. Generally, the titulary of metalworkers is of low rank; few exceptions of more complex titulary are preserved. Even these persons could only afford tombs of modest size, indicating their rather lower social status among Memphite officials. At least one Old Kingdom metalworker managed to equip his tomb with a biography, unfortunately only fragmentarily preserved (Dynasty 5 Itush from Saqqara). Besides tombs, funerary monuments with the names and titles of metalworkers existed, mostly removed from the original archaeological contexts by illicit digging at the Egyptian sites. Both tombs and smaller monuments (frequently also parts of the funerary cult and display), at least funded by metalworkers, show their manner of presentation in society. From the point of view of the contents, these tombs and monuments do not differ from other funerary monuments of ancient Egyptian culture.

The second category of sources consists of the already mentioned metalworking scenes from the Old Kingdom, First Intermediate Period and Middle Kingdom, a rendering of the craftwork as seen by ancient Egyptian craftsmen providing valuable indirect information on the context of craft. Such scenes were even satirized by ancient Egyptians in the Middle Kingdom Teaching of Khety.

Actual work logs of metalworking workshops are very rarely preserved. The most precious of such sources in the period under study is the papyrus Reisner II, the work log of a metalworking facility in the royal dockyard in town of This from the reign of Senusret I.

4.4.1. Sokar, god of metalworkers

The only deity directly connected to the metallurgy was one of the falcon deities, Sokar, the god of the Memphite necropolis and, on the basis of two mentions on Old Kingdom reliefs, also a deity mentioned by metalworkers themselves.[794] In the Pyramid Texts, Spell 669, Sokar himself produces metal harpoon heads for the deceased king so that he can break the egg in which he is before his rebirth (Figure 4.100).[795] Sokar was frequently mentioned in the tomb of metalworker Ankhi/Intji, this tomb having also references to the religious connotations of metalwork.

Two spells of the Coffin Texts demonstrate that metalworkers were perceived as the Sokar's craftsmen in particular in the Middle Kingdom, as well (Spells 590, 660, Figures

[794] (Fischer 1964a, 28; Altenmüller 1984).
[795] (Odler and Peterková Hlouchová 2017, 200–201).

4.112, 4.114–4.115). Spell 660 describes a basket that is a "skin of Sokar which belongs to his own fire-blowing".[796] Thus Sokar's craftsmen will not do their own smelting/fire-blowing. These words did occur in the context of metalwork (in the tomb of Ankhi/Intji, also mentioning Sokar, Figure 4.45), therefore it can be safely inferred that the craftsmen in question are metalworkers. Spell 590 further develops the topic of the Sokar as the craftsman of gods, making this time jewellery: "Horus has equipped his father Osiris with the gold collar of Sokar himself. Re has commanded that he make it. Thoth having received his wealth and the craftsmen of Sokar being assembled."[797] System of the patronage and ordering of the craftwork is here demonstrated in the realm of ancient Egyptian deities.

While we have at our disposal sufficient mentions from the periods under study to establish the definition of Sokar as the deity of the metalworkers and a metalworker of the ancient Egyptian pantheon (early precursor of Hephaistos), sufficient amount of evidence to study these connotations is preserved only from the New Kingdom, probably having also some features which were added during the course of time and development of the cult of deity.[798]

4.4.2. Early Dynastic Period

Unique textual indication provides evidence that some Early Dynastic institutions possessed also metal workshops and the products were sent to royal tomb(s). Two vessels, apparently from the burial equipment of King Qaa from Dynasty 1, bore the names of the palaces (Figure 4.30).[799] The bowl Ab K 1647 was inscribed as one of the *pj-ḥrw-msnw*, presumably located in Pe near Buto, and naming the title "foremost of the royal house", then mentioning censer. Another bowl, Ab 1646, of a palace *sꜣ-hꜣ-nb*, allegedly located in the Memphite area, mentioned alongside Green phyle.[800] Besides those copper vessels, also stone vessels were inscribed with these institutions' names, and other products were sealed. Thus, this is the singular, but strong evidence that metal workshops were parts of the domain/palace structure of Early Dynastic Egypt. Moreover, if the presumed location of the workshops is correct, they were located in the area without ore sources, thus they had to be provided by a state distribution network. The circulation of metal must have worked effectively already in Early Dynastic Period.

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796 (Faulkner 2004, Vol. II, 231).
797 (Faulkner 2004, Vol. II, 191).
798 (Gaballa and Kitchen 1969; Graindorge-Héreil 1994).
799 (Engel 2017, 84–86, 93–95, 419–421, 522, Abb. 264, 319, Taf. 30f).
800 (Engel 2017, 264, 268).

Not a single tomb of a metalworker has been found from the Early Dynastic Period. The strongest indicator of the existence of at least one funerary monument is an unprovenanced statue now in the British Museum most probably coming from a tomb in the vicinity of the administrative centre of Early Dynastic Egypt at Memphis. It is a red granite statue of Ankhua dated to Dynasty 3 (Figure 4.41–4.44). Above the left knee on the kilt of Ankhua is a hieroglyphic inscription, translated in the corpus of Dynasty 3 inscriptions as: *metalworker / property custodian of the king / shipwright of śmꜣ-ships / Ankhua*. The title property custodian of the king is the most important in this set; it indicates that Ankhua was a courtier at the royal court.[801] The combination of the titles of metalworker and shipwright indicates that the professions of the smelters and other craftsmen could be exercised by the same person (and the subsidiary graves contained persons with the symbols of status – the tools). He must have resided somewhere in the Memphite area, however; the red granite was imported from Aswan quarries at the first cataract. It was a material of elite significance, provided by the king himself or the royal administration. The adze should be a symbol of the most important profession of Ankhua. The statue belongs to the pre-canonical Egyptian style of statues; later, working tools were absent from high-end statuary. The statue shows clearly that the social status of some craftsmen could be rather high in early Egyptian society.[802] His tomb might be expected somewhere in the Memphite area, perhaps at Saqqara. The position of the statue was probably in the serdab or elsewhere in the tomb as part of the statuary programme.[803] Red granite is found in the context of royal craftsmen also later: the statue of overseer of tomb makers Neferihy from late Dynasty 5 was made of granite with polychromy.[804]

Tombs of metalworkers might have been present in the clusters of craftsmen's tombs at Saqqara and Helwan. The first cluster is located at Saqqara, near the pyramid of Netjerykhet. Some of the tombs were probably later destroyed by the causeway of Wenis pyramid. One of the tombs was of the overseer of faience Itisen.[805] The second cluster is on the opposite bank of the Nile, at Helwan. Slab stelae from Helwan belonging to carpenters and sculptors indicate that tombs of other craftsmen including metalworkers had to be expected as well on the east bank of the Nile at Helwan.[806] Dynasty 1 subsidiary graves

[801] (Bárta 1999, 82, 88).
[802] (Köhler 2008, 392).
[803] Cf. (Bárta 1998b).
[804] ÄMUL 2687, accessible on link http://www.giza-projekt.org/Funde/UL_2687/UL_2687.html, last visited on 21st January 2020.
[805] (Moussa 1972; Baud 2007, 217–218).
[806] Köhler – Jones (2009 *passim*).

represent earlier evidence of different burial customs, but there are no graves with at least indications of metalworkers buried at Helwan, although the metal tools and model tools did occur in several undisturbed graves.

Well-known assemblage of the stone vessels in the mortuary complex of the King Djoser did contain also inscriptions, titles and names, of the presumed private donors, including craftsmen. Metalworkers could be providers of such gifts, but the number of copper finds from the Djoser's complex is meagre. However, it is worth noting that the practice of gift-giving might have been coming also from "bottom-up" in the social "pyramid".[807]

In the provinces, two seal impressions from Elephantine might have named metalworkers, sealing cat. no. 227 with name Pet... (*Pt…*) and sealing cat. no. 629, bearing the name Hemunrudj (*Ḥm-wn-rwḏ*) (Figure 4.12).[808] While Hemunrudj's title can be read as *bḏ.ty* with a misrepresented sign b in the beginning and a sign for crucible. Another group can be read as *ḥm.tj*, written with the sign U36, but it does not have to mean the metalworker, it could be unusually written *ḥm*(*w*)*.tj*, craftsman, or a (female?) servant. The dating of the sealings is unclear, but as inscribed seal impressions were quite scarce in late Old Kingdom Elephantine, the Early Dynastic Period is more probable.[809] That would also explain lack of formality in the sealings and titles, causing problems in reading.

4.4.3. Old Kingdom

4.4.3.1. Institutions with metalworkers

Old Kingdom evidence on craft organization is more detailed. We need to understand metalworking in the general framework of the organization of crafts in the Old Kingdom, as the metalworkers were no exception to it. On the contrary, they are frequently used as the best documented case of the organizational structure of craftsmen. Several most frequent institutional affiliations of the Old Kingdom need to be discussed herein as larger units in which the metalworkers might have worked. The numerous other craft specializations that used metal tools will be mentioned, but they will be discussed in detail in the subchapter dealing with the use of artefacts. Generally, the institutions present were either parts of the royal administration or, in lesser numbers, of non-royal institutions.

4.4.3.1.1. Metalworkers of the Great House – *pr ꜥꜣ*

[807] (Mazé 2018, 123).
[808] Pätznick (2005, 116, 386, 605, Tab. 44, Kat. 227, 629).
[809](Bussmann 2010).

The Great House is one of the names of the royal palace in the Old Kingdom, all of these with slightly different meaning.[810] This particular term is administrative in nature, connected with the daily life of the ruler, "actual royal residence".[811]

The Great House as the affiliation means most probably the employment of craftsmen at the court or the state centre.[812] The Old Kingdom Great House must have had both storage and production facilities (Figure 4.16). The Great House had its own treasury with sealed things; gold is mentioned separately in it, as are the regalia: the thrones and jewellery but also e.g. ornaments of the dancers. The Great House employed also other craftsmen besides metalworkers: builders/masons, sculptors, carpenters working also in the institution's shipyard, workers with precious stones, necklace-stringers and people taking personal care of the king (physicians, hairdressers, barbers and manicurists). Thus, the institution not only stored artefacts needed for the well-being of king and the performance of the kingship; it also was able to produce such objects. Apparently, Great Houses of a special kind were also parts of the temples, as the temple of Thoth had barbers in the House, and there was a treasury of the Great House also in Heliopolis.

The following three subchapters discuss institutional affiliations that might express a similar kind of interdependence using different words. Moreover, known metalworkers held titles also in differently designated institutions.

4.4.3.1.2. Craftsmen of the king – *nswt/pr nswt*

A reference to the king himself could have been part of a profession denotation (Figure 4.17). The *pr nswt* is interpreted as a term slightly different from the Great House, meaning "royal administration."[813] The term is also being translated as "king's domain", interpreted as having political and economic dimension, in the latter regard being the king's personal property and its administration.[814]

As the categories represented were less numerous, but partially overlap with the previous affiliation, they might have expressed different facets of a similar connection. People responsible for storage were present (royal sealers), as were royal craftsmen (architects, carpenters) and people of personal care (hairdressers, barbers, manicurists). In this context, a single metalworker of the king's ornaments is known from the Old Kingdom. A doubling of the institutions while there was a single king would be improbable. This group of craftsmen

[810] See discussions in (Goelet 1982, 1989; Verner 2014, 108–114).
[811] (Goelet 1989).
[812] (Drenkhahn 1976, 143–144).
[813] (Goelet 1989).
[814] (Verner 2014, 104–108).

most probably served the king himself in his life.[815] This is a plausible explanation; a more nuanced interpretation would require a contextual analysis of the titles.

Although the designation *nswt* indicates a connection to the king and the centre of the state, this title could in fact mean also activity in the provinces, thus not only in the personal vicinity of king. Royal architect/carpenter Nekhebu of Sixth Dynasty wrote in his tomb biography about his missions to the provinces at the king's behest.[816] In another fragment of his biography, Nekhebu claims that the king himself (Pepy I) gradually "conferred" higher and higher offices on him. He also describes the process of the gradual appointment of his brother to further offices, culminating with the functions of the sole companion and the king's architect in both houses and then of the overseer of works.[817] In the case of the specialists' work, the access to higher titles might have been influenced by the experience and a certain rule of career succession.

4.4.3.1.3. Metalworkers of Both Houses

Another possible way of expressing the state level of craftsmen's activity might have been the affiliation to "Both Houses" (Figure 4.18). The institution of *pr.wy* was mentioned with the titles of other craftsmen and of the high priests of Ptah.[818] Helck interpreted it as a reference to Lower and Upper Egypt.[819] As was mentioned in the subchapter on the Treasury, dual most probably meant the "state level" of the institution.

Both Houses comprised an armoury, but the armoury itself also had two houses. There were two houses also for the storage of gold, the regalia and the separately mentioned golden regalia. Both Houses had craftsmen including metalworkers, builders/architects and sculptors. As there was only one king at a time in the Old Kingdom, some professions, arguably including metalworking ones, were mentioned repeatedly in different contexts, with different denotations. While the nuances may escape our attention, there either existed very similar institutions in the centre of the state or different words were used to name the same phenomena.

4.4.3.1.4. Metalworkers of the Workshop – wabet

A wabet was most probably a workshop or an assemblage of workshops that took part in the preparation of the king's burial and burial place.[820] According to the titles, there existed the workshop of the Great House, the royal workshop, both workshops and also the southern

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[815] (Drenkhahn 1976, 145–147).
[816] (Dunham 1938, 2–3).
[817] (Dunham 1938, 4–5).
[818] (Freier 1976, 11-12).
[819] (Helck 1954, 105)Helck (1954, 105).
[820] (Drenkhahn 1976, 147–151; Brovarski 1977).

workshop.[821] A dual expression might have expressed a higher status that singular workshops. Was the name of Both Houses referring to a similar situation, or were those differently named institutions identical? The singular workshops could well be different names for a similar reality (Figure 4.19).

Recently published text from tomb at Saqqara, of an inspector of royal house (*sḥḏ pr-nswt*) Ptahshepses Tjemi, that for two days, a wabet workshop at Heliopolis was working on the shaping of his sarcophagus from Tura limestone. Both the sarcophagus and whole tomb was a gift from the King Wenis to the official.[822] Important information provided is that the workshop did not have to be located at the necropolis, but on the western bank of Nile instead.

The only bearer of the title of the overseer of the southern wabet was the metalworker Ankhi/Intji (Figure 4.45).The only other specification for a metalworker was found in the tomb of Itush, who was employed in the *wꜥb.t* of the Djedkara pyramid (Figures 4.46, 4.47). Another wabet of which he was an overseer, was the wabet of both golden houses, as is written on the fragments of his tomb in KHM Wien. Workmen of a *wꜥb.t* might have produced also pieces of the tomb furnishings for private persons under the supervision of the king (false door produced for physician Nyankhsakhmet).[823]

4.4.3.1.5. Metalworkers in private/funerary estates – *pr ḏ.t*

The only distinction that was considered clear in the Old Kingdom sources was the distinction between royal (*pr ꜥꜣ, nśw.t, pr.wy, wꜥb.t*) and non-royal, also called private institutions. Mutual influence of both spheres is only taken seriously if present in the written or iconographic sources; arguments by material culture (possible distinguishing of the royal and private production of selected artefacts) are less understood generally.

Old Kingdom evidence on metalworkers in private service of the funerary estates is meagre (Figure 4.20).[824] Metalworkers depicted in non-royal tombs often had no specification of the institution, the only exception being the tomb of Mehu at Saqqara with the overseer of the metalworkers of the funerary estate (?), *jmy-r bḏ.tyw n pr-ḏ.t*.[825] In the tomb of Mereruka, weighing is done under the surveillance of *jmy-r pr jḫj* – steward Ikhi, possibly a member of the Mereruka's household.[826]

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[821] (Jones 2000, 87–88).
[822] (Soleiman 2018, 148–149).
[823] Tomb D11 at Saqqara was published by Mariette (1889, 202–205). Wilson (1947, 241-242), Strudwick (2005, 302-303).
[824] (Drenkhahn 1976, 135–142).
[825] (Scheel 1985, 139).
[826] Scheel (1985, 139).

The silence about private/non-royal metalworkers in Old Kingdom sources might have been due to lower importance of this information. It can be assumed that only rather large households or estates could afford their own metalworkers and supply of the material. Other professions were mentioned as taking part in the operation of (funerary) estates: craftsmen in general, carpenters, necklace-stringers, fishermen. Their total number was rather scarce; the funerary estates rather possessed unspecified workforce and mortuary priests. Private estates were apparently imperfect imitations of the largest estate in the state, that of the king.

4.4.3.1.6. Metalworkers without specification of institution

An important problem of Old Kingdom research are titles without a designation of the institution. Sometimes, it can be inferred from the context. The smiths Neferseshemptah and Sekhentyu were both royal intimates (*mḥnk*) and their connection to the royal craft organization must have been clear to an Old Kingdom reader of the text (Figure 4.46).[827]

For whom, however, worked craftsmen without a specification of institution of whom only a single piece of evidence has survived? Were some of them "freelancers" employed temporarily in royal or private service? In case of employment in the royal service, it can be assumed that such a fact would likely be listed in the inscriptions. Or were they steadily employed in the private service of a household?

4.4.3.2. Other titles of metalworkers

For a true indication of the social status of metalworkers, it is inevitable to study other titles that they bore on the monuments. Other titles of metalworkers represented other crafts, the organization of craftwork and resource management, religious aspects of metalwork and royal connections of metalworkers (Figure 4.46, 4.47). Although this concept is difficult for us to grasp, subtle hints in Old Kingdom sources enable us to assume that some metalworkers could attain high status due to their relationship to the king. Two such personalities were Itush and Intji buried at Saqqara. Only the tomb of Intji was preserved completely and demonstrates the extent of the expertise by a craft specialist.

The highest-standing holders of metalworker titles, Intji and Itush, had also other duties at the royal court: they were *ẖrp mḥnk nśwt*, directors of the body servants of the king/intimates (*mḥnk*).[828] Persons with such designation were close to the king, participating on his personal care and adornment, including regalia – which might be the metalworking link in these two cases.[829] This title and the lower titles of royal intimates of other metalworkers

[827] (Moussa and Junge 1975).
[828] Jones (2000, 719-720).
[829] (Moussa and Junge 1975, 16; Dulíková 2016, 143).

makes them persons with the more regular access to the ruler than most of the Egyptians living in contemporary Egypt. The ability of producing metals gave the metalworkers access also to some aspects of the ancient Egyptian religion, which we cannot fully comprehend at present.

The titles overseer of speckled snakes and controller of the overseers of speckled snakes was possibly connected to the royal cult and religious rituals.[830] Moreover, C. Cannuyer notes that the snakes are as a symbol connected to the fire, not only in ancient Egyptian culture.[831] Other their titles indicate that they organized also practical aspects of the craft activity at the royal court and storage of its products, e.g. weapons, jewellery and images of deities.

Most of the title holders attained only a few functions and they were listed on their funerary monuments. Since usually only a single monument is preserved, it is difficult to tell whether they omitted other titles. E.g. the lintel of Nedjemib gives most of its long text to the aspects of the mortuary cult rather than to the mundane titles of the functions, listing the most important ones. Therefore, many pieces of information from the practical conduct of the life of craftsmen might be lost, as the focus of funerary monuments was elsewhere.

Among these titles were, nevertheless, also titles referring to the activity of craftsmen on the royal court, second title of the already mentioned Nedjemib was royal intimate (*mḥnk*),. Several metalworkers were also property custodians of the king, although only in the case of Dynasty 3 metalworker Ankhua and presumed Dynasty 4 official associated with metalwork, Nyankhseshat, this title might indicate real influence at the court. In later times of the Old Kingdom, the title lost its importance.[832]

To conclude, preserved titles of the Old Kingdom metalworkers indicate that they were among the retinue of middle- and low-rank officials at the royal court, predominantly specializing in their craft, other crats, and rarely also other domains of administration. Even though Ankhi/Intji displayed his esoteric specialist knowledge in his tomb at Saqqara, his social standing enabled him to order only a modest funerary monuments, compared to the large decorated Dynasty-6 tombs of the most powerful officials.

4.4.3.3. Metalworkers in Gebelein papyri

[830] Jones (2000, 468).
[831] (Cannuyer 1990, 104–105).
[832] (Bárta 1999).

The Gebelein papyri are a corpus of documents from late Dynasty 4 found in an Old Kingdom tomb (Figure 4.12).[833] Papyri II and V were the accounts of grain delivered to various workers named in columns. Both papyri contained the names and titles of six metalworkers (*bḏ.ty*) and one director of the metalworkers (*ẖrp bḏ.tyw*). The heading of papyrus II on the recto was not preserved; the document recorded grain wages on days 10 to 30 of a month in an unknown year. It is safe to assume that the names on papyrus II listed workers of a workshop with five metalworkers and one directing craftsman. The account of the recto of papyrus V recorded among other things the grain wages of the inhabitants of the settlement *Jꜥrw* including a metalworker named *Jnw*. He might have been the only metalworker in this settlement, but we do not know the affiliation of the workers on papyrus II. The Gebelein papyri provide valuable information about metalwork, as they confirm the presence of at least five metalworkers in a "provincial" area in Dynasty 4. The structure of the workshops had at least two levels: common metalworkers and a superior craftsman.

4.4.3.4. Old Kingdom tombs of metalworkers

The evidence of tombs and funerary monuments of metalworkers occurs at Memphite necropoleis, at Giza and Saqqara. Few concentrations of the tombs of persons engaged in the organization of work in the Old Kingdom show that the craftsmen tended to group and build their tombs together. On the practical level, this might have also been a result of grouping the funerary services of persons related not only in their life but in the Afterlife as well. Similar cases of a grouping of professions have been observed at Abusir with a concentration of physicians and at Giza with a cemetery of palace attendants.[834] And because professions were often inherited from the predecessors, similar concentrations of tombs might have been concentrations of the tombs of a (wider?) family.

4.4.3.4.1. Saqqara and Abusir

The titles of royal metalworkers and titles from the rank of overseers occurred among the tomb-owners at Saqqara. The highest-ranked title-holders of the Old Kingdom in the metalworking craft were buried there, in the vicinity of the first pyramid. Moreover, Saqqara was a sacred place of the god Sokar, who was also the metalworker of the gods in one of his aspects. The ideal of building a separate tomb for a single owner was not achievable for everyone in Old Kingdom society. Examples of tombs for several people can be found also among metalworkers, with altogether five structures comprising also metalworkers.

[833] (Posener-Kriéger 1975, 2004).
[834] (Roth 1995).

An official recently discovered at Abusir South, Nyanksheshat, held both the title of the overseer of speckled snakes and controller of the levies of gold, although his most important title was the property custodian of the king. Since the same main title had the metalworker Ankhua, and overseer of speckled snakes is a title clearly associated with metallurgy in the Old Kingdom, it might be presumed that Nyankseshat was close also to the metalwork and metalworking title might have been on the broken off parts of his offering table (5/AS104/2018).[835]

Two craftsmen, overseer of metalworkers Neferseshemptah and overseer of goldsmiths Sekhentyu, were buried in two Dynasty 5 nearby tombs from the reign of Nyuserra or Menkauhor. Both of them were also royal intimates (*mḥnk*), which is most probably why they have a decorated stone tomb.[836] It is unclear, however, whether the occurrence of the title "overseer of metalworkers" might be only a shortened version of the title "overseer of goldsmiths".

The slightly later tomb D43 features a corridor chapel and two areas with a rectangular ground plan for the funerary cult.[837] The location of the tomb was denoted in both Mariette's and de Morgan's maps, situated on a rather high position in the local landscape.[838] The tomb was looted before Mariette's workmen excavated it again, with fragments of reliefs dispersed in several collections.[839] The tomb provided the second highest concentration of Old Kingdom metalworking titles, another exception being also from Saqqara. A biographical inscription datable to the reign of Djedkara Isesi was once part of the tomb decoration; only meagre fragments were preserved.[840] The tomb owner, Semenkhuptah/Itush, held several important titles: beloved metalworker of the Great House, controller of royal intimates (*mḥnk*), metalworker of the royal jewellery, overseer of every secret, overseer of the workshop, overseer of Both Golden Houses, overseer of speckled snakes, overseer of the Golden House, secretary of the king in the Great House. Another fragment with Itush's titulary adds the title of a metalworker of the wabet of the pyramid Beautiful is Djedkara to the list. Fragments of his tomb in KHM Wien add the title overseer of the wabet in both golden houses. His most beloved son Merer had even higher social rank, having become a juridical *ꜥḏ-mr* official.[841]

835 (Odler et al. 2019).
836 (Moussa and Junge 1975).
837 (Mariette 1889, 296–297).
838 (Hamernik 1985, 139–141).
839 (Capart 1939).
840 (James 1974, 14–15).
841 Jones (2000, 806).

Another of his sons, Mereruka, was also metalworker in both royal houses and overseer of the royal jewellery; his was most probably the second place in the tomb's funerary cult. A fragment of the relief is now in the British Museum.[842] The striding figure of Metet/Mereruka, possibly the same son of the tomb owner or another one of his children, is preceded by three titles in the inscription: metalworker of the Great House*,* assistant in the procession*,* and overseer of the speckled snakes.

A small mudbrick chapel D26 adjoining a larger tomb D25 contained fragments of a false door.[843] Neither the shaft nor remains of the burial have been found. The fragments rendered the name Hunyankh. Another person named on the supposed false door, Metet (*Mtt*), held the title of senior overseer of metalworkers of the royal house and overseer of craftsmen. It is questionable who was the most important recipient of the mortuary cult or whether the two personal names were of one person. The tomb is most probably from Dynasty 5, but an earlier date cannot be ruled out because of the basilophoric name Hunyankh of a Dynasty 3 king. From it can be assumed that the person might have been born in the reign of Huny.

A concentration of private tombs of officials engaged in the organization of state workshops was located near the western side of the enclosure wall of the Djoser pyramid.[844] Besides inspector of craftsmen of wabet Nesuwesret and overseer of the expedition Pernedju, a single metalworker was buried here: Ankhi/Intji.[845] The cult place of Ankhi/Intji was the smallest in the concentration of mastabas and the second closest to the funerary complex of Netjerykhet. The false door was directly facing the outer enclosure wall of the step pyramid complex.[846] The unusual contents of the inscriptions enable dating to the Dynasty 6, which is mostly followed in the literature.[847] Intji held several important titles, similar to the titles of Itush from Tomb D43. The social status of the two metallurgists must have been similar, and one has to ponder whether they might have been the members of a single, modestly influential family of metalworkers, the substantial reason being the closeness of the titles and the hereditary nature of the craft in the ancient Egypt. Ankhi/Intji was apparently a metalworker active at the royal court, especially in the practical organization of the craft and storage of its products, moreover he must have been a specialist on religious activities connected to metallurgy. Tomb inscriptions contained many unusual expressions and formulae, with some

[842] EA1185, James (1961, 243-244, Pl. 21).
[843] Mariette (1889, 254-255).
[844] (Porter et al. 1981, 611–612).
[845] (Drioton and Lauer 1958; Goyon 1959).
[846] (Goyon 1959, 11, plan).
[847] (Goyon 1959; Cannuyer 1990; Strudwick 2005, 217–218).

parallels in the tombs of Ptahhotep II and Tepemankh. Ankhi/Intji displays in the inscriptions arcane knowledge of the subject and some of his titles still defy attempts of translation. The inscriptions themselves would deserve a new detailed study, the main disadvantage being the initial “poor publication”.[848]

The Dynasty 6 tomb of Nedjemib featured an inscription naming the title of overseer of metalworkers of the Great House and royal intimate (*mḥnk*). The inscription itself is a rather long assemblage of the funerary formulae, with the mentioning of Anubis and Osiris, and the listing of the festivals, in which the invocation offerings have to be performed for Nedjemib. Text ends with the mentions of Nedjemib’s titles. Already Mariette dated the tomb to Dynasty 6, and this dating is followed later.

A simple rectangular libation basin made of limestone with a funerary inscription for overseer of metalworkers Kai (*Kꜥj*) was found during the excavations by Mariette.[849] The offering basin with a single central depression is of type B1.[850] Offering that king gives was given to Anubis, the foremost of the necropolis. The formula *ḳrstj=fj m ẖr.t-nṯr* is used on the basin.

4.4.3.4.2. Giza

Metalworkers buried at Giza had lower social status than those from Saqqara. Only two tombs of metalworkers have been identified (Figure 4.46, 4.47); a third one was discovered recently by the Russian mission.

The tomb of certain Nykaukhnum, dated by Porter – Moss – Málek to late Dynasty 5 or early Dynasty 6, was built at the Western Cemetery in Giza. The tomb had an L-shaped chapel with the main niche on the southern side, a serdab and four shafts. The name of Nykaukhnum was preserved on the southern wall of the chapel, in a scene with an offering table and censing, without any title.[851] The door drum over the entrance into the chapel bore another name and titles: king’s acquaintance*,* possessor of reverence, copper metalworker Neferseres. The inscriptions pose several questions, first of all concerning the gender of the person named. This name is mostly female in the Old Kingdom, but one preserved example is also male. In the case of this tomb there is a question mark in the entry by Scheele-Schweitz.[852] The omission of any feminine *–t* ending throughout the inscription in the epithets king’s acquaintance and owner of *imakh* might be a hint making the male gender of the

[848] (Strudwick 2005, 217).
[849] (Mariette 1889, 440, now in Neues Museum, Berlin 7725).
[850] (Hölzl 2002, 13–14, Tab. 2).
[851] (Junker 1950, Abb. 26).
[852] (Scheele-Schweitzer 2014, 481).

person mentioned more probable. The title was interpreted by Junker as *sšp-bj3* "metal-polisher",[853] but Drenkhahn included it among metalworker titles and interpreted as "metalworker with copper".[854] The title is a combination of the sign for worker and the sign for the material worked. The explanation of the person's gender relates to the interpretation of his or her connection to the supposed tomb owner; originally, she was considered Nykaukhnum's sister, later his wife.

The tomb of Neferherenptah was also located at the Western Cemetery.[855] The unfinished rock tomb had only a small chapel (2.85 × 1.80 metres) and two small burial compartments without any trace of a burial. It is questionable whether there were any Old Kingdom burials in this tomb. There is an unfinished relief of the owner, his wife and a child beside her right leg on the eastern wall of the tomb and an unfinished striding figure on the left jamb. On the western wall were unfinished stages of a false door, another indication that the tomb was never used as a burial place for the two persons. An inscription with the titles of the tomb owner and his wife is on the drum over the entrance, with touches of light green and red colour. He was inspector of the metalworkers of wabet, king's acquaintance and overseer of the carpenters. His wife Tjentites had no title besides the epithet "beloved of her husband". At least two stages of the production and use of copper are preserved in the titulary of Neferherenptah.

The Russian mission at Giza discovered the tomb of Perinedju (Tomb GE 19, Shaft 6, burial chamber 6B) at the Eastern Cemetery. The shaft contained two small copper plates and three stone pounders. According to the inscription in the tomb chapel, the title of the deceased was metalworker of the royal jewellery.[856]

Metalworkers took part in the mortuary cult of other persons, but this evidence is even more scarce that the evidence of their tombs. Some offering bearers were depicted in the tomb of the steward of the palace Iymery (G6020). The first in the row of offering bearers on the southern section of the eastern wall in the third chamber was funerary priest and inspector of the metalworkers Nyptah, presenting a goose in his outstretched hands, followed by funerary priest and metalworker Kaemankh, also holding a goose.[857] Even more interesting the metalworking scene in the first chamber depicting inspector of metalworkers Kai hammering the base of a wash basin positioned on a paddle. Four other people were shown hammering

[853] (Junker 1950, 62-–63, Abb. 24).
[854] (Drenkhahn 1976, 38).
[855] Bakr (1953, 121–123, Fig. 99-100, Pl. LXVI).
[856] Maksim Lebedev, pers. comm. (e-mail from 5th July 2014).
[857] Weeks (1994, 52, Pl. 42).

another vessel; one of them, named as funerary priest and metalworker Kaemankh, was most probably identical with the person among the offering bearers.[858] The wall was not preserved in full, but other persons in the metalworking scene had no titles; verbs denoting the craft were preferred. The only other exception in an Old Kingdom tomb where a metalworker is also named is a scene from the tomb of Tepemankh at Saqqara with the name of overseer of metalworkers Kakherptah.[859]

4.4.3.4.3. Unprovenanced texts

A wooden statue of metalworker Kakherptah was dated to Dynasty 5 in the original publication (Figure 4.13, 4.46, 4.47).[860] The statue is of unknown provenance, but the titles mentioned on it indicate Saqqara as the most probable burial place of the high-status craftsman. The statue depicts a striding figure with the left forearm stretching forward, originally holding a staff, which is not preserved. The inscription on the statue lists the person's titles and name: overseer of metalworkers of wabet, revered in front of the great god, king's acquaintance Kakherptah.

The collection of the National Museum in Havana includes late Old Kingdom false door of metalworker Idu (Figure 4.14). The false door with a cavetto cornice is rather small, and the quality of workmanship is not high. Porter – Moss dated it to Dynasty 6 or later. Idu was also lector priest and inspector of the Great House. Lipińska cited Fischer's opinion that the sign cannot be equated with *bjꜣ* or *bḏ.t*, but he did not offer any other reading. Her interpretation is most probably correct, especially in the light of other parallels of the sign. Again, the monument could originate from the Saqqara area, because of Idu's connection to palatial administration.

4.4.3.5. Workshop scenes

Workshop scenes are the most vivid part of evidence often used in popular works to represent ancient Egyptian metallurgy. They need to be perceived in the broader context of tomb decoration. The scenes of metalworking were embedded in the broader framework of so-called *mꜣꜣ*-scenes, the scenes of seeing, where the tomb owner is standing or sitting while observing craftwork done on his behalf.[861] The scenes were focusing on the process of the production of the objects and of their use, in the economy of delayed return. Most of the objects produced were part of the burial equipment, but they could have been used also in real life. Workshop scenes in tombs most probably refer to the role of the work in the sustenance

[858] Weeks (1994, Pl. 30, register 3).
[859] (Smith 1942, 515–518, Fig. 6).
[860] Borchardt (1911, 169-170, Blatt 57: 267).
[861] And often it is accompanied by his wife (Fischer 2000, 13).

of the ka of the deceased.[862] What was done for the tomb owner in real life was depicted as done also in the Afterlife. Let us deal with general aspects of the scenes at this point together with the processing of semi-finished products and melting; the production of the objects themselves is discussed in the relevant subchapters below.

Tomb decoration in Dynasty 3, if preserved, was focused on the display of finished products, as represented in the tomb of Hesyra. From Dynasty 4 on, the focus shifted from finished artefacts to the process of their production (Figure 4.55–4.56). Workshop scenes appeared in Dynasty 4, all of these were found at Giza, and finished products were only marginally present in the offering lists. As a part of unwritten *decorum*, the main objects of the burial equipment such as sarcophagi or wooden coffins are seldom represented, as is the building of tomb itself, which is not depicted in any Old Kingdom scene. Inscriptions in workshop scenes appeared in early Dynasty 5. Scheel defined four categories of inscriptions: description of the process, titles of the workers, statements by the metalworkers and responses of their co-workers.[863]

Old Kingdom sources come from the Memphite necropoleis and the provincial cemeteries. Altogether 37 metalworking scenes (featuring processing of gold, silver, electrum and copper, but also often unspecified metal) have been found (Figure 4.35–4.39);[864] the most recent one has been published from the tomb of Ptahshepses at Saqqara by Egyptian Egyptologists,[865] and there is also a not yet published metallurgical scene in the tomb of funerary priest Wahty at Saqqara.[866] At least one of the known scenes has not been sufficiently published until now: the scene in the tomb of Vizier Rashepses at Saqqara.

Scheel distinguished 13 phases of the *chaîne opératoire* in the scenes; all of these phases were not depicted together anywhere.[867] There are no scenes depicting ore mining and its initial processing. The depicted scenes capture later phases of the processing of mined and possibly also primarily worked metals. The following production phases were included: weighing of raw metal/ingots, melting, transport of melted metal, pouring of melted metal, blade working, sheet hammering, vessel hammering, shaping of the sheets, shaping of the vessels, polishing of the vessels, weighing of the finished products and the delivery of the finished products to the official or the tomb owner. The frequency of the scenes differed:

[862] Cf. (Roth 2002).
[863] (Scheel 1985, 137).
[864] Oxford database lists 33 examples.
[865] (Batal,Soleiman and Turkey 2015).
[866] Discovered in the autumn of 2018 and announced by the Egyptian Ministry of Antiquities. Preliminary report published by (Waziri and Youssef 2019).
[867] (Scheel 1985).

weighing of the ore and finished products (10 scenes); sharpening of a blade (1 scene); melting of noble metals (18 scenes); pouring of melted metal (3 scenes); hammering of a copper and golden sheet (13 scenes); hammering of vessels (3 scenes); further working of vessels (2 scenes); delivering of vessels (1 scene), polishing of copper beads (1 scene); perforation of beads (1 scene).

There is an ongoing discussion between the proponents of two interpretative frameworks: one considers Old Kingdom reliefs works of art of a specific style based on "pattern" books with only a loose connection to reality, the other believes they represent a realistic rendering of metalworking processes.[868] It is unlikely that the draughtsmen and sculptors who produced the reliefs and paintings were detached from the other craftsmen; on the contrary, they lived among other craft specialists and must have been familiar with the processes involved in the production of pigments, metal tools and other objects. Rather than art in the modern sense, it was one of the "crafts" employed. Just as we have learned to read Old Kingdom depictions of the human body by comparison with material culture, we can also learn to read the depictions of metallurgy. This is not pure realism but rendering of the processes as seen by the "period eye" of Old Kingdom craftsmen. Most problems in the interpretation are caused by the two-dimensional representation of three-dimensional reality and by fanciful application of the size ratios of objects and persons in the scenes, rendering some important objects as larger. The way ancient Egyptians were able to sketch the reality of life is preserved painted on the wall of the burial chamber of Kaemankh at Giza, with sketchily painted but forceful representations of craftsmen at work (Figure 4.35g). This is the "period eye" at work.[869]

The basic division of metalworkers can be studied in the captions of the metalworking scenes. Co-workers addressed themselves as *nty ḥnꜥ=j* (hey you with me!), the overseers were called father, *jtj*. This could be said in a metaphorical sense, nevertheless, also often in a real one, as the craft was passed generation after generation.[870] The smelters of metal were at the lowest level. The smiths working with copper and golden sheet most probably had higher status and were considered to be specialists, as were vessel producers. The persons with the highest social status appeared in the most important scenes of the control of metal, in the form of either ore/ingots or finished products: the scribes and overseers of metalworkers.

868 (Davey 2012).
869 On "period eye" concept in the art history see (Baxandall 1988; Langdale 1998).
870 Scheel (1985, 174–175).

Metalworking scenes were among the most popular Old Kingdom workshop scenes in non-royal tombs (the tomb of Queen Meresankh III is included in the category, since it is more akin to private tombs, even though it belongs to a royal individual; two other examples are the mortuary temple of King Wenis and presumably also that of Queen Khentkaus II, where only a tiny detail of a scene was preserved).[871] We are most probably missing the fundamental pieces of evidence, as it seems that the decoration of the royal funerary complex was "setting the tone" and offering new motives to be imitated, as the king was the employer of the best craftsmen of the Old Kingdom state. The scenes from the highest officials, viziers and people close to the office, as Ty of Saqqara, are the most detailed, as they were offering the largest area to cover with reliefs, it must be reiterated that the largest decorative surfaces of the royal mortuary temples are nowhere preserved in full. The scenes from the tombs in the centre of the state, from Giza, Saqqara and Abusir are the most "talkative", having the highest number of captions. This manner of decoration reached Meir and Deir el-Gebrawi in middle Egypt (and Ibi proudly mentioned in the tomb inscription that the stonemasons from the Residence took part in the decoration),[872] but the captions of tombs to the south of these site are more laconic and descriptive. Each scene from each site can provide significant detail or information, alas, not each scene is published sufficiently. For a long time, craft scenes were treated as the major pieces of evidence on the ancient Egyptian metallurgy, somewhat on at the expense of the research of its other aspects.

4.4.3.6. Work organization in provinces

With the already discussed exception of Gebelein papyri, and inferences that might be made from metalworking scenes, we do not know much about the organization of the metalwork. In general terms can be studied the organization of the work in general, especially in well preserved case of Akhmim.

Akhmim is one of the best-known provincial centres of the Old Kingdom. The reason lies not in the excavations of the provincial town itself but in the research and excavation reports from the main provincial cemetery of this nome situated at modern al-Hawawish.[873] The results of the excavations were then evaluated by Kanawati and McFarlane.[874] The documented tombs provide data about the titles and names of the inhabitants of Akhmim in the Old Kingdom and about their social structure. We can infer some information about the

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[871] In case of Khentkaus II, a relief fragment 179/A/1978 includes a fragment of a standing man with a title *bḏ.ty* in front of him (Verner,Posener-Kriéger and Jánosi 1995, 74, 88, Pl. 21).
[872] (Kanawati 2007, Pl. 72).
[873]E.g (Kanawati 1980b, 1981, 1983, 1987).
[874] (Kanawati 1992).

structure of the crafts and administration of natural resources. Ordinary craftsmen were not buried at al-Hawawish. Preserved titles are referring to the officials organizing work and ordinary workers were not even named in the decoration of tombs.

The title of the overseer of the works of the king is scarce in the provinces, one of the holders was Hesymin of late Dynasty 5.[875] According to Kanawati, his duties might have been lesser and more restricted as in the case of the overseers of all works.

There were several lower officials included in the organization of work at Akhmim. *ẖrp jz.t* (director of a gang of workmen) Kheti (*Ḫtj*) was one of the dependants of *jmy-r šmʿ* Hem-min from the early reign of Teti.[876] Among his dependants were displayed also *jmy-r jzwt* Iunet (*Jwnt*).[877] Unnamed *jmy-r jzw.t* was depicted in the tomb of nomarch Kheny (*H̱njj*).[878] One of the sons of Hesymin (*Ḥzy-mnw*) with damaged name, beginning with *m*, had the titles *zš pr* and *jmy-r jzw.t*.[879]

It is interesting to note, however, that the titles connected to the organization of work, present at least marginally in Akhmim, are almost totally absent from the corpus gathered by Fischer from the surroundings of Naqada, except for titles dealing with the organization of expeditions.[880] One of the reasons might be the lesser extent of the corpus.

4.4.4. First Intermediate Period

Except for a single occurrence at Memphis, of the false door of Iniptah, and the already listed stela of Idu, there are no other funerary monuments of metallurgists from the First Intermediate Period. The nicely decorated tomb of chancellor of the king of Lower Egypt Sehu at Heracleopolis Magna does not only evidence the use of metal tools; its decoration includes a scene with two metalworkers, clearly inspired by Old Kingdom scenes (Figure 4.40a). The context of the scene was lost when a false door was added to the wall and erased the right part of the scenes, the crucibles and presumably another pair of metalworkers. Another First Intermediate Period metalworking scene was fragmentarily preserved at Moalla, in the tomb of Sobekhotep (4.40b).

4.4.5. Middle Kingdom

Institutional changes that might have occurred in the First Intermediate Period are not fully documented until the Middle Kingdom. While the Old Kingdom Treasury was most probably a passive storage centre of materials and objects, the institution had its own craftsmen in the

[875] (Kanawati 1983, 7).
[876] (Kanawati and McFarlane 1985, 8).
[877] (Kanawati and McFarlane 1985, 8).
[878] (Kanawati 1981, 11).
[879] (Kanawati 1986, 8).
[880] (Fischer 1964b).

Middle Kingdom. Moreover, the complex structure of craftsmen of the third millennium BC stabilized later in the Middle Kingdom with only some of the titles continuing.

4.4.5.1. Titles of metalworkers in the Middle Kingdom

Middle Kingdom Egyptians realized that craftsmen (including metalworkers) were an important part of society. This idea was clearly formulated in the so-called Loyalist Teaching (10): "The professions are what provide provisions." It is expressed more generally a few verses above: "It is mankind who create all that exists."[881] From the rarely preserved texts of the self-presentation of Middle Kingdom craftsmen, it is evident what was important, similarly to the Old Kingdom: to serve well the ruler in the assigned office, in order to incorporate these statements into "biographies".[882]

Craftsmen were organized in "sections" (*wꜥr.t*) led by the "overseer of the section" (*jmy-rꜥ wꜥr.t*).[883] Copper was processed by "coppersmiths" (*bḏ.tyw*)[884] and copper dust by "glaze-workers" (*ṯhnt.yw*).[885] Other craftsmen working with metals were "jewellers" (*msw-ꜥꜣ.t*), gold-workers with "overseer of the gold-workers" (*jmy-rꜥ wꜥr.t n nbyw*). An overview of the types of sources for all craftsmen of the Middle Kingdom was presented by S. Quirke, compared also to high officials.[886]

Only several metalworkers of the Treasury are known.[887] They evidence that the Middle Kingdom Treasury was engaged also in the processing of materials brought from the expeditions. It is, however, strange, that the only other specialized professions of the Treasury in the Middle Kingdom are seamen (in Dynasty 13) and one painter. This might be due to the imperfectly preserved sources.

A "House" of *šmꜣ* is mentioned as a turquoise gallery on the stela of Khety and as a part of the title of a metalworker on another stela (CG 20103). This term is interpreted as a building or an institution by Schneider,[888] or, in the light of Khety's stela, as a toponym, most probably in the area of Wadi Maghara, the "domain of the Bedouins *šmꜣ*."[889]

Besides the overseer of counting copper, sealings at Mirgissa bear evidence also on overseer of metalworkers Wehemankh. Copper was not only controlled here, but also

[881] (Parkinson 2009, 240).
[882] (Stauder 2018, 250–251, 263–264).
[883] (Quirke 2003, 89–93; Grajetzki 2013, 252–253).
[884] Stela CG 20560 from the Middle Kingdom, Dynasty 13, middle, the time of Senebsumai and Senbi.
[885] More on the Middle Kingdom faience production in (Miniaci 2018).
[886] (Quirke 2018, 178–179, Table 1-2).
[887] (Desplancques 2006, 389–398).
[888] (Schneider 2003, 258).
[889] (Tallet 2018, 29).

processed. Wehemankh was also elder of the portal, thus bearing judicial and military function, and a title *ꜥ3m s3* – son of Asiatic?? He was probably mentioned in pBoulaq 18.[890]

Craftsmen in the province, as a part of the local "court" of a nomarch, in this particular case of an Oryx nome, were mentioned in the biography of Khnumhotep II at Beni Hasan.[891]

Among the entries of Papyrus Reisner II (discussed below in detail) is an order of the vizier Antefiqer to the stewards of the *pr-ꜥ3*: "As for any [one of you who passes(?) the dockyard workshop, and his craftsmen are taken away, let him write to me about his craftsmen who have been taken away,· and I will cause the giving <of them> to him."[892] Apparently, the craftsmen from a royal dockyard could have been taken by another authority (nomarch?) and an intervention of vizier was needed to restore the order.[893] Local patrons could mobilize the workforce, apparently also from the "royal" sources.[894]

Stephen Quirke argued that the workshop organization of Middle Kingdom crafts is our modern preconception, that the organization of crafts was rather project-based and the term "circle" or a "crew" can be used instead of "workshop".[895] However, the evidence of the papyrus Reisner II proves at least three-year the existence of a copper workshop in This, and if the list from the papyrus Reisner I also concerns this workshop, the work lasted there for at least eight years during the reign of Senusret I. The existence was not permanent, as there are months without entries, but the repeated presence of the craftsmen for this workshop is confirmed by the papyrus. Perhaps it would be useful to make a division between project-based works of sculptors and painters on the one hand, and workers needed for the permanent care about the equipment (metalworkers repairing tools, as in the papyrus Reisner II). These categories are surely not mutually exclusive.

4.4.5.2. Monuments of metalworkers in Middle Kingdom

Not a single metalworker tomb has been identified in the Middle Kingdom. Smaller funerary monuments provide no exception to general trends; as for the provenance of stelae, most have been found at Abydos. At least the stelae where the metalworker himself is the main recipient of the cult can be used as evidence of the existence of metalworker tombs in the Middle Kingdom.

4.4.5.2.1. Dynasties 11 and 12

890 (Gratien 2019, 55).
891 (Jurman 2018, 109).
892 (Simpson 1965, 22–23, Section G).
893 As noticed by (Quirke 2018, 187).
894 (Moreno García 2013, 90–91)
895 (Quirke 2003, 119–122, 2009, 119–122).

The earliest preserved stela, currently in the Louvre under the number C 14, comprises a well-known text of an "artist" boasting about his abilities to work any (precious) stone, including metals into the category.[896] It is the listing of various specific capabilities that makes the source suspicious. Most craftsmen in other documents list only one or two titles or specializations, while this one represents in the text the entire range of contemporary craft. At least one early Dynasty 11, a rock inscription, might indicate that this was the manner of artisan representation in that time.[897] According to Quirke, he might have been the "outline draughtsman" for all these various materials.[898] Due to the combined intricacies of the text itself, but also its hieroglyphic writing, Irtysen might have been an "ideational" artist, a "designer" of the "artistic" representations.[899] Its Old Kingdom precursor, much less eloquent, but also referring ubiquitously to the restricted knowledge, is the tomb of Ankhi/Intji and its inscriptions and titles, indicating participation on the ritual activities and production of cultic images.

Metalworkers as the recipients of the cult were depicted on five stelae; the fifth one shows metalworker Djaa (*Ḏꜣꜣ*) in front of an offering table and with an epithet and title, while the four other stelae had metalworkers among the participants of the funerary cult (Figure 4.48, 4.49). Although Quirke downplayed the hierarchic interpretation, the concentration of workmen of the same profession is known already from the Old Kingdom.[900] These persons might have had a common funerary cult or at least participated in the funerary cults of their colleagues, and as the craft was inherited, colleagues meant often also family. Several names of metalworkers and persons related to them by family or occupational links have been interpreted as Asian.[901]

Metalworkers are known from the reigns of Senusret I, Akhmim, Senusret III – Amenemhat III, Amenemhat III, from middle to late Dynasty 12, possibly Dynasty 12 and from the time between Dynasty 12 and 13 (Figures 4.48, 4.49). With the exception of the stela CG 20103, the only one that mentions the Treasury, the stelae bore modest information about the organization of the craft. The sign *bḏ.ty* was accompanied by a sign of an animal (crocodile?) on the Middle Kingdom stela CG 20024; the interpretation is unclear.

4.4.5.2.2. Dynasty 13

[896] The text interested many scholars, the most detailed treatise being by W. Barta, but discussions over the interpretation and translation of this difficult text continue (Barta 1970; Fischer-Elfert 2002; Stauder 2018).
[897] Interestingly enough, certain Ipi, son of Ipi, wrote his titles in a rock inscription from the reign of Mentuhotep II and two titles boasted his superior prowess in all "minerals" (*ꜥꜣ.t*) (Couyat and Montet 1912, 46–47, Pl. XI).
[898] (Quirke 2009, 119–120).
[899] (Stauder 2018).
[900] (Quirke 2003, 92–93).
[901] (Schneider 2003, 258–259).

The stela Cairo CG 20560, once belonging to the overseer of the section of coppersmiths Sawenet (*S3-wn.t*), is the most important, offering a glimpse of the organization of metalwork. It has recently been dated to Dynasty 13 by Ilin-Tomich.[902] Sawenet was the son of the metalworker of the Treasury named Tur (*Twr*). Another man on the stela had the same title. Four other overseers of metalworkers were named on the stela. Another stela from the dynasty depicted overseer of the metalworkers Wahpuptah (Figures 4.48, 4.49). A sealing from Geneva (Acc. No. 18158) of an unknown origin dated to Dynasty 13 by Newberry and Martin[903] preserved the name and title of overseer of metalworkers Nehy (*Nhy*). Another stela from Abydos that can be dated to the Second Intermediate Period provides evidence on metalworkers after the end of the Middle Kingdom.

Intriguing source is a Dynasty-13 stela of a King Khasekhemra Neferhotep.[904] Being inspired by the writings of the "House of Osiris Khentamentiu lord of Abydos", the ruler commissioned a statue of Osiris "with his Nine Gods", as the king himself "has seen in his writings". At the preserved end of stela, as the remaining text was broken off, king in person is directing the work in "silver, gold and [copper]". This stela demonstrates the function of the king as a patron and instigator of the production of cultic/"artistic" work, overseeing its completion. The craftwork was performed in the "House/Mansion of gold" (*ḥwt-nbw*).

4.4.5.2.3. After Dynasty 13

A statuette of a man named Hepu, originally dated to the late Middle Kingdom but with currently accepted dating in late Dynasty 17 or early Dynasty 18[905] needs to be briefly mentioned. It was dedicated by Hepu's brother, goldsmith Tchenena; the name is considered to be Asian or Nubian.[906] Hepu's title and profession are unknown. The object he holds in his right hand resembles an adze but has been also interpreted as a folded cloth. Its frontal side looks like an adze blade, but the back is bent. It might be a damaged adze. He has an unusual, "bowl-cut" natural hair style. In this context, it was interpreted by E. Tourna as pointing to a restricted group of individuals (craftsmen) who might have different access to metals and their products than other Egyptians.[907] Although the hairstyle was considered foreign, there is no proof of a link between this particular type of hair and ethnicity.[908]

4.4.5.3. Workshop scenes

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[902] (Ilin-Tomich 2017, 210).
[903] Newberry (2004, 154, Pl. IV: 11), Martin (1971, 63, Pl. 35: 29).
[904] (Helck 1983, 25; Quirke 2009, 128–130).
[905] (Hill 2007).
[906] Hill (2007, 10).
[907] (Hill and Tourna 2007, 19–21).
[908] Hill (2007).

Middle Kingdom metallurgical scenes are rare; but the scenes are more numerous than presented by Scheel.[909] Four were preserved from Dynasty 11 Theban tombs of Dagi, Djar, and Khety; the only published is coming from tomb of Antef. Six scenes come from the tombs of the nomarchs of the sixteenth Upper Egyptian nome in Beni Hasan,[910] datable from the reigns of Amenemhat I to Amenemhat II. Only the tomb of Baket III features both coppersmiths and goldsmiths, on the south and north walls of the main room of the tomb, together with captions. It would be impossible to distinguish between copper and gold metallurgy in the scenes, were it not for the captions. Except a single headband in the jewellery scenes, other motives are indistinct. While Scheel's study focused on the iconography and correct translation and interpretation of the captions, I will discuss the material culture displayed in scenes and its handling. Weighing of the objects was discussed above. Scenes from Beni Hasan do not copy each other much, but they borrow from the same range of topics. Most frequently repeated motif is that of a couple of metalworkers, blowing by tuyeres into a fire with crucible. Crucible as such is enormously oversize in the goldworking scene from tomb of Baket III (Figure 4.40d), where electrum is prepared according to caption. Was this indented as an exaggeration or a joke? A crucible in a cauldron-shaped furnace is depicted in the tomb of Antef, where four metalworkers encircle the installation. Overall shape of the fire with perimeter resembles the "drop" shape of the "fire" sign.

Generally, the Middle Kingdom craft scenes have lower number of the "labels", denoting actions, and "captions", completing the "soundscape" of the two-dimensional depiction. If present and statistically evaluated, e.g. in a tomb of Khnumhotep II at Beni Hasan, they showed an interesting pattern. Activities of craftsmen and household were labelled most frequently, with the most persons with a listed name and title.[911] While this fact cannot be overinterpreted, it probably indicates a special status of household members and craftsmen, which were also mentioned in the biography of Khnumhotep II in his tomb.

4.4.5.4. Metalworkers in Teaching of Khety

The Teaching of Khety is the most important Middle Kingdom literary work providing detailed information on arts and crafts.[912] With the exception of Old Kingdom craft scenes where crafts were reflected by iconography and short accompanying captions, it is the earliest complex literary reflection of craft, seen through the prism of educated scribes looking at

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[909] (Scheel 1986)
[910] Scheel (1986, 182).
[911] (Jurman 2018, 109–113, Table 1).
[912] (Helck 1970; Quirke 2003, 101–103).

uneducated people who earned their living by the work of their own hands. If the analogy with ancient Egyptian visual culture can be used, this is also a satire on Old and Middle Kingdom workshop scenes, presenting orderly and *beautiful* craftwork being observed by the tomb owner.

A set of stanzas is internally organized on the basis of the use of copper tools in various crafts. The set begins with the mention of a sculptor, a goldsmith (see below) and finally the description of the work of a metalworker. The metalworker's duty was described as "service/servitude", *bꜣk* in the text[913]

One of the two metaphors used to describe the condition of the metalworker (*bḏ.ty*) is "his fingers are like crocodile's" (in the most complete New Kingdom version *ḏbꜥ.w=f mj ẖt msḥ*).[914] The explanation of the metaphor is that the melting of copper and hammering of the semi-finished products was performed by the same people. The hammerstones were stones of suitable size and shape, often used without further treatment or any haft, held in the bare hands. This wielding of the hammerstones could have changed the shape of the metalworkers' hands – their fingers were shortened and bent just like crocodile's fingers. G. Verly translates the crucial passage differently, not as "fingers", but as "skin" and proposes that this is an indication of mud as a protective measure against the heat of the metalwork.[915]

4.5. Use of copper artefacts

In this subchapter, we will discuss separately and in a diachronic perspective the individual groups of copper objects produced, the end of the *chaîne opératoire* dealing with the production, recycling, and deposition of copper. This will reveal distinct patterns and *lacunae* in the written sources. The artefact groups are discussed together with the specialists who worked with these tools. Ancient Egyptian mostly used verbs to describe activities with copper artefacts; direct mentions of tool names are rather less frequent. Thanks to the occurrence of inscriptions accompanying workshop scenes, we can describe the semantic context of the verbs in detail. The professions working with copper blade tools were perceived as one cognitive category by ancient Egyptians.[916] However, this is not permissible in the case of mortuary priests who occasionally worked with copper artefacts during the rituals, unless there is a clear mention of their use of metal objects in the sources.

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[913] Commentary to this passage in (Fischer-Elfert 1999, 131–132).
[914] (Helck 1970, Taf. IVc).
[915] (Verly 2017, 139–140).
[916] (Quirke 2003).

The evidence is clear in that copper objects were already in the Early Dynastic Period accessible not only to the kings but also to other persons performing the funerary cult, even though their presence in the offering lists is marginal.[917]

4.5.1. Uses of artisan tool kit

This tool kit consisted of the four major elements, or tool classes: chisels, adzes, axes and saws, with an occasional presence of tube and bow drills. We can infer from the iconographic sources that these tools were used predominantly by carpenters and stonemasons, the key professions in the production of Egyptian funerary monuments. On smaller scale, it was woodcutters and ivory cutters, generally could be called sculptors, in all different scales of the craft products. As the written and iconographic sources became more frequent in the Old Kingdom and their preservation rate is also slightly better, the sources provide more information about the use and handling of the artisan tool kit. Sources from real life in the past (such as tool lists) are underrepresented compared to funerary sources, which were written on more durable materials.

4.5.1.1. Inscribed tools in periods under study

Tools were infrequently used in ancient Near East as a medium for inscriptions. In ancient Egypt, this practice can be traced in all periods under study and it is discussed in this chapter concisely for all these periods, as the general trends can be thus described (specimens of inscribed tools and weapons known to the author are listed in a table, Figure 4.50). The evidence is meagre and cannot offer statistically significant corpus for analysis. I can offer only some suggestions, based on the knowledge of the contents of the inscriptions and general context of the craft organization in ancient Egypt.

First remark must be made on the technology, based on a study of several tens of specimens by the present author. Genuine ancient Egyptian inscriptions were stroke by stroke either cut out into the surface of the object by chisel (each stroke of a hieroglyphic sign by one or several cuts) or punched by a pointed pick (then the strokes of hieroglyphs are produced by a row of holes). It was not in the power of the ancient craftsmen to inscribe the hieroglyphs by a continuous incised line. Unfortunately, this is the case of several inscriptions on the tools in the former Michailidis collection, now e. g. in the Neues Museum, Berlin; the British Museum, London; and Los Angeles County Museum of Art.[918] The tools themselves are genuine and the inscribed full-size adze from Berlin was analysed, being found to be made of arsenical copper. But the inscriptions, including cartouches of the king Userkaf on adze and

[917] (Kahl 2004, 308–309).
[918] These tools were published by (James 1961; Kaplony 1965).

chisel blades, are most probably modern forgeries and need to be omitted from the discussions. Other forged inscriptions can be usually identified only by the meaninglessness of their inscriptions (examples of both categories on Figure 4.54).

The earliest evidence is provided by some Predynastic owner's marks, possibly meant as inscriptions (Figure 4.51). Three objects were found at Abydos, Naqada and Kubbaniya, with punched "signs" that might have been ownership marks.[919] Unequivocal inscriptions appeared for the first time in the Early Dynastic Period and the tools inscribed had sufficiently wide area to be inscribed: predominantly axes and adzes (Figure 4.51). Five adzes from the subsidiary graves at Abydos were inscribed; the inscriptions are interpreted as personal names.[920] In addition to that, an adze from subsidiary grave 461 of the funerary enclosure of Djer was inscribed with a serekh of Djer. On another adze from the same grave is just the name Bekh (*bẖ*), without a serekh. The adze from subsidiary grave 387 of the funerary enclosure of Wadj was inscribed with a serekh of this king. Artefacts with royal names provide information on what was available for the king also with respect to the material (cf. Chapter 6). The objects with the royal names were most probably provided by the early state administration. In cases of the absence of royal serekhs, the names of the craftsmen themselves can be presumed in the context.[921] Besides the meaningful inscriptions, so called "owner's marks" continue on the Early Dynastic tool types.

In the Old Kingdom, further development can be observed compared to the Early Dynastic Period and the inscribed tools can be compared against the evidence of specialized crafts. Once again, as these research questions have been discussed elsewhere in detail.[922] I only offer some new ideas here and the main specimens are illustrated on Figure 4.52. Some owner's marks continue to exist, further two main categories are the inscriptions of stand-alone personal names without titles, while more detailed inscriptions offer information concerning the phylae of the tools and thus the "controlling" institution of the objects. Phylae were inscribed on two adzes, an axe blade and a chisel.

A paradox of Old Kingdom sources is thus that, as we have seen above and we will see below, the titles of craftsmen provide evidence on the structure of organized craft; but the phylae formed the organization system of corvée labour, i.e. of people who were not professionals in craft and could perform tasks requiring little training. The context of the tools found is most probably that they were handed over to non-specialized workmen performing

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[919] Most recently (Odler et al. 2018, 426).
[920] (Petrie 1925, 1925, Pl. III: 1-5).
[921] Interpretation as the personal names of the craft specialists was proposed also by (Davis 1983, 130-131).
[922] (Roth 1991, 122–124; Odler 2016, 34–36).

the tasks. The material of the object is thus of the royal administration context. This means that metal tools in the Old Kingdom were wielded not only by specialized, most probably full-time craftsmen but also by the numerous workforces on Old Kingdom building projects. Only very few pieces were preserved until present day.

Specifically, if the names are solitary on the blades, without references to phylae, it might indicate personal ownership, probably of a specialized craftsman. For a regularly used tool, it was not needed to indicate both the status and the name, as either the name or the owner's mark was enough to identify the ownership of a tool.

In the First Intermediate Period and Middle Kingdom, artisan tools continued to be inscribed on their broadest face, most often axes and adzes, less so the chisels (Figure 4.53). A chisel UC1420 preserved both the title and a name of the owner. The signs on the axe blades with two lugs are more often than not specimens of the owner's mark category.[923] Such owner's marks were most probably reflected in the written sources, as in the papyrus Reisner II, discussed below.[924]

4.5.1.2. Early Dynastic Period

4.5.1.2.1. Tools: iconography, palaeography, and names

Early Dynastic evidence is not numerous but provides documents of phenomena better known from the Old Kingdom: tools occurred among funerary offerings and as signs of early hieroglyphic script.

Among the signs of early hieroglyphs were also those denoting artisan tools. The development of adze signs U20 and U21 can be followed from Djer to the end of Dynasty 2.[925] Other signs present for tools in the Early Dynastic sources were T7, an axe; U23, a chisel; U25, drill of stone vessels makers; U29, so called „fire drill"; u1, saw; and u3/u4, which is a "tool used by sculptors".[926] With its appearance, the last sign might be a short copper chisel in long wooden handle.[927]

The earliest offering list with tools was found in Helwan, carved on a white limestone funerary slab stela for carpenter Wabkhenemu, datable to Dynasty 3.[928] The artefacts named in it were a saw, an adze, two chisel types, another saw type, a crucible and possibly an axe. The order of the tools seems haphazard; all of them may have arguably formed a tool kit

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923 Davies (1987, 31, Cat. Nos. 18–23).
924 (Andrássy 2009)
925 (Regulski 2010, 195–196, 656; Odler 2015a, 93–94). This sign possibly appeared on the stela 277 found near the tomb of Den (Martin 2011, 184–185), both with a reading "*mḏḥ*" (?) – "carpenter" and on the stela 208 (Martin 2011, 148–149).
926 (Regulski 2010, 190–191, 196–199).
927 As found in the Saqqara tomb 3471, c.f. (Emery 1961, Fig. 128: 3).
928 It has been discussed previously by the author (Odler 2016, 31–32, Figs. 12–13).

without which Wabkhenemu would be unable to perform his craft. A link between the offerings and the profession of the deceased is possible, even though other craftsmen stelae did not contain tools among the offerings.[929] Their addition was optional and innovative, although slightly more numerous are Early Dynastic stelae with the names of copper offering vessels.

Most of the tools that had been listed for Wabkhenemu were depicted for the high official Hesyra, apparently with no need for an accompanying text (or it was lost through time and decay?). A two-dimensional painted depiction of the offerings, including the artisan tool kit as an apparent unit, was discovered in the tomb of Hesyra at Saqqara (Figures 4.55, 4.56).[930] The depictions contain also artisan tools with hafts stored in boxes. One box contained chisels, an axe and a saw with handles, a selection of blades and the handles of axes and a chisel; the only missing tool class is an adze blade. Near toolboxes were boxes with weighing stones, indicating contextual closeness of both artefact categories.

4.5.1.3. Old Kingdom

4.5.1.3.1. Tools: iconography, palaeography, and names

Due to the hieroglyphic determinatives, the names of the artefact classes represent a category of ancient Egyptian language with almost certain and coherent definitions. The names of tools in the Old Kingdom have been recently discussed by the author.[931] In the present work, we will discuss only research questions not addressed in the monograph.

The etymology of artefact names might have been inspired by natural phenomena if the homophony of some terms is to be interpreted as etymological and metaphorical connections. Such is the example of a nail and an adze, where the name of the tool might have inspired by the manner it was attached to the wooden haft. The blade is flatly attached to the haft, like a nail to a finger. It seems certain that *ꜥn.t* adze can be identified with the smooth adze hafts, while *msḫ.tyw* adze had angular haft. While the names of the tools are rather clear, the names of detailed parts of them are only scarcely preserved. Hannig, for example, interpreted the word *ḏbꜣwt.t* as the edge of a tool.[932] Although present in Old Kingdom burial equipment, tools were conspicuously absent from Old Kingdom offering lists, being only

[929] (Köhler and Jones 2009).
[930] Quibell (1913, Pl. XVI). Discussed in detail by (Vandier 1952, 715–723).
[931] Discussed elsewhere in detail (Odler 2016). The names of tools, their full-size shape and their two-dimensional and three-dimensional models have been organized in a semiotic triangle of meaning. The iconography of tools has been discussed in the monograph, along with a selection of palaeographic sources.
[932] (Hannig 2003, 1500).

named in three of them. However, it is possible that they were often hidden under the general term for the burial equipment, *ḳrs.tt*[933], or another, already examined term *ẖtm.t*, sealed things.

4.5.1.3.2. Tools in creation of monuments – performative aspects

Before discussing the professions that used the tools, it is necessary to emphasize the performative role of craftwork in society. The evidence is scarce, but it expresses connotations of craft that are not readily perceived by the modern scholarly audience. Subtle hints to this aspect of the craft were present in some epithets. Dynasty-3 official Khabausokar was "director of craftsmen of the workshop (*js*), who knows the perfection (of that) which is in the heart of his lord".[934] Early Dynasty-5 official Ptahshepses was one "who promotes/brings into favour all craftsmen before the king".[935] Both epithets give information about the means of the "promotion" of craftsmen thanks to their work

In two cases, the personal presence of the king in the creation of a monument or false door was stated in an inscription. In both cases, the use of copper tools has to be assumed, but they were not mentioned in text. A physician Nyankhsakhmet (*Ny-ˁnḫ-sḫm.t*) has a description of the making of two false doors in the royal palace of King Sahura inscribed on a false door in his tomb. The king ordered the making of a pair of false doors, according to the physician's wish.[936]

The false doors made of Tura limestone were created in the presence of the king in his palace; Sahura appears wearing the White Crown. The false doors were made by the craftsmen of the wabet (*ḥmw.tyw wˁb.t*) under the supervision of two *ḫrpw-ḥmw.tyw*, controllers of craftsmen, the High Priests of Memphis. At the end of the work, the false doors were painted blue (*ḫsbḏ*).

Another false door made in the king's presence was the limestone false door of Khufuankh from mid-Dynasty 5,[937] with an inscription stating: "Made in the presence of the king himself, at the portal of the audience-hall, while his majesty watched every day there."

Both texts provide evidence on the performative aspect of Old Kingdom craft not frequently mentioned in the texts. Possibly, it was self-evident for Old Kingdom Egyptians and referred to in these two *loci* because of the participation of ruler. The king's presence (*r-gs nśw.t ḏs=f*) and active role are stressed in the first text; the ruler is present (*r-gs nsw.t=f*)

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933 (Hannig 2003, 1340–1341).
934 (Jones 2000, 731).
935 (Jones 2000, 884).
936 Tomb D11 at Saqqara was published by Mariette (1889, 202–205). Discussion in Wilson (1947, 241-242), Strudwick (2005, 302-303), (Verner 2014, 112).
937 Tomb G 4520, Wilson (1947, 242). The false door is currently in the collection of the Museum of Fine Arts, Boston (Acc. No. 21.3081).

and seeing (*m33*) the work also in the second one. This is another facet of explanation for the context of *m33*-scenes in Old Kingdom tombs, where a member of the elite sees the work going on, not only in his workshops. A mastery of the craft might have been a vital aspect of this seeing, an appreciation of the member of the elite who ordered the craftwork and (over)saw its completion. This was most probably also a reason why the word *mnḫ* has two meanings: "a chisel" and "to be splendid; to make splendid; to be effective".[938] There are no specimens of stone chisels; metal ones must have already in the fourth millennium BC enabled minute and highly valued work with wood, ivory and stone.

Another recently published text from the reign of Wenis describes in meticulous detail that king has given to the official Ptahshepses Tjemi a tomb and sarcophagus of Tura, which was worked for two days in the workshop at Heliopolis and then transported in a wsx.t barque, made of foreign wood.[939] Here, the royal gift is stressed instead of a perfomative aspect.

The appreciation of high-end craftwork must have been present in Egyptian culture of the fourth and third millennia BC, however; the reason why the process was described in detail was the involvement of the king, which is worth mentioning in a non-royal tomb. An object obtained from the royal workshop in this manner is also an object of status display. On the other hand, titles also provide evidence on the "secrets" of the craft and the officials responsible for keeping them. The nature of the title is not exceptional compared to other "keepers of secrets".[940]

4.5.1.3.3. Copper tools in market scenes

Copper tools were depicted in three Old Kingdom market scenes, one featuring an adze blade and a bundle of three fish-hooks, another the exchange of a mirror and the last one fish-hooks again. They were discussed elsewhere.[941] These scenes are important as a confirmation that copper objects could have been personal property in the Old Kingdom and were subjected to market exchange for other goods, not only metal ones.[942]

4.5.1.3.4. Professions working with artisan tools

Old Kingdom evidence on craftsmen working with metal tools is complex, although most of the information can be inferred only from the titles. The structure of professionalized Old Kingdom craft has been discussed alongside the institutions above, in the subchapter

[938] TLA, lemma no. 71080.
[939] (Soleiman 2018, 148–149).
[940] (Jones 2000, 612–613).
[941] (Odler 2016, 33–34).
[942] (Bárta 1998a; Livingstone-Thomas 2011; Mazé 2018, 126–127).

discussing metalworkers. The structure of other crafts is of a repeated nature, with specialization on the type and size of the materials worked. Only seldom is the employment of the craftsmen defined not only based on the material specialization but also on the basis of the affiliation to an institution.

4.5.1.3.4.1. Stone quarrying and working

Although royal and non-royal stone tombs are the most enduring remnants of the Old Kingdom, the evidence on stone quarrying and rough stone working has been rather meagre in Old Kingdom sources. Only recently, a journal of Merer found at Wadi el-Jarf has added detailed information about the quarrying of white limestone transported from Tura to Giza.[943]

Stoneworkers who shaped the blocks of pyramids and tombs were seldom among the craftsmen represented in tomb decoration. Based on the titles, stoneworkers were divided according to specialization on those working hard and soft stones, respectively.

The term *ḥm.wty* is systematically translated as “craftsman” in the Old Kingdom, but it may well be possible that in some cases, it can be interpreted in its original meaning of the producer of stone vessels.[944] Such title or specialization may have its roots already in the Predynastic Period. A drill with a copper ending piece became the hieroglyph for a “stone vessel producer” and later generally for a “craftsman”.

The most important Old Kingdom site in this regard is Hatnub. Expedition inscriptions from Hatnub sometimes provide information about the objects gathered but remain silent about the tools used. It is therefore not certain that these expeditions used metal tools, but it can be presumed. Expedition inscriptions from Hatnub contain information about the stonework: inscription no. 36 is difficult to interpret,[945] four travertine hetep altars were gained in the year of fourteenth cattle count of the reign of Pepy II,[946] 300 travertine blocks in the unknown year of the reign of Pepy II[947] and 2000 travertine blocks in the year of the thirty-first cattle count of the reign of Pepy II.[948] The ship was built on the expedition during the reign of Pepy II.[949] Inscriptions from other sites did not enumerate the products brought.

4.5.1.3.4.2. Architects and builders

Based on existing titles, we can propose that there were two different categories of architects/builders in the Old Kingdom: one was focused on “engineering” tasks and buildings

943 (Tallet 2017a).
944 (Jones 2000, 595).
945 Eichler (1993, 41, No. 36).
946 Eichler (1993, 43, No. 39).
947 Eichler (1993, 44, No. 42).
948 Eichler (1993, 44-45, No. 43).
949 Eichler (1993, 43, No. 40).

of utilitarian nature, the other on stonework and the construction of royal and non-royal tombs. In both cases, we can assume that they either worked with metal tool blades or were in charge of workmen who did.

Where the simple term "builder" (*ḳd.w*) is used, however, it is difficult to ascertain the difference between both categories. The types of public works performed by the king's architect were named in the biography of Nekhebu.[950]

The structure of the tomb-workers can be described based on the preserved titles. The tomb builders were led by *ẖrp jrw js* and organized in the *jswt nt jrw js*. An ordinary tomb builder was called *jrw js*.[951]

Due to the nature of Old Kingdom administration, workers could be active in both public works and tomb building. A Dynasty-4 team of official Merer was engaged in the quarrying of casing stones for the pyramid of Khufu.[952] Other fragmentary papyri from the archive at Wadi el-Jarf await their final publication, but according to already available information, Merer's team took part also in a sort of public works in the Delta, mentioned on the Papyrus C.[953]

4.5.1.3.4.3. Sculptors

The craft of statue making is on the boundary between the use of stone and wood. Because of the "artistic" connotation of the profession, the works are more numerous than those on other Old Kingdom crafts, dealing predominantly with the statues rather than with the sculptors.[954]

Sculptors were listed either without specification or as overseers and under-supervisors of the sculptors of the Great House.[955] There were other overseers of the sculptors in Both Houses.[956] From the absence of sculptor titles in private service, R. Drekhahn inferred that sculptors (and painters) were strictly royal employees who worked for non-royal persons at the king's behest.[957] Even sculptors were, however, rarely individualized in workshop scenes: a workshop itself with its architectural setting was depicted in the tomb of Ankhmahor, and a sculptor and an inspector of sculptors in two actions in the tomb of Ptahshepses.[958]

4.5.1.3.4.4. Woodworking

[950] (Dunham 1938).
[951] (Verner 1991, 82).
[952] (Tallet 2017a).
[953] (Tallet 2017b, 15–16).
[954] (Eaton-Krauss 1984).
[955] (Jones 2000, 265, 298).
[956] (Jones 2000, 469).
[957] (Drenkhahn 1976, 138–140).
[958] (Eaton-Krauss 1984, 44–45).

The evidence on craftsmen working with wood is rather complex; three main categories can be distinguished: *mḏḥ* – carpenters, *mḏḥ* – shipwrights and *fnḫ* – furniture makers.

The most frequent title *mḏḥ* had a broader connotation in early history. Written down as a combination of an axe and an adze, it meant both a carpenter and a shipwright. The hieroglyphic signs interpreted in the past as two axes were rather a combination of an axe and an adze. In the Early Dynastic Period and the early Old Kingdom, the m*ḏḥ* title denoted also an overseer; it was perceived as archaic already by Old Kingdom Egyptians. It is also an indication that craftsmen were among the main groups of officials in early Egyptian history.[959] Because of this double nature of the word, the title is sometimes translated as "royal master, leader of the workforce on the place of the building".[960]

The earliest evidence of a royal carpenter is on the year label of Dynasty 1 King Den.[961] The title interpreted as the overseer of royal carpenters (*mḏḥ mḏḥ*(*.w*) *nsw.t*) was quite frequent on the year labels from the reign of Semerkhet and Qaa, mentioning the imports of foreign and domestic types of wood. The title "both carpenters of the King of Lower Egypt" (*mḏḥ.wj bj.ty*) is connected also to the sending of oil to royal tomb of Qaa.[962] The title *mḏḥ* thus seems to have earlier broader connotations.

Royal carpenter, *mḏḥ-nsw*, took part in the Sinai expeditions as mentioned; the oldest evidence is from the reign of Netjerykhet when this title was held by *Mry-jb*.[963] The presence of this official could be interpreted as an indication of the means of transport to Sinai by wooden boats. The presence of *sḥḏ mḏḥ.w* in an Old Kingdom expedition in Wadi Maghara has been recently confirmed by another inscription.[964]

The titles of metalworkers and carpenters/shipwrights were rarely combined. Ankhua was a metalworker and carpenter of sema-ships (Figure 4.47). Old Kingdom inspector of metalworker and overseer of carpenters Neferherenptah (Figure 4.47) probably held the same combination of titles.[965]

An overseer of the carpenters (*jmy-r mḏḥ.w*) was shown in a craft scene of *m33*-type in the tomb of Kahep from around the middle of the reign of Pepy II.[966] The verb *nḏr* (polishing)

[959] (Hannig 2003, 580–582). Discussion of title in (Pätznick 2005, 111–113).
[960] (Verner 1991, 82)(Verner 1991, 82).
[961] (Spencer 1980, 64, Pl. 49, 53; Tallet 2010).
[962] (Engel 2017, 315–352).
[963] (Eichler 1993, 29, No. 2).
[964] Tallet (2012, 220-222, doc. 248).
[965] Metalworker and carpenter Pentahutnakht is known from late New Kingdom Deir el-Medina, cf. (Hölzl,Neumann and Demarée 2018, 14).
[966] Kanawati (1980, Fig. 9).

in a scene from the tomb of Kheni was misinterpreted by Kanawati as a carpenter title.[967] In fact, this inscription must be emended to *ndr m mjnb.t* – polishing with an axe.

As for *fnḫ*, R. Drenkhahn translated the title as "furniture maker", clearly a different occupation from *mḏḥ*.[968] The translation is based on the only available evidence, Old Kingdom workshop scenes. A recently published document indicates that the scope of their work might have been wider, producing also wooden columns. L. Pantalacci published a rare source, a clay tablet from Balat, dealing with the organization of carpentry and timber-working over a period of eight days, ranging from the arrival of the crew (*ṯs.t*) and felling of trees to the work done in the workshop.[969] The course of the woodwork can be observed in the document. The felling (*swꜣ*) took one day, following by two days to moving the trees away (*wꜣy.t*), one day was spend with the owner(?) of the carpenters (*nb fnḫ.w*) (this is the interpretation of the phrase *hrw n nb fnḫ.w* by the present author; according to Pantalacci, it rather deals with the sharpening of saws), one more day by preparation for another move (*wꜣy.t dj n fꜣ.t*), and two more days were then spent in the workshop (*wḫr.t*). The author of the tablet promises to write another tablet when the lotus columns are finished. The use of the tools is implied but not expressed in the text. The official responsible for the work is neither named nor subscribed in the document.

The name *fnḫ* was connected in Egyptological literature with the supposed etymological origin of the ethnonym Phoenicians.[970] This would probably imply foreign origin of *fnḫ.w* in the Egyptian perception, but throughout the third millennium BC, a designation for a shipwright is *mḏḥ*. An assumption of Bietak that among Old Kingdom Asians were also shipbuilders is not founded on direct evidence.[971]

4.5.1.3.4.5. Shipwrights

Where the title *mḏḥ* is mentioned in a clear context with ships, it is translated as "shipwright". The occurrence on the statue of Ankhua (Figure 4.44) is clear. Dürring was able to identify ten cases of shipwrights in the Old Kingdom and the First Intermediate Period.[972] Newly can be added an evidence of the inspector of shipwrights/carpenters from Ayn Sokhna.[973]

The structure based on the titles is of the carpenters and keepers of the dockyard, scribes, sealers and privies to the secret of the dockyard. There were unspecified dockyards,

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[967] Kanawati (1981, 22, Fig. 19).
[968] (Drenkhahn 1976, 124–125).
[969] (Pantalacci 2010b, 148–153, tablet 7089).
[970] Most recently (Ramírez de Arellano 1996; Verner 2014, 72).
[971] (Bietak 1994, 17).
[972] (Dürring 1995, 185–186).
[973] (Abd El-Raziq et al. 2012, 6).

the great dockyard and the king's dockyard. Another title of a higher-positioned official was the "elder of the shipyard". There is also evidence on a "juridical elder of the dockyard" and a "senior of the dockyard of *nḫb*-boats".[974]

Overseer of the officials of the royal shipyard (*jmy-r sr*(*w*) *wẖrt nśw*) Mereri was named on an architrave datable to Dynasty 6.[975] According to Kanawati, his other title *špsj nśw,* the reference to Ptah-Sokar and the shipyard title may point to the official's Memphite origin. The style of the monument was rather provincial and we know that a royal shipyard existed in This during the reign of Senusret I,[976] which means that a similar installation could have existed in Old Kingdom Akhmim as well. A stela of certain Idi/Iti refers to his title of *śmśw wẖr.*t, the elder of the shipyard.[977]

4.5.1.3.5. Copper in Balat inventories

Documents from Balat represent an important source concerning the provincial administration in Dakhla Oasis in Dynasty 6. As the corpus has not yet been published in its entirety, only partial information is available at present. No information about metalworkers present in Dakhla Oasis has been published as yet, but their work is available in the form of artefacts in the mortuary equipment and ka sanctuaries. Apart from other types of documents, the clay tablets from Balat contained inventory lists of tools and weapons.[978] No detailed information concerning these lists has been published to date. The items were stored in magazines (*wḏ3w*).

4.5.1.3.6. Copper in funerary offering lists and Pyramid Texts

Old Kingdom offering lists contained food and drinks for the ritual meal and sometimes also mortuary equipment. The canonized version of the offering list, the so-called type A list, was established in late Dynasty 4 to Dynasty 5.[979] Tools appeared in three cases. In all three, there was a connection between the titles of the deceased and the tools in lists. Two persons were connected to the Treasury and one to the overseeing of royal works.[980]

What is intriguing is the conspicuous absence of tools from the Old Kingdom offering lists while the tools were present in the burial equipment. Different rules of "decorum" were in action here. The depiction of the burial equipment started in late Dynasty 6, but it was not until the end of the First Intermediate Period and the Middle Kingdom that tools were present in so-called object friezes (see below).

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[974] (Drenkhahn 1976, 123–124; Dürring 1995, 186–188).
[975] Kanawati (1987, Pl. 7c, Fig. 34c).
[976] Simpson (1965).
[977] Kanawati (1986, 59, Pl. 11b, Fig. 27b).
[978] (Pantalacci 2013, 213).
[979] (Barta 1963; Morales 2015).
[980] They were discussed elsewhere in detail - (Odler 2016, 31–33).

Another silent connotation of tools might have been regarding their role in the creation of the "images" of the deceased, either two- or three-dimensional. For the Old Kingdom, the only evidence comes from the Pyramid Texts. sThe only artisan tool occurring frequently in the Pyramid texts was an adze, in the Old Kingdom version of the Opening of the Mouth ritual. Its role has been discussed elsewhere.[981] In summary, we can say that adzes could have been perceived also in their religious roles in the Old Kingdom, but they most frequently occurred in the context of model tool kits. If the religious aspect was also important, it did not become fully expressed until the Middle and New Kingdom, with the craftsmen as participants in the Opening of the Mouth ritual.[982] A saw also occurred in the Pyramid Texts, in the context of the destruction of the royal palace.[983]

4.5.1.3.7. Craftsmen as priests

Religion is an inseparable aspect of Old Kingdom society. Some religious titles refer to craft actions, but in the aspect of the cult of deities and the performance of ritual actions. Some craft hierarchies gave rise to ranks of the priesthood of deities venerated by craftsmen, such as Ptah and Sokar. Especially in the case of Ptah, it is difficult to say when the title greatest of the director of craftsmen (*wr ẖrp ḥm.wt*) ceased to denote an actual director of craftsmen.[984] In the Early Dynastic Period and for a considerable part of the Old Kingdom, the title must have denoted a person who led and controlled the work of the craftsmen within work projects.[985] Later on, this title was used for the High Priests of Ptah in Memphis. There is late Dynasty 5 evidence of the greatest of the director of craftsmen of Wenis, apparently the title of a craftsmen's director, possibly overseeing also metalworkers.[986] On a lesser level, could the interpretation of the title workman of Ptah be more related to the craft or to religion?[987] Unfortunately, we have far less information on the Old Kingdom priesthood of Sokar, with only a few titles, predominantly of the god's servants of Sokar, in his whole place but also in Both Houses.[988] That metalworkers were also included is proved by metalworker Ankhi's title of the "possessor of rank (as) a goldworker in the retinue of Sokar".[989]

The title based on carpenters (*mḏḥ*) also had religious connotations. From the Old Kingdom, we know fashioners of Anubis and Mehyt, and a less frequent fashioner of an

[981] (Odler 2016, 129–132).
[982] (Fischer-Elfert and Hoffmann 1998).
[983] (Odler 2016, 162).
[984] On the priests of Ptah (Freier 1976).
[985] (Verner 1991, 82).
[986] (Freier 1976; Jones 2000, 391–393).
[987] (Jones 2000, 998).
[988] (Jones 2000, 438, 481, 572–573, 610–611, 745).
[989] (Jones 2000, 481).

unspecified god.[990] Frequently discussed was the title *mḏḥ Nḫn*, carpenter/shipwright of Nekhen, whose craft connotation was downplayed.[991] However, the above-mentioned royal sealer Seneni was also *mḏḥ nḫn jrrj wjꜣ n ḥwt-ḥr nb.t jwn.t* – shipwright of Nekhen, who makes the barque of Hathor, Mistress of Dendera, which might refer to the actual duties of the "carpenter of Nekhen".[992] His namesake, royal sealer Seneni, was a royal carpenter in Dynasty 9.[993]

4.5.1.4. First Intermediate Period and Middle Kingdom

Craftsmen working with metal tools were organized under the "section overseer of furniture carving" (*jmy-rꜥ wꜥr.t n ỉrw wḥm.t*), "builders" (*ỉḳd.w*), "sculptors" (*gnw.tjw*) and "sandal-makers" (*ṯbw.tjw*). An overseer of the phyle of sculptors is once mentioned in one of the Beni Hasan tombs.[994] The professions that worked at least sometimes with stone (and copper tools) included apart from necropolis workers also quarrymen. While the organization into sections was typical of other craft professions, stoneworkers and quarrymen were usually organized in phyles, with an overseer as the head of the organization (*jmy-r sꜣ n ẖrtyw-nṯr/jkyw*).[995]

Performative aspects of the craft continued in the Middle Kingdom, at Beni Hasan, in the tomb of Khnumotep II, a carpenter Netjernekhet, which is working, is featured directly in front of the watching nomarch.[996]

It seems that from the late Middle Kingdom onwards, the installation where craftsmen were producing e.g. statuary on royal court was called Golden House/Mansion, *pr-nbw* in the Duties of the Vizier, *ḥwt-nbw* in a stela from Dynasty 13.[997] Then, in the post-Amarna period, biography of the sculptor Hatiay (Leiden V.1) states that he was working on the images of gods in the House of Gold (*ḥwt-nbw*).[998]

4.5.1.4.1. Palaeography and names of tools

Because of the practice of adding captions to some object friezes, a general term for the tool kit was preserved, *wẖry.t* or *wẖry.t nt bjꜣ*, "tool kit" and "tool kit of copper".[999] There was also more general term of *ẖꜥw*, broadly translated as "equipment", which might be as well translated by the term "tool kit".[1000]

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[990] (Jones 2000, 456–460).
[991] (Jones 2000, 462–463).
[992] (Fischer 1968, 123–127).
[993] (Fischer 1968, 195).
[994] (Kóthay 2007, 143).
[995] (Kóthay 2007).
[996] Observation in (Quirke 2018, 185).
[997] (Helck 1983, 25)
[998] (Stauder 2018, 264–265).
[999] (Jéquier 1921, 270).
[1000] (Herslund 2011, 115–119).

The names of tools continue from the previous periods, although the axe, for example, lost its feminine ending and became *mjnb* out of *mjnb.t.*[1001] And once in an object frieze, an axe was named *bjꜣ n sẖt*, "copper for chopping".[1002] New term occurred also for a specific type of saw, named in the object friezes and in the annals of Amenemhat II as *ḏꜣssw*.[1003] The metal piece of the borer was named *hty.t.*[1004] Otherwise, an.t was still an adze and two types of chisels continued, *mnẖ.t* and *mḏꜣ.t.*[1005]

The palaeography of the tools became standardized, with the use of specific signs for their names. Annals of the Amenemhat II and very scarce craft scenes from the Middle Kingdom tombs (e.g. Figure 4.121) are the only sources which preserved hieroglyphic forms of the tool names and their determinatives. Tool names in the Coffin Texts and other sources were usually painted and written in cursive hieroglyphs, or even in hieratic, as in the papyrus Reisner II.

4.5.1.4.2. Object friezes

It took almost the whole Old Kingdom for some objects to enter the mandatory presentation of the funerary offerings. Unequivocal Old Kingdom evidence is preserved for mirrors; other objects were added to the object friezes in the early Middle Kingdom, within the decoration of the burial chambers, but most frequently the interior sides of coffins. The research of the object friezes is difficult due to the uneven quality of the publications of both decorated burial chambers and coffins, only a selection of the material is accessible and therefore only the main outlines of the development can be described and depicted.

Concerning the artisan tool kit, it became one of the possible parts of the object friezes, usually painted on the inside of coffins, at their foot end, or near feet end at their longer side, orientated towards east.[1006] The artisan tool kit comprised chisels, adzes, axes, saws, often also bow drill and lower pieces of drills, on which was the drill mounted. It can be inferred from the depictions that some chisels with rather long wooden handles, might be in fact the drills themselves, as they are depicted close to the bow drills. In other cases, the identification of the artisan tool kit pieces is clear. Tools are often only single specimens of their class in the painted group, in some cases the painters attempted symmetric composition with several specimens. The depictions of this tool kit from the early Middle Kingdom, e.g. on Abusir coffins, are rather realistic in rendering of the objecst in the tool kit. Coffins

[1001] (Edel 1986; Davies 1987, 64–65).
[1002] (Davies 1987, 66–67)
[1003] (Altenmüller 2015, 73; Jéquier 1921, 273; Herslund 2011, 136).
[1004] (Jéquier 1921, 277; Herslund 2011, 113).
[1005] (Jéquier 1921, 277–278; Herslund 2011, 105–106, 109–111).
[1006] (Willems 1988, 200–228).

produced late in the Dynasty 12, e.g. in the reign of Senusret III, render the artisan tool kit in more "impressionistic" manner with sketchy representations of the tools.

One observation must be pinpointed, being similar to the presence of the Old Kingdom model tool kits in the burial equipment: the artisan tool kit was depicted on the coffins of persons with social standing that excluded use of the artisan tool kit in their life. It is hardly probable that they used this tool kit, therefore the meaning of the tool kit might be connected to their social status, as they were the patrons that could in theory and practice order the craftwork on their behalf. The use of artisan tool kit in the coffin decoration was not mandatory and there were also many coffins without this particular tool kit.

4.5.1.4.3. Papyri Reisner

The papyri Reisner I–IV were found at the site Naga ed-Der, on one of the three wooden coffins in the tomb N 408.[1007] Most important evidence is provided by papyrus Reisner II, the accounts of a dockyard workshop at This, processing metal tools.[1008] The fragmentarily preserved papyrus originally exceeded 2.30 m in length and was about 33.5 cm wide. The papyrus was divided by Simpson into sections with letters A–M, based on the contents of the entries, plus five other fragments. The bulk of the entries contain copper tool and hide accounts. Copper tool accounts occur in sections A, B, C, F, H, J, L and M and on recto fragments 1–5 and verso fragment 5. Hide accounts are also connected to copper tools because the blades were attached to the wooden hafts and handles by leather thongs. Most of the papyri have been prepared for writing by ruling out the horizontal lines for the tables.

The papyri are dated to years 16 to 18 of the reign of Senusret I. Most of the documents are from years 16 and 17, only section C is from the end of year 18. It is interesting that the entries were written down only in the seasons *ꜣḫt* (months I and II) and *šmw* (months II, III and IV).[1009] This might indicate a seasonal character of the craft activities recorded in the papyrus.

It was assumed that papyri Reisner I–III were all written by scribe Sefkhy, son of Antef. Another recurring person in the documents is steward Inherhetep, son of Iy.[1010] A stela in KHM Vienna (Inv. No. 90) was dedicated to both persons by the son of Inherhetep.[1011] There is no decisive evidence for the origin of the papyri, i.e. the archive from which they were coming before the deposition in the tomb.

[1007] (Simpson 1963, 17).
[1008] Simpson (1965).
[1009] Cf. table in Simpson (1965, 17).
[1010] (Simpson 1965, 41).
[1011] (Simpson 1984).

The This workshop (*wḫr.t*) was building ships and subjected to the palace (*pr-ꜥꜣ*). Simpson interpreted the copper workshop as attached to the carpenter workshop.[1012] One title of the account might be interpreted as an evidence of an independent workshop (C2: *wḫr.t nt bjꜣ* – workshop of copper), but another passage subordinates the handling of copper to the palace workshop (J2: *ḥmty* [*rd*]*yt r wḫr.t nt pr-ꜥꜣ* – account of copper given to the workshop of the *pr-ꜥꜣ*). It might be concluded that in reality, copper was processed in an independent workshop area built and used for this purpose. As an administration unit, this workshop was subordinated to the royal dockyard.

Simpson later changed the reading of *ḳrt* in papyrus Reisner I to *wḫr.t* (D 29), and the bottom of section D (lines 29–40) is to be thus interpreted as a list of the workers of the dockyard workshop.[1013] Some of the names are the same as in papyrus Reisner II, but it cannot be proved that both documents name the same persons. The list in papyrus Reisner I did not contain the titles of the persons, and the names in the Reisner papyri are highly repetitive.[1014] The papyrus Reisner I is from the 24th and 25th regnal year of Senusret I.

The structure of the accounts was discussed in detail by Simpson.[1015] After the date of transaction, two lines follow that name the person delivering the copper artefacts and receiver of the freight. The line denoting the deliverer begins with *fꜣꜣ*(*w*) – "delivery", *jnn* – "brought". The receiver of the tools is marked by phrase *dj*(*w*) *n* – "given to". Table with a list of received artefacts follows, naming the material (i. e. in these cases copper) in the first column, tool name in the second column, place names or other short remarks in the third, weight indication of the tool written in red in the fourth, repeated mark of the material with a number of the artefacts with this weight in the fifth column. Last column list different names of persons. The fifth column contained total sum of the tool number. Repeating words were omitted in the lines under its first occurrence.[1016] The names right from the tool entries were interpreted by Simpson as owners of the tools, which deliverer handed over to the receiver, a representant of the metallurgical workshop. Place names in the third column represent the geographical origin of the tools and their owners. Simpson went further in interpreting "the individual of the C-name as an agent for the town cited or the tool listed as the property of the town".[1017] Section J is different, the entries are organized primarily according to the names of

[1012] (Simpson 1965, 17).
[1013] (Simpson 1973).
[1014] (Simpson 1999).
[1015] Simpson (1965, 18, 24–27).
[1016] (Helck 1974, 44–45).
[1017] Simpson (1965, 27).

the deliverers/owners of the tools. The order of the column with names is changed, the names are first.

Most probably due to the highly repetitive nature of the documents, Simpson decided to translate only excerpts from the papyrus, while the entire text is available only as photographs of the papyrus and hieroglyphic transcriptions of the text (Figure 4.60–4.78). The documents do not always provide all necessary information for the analyses, for instance the complete set of data in the entries. The omissions were presumably caused by the scribe, who overlooked some data while writing them down.

Of the tools named, the most frequent are axes (*mjnb*), adzes (*ꜥn.t*) and chisels (*mnḫ*); gravers (*mḏꜣt*), borers (*htyt*), middle pieces (*ḥry-jb*), unidentified tools, most probably a type of chisel (*tḥꜣ*), branding metals pieces (*ꜣbw*)[1018] and saws (*tfꜣ*) are mentioned less often. The word *pdt* was interpreted as denoting "bow" by Simpson.[1019] One *locus* in the papyrus names a "bow of the saw", which might be a metaphorical name for the saw blade. Ancient Egyptian saw blades had a straight back and a curved blade with teeth, resembling the shape of a bow. Only the general emic word categories are used, supposing that the delivered tools were connected to the main activities of the dockyard workshop.

The tools were categorized by quantitative and qualitative measures. The most important was the weight of the tools, interpreted by Simpson as written down in debens. The copper deben had the Middle Kingdom value, as exemplified by Vercoutter, discussed in Chapter 5.[1020] The numbers of the tools are another important piece of data. In view of the fact that these are the accounts of a royal workshop and that geographical marks indicate wide area of its agency, it is rather surprising that the quantity of the metal is rather low in the accounts.

Plain sums of debens and tools might be denoted by the word *dmḏ* – sum, which is indicated by a comparison of neighbouring quantities of the tools. I have transcribed the data from the account F in the form of charts. The account was from the 22nd day of the second month of *ꜣḫ.t,* and the listed copper tools were brought by foreman Isi's son Inyotef. The number of axe blades was only slightly higher (Figure 4.67), but their weight was by far the largest in the assemblage (Figure 4.68). The numbers in lines F18–24 is the repetition of the number of tools in the preceding 17 lines of the document. The last corpus of figures probably lists the number of repaired tools (Figure 4.69).

[1018] Discussion on them in (Herslund 2011, 89–90).
[1019] (Simpson 1965, 36).
[1020] (Vercoutter 1977).

In total counts, we can observe prevalence of certain types and sizes of the tools, heavy 50 deben axe blades (Figure 4.79), lighter 15 deben adze blades (Figure 4.80), and two forms of *mnḫ*-chisel, 20-deben and 14-deben (Figure 4.81). Thus, the standard shipwright kit might have consisted of axe blades weighing 1,375 grams, adze blades of 412.5 grams, and *mnḫ*-chisels of 550 grams and 385 grams. In all cases, tools are considerably heavy.

Qualitative categories are seldom present; they occur on the left side of the entries, near or in the columns with geographic determinations. The terms *mꜣꜥ* (new) and *jꜣw* (old) are frequent, presumably denoting the use-wear of the tools. The translation of the frequent remark "*n-ḥꜣ*" is unclear. Read as "*nḥꜣ*", it might refer to insufficient quality of the tool itself, with TLA definition of the word as "uneben sein; heftig sein; gefährlich sein; krankhaft sein (to be fierce; to be unruly; abnormal)".[1021] This word has, however, a different orthography. Is it an idiosyncratic version of this word or a scribal mistake?

The titles of the owners are connected to the local royal administration (stewards), who were assigned various tasks by Vizier Antefiqer residing in the capital. Most of the titles relate to the organization of the works: *ẖrp* (foreman), *jmy-r ṯst* (overseer of a crew), *ṯsw* (commander), *ṯst* (member of the crew), *pr*(*y*) (carpenter). An official of the Treasury only appears in section K containing grain rations; he is the recipient of this account. The mention of (possibly the same) official on the verso of Fragment 5 is obscured by its fragmentary nature. The most frequent participants in the transactions are steward Inherhetep as the deliverer and metalworker Nekhty as the recipient. The names in the last columns of the entries might denote the ownership of the tools.[1022] Another possible interpretation is that most of the tools are royal property, handed over to the particular craftsman for work. What we can observe is the absence of connection to metalwork in the titles, thus these officials were handling the copper tools, but without papyrus Reisner II, we would not know

A perplexing feature of the accounts are geographical marks, which range from Upper Egyptian nome 1 to nome 10, except for nomes 2 and 6; according to Simpson, they indicate the origin of the owners (or possibly the users) and thus the geographical origin of the tools themselves.[1023]

The most important question, and yet the most unclear, concerns the character of the actions behind these accounts. Simpson says: "In the Reisner accounts it is particularly difficult to ascertain whether the workshop is producing the blades (manufacture), issuing the

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[1021] TLA, lemma no. 85950.
[1022] (Seldom confirmed by the occurrence of the word *ẖt* – property, Simpson 1965, 18).
[1023] (Simpson 1965, 44–47; Andrássy 2009).

blades to the foremen (lending), or engaged in sharpening and recasting (repair)."[1024] The recycling of some tools is denoted by the phrase *jr m* – "made in(to)" with another tool cited in the last column of the entry. The accounts of section H with the pertinent presence of *jr m* could be complete notations of recycling operations, where the semi-product is described by the number of debens of the listed tools. Simpson's transliteration *r.f* must be emended to *dbn* written in hieratic. The numeral 40 is missing in H28, which is evident from this entry's (recycled) sum total of 120.

4.5.1.4.4. Copper in Lahun papyri

The Lahun papyri are a corpus of documents found during Flinders Petrie's excavations in the pyramid town of Senusret II near the Lahun site. The account fragment UC 32176 is similar in the template to the tool accounts on the papyrus Reisner II, bearing evidence that similar documents were produced throughout Egypt to document the properties of metal tools.[1025] The determination of material is followed by the object class, the weight in deben written in red and the number of tools. The first line on the fragment is obscured, it is not clear whether the word *dbn* is for the column below or denotes another object (a ring), as translated by Collier and Quirke.[1026] The phrase "strong copper" is interesting, it might indicate an alloy different from "plain copper". The accounts UC 32148 D and 32152 A used a slightly different template with personal names.

4.5.1.4.5. Craftsmen in the Teaching of Khety

The text just before the already mentioned description of the servitude of the metalworker deals with the absence of a sculptor "commanded" to work (*m wpw.t*) and a gold worker in "the place of his sending" (*bw-h3b=f*).[1027] The following three stanzas discuss the carpenter (named in the New Kingdom version as *ḥmww nb ṯꜥy ꜥn.t*, any craftsman using an adze), the jewel-maker (*ms-ꜥ3.t*) and the barber (*ẖꜥḳ*), three professions that used copper tools in their work. The negative impact on the physical condition of the body is stressed in the stanzas about metalworking, carpentry and also arrow-making (the stanza after the barber), who could also work with metal tools. The stanza about the carpenter is based on a likening of wood to the field and a metaphor of the similarity between the adze and the hoe and thus the resemblance of the carpenter's work to fieldwork.[1028] According to the author, the carpenter's weariness is even greater than that of the fieldworker. The carpenter has to work through tge

[1024] Simpson (1965, 24).
[1025] Although we do not have similar documents from the Old Kingdom, it might be presumed that such texts existed already before the Middle Kingdom.
[1026] (Collier and Quirke 2006, 105).
[1027] The passage is commented upon in (Fischer-Elfert 1999, 131–132).
[1028] (Parkinson 2009, 282).

day and night. The following two stanzas describe the potter and the brickmaker, who both work with clay and mud. The eleventh stanza returns to the carpenter (*mḏḥ*), who must build the roofing of a chamber.

4.5.1.4.6. Craftsmen in other sources

The intricate and sophisticated self-presentation of an ancient Egyptian craftsman was preserved on a stela C 14 of the craftsman Irtysen. He claimed that he worked with all *ꜥꜣ.t*, every precious material, "beginning with silver and gold, ending with ivory and ebony". That listing most probably included also copper, as it begun with the sorts of metal. The craft skills were transferred to the eldest sons of the craftsmen, as the stela of Irtysen confirms.[1029] It is another corroboration of the assumption that professional ties might have been in fact based also on the family ties of the persons involved.

Concentration of the craftsmen in the capital of Egypt, in the centralized phase of its history, can be presumed from the written sources.[1030] A study of offering tables revealed centralized production in the Middle Kingdom, but also local production centres, e.g. Asiut.[1031] In the Second Intermediate Period, situation changes and there exists evidence of several local workshops, producing statuary for funerary cult.[1032]

The absence of builders is conspicuous in the Teaching of Amenemhat I, in which the author appeals to his successor to raise his monuments and endow his tomb shaft.[1033] The king builds, but the builders and mourners were not important enough to be mentioned. The latter part of the verse might be also a hint that the burial equipment was being prepared during the reign of the king, who was personally engaged in its selection and preparation.

On the contrary, the building of a pyramid and the preparation of the funerary equipment including the craftsmen involved are dutifully listed in the closing lines of the Tale of Sinuhe (B295–B310). Here, we can find another confirmation that the burial equipment was overseen by the buried person while still alive.

The absence of architects/pyramid builders who had become agricultural workers was lamented in the Dialogue of Ipuur (3.6–10).[1034] It can be inferred, thus, that the craft activity was considered to be more important than agriculture. Further in the text, the carving of

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[1029] (Barta 1970).
[1030] (Connor 2018, 21–22). But the evidence is far from being numerous and indicates movement of craftsmen around Egypt for specific projects (Quirke 2009, 117–119).
[1031] (Ilin-Tomich 2018).
[1032] (Connor 2018, 27).
[1033] The work is preserved only in New Kingdom copies, Parkinson (2009, 203-211).
[1034] Enmarch (2008).

offering altars is recalled (11.1–11.3) and it is asserted again that "It is so good when people's hands build pyramids" (13.12).

Papyrus Ramesseum E describes a procession for a funerary ritual, including a number of craftsmen, involving carpenters, furniture makers, goldsmiths, and others. The craftsmen, together with their tools participated in a closing rite, circulating around a mound near a burial place.[1035] Since the royal children were mentioned, the document is presumed to be connected to the court.

4.5.1.4.7. Artisan tool kit in the Coffin Texts and the annals fragment

The developed text of the ritual of the Opening of mouth is only preserved from the New Kingdom. The crucial role of the craftsmen/sculptors as the creators of the "living image" of the deceased in the performance of the ritual is evident in those texts.[1036] It is impossible to decide whether this aspect of the interpretation was connected to copper model tool blades already in the Old Kingdom. However, from the Middle Kingdom, a few mentions in Coffin Texts allow us to deliberate about the role of artisan tool kit in the ritual (Figure 4.103–4.115).

In Spell 479, the tools belong apparently to Ra, although the text is not fully preserved: "Its adze, chisel and saw are what is in the mouth of Ha and the ... of Nephthys." (Pap. Gard. II, CT VI, 38n/o). In Spell 280, an interpretation of adzes as the celestial constellations of *Ursa maior* and *Ursa minor* continued from the Pyramid Texts: "O N, you are the Elder <Horus>, you have judged between the Rivals, namely the two who would destroy the sky; you have adzed Orion with the two adzes of Seth, you have given judgement in this sky for Re, light and dark are at your will." (CT IV 28k–29c, Spell 280).

In Spell 936, found only on a single coffin from Gebelein (G1T), a connection of the *mḏꜣ.t* chisel and the ritual is clearly stated: "The opening of the mouth with the iron chisel. As for all that you do for yourselves, you shall do (it) for N." In Spell 231, the deity opening the mouth is Thoth: "Ho N! may your head be purified by Hapi, may your eyes be made bright by *dwꜣ-wr*, may your mouth be split open by Thoth with this wondrous chisels of his wherewith he split open the mouth of the gods. He speaks and splits open the mouth of N that he may speak." Faulkner mistakenly translated the word *mḏꜣ.t* with its other meaning as a "scroll",[1037] but the translation "chisel" is meaningful in this context.

In Spell 520, artisan tool does appear in the context that was fully developed in the New Kingdom, where a son of the deceased is at the same time the craftsman that produced

[1035] (Díaz Hernández 2014; Quirke 2018, 186–187, 2003, 88).
[1036] (Fischer-Elfert and Hoffmann 1998).
[1037] (Faulkner 2004, I, 184).

the image of the deceased and the context is unequivocal: "You have come that you may gather my father N together; join him up, smoothe(?) him,/use the adze on him and you will be his good fortune, for you are my son, a child of Horus." (CT VI 110c, Spell 520).

Annals of Amenemhat II have two preserved major fragments, the lesser one is called "Petrie fragment", it was much more damaged, and the text is much more difficult to be read and interpreted. The dating of this lesser piece might not be the same as in the case of Farag fragment from the Year 30 and 31 of the king's rule. In the column P4 is mentioned a sphinx statue(ette) and then several sign groups.[1038] The first group was read by Altenmüller as [*mjn*]*b*, but a comparison with other similar sign groups (Figure 4.8–4.10) rather indicates classical reading of the group as *bjꜣ*. Another group begins with the material denotation of arsenical copper/tin bronze, the words *jrw wꜣt* and a determinative for a single axe. The words can be translated as "opener of way" and it is idiosyncratic term for an axe, not preserved elsewhere. Then copper adze of angular *msḫ.tyw* shape follows. A table or a box of conifer wood is the further group, usually being listed at the end of such endowments, probably holding the previously mentioned items. Finally, Upper Egyptian natron is named and in the missing part the geographical location was once chiselled. Unfortunately, the overall context of the inscription is not clear, what is clear that some artisan tools could have been employed in the religious contexts. On the other hand, both here and on Farag fragment, the predominant cultic equipment are vessels made of metals.

Finally, a stela from Dendera must be mentioned, from the mastaba of Rediukhnum.[1039] Below the biographical text of the stela owner is an offering scene. Tomb owner's son Antef is the first offering bearer, holding a chisel/drill on a bowl (or a sistrum of Hathor?). Unfortunately, no documentation of the stela focused on the object in the Antef's hands, enabling to assess its precise morphology, and perhaps other details. Female offering bearer Ipui is holding a mirror and a bag, probably of eye paint.

4.5.2. Uses of the cosmetic tool kit

In the third millennium BC, in the Early Dynastic Period and the Old Kingdom, evidence can be gathered concerning the cosmetic tool kit (mirrors, razors, tweezers, hair curlers, kohl-sticks) and the professions performing actions with these objects (hairdressers, barbers, manicurists). The best source in the Early Dynastic Period is iconography. Burial equipment depicted in the tomb of Hesyra at Saqqara contained apparently wooden boxes with cosmetic equipment, two with razors and tweezers and one with eye paints (Figure 4.55, 4.56). One box

[1038] (Altenmüller 2015, 168–170).
[1039] CG 20543: Petrie (1898, Pl. XV); Lilyquist (1979, 26, footnote 274); Landgráfová (2011, 74–78).

contains razors stored separately with curved blades and handles narrowed in the middle, altogether eight specimens; above them were three pairs of tweezers. In the second box there were eight razor blades as well but stored in etuis, one for each pair of razors; above these were four pair of tweezers. Rolled pins, otherwise unknown, were also depicted in some of the tweezers. The third and fourth box from right bear the inscription “barbering” and depict other necessary items, probably eye-paint and a rectangular blade with a tang that might be also an otherwise unknown type of razor (?) resembling saw blades.

Old Kingdom written and iconographic sources dealing with the cosmetic tool kit were discussed earlier.[1040] Herein, I add sources missing in the previous publication and predominantly discuss the professions using these objects. One important source was missed in the previous publication,[1041] list of offerings for Neferet from Meidum (Figure 4.86b). Although the material denotation was not preserved, there are two vessels, one made of Asian copper, another a censer, and two types of razor blades, one preserved only with determinative, being a pair of razor blades with a narrowed handle, thus usual *ẖꜥḳ* razor. Another blade is possible to match with the name, it is rectangular razor blade of Type A, made of flint, copper and gold in the Old Kingdom, and was named *ḥsb.t*. It is the fourth Old Kingdom example of an offering list with tools, in this particular case of cosmetic tool kit.

Old Kingdom Egyptian distinguished three categories of the professions working with the cosmetic tools: hairdressers, barbers and manicurists. Besides hairdressers without affiliation (unspecified, inspector, leader, overseer), there were also hairdressers who were clearly associated with the care about the king; they were employed in the Great House, with the same craft structure.[1042] A hairdresser could be also “intimate of the king in the works of hairdressing”.[1043] A rather unique piece of information says that a hairdresser could handle an item from the regalia: “royal hairdresser who adorns the white crown on the brow (of Menkauhor)”.[1044]

There is less diversity in the titles of barbers, which existed without affiliation (unspecified, instructor, overseer) and in association with the Great House (barber, overseer). A similar structure existed for the manicurists, either non-affiliated or working in the Great House; there is evidence on the “inspector”[1045] but not on the “overseer”.[1046]

1040 (Odler 2016, 173–194).
1041 (Odler 2016).
1042 (Speidel 1990; Tassie 2017).
1043 (Jones 2000, 450, title no. 1687).
1044 (Jones 2000, 311, title no. 1136).
1045 (Jones 2000, 914–915, title no. 3360).
1046 Old Kingdom barbers and manicurists were recently collected by (Altenmüller 2011).

All three professions in the "Great House" were in close contact with the ruler on a day-to-day basis, and some personages used this influence to raise their own social status. The best-known examples were Dynasty-5 officials Ptahshepses, buried at Abusir, and Nyankhkhnum and Khnumhotep, buried at Saqqara. For Nyankhkhnum, a *ḏ.t* servant is known from his tomb.[1047] Overseer of the barbers Ka… was inscribed in the archive of the mortuary temple of Neferirkara.[1048]

Although we are aware of the ritual cleanliness that must have been required from the performers of rituals, direct mentions of it are rare in third millennium BC sources. When King Pepy I was coming to the Afterlife, his head was shaven.[1049] In the Coffin Texts are more mentions of the shaving (Figure 4.107, 4.108), "day of the shaving of female mourners" (CT IV 338d, Spell 339); a reference to self-shaving "what I shave is my cheeks" (CT VII, 96, Spell 885); and a goddess, "she has shaved the side-whiskers of Anti" (CT VII 156, Spell 942; Figure 4.110–4.111).

The titles of the barbers are also iconographic sources depicting razors in their etuis.[1050] In late Dynasty 6, mirrors begun to be depicted in the burial chambers besides other items of the burial equipment and later on, in the First Intermediate Period and the Middle Kingdom, in the so-called object friezes. Mirrors were also popular as offering gifts, especially for women, throughout the late Old Kingdom and the early Middle Kingdom.[1051] Mirrors as offerings were then used also in Middle Kingdom tomb scenes and on the inner sides of Middle Kingdom sarcophagi. Mirrors were depicted either unpacked or stored in etuis, which were made of leather according to painted decoration.

Dynasty 11 prosopographical evidence concerning two royal hairdressers is preserved.[1052] In the Middle Kingdom, three different ancient Egyptian names of "hair-dressers" were translated as such by W. Ward.[1053] Another title was translated as "coiffeur".[1054]

The barber in the Teaching of Khety had to be excessively exerting himself to earn his living by shaving. A bag is part of his equipment. Author compares barber to a bee. There is no indication that a profession of barber meant higher social status in the text. However, for

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[1047] (Moussa and Altenmüller 1977, 173; Verner 1986).
[1048] Posener-Kriéger and Cenival (1968, Pl. LXIV: G).
[1049] (Allen 2005, 175; Vlčková 2006, 388).
[1050] (Montet 1933).
[1051] (O'Neill 2015).
[1052] (Riefstahl 1952, 1956).
[1053] (Ward 1982, 56, 100, 153).
[1054] (Ward 1982, 177).

Sinuhe returning back home to Egypt, one of the traits of him becoming again Egyptian, is an expression “I became clean-shaven,” (B291).

Iconographic evidence preserved a change of the type of razor blade from the early form resembling typical Old Kingdom hieroglyph for a razor in an etui. In the tomb of Baket III at Beni Hasan, short scene with the caption “shaving” is demonstrably having a painted determinative of an early type of Middle Kingdom razor, with a side of blade projecting out (Figure 4.83). However, the name of both the razor and the mirror continued from the Old Kingdom, as *mẖḳ*(*.t*) and *ʿnḫ* / *mꜣꜣ-ḥr* respectively.[1055]

Mirrors continued in the unchanged shapes from the previous periods, and, again, mirror could have been a funerary offering both for men and women, thus it was not perceived as gender-specific. However, in absolute counts, mirrors would be more frequently associated with women. One or several mirrors were often depicted either on the inside of decorated coffins or on the walls of decorated chambers. The mirrors were painted in the vicinity of the heads of deceased, just as the full-size mirrors would be deposited. The depictions of the mirrors on coffins were analysed by C. Lilyquist.[1056]

In the entourage of nomarch Amenemhat at Beni Hasan, warriors accompany him with spears, but one also with a mirror.[1057] It was rather an object of social distinction as one textual source confirms. From the late Middle Kingdom or Second Intermediate period comes the Dialogue of Ipuur. In the *locus* 8.5 of the dialogue, a mirror is described as an artefact of social difference among the social layers„… she who looked at her face in the water is the owner of a mirror.“ [1058] This passage was doubted by C. Lilyquist, who pointed out that mirrors have been found in poor graves and graves of children.[1059] After the study of Middle Kingdom funerary practices by Richards, we know that funerary display could take several ways to exhibit social status of the buried person.[1060] Mirror could be the only symbol of attained social status in otherwise poor grave, thus denoting in the ancient Egyptian terms a “rich” grave.

Mirrors offered sufficient space to bear inscriptions, in ancient Egypt, it is traditionally located at the base of the disc, above the tang, in order not to conceal the polished functional part. Inscribed razor blades are rather rare (Figure 4.82). In contrast to the tools, contents of the inscriptions on cosmetic tools has a stable structure of title or titles of the presumable

1055 (Jéquier 1921, 126, 136–137; Herslund 2011, 92–93, 106–107).
1056 (Lilyquist 1979).
1057 Kanawati – Evans (2016, 36–37,Pl. 94, 96).
1058 The same interpretation in (Enmarch 2008, 140). The context of passus also in (Castañeda Reyes 2010).
1059 (Lilyquist 1979, 86).
1060 (Richards 2005).

owner and hers or his personal name. Since many of the specimens from the archaeological contexts were found among the items of the burial equipment, we can presume that also unprovenanced finds were of similar provenance. Old Kingdom inscribed mirrors and razors were discussed earlier.[1061] Middle Kingdom inscriptions were collected by C. Lilyquist.[1062] A mirror missing from the latter collection is only recently discovered inscription on C-Group mirror from Toshka in Nubia. It was published recently.[1063] This mirror made of arsenical copper (KHM Wien, ÄS 7334) was, according to the inscription, a gift from overseer of the (warrior) troops In to his daughter Itu: *ꜥnḫ-mꜣꜣ-ḥr jr.n mr mšꜥ Jn n sꜣ.t=f Jtw* = "a mirror for seeing face being made by the overseer of troops In for his daughter Itu",. The craftsmen producing the mirror are the least important part of this transaction; they are not even mentioned in the text.

4.5.3. Uses of personal adornment and raw materials

Contrary to several other artefactual categories, the written and especially iconographic evidence on personal adornment – jewellery is overwhelming. As even a modest selection is impossible, I could only discuss positively identified copper jewellery, if even this identification would not be highly problematic. The situation is complicated by frequent information on golden jewellery that is, in view of material culture, often produced of a copper sheet covered with a gold foil. This enabled the production of "gold" jewellery while reducing the amount of gold and increasing the durability of the objects. The clearest iconographic and textual source on the mutual work with gold and copper is the gold working scene from tomb of Baqet III at Beni Hassan (Figure 4.40d).

Extensive iconographic and written sources are preserved from the Old Kingdom. R. Drenkhahn categorized jewellery production into three categories: the jewellers producing necklaces and headbands, depicted in the vicinity of metalwork and thus also making objects from metals; those producing beads from (precious) stones using metal drills, and the producers of royal jewellery (part of the regalia), who were never depicted at work.[1064] The profession named "necklace-stringer" or specifically "necklace-stringer of gold" had its own "director" and "overseer". It was also a private profession, as evidence of "necklace-stringer(s)/jeweller(s) of the funerary estate" exists. The Great House had its own workers producing beads, as the title "worker in precious stones of the Great House" (*ms.w nšd pr ꜥꜣ*)

1061 (Odler 2016, 190–192, Figs. 17, 194).
1062 (Lilyquist 1979, 86–93).
1063 (Satzinger 1991; Odler et al. 2018, 437–439).
1064 (Drenkhahn 1976, 43–51).

shows.[1065] In one person, a faience production was connected with the royal jewellery: “overseer of the faience work and supervisor of the King's ornaments, Itisen.”[1066] In private service, bead-drillers were shown in Tomb of Ibi at Deir el-Gebrawi.[1067] Some Old Kingdom inscriptions evidence gold working for the burial equipment (*ḳrst.t*).[1068] Eichler assumes that those metalworkers were working in the *pr ḏ.t* of the private owner of the tomb and that raw gold was coming from the royal *pr ḥḏ* as a kind of “Belohnung” – “gift”. Copper model tools covered with a golden foil represent material evidence of such “gold-working”. Handling of the probably personally owned adornment is depicted in the tomb of Metjetji, where a (gold) necklace is taken for the tomb owner.[1069]

Types of jewellery from iconographic sources that could have been made of copper (or with a copper core) include bracelets, anklets, headbands, and various types of necklaces.[1070] In the sphere of personal adornment applied to the body itself, a green eye paint was provided by malachite. The material had to be brought into Egypt, and the evidence has been analysed in the subchapter discussing the expeditions. Old Kingdom green and black eye paint was stored in sealed sacks which were later, in Dynasty 6, replaced by stone vessels.[1071] The mentions are too ubiquitous to be listed, as these were the two fundamental colours of the eye paint.

The division between the “necklace-makers” and “bead-makers” continued in the Middle Kingdom. There is evidence on “necklace-maker”, “hall-keeper of necklace-makers”, “steward of necklace-makers” on the one hand; on the other hand, “driller of stone” and “lapidary, jeweller” existed, as well as “overseer of drillers” and “overseer of drillers on stone”. The highest position is the “overseer of the workshop of jewellers”. In the annals of Amenemhat II was in the column M25 preserved an entry about the rewarding of the soldiers, and among the rewards was named unspecified gold.[1072] Most probably is this the case of the “gold of honour” reward from the early Middle Kingdom, meaning rewarding soldiers with the golden jewellery or jewellery made of copper and covered with gold foil. The word for ring is preserved from the Middle Kingdom onwards, *šʿḳ*.[1073]

1065 (Jones 2000, 451, title no. 1689).
1066 (Moussa 1972, Taf. XXIX)
1067 (Kanawati 2007, 48, Pl. 72).
1068 (Eichler 1993, 318-319).
1069 (Kaplony 1976, 21–22, Nr. 2).
1070 (Staehelin 1966, 100–154; Brovarski 1997).
1071 (Boochs 1982, 19).
1072 (Altenmüller 2015, 113).
1073 (Herslund 2011, 130–131).

A tradition of broad collars continued from the Old Kingdom.[1074] Jewellery was besides the practical life uses and funerary cult used also on the cultic statues of kings. Annals of Amenemhat II mention collar, counterbalance, and armlet, all made of "many precious stones" – *ꜥꜣ.t ꜥšꜣ.t*.[1075]

The author of the Teaching of Khety did not forget to mention a jewel worker (*ms-ꜥꜣ.t*), who uses tools to cut hard stones, and the tool mentioned is a chisel.[1076] Parkinson's translation of the phrase *ḥr wẖꜣ.t m mnḫ.t*, "boring with his chisel" might be not the best, a better term might be "hollowing out with a chisel".[1077] In the evening, the jewel worker even eats in his crouched position.

Hairpins occurring in the hair of early Middle Kingdom elite ladies were most probably made of ivory. They were called *ꜣb* and Gardiner thought that the bi-consonantal sings for *ꜣb* and *mr* depict both chisels. E. Riefstahl corroborated conclusions of Wreszinski and Weigall that these signs depict different objects, an (ivory) pin and a chisel.[1078]

4.5.4. Uses of the textile processing tool kit

Needles and awls were copper components of the textile processing tool kit. The awls are discussed in the following chapter dealing with leatherworking. This leaves us with the needles, which were unfortunately too small to be recognized by the iconography, and they were also omitted in written sources of periods under study. While textiles were often mentioned in the textual sources,[1079] their connection to sewing or stitching with needles cannot be explored on this basis.

A Middle Kingdom word for needle might be *ḥty*, as found in the dramatic papyrus Ramesseum B. The context rather speaks against this explanation, however; the word means rather a (carneol) "necklace/string".[1080] A netting "needle" *ꜥḏ*, a piece of wood used for the attachment of a net string, is frequently mentioned in the Coffin Texts.[1081]

4.5.5. Uses of the leather-working tool kit

Tools with metal blades used in leatherworking were an awl and a leather-cutting knife, the former featuring in hieroglyphs, the latter depicted in leatherworking craft scenes.

Leatherworking was a craft that was represented in the hieroglyphic script by a tool with a metal point, an awl. The evidence is from the Early Dynastic Period and the Old

1074 (Grajetzki 2018).
1075 (Altenmüller 2015, 275–276).
1076 (Helck 1970, VIa).
1077 TLA lemma no. 49100, *wẖꜣ*: "ausleeren; ausschütteln".
1078 (Riefstahl 1956, 16).
1079 E.g in Early Dynastic Helwan, cf. (Köhler and Jones 2009, 47–49, Fig. 22).
1080 (Sethe 1928, 180–181; Hannig 2006, 1789).
1081 (Hannig 2006, 580).

Kingdom.[1082] The reading of the hieroglyphic sign representing awl is uncertain, however. Work with leather was represented in five Old Kingdom craft scenes; three of them contained leather-cutting knives.[1083] Already Junker noted down different typology of the knives in the Old Kingdom, with bigger and smaller knives.[1084] Parts of the structure of leatherwork can be reconstructed based on the titles “leatherworker”, “assistant of leatherworker”, “director of leatherworkers” and “sandal-maker of the king”. An “overseer of sandal-makers of the Thinite Nome”, Weta, was known, but the finer dating of the inscriptions on his coffin is a debated issue6.[1085] Also from the concentration of other titles, it seems that Thinite nome was a centre for leatherwork and sandal making.[1086]

Later, in the Middle Kingdom, the name of the profession was most probably replaced by “sandal-maker” and written down by the hieroglyphic sign of a sandal.[1087] The profession of “sandal-maker” figured also in the Teaching of Khety/Satire of Trades, but with a reference to leather and its soaking, rather than to the use of any tool.[1088]

Leatherworking was represented in First Intermediate period tomb of Sebekhotep at Moalla, and three Middle Kingdom scenes: Theban tomb of Antef, tombs of Baket III and Amemenmat at Beni Hasan, except of Antef’s tomb with leather-cutting knives depicted. Leatherworking products were represented in the form of mirror and razor cases. The titles of leatherworkers changed into “sandal-maker”, “overseer of sandal-makers”, “royal sandal-maker”, and “keeper of royal sandals”, “keeper of sandal-bag”.[1089] Leatherworking in Nubia was on high level throughout the periods under study and Nubians seem to be one of the main suppliers of hides, even influencing new types of fashion, e.g. leather loincloths.[1090]

4.5.6. Uses of the hunting and food processing tool kit

Two artefact classes with metal blades were used for hunting: harpoons and fish-hooks.[1091] All categories of evidence for Predynastic, Early Dynastic and Old Kingdom uses of harpoons were examined elsewhere.[1092] To the lists in the article may be added a presumed image of the

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[1082] (Junker 1957, 7–20, 33; Drenkhahn 1976, 7–17; Schwarz 2000; Regulski 2010, 199, sign u5).
[1083] (Odler 2016, 205–206).
[1084] (Junker 1957, 20–27)
[1085] (Junker 1957, 9; Jones 2000, 268, title no. 967). For recent references on Weta and a translation of the inscriptions, see (Stauder 2018, 262–263).
[1086] (Moreno García 2018, 160).
[1087] (Drenkhahn 1976, 7–17).
[1088] Parkinson (2009, 278).
[1089] (Ward 1982, 53, 67, 184).
[1090] (Moreno García 2018).
[1091] In two rare cases, an axe is depicted as a weapon for killing the hippopotamus in Old Kingdom fishing scenes, cf. (Odler and Peterková Hlouchová 2017, 208).
[1092] (Odler and Peterková Hlouchová 2017).

deity *ʿš* on the year label of King Den in the compartment of a malachite booty from Sinai (Figure 4.21a).

Old Kingdom evidence on fish-hooks was also discussed earlier.[1093] However, it needs to be reminded that the occurrence of a fish-hook cluster in two market scenes is an indication of copper objects as parts of the exchange.[1094] Old Kingdom evidence on fishermen is rather scarce; for Old Kingdom Egyptians, they were in the same category as fowlers. We know about an "overseer of fowlers/fishermen" without affiliation and "overseers of fishers/fowlers of the funerary estate".[1095] The profession was thus active within the framework of the private estates of the Old Kingdom elite. We can glimpse another aspect in the existence of the title "overseers of fishers, fowlers and hunters of the nome". Two persons had such titles, Menankhpepy – Meni from Dendara and Hagi from Naga ed-Deir, both datable to late Dynasty 6 or the First Intermediate Period.[1096] The existence of the title probably reflects the changing administration of the late Old Kingdom, like the above-mentioned title of the sandal-makers of the Thinite nome. Fishermen titles are not preserved from the Middle Kingdom.[1097] Only in a single rock inscription from Wadi Hammamat from the reign of Mentuhotep II was present an "overseer of harpooners on the rivers" (*jmy-r msn.w hr jtr*(*.w*).[1098] According to other titles of "overseer of soldiers on the deserts, overseer of the house on the Black Land", the official was not of low status (although his subordinates, harpooners themselves, could have been of lower status). Similarly, the information about harpooning in other Middle Kingdom sources is overtly focused on the social elite.

Two Middle Kingdom literary works allude to the use of harpoons and fish-hooks. In the Tale of the Eloquent Peasant, a peasant reminds a high official about his elevated social status: "Look, you are a hunter who slakes his desire, / … /who harpoons hippopotami …" (B1 237–238).[1099] Later on, in another speech of the peasant, the high official is also "the fish-spearer harpooning the ubbu-fish, …" (B1 259–260).[1100] In the fragmentarily preserved Account of the Pleasures of Fishing and Fowling, "… and the catcher and harpooner come to us, … your fishing-rods have been kind to you …".[1101] In a text above fish-spearing scene in

[1093] (Odler 2016, 198–200).
[1094] (Odler 2016, 33).
[1095] (Jones 2000, 104–105).
[1096] (Jones 2000, 105).
[1097] A fisherman operating fishing nets is, however, mentioned in the Tale of Eloquent Peasant (Parkinson 2012, 212–214).
[1098] (Couyat and Montet 1912, 32–33; Fischer 1968, 172).
[1099] More parallels in (Parkinson 2012, 197–198).
[1100] (Parkinson 2012, 212–213).
[1101] Parkinson (2009, 294).

the tomb of Khnumhotep II at Beni Hasan, the tomb owner is named as "overseer of the fishermen/fowlers of the swamps and fowl ponds", who hunted down with his spear/harpoon 30 fish. At the end of the text is exaltation "How delightful is the day of the spearing the hippopotamus".[1102] Spell 549 of the Coffin Texts describes and sums up some duties of the member of elite: "TO ASSEMBLE A BURIAL. O N, you are one of those who spear (fish), who are over the netters, who have gone to the *ṯnnt*-shrine and have found a coffin for themselves. TO ASSEMBLE A MULTITUDE FOR BURIAL." (CT VI 147, Spell 549; Figure 4.114, 4.115). In all mentioned cases, harpooning was an allusion to an activity that was not regularly performed and was rather a prerogative of the social elite. Moreover, harpooning of the hippopotamus was an iconographic motif only used by the kings in the periods under study; non-royal tomb owners were not depicted killing the animal single-handedly.[1103]

In Spells 474, 479 and 480, the spears are mentioned as weapons of the enemies of deceased, e.g. in Spell 474: "O you who look backward (*mꜣ-ḥꜣ.f*), aggressive one who fishes with the spear, the fisherman of the *wꜣḏt-tꜣwy* net … you shall not catch me in [your] net in which you catch the dead."

The harpoon *mꜥbꜣ* was once mentioned in the Coffin Texts, in a mythological text, in which surprisingly, the weapon does not belong to Ra, but to his opponent (CT II 278–279b, c, Spell 154; Figures 4.105, 4.108): "It so happened that Re disputed with the *Ỉmy-whm.f* serpent concerning the division of On, and his mouth was injured, and that is how the reduction in the monthly festival came about. Then said *Ỉmy-whm.f*: 'I will take my harpoon and I will inherit this city', and that is how the Harpoon came into being. Then said Re: 'I will erect my flagstaffs against him, I will oust him, and that is how the *snwt*-festival came about."

The presumed metal tool for food-processing was a knife. Sources from the ubiquitous Old Kingdom butchering scenes were clearly showing the use of flint knives. Although copper knives could have been used as well, flint was the preferred material.[1104] Based on written or iconographic sources alone, it would be impossible to assess when and if metal knives were used more frequently.[1105] Butchers are known from the sources, but they are of marginal interest herein; contrary to expectations, their social status was rather high compared

[1102] Kanawati – Evans (2014, 58–59, Pl. 136).
[1103] (Odler and Peterková Hlouchová 2017, 205–207).
[1104] Knives are examined by author elsewhere (Odler 2016, 201–205).
[1105] Cf. discussion by (Ikram 1995, 63–70). Metal knives in butchering scenes can be securely identified only in the New Kingdom.

to “commoners”. A part of their social standing came presumably from their participation in the rituals.[1106]

Knives are rather frequently mentioned in the Coffin Texts, as weapon used for the defence of the deceased or against him. The terminology of the knives is rich but matching of the names with the artefacts is impossible, due to generic determinatives. We know e.g. about *smꜣ.ty*, “killing knives” and *ḏꜣt-ꜥ*, another type of a knife for violent action.[1107]

4.5.7. Uses of vessels

This topic cannot be discussed *in extenso*, as the vessel types were made of several broad categories of material – metal, stone, pottery, and even wood – and we often lack accurate data about the material of the vessels named or depicted. Therefore, only the vessels positively identified as made of copper and its alloys can be examined. Moreover, as many aspects were already covered by A. Radwan,[1108] the present text can only have the form of additions to this magisterial work.[1109] Since the typology was described by Radwan, I will focus on some other problems connected with written sources. In addition, the textual typology of copper vessels was recently updated by Herslund.[1110] Perusing two main categories of evidence, lists of copper vessels and inscriptions on the copper vessels themselves, we are able to ascribe the vessel types to the specific rituals and peculiar ritual handling, as the vessels were appropriate “tools” of the rituals. Using these inferences, it is possible to approach the details of the Old Kingdom temple rituals also with the remains from “funerary” contexts. In addition, it is possible to formulate hypotheses of how copper coming from the royal and non-royal contexts can be identified in the temple furniture.

4.5.7.1. Early Dynastic and Old Kingdom copper vessels

Predynastic written sources do not inform on the presence of copper vessels. They occurred in the offering lists since the Early Dynastic Period. Their presence in the sources is marginal but undoubted in three offering lists (Figures 4.85, 4.89).[1111]

4.5.7.1.1. Artefacts in the offering ritual – *pr.t ḫrw*

The most frequent occurrence of copper vessels in Old Kingdom sources was in the so-called offering ritual. In Old Kingdom Egyptian, it was named *pr.t ḫrw,* denoting the words recited during the putting forward of the offering meals. I have examined the course of the ritual in

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[1106] (Eyre 2002, 188–189).
[1107] (Herslund 2011, 126, 136).
[1108] (Radwan 1983).
[1109] Like some of my previous articles, which also build on Radwan’s work, (Odler 2017b; Arias Kytnarová,Jirásková and Odler 2018).
[1110] (Herslund 2011, 2015).
[1111] (Kahl 2004, 308).

detail elsewhere;[1112] the ordering of the vessels in it can be expressed in the form of a table (Figure 4.89).

What is intriguing is that the lists preserved do not provide a full set for the ritual made of a single material. The lists from the mortuary temple of Neferirkara are organized on the basis of the materials and a selection of the vessels is always written down (Figure 4.87). Fragmentary inventories from the pyramid temple of Raneferef have preserved lists of stone and metal vessels (Figure 4.88).[1113] The documents distinguish between (ordinary?) *bjꜣ* copper and Asian copper – *śṯꜣ.t*. The lists on Pls. 28–30, 31B preserved vessels for the rituals of the funerary repast and for the Opening of the Mouth ceremony. The artefacts were stored in the *pr-mnẖ.t* (the storeroom of cloth).

The papyri do not inform about the size of the objects. They could have been full-size vessels or models; we do not know much about the Old Kingdom ritual practice in this regard. An important observation is that the objects are written down in the order of the materials, meaning that the material was more important than the type of the object and its cultic role when the inventory lists were made.[1114]

The washing sets probably featured as the most important part of the offering ritual throughout the depictions of offering scenes with offering tables and the tomb owners seated at them. [1115] Washing sets appearing in the iconography in general terms correspond to the development of copper alloy vessels (although we have to bear in mind that the existing vessels were dated based on the iconography).[1116]

An array of depictions of ritual vessels can be listed, including many depictions of the washing sets, where we cannot be sure that the artefacts depicted were made of copper alloy, although the ritual context might indicate that they were made of some precious metal. An example is a spouted *ḥs*-vase (*kbḥ* vessel) with a lid and a stand shown in the expedition inscription in Wadi Maghara from the reign of Nyuserra, the year of the second cattle count.[1117] A door architrave from the ka-temple of King Pepy I in Bubastis contained a scene with the king receiving ankh from Bastet, accompanied by Hathor from Dendara and Iunmutef. On the left side of the scene is the Nile deity with the Lower Egyptian plant on his head, holding a spouted *ḥs*-vase, his left hand on the narrowest part of the vessel and right

[1112] (Odler 2017b, 294–295).
[1113] Posener-Kriéger – Verner – Vymazalová (2006).
[1114] Eichler (1993, 298).
[1115] Again, they were already examined earlier (Odler 2017b, 294–295).
[1116] And their development is in detail described in (Radwan 1983).
[1117] (Tallet 2018, 302, inscription IS 10).

hand on the rim opposing the spout. The vessel is in an upright position.[1118] A doorframe from the ka-temple of King Pepy I in Bubastis depicts the god Hapi and goddess Akhet together for the first time. They are holding high and narrow *ḥs*-vases, the narrowest part of their diameter with their left hands and the rim of the vessel with the right hands, prepared for the libation. Both vessels are inclining, the vessel in the hands of Akhet is inclining more towards the door frame, which is not preserved.[1119]

4.5.7.1.2. The Opening of the Mouth ritual

Much less is known about the Opening of the Mouth ritual in the third millennium BC.[1120] In Old Kingdom written sources, it is associated with the statues of the deceased but also with statues of deities, such as an electrum statue of Ihy, finished in the temple of Hathor in the town *Mrt-snfrw* in the first year of Neferirkara's reign.[1121] The main discussion in recent literature is whether the ritual was first used for statues or in the funerary context.[1122]

The accessories needed for the ritual were named in the so-called offering lists of type B, which is shorter than type A.[1123] *Nṯr.ty* blades from these lists could have been made of either stone or copper.[1124] Less frequently occurring were other objects, pieces of divine metal from the Nile Valley and the Delta, mentioned in the text for the ritual in the Pyramid Texts.[1125]

4.5.7.1.3. Unknown rituals

The list on Pl. 32 in the papyri from the Raneferef's mortuary temple has preserved another set of objects, including a copper vessel with the *mrḥ.t*-oil, but their religious context is less clear. The description on the papyrus on Pl. 36D describes the state of preservation of an unknown vessel: *wrwt ꜥšꜣ m bjꜣ nt m ḥꜣ.ś* (a great number of wrinkles in the copper, which is from the outside of vessel). The remains of other artefact lists with copper objects were preserved on Pls. 37C, 37N and 43H (all on Figure 4.88).[1126]

4.5.7.1.4. Priests performing rituals

Titles of the priestly service were present in Old Kingdom titulary. One of the frequent is the title *zmꜣ*, translated as stolist, a priest who cared about the clothing, ritual cleaning and daily

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[1118] (Bussmann 2010, 159, Abb. 4.8).
[1119] (Bussmann 2010, 164, Abb. 4.27).
[1120] (Quack 2015).
[1121] (Wilkinson 2000, 172-176).
[1122] Cf. (Quack 2015, 145–147).
[1123] (Barta 1963, 78–79).
[1124] (Roth 1993).
[1125] (Allen 2005, 20).
[1126] Posener-Kriéger – Verner – Vymazalová (2006, 242–260).

service for a deity, therefore he most probably handled the ritual equipment pertaining to the cult.

4.5.7.1.5. Private donation of temple inventory from Coptos

A fragment of a stela from Coptos is datable to Dynasty 8, probably to the reign of King Neferkauhor (Figure 4.86j). It is a list of offerings donated to the temple of Min and Thoth, presumably in Coptos, by the noble, royal son, stolist of Min Hetepkamin, unknown from other sources. I have dealt with the document elsewhere.[1127] Goedicke argued that the inventory is a document confirming social circumstances continuing from the Old Kingdom. The question is, however, whether a high official is the most appropriate person for the donation of cultic equipment. A fragment of the annals of Amenemhat II discussed below presents the ruler as the primary benefactor of cultic equipment for the veneration of important deities. The donation from Coptos testifies to different social conditions and high official is an unusual donator of the cultic equipment.

4.5.7.2. First Intermediate Period and Middle Kingdom

We can observe the use of cultic equipment in the iconographic scenes, but the material of their production is unclear, if not named. In a scene titled *wdn wdḥw,* Mentuhotep II offered six *ḥs*-vases, three slender and three more ovoid ones, in a table of a frame structure, together with necklaces stored in a box and a sceptre to an unknown deity.[1128] The same table with six vessels appeared in the offering scene of ka-house in Dendera among the offerings brought by a woman named Field (*sḫ.t*) to the enthroned king.[1129] A different table with four similar slender *ḥs*-vases and two other strange objects comes from the Abydos temple.[1130]

4.5.7.2.1. Endowments of metal vessels by Senusret I and Amenemhat II

Fragment of the Heliopolitan annals of Senusret I was a list of donations of the king to the Bau of Heliopolis, lords of the *ḥwt-ꜣꜥt*, i.e. the deities of the temple, Ra/Atum, Shu, and Tefnut (Figures 4.116, 4.118).[1131] Unfortunately, finer dating of the document in the reign of king is impossible for now. Among the artefacts were two specific heset vases and an aperet vessels, two or possibly all three (material of the first vessel is not preserved) made of arsenical copper/tin bronze in a Year x + 1 (column x+1), silver nemset vessel, three more heset vases of arsenical copper/tin bronze, four heset vases made of copper in a Year x + 3 (column x+10); and a golden heset vase in the Year x + 4 (column x + 19). Most intriguing

[1127] (Odler 2017b, 307–308).
[1128] Bussmann (2010, 182, Abb. 4.112).
[1129] Bussmann (2010, 182, Abb. 4.115).
[1130] Bussmann (2010, Abb. 4.120).
[1131] (Postel and Régen 2005, 238–239).

are two specific heset vases, as one had a top in a shape of human head, another in a shape of a falcon, interpreted by the authors of the publication as referring to Atum and Ra-Horakhty, although this is not explicitly stated in the preserved text. Such vessels were known before only from the New Kingdom iconographic sources. Moreover, such vessels were depicted in the temple of Sethi I at Abydos, serving in the purification rites, accompanied by a text with Heliopolitan allusions. Therefore, the entry in the annals might be indication of the performance of rituals, found in evidence only much later.[1132]

Quite frequent topic of the fragment of another fragmentary, annals, of Amenemhat II, is a donation of the cultic equipment to temples, and often also the material is listed (Figures 4.117, 4.118). Amenemhat II endowed a temple in a "palatial district" (*š-n-pr-ꜥꜣ*) with a statue of him and cult equipment (columns M5, M6), including a silver *ḥs.t* vase, two *gnw* stands, two *ẖꜣw* bowls, two censer arms (*ꜥ n (j)ḫt nṯr*) and two spouted jars (*ḥsmny*), all six made of copper, and two censers (*sꜣ(p)tj*) made of arsenical copper/tin bronze on copper (*ḥsmn ḥr bjꜣ*). The offerings could be used in the *pr.t-ḫrw* ritual, and their doubled counts might indicate two receivers of the ritual activity. Another metal endowment is listed in the same column, a copper *ḏbꜥ.t* seal for the king Teti.[1133]

More metal endowments were listed in the column M9; the vessels were destined to be used in the cult of several statues. They included two *ḥs.t* vases, a washing set (*jꜥj*), two censer arms (*ꜥ n ḫt nṯr*) and 1 *hn*- box for the Opening of the Mouth ritual and, as the text confirms, with complete objects for the ritual inside. All the objects were made of Asian copper. The text ends with the place of issuance of the objects: all the artefacts were brought from *pr-nswt.* Furthermore, column is ending with a *ds*-vase, i.e. "beer jar", made of Asian copper, offered for the god Montu in Armant and another one for the same deity in El-Tod.[1134]

Endowments continued in the next regnal year. An endowment for the cult that was not preserved (but it might be the cult of the statue of the king himself) in the annals consisted of an *ḥs.t* vase, an *ḥsmny* spouted vase and a censer arm (M27). In case of these objects, the issuance was instigated on a basis of a command, *wḏ*, of the king, in the words of annals *wḏ ḥm=f rḏj.t*, "command of his majesty to give".[1135]

A temple at Gebel el-Silsila, received one *ḥs.t* vase, one nemset jar, one censer arm, one *gnw*-stand and one *ẖꜣw* bowl, all made of *jwḥw*-copper (M29). The deity in question was

[1132] (Postel and Régen 2005, 242–244).
[1133] (Altenmüller 2015, 16–21).
[1134] (Altenmüller 2015, 30–34).
[1135] (Altenmüller 2015, 123–125)

probably Sebek.[1136] The vessels were once again most probably used in the *pr.t-ḫrw* offering ritual.

The temple of Amun at Karnak received a gilded wooden statue of Amenmehat II, together with a similar set of objects as the cult of Sebek. The list had been longer but was not completely preserved; an *ḫ3w* bowl was omitted in the preserved part and an *ḫnt* offering table added (M30).[1137] The temple of an unnamed deity (Seth?) venerated at the capital of nineteenth Upper Egyptian nome included also cults of Hathor and Nebthet, and received two golden *ḥs.t* vases, these copper vessels: two *gn.w* stands, two censer arms, two censer stands, two spouted jars, five *ḥs.t* vases and one situla, together with two nemset vases made of *jwḥw* copper (M31).[1138]

On the Petrie fragment, not necessarily from the same regnal years as the Farag fragment, were listed two golden Hs.t vases, the second one heading to Karnak. Arsenical copper/tin bronze nemset vase and gnw-stand was destined for the cult of Sebek in the 7th Lower Egyptian nome.[1139]

These endowment lists refer to one of the ruler's duties: to embellish and provide cultic equipment for the temples, both in the centre of the state and in the provinces (although the temples in Armant and El-Tod were close to Thebes and the god Montu was one of the most important deities in Middle Kingdom Egypt). This activity of the kings could have been institutionalised in the late Old Kingdom when an increasing presence of the royal artefacts and royal activity was documented in the provinces.[1140] The endowments in the annals could be perceived as a continuation of late Old Kingdom practice. The annals do not inform whether the temples were newly built shortly before the reign of Amenemhat II or they were the established institutions existing for a longer time and endowed on special occasions, as could be the king's sed-festival and a beginning of a new year. In this context, again, the donation of the cultic inventory from Coptos has to be interpreted as an extraordinary document of a private endowment for a temple, in light of the comparison with the numbers of the endowed objects also rather of unusually high numbers of the objects endowed to the temple.

4.5.7.2.2. Copper vessels in Middle Kingdom literature

[1136] (Altenmüller 2015, 129–131)
[1137] (Altenmüller 2015, 136–138).
[1138] (Altenmüller 2015, 138–142).
[1139] (Altenmüller 2015, 172–174).
[1140] (Bussmann 2010).

In a passage of the Dialogue of Ipuur (7.14), metal vessels were the symbols of previous high social status: “Look, the lords of copper offering vessels, / no jar is garlanded for a single one of them.” Parkinson translates *wḏḥw* as vessels, Enmarch uses the translation “offering-stands” in the referenced stela of Sarenput, while Franke translated this word as “Gefässe” but admits the possibility of translation as “Opfertisch”.[1141] The material is named as *bjꜣ*, thus copper seems to be correct translation of the material, as Enmarch decided, while Parkinson opted for bronze.[1142]

4.5.8. Uses of furniture and thrones

The use of copper in the furniture is better observable in archaeological sources, with the exception of an undoubted occurrence of copper tables in the iconography.

One specific category of furniture is very frequent in written and iconographic sources but non-existent in archaeological evidence: thrones. The Name of the Two Ladies of King Adjib of Dynasty 1 was *Mrj-pj-bjꜣ*, in one possible translation: “Beloved of the copper throne”. Wilkinson mentions this title but does not discuss it.[1143] Kahl translates this word as “beständig“, ”fest“.[1144]

In the Old Kingdom, the Pyramid Texts provide hints that at least some of the regalia of ancient Egyptian kings were made of metal. The term “metal throne” is the most frequent (Figures 4.90–4.102).[1145] The throne stood in front of the Great Ennead from Heliopolis, and the king issued judgements while seated on it. He also held a metal sceptre. According to another locus, the sceptre was in the house of *ba*. The throne was also one of the means of transport to the heavens, in the manner used by Horus on his standard, and also of transport in other contexts. The king, cleansed by natron, was carried on his throne; the ritual cleansing was needed also before seating on the throne. The king had to collect his bones, had to be “resurrected”, ritually cleansed, and then he could sit on his throne. He could eat on his throne, a foreleg from the slaughterhouse of Osiris and ribs from the slaughterhouse of Seth. He travelled on his metal throne to the north and south mounds and to the mounds of Horus and Seth. The king was cleansed on the metal throne during the morning ritual.

4.5.9. Uses of agricultural tools

The use of metal agricultural tools is highly improbable in the periods under study; the written sources can neither positively corroborate this observation nor enable us to refute it. Only in

[1141] (Franke 1994, 156, 170, x + 17-18).
[1142] (Enmarch 2008, 137; Parkinson 2009, 179).
[1143] Wilkinson (1999, 203-204).
[1144] (Kahl,Bretschneider and Kneissler 2002, 137–138).
[1145] In detail discussed by (Kuhlmann 1977).

the Teaching of Khety/Satire of Trades, the moves of the carpenter were likened to the moves of a field worker using a hoe. Moreover, a hoe is also similar to an adze blade in structure, but there is no evidence of hoes with metal blades.[1146]

4.5.10. Uses of weapons

Written and iconographic sources of the periods under study are predominantly silent about the material of which weapons were made. Inferences can be made from the comparison with material culture, and the depicted form sometimes indicates the material. Based on material culture, it seems that the number of weapons with metal blades gradually increased. The most important problem that we should bear in mind is a differing approach to the depiction of violence and the king or the royal administration’s monopoly on it in ancient Egyptian society.

In the Predynastic Period and at the beginning of the Early Dynastic, the motifs of hunting are frequent, as is information about violence against social groups both inside and outside of Egypt.[1147] Inferences concerning the material can be only made based on material culture (cf. Chapter 5).

In the latter part of the Early Dynastic Period and the Old Kingdom, violent scenes were displayed either in the royal mortuary complexes or outside of Egypt proper, on Sinai. Besides scenes in non-royal tombs, the depiction of weapons was extremely rare, although this may be caused by the poor preservation of the decoration of Old Kingdom royal mortuary temples. Only daggers were seemingly obligatory parts of the ritual attire of the kings while wearing the white crown.[1148] Dagger occurred very soon in the hieroglyphic script, as sign T8.[1149] Its name is preserved in the Old and Middle Kingdom sources in two versions, earlier *mꜣgsw* and later *bꜣgsw*.[1150] A dagger is named in the Texts of the Pyramid of Queen Neith.[1151]

Four epsilon battle axes were held by four deities in the procession of captives in the mortuary temple of Sahura and one more block fragment allegedly moved from Abusir to Giza. Other weapons were marginally present, such as a “halberd” depicted in the mortuary temple of Pepy II. In non-royal tombs, there are only two confirmed occurrences of siege scenes and one more scene of weapon making. Weapons with metal blades present in these scenes were axes and spearheads.[1152]

1146 Parkinson (2009, 275-276).
1147 (Gilbert 2004).
1148 (Petschel 2011, 67–73).
1149 (Regulski 2010, 191).
1150 (Herslund 2011, 99–100).
1151 Petschel (2011, 79).
1152 Odler (2016, 156, 207 – 210).

The more frequent inscriptional evidence consists of the titles of army officials. Ongoing discussion on the existence and permanence of the army in the Old Kingdom is beyond this work's scope. However, it is difficult to believe that state that built pyramids and other monuments and procured resources outside its borders, in territories inhabited by the Nubian, Medjay and Sinaitic people, would exist without a monopoly on violence inside the state and out. Weni's biography might offer an indication of *ad hoc* conscription of troops.

The titles inform about the organization of the troops but seldom about their arms. Only in the case of Nubians and "foreign bowmen",[1153] we can guess that they were equipped with bows and arrows, most probably with stone heads. The titles thus indicate the presence of Nubian weaponry in Old Kingdom Egypt. Old Kingdom Egyptian weaponry was stored in an institution called the armoury and it included presumably also Old Kingdom weapons with metal blades.

4.5.10.1. *Pr-ꜥḥꜣ.w* – Old Kingdom armoury

The first evidence concerning the armoury (*pr-ꜥḥꜣ.w*) is datable to Dynasty 3[1154] The following titles refer to the armoury: overseer of the arsenal/armoury; overseer of the house of weapons/arsenal; overseer of the royal documents of the arsenal/armoury(?) or, possibly, overseer of the arsenal "by royal decree" (?); overseer of the arsenal of the two houses "by royal decree" or overseer of the royal documents of the two arsenals(?); overseer of the arsenal of the royal authorisation, (or by royal authorisation/decree?); and overseer of the house of the army (? or overseer of the house and of soldiery).

Twelve overseers of the armoury and both armouries are known from the Old Kingdom, and one from the First Intermediate Period. Viziers (Senedjemib Inti, Senedjemib Mehi, Seshemnefer, Kay, Mereruka) as well as lower officials are among the holders of the title. A variant of the title, overseer of arms, occurs twice, and once again, with the same person Mesetka, in the First Intermediate Period. The title was written down using the signs for the bow, arrow, and mace head. Among the reliefs from the mortuary temple of Sahura is another title with a singular occurrence, (*j*)*r*(*y*)-*ꜥḥꜣ.w*.[1155] The weapon blades depicted are certainly not made of metal, although metal weapons must have been part of the goods stored in the armoury.

Many of the holders were connected also with work for the Treasury, *pr-nbw* and royal ornaments. Some holders are linked by other titles with the overseeing of work

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[1153] (Jones 2000, 73–76, 135). On the word *ꜥḥꜣ.w*, weaponry, see (Herslund 2011, 96–99).
[1154] (Chevereau 1987, 40–43; Eichler 1993, 207–209).
[1155] (Borchardt 1913, 87, Blatt 11).

(Ankhemka, Senedjemib Inti, Senedjemib Mehi, Seshemnefer, Kay), the Treasury (Nefer of G 2110 at Giza, Akhetankhnes) or both golden houses (Senedjemib Inti, Senedjemib Mehi, Kay). Besides prosopographical evidence, S. Desplancques cited yet unpublished text source on a storage room (*pr-ḥḏ*?) from the Dynasty 6 governors' palace at Balat where weapons and textiles were stored. It seems that this might have also been a type of armoury, but we need to wait for the final publication.[1156]

4.5.10.2. First Intermediate Period and Middle Kingdom

Military phenomena of ancient Egyptian society became expressed frequently after the end of the Old Kingdom. Full-size and model blades of axes and spearheads occurred in the burial equipment (cf. Chapter 5), an eloquent three-dimensional iconographic source of their context being a troop of Egyptian soldiers from the tomb of mayor Mesehty at Asyut.[1157] The production of arms out of copper, instead of unspoken peace purposes of the material, was mentioned in the prophecy of the sage Neferty.[1158]

Weapons started to be depicted among the burial equipment in the so-called *frises d'objets*, on coffins and in the decorated burial chambers. The weapons were either depicted freely, or standing in a rectangular appliance, probably a "rack" for deposition of weapons. Although the real-life parallels are absent, we might presume that this was a manner of the storage of weapons in practical use, standing upright in such racks. The depicted weaponry sometimes included only bows and arrows, arrowheads being presumably made from flint. Weapons with metal blades included in the object friezes are battle axes, daggers, and less often spears. Battle axes have often the form of epsilon axe blades, clearly only used as battle axes. However, also lugged axe blades occur among weapons, therefore they cannot be considered solely as working axe blades. It might be presumed that the lugged battle axes were smaller and might have been predecessors of splayed lugged axe blades, symmetrical in the late Middle Kingdom. Smaller lugged battle axe and a bigger axe from the artisan tool kit were painted on coffin EA20842.[1159] Weapons have different names than artisan tools in the language. The Middle Kingdom battle axe was named *mṯnwt* and later *mtnyt*.[1160] Daggers continued also in royal formal attire since Dynasty 11 and in Dynasty 12.[1161] Although literary

[1156] (Desplancques 2006, 215).
[1157] Borchardt (1911, 165, JdE 30968)
[1158] Parkinson (2009, 137). Only Ramesside copies of the works are preserved.
[1159] (Davies 1987, 32, Pl. 39: 5, 6).
[1160] (Davies 1987, 66–67).
[1161] Petschel (2011, 67–68).

King Merykara thought that "the words are stronger than any weapon" (9; P 32),[1162] weapons were turned against King Amenemhat I by his bodyguards and he was assassinated.[1163]

Several scenes of siege of fortresses and other scenes of personal guards of nomarchs depicted the usual weapons of Middle Kingdom infantry, battle axe, spear, and a dagger (Figure 4.119). Such scenes can be expected in the royal mortuary complexes, and this tradition continued from the Old Kingdom. But the Middle Kingdom regional elite, nomarchs, took over the local monopoly on the violence, similarly as some other former royal prerogatives.[1164] Even in the scenes of craftsmen, nomarch Khnumhotep II is brought in a carrying chair held by four men to see the work of his shipwrights, behind Khnumhotep in the chair is a fifth man, holding a shield and a battle axe, apparently a bodyguard (Figure 4.121). More examples of such personal protection are listed in Figure 4.119. In case of the battle scenes, either a siege of a fortress and a war with Asians is depicted, but from time to time, both fighting groups are Egyptians, which is sometimes interpreted as a training (Figure 4.122). One has to think about the "slain soldiers" of Deir el-Bahari Tomb MMA 507 that instead of training, it might be rendering of some more serious events.[1165] On the other hand, some Egyptian officials might have witnessed wars not only on their own territory or close to it, as demonstrates the inscription of a different Khnumhotep at Dahshur, of a conflict between Byblos and Ullaza.[1166]

The weaponry must have been always present in ancient Egypt, even though the Early Dynastic and Old Kingdom evidence is meagre. From the First Intermediate Period on, weaponry became almost indispensable part of the presentation of elite in the funerary decoration of the tombs and their coffins.

While there is evidence of overseers of different parts of the military, including foreign troops used in Egypt and on Sinai (Asians, Bedouins, bowmen, foreign mercenaries), overseers of the armoury ceased to appear in the evidence. The armoury could have become part of another institution (the Treasury?). Overseer of weaponry/weapon makers Hetepy provided an inscription at Kumma in the reign of Amenemhat III.[1167]

The use of weapons is mentioned in several *loci* in the well-known Tale of Sinuhe.[1168] In preparation for a fight with a hero from Retjenu, Sinuhe strung his bow, tried his arrows,

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[1162] Parkinson (2009, 218).
[1163] Parkinson (2009, 207).
[1164] (Doxey 2009; Willems 2014).
[1165] (Winlock 1945; Vogel 2003).
[1166] (Allen 2008).
[1167] (Hintze and Reineke 1989, 142–143, Inschrift Nr. 493, Taf. 200).
[1168] (Gardiner 1909; Koch 1990).

sharpened a dagger and polished other weapons (B127–B129). The hero of Retjenu was armed with an axe, spears/javelins and arrows and protected with a shield. Sinuhe shot him with his arrow and killed him with the hero's own axe, presumably of Middle Bronze Age South Levantine appearance (B135–B140). Noticeable are references throughout the Tale of Sinuhe to the use of archery, both by the king (B60–B61, B274) and by Sinuhe himself (besides a fight in B105). Even though archery was presumed to be a Nubian *forte*, as displayed in Mesehty's Nubians with arrows, while Egyptians fought with javelins and shields, Sinuhe provides evidence that Egyptian warriors frequently used archery as well.

A stanza in the Teaching of Khety describes a reed-maker who could have used a (metal?) knife to cut reeds for arrow-making (15).[1169] Although copper arrows occurred already in the Old Kingdom, this stanza most probably describes only the acquisition of arrow hafts from Lower Egyptian reed. The arrow-maker is "killed" by insects in the Delta. The fifteenth stanza returns to the arrow-maker. According to Parkinson, the arrow-maker had to travel abroad to gather flint for the arrowheads.[1170]

In the late Middle Kingdom and early Second Intermediate Period, the presence of foreign weaponry is clear in the eastern Delta in material culture. E.g. the word *ḫpš* for the so called "sickle sword", which originally meant both "arm, strength" and "(oxen) foreleg", must have been used already, but it is preserved only in the New Kingdom sources.[1171]

Inscribed weapons are scarcer than the tools and mirrors. The list of the examples known to the author is on Figure 4.50 and some specimens are on Figure 4.121. A late Old Kingdom exception is an inscribed spearhead of the overseer of Upper Egypt Idi, now in the Metropolitan Museum of Art (acc. no. 29.2.8). Since the object contains several titles of the person, it might be coming from the burial equipment, parallel to similar inscribed specimens, but of mirrors. An inscribed axe from Mostagedda was found in a grave of the Pan grave culture, but its shape is Egyptian, as well as the hieroglyphic inscription, naming the King Nebmaatra of Second Intermediate Period. Another unprovenanced battle axe blade is of King Djedankhra. In the late Second Intermediate Period are known inscribed daggers, one from Diospolis Parva, and the habit of the inscribing weaponry continued into Dynasty 18.[1172] In this context, it is remarkable that the weapon blades of the previous eras were almost devoid of inscriptions.

4.5.11. Uses of hardware and architectural elements

[1169] Parkinson (2009, 278).
[1170] (Parkinson 2009, 282).
[1171] (Herslund 2011, 119–121).
[1172] (Davies 1974; Petschel 2011, 109, 362, Cat. No. 17, unprovenanced with inscription Cat. No. 18).

Written or iconographic evidence on the use of hardware, small objects used to connect pieces of varied materials such as clamps or nails, is almost non-existent, in contrast to material culture. Among the objects, which are known from the written sources early, in the Old Kingdom, but they are not yet identified in the material culture, are branding "irons", *ꜣbw*.[1173]

In the Old Kingdom, pl. 45–46 of the Raneferef papyri corpus preserved a protocol of exchange between the phyles serving in a mortuary temple (Figure 4.88l). Three copper rings were located in the open court (*bjꜣ ḏbꜥ 3*) and in the entrance to the storerooms (*bjꜣ ḏbꜥ* 4).[1174] Based on the context where only wooden columns – architectural elements are listed, the copper rings might have been a reference to an architectural element of the temple.

On the papyri from the mortuary temple of Khentkaus III was mentioned an appliance *špw*, although the material was not preserved.[1175] The material was also lost in the fragment of annals of Senusret I from Heliopolis, where the appliance was named *ẖpw* and mentioned together with the door wings (column x + 15). Only in the New Kingdom sources were these artefacts mentioned as figurines, made of metals, attached to the door wings.[1176]

In the Middle Kingdom, the Teaching of King Amenemhat (*locus* 13 (M 3.3) describes a mansion with "doors of copper, bolts of bronze" in Parkinson's translation.[1177]

The Third Hymn of the Hymns to King Senusret II alludes to the king as being a fortification made of *ḥsmn* (2: 14 (lot LV.1).[1178] While this word is traditionally translated as "bronze", I have argued that the translation "arsenical copper" could be appropriate for the Middle Kingdom. The extolled characteristic of the material is its hardness, which can represent both materials.

4.5.12. Uses of regalia, statuary and boats

As statuary made of copper must have been originally the prerogative of kings, it is discussed within this subchapter together with other regalia. As ancient Egyptian, modern Egyptologists face the power of ancient Egyptian crowns in awe, not asking often practical questions, how the Red and White Crown were made and of what material. The intricate shapes of the White Crown and the Red Crown of Egypt indicate the use of metal for the production of the crowns in practice: the Red Crown was most probably made of unalloyed copper; *nwḏ.t* was most probably the term for the "wire" on the Red Crown.[1179] The makers of the regalia were

[1173] (Herslund 2011, 89–90).
[1174] (Posener-Kriéger,Verner and Vymazalová 2006, 262–264).
[1175] (Posener-Kriéger 1995, 136, 139, Pl. 28 B).
[1176] (Postel and Régen 2005, 264–265).
[1177] Parkinson (2009, 208).
[1178] (Griffith 1898, 2–3, Pl. II; Parkinson (Ed) 2004, 46–47; Collier et al. 2004, 18).
[1179] (Hannig 2003, 607).

categorized by R. Drenkhahn based on their titles: "necklace-stringers of the regalia", "overseer of the craftsmen of the regalia", "overseer of gold-workers for the regalia" and "cutters of the regalia".[1180]

In addition to royal statuary, images of the gods also needed to be produced in metals. The production of statuary is reflected in the titles of some Old Kingdom metalworkers, as making the images of deities was one of the tasks of the metalworkers.

The earliest Palermo Stone entry on metals concerns the making of a statue of King Khasekhemwy named "High is Khaskehmwy" with an exact measurement of its height: 2 cubits, 6 palms, 2.5 fingers (Figure 4.3).[1181] It is possible that other mentions of statues also concern statues made of copper core.[1182] However, a statue of Ihy made during the reign of Neferirkara was created from electrum (*ḏꜥm*).[1183]

Coptos decree G is an endowment for a statue of King Pepy Neferkara (Figure 4.33). In the eighth line of the preserved fragment of the document, the statue is described as being made of copper, coloured pastes and gold. The determinative depicted a standing statue, reminding of the only almost complete pieces of Old Kingdom copper royal statuary, the statues of Pepy I and Merenra from Hierakonpolis.[1184] The statue of Pepy II might have looked similar.

In the Middle Kingdom, statue of a deity made of copper was again mentioned, in the Teaching for King Merykara (43 (P 123): "Respect should be shown to God on His path,/made of jewels, fashioned from copper."[1185]

In the Pyramid Texts, the king's body had metal bones and metal limbs. Isis and Nephthys had metal fingers (Figures 4.90–4.102). These might be indications of existing metal images of deities (i.e. statuary) in the period.

Neferirkara had an evening and a morning barque of copper made for the sun temple Setibra in the Memphite area (Figure 4.5).[1186] The entry contains also the measure of "8 cubits", which most probably refers to the length of the barques. This information has been rarely discussed in the literature, although it mentions the making of two boats, 4 metres long, made of copper. The entry may refer to a copper sheet covering the barques made of other material. Von Bissing found a fragment of gilded wood and a copper nail near a mud-brick

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[1180] (Drenkhahn 1976, 49–51).
[1181] (Wilkinson 2000, 133-134).
[1182] Roccati (1984, 40, 41, 45).
[1183] (Wilkinson 2000, 172-176).
[1184] Shafik – Eckmann (2005).
[1185] Parkinson (2009, 226).
[1186] (Wilkinson 2000, 179-180).

barque in the sun temple of Nyuserra and thought these objects were the remains of the gilding of a mud-brick barque.[1187] The interpretation of this locus as a mention of barques made of another material covered with copper sheet is more probable than the making of solid copper boats 4 metres long.

Once again in the Pyramid Texts, the solar boat is anchored by ropes made of metal. The bow of the Sokar barque is made of metal. A path made of metal leads into the heavens. A metal door was located in the heavens.

A production of a statue of electrum in the "Gold House" of the king Pepy II was mentioned on a fragment, currently in the Egyptian Museum, Cairo.[1188] On the Petrie fragment of the annals of Amenemhat II (column P12) was mentioned opening of the mouth of two statue(ttes), one of them female figure made of ivory. In the beginning of the entry is a sign of gold, which was emended by Altenmüller as the "house of gold" (*ḥwt-nbw*).[1189] Connection of the statue production and the House of gold is plausible, moreover, similar state of affairs is confirmed for the Dynasty 13.[1190]

4.5.13. Uses of musical instruments

Some of the musical instruments in the periods under study could have been made out of metals and also copper. Their material is often unknown, as on a First Intermediate Period stela from Dendera with a sistrum.[1191]

Two pieces of copper (*bjꜣ.tj*) from the Coffin Texts were translated by Faulkner as "gongs" (Figures 4.103, 4.108). They are operated by Isis and Nephthys in Spell 24, CT I 74g, "the Two Kites, who are Isis and Nephthys, scream for you, striking for you on two gongs in the presence of the gods." It is a sound for a deity in Spell 60, CT I 248b: "The god appears within his shrine, he hears the striking for him on two gongs, protection is made for him among the gods, among the Children of Horus Protector of his Father."

4.5.14. Looting of copper

The sources offer only general information on tomb looting, and no copper is mentioned. Under normal circumstances, a grave or tomb was sealed, together with at least parts of the funerary equipment.[1192] Of course, this action could not impede the tomb robbers.

Looting of the graves was a symbol of the politically unstable times of the intermediate periods. A frequently cited *locus* from the Teaching of Merykara concerns the

[1187] (Borchardt and Bissing 1905, 53–54).
[1188] (Schott 1974).
[1189] (Altenmüller 2015, 183–186)
[1190] (Helck 1983, 25)
[1191] (Fischer 1968, Fig. 28).
[1192] (Boochs 1982, 38–39).

looting of tombs at Abydos.[1193] In the later part of the Second Intermediate Period, another case of the widespread looting targeted Upper Egypt from the Kerman Kingdom.[1194]

4.5.15. Contacts with material culture foreign to Egyptians

Textual and iconographic sources provide limited evidence on the contacts and confrontation of ancient Egyptians with material culture that was completely foreign to them. Nubian material culture is not counted in this, as the Egyptians at least inspired the production of metal objects in Nubia. Further beyond, ancient Egyptians clearly encountered artefacts and technological solutions that they themselves did not use. Old Kingdom axe blades and daggers were mentioned above.

A Middle Kingdom booty described in detail in the annals of Amenemhat II must have brought a spectrum of foreign objects to Egypt. Three columns were dedicated to the listing of the booty captured at two fortresses, *Jwꜣj* and *Jꜣsjj* (M17–M18), consisting among other things of complete tools and weapons designated as arsenical copper/tin bronze and wood: 10 axes, 33 sickle-blades, 12 daggers, 4 ¼ saws, 79 knives, 1 *ṯḥꜣ*-chisel, [1195] and 4 razors, these artefacts meant no problem for the Egyptian administrators, as they could use the words for the artefacts used also in Egypt. Then there is a lacuna in the text of missing part of the inscription, and follow other artefacts, which are sometimes described with more details, as they might have been not so well known to Egyptians: 5 "harpoons with five barbs", 45 *mšd* swords, 36 *mꜥbꜣ* harpoons, 3 balance stands, 61 "wheels"? (*ḏḥꜥꜥt*), 30 *nstjw*-spearheads and 26 *nstjt*-spearheads,[1196] 1 copper *sk*-spear, made of copper with wood, 3 golden "armlets",[1197] and 38 other pieces of jewellery. 646 deben of scrap copper and 125 deben of new copper were seized as well.[1198] Figure 4.29 shows the quantity of the booty captured in the two fortresses in the form of finished tools and weapons. Smaller artefacts are more numerous, and some of the types did not occur in Middle Kingdom material culture.

Some metal artefacts were included also in the load of expedition coming to Egypt from Lebanon: gold and silver seals of the Asians (*ḫtm n ꜥꜣm*) (M19), 2 mirrors and 16 daggers made of arsenical copper/tin bronze, gold and ivory, and 21 daggers made of arsenical copper/tin bronze and ivory (column M20).[1199] Figure 4.28 displays the artefacts brought from Lebanon; we can see that these were only complementary gifts to the bulk of the

[1193] (Parkinson 2009, 221–222).
[1194] (Török 2009, 109–110).
[1195] According to (Willems 2017, 475) this translation is doubtful.
[1196] A reading *nsꜣ* was proposed by Eder, cited by (Willems 2017, 475–476). Nsw.t is mentioned in the story of Sinuhe, translated as spear/javelin, cf. (Herslund 2011, 112).
[1197] (Willems 2017, 476) proposed different, but acceptable, reading "three debens of gold".
[1198] Detailed list in (Altenmüller 2015, 67–82).
[1199] (Altenmüller 2015, 88–93).

debens imported into Egypt. It is interesting to note and observe that ancient Egypt received a steady flow of imported ore materials and finished artefacts from the Near East, yet they are mostly not preserved in the archaeological record. They might have been either remelted or changed and reused in different social contexts.

The leaders of the Asians were depicted with axes on their shoulders on three stelae from the reign of Amenemhat III. They rode donkeys, in two cases with striped kilts. These two more detailed sources also depict spears of two men in the chieftains’ retinue. It is a depiction of a foreign weapon by an ancient Egyptian artist: the axe has a curved haft and an indistinct blade; the spears are straight with leaf-shaped blades.[1200] Spears were depicted in the procession of Asians as their weapons in the tomb of Khnumhotep II at Beni Hasan (Figure 4.120).

[1200] (Tallet 2018, 40).

5. Archaeological sources: material culture

Archaeological sources were defined in the Introduction and Chapter 1 as preserved material culture, i.e. the artefacts. This chapter discusses their categories, arranged on the basis of *chaîne opératoire*, and in the diachronic order. Since the author had already published several outputs on the topic (as discussed in subchapter 1.8), this chapter focuses on the topics outstanding from the previous work. This includes initial steps of the *chaîne opératoire*. In case of artefacts themselves, typology is mostly left out[1201] and the chapter focuses on the census of available sources, i.e. total counts of the existing artefacts, which were made of copper ore or processed copper, in broad sense. It is c. 2,100 archaeological contexts from the periods under study in the database, which were extracted for the total counts. This census aims at a description of the available sources. It must be stressed that this number is likely the minimal count and there might be contexts either unpublished or unknown to author in the museum collections around the world and from the recent excavations. Information on the completeness and measurements was either extracted from the literature or documented by the author. The measurements, including weights, are then statistically evaluated by the method of kernel density estimates,[1202] with a specific aim to corroborate or refute the hypothesis of the controlled production of the artefacts. Broad time scale of the periods under study enables us to study the trends and changes spanning Egypt and Nubia.

The material culture is treated in this chapter as a historical source of "serial" nature. Single object is usually a minor witness of history, but if they can be studied in repetitions, preferably from documented archaeological contexts, objects become evidence of the intentional past behaviour. Copper objects were produced to fulfil practical roles in the society, and they were required to have certain form and properties. Even if the social context of the objects can be only roughly assessed on the basis of the written, iconographic sources and the practical properties of the artefacts, it can be reconstructed. Artefacts were produced with certain mental templates in mind and they have similar forms. Change in time of their forms and properties can be observed and explanation of such change must be at least attempted. If an object is unique, comparison to the serially and repeatedly preserved artefacts establishes this uniqueness, one cannot be defined without the other.

Looking on the regional distribution of the 2,253 contexts (Figure 5.1), almost one fifth is concentrated in Memphite region. Significant is also presence of the contexts from sites between Asiut and Abydos, where were excavated burial assemblages by British and

[1201] The typological definitions, based on the semiotic triangle of meaning, were published (Odler 2016).
[1202] (Baxter 2003, 29–37).

American archaeologists. Well represented are Abydos, Delta, and Nubia with c. 10% of contexts each. Rather surprising is low number of contexts from Theban area, where many tomb contexts are until now unpublished. If we split the regions into the general periods (Figure 5.2), most apparent trend is the regionalization, apparent in the Predynastic and diminishing in the Early Dynastic Period, to reach the lowest point during the Old Kingdom. The peak of the regional distribution of the archaeological contexts is in the Middle Kingdom. Expected is the prevalence of some regions in certain periods, as Abydos in the Early Dynastic and Memphite region in the Old Kingdom.

5.1. Procurement, initial processing and transport of ore

The presence of the ancient Egyptians in Eastern and Western desert, on Sinai and in Nubia, can be verified on the basis of the archaeological finds, mostly finds of ceramic vessels' fragments, besides the traditionally used expedition inscriptions (Figures 5.3, 5.4). Egyptologists are used to deal with the historical sources that have historical dating, to a particular reign of the king and sometimes to a particular month or even a day. The dating of the archaeological evidence, such as pottery, is of interval nature, enabling to inform us about broader chronological unit, i.e. particular dynasty/period, but not in a detail typical for the written sources. Nevertheless, this approach of different character of dating does not justify ignoring of the archaeological evidence. Written sources are only part of the evidence, not the complete evidence, as it is often treated in Egyptological literature.

General model supposes existence of several steps of *chaîne opératoire*, but particular information from the sites might be different. First phase of the process of ore extraction was crushing of the ore into smaller pieces and fragments and smelting of the product in the crucibles. Charcoal was used as the fuel and tuyeres with reed blowing pipes were used to provide oxygen. Although simpler smelting of the oxide copper ores was supposed to be earlier than the processing of sulphidic ores, requiring more steps, it can be demonstrated that very soon ancient Egyptians were rather early smelting also sulphidic ores.

Smelted metal was either crushed again and refined or poured into moulds/sand with hollow space shaped to the desired (semi-)product. It was supposed that generally, first smelting of the ore is more economical close to the ore deposits.[1203] In fact, there are locations in the time and space, where this premise was not working[1204] Melted metal was then worked with hammerstones. Moulded object could serve as a semi-product for the final production of

[1203] This premise is used for the mining of all metals important in the economics of ancient and modern states (Anfinset 2010, 118).
[1204] As was proven in the Chalcolithic Southern Levant (Anfinset 2010, 118–119).

a tool or a metal sheet used for further working. After the smithing, also the phase of annealing could be used for the hardening of the structure of metal, when the metal is heated and then quickly cooled several times. This technology changes the internal structure of the metals.

Transport of the ore over long distances supposed the use of domesticated animals for the moving of heavy loads, especially donkeys. Domestication of donkey can be counted among the major advancements, enabling further increase of complexity of ancient Egypt. Donkey is able to carry 75–100 kgs[1205] of load and can have working life up to 15 years. It copes well with the dry climate and difficult terrain.[1206] The evidence of donkeys in Egyptian contexts can be dated from fourth millennium BC, from el-Omari and Maadi, a burial of this animal was found at Hierakonpolis. A frieze of donkeys was depicted on so called Libyan palette, among the supposed booty from Libya. Early Dynastic burials of donkeys were found at Abusir, Abydos, and Tarkhan.[1207] Skeletons of Dynasty 1 donkeys from Abydos were close to North African wild asses, however, they already served as transport animals.[1208] Thus, already from the fourth millennium BC were donkeys most probably used to transport heavy loads from around Egypt.

The domestication of donkey, together with the advances in the watercraft technology, enabled ancient Egypt to provide sources for the increasing demands of the state and its actors, beginning with the ruler on the top of social "pyramid".[1209]

Preconditions for the expeditions must have existed in the fourth millennium BC. The overview of the mining and smelting sites must be started in Eastern desert, with the oldest evidence of the mining and smelting activity datable to this period. Moreover, Eastern desert is an example of important cluster of sites, in some areas without large corpus of inscriptional evidence, and datable only by ceramics.

5.1.1. Badarian

Human presence in Eastern Desert is datable already to Middle and Lower Palaeolithic,[1210] and there is also evidence of Pre-pottery Neolithic B in Wadi Arabah.[1211] Badarian sites are also known from the Eastern Desert and we can speculate that their presence was also due to the collection and probably mining of minerals.

1205 *Contra* (Nieto 2014, 58), assuming only light loading of donkeys, with "small pieces of turquoise".
1206 (Shai et al. 2016, 16).
1207 (Mitchell 2018, 40–49).
1208 (Rossel et al. 2008).
1209 As described e.g. for Early Dynastic period by (Köhler 2008).
1210 (Bomann and Young 1994; Mercier et al. 1999).
1211 (Tristant 2012).

Local origin of the production was supposed for the Badarian copper artefacts.[1212] Krzyzaniak and Anderson opt for Sinai or Eastern Desert as the origin of malachite;[1213] Midant-Reynes for Sinai, also for turquoise and steatite, via Red Sea trade route [1214] Needler for Eastern Desert.[1215] The presence of Badarian sites in the Eastern Desert would indicate this place of origin for copper. The sites are located to the north of Wadi Hammamat, in Wadi Atulla and Sodmain Cave.[1216] Badarian and Amratian settlement in the region Lakeita of Eastern Desert provided raw fragments of copper and slag.[1217] Moreover, Badarian is also present in Dakhla and Kharga in Western desert, being evidence of the possible movement of Badarians into desert.

5.1.2. Naqada culture, Early Dynastic period, and Old Kingdom

Mining and ore processing sites on the Sinai Peninsula and in the Eastern desert, datable by pottery to the late Predynastic and Early Dynastic period, show that these activities were more frequent than the textual evidence shows and not always the text sources on such activities were preserved.

5.1.2.1. Eastern Desert

Several areas must be distinguished in the Eastern desert. Ports on the Red Sea coast, for now the oldest known at Wadi el-Jarf and its Old and Middle Kingdom successor Ayn Soukhna were points of departure for Sinai Peninsula. Therefore, also raw materials (copper) occurring on these sites need to come from Sinai. As other group must be perceived mining sites for copper and gold inland in the Eastern desert, some of them also bearing evidence of copper processing.

Fascinating insight into the logistics of the Old Kingdom is provided by the site structure at Red Sea. The earliest known Egyptian port has been founded in the reign of Khufu at Wadi el-Jarf. Earliest occupation phase was a light structure, the aim was most probably to survey the area and examine the resources available on the spot. In the second phase, complex infrastructure of the port was built, with underwater pier; storage building and living quarter at the coast, in the so called Zone 6; barracks for workers on the halfway to the galleries, on a remote place in a distance of ca. 5 km from a seashore, but suitable for hewing the galleries. Building 1 in Zone 6 (20 × 15–12.25 m) had four rooms with identical size for

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[1212] Some authors assumed local origin of the copper processing in Upper Egypt: (Trigger 1983, 29–30) and (Vercoutter 1992, 131) argued against “Asian“ origin of the metallurgy. (Golden 2002, 234) supposed that there were at least two “markets“ in that time.
[1213] (Anderson 1992, 61).
[1214] (Midant-Reynes 2000b, 155, 160–161).
[1215] (Needler 1984, 21).
[1216] (Math 2007, Abb. 1).
[1217] Described by Debono, cited according to (Midant-Reynes 2000b, 162–163).

storage (each with floor area of about 35–36 m^2) and one longer room, controlling access to the storage space. Could this be a space destined to be used for the storage of copper coming from Sinai? Barracks for the workers have 13 long rooms in a structure built from local limestone boulders and with assumed light roofing (60 × 30 m). Sealings preserved at the settlement are from the reign of Khufu, thus dating the occupation of the site. Some of them even name the pyramid of Khufu and authors assume that this was the final destination of the goods transported from Sinai through this site. Metals are absent from the material culture in the Zone 6 buildings and workers' barracks,[1218] preserved tools were made of stone. Built structures have close analogies in the features excavated at Dahshur and securely dated to the reign of Snofru, the specialists for the organization of work thus used the engineering and architectural knowledge of the previous reign. This indicates continuity of the people working on the royal projects.

At the end of the reign of Khufu, the structures were cleaned, closed, intentionally abandoned, and then covered by wind-blown sand. In the area of barracks, short temporary reoccupation is datable to the reign of Khafra. Main focus was transferred far north to the area of Ayn Soukhna. Its disadvantage was bigger distance to the copper and turquoise mines on Sinai, its advantage was shorter distance to the capital Memphis. From Soukhna, almost all Old Kingdom rulers are attested by inscriptional evidence and longevity of use confirms its more suitable position for ancient Egyptians than Wadi el-Jarf. While for both port sites a connection to the copper procurement is presumed, unequivocal archaeological evidence is in the Old Kingdom meagre.

In the inland Eastern desert, several clusters of sites bear traces of the mining of the oxidic and sulphidic copper ores. If the archaeological research was detailed enough, temporary presence at a site was usually replaced by more permanent structures in the promising areas. Since some of these sites are rather unknown in the literature, we will describe in detail at least selection of them. The northernmost cluster is in Egyptian Wadi Arabah. Three Old Kingdom mining sites have been discovered at Kasr Girgis. WAN001 comprises three rectangular buildings made of stone with regular ground plan of galleries (25–27×17–20 m). Pottery from the structures dates them to Dynasty 4. The buildings are c. 100 metres from galleries, where malachite was mined. Another cluster of similar buildings is to the north-east of this site (WAN002), datable to the roughly same period. Eight kilometres to the north, at the foothills of Galala North, is a site in Wadi Abu el-Maysa/Wadi Bikheit

[1218] Tallet – Marouard (2016, 153).

with unstratified finds of Old Kingdom pottery, but stronger presence of Middle Kingdom. Although Y. Tristant assumes short-lived presence of the Old Kingdom Egyptians, the structures are similar to Wadi el-Jarf, with the aim of temporary repeated visits, at least from a single reign (Khufu?).[1219]

Joint Egyptian and French geological and archaeological surveys discovered three clusters of sites in the wadis of Eastern desert, in the area west of Gebel Zeit with galena mines. They were named according to their respective wadis, northern cluster as Wadi Dara, western as Wadi Um Balad, and southern as el-Urf/Mongul South.[1220] While in both areas was mined copper ore, only at Wadi Dara are also installations for the crushing of ore and furnaces. Archaeological remains thus reveal a hierarchy of the sites. R. and D. Klemm tried to argue for the local Bedouin exploitation of gold in the early periods before the New Kingdom, which would encompass also copper mining sites. Both settlements and Egyptian pottery is, however, evidence of the active participation, if not exclusive, of ancient Egyptians in the ore procurement in Eastern Desert.[1221]

Northern concentration of sites at Wadi Dara consists of eight habitation sites from the Early Dynastic period and Old Kingdom, with stone-built huts, areas for the crushing of ore and furnaces. The site was explored in the years 1989–1996.[1222] Huts were built from dry stone masonry (Early Dynastic or early Old Kingdom, Site 5E and 5D). An excavated hut 5D had two rooms, which were used for the habitation with work and storage respectively. Fragments of malachite have been found in the working room. The huts are interpreted as first temporary settlement of the site, with an aim to survey the location.[1223] After this initial settlement, camps were built to secure large scale work here. Since the sites were published in detail and they do provide detailed evidence of the ore processing, they need to be described in detail.

A camp, dated to the late IIIB phase of Naqada culture and early Dynasty 1 (Site 5A, 24×18 m), had three habitation units with 15 rooms, some of them with kilns and fireplaces. Two storage jars have been found, one probably filled with grain, another with 8 kgs of mineralized and crushed rock with hematite. Besides pottery, stone tools were found

[1219] (Tristant 2012).
[1220] (Tawab et al. 1990; Castel et al. 1992).
[1221] (Klemm and Klemm 2013, 3–8).
[1222] Final excavation report of the excavations has not yet been published. However, series of detailed preliminary reports is available, sometimes with contradictory information (that will be hopefully cleared by the final publication): (Tawab et al. 1990; Castel et al. 1992, 1995; Grimal 1993, 423–434, 1996, 571–572; Leclant and Clerc 1997, 327; Castel and Pouit 1997).
[1223] (Grimal 1993, 483).

(hammers, pounders, silex blades), animal bones, charcoal, ash, shells and ore fragments. Absence of slag on the site was noted.

Camp 3 B was excavated thoroughly in the years 1991–1993, with Early Dynastic mines at the site and early Dynasty 4 camp.[1224] It is situated on left bank of wadi, on a terrace. At the Camp 3 B (40 × 10–18 m) was a habitation area with rooms built of dry masonry (altogether 40) and fireplaces. Habitation rooms have been found to be located at the hills, with smaller measurements (1.8–2.6 m), while metallurgical rooms were closer to wadi. Initially, five rooms were explored, four rooms for habitation; a rectangular box for tools has been constructed in largest Room D with stone picks and hammers; in the opposite corner was U-shaped furnace for ore reduction. To the south of the buildings was area with charcoal, ash, slag and malachite fragments. Later on, 16 rooms were excavated, seven for the slag crushing, four for the fusion of the copper in furnaces, two for diverse purposes and six were mostly for storage. Slag crushing was done with granodiorite polygonal paddles (of two types, big in the centre of rooms and small at the side) and spherical anvils. Reduction furnaces were of diverse size types (big, medium and small), with three types of slags. Storage rooms were significantly smaller (2×3 metres). Finally, the rest of settlement was excavated, together with batteries of wind-powered furnaces, of one or several batteries for each camp. Six batteries were found with altogether 30 furnaces for whole site. In case of Camp 3B, furnaces were north of the location.

The *chaîne opératoire* comprised three phases, with wind-powered copper reduction furnaces on hills, smelting ore (with addition of hematite?), and producing slag with copper prills.[1225] The furnaces were located towards north, to the prevailing direction of winds. The furnaces were built of granodiorite slabs lining the furnace, with U-shaped ground plan and floor. As a rule, covering and frontal side of the furnaces were not preserved. Inside of the furnaces was lined with clay, straw and probably also silica, on the vitrified lining were preserved fragments of slag, malachite and even copper. Debris contained also fragments of crucibles (altogether only one reconstructed and two fragments), ash and vitrified clay.

The resulting slag, containing prills of copper, was crushed and processed again in the furnaces at the camp, together with hematite.[1226] The smelting furnaces were made of stones, built at the walls of rooms, and of three types, small, medium and big.[1227] Small and medium

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[1224] In the later report, Camp 3B is dated to Dynasty 1 (Grimal 1996, 571–572).
[1225] (Grimal 1994, 429–430).
[1226] While Grimal (1993, 485–486) lists hematite as used in the second phase, later report by Castel et al. (1995) mentions hematite in connection with wind-powered furnaces.
[1227] Grimal (1993, 485–486).

furnaces were sunken into the floor, big furnace was partially sunken. The bottom of furnaces was inclining to make easier the movement of melted copper. Slag, charcoal and vitrified pottery was around the furnaces. The slag was of three types: black magnetic slag with a few prills of copper and bits of non-reduced malachite; massive black slags with bubbles and lighter than the first type and vitrified fragments of crucibles. Reeds were used to provide oxygen to the furnaces, although no fragments of tuyeres have been found.

Another concentration of sites was documented at Wadi Um Balad.[1228] Four groups of settlements with c. 100 rooms were located in Zone 2. Pottery dated the habitation to the Naqada III, Dynasty 1 and Dynasty 4, although some Naqada III buildings were already standing on mining debris – thus there was also an older phase of use, without pottery. Chalcopyrite, sulphidic copper ore, was mined through galleries. Tools used were made of diorite. In Zone 3 was located a battery of furnaces. However, the excavators presume that most of the ore was not processed on spot but must have been transported to Egypt proper. Several other zones (4–7) had traces of mining, in Zone 1 was located Early Arabic mining district.

Southern site cluster of el-Urf/Mongul South is a concentration of sites around north-south running Wadi Makhrag El Ebel. 15 small habitation sites with stone-built huts and some temporary camps have been dated to the end of Predynastic Period, Early Dynastic Period and Old Kingdom on the basis of pottery (bowls and jars, in the Old Kingdom red carinated vessels of early Dynasty 4 dating[1229]). Mining galleries are not longer than 50 m, not wider than 12 m and not higher than 1 m. Heavy gabbro-diorite hammers with wooden hafts have been used for mining (published specimen has 35×16 cm and weight ca. 15 kg).[1230]

The number of sites with copper mining was enriched further by the Egyptian-German archaeological survey project, confirming earlier work further south. Site Wadi Semna I is datable to the end of Predynastic period and Dynasty 1, sites Wadi Semna II and III to the Old Kingdom.[1231] Other cluster of sites was found by British mission, Wadi Abu Had.

5.1.2.2. Nubia

According to the archaeological report, 578 storage pits were discovered in the entrance to gold- and copper-bearing region of Wadi Allaqi, 74 of them contained ceramics datable to the Naqada phase IID2 to IIIA1. No other traces of processing any material were found and thus

[1228] (Castel et al. 1998).
[1229] K. Arias Kytnarová (pers. comm.).
[1230] Copper ore mining was resumed at the site in the Roman Period. Complex structures have been preserved only from the Arab Period, focused on the occurrence of gold, yet the yield of gold was not high and the particles of gold are not visible by bare eye, and it is possible that they were not noticed by the early prospectors.
[1231] (Abdel-Motelib et al. 2012).

the purpose of the situation is not clear, but it might be probably connected to the presence of ores, far up the Nile in Nubia.[1232]

Recent analysis of the Nubian pottery at the settlement of Elephantine demonstrates the contrary, continuing presence of Nubian material culture in the Egyptian contexts, even in the periods of "hiatus".[1233] Thus this hiatus is being doubted from Elephantine, as well as from the analysis of early C-Group.[1234]

Archaeological knowledge of the Old Kingdom Nubia is limited and most of the sites are now under water of Aswan dam. The best known site is Buhen, an Old Kingdom town, settled on the basis of sealings during the Dynasties 4 and 5, from the reigns of Khafra to Nyuserra.[1235] In addition, heaps of copper smelting slag with estimated weight of about 200 tonnes was reported from the vicinity of Kubban fortress, but without any dating.[1236]

Buhen has entered the literature as copper processing site, on the basis of claims made W. B. Emery in the preliminary reports on the site.[1237] However, the interpretation must be fundamentally modified after the final publication of the documentation by D. O'Connor. [1238] The discussion herein is longer, as it must be explained that Buhen is not a copper "factory", being the first published assumption of Emery. The Old Kingdom town had approximate area of c. 1.24 ha and is smaller than better known settlements from the periods under study.[1239] Although Emery assumed Early Dynastic phase at the site, O'Connor is convinced that the settlement was found in the Dynasty 4, around the reign of Khafra and abandoned in Dynasty 5, around the reign of Nyuserra.[1240] Only sherds of A-Group and a fragment of Naqada III vessel might be indication of earlier inhabitation of this area.[1241]

Buhen town had two main phases, one set in the Dynasty 4 and another starting in early Dynasty 5, in the reigns of Sahura and Neferirkara. Between these phases, at least some of the parts of the town were laid barren and covered with sand. This might indicate continual re-occupation of the side in the mentioned periods. The town contained administrative centre, storage facilities, cultic building, and production area in the Block XII.

1232 (Piotrovski 1967; Kopp 2006, 84).
1233 (Raue 2019).
1234 (Glück 2005, 2010, 2018).
1235 Other sites with alleged documented presence of Old Kingdom pottery in Nubia are Aniba, Kubban and Ikkur (Vogel 2004, 35–38).
1236 El-Gayar and Jones (1989, 38, Fig. 4).
1237 The site is missing from the monograph on early Egyptian urbanism by N. Moeller (2015).
1238 Emery (1963); O'Connor (2014), see also review by Knoblauch (2016).
1239 O'Connor (2014, 17, Fig. 1.5).
1240 O'Connor (2014, 34, 323–325).
1241 Nubian pottery: O'Connor (2014, 34, 289–322) and Naqada III sherd on p. 310, Fig. 10.3. But see remarks in (Knoblauch 2016).

Copper ore occurred extensively in Blocks XIII, probably Block XII, and possibly also in Block V.[1242] Series of long rectangular rooms (size of incomplete rooms 5.10×1.22 m), Block XII, Rooms 2–12 with occurrence of grindstones, was interpreted by Emery and Mills as the remains of workshop for grinding ore, but this possibility is doubted by O'Connor. Contrary to the information provided by Emery in preliminary report (of the occurrence of ore, crucibles, etc.), only the grindstones were reported here in the field documentation. The ore might be associated with above located Block XIII.[1243] The alignment of the structures resemble other comb-like ground plans of Old Kingdom buildings, some with clear production purpose. Yet the finds are not conclusive and other analyses are impossible. Concentration of ore over the Block V is only assumed by O'Connor based on Emery's remarks and does not have a connection with the assumed cultic function of Block V building.[1244]

Block XIII postdates Block XII and it is assumed to be from the second phase of the settlement.[1245] The features of the block were much eroded and it was not attempted to reconstruct the ground plan. Many pieces of copper ore were recorded in the field documentation, but there was significant lack of other finds, only with some ceramic fragments of rough and red ware.

Three pyrotechnological installations, so called Furnaces A to C, have been located to the south-east of Terrace 1 and were built relatively late in the town. They were originally interpreted by Emery as copper smelting furnaces. Revision of the field documentation, together with existing analogies, enable the definitive interpretation of the installations as pottery kilns.[1246] Only near Furnace B was documented occurrence of "fragments of melted copper slag", but in no clear association with the furnace.[1247] Coeval copper smelting furnaces had different construction, as the specimens excavated in Eastern Desert and on Sinai demonstrate.

Ceramic fragments, described in the field documentation and by Emery as crucibles and crucibles fragments, named as Type 4 of the corpus, are in fact regular Old Kingdom bread moulds.[1248] Thus they have to be interpreted as such. The only known possible

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1242 O'Connor (2014, 134–136).
1243 O'Connor (2014, 131–138).
1244 O'Connor (2014, 134).
1245 O'Connor (2014, 156–158).
1246 Already (Nicholson 1993, 108–109) with earlier references, also Knoblauch (2016). D. O'Connor (2014, 220) left the decision to "experts on the topic".
1247 O'Connor (2014, 217).
1248 O'Connor (2014, 226–228, Pls. 38: 4; 64).

exception is a bread mould fragment UC20064, with green stains of copper.[1249] Even in this case, copper stains are on unexpected place, on the outside of the vessel side. This is an analogy of a situation uncovered at Giza, workshop D17x (see below).

Overall, Emery's reports created an impression of the industrial scale of copper processing at the site. The actual evidence, presented by D. O'Connor, is much more modest. He proposed that the main metal processed here was gold, although there is no direct evidence for this.[1250] Traces of metallurgical activity refer rather to processing of copper, with copper ore in quartz, bread mould with a copper stain, moulds for semi-products and pounders. The metal processing took place probably in the second phase of the settlement, in the Dynasty 5. Gold might have been involved as well, as Klemm and Klemm identified the *modus operandi* of third millennium BC Egyptian prospectors, looking for associations of quartz with malachite, and frequently also gold.[1251] And, although some finds connected to the metal processing, were in the vicinity of the kilns, these were kilns used for the production of pottery, probably located in the area with other craft activities. The kilns were located to the south-east of settlement, traditionally because of the prevalent winds that would in this case blow the fumes away from the town.[1252]

Surveys in Nubian Desert by R. and D. Klemms added to the map of Nubia possible mining sites of copper ore and gold.[1253] The sites were dated on the basis of occurrence of stone tools, used for the procurement of the ore. The dating is not as fine as it would be with pottery or sealings and seal impressions, but this evidence cannot be ignored. Among the identified sites is one malachite mine, four other sites were rather used for procurement of gold.[1254] Settlement with about 15 huts nearby a malachite mine was identified on site Umm Fahm 1 and Klemms slightly favour Old Kingdom dating of the remains. These sites are candidates for the origin of ore processed at the Old Kingdom town Buhen or at Middle Kingdom Nubian fortresses. Only archaeometric analyses would prove or disprove the connections.

5.1.2.3. Sinai

[1249] Now in the Petrie Museum UCL, with a photograph accessible in the online collection.
[1250] O'Connor (2014, 336–337).
[1251] Klemm and Klemm(2012).
[1252] (Eaton 2013).
[1253] Klemm and Klemm (2012).
[1254] Extensive remains of Old/Middle Kingdom, or possibly Kerman, gold mining are known from gold mine Duweishat, Site 2; three shafts and pounders of Old or Middle Kingdom date have been found on the gold mine site Sokar. Large Early Dynastic two-hand pounders occurred on gold mine site Marahig (also Marahib), much eroded grooved stone axe of possible Old Kingdom date is from gold mine Abu Siha.

Archaeological evidence from Sinai is published predominantly in the form of preliminary reports, therefore the information available will be hopefully richer in near future.[1255] Predynastic smelting was claimed to be found at Bir Nasib area, but it is impossible now to independently check the dating of the site. Site 702B has been discovered in Wadi Ahmar west, at Bir Nasib, with remains of two settlement and smelting phases, the earlier from the Predynastic Period (in article as 5th millennium BC, but this is most probably a typographical error and fourth millennium BC should be correct) and the later from the Old Kingdom.[1256] Stone settlement in Wadi Maghara is not datable clearly, but it has to be either from the Old or Middle Kingdom. A single copper chisel was the only metal find here.[1257]

The part of the transport network could be the fort on the site Tell Ras Budran.[1258] Due to the results of Wadi el-Jarf excavations, the role of the fort at Tell Ras Budran was reinterpreted.[1259] The site had ideal position on the el-Markha plain, as the landing spot close to the mining areas on Sinai.[1260] The site was dated by Tallet and Marouard in the reign of Khufu and the phases of occupation at fortress can be connected to the inhabitation phases at the port of Wadi el-Jarf. Pottery production present at the fort was undoubtedly produced at Wadi el-Jarf and used on the opposing shore of Red Sea. The only difference is that copper droplets were occurring throughout the deposits at Tell Ras Budran, while nothing like this is mentioned from Wadi el-Jarf.

Based on current knowledge, Old Kingdom Egyptians used without doubt the copper sources of Sinai. Old Kingdom smelting furnaces have been identified at Bir Nasb[1261] and another mining site at Wadi Kharig.[1262] Site Seh Nasb of Dynasty 5 contains on a length of almost a kilometre 27 batteries of copper smelting furnaces with c. 3,000 units.[1263] In Wadi Kharig was built a settlement and this is the context of the rock inscription of Sahura, as it is well visible from the village.[1264] Even from the preliminary reports, strong presence of Dynasty 5 on Sinai is remarkable.

Greater part of the Sinai Peninsula was probably never visited by ancient Egyptians and the Early Bronze Age local inhabitants were living there, named by Egyptians as

[1255] After the publication of sites surveyed by IFAO.
[1256] (el-Gayar and Rothenberg 1995).
[1257] (Chartier-Raymond 1988, 21).
[1258] (Mumford – Parcak 2003; Mumford 2006).
[1259] (Tallet and Marouard 2016).
[1260] More reasons are listed in Tallet and Marouard (2016, 169).
[1261] (Tallet 2009, 622-623).
[1262] (Abdel-Motelib et al. 2012).
[1263] Published only as preliminary information: Tallet (2018, 5).
[1264] (Chartier-Raymond et al. 1994, 41).

"Bowmen". Site Ayn Fogeya was perhaps destroyed in the Dynasty 1 and malachite from here brought into Egypt. Complicated relations to the local inhabitants continued and official Egyptian sources stressed the war-like nature of the kings and expeditions. Reality could have been different and local inhabitants might have helped in the mining operations, and they might exchanged materials inaccessible for Egyptians from other parts of Sinai. The most important candidate is a site Wadi Tar, located too far from the Egyptian presence, near the southern tip of peninsula, of its south-east coast, with no ancient Egyptian material culture was reported from the site. Yet it is the only known occurrence of ores of copper with arsenic on the whole Sinai. The Early Bronze Age sites between Egyptian mining regions and Wadi Tar were excavated and published by the Ophir expedition. The metalwork of the local Sinaitic populations was different from the Egyptian material culture and was analysed by K. Pfeiffer.[1265]

5.1.3. Wadi Arabah

Another presumed source of the Old Kingdom copper, Wadi Arabah, is now located in Israel and Jordan. Although Timna (now Israel) was expected to be used from the 4th Millennium BC to the end of Old Kingdom in the earlier publications, this view is being corrected.[1266] There was also Early Bronze Age mining in Timna, but only to a limited extent.[1267] In the vicinity of Timna is another complex of sites, named Wadi Amram, which might have been exploited from the fourth millennium BC.[1268]

Finds of the ceramic moulds at the site Tell Hujayrat al-Ghuzlan near Aqaba (Jordan) are similar in the shape and dimensions to the two ingots found at Maadi. Copper processing is here dated to the period of 3700/3650–3550 BC. There are differences in the types of axes and daggers in Egypt and Levant, thus the only material distributed were the ingots.[1269] Except of a single copper prill from Tell el-Farkha there is no evidence about copper metallurgy in the predynastic Delta.

Some authors think that Feynan in Jordanian part of Wadi Arabah was principal source of Old Kingdom copper ore.[1270] A site from Early Bronze Age III and IV, Khirbet Hamra Ifdan, is supposed to be the main supply source for the Egyptian state.[1271] The chronological position of Khirbet Hamra Ifdan is determined on the basis of only six

[1265] (Beit-Arieh 2003; Pfeiffer 2013).
[1266] Ogden (2000, 150).
[1267] E. Ben-Yosef (Tel Aviv University), pers. comm.
[1268] (Rothenberg 1999).
[1269] Klimscha (2011, 198–199).
[1270] (Abdel-Motelib et al. 2012; Bárta 2011, 266; Ben-Yosef et al. 2016).
[1271] (Levy et al. 2002, Hauptmann et al. 2015).

radiocarbon samples.[1272] Lead isotopes showed that the ore from Feynan was transported in the form of ingots to the sites in Central Negev Highlands.[1273] A specific shape of the ingots was a bar with crescent-shaped protuberation. This type of ingot has been not yet found in 3rd Millennium BC Egypt, at least to my knowledge.[1274] Trace element analyses and lead isotopes have proven that ingots from Har Yeroham in Negev and from Hebron Hills were made of the copper coming from Feynan.[1275] So called "axe-blades" were similar to a shape of Old Kingdom necked adze blades, most frequently of the D1 variant, but they are typologically not the same objects.[1276] Currently available evidence does not support direct connection between Feynan and Egypt and Old Kingdom copper supply from Wadi Arabah.

Recent development in the ^{14}C dating of the sites in Levant poses serious questions about the coexistence of the sites of Early Bronze Age III and IV and Ancient Egyptian Dynasties 5 and 6. Transition of EBA III and IV is now dated to around 2500 BC. This new chronology was recently confirmed also at EBA Megiddo.[1277] New development shifts the context of copper exchange network as imagined by M. Haiman.[1278]

5.1.4. Saudi Arabia

Unsuspected early sources might be soon included among the regional providers of copper. A mission of Austrian archaeologists is excavating a site Qurayyah, inland, but in the vicinity of the gulf of Aqaba, with a complex system of irrigation in a densely populated oasis. The site is datable to the 22nd-20th centuries calBC and an arsenical copper workshop was identified here.[1279]

5.1.5. Middle Kingdom

5.1.5.1. Eastern Desert

Generally, Middle Kingdom presence in the Eastern desert is less frequent that in the Old Kingdom, on copper mining and processing sites. Wadi Abu el-Maysa in Wadi Arabah comprises rectangular structure built of dry-stone masonry, workshop for ore crushing, mining galleries with fragments of malachite and slag in front of the entrances. Pottery dates the activity to the latter half of Dynasty 11 and early Dynasty 12.

[1272] (Levy et al. 2002, Table 1).
[1273] (Adams 2006, 140; Hauptmann et al. 2015).
[1274] (Levy et al. 2002, Fig. 3: 4,5); Odler (2016).
[1275] (Hauptmann et al. 2015).
[1276] (Levy et al. 2002, Fig. 3: 7).
[1277] (Regev et al. 2012, 2014).
[1278] (Haiman 1996).
[1279] Paper presented by M. Luciani, M. Mehofer and M. Renzi, with a title "Early Copper Metallurgy: a New Case Study from Northern Arabia", presented on 12th December 2018 at the workshop "Archaeological Finds and Analytical Methods" in Vienna.

The site of Ayn Soukhna was reused again in the early Middle Kingdom, as a departure point of boats navigating to Sinai. About 40 furnaces datable by pottery to Dynasty 12 have been excavated and published at Ayn Soukhna, most probably working with copper ore from Sinai.[1280]

Another departure point of the Middle Kingdom Egyptians was a harbour of ships going south to the land of Punt at Wadi Gawassis.

5.1.5.2. Nubia

Archaeological evidence of moulds, crucibles and finished artefacts provides evidence for the Middle Kingdom metallurgical activities at Buhen fortress.[1281]

Several authors presume that one of the subjects of the exchange between Egyptians and Kerma culture was copper, as it was absent in Upper Nubia, core of the culture.[1282] Moreover, donkey as a transport animal is known also from Kerma.[1283]

While politically, Nubia was lost to Kerman dominion, exchange with Egypt and even Hyksos continued in the Second Intermediate Period.[1284] Archaeologically, ascent of the local elites of G-Group can be observed on the main cemetery at Aniba. Large stone tumuli with circular ground plans, with funerary chapels, were built and the burials at the cemetery are significantly richer than ever before. Both people of C-Group, as well as remaining Egyptians, were supposed to work either for the Kerman rulers or in the interregional exchange.[1285] This situation was not impeding local procurement of the materials, but also its coming from a distance, to, for now, politically independent Nubia. Some Nubian gold mining sites might be exactly from this period.

5.1.5.3. Sinai

Middle Kingdom presence is most vividly documented by the temple of Hathor at Serabit el-Khadim, located in the predominantly turquoise mining area. Contemporary copper processing sites were located, but not yet definitely published, besides Serabit el-Khadim itself, at Gebel el-Lahian, Gebel Hazbar, and Wadi Kharig.[1286] According to the interpretation of Bietak, Levantine inhabitants of Tell el-Dab^{c}a took part in the Sinaitic expeditions of late Middle Kingdom and they were specialized in woodwork, especially ship building.[1287]

1280 (el-Raziq et al. 2011).
1281 (Emery 1979).
1282 (Raue 2019, 77)
1283 (Mitchell 2018, 66–67, Fig. 3.15).
1284 (Török 2009, 107).
1285 (Török 2009, 115–116).
1286 (Tallet 2018, 217–218).
1287 (Bietak 1996, 19–20, 31).

Mine L from Serabit el-Khadim was sometimes included into the Middle Kingdom evidence, although excavator I. Beit-Arieh dated the assemblage to the New Kingdom.[1288] Remains of metallurgical workshop with moulds for tools were found: axes, adzes, chisels, daggers/knives, saw blades, and mirrors. Since the axes, adzes and daggers/knives are clearly of New Kingdom shapes, the whole assemblage most probably comes from the New Kingdom. Moreover, foot bellows occurred in the corpus, again a New Kingdom trait. An assemblage is an apt indication that full range of the metal objects was produced by a solitary group of workers.

5.2. Copper storage, revenues, and transactions

An issue that is at least partially documented in the textual sources is very difficult to be observed by archaeology. Objects preserved are finished artefacts, it is difficult to find any specimen of an ingot, semi-product of metalwork.

5.2.1. Copper storage

5.2.1.1. Copper storage before the Middle Kingdom

Storage facilities were not confirmed from the excavated predynastic or Early Dynastic houses and settlements. Storage spaces were found at above mentioned settlements near mines at Wadi Dara.

It can be presumed that storage spaces in the contemporary Egyptian tombs reflect the approach to the storage of copper. Thus, the blades of the objects might have been stored separately, packed in textile or bound by threads into packages of several blades, and then stored in wooden boxes. It must be clarified, however, that assumed ingots from the Tomb 3471 at Saqqara are rather either semi-products destined to be made into regular axe blades or finished axe blades.[1289]

Old Kingdom treasuries are unknown for archaeology. We are not sure, whether the storage rooms of the mortuary temples of kings, and storage rooms of the bigger tombs of non-royal persons were denoted by the Old Kingdom Egyptians as *pr-ḥḏ* or were rather representations of smaller storage spaces, i.e. *šnʿ*.

5.2.2. Middle Kingdom

The treasuries of the Middle Kingdom are equally unknown. In the area of the Treasury of Thutmose I at Karnak were found sealings from Dynasty 13, indicating the position of earlier structure.[1290] In Nubian fortresses, the hypotheses for the architectural location of the

[1288] (Beit-Arieh 1985; Tallet 2018, 41; Philip and Cowell 2006, 204, 215).
[1289] (Davies 1987, 71).
[1290] (Desplancques 2006, 412).

Treasury were proposed at Uronarti and Askut. S. Desplancques argued convincingly that the ground plan of Block D at the fortress of Buhen is similar to the Treasury of Thutmose I (Figure 5.6), thus indicating that at least in fortress of Buhen, we are able to identify securely a Middle Kingdom Treasury (Figure 5.5).[1291] Much broader is corpus proposed by B. Gratien, with treasuries present at Kumma (Block D), Uronarti (Blocks D-F), Shalfak (Block D), Askut (Block C) and already mentioned Block D of Buhen.[1292]

Concerning ingots, two presumed bowl-shaped (reg. no. 5334, diameter 90 mm, max. thickness 22 mm) and disc-shaped (reg. no. 5335, fragment of an object with max. diameter 115 mm and max. thickness 18 mm) ingots were identified at Tell el-Dabca. Analysis of their composition showed that they were made of unalloyed copper, although the ingot 5334 contained c. 3 % of iron. The composition suggests a production from a fresh metal, not scraps of the discarded objects.[1293] It is remarkable how relatively small these ingots are, indicating that smaller fragments of such objects might have escaped attention in the large-scale excavations of the past.

5.2.3. Measuring copper

Copper and other metals were under control in the periods under study of Egyptian history, as the sources hinted at in the subchapter 4.3. The ancient Egyptian units of weight are most important in this context. Iconographic and written sources prove that metal was weighed before the production of artefacts and then on the finished product (This indicates that the metal ought to be already smelted for use somewhere else and that there might have not been vast difference between the weight of the raw material and the finished product.) Less frequently were in this regard researched ancient Egyptian units of length. These will be explored on the amassed data on artefacts in subchapter 5.4.

Contemporary Sudanese craftsman Mustafa, specialized in the production of beds, was quoted in the making of a wooden bed, similar to ancient Kerman examples.[1294] He was using measurements of his body to measure the ancient example, then producing the first of four legs of the bed. All three other legs of the bed were made according to the first one produced, thus ensuring similar measurements. We can call this a “single-event” standardization, where in a single craft operation, standardized measurements are secured by a comparison to already made specimens. Moreover, we can suppose that the craftsman will be repeating mental

[1291] (Emery et al. 1979, 65–66, Pls. 24–25; Desplancques 2006, 412–418).
[1292] (Gratien 2019, 106).
[1293] (Philip and Cowell 2006, 169–170, 213–214, Fig. 61, Table 18).
[1294] The British Museum, Curator's Corner Season 5 Episode 9 https://www.youtube.com/watch?v=LKWl9pwQZfY, last accessed on 25th January 2020.

template of the production of similar items in the past, although the exact measurements will be through time slightly different.

Analyses of the Old Kingdom beer jars and bread moulds have shown that pottery is standardized in synchronic single events (primary contexts from one tomb), but the dimensions are rather diverse in the diachronic perspective.[1295] Copper model tools are the products of the attached craft specialists; they are mostly preserved in contexts connected with single events (burials). Copper objects demonstrate the ability of the Ancient Egyptian metalworkers to produce fairly standardized artefacts. The control of the amount of copper might be thus reflected in the Old Kingdom metal material culture. This possible evidence of a more tight control of a rather precious material does not go against the model of the informal, self-structured system, which is more likely to explain the economy of the Old Kingdom as a whole.[1296]

As the weighing stones were inscribed, in the following text, we are coming back to the written sources. Nevertheless, the weight of the weighing stones, their "materiality" is more important in this regard, although inscriptions can set the objects into the specific reign or at least in broader time frame (Figures 5.7–5.8).

5.2.3.1. Early Dynastic period

Silo concentration at the north-eastern corner of the temple enclosure of Nekhbet was dated to the Dynasty 3 or early Dynasty 4 and then used as a rubbish dump. Two weights found thus cannot be dated with certainty. Gneiss diorite weights used a unit weighing about 23 grams (weight E.8336, three incisions, weight 71 g, unit is 23.67 g and weight E.8337, five incisions, weight 117 g, unit is 23.4 g).[1297] Rather surprisingly, these units are off of what is known about deben in third millennium BC, especially Old Kingdom.

5.2.3.2. Old Kingdom

Iconographic evidence shows that the amount of metal ore and end products (tools, vessels) which were used (mostly gold, silver, electrum and copper) was controlled by the administration in the Old Kingdom.[1298] The basic Old Kingdom weight unit was being reconstructed as the *deben*, which weighed around 13–15 g.[1299] Cour-Marty supposed that weighing stones with royal cartouches represented units for the weighing of gold. This assumption is not corroborated by the inscriptions on weighing stones, mentioning *deben*, but

[1295] (Warden 2014).
[1296] Warden (2014, 245–268).
[1297] (Hendrickx – Eyckermann 2009, 20, Fig. 29.1-2).
[1298] (Eyre 1987, 13).
[1299] (Cour-Marty 1997).

in not a single of the five cases there is no mention of gold. Therefore, we can presume that this might be weighing unit also for copper.

Old Kingdom weighing stones bore names of the officials as well, names of kings being absent on these artefacts (Figure 5.7). When the weights of named officials are added to the statistics, the unit fluctuates around the value 13–15 g. This numerical oscillation, statistical "noise", might be trace of the original ancient Egyptian lack of precision among the smallest units of weight.

The overview of the names and titles on the weighing stones shows that the evidence is scanty: there are few officials which were active in the overseeing of production and labour: overseer of both workshops, overseer of work, great of tens of Upper Egypt (and lector priest, stolist of Anubis), and custodian of king's property. But among the officials are also already mentioned lector priest and stolist of Anubis, stolist, and judicial official, i.e. the officials, which would not be otherwise assessed for a connection to the weighing of metal, as their titles do not refer to such activities. Two names preserved on the weighing stones could be interpreted as feminine, according to Cour-Marty. The only case might be defendable, weighing stone no. 16, which has an element *nb.ty*, often present in the names of the queens and princesses of the Old Kingdom, but not only them.[1300]

M.-A. Cour-Marty incorporated into the study also weighing stones that were analogical to the inscribed Old Kingdom specimens by their forms. And this comparison revealed even more oscillations, providing units around 6–8 g, 9–10 g, and 18–20 g.[1301] The counted units of the weighing stones are wildly disparate. One of the units smaller than deben must be most probably the unit *šꜥ.t*, known from written sources.

After the publication of her study, weighing stones coming undoubtedly from the Old Kingdom archaeological contexts were published. The system presented by M.-A. Cour-Marty can accommodate most of these units, but surprisingly there are outliers even beyond the defined weighing values. Newly found weighing stone of Wenis had three strokes with deben sign and a weight 69 grams, which would give a unit 23 g. According to A. Dorn, two more strokes could have been worn off during the use and the unit would be 13.8 g.[1302] A weighing stone from Dynasty 5 Elephantine had inscribed a circle ("deben") and one stroke, the unit is however 17.5 g. Two weights had even bigger units, one 18.72 g, another 19.89 g. Other stone had six units, with one unit of 13.7 g, thus the expected weight of deben.

[1300] (Verner and Callender 2002; Callender 2011).
[1301] (Cour-Marty 1997, 130).
[1302] (Dorn 2015, 103, Abb. 187, 188).

Late Old Kingdom weighing stone with an inscription “1/2 gold” has 8.4 g, thus the unit was 16.8 g.[1303]

The situation in the Old Kingdom is complex and would deserve a separate, detailed study. Nevertheless, the presented data enable the conclusions about the most promising candidates for the weighing units, represented by the inscribed weighing stones, displaying if not standardized, then regularized values. More extreme existing outliers of the weighing stones might be very well also false contemporary weighing stones of the fraudulent users.

5.2.3.3. Middle Kingdom

Weighing of metals was centralised in the Middle Kingdom, as some weighing stones contained royal names.[1304] Weighing sets for gold and copper were found at Nubian fortress Mirgissa. Vercoutter established that the copper deben in the Middle Kingdom was c. 27.5 g (Figure 5.8). On the contrary, unit for gold was about a half, with a value c. 13 g (retaining the original Old Kingdom deben). Interestingly, quite different measures do occur, Middle Kingdom weighing stones from Ayn Soukhna have quite different 1 unit (34.84 g) and 2 units (53.2 g).[1305]

5.3. Metallurgical workshops

5.3.1. Evidence of workshops and their material culture

Copper was mined and transported to Egypt and after possible storage for some time, it was made into objects. In this subchapter, evidence of the metallurgical workshops is listed in Egypt herself and in some mining areas as well, and material culture present there, together with the evidence on metalworkers (Figure 5.9). Then, techniques of the production observable on the existing artefacts are listed, in order to be compared with the iconographic sources.

Since the size of the preserved crucibles was rather small (Figure 5.10), also the magnitude of the production has been estimated as such. Evidence from Giza and Buhen of the use of bread moulds for the production of copper contradicts this assertion and it can be very well supposed that for larger operations of copper smelting, bread moulds, some of the largest vessels of the third millennium BC were used.

5.3.1.1. Early Dynastic period

[1303] (Kopp 2018, 67–68, Abb. 37).
[1304] (Vercoutter 1977).
[1305] (Abd El-Raziq,Castel and Tallet 2016, 20, Fig. 138).

In both Early Dynastic sites with the metallurgical workshops, Elephantine and el-Kab, the excavations only partially uncovered the metallurgical activity, which was taking place elsewhere.

Preliminary publication of a metallurgical workshop from Dynasty 2 found at el-Kab offers the earliest known indication of a metallurgical installation in Egypt. A crucible, together with a large quartz pebble, another pounder, and other finds (including flint sickle blades) were found on a floor of a building with L-shaped ground plan, at its north-eastern wall.[1306] The building is datable to the Dynasty 2, based on the ceramics, but also 14C dates obtained from the context. Traces of a collapsed wooden and subsequently charred roof were found in the room. Also, from this phase of the settlement are sealing impressions, being evidence of the state control at the settlement. Adjacent Trench 2 comprised two small furnaces, fragments of furnace lining and copper ore (malachite), with fragments of slag. Interestingly, this assemblage is rather datable to the late Dynasty 3 to early Dynasty 4, bearing witness to the continuing metalworking activity at the site. The area was not excavated completely, therefore more finds can be expected in the future.

Evidence of metallurgical activity in settlement layers was reported also from Early Dynastic Elephantine. In the layer 4 of the Naqada settlement from the early Dynasty 1 was found a fragment of probably a crucible (in original “Gußteller”), with glass-like green surface. Some small copper prills were found in the settlement layers as well. The excavator doubts the metallurgical activity, however, due to the absence of other slag fragments. But this is not a problem and the metallurgical activity could have taken place not at the settlement itself.[1307]

5.3.1.2. Old Kingdom

The most surprising fact on the Old Kingdom copper metallurgy is that there is thus far no evidence of any large metallurgical installation. And we must suppose at least one for each part of Memphite necropolis and also for the stone necropoleis at provinces. The original, Early Dynastic (or even predynastic one) could have been in the area of Saqqara (counting into that also Abusir). The strongest indication is the connection of Sokar to the metallurgy, a deity that was most probably local to the area. The excavated workshops indicate small-scale local smelting and maybe repair of objects. The only exception seems to be the settlement at the pyramid of Menkaura, yet it was unfortunately not published well.[1308]

[1306] (Claes,Davey and Hendrickx 2020).
[1307] (Kopp 2006, 33, Abb. 12).
[1308] (Saleh 1974).

5.3.1.2.1. Giza

Metallurgical workshops were identified in the area of Giza at the so called Kromer settlement debris in the reigns of Khufu and Khafra and at Heit el-Ghurab, in one of the galleries, and in so called Menkaura settlement, both datable to the reign of Menkaura.

The most completely preserved and excavated was a workshop in one of the chambers of Gallery III.8 at the Heit el-Ghurab, denoted as D17x, uncovered in the years 1997 and 1998.[1309] It contained two rooms with embedded bread moulds, serving as crucibles for copper processing. Moreover, small copper artefacts were found here, and the workshop is interpreted as being for local processing of small amounts of copper. Recent, thus far unpublished analyses proven that arsenical copper was worked here.[1310]

5.3.1.2.2. Buhen

Further copper processing at Old Kingdom Buhen is indicated by several groups of finds. This is where we come closest to a possible production of ingots on an Egyptian site. Besides the mentioned fragments of probably quartz with green copper ore, these are the ceramic moulds and pounders. Moulds (altogether 11 fragments are listed among artefacts found[1311]) have been found to the south-east of the centre of town, most probably in secondary locations. Ceramic moulds were of three types, but only two of them are reconstructed.[1312] Type 1 had size about 10 × 6.8 × 5.7 cm, but the complete length was never preserved. The inner hollow space had width of ca 2 cm and depth of about 2.5 cm. The length of the complete mould is difficult to estimate, but it would produce rectangular block. Type 2 moulds had large size, with depressions inside of ca 4.4 cm in width and 1.8–3.8 cm in depth. The produced objects must have been thicker than in case of Type 1 mould. Some of the moulds had blackened depression, with occasional traces of copper. Albeit O'Connor doubts finite determination of their purpose, it is legitimate to assume their function in the production of ingots or semi-products of smelted copper, which would be then finished, hammered and annealed as tool blades, being it probably chisels and adzes. This we can deduct from the shape of the inner mould cavities.

The semi-products might then have been shaped by the pounders preserved at the site, 14 in the Object Register. They had size accommodable by a single hand. Only Type 1 pounders served to crush ore or shape objects, as the finds of latter type were probably used

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1309 (Lehner and Hawass 2017, 370, Fig. 15.18).

1310 The material is under study by the author of the thesis and Jiří Kmošek.

1311 However, in the Petrie Museum UCL online collection, 12 moulds are listed as coming from the Old Kingdom Buhen.

1312 O'Connor (2014, 222–225, Figs. 6.20–6.22).

for fire ignition (although one example of the Type 2 had copper globule on one of the surfaces).[1313] They have been found in the vicinity of furnaces. Grindstones, found *in situ* in Block XII, have not been detected in association with the pounders.

Intriguing interpretation was offered by D. Raue, that the copper workshop at Buhen was used as a production centre of the objects to be exchanged with Nubians further south.[1314]

5.3.1.3. First Intermediate period

First Intermediate period metallurgical workshop has been excavated at Balat.[1315] It was part of a governor‘s palace from the period, the complex of rooms on an area 13.3 × 11.6 m provided evidence on the craft production, especially of the sickle blades and metalwork.

5.3.1.4. Middle Kingdom

One of the early finds of late Middle Kingdom workshops was made at Kahun by Flinders Petrie.[1316] Besides tools, five moulds for the artefacts were found in the workshop (Figure 5.12). Another important corpus was found in Tell el-Dab^{c}a.[1317] The knowledge about Middle Kingdom copper production was significantly improved recently by the excavation and publication of the metallurgical workshops in Ayn Sokhna.[1318] Five workshops have been excavated on the site, documenting important parts with 40 reduction furnaces. They are datable to the Dynasty 12 according to the pottery. The furnaces are divided into the batteries with standard number of four pieces. The metallurgical production was limited in time and rather extended in space; authors do not provide definitive interpretation. The moving of the workshops from Sinai to the coast of Eastern Desert could be caused by some historical event, probably unrest on the Sinai Peninsula, which forced Egyptians to move temporarily ore processing on the western coast of the Red Sea.

5.3.2. Moulds

Question of moulds connects the topic of the initial ore procurement and production of metal artefacts. The preservation of moulds is, however, very rare. Here is presented tentative reconstruction of the major steps in the development of metallurgy based on the meagre preserved finds, an exceptional case being Tell el-Dab^{c}a, with bulk of the moulds made of stone (Figures 5.11–5.14).

Old Kingdom moulds from Buhen are evidence of production of rectangular bars, which were later formed into the desired shape (Figure 5.11). Thus, there was middle stage

[1313] O’Connor (2014, 225–227, Pl. 55).
[1314] (Raue 2019, 77).
[1315] (Jeuthe 2012, 277–289, Abb. 115-118).
[1316] (David 1986, 165–166, Pl. 20; Gilmore 1986a, 216).
[1317] (Philip and Cowell 2006).
[1318] (Abd El-Raziq et al. 2011).

between the ore processing and the final product, decisions on the final shape of objects were made only by the shaping of the semi-product. The advantage of the process can be in the preparation of unspecified semi-products, bars, “ingots”, for further processing – which could have taken place elsewhere, not necessarily in Buhen. Such semi-products would be also easier to store and transport.

Middle Kingdom moulds of the tools (1605, 1666, 1746: axe, 1549: saw/knife, a chisel?) from Nubian fortresses Buhen and an adze from Askut (Figure 5.11), together with the artisan tool moulds from Kahun are an evidence of different approach, where the final form of the object is already present in the mould and casting takes from the start the shape of the final product (Figure 5.12). The product requires further shaping and hardening of the blade edge, but the final product is visibly defined.

Same approach can be observed also on the corpus of the single-sided limestone moulds from Tell el-Dab^{c}a (Figures 5.13–5.14).[1319] The objects produced are tools and weapons, axe blades, adzes, chisels, saws/knives, and bilaterally barbed harpoon heads which are absent in Egypt, as the Egyptian harpoon heads had unilateral row of barbs. Large part of these moulds were found above the layers of the Dynasty-13 palace, probably removed from an original location in an “institutional workshop”.[1320] Scarce fired clay moulds were cheap, the only problem being that they had to be broken after the production of the objects (Figure 5.14: 7023C). Two-piece steatite moulds are also rare and more precious, given the absence of high-quality stones in eastern Delta. Also the moulded products are foreign to Egypt, bilaterally barbed harpoon heads and so called “chisel-shaped” axes, but also a “universal” shape of a chisel blade (Figure 5.13–5.14: 300, 4804, 7413, 7421). Rich corpus from Tell el-Dab^{c}a demonstrates a merger of the Egyptian and Levantine traditions of mould production. An Egyptian approach of the moulds shaped in the final form of tools continued into the New Kingdom, as proves the assemblage from Mine L at Serabit el-Khadim, where diverse moulds for artefact types of tools, cosmetic tools and weapons were found.[1321]

Throughout these periods, production of the large plates of metal sheet must have continued, as most of the vessels from the periods under study were formed into the final shape by hammering. Only situlae were the vessels fully produced by casting in the Middle and New Kingdom.[1322]

[1319] (Philip and Cowell 2006, 171–197).
[1320] (Philip and Cowell 2006, 204)
[1321] (Beit-Arieh 1985)
[1322] (Radwan 1983, 147–152).

In this context must be mentioned also unique metallurgical installation found at Kerma, confirming that the Kermans were capable of large-scale metallurgical operations, even though the material itself, copper and tin bronze, could have been imported from the north. According to the latest interpretation, this installation served for the production of large slabs of metal.[1323]

5.3.3. Techniques of metalworking on artefacts

The product of casting, being it sheet or a cast of a semi-product or a tool, must have been further shaped. Features wanted on the object were worked until the desired shape, e.g. the sharp edge of a tool or a weapon. Unwanted or failed features of the cast were removed mechanically or by hammering. Methods of macroscopic (and microscopic) observation of the use-wear of copper tools, weapons and other objects are in its infancy in Egyptian archaeology. Inspiration must be taken from the approaches focused predominantly on weapons, and thus far only marginally on artisan tools.[1324]

5.3.3.1. Casting

Melted metal was poured into moulds, which were usually one-sided. Spouts of the ewers were sometimes cast and only lightly worked afterwards.[1325] Air bubbles in the mould, otherwise unwanted feature of the casting, might be observable on the finished artefacts as pitted surface.

5.3.3.2. Hammering

Hammering was the most frequent approach used to shape metal casts from moulds.[1326] According to Ogden the earliest evidence is from the Dynasty 1.[1327] But already the produced objects from Predynastic cemeteries indicate hammering to the final shape, as the earliest Badarian beads made of rolled sheet, and the list can go on with almost any tool, weapon or vessel. Also beads of meteoritic iron from Gerza were hammered into the final shape.[1328]

5.3.3.3. Soldering

Silver soldering for copper objects was used in the Dynasty 4 for the canopy joints in the tomb of Hetepheres .[1329] Spouts of the spouted jars were soldered in the Dynasty 4, but

[1323] (Verly et al. 2019).
[1324] (Dolfini 2011; Dolfini and Crellin 2016; Kuijpers 2018b).
[1325] (Schorsch 1992).
[1326] (Scheel 1989, 51-53).
[1327] Ogden (2000, 157).
[1328] (Rehren et al. 2013; Johnson et al. 2013)
[1329] Lucas – Harris (1962, 216).

separated spouts, attached to the vessel's body, were present already in the Early Dynastic Period.[1330]

5.3.3.4. Polishing

Finished artefacts were polished. Scheel assumed used of agate or abrasives (e.g. sand) and as a final polishing material textile or leather.[1331] Polishing marks are also well visible on many artefacts, although these marks were not studied systematically for Egyptian objects.[1332]

5.3.4. Graves of metalworkers

In this subchapter are listed only graves that lack inscriptional evidence, but the associated finds might indicate the profession of the deceased. Until now unpublished is a burial of a metalworker in a burial chamber of a shaft from the Eastern field at Giza, datable to the Old Kingdom.[1333]

Grave 4964 was found at Badari.[1334] The burial chamber of the grave had longer axis to north and was collapsed. Adult male was crouched on the left side with hands stretched. He had white and grey cartonnage mask overhead and ceramic vessel at feet, together with crucible.[1335] The crucible had traces of copper inside and plaster on the outer surface. Two big grey pebbles have been found inside. Pottery in the grave was dated by Brunton to Dynasty 7-8 and by Seidlmayer to the phase IIC, i.e. the First Intermediate period. Two pebbles inside the crucible could be hammerstones used to work on sheets and other semi-products of the artefacts. Melting and hammering were two main activities of *bḏ.tyw* in the iconographic sources. The grave is to be interpreted as a burial of local metalworker, serving the local community in the model of independent craft specialization. Dependent on the local power, he might have been also included in the attached model of the nome centre. Situation was probably similar to the metalworkers listed in the papyri Gebelein, in the Dynasty 4.

At Ayn Soukhna, excavations uncovered in the last phase of the existence of metallurgical workshop a partially disturbed skeleton in Area O5. It was in crouched position, with remains of textile. Lower part of the body was disturbed and burial equipment consisted of two silex pounders with a diameter of c. 5 cm. Nearby was also positioned a little packet of textile (diameter 4 cm), with copper prills, presumably also connected to a burial. Another very disturbed burial, without other finds, was found in Area O3, with its scapula dislocated

[1330] (Schorsch 1992).
[1331] (Scheel 1989, 39).
[1332] For published examples see e.g. (Odler et al. 2018, Fig. 21, 25).
[1333] Maksim Lebedev, pers. comm.
[1334] Brunton (1927, 36, Pl. xli, 25).
[1335] (now in the Petrie Museum UCL, inv. no. 181.46, published by Davey (1985, 145-146).

in Area O1.[1336] In both cases, it might be presumed that these are the remains of metalworkers present at the site, who died and were buried here.

It is clear from this brief overview that several skeletons of the metalworkers were preserved, and their specialization might be inferred from the wider context and associated finds. Unfortunately, no studies of Egyptian skeletal material focused on the trace elements of such skeletons. The evidence of some chemical elements, e.g. arsenic, is disputed,[1337] but the study itself would be worth trying.

5.3.5. Question of independent Nubian metalwork

For the A-Group and C-Group, archaeologists almost usually assumed the import of the ore and the objects themselves from Egypt. The parallels of shapes of tools and weapons indicate indeed that most of the objects might have been brought from Egypt.[1338] For the axe and adze blades, and mirror discs, there is enough measured data to compare the sizes of the artefacts. The bulk of the axe blades have the same measurements in Egypt and Nubia, and even few outliers are among the outliers from both regions (Figure 5.15). Adze blades have even more stringent differences (Figure 5.16). In their case, minor morphological differences between Egyptian and Nubian adzes were described in the literature, we might think about the local reshaping, or even a production.[1339] Mirror discs measurements are in the middle between the last two by the number of outliers, although also these have their Egyptian parallels (Figure 5.17).

Regarding other artefacts, an analysis of the daggers found at Aniba by W. Wolf is intriguing. While four of the five found daggers had clear Egyptian parallels, there was a dagger from Tumulus N 686, not being similar to either Egyptian or Kerman daggers, with much longer handle with an eye and a shorter blade, attached by four rivets to the handle. This dagger might well have been produced locally.[1340]

The main argument for the Egyptian imports of metal blades into Nubia remains the typology of the artefacts, not different from the Egyptian objects, corroborated by the comparison of their respective measurements. However, there are indications of possible local production, as some small typological differences occur on adzes, and a dagger from Aniba can be explained as well as a local production. Moreover, small copper objects, such as

[1336] (Abd El-Raziq et al. 2011, 15, 17, Figs. 62, 73–78).
[1337] (Oakberg,Levy and Smith 2000; Pike and Richards 2002).
[1338] On the context (Firth 1927, 17; Trigger 1983). Imports of Egyptian copper artefacts have been assumed also by other authors (Bietak 1968; Tadmor 2002, 249; Roy 2011).
[1339] (Odler et al. 2018, 426–427).
[1340] (Wolf 1935, 114–115, Taf. 70: 3).

tattooing needles, might have been certainly produced in small-scale craft activities.[1341] Further arguments on the imports of the copper objects are presented in Chapter 6.

5.4. Copper artefacts, their uses, distribution, and metrics

My earlier studies of the topic were mostly typological,[1342] but I would like to move beyond typology and focus on two levels. On the level of larger meaningful units, tool kits that are created from the separate tools occurred in different contexts. On the level of the singular artefacts on their metrological properties and how these comply with the ancient Egyptian measuring units.

Tools are usually defined in the literature as objects that can practically cause change to other materials, a utilitarian definition of this category of artefact.[1343] I am arguing for a broader definition of the tool, as for the past societies, "practical" considerations might not have been the only considerations. In case of "weapons", the ground for their distinguishing is ethical, as they were the tools of the warfare. Questions of their practical use were vital to ancient Egyptian warriors. Marginal members of the "tool" category are e.g. mirrors, which are aiding in changing the appearance of humans, although their contribution is not direct. Further, in case of ancient Egypt, we can demonstrate how vessel sets are "tools" in particular rituals that have, at least for ancient Egyptians, "practical" consequences. Such vessels sets can be interpreted as "tool kits" needed in performance of the ritual. Moreover, objects of personal adornment, i.e. jewellery, were often signalling social standing of the owner in the society, in case of "gold of honour" also his specific relationship to the pinnacle of power, to the king himself. It is a "tool" expressing social relations. With this broad definition, the objects left out from the tool kit and tool definition are mostly accessories of furniture and other aids of hardware (nails, clamps), but also these are helping with their practical purpose to larger complex objects

During the research for this thesis, it became apparent that full counts of the preserved artefacts is impossible to offer at the current state of knowledge. Surely there is more material out there than it is published. There are problems with the publications, access to the museum collections and excavation reports. Each museum or excavation collection requires the work of a specialist/specialists, in order to assess and evaluate the typology of the artefacts. Even though the PhD research took longer than usual, it is impossible to visit each museum and excavation collection. While I could choose to capitulate and present only a limited case

[1341] On their archaeological context see (Nordström 2002)
[1342] (Odler 2012, 2015a, 2016).
[1343] As in (Neustupný 2010, 61–62).

study, I am opting for an attempt to demonstrate the total counts of the existing material culture, offering minimal number of individuals.

5.4.1. Artisan tool kit

Original tool kit, used for the woodwork, was created already in Palaeolithic. In Africa was also invented hafting as means of combining two different materials, thus enhancing the practical physical properties of single material and human power.[1344] The wood working tool kit was arguably in ancient Egypt applied also on stone and accommodated to the possibilities of the new material. Earliest copper tools of fourth millennium BC were based on the stone precursors, and this was noticed e.g. by Flinders Petrie and Midant-Reynes, latter calling this process ”symbiosis”.[1345] Imitated tools were according to Petrie knives, axes, saws, scrapers, adzes need to be added as well.

As noted above, in the previous chapter, four main components of the tool kit were chisels, adzes, axes and saws, with presumed use of fifth component, drills. Altogether, there is 74 archaeological contexts, in which the complete artisan tool kit was preserved (Figure 5.18). Almost complete tool kits in the fourth millennium BC contexts did occur only in very rich tombs and unfortunately, those were not preserved well from the Egypt proper. While a common tradition was assumed to exist from Levant to Nubia, detailed comparison of singular tools can reveal typological differences.[1346] Partially preserved tool kits and only singular tools are known from more sites. Fragments of blade tools are known from Maadi.[1347] At Naqada, several tombs comprised two or three tool blades. Predynastic and Early Dynastic graves with the conspicuous presence of tool blades were collected and discussed by W. Davis.[1348]

In the Early Dynastic period, the most complete context with tool kits is from Tomb 3471 at North Saqqara. It contained chisels, adzes, axes and saws, also with preserved wooden hafts and handles. The royal tombs in Abydos were heavily looted and only remains of the original burial equipment have been found there, e. g. a wooden adze haft and an adze blade in the tomb of Anedjib.[1349] Arguably, royal tombs also must have included complete

[1344] (Rots,Van Peer and Vermeersch 2011).
[1345] (Petrie 1917; Midant-Reynes 2000b, 59).
[1346] For common tradition see (Tadmor 2002; Wengrow 2006, 39), *contra* single tradition for adzes (Odler et al. 2018, 426–427).
[1347] Rizkana – Seeher (1989, 13–18).
[1348] (Davis 1983).
[1349]Petrie (1901, 36, pl. XLII: 37, 74).

tool kits. The only exception from the smaller graves is Tomb O.31 from Abydos, with three copper tool blades.[1350]

It seems that copper tools were, in the Early Dynastic period gender-specified for men (kings, high officials and craftsmen). Wengrow sees Early Dynastic tombs as "a transformation of the extended household" and as model estates of the deceased, source of production and life in general.[1351] Copper tools as means of production are an indispensable part of this mansion for the Afterlife. The burial and tomb equipment thus mirrored the property of the tomb owner. In lesser graves, only sparse number of the tool blades was preserved, even in undisturbed contexts. Solitary finds of adze blades might point rather to the personal use of the tools by craftsmen.[1352] We do not know either who provided the copper from which these tools were made or who was the "owner" of the tools and their material (most probably king and royal administration in both cases). For the Dynasty 3, the best-preserved tool kit came from high official's tomb at Beit Khallaf, in 8th Upper Egyptian nome. Chisels, adzes, axes, and saws were represented, both in full-size, but also as models.[1353]

Old Kingdom contexts with the fully preserved tool kits, but also with partial ones were discussed elsewhere in detail.[1354] Full-size functional tools were rarely preserved from Old Kingdom Egypt and Nubia, models were dominant. While tool classes were preserved, the morphology of singular tools evolved from rather narrow blades into wider blades, trying to use more effectively the properties of the material.

First Intermediate period and early Middle Kingdom tool kits continue to be preserved mostly in the form of models, although they were complemented either by full three-dimensional representation of workshops (Figures 5.19, 5.20) or two-dimensional representation of tool kits on inner walls of decorated coffins. In the Middle Kingdom, fully preserved tool kits of functional tools are rare, the most intriguing assemblage known being a tool kit from the lower portico of the mortuary complex of Pepy II, although with axes absent.[1355] Model tool kits were more numerous, continuing the custom from the Old Kingdom. The shapes of axe blades changed, into the lugged forms of axes. Many contexts were published only superficially, with the information that the model tools are present, but without exact numbers, as e.g. at Beni Hasan.[1356] In addition to the funerary contexts, model

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[1350] (Petrie 1901c, 8, 24, Pl. VI: 18, 23–26)
[1351] (Wengrow 2006, 243–244).
[1352] (Davis 1983).
[1353] (Garstang 1903, 10, 12, Pls. XV, group one, XVI, XXIII).
[1354] (Odler 2016).
[1355] (Jéquier 1940, 48–49, Figs. 47–48).
[1356] (Garstang 1907b).

tools begun to appear in the foundation deposits of temples, e.g. at valley temple of Senusret II at Lahun.[1357]

5.4.1.1. Distribution and metrology of the tools

We cannot study each tool specimen in a detail, but we will look on the specific objects of the artisan tool kit in broad perspective of the temporal and geographic distribution. Besides these traditional questions, we can use the known tools also in other way as objects of serial character. By the comparison of ancient "big data", we can observe the properties of objects, which are not clear from the solitary artefacts. Unfortunately, many publications offer only the length of the objects, therefore we will focus mostly only on this metric trait.

Chisels are the most numerous class of the artefacts with 1,597 chisels in this iteration of database (Figures 5.21). Almost 70% of known chisels was found in the Memphite region, at its cemeteries. But together with Abydos and the region between Asiut and Abydos, these contexts most frequently comprised so called model chisels. Even more clear is the situation in temporal units, as the Memphite region is predominant in the Early Dynastic Period and Old Kingdom, while cemeteries south of Asiut taking the lead in the Middle Kingdom (Figure 5.22). In this iteration, only one third of chisels qualifies in the comparison of the published length (Figure 23). Most of these chisels are shorter than 75 mm, thus most probably models. Some of the longer blades might be also models, but surely among these are present also chisels used by carpenters and stone masons. Comparison with the table of chisels from ancient Egypt demonstrates that very long chisels, the longest having 52 cm were most probably made only later.[1358] Peaks of chisels do not occur on the indicated ancient Egyptian measures of length.

The observation repeats on the corpus of adzes, where the same three regions are well represented, as in the case of chisels (Figure 5.24). The same is true also for the temporal and regional distribution (Figure 5.25). Lengths of 418 adze blades were accessible, and their distribution is divided into two larger groups, one below 75 mm, apparently models, another around 200 mm, being most probably functional tools (Figure 5.26). Among the adze blades are presumably tools used by furniture makers, other carpenters, and shipwrights, used for different tasks, and needing different length.

Case of axe blades is different. Since the specialized studies of E. Kühnert-Eggebrecht and V. Davies are available, axe blades of unknown origin could have been included in increased number. Thus almost 40% of existing axe blades have unknown or only presumed

[1357] (Petrie,Griffith and Newberry 1890, 21–22, Pl. XIV: 1-10).
[1358] (Arnold 1991, Table 6.1).

provenance (Figure 5.27). The representation of the three regions with the highest number of archaeological contexts with models is thus lowered. On the temporal scale can be observed that most of unknown axe blades can be datable to the First Intermediate Period and early Middle Kingdom, and otherwise the distribution is very similar to the classes of chisels and adzes (Figure 5.28).

To facilitate understanding of further plots, the updated typology of the axe blades is presented (Figures 5.29–5.30). Types A to C are presumed to be the working axe blades, although each of these artefacts could have been used as a weapon. Type D is most probably adaptation of an artisan tool to a weapon, increasing the stability in haft by perforations and lashing. Types E to H were weapons, although some specimens of E could have been used differently. These are all axe blades ascribed to the development of weaponry in the First Intermediate Period and later. Nevertheless, some similar weapons did occur in the Old Kingdom iconographic sources and one must be careful in dating all artefacts after this period, especially those without known provenance. Three variants of foreign socketed axes are included in the table, as these were found in Egypt. These artefacts are clear imports, although many of such socketed axes could have been made at Tell el-Dab^{c}a.

Axe blades are herein compared together, all measured axes as tools and battle axes, as in case of lugged axe blades, it is difficult to distinguish artisan tools and weapons. Focusing on measured axe blades, we would expect that the histogram would demonstrate the use of the ancient Egyptian measures of length by the largest concentration of the lengths on the limits of the units (i.e. 75 mm, 150 mm, 225 mm, etc.). In fact, kernel density estimate shows a different approach, in which the units are the least used values, thus the axe itself is measured "until" a measure, a unit representing upper limit (Figure 5.31). Widths of the axe blades show much less diversity and most of the axes are shorter in width than 75 mm (Figure 5.32). There is insufficient data on the weight of axe blades, indicating prevalence of the lighter blades and several outliers, much heavier than the rest of the corpus (Figure 5.33). Two-dimensional kernel density estimate comparing length and width of the axe blades demonstrates well that the most important unit of the measure of blades is length, having greater diversity than width (Figure 5.34). Three-dimensional plot indicates existence of several groups of axe blades, based on the length and width of axe blades, with the longest axis representing the prolonged battle axe blades (Figure 5.35).

When we split the types A – C on the side and E – H on the other, a comparison of the preserved dimensions reveals differences, but also some overlapping categories in the middle (Figure 5.36). Artisan blades tend to be squarer in the dimensions, while weapons were longer and thinner, with ancient Egyptian craftsmen clearly experimenting with longer blades and longer cutting edges. Curiously, artisan tools have two peaks, around model blades and functional blades, while the weapons have the highest distribution right in the middle (Figure 5.37). This situation mirrors itself in the width of the blades (Figure 5.38). Available data reveal certain patterns; thus, it can be concluded that the process of the production of axe blades was in a certain degree standardized. These patterns can be observed only based on "big data".

With saw blades, we are returning to the regularities in data, as in the case of chisels and adzes, with the three most important regions, around Memphis, south of Asiut and in Abydos (Figure 5.39). Memphite regions then dominates also in the temporal perspective (Figure 5.40). Preserved saw blades were both short and long and there is even a peak around 150 mm, at the double multiplication of ancient Egyptian palm, not usual among other tools (Figure 5.41). Among the existing specimens are most probably tools used by different craft specializations, starting with furniture makers, and ending with shipwrights and probably also stone masons.

In conclusion, a habit of the deposition of model tools strongly influences the total counts of the known tools. But the examination of the lengths of them, the only sufficiently available measure, indicates that among the preserved artefacts are surely many full-size functional tools and this category of material culture is not to us entirely lost.

5.4.2. Cosmetic tool kit

Throughout the Egyptian prehistory, cosmetics must have been important, but the evidence comprises mostly cosmetic palettes and use of colouring materials, especially malachite.[1359]

Finding evidence for the complete cosmetic tool kit is much more difficult in the periods under study. It contained mirrors, razors, tweezers, hair curlers, and kohl-sticks. Such context is impossible to be found. With less stringent criteria, looking only on the contexts with both mirrors and razors, there are just twenty such contexts from the periods under study, two even from Kerma (Figure 5.42).

Earliest examples of razors can be distinguished inferring from the shapes of later, confirmed razor blades. Early razors are thus known from Naqada and Tarkhan, in Nubia from Naga el-Sheikh and Ashkeit 332.[1360] Earliest tweezers are also most probably

[1359] (Stevenson 2009a).

[1360] (Firth 1927, 201, Pl. 22b: 6-7; Nordström 1972, 122–124, 178–179, Pl. 89: 31, 32; Petrie and Quibell 1895, 27, Pl. LXV: 4; Petrie,Wainwright and Gardiner 1913, Pl. IV: 17, 22).

Predynastic.[1361] Razor blades were present also at Early Dynastic North Saqqara.[1362] These are complemented by the earliest evidence on copper mirrors, at least in the case of Abusir made of arsenical copper.[1363] In the Old Kingdom, copper hair curlers and kohl-sticks were added, and the Old Kingdom evidence was discussed in detail elsewhere.[1364]

First Intermediate Period and Middle Kingdom cosmetic tool kits were completely preserved seldom. Spectrum of the razor form commenced to change, but not everywhere. Treasurer Nekhet from Asiut had trapezoid blade, akin to late Old Kingdom blades.[1365] But Middle Kingdom razors begun to have side projection on a blade, as e.g. on two razor blades of Princess Sithathoriunet buried at Lahun. Moreover, these two blades were made of tin bronze.[1366] Besides the larger blades, another typological development was leading to the narrow *dgꜣ* blades of the New Kingdom.[1367] The precursors of such blades have most probably pointed end.[1368] The early *dgꜣ* blades were found e.g at late Middle Kingdom Buhen.[1369]

Meanwhile, the mirror discs changed a little, and the main development underwent the mirror handles.[1370] Also tweezers, hair curlers and kohl-sticks did not changed, even more thus stands out the specific case of razor blades, deserving further study.

5.4.2.1. Distribution and metrology of the artefacts

A comparison of artisan tool kits to mirrors is striking, mirrors have much more diverse provenance (Figure 5.43). One fifth of all assemblages was found on the cemeteries south of Asiut, which were most probably less affected by the tomb robbers. Mirrors from Delta are quite numerous, although many of these mirrors from the Middle Kingdom cemetery Kom el-Hisn were not published sufficiently. Plotted geographical and temporal distribution demonstrates increased regionalization from the Old Kingdom down to the late Middle Kingdom (Figure 5.44). As the written and iconographic sources stress, the mirrors ought to be considered as indicators of the social elite.

1361 Kubbaniya, Grave P. 225: (Junker 1919, 118, Taf. XXXIX), Amra, Grave a 104: (Randall-MacIver and Mace 1902, 23).
1362 (Emery 1949, Fig. 17: 4).
1363 E.g.: Sedment, Grave 315 (Petrie and Brunton 1924, 2, Pl. XXII); Abusir, Tomb 12B-1 (Bonnet 1928, 48, 52, Taf. 32). From Dynasty 3 is most probably a mirror fragment from Abusir, Tomb AS 20 of Hetepi, find no. 3/AS20/1999_a, (Bárta,Coppens and Vymazalová 2010, 24, Pl. 28).
1364 (Odler 2016, 188).
1365 (Vercoutter 1981, 126, Louvre, E 12025).
1366 (Kopp 1934).
1367 (Davies 1977; Herslund 2011, 135).
1368 (Petrie 1900a, Pl. XXII, middle photograph).
1369 (Randall-MacIver and Woolley 1911, 158, Pl. 63).
1370 (Lilyquist 1979, 58–63, 95).

Mirrors are especially suitable for the focused study of ancient Egyptian metrics. Their most strained parts were tang projections, sometimes these, as broken off during use, were replaced by new pieces of copper.[1371] However, the discs were not changed since they were produced, they retain the original measurements. In case of tools and weapons, those might have been reshaped by hammering during their use life.

Kernel density estimate shows tight constraints for the height of the mirror discs (Figure 5.45). The measures of width are expectedly slightly higher than the height, and again showing measuring up to a certain limit, but not reaching it (150 mm) (Figure 5.46). In two-dimensional comparison of height and width, mirrors create a linear function of the two variables, with two peaks (Figure 5.47). The observation is confirmed also by the three-dimensional KDE plot (Figure 5.48). The production of mirrors appears from the data as highly regularized, with a well-defined idea of how big a mirror ought to be.

Artefact class of razors is much more regionally bound to the cemeteries around Memphis, more than half of the known contexts are from there (Figure 5.49). Memphite region is especially well represented in the Early Dynastic Period and Old Kingdom, with increased regional diversity in the Middle Kingdom. Remarkable is a concentration of razor blades in the Kerman contexts, although this number includes the Egyptian types and also Kerman razors being analysed (Figure 5.51).[1372] The lengths of razor blades are rather diverse, with several peaks below 150 mm, and even razor longer than 200 mm (Figure 5.50). However, in the length is also counted a tang on a razor blade, inserted during the practical use into handle.

The tweezers were much rarer artefact, but they do occur throughout the periods under study. Remarkable is a high number of these objects preserved from the late Middle Kingdom, i.e. contexts of Dynasty 13, early Second Intermediate Period and Pan Grave culture (Figure 5.52). Hair curlers are even more limited in number (Figure 5.53).

5.4.3. Personal adornment

This category comprises several groups of material culture. As in the case of written sources, it is impossible in the scope of this work, to gather evidence on all found copper beads from archaeological contexts. Closer look on the published contexts reveals their scarcity in

[1371] Long ago, this was observed and noted by (Brunton 1927, 61).

[1372] Example of Middle Kingdom type razor blade from Kerma, now in the Museum of Fine Arts, Boston, acc. no. 20.1801: (Reisner 1923a, 407, Fig. 136, 1923b, 183, Pl. 49: 2–4).

Egyptian necklace strings.[1373] Other, rarer pieces of jewellery were often made of copper core covered with the gold foil.

Moreover, copper ore malachite was used in the cosmetics as a provider of green colour. Again, it is impossible to gather all mentions of green stains on cosmetic palettes and each existing piece of malachite. Source of the black colour, ore and mineral galena, is also important category of evidence for ancient Egyptian metallurgy, but again, without analyses, it is difficult to ascertain how many pieces of galena were occurring in the archaeological contexts. It is hard to imagine that Egyptians mined copper ore and malachite with galena for cosmetics on separate places than ores used for production. Written sources, if detailed enough, clearly speak about the aim of the expeditions to gather all materials available.

Lastly, faience production can be connected to the copper metallurgy because copper was needed as a colourant. A separate thesis would be needed for the comprehensive study of faience objects and there is already an excellent monograph by Kaczmarczyk and Hedges.[1374]

5.4.3.1. Badarian

Earliest copper artefacts have been found in the archaeological contexts of Badari culture and they must be examined in their wider context.[1375] These objects are few in number, beads used as personal adornment and a pin or needle. These scant remains however provide some interesting information, because of the graves where are included and objects themselves, testifying for technological abilities of the contemporary producers of copper alloy objects. Malachite was used also as a pigment, most probably connected to women and children. Concerning lead ore galena, Midant-Reynes listed remains of a supposed galena fragments in a settlement pit, stored in a leather bag.[1376]

The problem with the inner chronology of the Badarian culture is the sparsity of finds preserved in graves.[1377] Available 14C dates show rather long span of about 600 years for the duration of the culture.[1378] However, setting the copper finds in the context of Badarian culture is easier because of the quantitative analysis of Badarian mortuary remains.[1379] Almost 3,000 grave goods were distributed among 262 burials out of 725 total number of preserved burials at Matmar, Mostagedda and Badari. Khi-squre tests were used, with a result that "luxury goods" tend to appear in graves with larger area and sometimes also more elaborate,

[1373] As an example, Naqada IIC grave B 50 contained 492 blue-green-glazed steatite beads, 2 carnelian, and 1 hematite bead, together with a single cylinder copper bead, made of rolled sheet (Payne 1993, 208).
[1374] (Kaczmarczyk and Hedges 1983).
[1375] Copper in Badari culture: G. Brunton (1925); Anfinset (2010, 144–145).
[1376] (Midant-Reynes 2000b, 122).
[1377] (Math 2007).
[1378] (Dee et al. 2013).
[1379] (Anderson 1989, 1992).

which have more grave goods than other graves, and they are disturbed or robbed more frequently. This might indicate that the “richer” graves were marked by some means also on the surface. Some burial items, as ivory and carnelian, have tendency to concentrate in specific areas. From the analysis by W. Anderson can be inferred that there was a sort of social inequality in Badarian society,[1380] expressed by the differences in the distribution and location of grave goods, with two main groups of “rich” and “poor” burials. W. Anderson defined two categories of graves, in which fall the graves with copper or malachite, firstly, wealthy burials with goods made specifically for burial, and wealthy burials with objects, clearly used before the interment.[1381] Already then, copper and malachite was associated with rather rich graves in terms of the burial goods. These “rich” graves were not, however, restricted to men, rich burials are also of women and children.

Beads and pin/needle provide evidence that producers of the objects were able to hammer the copper to the desired shape. Beads are rather tiny, but already there are two types of them, simple one with a sheet rounded in a tube and more complicated flat cylindrical beads with a hole in the middle (from Mostagedda). The producers of these objects were capable of exceptionally fine hammering of metal and thus could have worked with the metal more regularly. It can be argued that some other prestigious objects, produced i.e. from ivory, were worked with copper alloy tools. This would require detailed study of the production techniques of ivory objects.

5.4.3.2. Remarks on the later development

Copper pins, beads, armlets and anklets are known from Naqada I phase.[1382] Jewellery pieces made of copper, e.g. armlets, beads, rings, were then present in Predynastic Egypt and Nubia.[1383] Early Dynastic jewellery was rarely preserved.[1384]

Existing examples of unique headbands from the Old Kingdom, with a copper core and gold foil covering the core, can be interpreted as a royal “gold of honour”. Four Giza finds are in the MFA Boston (37.606), ÄMU Leipzig (ÄMU 2500), KHM Wien (AE_INV_ 7529), and Egyptian Museum, Cairo.[1385] Thus, copper and gold most probably coming from the royal workshops is represented in these cases.

[1380] (Anderson 1992).
[1381] (Anderson 1992, 62).
[1382] (Wengrow 2006, 34).
[1383] E.g armlet: Amra (Randall-MacIver and Mace 1902, 20–21, Pl. VIII); ring: Amra (Randall-MacIver and Mace 1902, 18); wire with beads: Naga ed-Deir (Lythgoe 1965, 288–289, Fig. 130a-c); copper jewellery in A-Group Nubia (Hofmann 1967, 44–45).
[1384] (Spencer 1980, cat. nos. 541-574; Bagh 2004).
[1385] (Dunham 1946; Butterweck-Abdelrahim 2002; Binder 2008).

Other objects of personal agency, and adornment, were seals. Some Old Kingdom cylinder seals were made of copper.[1386] Among these is one of the rare pieces of evidence on the rule of King Shepseskara from Dynasty 5.[1387] Also some copper circular and pyramid seals were found.[1388]

Middle Kingdom jewellery was building partially on the tradition from the Old Kingdom, but new types were introduced. Especially tombs of Middle Kingdom princesses preserved objects that must be considered as the masterpieces of the era.[1389] While the funerary contexts are expected as containing such objects, sometimes can such objects occur at unexpected locations. A golden bead with herringbone granulation, with analogies in Dahshur, was found in one of the galleries at the port Ayn Sokhna.[1390]

Artefact class of pins occurred throughout the periods under study, and is most frequent in the late Middle Kingdom, at Tell el-Dab^{c}a (Figure 5.54).[1391] Before this period, they are much less frequent and often not enough information was published about them, thus they might well belong into the next category of artefacts. Distinction between the awls and tattooing implements, used for personal adornment of body, is also fluid, as both artefact classes could serve such purpose.

5.4.4. Textile- and leather-working tool kits, tattooing

Distinction of the artefact classes according to the iconographic sources is easy, as only awls and leather-cutting knives were depicted. In case of material culture, objects preserved fragmentarily are difficult to be distinguished, especially fragmentary thin copper rods, which might be either needles, awls or other artefacts (e.g. tattooing implements, see below). Therefore, both tool kits are discussed within this subchapter, textile- (awls, needles) and leatherworking (awls, leather-cutting knives).

Thin copper objects with circular, square to rectangular, and lentoid section occurred since Predynastic period. The artefact types are not easily distinguished. If preserved completely, needles with or without eyes can be distinguished.

Needles are remarkably frequent artefacts, with 662 specimens from the periods under study. More than 60% of them was found at the Memphite cemeteries (Figure 5.55). Temporal division is even more revealing, as most of the contexts are from the Early Dynastic Period and Old Kingdom, and much less afterwards (Figure 5.56).

[1386] (Boochs 1982, 95).
[1387] (Daressy 1915; Verner 2014, 55–56).
[1388] (Wiese 1996).
[1389] (Morgan 1895; Winlock 1934; Grajetzki 2014; Stünkel 2015).
[1390] (Abd El-Raziq et al. 2012, 5, Fig. 6).
[1391] (Philip 2006, 94–107).

Skewed distribution is apparent also in the case of awls, which are predominantly coming from Nubia in the A-Group (Figure 5.57). These tools were named “awls”, but they apparently served as tattooing implements and especially occurred in the graves of women.[1392] Similar practice was presumed to exist also in Egypt, as this was interpretation of a corpus of copper points from a grave found at Kafr Hassan Dawood.[1393] Presumed awls after the Predynastic period are rarer, but they fulfilled the purposes of the textile and leather processing (Figure 5.58). Complete awls with elegant short wooden handles were most probably preserved also among the objects in Dynasty-1 Tomb 3471.

Similarly restricted in time are so called net needles, i. e. thin copper rods with a bent circular head, usually open, presumed to be use for purposes similar to needles and awls. Their distribution is clearly limited to the 4th and third millennium, until the end of the Old Kingdom (Figure 5.59).

Leather-cutting knives were found only in Old Kingdom contexts.[1394] Needles were quite frequent as settlement finds, and these were most probably objects made of copper used most widely.[1395]

Middle Kingdom material is also low in number. The largest assemblage of known finds comes again from a settlement, from the town Kahun. One needle had a hollow bone case and reed packing (Manchester Museum, inventory number 97). Other needles from Kahun are also in Manchester, but also in the Petrie Museum and the Oriental Institute, University of Chicago.[1396] Needles are also known from the C-Group contexts in Nubia.[1397] Indirectly, woven patterns occurred on ancient Egyptian textiles at least from the early Middle Kingdom, indicating use of fine tools for the work,[1398] but the preservation rate of textile is not very high even in Egypt. It can be concluded that needles were among the most frequent, if not the most frequent copper objects used, and often discarded, in the periods under study.

The technique of the tattooing changed through time, as instead cast and hammered points were used copper sheets rolled into a point. A corpus of seven pieces was found at Ghurab and is currently in the Petrie Museum (UC7790). The dating of the corpus is unclear, it might be from the New Kingdom phase of the town.[1399]

1392 (Nordström 2002).
1393 (Tassie 2003).
1394 (Odler 2016, 205–206).
1395 (Odler 2016, 196).
1396 The Manchester Museum: inventory number 233; Petrie Museum: inventory number UC69905; Oriental Institute: E9210.
1397 (Hofmann 1967, 237).
1398 (Barber 1982, 444).
1399 (Booth 2001).

5.4.5. Hunting and food processing tool kit

Evidence demonstrates that lithic and bone objects were used predominantly, and copper artefacts were induced only gradually. Among the hunting tool kit accessories are counted harpoons and fish-hooks, food processing tool kit includes knives. Harpoons were already examined in a separate case study.[1400] Artefact forms are inspired by these materials, only later were accommodated to the properties of metal. Change from curved shapes inspired by the original bone and antler harpoon heads to more angular shapes, better suitable for copper, were in detail described by Czarnowicz.[1401] Both fish-hooks (Figure 5.60) and harpoons (Figure 5.61) are not artefacts preserved in high numbers, but they occurred throughout the periods under study.

Already in the fourth millennium BC, harpoons, fish-hooks, forked harpoons and simple points were found in the Naqada I graves.[1402] Fish-hooks are also known from Maadi.

Old Kingdom harpoons were discussed elsewhere. Recent find of a harpoon head with four points on a flat base, from Old Kingdom context at Giza, East Field, shows that even artefacts with completely unknown morphology might be preserved.[1403]

First Intermediate period and Middle Kingdom artefacts continue to be seldom, with fish-hooks being preserved also from settlement contexts.

A case of technology foreign to Egyptians is present at Tell el-Dab^{c}a, where harpoon heads with two lateral rows of barbs were cast (Figure 5.14). Egyptian harpoons were typical by barb row only on one side of the harpoon head.

In case of knives, they have diverse typology and they are not well represented in the archaeological contexts (Figure 5.62). Moreover, the term “knife” was very often in the past mistakenly used for the saw blades. In this thesis, I have tried to distinguish knives from the saw blades, but it is not excluded that in the future some more knives will be determined as saw blades.

5.4.6. Vessels

The metals were important material for the making of vessels. Especially copper and its alloys are prone to be preserved, as gold and silver vessels were rather object of recycling or removing from original context by robbery. Comprehensive catalogue of copper and bronze vessels was already offered by A. Radwan.[1404] Besides introducing newly found material,

[1400] (Odler and Peterková Hlouchová 2017).
[1401] (Czarnowicz 2018).
[1402] Wengrow (2006, 34).
[1403] Maksim Lebedev (Russian Academy of Sciences, Moscow), pers. comm.
[1404] (Radwan 1983).

focus is on the metrology of vessels, continuing in published approach.[1405] I am considering vessels as tools in a tool kit, tool used in specific rituals. Through the framework of ritual, vessel roles in the ancient Egyptian context(s) can be understood. The vessels were tools in the rituals, with "practical" effects, at least for ancient Egyptians, for the world of deities, rulers and other persons.

If we focus on the geographical distribution, almost 70% of vessels were found at the cemeteries around Memphis (Figure 5.63). Well represented isn then only Abydos with 11% and the cemeteries south of Asiut with 5%. The bulk of the preserved vessels is coming from the Early Dynastic period and the Old Kingdom (Figure 5.64). As was already established by Radwan, the Dynasty 6 is a period of a remarkable boom of the production of copper vessels, concentrated to Memphite cemeteries.

Vessels are, besides mirrors, another category of the material culture which was supposedly preserved in the original state of production. Thus the data on the diameters of the complete vessels reveal similar pattern of the measures below the limits of the ancient Egyptian measures of length, especially well visible under 150 mm and 225 mm (Figure 5.65). The data on the height of vessels demonstrate slightly different pattern, also with a concentration at the 150 mm, i.e. double multiplication of the Egyptian palm (Figure 5.66). Most of the vessels on both plots have the measures below the threshold of 75 mm and are thus most probably models.

5.4.6.1. Predynastic and Early Dynastic period

fourth millennium BC vessels are rather rare and of limited types represented. In the Early Dynastic period, alongside rudimentary evidence for offering ritual, vessel types that were included in the ritual, begun to appear in the archaeological contexts. Clear connection is in the case of spouted jar and wash basin, featuring not only on offering stelae, but also in the material culture. Other vessel types were less frequent, among them e.g. plates and bowls. Their indented use can be assessed from some contexts. In the funerary repast from the Saqqara Tomb 3477 were copper vessels, but no copper implement, lithics served as "cutlery".[1406] Then, there are also unique vessels by typology, as a situla with twisted handle from Tomb of Khasekhemwy, with no good parallel elsewhere.

5.4.6.2. Old Kingdom

[1405] Newly discovered is eg. an inscription on vessel ÄS 7441 (Odler et al. 2018, 442, Figs. 32-35), metrological assesment of vessel production defined in (Odler 2017b).
[1406] (Emery 1962).

Fully preserved "tool kits" for offering ritual are from the Old Kingdom, and their "standard" set could have been established alongside the standardization of the offering list in the period of the end of Dynasty 4 and early Dynasty 5. However, sets preserved in undisturbed contexts indicate that the rules were applied freely, not strictly.

Even in the cases, where in undisturbed contexts were only few vessels, they might have been considered as "pars pro toto" representative for the offering set. I have also already argued that vessels from the burial chambers are analogical to the sets used in the Old Kingdom temples for the benefit of deities and rulers in the funerary repast ritual.[1407] Evidence from the Old Kingdom temples is only very limited. If the parallel with the annals of Amenemhat II is valid, usual form of temple endowment was by the king himself. The vessels found in the temple contexts indicate what material was used by the royal administration.[1408]

Less frequent are vessels that were involved in the performance of the B-list of offerings, serving for the Opening of Mouth ritual.[1409] On the offering altar from the burial chamber of Inti Pepyankh were copper and stone vessels for two rituals, offering ritual and Opening of the Mouth. Thus, on one longer and one shorter side was a *htp*-sign for each, indicating dual usability of the artefact. For the Opening of Mouth copper *hꜣṯs* vessel vessels made of white rock crystal and black stone (basalt?) were present.[1410]

Again, as in Early Dynastic period, vessels in marginal numbers and exceptional typology were preserved. Specific type of the vessels were models of the metalworking crucibles. The earliest example might have been found at Hierakonpolis, the artefact had a shape similar to a "pipe-head".[1411] The type of vessel, listed on the slab stela of Wabkkhenemu in Dynasty 3, is as model vessel in copper present only in late Dynasty 6.

5.4.6.3. First Intermediate period and Middle Kingdom

Guidelines for the contents of the ritual sets, established in the Old Kingdom, continued to be used in the following periods. The undisturbed contexts with fully preserved sets were not numerous.

5.4.6.4. "Metallschock" – vessels of metals and other materials

Practical application of the "Metallschock" paradigm sheds light on the interpretation of fine ceramic ware in the Old Kingdom funerary contexts. Following the assertions of Reisner and

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1407 (Odler 2017b).
1408 A dedication of temple furniture for the temple of Min in Dynasty 8 by Hetepkamin, a non-royal person, can be perceived as aberration from the usual state of things.
1409 (Barta 1963, 78–79).
1410 (Odler 2017b).
1411 (Bussmann 2010, 283, 581, Abb. 5.642).

Radwan, fine "Meidum" ware is in fact cheaper imitation of the metal, copper vessels, and they were only substitute to more expensive material. The metal vessels were not necessarily bigger. Comparison of the size of spouted bowls made of ceramic with the only Old Kingdom specimen of copper demonstrated that the inscribed copper vessel is by far the smallest in the category.[1412] And the process is not unidirectional, materials influence each other, as can be observed by the occurrence of copper beer jars on stands inspired by ceramic forms.[1413]

The typology of ceramic vessels was mirrored in the copper sets of the offering ritual, the vessels represented commonly used objects. The bowls were used for eating food, the best Old Kingdom example is one of the galleries at Heit el-Ghurab with ubiquitous remains of food and carinated bowls.[1414] Drinks were represented by wine jars and beer jars; the former have not been preserved in copper, both vessel types occurred in copper in the Dynasty 6.[1415] Offering stands with trapezoidal section were made of travertine, e.g. offering stand of Pepy II from Heliopolis.[1416] Fairly frequent were also offering stands made of ceramics, usually covered by red slip, arguably imitating copper. In case of Giza, present author with his colleagues tried to delineate the trajectories of the development of offering vessels in the Old Kingdom funerary equipment from Giza.[1417]

5.4.7. Hardware, furniture and thrones

While written source are rather numerous, out of the furniture of the periods under study, only bits and pieces were preserved, such as furniture finials. The only assemblage indicating use of copper pieces in the more complex specimens of ancient Egyptian furniture is burial equipment of Queen Hetepheres I from Giza. Copper was here used in the most strenuous parts of the furniture, while being covered with gold as the more precious material. Bits and pieces of hardware from the royal mortuary temples of e.g. Menkaura and Raneferef offer rare opportunity to sample artefacts from the royal context of the Old Kingdom.

Massive pieces of furniture could have been made of copper, as two caskets with the cartouches of Amenemhat II, enclosing silver treasure of el-Tod.[1418]

In this context, we can discuss also other small types of hardware, small metal accessories that were used to join either copper or other materials. These are clamps, used to attach mirrors to their handles. Other category of hardware were nails, joining pieces of wood.

1412 (Odler et al. 2018, 441, Fig. 31).
1413 (Arias Kytnarová and Jirásková 2015).
1414 (Faltings 1998, 267–274; Lehner 2002, 42–46).
1415 (Arias Kytnarová and Jirásková 2015).
1416 (Bussmann 2010, 102, Abb. 4.78).
1417 (Arias Kytnarová,Jirásková and Odler 2018)
1418 (Bisson de la Roque 1950; Pierrat 1994).

In Pan Grave culture, copper nails were documented e.g. on a travertine receptacle and on a plaque used on the butt end of the axe's haft. But on the same object were more often used also wooden pegs.[1419]

5.4.8. Agricultural tools

As the written and iconographic sources indicate, agricultural tools were not produced out of copper, although greatest part of the ancient Egyptians were active in the agriculture, in order to sustain the wellbeing of whole society. Agricultural tools made of iron could have been produced on massive scale only in the Ptolemaic Period. There are two artefacts, hoes with socket eyes, which were dated by the excavators to the periods of the study, but they must be considered as later intrusions. One was found near the pyramid Lepsius 24 at Abusir Centre, another at Sedment, Grave 658. Sedment specimen was, according to excavators, found with a pottery of Dynasty 9.[1420]

5.4.9. Weapons

Weapons play key role in the interpretation of the ancient Egyptian society. The metal weapons (and weaponry made of other materials) were found in Predynastic and earliest Early Dynastic contexts,[1421] then in First Intermediate Period and Middle Kingdom. In the Old Kingdom, weapons were conspicuously absent, and this inspired deliberations on the "peacefulness" of Early Dynastic and Old Kingdom society. This is rather case of the reuse of material and conscious omitting of the weapons from the most ubiquitous contexts – from the assemblages of model tools in the burial equipment.

Among the Egyptian copper weaponry were spearheads, arrowheads, daggers, and axe blades. Battle axe blades were already discussed above, in the subchapter on the artisan tool kit. Daggers are rather scarce before the Middle Kingdom and then much more numerous (Figure 5.69). Very similar is the distribution pattern of the spearheads (Figure 5.70). Arrowheads are quite rare in the periods under study (Figure 5.71).

Those are rarely preserved in assemblages, usually, one or two weapon blades per context were maximum. Most characteristic Egyptian weapons with metal blades were spears and axes. In the fourth millennium BC, earliest metal weapons were in Naqadan and A-Group graves.

Early Dynastic contexts are only scant, while Old Kingdom contexts are non-existent. It was already argued that this does not mean absence of the weapons in the Old Kingdom

[1419] Except of (Brunton 1937, Pl. LXXV: 27, 41).
[1420] (Krejčí 2008a, 187–188, Fig. 5.71; Petrie and Brunton 1924, 8, 16, Pl. XXII).
[1421] (Gilbert 2004).

society.[1422] Seemingly "sudden" appearance of weapons in First Intermediate period is an expression of changed attitude to the presence of weapons in specific cases of decorum. Weapons occurred either as full-size functional objects or as models in the model tool assemblages, alongside artisan tool blades. In miniature, fully equipped Egyptian troop with model spearheads comes from the tomb of the mayor Mesehty.[1423]

If we map out the occurrences of the battle axes (Figures 5.67, 5.68), it is clear what is one of the major changes between the Old and Middle Kingdoms in funerary archaeology. The social elite begun to display their warfare powers more regularly and one of the good examples is the undisturbed burial chamber of the treasurer Nekhet from Asiut, with both full-size weapons and their models.[1424] But this display of the warrior status did not end with the largest tombs. Well-contextualized specimens e.g from Beni Hasan are from the shaft tombs of the "middle class". And there is a multitude of other examples of the battle axes found in the cemeteries of the provincial centres, beginning with Dendera (17 battle axes!), ending with Kom el-Hisn in delta (even more, 24 axes!). And these numbers are left after the thousands of years of looting, therefore, we could expect more material, and at each Middle Kingdom provincial centre. While this is in detail certainly not comparable to Tell el-Dab^{c}a, it cannot be said that "there is not published evidence to indicate that the deployment of weaponry in Egyptian elite burials in the Nile Valley was comparable to the highly structured sets of weapons seen at Tell el-Dab^{c}a, …".[1425] On the contrary, in the Egyptian type of such assemblages, the main metal weapons of Egyptians do occur, battle axes, spears, and daggers, although almost never in full presence.

In the late Middle Kingdom, the harbinger of the things to come (increased presence of foreigners and their warriors in Egypt) are the rich burials of foreign type at Tell el-Dab^{c}a. It was suggested that these persons might have been involved in the organization of the expeditions to Sinai.[1426] The particular types and shapes of weapons are exotic to Egyptians, but with the exception of swords and metal belts of warriors; battle axes, spearheads and daggers were also the Egyptian weapons of choice (and Sinuhe used in his fight with the giant from Retjenu these weapons exactly). This aspect of the material culture involves Egyptians into the wider Eastern Mediterranean world, and there are foreign weapons in the Egyptian contexts as well, for their overview see below subchapter 5.4.17.

1422 (Odler 2016, 207).
1423 (Borchardt 1911, 165, JdE 30968; Zitman 2010, 157–164, 210–212).
1424 (Chassinat and Palanque 1911, 47–48, 111, 112, Pl. XIII, Pl. XXII: 1, Pl. XXIII: 3; Zitman 2010, 257–260)
1425 (Philip 2006, 230).
1426 (Philip 2006, 228–231).

One of the topics of the recent research was presence of the items of personal care (such as razors and tweezers) in the burial equipment of the Bronze Age warriors,[1427] in north-eastern Africa especially in the Kerman burials.[1428] In Egypt, similar examples can be found, again in the burial equipment of Nekhet, containing both battle axes and razors. The external influence in Egypt might be identified with weaponry, but the cosmetic tool kit is a standard item of the elite burial equipment.

Final remark must be expressed about the occurrence of weaponry in the female graves. Weapons are often considered as the clearest example of the "masculinity" of the buried person. Yet, also in the periods under study, this idea is being effectively doubted by some finds. A full-size dagger was found in the sarcophagus with Princess Ita at Dahshur.[1429] A wooden model of a dagger was found with the Princess Nebuhetep, also at Dahshur.[1430] In much humbler area of the C-Group culture, a few daggers were found with female bodies as well.[1431] For a major burial of a woman with weaponry, one must step slightly out of the periods under study, but the famous Dynasty-18 burial assemblage of Queen Ahhotep II included daggers and blades, one with the cartouche of the King Ahmose.[1432] If the circumstances of the find would not be known, this axe would be certainly ascribed to the king himself, based on the Egyptological practice of identifying inscriptions with the owners, not to the funerary equipment of a queen. The available evidence indicates that some weaponry was probably used also by women.

5.4.10. Statuary, regalia and boats

The evidence of the copper and bronze statuary in the periods under study is scarce, due to the possible recycling of the material in later periods. Statues and statuettes perhaps offered extensive source for the remelting of copper, arsenical copper and tin bronze. However, sufficient evidence is preserved to outline the chronological and technological development of this category of material culture. Chorological aspect is more problematic, because of the almost no information about the archaeological contexts of many pieces of statuary.

Two technological categories can be delineated[1433]: firstly, the statuary made of metal sheet (called also by Greek word *sfyrelaton*), which was made by hammering of the cast metal sheet into desired shape. The only extant copper examples of this type, from the whole history

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1427 Seminal article on Bronze Age European warriors was published in 1995 and the discussion is ongoing: (Treherne 1995; Frieman et al. 2017).
1428 (Hafsaas-Tsakos 2013; Manzo 2016).
1429 (Morgan 1903, 48, 51–52, Fig. 106; Podvin 2000, 328–329, ME23)
1430 (Morgan 1895, 107–117; Podvin 2000, 333–334, ME30)
1431 (Wolf 1935, 114–115).
1432 (Davies 1987, 53).
1433 Technologies of the production of statuary were described in detail by (Schorsch 2007).

of Egyptian art, are two statues of Pepy I and Merenra found in Hierakonpolis. The head of falcon (Horus?) made of golden metal sheet and body of the falcon, made of copper sheet, was produced by the same technique.[1434] Secondly, more numerous category are statuettes, which were cast into the moulds. Earliest cast statues and statuettes were solid casts, hollow castings appeared only in the late Middle Kingdom. The statuary was cast into moulds, which were then destroyed to gain the result of casting.

Concerning the preserved types of the statuary, three main types can be defined, of cultic images, royal statuary and non-royal statuary. The function of the preserved royal and animal statues was most probably cultic, they have served as cultic images of the royal and divine cults. Metals were materials used for the production of the cultic images, but most probably not all of them were made of metal. The crouching falcon from Hierakonpolis is an example of cultic image, possibly buried due to the refurbishment of the temple. Golden head of the hawk (presumably cult statue depicting Horus of Nekhen) was supported by a copper body. In front of the falcon was standing figure, most probably a king.[1435] Other example is the statuette of crocodile (Sobek?), now in Munich. Two copper feathers from Abydos are very unusual remains of statue. According to Bussmann, they might have been from the atef-crown of Khentiimentiu, if he had similar iconography as Osiris later.[1436] They have been found in the Building H together with some other temple equipment, e.g. copper cylindrical vase.[1437] Two copper statuettes from Abydos were the only metal statuettes found there. They might have been votives deposited in the temple.[1438]

Royal statuary is represented by the striding king trampling on the representation of nine bows (Pepy I from Hierakonpolis). Striding king is also the subject of one of the statues from Fayum. The statue of the child (Merenra I) with falcon protecting his head has parallels in the stone royal statuary, in the statue of young king Raneferef.[1439] The statuette on the censer lid depicts prostrating king Senusret I and was found at Deir el-Ballas.[1440] This statuette is different in enacting the ritual activity, thus an action of the king in front of the deity. Just the fragments of ancient Egyptian royal crowns were preserved. In case of stone statues, a copper “wire” on the Red Crown was made separately from copper. Presumed

[1434] Some authors expressed their opinion on the New Kingdom dating of the falcon statue, (Rössler-Köhler 1978; Eaton-Krauss 1981).
[1435] (Blumenthal 2003; Eckmann et al. 2005).
[1436] Bussmann (2010, 198).
[1437] (Bussmann 2010, 93).
[1438] (Bussmann 2010, 323, Abb. 5.1062 - 5.1063).
[1439] JdE 98171 (Benešovská 2006, 386–391, Fig. 2.7.24; Stadelmann 2005, 128).
[1440] (Hill 2007, 9, Figs. 4-5).

fragment of a royal statue from Náprstek Museum, National Museum, Prague, is in bad, corroded state of preservation and was most probably cast without further processing.

Woman nursing her child (in one case princess Sobeknakht nursing her son and in the other probably Isis nursing Horus) are examples of the statuettes connected with both previous categories, and possibly based on the local traditions of informal subjects.[1441]

The use of metal statues for persons other than the king or royal family is highly improbable until the end of the Old Kingdom. The statues of officials had copper eyebrows at best, or in one probable case copper earrings. The earliest examples of small copper statuettes are usually dated to the late Old Kingdom and First Intermediate period. Then they continued in the Middle Kingdom and Second Intermediate period. In general, they are small and often works careless for the details and of mediocre craftsmanship. Metal statuettes of officials were in general smaller than the non-royal statuary in the stone and wood. We are lacking finds in the archaeological contexts, and it is difficult to guess their function. They might have been participants in the cult in the temples, donations of the wealthy individuals. Copper was more expensive material than limestone or wood.

Besides the falcon from Hierakonpolis, another early specimen of the statuary in shape of animal is a statuette of a bovine. It has bent legs, as if bound by a cord, prepared for killing, the statuette had a hollow space at one side, with four copper chisels found in it. It was found in the burnt layer over the palace of the governors at Balat, thus it is datable to the late Old Kingdom or early First Intermediate Period.[1442]

The most important Middle Kingdom find is a cachette of four statues from Fayum, currently on display in Munich.[1443]

Although we know about Neferirkara's barques made of copper from the Palermo Stone, archaeological evidence of such objects is meagre. The only remain of possible copper furnishing of a royal boat is a nail found during the uncovering of the mudbrick boat near sun temple at Abu Ghurab.[1444]

5.4.11. Musical instruments

Although written sources marginally mention metal, presumably also copper, musical instruments, evidence in the material culture is lacking. A calcite sistrum from Dendera, datable to the reign of Teti, had two rows of perforations that once probably held copper

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[1441] (Hill 2007, 12).
[1442] (Pantalacci 2010a).
[1443] (Giumlía-Mair and Craddock 1993; Giumlía-Mair 1996, 1997; Giumlía-Mair and Quirke 1997).
[1444] (Borchardt and Bissing 1905).

wires.[1445] Middle Kingdom glazed steatite sistrum fragment with the names of Senusret I was in a shape of Hathor's head, and the eyebrows were made of copper.[1446]

5.4.12. Objects of unknown uses

There are several preserved artefacts from the periods under study that defy simple distinction of their purpose by the comparison with written, iconographic sources or by other inferences. They thus represent objects of the unknown uses.

5.4.13. Looting of copper

Copper objects were one of the frequent aims of tomb robbers. It is not possible to estimate what was stolen, but some inferences can be made out of published contexts. In many cases, tomb robbers perfectly knew what was in the burial equipment and aimed for such objects. In Tarkhan, Petrie observed that copper was left at the ends of some burial chambers in graves.[1447] We can infer that at least some of the graves were disturbed by robbers who were not acquainted in detail with the burial customs at the site and might have been later when the exact burial customs were forgotten. The *modus operandi* of the looters differed from site to site and there are some, e.g. Naga ed-Deir or Balat, where substantial amount of copper was left and some other materials were rather taken out.[1448]

Some wealthy tombs conspicuously lack copper in the burial assemblages. The list is potentially endless, but only a few cases are needed to be discussed. As an example can be listed Tomb U-j from Abydos, datable to the phase IIIa2 of Naqada culture.[1449] The tomb was looted partially in the past, but there have been found lot of remaining objects from various materials, but not a single copper artefact. It is possible that looters targeted on copper as one of the interesting materials and copper artefacts were deposited in the looted part of the tomb. The finds from the so called „Meni" tomb in Naqada provided no copper artefacts as well, tools were made of bones and flint (115 pieces). Tomb is dated to the reign of Aha[1450] and ascribed to Queen Neithhotep.[1451]

Hierakonpolis is an example of an important predynastic site in Upper Egypt, where copper appeared only rarely. According to B. Adams either metallurgical parts of the site are

[1445] Metropolitan Museum of Art, New York, 26.7.1450 (Fischer 1968, frontispice).
[1446] (Stünkel 2015, 104–105, cat. 45).
[1447] (Petrie,Wainwright and Gardiner 1913, 13).
[1448] (Mazé 2018, 129).
[1449] (Dreyer et al. 1998a).
[1450] (Kahl et al. 2001).
[1451] (Callender 2011, 7-9).

located outside of the excavated area or the level of the ground water was to high to preserve copper artefacts as well.[1452]

5.4.14. Foreign material culture in Egypt

From the written and iconographic sources, we can infer a presence of foreign material culture in Egypt, at least since the Old Kingdom. Metallurgy itself must have been a foreign import in Egypt, unfortunately, we do not have any preserved workshops from the fourth millennium BC. Many morphological and typological conclusions in the previous literature were used as a support for wishful thinking, although the differences in material culture items were demonstrable. More solid conclusion might be formulated only with the support of the archaeometallurgical methods. Nevertheless, there are several incidences of copper objects typologically foreign to the Egyptian material culture.

Among the earliest examples of foreign objects in Egypt can be included two most probably Early Dynastic spearheads with hooked tang, one found at Tura, another at Saqqara.[1453] The blade from Tura was made of arsenical copper and might be, alongside Saqqara specimen, local Egyptian imitation of the Levantine hooked spearheads, typical for the Early Bronze Age.[1454]

Weapons of the enemies of ancient Egypt were depicted in Old Kingdom reliefs, but they are absent in the material culture. The iconography provides decisive evidence that the Egyptians were acquainted with the foreign weaponry.[1455] Long crescentic axe blades are rather old in the Near East, presumably invented in the northern Mesopotamia in c. 2900–2700 BC, earliest Egyptian depictions are in the mortuary temple of Sahura at Abusir.[1456] Axes of foreign shapes are certainly present in Egypt in the First Intermediate Period and Middle Kingdom. This is the case of anchor axes (Type Foreign1 on Figure 5.30), found at Abydos and Helwan, Abydos specimen moreover made of tin bronze.[1457] They probably originated in Syria, a specimen is known from Byblos, but they were also found in Mesopotamia and in Transcaucasia. These axes are dated to the period between EBA IVB and MBA I in southern Levant.[1458] Analysed Levantine fenestrated axes were made of tin bronze, and few of leaded bronze.[1459] From the Western Delta, from Kom el-Hisn, are the finds of most probably the epsilon axe blades with socket eye at butt, although the published

[1452] (Adams 1995, 172).
[1453] (Firth and Quibell 1935, 124, Fig. 11, Pl. 93: 3; Odler et al. 2018, 429–430, Fig. 10).
[1454] (Montanari 2015, 72–73, Figs. 4-5).
[1455] (Odler 2016, 160).
[1456] (Gernez 2017, 93)
[1457] (Petrie 1925, 6, Pl. V: 28, 29; Saad 1948, 173–174, Pl. LXXXVIII).
[1458] (Montanari 2015, 68, Fig. 2: 6; Gernez 2017, 64).
[1459] (Philip and Cowell 2006, 212).

specimens were made available without complete documentation.[1460] These seem to be the representants of the early type, occurring in southern Levant since EBA IV.[1461] Some other foreign axe blades were found unsurprisingly at Tell el-Dabᶜa, and these are later specimens of the duckbill axe and chisel-shaped narrow axe blades with socket eyes.[1462]

This site is also a source of other artefacts otherwise foreign to Egypt, as e.g. an early example of curved sword from Stratum F, and several examples of copper belt buckles, object not known elsewhere in Egypt.[1463] Also in case of sickle sword, it is a late appearance of a weapon used already by Akkadians.[1464] Somewhat later specimen than from Tell el-Dabᶜa was found further south, at Abydos, datable to Dynasty 15 or later. Typologically in between is positioned a sickle sword from Byblos, by K. Kopetzky.[1465]

Annals of Amenemhat II describe the booty of the most probably Middle Bronze Age Cypriot and Cilician material culture brought to Egypt. With the help of the archaeological knowledge of the region, we can attempt to estimate the forms of the artefacts. This period falls into the Middle Bronze Age / Prehistoric Bronze Age of Cyprus (c. 2400–1690/1650 BC).[1466] Early weaponry of Cyprus demonstrates affinities to the inventories of Anatolia and, in lesser degree, to Northern Levant.[1467] A large corpus of the objects from the first half of the 2nd millennium BC was just recently analysed from the site Lapithos, near the northern coast of Cyprus, facing Cilicia (Figure 5.73). Tin bronzes, clearly not made of local tin source, alongside leaded bronzes and arsenical copper were identified.[1468] It seems that the Egyptians tried to described the objects from Cyprus by the analogical words in Egyptian, and e.g. razors were quite similar to the ancient Egyptian earlier types.[1469] Also other objects in the first part of the list are by Egyptian administrators determined without any problem by the usual hieroglyphic determinatives. Among the products of the Cypriot metallurgy were also swords, probably denoted by the word *mšd* in the annals (Figure 5.72).[1470] Another Eastern Mediterranean object might be a harpoon with five points.[1471] Such object was not published

[1460] (Hamada and Amir 1947, 198, nn. 7, Pl. xxxi, top right; Davies 1987, 78, 80, 81).
[1461] (Montanari 2015, 68, Fig. 2: 5).
[1462] (Philip 2006, 33–41).
[1463] (Forstner-Müller 2001, 217, Abb. 19; Prell 2020).
[1464] (Gernez 2017, 132–133)
[1465] (Kopetzky 2018, 332–333, Figs. 22-24).
[1466] (Knapp 2013, 521).
[1467] (Gernez 2017, 163–165).
[1468] (Charalambous and Webb 2020).
[1469] C.f. (Webb et al. 2006, Fig. 1: 15, 16).
[1470] (Webb et al. 2006, Fig. 1: 8; Altenmüller 2015, 75).
[1471] (Altenmüller 2015, 74–75).

from Cyprus, but such harpoons were in the Second Intermediate Period produced in Tell el-Dab^c^a (Figure 5.14). Parallels of other objects are difficult to find.

One issue is remarkable. Egyptians were in contact with the seemingly more elegant technological solution, such as socket eye for the insertion of haft. Yet, Egyptians followed rather their tradition and a solution which was working in their social and technological conditions, solution of the binding blade to a handle or a haft by leather thongs. Clear foreign influence can be seen in the production of weaponry, where ancient Egyptian craftsmen tried as well to prolong the blades of battle axes, in order to increase their efficiency in combat. *Vice versa*, Egyptian influence did not reach even Sinai. Local inhabitants of the peninsula produced also metal objects, but they are more similar in their morphology to the Levantine artefacts.[1472] But curiously enough, a razor blade from Byblos and another specimen from Cyprus, Toumba tou Skourou, is inspired by the late Middle Kingdom shape of razor blades.[1473]

Comparison of mere shapes and forms can be misleading, we might be able to find out the foreign artefacts or material and identify thus invisible connections by another approach, with the help of the archaeometallurgical methods. But the knowledge of the ancient Egyptian copper metallurgy is still only rudimentary, as the next chapter explains.

[1472] (Beit-Arieh 2003, 196–208; Pfeiffer 2013).
[1473] (Kopetzky 2018, 333, Fig. 25).

6. Archaeometallurgy of ancient Egyptian copper

After discussion of conventionally used written sources, less conventionally studied archaeological sources; I have to approach in this chapter the sources which until now have rather marginal impact on the reconstruction of ancient Egyptian history. These are the methods and results of natural sciences that can be used to study the physics, chemistry, and technology in general of ancient objects and environment. This chapter provides short description and evaluation of methods used in the analyses of ores and artefacts, a synthesis of the natural sources of copper available to ancient Egyptians, and the evaluation of published results on the metalworking and finished products of metalworkers. Archaeometry provides methods suitable for the analyses of each stage of *chaîne opératoire*. The methods are not an end in itself, they are tools that can be used and misused for various purposes. With the use of specific methods – tools, the usability of the information provided is changing. Egyptologists need to understand the potential and limitations of the methods, in order to correctly perceive and comprehend the results.

A database for the synthesis of the archaeometallurgical information on the periods under study includes 962 items of analysed artefacts and ecofacts, connected to the use of copper. These were gathered from the all accessible published and some unpublished sources, and for the first time, the information is connected back to the archaeological context of the finds, if it was possible to be tracked down from the literature. Only 192 items of the database, 20% of the corpus, is of unknown provenance and in most of these cases, typology can help in the dating of the objects. Therefore, 770 artefacts and ecofacts can be mapped in Egypt and Nubia, located at least on the precision level of a site (Figure 6.1). This corpus enables to assess the use of specific alloys and materials in ancient Egypt from Badarian to the beginning of the rule of Hyksos. Looking on the regions represented, one fifth of the corpus is from Abydos, although most of the analyses were done in earlier studies. Still rather well represented is the region between Asiut and Abydos, with almost one seventh of corpus. Clearly underrepresented is Memphite region, with the most numerous archaeological finds from the periods under study, and the situation is even worse in Thebes, where there is almost total absence of analyses of Middle Kingdom material. The gravest problem causes the low number of the analyses from archaeologically documented Sinai and Eastern Desert contexts, since they were the major sources of the copper ore of ancient Egypt. Current policy of handling with samples in Egypt will impede increase of precisely this number in the future.

6.1. Methods and their use in the periods under study

The methods represent a toolbox, with which it is possible to answer specific research questions. Several methods used at once can bring stronger corroboration of arguments, more "weight" to the reasoning. However, the numbers produced by the methods do not always have fully comparable precision and accuracy. Egyptologists, non-specialists in the archaeometric research, need to be aware of these limitations and with this knowledge assess the results. This understanding is necessary in communicating the results of scientific disciplines. Honest approach is to be open about the background data, how they were obtained, and what were the steps in reaching the published conclusion.[1474]

Egyptian archaeology uses the data of the natural sciences based on the current state of research in respective fields. The published results often represent best judgment of the authors, based on existing evidence. E.g. the latest results of the lead isotope analyses can be interpreted differently in the future.[1475] The presence of nickel in the alloy of iron objects was sufficient argument for the meteoritic origin of the iron, latest analyses need to study the microstructure of the metal and presence of other trace elements.[1476] It is not an argument against the analyses. Only on the wider basis of data, earlier hypotheses can be redefined.

Figure 6.2 displays the published analyses from the periods under study and the number of artefacts and ecofacts.[1477] Only two surveys were of sufficient statistical relevance for Egypt, with more than hundreds of analyses, of H. McKerrell and M. Cowell, although McKerrell's data are currently rather antiquated. Most of the recent publications contributed by tens of new analysed artefacts, and in these cases, several methods are used for a single artefact, in order to comprehend more aspects of its use. But bulk of the published reports offered less than five analyses for the periods under study. Total number of 962 analyses seems to be high, but as it is expressed above and below, the corpus represents well only selected artefacts, areas, and periods. In the nearest future, more analyses can be expected to be published from the RMAH Brussels collection and material excavated by Karl Kromer from Giza.[1478]

Figure 6.3 demonstrates the popularity of methods and combination of methods in the corpus, and also reflects that before 1960s, it was not considered usual to inform about the

[1474] To put it simply, none of the methods is capable of inserting a sample in a machine, pressing a button and after a while, results together with the final interpretation come out. This is for now impossible and most probably never will be.
[1475] On this topic, see e.g. (Ben-Yosef 2018).
[1476] (Johnson et al. 2013; Rehren et al. 2013).
[1477] From the published reports is missing (Boatright 2010), as the complete elemental results were not published.
[1478] Preliminary assessment of Brussels material in (Rademakers et al. 2016), Kromer material will be published by the present author, J. Kmošek, M. Fikrle, Y. Kochergina and M. Racek.

methods applied (undefined methods used). One third of the corpus consists of X-ray fluorescence data and this method is still on the rise, but it has many inherent problems. One quarter of the corpus is represented by the results of the atomic absorption spectroscopy, considered comparable to current methods. Hopefully, the number of analyses by ICP-MS, NAA and PIXE will be rising in the future. Metallography is not well represented, as it requires sometimes substantial amount of a sample. In case of museums, British museums contributed the most, then French and German museums. Rich collections in Egypt, Sudan and United States remain the least known, and Egypt is clearly leading in the number of artefacts not analysed by any method. In following subchapters, subsets of data for each method are evaluated, in order to describe the current state of research.

In cases of ten artefacts, it is possible to compare the results of the analyses of the same artefacts in a few consecutive studies (Figure 6.4). One of the apparent problems of the early methods was the identification of arsenic, thus several objects were considered to be mere copper with impurities, in case of chisel from Kahun and axe of unknown origin (1554). Most of the analyses, however, identified main elemental patterns. Further statistical operations are reasonable only with AAS results, not the XRF. In the corpus, I have aimed for completeness, thus also these early less reliable results were incorporated. In order to further the discussion in Egyptian archaeology, main elemental patterns are important to be followed, comparing results of the methods with different precision and accuracy.

Two issues must be considered for each method: precision and accuracy. Precision means comparability of the data; accuracy means reliability and "limits of inference".[1479] Comparison of the methods reveals that not always the latest methods have the best sensibility. By far the best methods for the establishing of chemical composition are either ICP-MS or NAA, more inaccessible solution is PIXE.[1480] Other fundamental categorization of the methods is in the information offered, whether it is qualitative, giving information only on the chemical elements present, or quantitative, capable of assessing the ratio of the elements in the object or sample. Herein, the methods are divided not on the basis of their chemical, scientific approach, but from the archaeological and curatorial point of view – whether they do require or do not taking of a sample. For a detailed technical description of the methods, reader needs to seek elsewhere.[1481]

6.1.1. Non-invasive methods

[1479] (Knapp 2000).
[1480] (Pollard and Heron 2008, 32–33).
[1481] E.g. (Pollard and Heron 2008).

These methods do not require taking of samples and they offer information on the internal structure of objects. However, the last listed method, X-ray fluorescence analyses surface of the sample. Thus, often corrosion products need to be cleaned on the selected spot of the object, and from the point of view of many archaeologists and museum curators, it is already an invasive method. However, if only corrosion products are analysed, no substantial information on the original artefact is provided.[1482]

6.1.1.1. Radiography

Radiography or X-ray photography provides information about the internal structure of the simple and compound artefacts. It can identify the metal core of the otherwise corroded objects, thus leading to informed sample taking.

Most of the artefacts from periods under study are rather simple, with only a few parts of assembly at most, therefore, the radiography was applied only seldom. D. Schorsch used macroscopic examination and X-ray photography for the examination of production techniques of the Early Dynastic and Old Kingdom spouted jars.[1483] Spouts were made from the copper plates or poured into the mould. They were attached to the vessel body by the nites and cold hammering. The vessels were made only by hammering.

Potential of the radiography methods lies in the research of the composite objects, in the periods under study especially weaponry and jewellery. Moreover, radiography can reveal the internal structure of the artefacts and their remaining metal core, which can help in the decision whether is reasonable to sample the object.

6.1.1.2. Computer tomography (CT)

X-ray computer tomography is a method that also provides information about the internal morphological structure of the simple and compound artefacts. In case of Old Kingdom vessel ÄMUL 2169, tomography displayed well the pattern of the hammer blows used to shape the vessel (Figure 6.5). A selected number of the artefacts photographed from the collection of the Egyptian Museum of Leipzig University were published.[1484]

6.1.1.3. Other methods

Some non-invasive methods are used only infrequently, as they require complex and expensive equipment. In the study of iron beads from the Naqada culture cemetery at Gerza was used prompt gamma activation analysis, quantitative assessment of chemical composition that can determine the composition of a complete small object, e.g. a bead. For the picturing

[1482] As is the case of one recent papers (Abe et al. 2019).
[1483] (Schorsch 1992).
[1484] Article in Czech (Odler et al. 2016).

of the internal structure of the bead, neutron radiography was applied.[1485] These methods can be performed only at the specific installations, as these were located at the Wigner Research Centre for Physics, Hungarian Academy of Sciences, Budapest, and the beads were transported to the facility from Petrie Museum, UCL, in London. The approach is justified by the uniqueness of the finds.

Neutron radiography offers significant new avenue of the research, as it is capable of uncovering the structure of the object, but also, accompanied by other methods, assess its chemical composition. It was not yet applied to ancient Egyptian material. The current problem of the method is its rarity, a source of neutrons, usually nuclear reactor, is needed.

6.1.1.4. X-ray fluorescence spectrometry (XRF)

XRF is a technique using X-ray fluorescence to excite the surface of the sample, in order to shift electrons in the outer shells of the atoms.[1486] Two phenomena occur, absorption of photons and emission of the X-rays fluorescence. The method can be performed either on the invasive samples that were homogenized and XRF is stationary, or on a cleaned surface of an artefact with the portable XRF analyser. Two approaches are possible in the analyses of the results, either energy-dispersive X-ray fluorescence (ED-XRF) or wavelength-dispersive X-ray fluorescence (WD-XRF). ED-XRF is faster and also cheaper method. Due to the surface sensitivity problems, ED-XRF needs to be perceived as qualitative or only semi-quantitative method on analysed archaeological surfaces. Portable XRF methods are exceedingly popular currently, but there are many inherent problems with the use of this type of instrumentation. Since only surface of the sample or artefact can be analysed, the technique might give very imprecise information about the bulk composition of objects. Portable XRF does not replace techniques with better precision and accuracy.[1487]

XRF data in Egyptian archaeology are numerous, but due to the increasing precision of the method, past data bear only qualitative information on the analysed objects. This is valid for more than 400 objects analysed in 1970s in the Ashmolean Museum, of which 209 are incorporated in the examined corpus.[1488] However, at least it is possible to distinguish the main alloy patterns. Because of the popularity of this method, let us also examine the analysed artefacts, their sites and dating (Figure 6.6). Major study of H. McKerrell gave the most numerous data and Ashmolean Museum collection is rather well described for the state-of-the-art technique of early 1970s. X-ray fluorescence targeted provenanced objects and two

[1485] (Rehren et al. 2013).
[1486] (Pollard and Heron 2008, 33–45).
[1487] Recent discussion of problems with portable XRF in (Pearce 2019).
[1488] (McKerrell 1971; Eaton and McKerrell 1976). Published were only major counts of sites and alloys.

main represented sites are Early Dynastic Abydos (half of all Early Dynastic objects analysed was from Abydos) and Bet Khallaf. Recent studies offer less numerous data, but the methodology is described in greater detail and presumes further comparability of data.[1489]

6.1.1.5. Electron microprobe

The character of this method is invasive only on a micro-level, depends on the size of analysed objects or samples taken. It uses electron beam to excite the emissions characteristic for various elements. In the periods under study, it was not used often, but if it was, it analysed very important materials mainly in the form of their cross-sections: metallurgical remains from Sinai and Buhen; besides two daggers from Kerma.

6.1.2. Invasive methods

The boundaries between methods are not clear-cut and the categories presented here can be sometimes interchangeable. With the sufficiently big chamber, scanning electron microscope is able to encompass whole artefact, just as if portable XRF technique can reach the metal core through a broken off edge in the past, it can provide reasonable information about the bulk composition. But in general, methods listed below do require taking of a sample. Techniques used for the removal of samples are usually either drilling or sawing for flat samples for microscopy. The amount of sample depends often on the one hand on the capabilities of the person sampling the object, on the other hand on the discussion with the archaeologist and curator. The taking of sample should impair minimally the appearance of the object and c. 50 milligrams of the metal is often enough for wide range of analyses, as well as 1 or 2 mm^3 is enough for an examination under SEM microscope, for metallography or other methods.

6.1.2.1. Scanning electron microscope and Energy-dispersive X-ray spectroscopy (SEM – EDS)

Electron beam can be used to stimulate X-ray emission, in order to study the samples. The microscope might be equipped with energy-dispersive X-ray spectroscopy (EDS) or wavelength-dispersive spectroscopy (WDS).[1490]

6.1.2.1.1. Metallography

Macroscopic evidence was discussed in the previous chapter on archaeological sources. On the micro-level, the only way of finding out about the microstructure is by taking a metallographic sample.[1491] Metallographic sections of the ancient Egyptian artefacts are not

[1489] E.g. (Odler et al. 2018).
[1490] (Pollard and Heron 2008, 45–49).
[1491] (Scott 1991; Scott and Schwab 2019).

common, exactly because of sample taking. The size of the sample depends on the abilities of the sampler, the sample taken should not impair the overall appearance of the object. However, in several museum collection exist horrifying examples of artefacts cut through or severely damaged by sample taking. It must be stressed that this is not the current state of the art.

Two fundamental techniques can be distinguished, the copper could have been either cast and only cleaned or cast, hammered and re-heated repeatedly, until it reached the desired shape and properties. The first approach leaves so called dendrites in the microstructure of metal, which are remains of the different cooling down of the various parts of the material. Hammered structure of the metal looks on the micro-level completely different, with a wrought structure. For the periods under study, the former structures would appear in the presumed ingots, then statuary or some parts of the vessels; the latter structures are typical for the objects practically used, such as tools and weapons. Besides wrought structures, annealing twins can appear. Ideal situation, which will be difficult to achieve, would be in having a metallographic sample for each artefactual class and type of artefact, in different periods and made of different alloys, cataloguing the production processes of ancient Egyptian metallurgy. Even highly fragmentary objects can be determined typologically and then studied within this context. These are often artefacts that will never be displayed in any museum collection, yet they might contribute decisively to the knowledge of ancient metallurgy.

While ancient tin or leaded tin bronzes are relatively easy to make in present, comparatively less is known about artefacts made of arsenical copper, because such objects were rarely sampled for metallographic sections.[1492] It is possible that due to a varying quality of the available ore, hammering and annealing of the objects was inevitable to secure the desired mechanical properties. Hammering is also a frequent motive of Old Kingdom metallurgical scenes in the tombs. Method for the measurement of the practical hardness of the material can be performed on the metallographic sections, Vickers microhardness, using Vickers diamond pyramid and small test loads. This method can be used on small samples and is widely used in archaeology.[1493]

Metallography is also decisive method in the assessment of the effort used for the production of ancient Egyptian models. Model tools were supposed to be a cheaper solution to

[1492] For bronzes see (Ottaway and Wang 2004), for ancient Egyptian arsenical copper (Kmošek et al. 2016a, 2018).
[1493] For a discussion of the method and other methods see (Scott and Schwab 2019, 60–64).

that of full-size functional tools in the tombs of the Early Dynastic period.[1494] This was indeed true with respect to the amount of metal. However, the metallographic analyses of the artefacts[1495] have shown that the copper model tools were repeatedly annealed and hammered into the desired shapes after the casting and that their production was a time-consuming issue as well.

Overview of the results of metallography and microhardness for the objects is presented on Figure 6.7. Generally, it can be seen that most of the functional full-size tools were cast, hammered and annealed into shape. Extremely rare are artefacts that were only cast and cooled down, but among those is also a rather big axe blade from Early Dynastic Abydos.

6.1.2.2. Optical emission spectroscopy (OES)

This method is not used anymore, but it was rather frequent especially in the period between 1950 and 1980. The powdered sample is excited by electrode and emitted light is focused on a prism and divided into specific wavelengths. The emission is recorded on a medium, e.g. photographic material. The advantage of the method is a possibility of quantification of the chemical elements present, and also possibility of finding out the elements unsought for. The disadvantages are the difficult reproducibility. Only c. 20 elements can be measured at once. Coefficient of variation is between 5 and 25%.[1496]

In Egyptology, it was used in case of Kerma and Middle Kingdom metalwork, unfortunately, this study did focus only on the occurrence of tin bronze and disregarded arsenical copper. Binary results of either “copper” or “bronze” were offered, where a more complex situation is to be expected.[1497]

6.1.2.3. Atomic absorption spectroscopy (AAS)

OES was replaced in archaeometry by another method, AAS.[1498] Light that is typical of a certain element has to be absorbed by the sample, what requires the sample to be in liquid form and only a single element can be measured at once. In a sequence of steps, many samples can be analysed for a presence of a single element. The disadvantage of the method is that the analysis cannot identify unexpected elements, although there is low chance of their presence in historical materials. Coefficient of variation for the elements is between 1 and 5 %, with detection limit between 1 and 100 mg/kg.[1499] The results of the AAS can be used until

[1494] (Grajetzki 2003, 19).
[1495] (Maddin et al. 1984).
[1496] For a discussion of the method with further literature (Pollard and Heron 2008, 24–25).
[1497] (Dunham 1943b, 1943a).
[1498] (Hughes,Cowell and Craddock 1976; Van Loon 2014).
[1499] (Pollard and Heron 2008, 25–29).

today and are comparable with results of other methods, identified elemental patterns are reliable.

As the AAS was one of the more popular methods in Egyptian archaeology, it is again possible to study the structure of the dataset (Figure 6.8). The largest analysed part of corpus was published by M. Cowell in the catalogue of axes in the British Museum. Since this collection comprises also a large number of unprovenanced finds, these create more than half of the corpus. Also, axes were the most frequent artefact class by AAS. From other areas and periods, only Early Dynastic Abydos and late Middle Kingdom Tell el-Dabᶜa stand out by the number of analyses.

6.1.2.4. Inductively coupled plasma emission spectrometry (ICP) group

ICP is based on the principle of OES, but a plasma torch is used to reach the temperatures of 8,000–10,000°C.[1500] The liquid sample is injected into the plasma, it is dissociated and excited. Up to 20 elements can be measured at once. Method is suitable for the multi-element analysis of samples. The torch can be used together with the mass spectrometry detector, for the measurement of the abundance ratios of elements, in archaeology especially lead. Mass spectrometry is based on an assumption that atoms of different atomic masses can be controlled by the imposition of electrical and/or magnetic fields.[1501] In straight mass spectrometry, thermal ionization mass spectrometer (TIMS) is used. In hyphenated techniques, quadrupole mass spectrometer is used instead but with lower precision of the results.

Laser ablation enables to vapour a solid sample from an object, thus limiting the sampling surface needed. The method can be used for tiny objects. Laser is directed on a solid sample, with beam diameter below 25 μm.[1502] In the periods under study, this technique was not yet used frequently, most notable exceptions being the study of ores from Sinai and Eastern Desert and a study of the objects from the Royal Museum of Art and History in Brussels.[1503] In latter case, more published results of the objects of Middle Kingdom and later periods are to be expected.

6.1.2.4.1. Lead isotopes analyses (LIA)

Lead isotope analyses was one of the most promising archaeometric methods, used in the determination of the ore sources. The method uses geochemical characteristics of lead to form a hypothesis about the origin of copper or lead in the alloy. Metals usually form different

[1500] (Pollard and Heron 2008, 29–33).
[1501] (Pollard and Heron 2008, 56–61).
[1502] (Pollard and Heron 2008, 60–61).
[1503] (Abdel-Motelib et al. 2012; Rademakers,Rehren and Pernicka 2017).

isotopes, but lead is unusual in the number of the isotopes – four – and that three of the isotopes are at the end of radioactive decay chains. The isotopes produced by the radioactive decay are *radiogenic*: ^{206}Pb, ^{207}Pb and ^{208}Pb. Fourth isotope, ^{204}Pb, is called *primeval*, because of its primeval presence in the solar system. The isotopes are analysed by thermal ionisation mass spectrometry (TIMS) or more recently by inductively coupled plasma mass spectrometry (ICP-MS).[1504] The results are plotted as two diagrams, displaying in the first $^{208}Pb/^{206}Pb$ against $^{207}Pb/^{206}Pb$ and in the second $^{204}Pb/^{206}Pb$ against $^{207}Pb/^{206}Pb$. The main information from the lead isotopic ratios is negative, it is possible to ascertain that material was not coming from a specific source.

The application of lead isotopes was initially focused on the Late Bronze Age Eastern Mediterranean, predominantly Aegean part. In 1990s, heated debate arose about the analysis and interpretation of results. Summary of two competing views can be found in the volume “From Mine to Microscope”.[1505] The archaeological point of view of reservations to the lead isotope analyses in the Late Bronze Age were summed up well by A. B. Knapp.[1506]

Ancient Egyptian metallurgical remains and objects were investigated, but to a much lesser extent.[1507] Current debate involves also the work of the author and his team.[1508] Lead isotope data from Ancient Egypt and Nubia are still scanty, but they have been neither summarized nor evaluated. In this thesis, I am summing up the disparately published data on the lead isotope ratios from the periods under study. Some issues must be made clear from the outset: study of the provenance suffers from the lack of data on ore bodies in Egypt and Sudan. Sinai Peninsula is best represented, but geologically rich Eastern Desert woefully lacks substantial data. Until this dearth of data will be replaced by analyses, many conclusions are only tentative. Equally under-represented are any samples of the ore from datable archaeological contexts. If we would rigorously omit all ore data without verifiable dating, we would have just a very few to use. Mapping out of the available data is presented on Figure 6.9. Only few sites have available higher number of isotopes, especially Abydos, Bet Khallaf, Maadi, Giza and Aniba (not yet published in full). Lead isotopes from datable archaeological contexts in Eastern Desert and Sinai are scant and highly improbable to increase significantly in the future.

1504 None of these machines is available in Egypt.
1505 (Pollard 2009; Gale 2009).
1506 (Knapp 2000, 2013, 413–416).
1507 (Stos-Gale,Gale and Houghton 1995; Shortland 2006; Rademakers,Rehren and Pernicka 2017; Yahalom-Mack and Segal 2018).
1508 (Ben-Yosef 2018; Kmošek et al. 2018; Rademakers et al. 2018).

The structure of the dataset needs to be also parsed to the types of artefacts and ecofacts and the chart demonstrates very heterogeneous group (Figure 6.10). Copper ore itself comprises almost 20% of the assemblage. Artefact types create diverse and random collection. 13% consists of galena, which is not even sufficient for the assessment of the copper ore used, as the bodies of lead ore might have slightly different origin.

In the wider region of Eastern Mediterranean, Egyptian sources, especially of Eastern Desert, are the least known (Figure 6.11). This fact needs to be named as the gravest problem of the current research of ancient Egyptian archaeometallurgy. Although the method of the evaluation of lead isotopes and trace elements has its disadvantages, some ore bodies are well known and can be identified, as will be discussed in subchapter 6.2. Surprises in the identification are not ruled out, such as identification of similar isotopic ratios as in Early Bronze Age Anatolia.[1509] A mixing of the ores might influence the resulting isotopic ratios, and it seems to be case of both arsenical copper and tin bronze. Recent case studies offered first larger datasets of isotopes from the third millennium BC sites. Nevertheless, it is clear from the mapping out of the sites and charting of the artefact types that existing data cannot fully represent the diversity of the lead isotopes present in the ores and artefacts used by ancient Egyptians.

6.1.2.5. Particle-induced X-ray emission (PIXE)

Proton beams can be produced by Van de Graaff accelerator and the diameter of the beam can reach down to micrometre depth.[1510] The great advantage of the method of minor and trace elements composition analysis is that it can be used invasively on micro-level, on artefacts, and even on the inks and other pigments used on papyri. The disadvantage is the high cost of the appliance and limited availability. This method is not used often in Egyptian archaeometry.[1511]

6.1.2.6. Neutron activation analysis (NAA)

NAA method was used since its beginning in 1950s also on archaeological materials, for the analyses of the chemical composition.[1512] The invasively removed sample is irradiated in the nuclear reactor with neutrons. The detection limits for some elements are below the level of mg/kg. There are however elements, such as lead and bismuth that cannot be analysed by

[1509] (Kmošek et al. 2018).
[1510] (Pollard and Heron 2008, 49–50).
[1511] Exception is (Golden 2002). One of the institutions that has both PIXE and a large corpus of ancient Egyptian copper objects did not use the PIXE yet on large scale for the analyses of these objects: the Louvre Museum in Paris.
[1512] (Pollard and Heron 2008, 50–56).

NAA and this is its main disadvantage. The results of NAA are well comparable with the results of ICP.[1513]

Unfortunately, not much of the ancient Egyptian copper was analysed by NAA. Largest corpus of the ancient Egyptian metalwork analysed by NAA is from Egyptian Museum of Leipzig University, until now only with the publication of Early Dynastic and Old Kingdom data.[1514]

6.2. Procurement, initial processing, and transport of ore

This subchapter is focused on the elemental and isotopic characterization of the ore deposits available for ancient Egyptians. There were several areas around ancient Egypt with occurrence of copper ore and all of them bear traces of mining. The mining is not always possible to connect directly with the Egyptian activities in the areas, the Egyptians must have somehow cooperated with the local populations and the copper thus cannot be named "domestic". The gravest current problem is that most of the data is not measured on the samples coming from documented archaeological contexts (Figure 6.10). If hypotheses on the origin of ores are presented, they are largely based on the assumptions of most frequent ore sources in the respective era or on the artefactual typology. Again, the literature is full with assumptions based on nothing else than educated guesses. In order to define the current state of research, these unfounded assumptions need to be identified and named.

6.2.1. Eastern desert

Eastern desert is vast region, but detailed archaeometallurgical data are still lacking for many areas. It is rich and complex in geology, existing data are not yet sufficient for the thorough description of the mining regions. Inferences about the mined areas can be based mainly on the archaeology and geology of researched areas.[1515] Archaeological map of the proven and potential sources of ancient Egyptian minerals was published in 1989, update for gold and copper deposits in 2013.[1516]

The ore sources, being it for copper, gold, lead, or arsenic, were present in the Precambrian basement complex of the Eastern desert.[1517] Early prospectors at work were observed by R. and D. Klemm and their *modus operandi* can be well described. They were looking for the sulphide copper ore mineralisations and secondary copper oxides, malachite linings, in hydrothermal quartz vein deposits along granodiorite rocks. Copper was most

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[1513] (Pollard and Heron 2008, 55–56).
[1514] (Kmošek et al. 2018).
[1515] For the mineral deposits of Egypt, see (Hussein 1990).
[1516] (Castel and Soukiassian 1989, 9–12, map on p. 10; Klemm and Klemm 2013).
[1517] (Hussein 1990).

probably the original target of such mining, but its association with gold must have been also discovered already in third millennium BC.[1518] Even if the prospectors would not be able to explain scientifically the connection, it was noticed and used to their advance. In comparison to the New Kingdom, the sites are fewer, nevertheless they indicate systemic effort.[1519]

At el-Urf/Mongul South, the attention was focused on copper oxides (malachite, chrysocolla) in granitoids, with thin layers in the granite fractures. Also, mineralizations of hematite-specularite, with magnetite and barytine occur here. In the box work occurs also pyrite and chalcopyrite. At Wadi Dara, mines were either open or closed galleries. Mineralisations occur in gabbros, diorites and granodiorites. Long and thick veins of ore with copper oxides (malachite and green chrysocolla, also black tenorite). The ore is richer in copper than at el-Urf but has poorer contents of gold. In box works are residues of pyrite and chalcopyrite. Excavators assume that about 50,000 tons of rocks were mined to gain the copper ore with not very high yield.[1520] Mining activity was resumed here in the late Roman and Byzantine era, possibly also Arab Period. The focus changed to the occurrence of gold.

Existing information in the earlier literature contained predominantly data on the lead isotopes of galena.[1521] Recent explorations of the joint Egyptian–German team in the Eastern desert and Sinai Peninsula have been aimed also to the gathering of lead isotope data about the copper ores from several Eastern desert mining areas Since the trace elements of the samples were rather low, and geochemical and isotopic similarity was high, the authors claimed that it is impossible to distinguish ore districts of Eastern Desert, Sinai and even Wadi Arabah.[1522] Unfortunately, this claim is for Eastern Desert based only on 11 samples, one of them being lead ore. Two of them are from Ayn Soukhna, where ore from Sinai might have been processed.

Eastern desert is geologically rich region and there are also other minerals that would be helpful in the copper metallurgy. The most important were the iron ores, iron used as fluxing agent for the smelting of sulphidic ores. Their use was proven in the Wadi Dara operations. The area might have been also source of some arsenic-bearing minerals, as it seems that for high contents of arsenic in artefacts, it must have been added from a different source than copper minerals. Ironically, the area provides also one of the very few sources of tin in the whole Old World, but it seems that it was not identified by ancient Egyptian

[1518] (Klemm and Klemm 2013, 4–5). In other cases (e.g Wadi Dara) gold mining took place in Arab Period, not in the Old Kingdom.
[1519] (Klemm and Klemm 2013, 601–607, Figs. 7.2, 7.3).
[1520] (Castel et al. 1995, 23).
[1521] (Hassan and Hassan 1981; Stos-Gale and Gale 1981).
[1522](Abdel-Motelib et al. 2012, 49; Pfeiffer 2013).

prospectors as a viable option of a tin source. Last but not least, there are also ores with copper and nickel, but no lead isotopes are known for these ores.

6.2.2. Sinai

Although some Egyptologists doubted copper mining on Sinai before Dynasty 3, the presence of Egyptians and procuring of copper can be now established from fourth millennium BC. The evidence could have been richer, but some of the areas, e.g. Wadi Maghara, were partially destroyed by modern mining. For last hundred years, another region, the Um Bogma area, focus of the activity of ancient Egyptians in the past, is mined for manganese and the area is still polluted from heavy and associated metals.[1523] In terms of the geology, Sinai is also rather rich region, its ores and lead isotopes are described better than those from Eastern desert.

Sinaitic copper ores have low trace elements as well, similar to the Eastern Desert. The remote site Wadi Tar in the south-east of Sinai is the single known occurrence of the arsenical copper and as such it is usually connected to the use of arsenical copper in Egypt, but also in Levant.[1524] Egyptians never controlled this area, if the arsenical copper reached Egypt, it must have been through the exchange with the local population.

The origin of ore from Sinai was assumed for artefacts from Tell el-Farkha, manganese ore from Maadi.[1525] Many recently published early objects in the Royal Museum of Art and History in Brussels are supposed to come from Sinai, especially objects found in the assemblage from Dynasty-3 Bet Khallaf.[1526] The earliest of these artefacts, net-needle from Gerza is datable to Naqada II phase and thus provides the oldest data about the presumable use of the Sinaitic sources in Egypt.[1527]

The only described metallurgical remains in the literature from Sinai cannot be independently verified with its dating, because the pottery from the site was not yet published. Electron microprobe was used for the microanalysis of slag pieces from the site 702B on Sinai, claimed to come from Predynastic and Old Kingdom contexts.[1528] Another earlier publication o the slags from Sinai is from H. G. Bachmann.[1529]

6.2.3. Saudi Arabia

[1523] (Khalifa and Arnous 2012).
[1524] (Segal,Ilani and Rosenfeld 2000).
[1525] (Pernicka and Hauptmann 1989; Rehren and Pernicka 2014, 247–251, Figs. 10-13).
[1526] (Rademakers et al. 2018)
[1527] (Rademakers et al. 2018, 177–178).
[1528] (el-Gayar and Rothenberg 1995). Samples of copper and iron ore, slag and crucibles have been taken from the Site 702B and analysed at the Institute of Archaeology UCL.
[1529] (Bachmann 1980).

Since the geological origin is the same for the ores of Eastern desert and Saudi Arabia, also their lead isotopic ratios are similar. Although origin of the artefacts of A-Group from here was proposed, on the basis of similarity of lead isotopic ratios, it can be argued that the ore is coming from Eastern desert instead.[1530] The situation might change after the publication of el-Qurrayah, when the ore sources used at the site will be identified.

6.2.4. Nubia

Copper sources in the Nubian Eastern Desert are frequently omitted from the considerations of the nearest copper sources to Egypt.[1531] Survey of R. and D. Klemm identified several Nubian sites, where copper ore co-occurred with gold.

Analyses of ores and artefacts were scarce. The ore from Buhen is described by O'Connor, who took part in the excavation, as "fragments – clearly broken off larger entities – of a quartz-like stone with veins of green corrosion running through it, the latter assumed to be copper by the excavators and the whole combination – stone and veins – hence being called 'copper ore'."[1532] And, indeed, this is how the copper ore might look like. Samples from the Old Kingdom town Buhen were analysed by X-ray methods: microanalysis, fluorescence and diffraction, and thermogravimetric analyses.[1533] The main copper-bearing ore was malachite, with copper chloride atacamite on the outer zones of the sample and thus interpreted as created only at the site of Buhen, after the material was gathered and stored there. Ore contained high percentage of gold and this is interpreted, in absence of analogies from other regions, as a feature of the Nubian ores. Authors also claim that the slags were rich in iron (and low in manganese), indicating use of ferruginous flux (not identified on site).

As an important discovery must be mentioned recent analysis of two awls from the A-Group contexts in Faras. According to the interpretation of trace elements and lead isotopes, the objects were made of ore from Sinai.[1534] The interpretation indicates that the ore sources used on Sinai reached Nubian deep down on the Second Cataract. But more data are needed and above-mentioned data from other sites were from Eastern Desert.

6.2.5. Wadi Arabah (in Jordan and Israel)

One of the frequent assumptions in the Egyptian archaeology is that a lot of ore was coming to Egypt from the mining regions in Wadi Arabah, now divided between two states, Israel and

[1530] Analysed by A. Hauptmann, published in (Anfinset 2010, 165, Fig. 6.50), reinterpreted as Eastern desert ore by (Kmošek et al. 2018, 205, Fig. 9).
[1531] The Nubian source of copper ore was e.g. omitted by K. Sowada (Sowada 2009, 186).
[1532] O'Connor (2014, 134).
[1533] (Gayar – Jones 1989a).
[1534] (Rademakers et al. 2018, 179).

Jordan. Two major ancient ore-bearing regions are Timna in Israel and Wadi Feynan in Jordan.[1535] To them was recently added Chalcolithic ore source near Timna, at Wadi Amram.

The first peak of activity in Feynan was Early Bronze Age, with the metallurgical centre at the site Khirbet Hamra Ifdan. The process of smelting and melting in order to refine the copper products was examined and described.[1536] No alloying was done at the site, which was centred on the production of semi-products: ingots for further export. Ores, raw copper and bar ingots (similar in shape to Old Kingdom model adzes) were analysed and reveal wide range of trace elements: lead, zinc, nickel, cobalt, arsenic, gold and antimony.[1537] Lead-isotope ratios for Feynan ores were also published in the article.[1538]

Early Bronze Age copper from Feynan was characterised by a low percentage of trace elements, up to 1%, of the Fe, As, Ni, Co, Ag, Sb and Sn. The only element with higher concentration was lead with up to almost 3%. Lead was not added intentionally but was present in the ores of the Dolomite-Limestone-Shale Unit. Lead isotopic signature of the Feynan copper has regular distribution and is well identifiable. The crescent-shaped bar ingots from the Early Bronze Age Negev sites and Hebron hills were made and exported from Feynan.[1539] None of such ingots or its fragments was found in Egypt until present day.

Timna was the most active region only in the Early Iron Age, there is also limited evidence of the Early Bronze Age mining activity.[1540]

Copper artefacts in Badarian ought to be imported from the Wadi Arabah, assumption was not based on archaeometric data.[1541] Origin from Feynan/Wadi Arabah was presumed for some ore samples from Maadi and Buto.[1542]

6.2.6. Anatolia

Anatolia is a region with rich sources of ore materials and one of the cradles of the use of native copper.[1543] But the distance from Egypt most probably rules out any direct contact and steady supply of metal. One of the characteristic traits of some Anatolian metalwork pieces is high contents of nickel, c. 1–10%. Several objects from ancient Egyptian contained nickel in percents and they were assumed to be made of Anatolian material. In two cases, the similarity

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1535 (Hauptmann 2007).
1536 (Levy et al. 2002).
1537 (Levy et al. 2002, Fig. 6).
1538 (Levy et al. 2002, Fig. 7).
1539 (Hauptmann et al. 2015).
1540 E. Ben-Yosef (Tel Aviv University), pers. comm.
1541 (Midant-Reynes 2000b, 161)
1542 (Pernicka and Hauptmann 1989; Pernicka and Schleiter 1997).
1543 (Yener 2000).

of the material to Anatolian copper metalwork is confirmed not only by the chemical composition, but also by lead isotope ratios.

The first unidentifiable fragment can be dated only roughly to the fourth millennium BC and it was found at Maadi.[1544] Anatolian copper ore sources came to the fore again only recently, due to the results of the lead isotope and trace element analysis of an Early Dynastic vessel from Abusir, housed now in the Egyptian Museum of Leipzig University, with inventory number ÄMUL 2160, produced out of CuNiAs material. A vessel fragment ÄMUL 2162 from the neighbouring tomb had also presence of nickel, but was too corroded to be properly analysed.[1545] Axe head from Matmar and needle from Naqada contained high nickel as well, but there are no lead isotopes available for these two objects.[1546]

While the lead isotope ratios and elemental composition is demonstrably similar to objects from contemporary Anatolia, origin of the material itself is unknown. Since high nickel objects, presumably from Anatolia, occurred also in Levant, at Nahal Mishmar and Kfar Monash, they could have come to Egypt through this area.[1547] One possibility is a supra-regional exchange, another is that some of the material was gathered during the incursion of Egyptians in southern Levant in first half of Dynasty 1.

6.2.7. Cyprus

Recent work on the material in the Egyptian Museum of Leipzig University defined a possibility of the use of Cypriot copper in Middle Kingdom and Second Intermediate period Egypt, as objects from C-Group Aniba cemetery and one dagger from Kerma were most probably made of this copper.

The evidence will be published soon, but thus far, it can be said that the occurrence of Cypriot copper is in line with the annals of Amenemhat II and bringing of material into Egypt. However, archaeological occurrence of Middle Cypriot pottery at e.g Tell el-Dab^c^a is datable only to the Dynasty 13, stratum G1-3.[1548]

Export of copper from Cyprus is assumed to be already taking place in its Prehistoric, Early and Middle Bronze Age phase (2400-1690/1650 BC).[1549] Only limited number of analyses for metalwork of the period is available, showing prevalence of arsenical copper, but also presence of tin bronzes, some imported from Anatolia. Not all objects were made of local

[1544] (Pernicka and Hauptmann 1989, 139–140, Tabelle 2; Abdel-Motelib et al. 2012, 48–49).
[1545] (Kmošek et al. 2018).
[1546] (Hauptmann,Schmitt-Strecker and Begemann 2011, 72).
[1547] (Tadmor et al. 1995, 133; Hauptmann,Schmitt-Strecker and Begemann 2011).
[1548] (Hein 2018, 129–131).
[1549] (Knapp 2013, 308–311).

copper.[1550] Outside of Cyprus is its copper demonstrated in use for the production of artefacts in Prepalatial and Old Palace period.[1551] Egypt might be added to this list after the publication of material from Aniba.

Just recently, a large dataset on the chemical composition of the Middle Bronze Age Cypriot metalwork was published.[1552] This is the sort of metalwork that might have been looted by the troops of Amenemhat II, if they indeed reached Cyprus. The analyses demonstrated use of different alloys for different artefacts, arsenical copper being used for spearheads, razors, daggers and axes. For these objects was used also tin bronze, with more frequent tin bronze occurrence among the toggle pins and tweezers. Not a single artefact category was produced only from one of these alloys. We can observe how in this period both alloys are used for the production of objects, and as it will be shown on the ancient Egyptian artefacts, this situation was very similar in the Middle Kingdom and late Middle Kingdom Egypt, although the total counts of tin bronzes are generally low, except of Tell el-Dab[c]a. It can be presumed that the booty from Cyprus and Cilicia, from the reign of Amenemhat II, included objects made of both main alloys and the scribes did not discriminate between these frequently used materials. The artefact blades are all named as made of *ḥsmn*.

6.2.8. Oman

An information from the Palermo Stone of bringing the malachite from the land of Punt hints at the possibility of copper import from the area further to the south-east. The nearest region with rich copper sources, used also in the Early Bronze Age, is Oman, and on the way to it also already mentioned Saudi Arabia.[1553] Copper sources and objects from Oman are well described in the literature,[1554] and there was not yet any copper from Oman identified in Egyptian contexts before the New Kingdom.[1555]

6.3. Copper storage, revenues, and transactions

It was possible to delineate the key features of the copper storage, revenues, and transactions on the basis of written sources. Evidence in material culture was less clear and even more difficult it is in the archaeometallurgy. Reconstruction of the inner distribution networks in Egyptian society would be possible only if we pay close attention to the archaeological

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[1550] (Webb et al. 2006).
[1551] (Stos-Gale 2001, 200–201).
[1552] (Charalambous and Webb 2020).
[1553] For now, the evidence exists for the late New Kingdom presence in Saudi Arabia, cf. (Hausleiter,Eichmann and al-Najem 2018).
[1554] (Prange 2001).
[1555] Omani provenance for some Dynasty-19 copper was suggested by (Rademakers,Rehren and Pernicka 2017, 63).

contexts of the artefacts. By deductive reasoning, we might be able to closely follow the existing and preserved parts of the distribution networks. This and following two subchapters are outlining the current state of the question. Firstly, I am beginning with the main material used, then the evidence from workshops is discussed and modern attempts to understand the processes, with the help of ethnoarchaeology and experimental work.

Concerning the analyses of the presumed semi-finished material, as we have seen, there are only very few and even doubtful identifications of the presumed "ingots" from ancient Egypt, even less were described by archaeometallurgical methods. The most certain are Predynastic ingots from Maadi, which were never analysed and stolen from the local museum in 2002.[1556] One presumed "ingot" was from the tomb of Khasekhemwy, but it is rather a spearhead.[1557] Typologically different ingots from Tell el-Dab^ca were discussed in Chapter 5.

The interpretative framework of the circulation of metals is needed to be focused on the archaeological context of the finds. In order to discriminate between various copper sources that might have been used, thorough analysis of the origin must single out the secure contexts. Specific object categories are discussed in the last subchapter. In general terms, it is prudent to assume that the objects found in the royal tombs were from the resources of the royal administration. Also in the case of the members of the royal family, this ought to be correct observation. Such contexts are well represented from the Early Dynastic Abydos (with highest number of analysed objects found in the tomb of Khasekhemwy[1558]) and less well from the Middle Kingdom royal cemeteries and buildings, it is almost totally absent from the Old Kingdom (with the significant exception of royal women burials of queens and princesses, from Abusir and Saqqara). The only exception are the artefacts found in the royal mortuary temples, but these might have been the personal belongings of the priests (e.g. needles, fish-hooks). Extremely rare are e.g. specimens from the temple furniture, one such full-size heset vessel was analysed recently, being found to be similar to Sinaitic copper ores and a needle from the tomb of Khasekhemwy, although the vessel itself is most probably from the Dynasty 6.[1559] Statistically significant data are needed to understand the processes, not only the single pieces of the material culture.

In case of non-royal persons, we need to be acutely aware that king was also the person that could use his own agency to provide burial equipment further down the social

[1556] (Abdel-Motelib et al. 2012, 52).
[1557] (Golden 2002).
[1558] (Kmošek et al. 2018; Rademakers et al. 2018; Ben-Yosef 2018).
[1559] (Rademakers et al. 2018, 184).

scale, from the resources of the state administration. Thus, also in the "non-royal" contexts could occur objects from the royal resources of the material. Evidence from the written sources cannot be ignored, that already in the Old Kingdom, non-royal persons, although members of the royal administration, could have disposed privately with copper, being distributed further to the workers on tomb. We cannot decide whether this was some form of ingots, or the tools used for the tomb building are mentioned in such manner.

6.4. Metallurgical workshops

6.4.1. Main groups of produced material

In the following text, main materials and alloys produced in the periods under study and their properties are described. Chart on Figure 6.12 with accompanying table demonstrates that the most frequent materials were copper with impurities and arsenical copper, both creating one third of the corpus. 12% consists of proper tin bronze. In case of copper with impurities, many examples might result from the early studies, having difficulties in identifying arsenic. 22 artefacts contained both arsenic and tin. Other alloys are only marginally present and might be connected to the larger groups by the elemental patterns. The exceptions are e.g. intentional alloys of precious metals (gold, silver) with copper and also rather peculiar alloys of copper with nickel, or nickel and arsenic.

Parsing the alloys into the broader periods on Figure 6.13 shows that the largest number of analyses incorporates First Intermediate Period and Middle Kingdom material, followed by the Early Dynastic Period. Predynastic and Old Kingdom are still represented well and in case of C-Group and Kerma, the number is exceptionally low. A separation of the Dynasty 6 demonstrates that although this period is well-known by the ubiquitous copper artefacts, only a fraction of them was analysed. Splitting of Middle Kingdom enables to observe an increase in the use of tin bronze, used alongside arsenical copper. C-Group and Kerman patterns of the alloy use repeat the pattern apparent in late Middle Kingdom, as a part of the same regional group. While singular artefacts might be questioned (as dating of "Old Kingdom" razor blade of unknown origin, made od bronze), archaeological contexts e.g. from Abydos confirm that tin bronze was an alloy known by ancient Egyptians. However, arsenical copper was undoubtedly most widely existing in practical use. By absolute numbers, Predynastic eras and the Old Kingdom are the least known periods.

Even if technology changed, unchanging is the toxicity of some metals. We need to also discuss the effects of metals on metalworkers. Perhaps the most difficult concept to grasp about the periods under study is the use of arsenical copper with the highly toxic arsenic.

Egyptologists are slow in accepting this fact, even if hundreds of objects are shown to be made of such material. We must try to understand what it meant in practice, in the periods under study, and what were the practical properties of the ancient Egyptian arsenical copper.[1560]

We must bear in mind one issue. Contemporary scientific methods offer detailed knowledge of materials and alloys, detail most probably unknown to ancient metallurgists. Only differences perceptible by the outward appearance of the material and practical properties[1561] might have been reflected in the ancient language, as they could have been seen also by non-specialists in the field of metallurgy, e.g. the scribes who noted down the objects. Therefore, another important line of research focuses on the colours of the produced metals (Figure 6.14).[1562] This concern was almost completely absent from the past discussion of the interpretations of ancient Egyptian terms denoting copper. The perception of colours is a difficult subject, and modern experiments cannot establish the ancient Egyptian perception. The previously listed results of the analyses enable us to focus on the most important ancient Egyptian alloys, which are copper with impurities, low-arsenical and high-arsenical copper, tin bronze.

6.4.1.1. Copper with impurities

Significant group of the artefacts from the periods under study was produced of copper, containing only minor amount of other trace elements (< 1 weight % of each element), named here "copper with impurities" and in tables and maps as "Cu+". These objects could have been made either of native copper, oxidic copper ore, e.g. malachite, or even sulphidic ore. Even copper can be toxic. Higher doses of copper can negatively affect humans, metal fume fever might occur by an exposure to metal oxides. Copper sulphates are toxic, they occur in the nature as mineral chalcanthite, occurring also in Eastern desert, formed in oxidizing copper deposits.[1563] A study of trace elements in the teeth of ancient Egyptians and Nubians identified concentrations of the element similar to modern data.[1564]

Native copper is in nature very rare and its analytical identification is complicated by several factors.[1565] Major impurities of native copper are silver and occasionally arsenic, but such metal can be also product of smelting of copper with impurities. Native copper contains

[1560] Analogically, the toxic effects of lead were known since antiquity but until very recently it was used in the petrol and even for the production of children toys.
[1561] Scientifically studied e.g. by (Mödlinger et al. 2017).
[1562] (Mödlinger et al. 2017).
[1563] (Ellingsen,Horn and Aaseth 2007).
[1564] (Stack 1986).
[1565] (Pernicka 1999, 167–168).

several mg/kg of mercury, but this element is adsorbed also from the ground water. And if the native copper was smelted, the mercury is lost. It is therefore almost impossible to identify unequivocally objects made of native copper.

Another possibility is that the copper was made of oxidic ores, e.g. malachite, which was easy to smelt into copper in almost slagless process. Many trace elements occurring in copper rather point to this potential type of source for such artefacts. Almost pure copper is rather soft; thus it would be impossible to use it for working of other materials. Objects produced of this material could be *simulacra* of the full-size functional objects. This is an option that was followed by V. Davies and M. Cowell in the study of the axes in the British Museum. “Full-size” objects, rather large, were categorized as “models”, if found out to be only made of copper with impurities.[1566] Objects produced out of copper with impurities occurred also in other contemporary cultures, e.g. on Minoan Crete.[1567]

Artefacts of such characteristics are spread over Egypt and Nubia, but rather in low numbers (Figure 6.15, 6.16). Two only larger concentrations are in Abydos and Bet Khallaf, but in both cases, this might be an “artefact” of the early analyses, just as spectrometry on Kerman objects in the Museum of Fine Arts did omit arsenic from the analyses, and thus produced 14 “copper with impurities” objects in the corpus. Nevertheless, copper with impurities keeps being identified also in recent analyses.[1568] Thus, it must have been produced and used in some contexts.

6.4.1.2. Important alloying and trace elements

There are elements accompanying copper in archaeological objects, which can refer to the provenance, to the technology, or to both categories at once. They have been categorised as such by E. Pernicka (Figure 6.17).[1569] The table is modified by the addition of arsenic to the main alloying elements, as it seems that higher concentrations of it were caused by intentional alloying. Of the elements named in the table, only five elements, all of them indicative of ore sources, can be identified in almost all samples: As, Sb, Ag, Ni, and Bi.[1570]

Products of ancient metallurgists were not homogenous in their structure and different composition might appear in the different spots of the artefact. Five spots on the model of an adze blade from tomb of Medunefer in Balat produced slightly different results regarding the

[1566] (Davies 1987, 24–25; Cowell 1987, 100; Lang 1987, 119).
[1567] (Evely 1993).
[1568] (Odler et al. 2018).
[1569] (Pernicka 1999, Table 1).
[1570] (Pernicka 1999, 169).

chemical composition.[1571] Similar case was observed on the trace elements and even lead isotopes of two Kerman daggers.[1572]

There are several approaches in the establishing of compositional groups of artefacts, based on trace elements. E.g. in recent case of Perucchetti, the presence of the elements is decided on the weight percentage of more than 0.1% in the alloy.[1573] Approach in this thesis is different in that it tries to include also rather early results of analyses. Thus, only general patterns of alloys can be compared, but exactly this is needed to be done in the current Egyptian archaeology. Compositional groups are named by the shortcuts of the chemical elements, which are present in the material by more than 1 weight percent.

In the following subchapters, alloys with arsenic, gold, and tin are described in detail. One of the other important metals is lead, with rich sources of it in Eastern desert, but, on the other hand, also surprisingly often a material brought into Egypt from abroad. Apart from arsenic, the most toxic ancient metal is lead. Poisoning by lead can affect nervous system, blood, blood-forming organs, kidneys, cardiovascular and endocrine systems, gastrointestinal tract. Since the addition of lead to alloys is in periods under study insignificant and even lead mining causes only moderate risk for lead exposure, it is not necessary to deal in detail with lead toxicity.[1574] It could have been an issue in the production of statues and statuettes, and also probably some vessels. Rather unexpectedly, also some tools and weapons did contain more than 1% of lead. On the other hand, we must be aware that galena was used as a black eye-paint throughout the Egyptian history and that ancient Egyptians thus must have been exposed to lead in this form quite frequently. Other trace elements can also cause health problems in some concentrations, but they were presumably present in the ores in low, not harmful amount: antimony, bismuth, iron, manganese, nickel, selenium, and tellurium.[1575]

6.4.1.3. Arsenical copper

The most ubiquitous group of functional objects in periods under study was made of arsenical copper. The material has arsenic as the main other element, which causes the resulting material to be harder than copper with low impurities of other trace elements, and similar in properties to the tin bronze.[1576] However, general properties of arsenical copper were studied

[1571] (Wuttmann 1986).
[1572] (Young 1996).
[1573] (Perucchetti 2017, 14–18).
[1574] (Skerfving and Bergdahl 2007).
[1575] (Fowler and Sexton 2007; Gerhardsson 2007; Högberg and Alexander 2007; Klein and Costa 2007; Ponka,Tenenbein and Eaton 2007; Šarić and Lucchini 2007; Tylenda and Fowler 2007).
[1576] (Lechtman 1996).

only seldom, because this alloy must be nowadays produced under conditions that protect experimenters from the toxic effects of arsenic fumes.[1577]

In low concentrations, copper can occur together with arsenic and up to 1% arsenic could have been fortuitous smelting of such minerals. Higher percentages were rather alloys., and the threshold for the considerably changed properties of the material is around 3%.[1578] Until the present-day several generations of the researchers suggested that arsenic in higher percentage was being added to the alloy,[1579] and numerous strands of evidence, especially trace elements, confirm this. Intentional gathering of the ores containing arsenic must be added to the supposed ore sources sought for by ancient Egyptians. Recent study of the metallurgical remains from the Kromer settlement refuse at Giza proves again that arsenic was added to copper, in order to produce the alloy, of which the tools are made.[1580]

Copper minerals rich of arsenic did occur on Sinai, especially in Wadi Tar, near the south-east coast of the peninsula, far from the Egyptian presence. The lead isotopes and trace elements allow to think about the uses of this source in ancient Egypt.[1581] But application of arsenic was not limited to metallurgy. Arsenic is the main element in the bright yellow mineral and pigment orpiment (As_2S_3). Earliest use of orpiment has been documented on a stela in Louvre from Dynasty 2 (E 27517).[1582]

Figure 6.18 maps the occurrences of arsenical copper objects. With exceptions of Abydos and Bet Khallaf, most of the sites have only 1 to 10 artefacts. The distribution of the artefacts (Figure 6.19) spans through the whole defined period, beginning with the second phase of Naqada culture. Large group of objects of unknown provenance is from the First Intermediate Period / Middle Kingdom, mostly representing axes from the British Museum. Arsenical copper thus occurs almost on each site from the periods under study, where analyses took place. Many specific artefact categories, made of arsenical copper, are listed in subchapters on the objects.

As for the colouring properties of the arsenic, c. 2 wt% “draws the alloy towards a greenish color”. And if the amount of the arsenic increases: “The perceived result is a more white-grayish appearance of copper with increasing arsenic content.”[1583] Slightly different

1577 Recent exception being studies by (Mödlinger and Sabatini 2016; Mödlinger et al. 2017; Mödlinger,de Oro Calderon and Haubner 2019).
1578 (Kuijpers 2018a)
1579 (Eaton and McKerrell 1976; Cowell 1987; Kmošek – Odler et al. 2016; Rademakers et al. 2018, 185–187).
1580 (el-Gayar and Rothenberg 1995; Odler et al. submitted).
1581 Rademakers et al. (2018, 188–189).
1582 (Colinart 2001, 3; Pagès-Camagna and Guichard 2010, 28).
1583 (Mödlinger et al. 2017, 18).

scale of resulting colours is offered by M. Kuijpers.[1584] In case of ancient Egypt, specific experimental work on the alloys uncovered by analyses would help in assessing the available range of the colouring. But this would require statistically significant sum of analyses.

Arsenic is a recognized poison.[1585] Lethal ingested dose is 1–3 mg/kg, exposure through air and skin has no immediate lethal effects.[1586] Arsenic affects several organ systems: gastrointestinal, dermal, neural, renal, hepatic, haematological, cardiovascular, respiratory and ophthalmic. In recent copper smelters, increased risk of cancers of e.g. urinary, bladders, kidney, haematolymphoid system and brain and nervous system was observed.[1587] Acute poisoning may appear by inhaling during smelting of ores with arsenic. Chronic poisoning can be diagnosed by arsenical dermatosis, peripheral neuropathy, and perforation of nasal septum. Besides upper respiratory systems, also liver may be damaged. Other possibility of arsenic poisoning is by arsine, hydrogen arsenide, highly toxic flammable gas with a garlic-like or fishy odour.[1588] Poisoning dose is 3 – 10 mg/m^3 and lethal dose is 250 mg/m^3. Arsine causes "nausea, abdominal colic, vomiting, backache, and shortness of breath, followed by dark blood urine and jaundice".[1589]

Ancient Egyptian metalworkers must have been aware on the effects of arsenic and they most probably performed crude protective measures. Boiling point of arsenic is 615 °C, thus during smelting, metalworkers could have been exposed to arsenic in gaseous state. Nevertheless, they must have been exposed to at least small regular doses of arsenic for the whole active life as craftsmen. Such lives could not last long, most probably. It was even suggested that use of arsenical copper inhibited ancient Egyptians in large-scale production of metals.[1590]

6.4.1.4. Black copper

Alloy of copper and small amount of gold is named "black copper" (*bjꜣ km* in ancient Egyptian) appeared in the late Middle Kingdom. Gold causes the surface of the metal to blacken. Two statues from the late Middle Kingdom Fayum corpus were made of this alloy.[1591]

6.4.1.5. Tin bronze

[1584] (Kuijpers 2018a).
[1585] (Fowler et al. 2007).
[1586] However, a case of a worker buried under arsenic trioxide in an industrial accident was reported. A few minutes of inhaling dust with arsenic caused his death in six hours (Gerhardsson et al. 1988).
[1587] (Fowler et al. 2007, 383, 388, Tables 2, 5).
[1588] (Anon).
[1589] (Fowler et al. 2007, 397).
[1590] Anthony Spalinger (University of Auckland, New Zealand), pers. comm.
[1591] (Giumlía-Mair and Quirke 1997).

Already in the Early Dynastic Period, Egyptians certainly knew tin bronze as one of the copper alloys (Figure 6.20). The earliest tin bronzes were found at Abydos, in royal tombs of Den and Khasekhemwy, high official's tomb K1 at Bet Khallaf, and also at Early Dynastic to Old Kingdom strata of Buto. It can be supposed that in the Early Dynastic and Old Kingdom Egypt, tin bronze was a special alloy, used mainly to produce vessels. On the other hand, a saw was made of tin bronze at Bet Khallaf. Its practical advantages were not realized, moreover it must have been difficult to obtain tin as an alloying element. Usually, it is assumed that tin is added to the alloy. Ores with the simultaneous presence of copper and tin are exceedingly rare globally. It is interesting to note that also in Mesopotamia, the first mentions of the tin bronze are datable to the roughly the same period as its occurrence in Egypt.[1592]

Altogether, tin bronzes were found on several sites of the periods under study, mostly datable to the Middle Kingdom (Figure 6.21). The listed occurrences indicate that the tin bronze might have been known already before the late Middle Kingdom. How widely, it is difficult to say as not many analyses provide statistically representative samples of periods and sites. Significant context in the dating of the occurrence of tin bronzes is a burial of Princess Sithathoriunet from Lahun, having the objects with the names of Senusret II and Amenemhat III in her burial equipment.[1593] Both Middle Kingdom razor blades of Egyptian typology from the context were made of tin bronze.[1594]

Tin bronzes became more frequently used in the late Middle Kingdom at Tell el-Dab^c^a, where Middle Bronze Age Levantine population used the material, which was by them commonly used, alongside arsenical copper. The representation of the whole situation is here better, as several tens of analyses were already done. It is intriguing that the amount of tin bronzes was at Tell el-Dab^c^a decreasing through time.[1595] As a sign of changing times might be perceived also Grave 3138 of Pan grave culture from Mostagedda.[1596] Two axe blades were found in the grave, one was made of arsenical copper, another of tin bronze. Although they were interpreted as being a battle axe and an artisanal axe in one grave, it cannot be excluded that they were both battle axes.[1597] A group of objects found in the house with the Group 9 at Kahun, datable to the late Middle Kingdom, Dynasty 13, contained a range of

1592 (Weeks 2012, 309–310)
1593 (Winlock 1934).
1594 (Kopp 1934).
1595 (Philip and Cowell 2006, 214).
1596 (Brunton 1937, 117, Pls. LXXI, LXXVII: 10, 11; Liszka 2012, 496, Table 21).
1597 (Davies 1987, 82, Cat. Nos. 104, 105)

alloys.[1598] A mirror, a chisel, and an awl were made of arsenical copper; another chisel, two awls, a torque were produced from the tin bronze; saw blade of copper with both arsenic and tin, and last awl of copper with impurities.[1599]

There are several secure archaeological contexts, where artefacts made of arsenical copper occur together with the tin bronzes, proving concomitant use of both materials (Figure 6.22). These are the already mentioned contexts of the Early Dynastic period, of the funerary character, from Abydos and Bet Khallaf. From the late Middle Kingdom, such contexts were identified at Aniba, Dahshur, Diospolis Parva, Kahun, Mostagedda, and Tell el-Daba. Archaeological contexts span different cultures of Tell el-Dab^ca, Egypt itself, C-Group and Pan Grave people. Tin bronze does not seem to be used ubiquitously, but it is clearly used alongside arsenical copper.

Another peculiarity of the ancient Egyptian use of tin bronze is an alloy based on copper, containing both arsenic and tin. Similar artefacts occurred through the periods under study (Figure 6.23), but only in 22 cases, of which 10 are of unknown provenance. They occurred in both Egypt and Nubia and might be of different origin. It can be an indication of mixing of arsenical copper, used also to produce tin bronzes.

Although tin is surely healthier to be used than arsenic, it is not without problems. Higher intake of tin might cause liver and kidney problems, anaemia, and abdominal pain. Workers inhaling tin oxides might have benign pneumoconiosis, called stannosis.[1600]

6.4.1.6. Corrosion products

Corrosion products are perceived as an obstacle impeding the analysis of metal core. In case of museum objects, these have been in the past removed, often without an entry in the museum archive. Exceptions are e.g. reflections on past conservation in the Ashmolean Museum and Petrie Museum.[1601]

The analysis of corrosion products can, however, reveal also indirect information about the objects themselves. Among the rare published studies is a study of blue-coloured corrosion, typical for many Egyptian objects in museum collections.[1602] Corrosion products were also studied on Old Kingdom artefacts from Giza.[1603] Moreover, rarely is also published reflection on past approaches,

1598 (Petrie 1891, 12-13, Pl. XIII: 1-18); Lilyquist 1979, 35, footnote 396, 397, Figs. 74, 75).
1599 (Gilmore 1986).
1600 (Ostrakhovitch and Cherian 2007).
1601 (Jaeschke and Jaeschke 1988, 18–19; Norman 1988, 13–14). For the updated overview of museum conservation of metals, see (Schorsch 2018).
1602 (Thickett and Odlyha 2000).
1603 (Kmošek et al. 2016a, 242–245, Fig. 228).

6.4.1.7. Glazed materials with copper contents

A separate thesis could be devoted to the glazed materials that are products of the pyrotechnology and use copper as a colourant. The most widely known is faience,[1604] but there are also other types of materials. In ancient Egypt, these materials have rather early origins. The problem of Brunton's determination of "turquoise" in Badarian contexts is being examined currently. It has been shown that so called turquoise is in fact glazed steatite.[1605] A discovery of Egyptian blue has been recently claimed from the reign of ruler Scorpion.[1606]

Faience and other blue and green materials were produced throughout the periods under study. For their production could have been used dust remaining after the use of copper alloy tools. Copper was also used in the blue and green pigments and the studies of the pigments were attempted to be used as proxy data for the development of metallurgy.[1607]

6.4.2. Ethnoarchaeology and experimental archaeology

Two approaches contribute to the knowledge of ancient metallurgy by generating comparative data: ethnoarchaeology focuses on the practices of current craftsmen, experimental archaeology is trying to reconstruct past processes of the *chaîne opératoire*. These approaches cannot replace the research of the material preserved from the past, but their potential is in offering insight into previously unacknowledged practical questions.

Ethnoarchaeological studies do not serve as a source of direct analogies for the interpretation of archaeological sources, but can deliver contextual information otherwise unavailable.[1608] Experimental work of Belgian group, led by G. Verly and F. Rademakers, is based on the archaeological excavation of Middle Kingdom metallurgical installations at Ayn Soukhna.[1609] A battery of two furnaces was rebuilt in Belgium, at the Archéosite d'Aubechies, with the aim of repeating the ancient processes. The research has proven that wind-power was not necessary to the furnaces, a chimney effect works well in the installation.

D. Stocks used for the reconstruction of smelting furnaces the dimensions of the furnace from Timna. The copper-alloy was with trace elements tin and iron, he did not use arsenic.[1610] For the experimental production of the ancient Egyptian objects were used tin

[1604] (Kaczmarczyk and Hedges 1983).
[1605] (Horn 2015).
[1606] (Newman 2014, 506).
[1607] (Jaksch et al. 1983).
[1608] E.g. the most important reason for the location of the workshop in a village in Tamil Nadu Svamimalai the appearance of fine river clay for the production of clay moulds. Availability of the metallic ore was therefore not essential reason for locating production workshops (Levy et al. 2008, 26).
[1609] (Rademakers,Verly and Delvaux 2016; Verly 2017; Rademakers and Verly 2018; Verly,Rademakers and Téreygeol 2019).
[1610] (Stocks 2003, 56–57).

bronze artefacts, not the arsenical copper ones, as would be typical for the periods under study. Experimental work with arsenic is, however, difficult to be realized. Another attempt of experimental archaeology was focused on the production of a copper needle with perforated head.[1611]

D. Stocks also experimentally tried to use copper drill tubes to drill Aswan granite, with a particular aim to estimate the amount of material needed for the production of the granite sarcophagus of King Khufu. According to his counting, the loss of copper would be 168 kg in case of saws and 266 kg in case of the tubes. Since 3,186 kg of granite would be removed by this operation, i.e. the ratio is 1:12, it is an effective approach to the production of sarcophagus.[1612] Nevertheless, it must be noted that Stocks did not use arsenical copper, which was presumably the material, out of which the saws and tubes were produced.

6.5. Chemical composition and other properties of copper artefacts

Herein is discussed the current state of knowledge on tool kits, specific tools, and other objects. Current "fashion" is to answer the questions of the chemical composition and provenance of the metal, leaving aside insights that could be gained from other methods. In order to establish complex knowledge of ancient Egyptian metallurgy, trace elements and lead isotopes are simply not enough.

In the field of material culture, Egyptological literature, especially excavation reports, are full of material determinations based on nothing else than the perception of what was the most common alloy in the respective era. These determinations can be later proven wrong by new analyses, as the project of Czech Institute of Egyptology and Kunsthistorisches Museum Wien showed, with presence of copper with impurities and arsenical copper in objects that were assumed to be made of tin bronze in excavation reports.[1613] It is advisable to approach the information in excavation reports with caution, especially if there is no reference to the scientific analyses of the excavated objects.

If we compare full numbers of the preserved artefacts presented in Chapter 5 with the analysed artefacts, it is immediately clear that the analysed artefacts represent only a fraction of all known objects (Figure 6.24). Nevertheless, many of these artefacts without analyses are models, too corroded through to offer any substantial results. With a bit of luck, we might be able to identify some trace elements remaining in the corroded object as well, and any information is in this case better than no information.

[1611] (Nunn and Rowling 2001).
[1612] (Stocks 2003, 176).
[1613] (Odler et al. 2018).

I have collected data on the published analyses of ancient Egyptian and Nubian objects from the Naqada culture until the end of Middle Kingdom (Figure 6.25). One third of corpus are artisan tools, either full-size or model ones. One fifth of the assemblage are full-size weapons. Then the most numerous category is the full-size cosmetic tools, i.e. mainly mirrors. Other categories of material culture are less well represented. In each case, find dating and its type was checked and connected either to the archaeological context or the museum collection, in order to provide secure evaluation of the data. In case of ancient Egyptian material culture, most important is distinction between full-size, presumably practically functional, and model blades. Furthermore, find context can significantly add to the interpretation of analyses. Each geographically defined data point, from a site with known provenance, can be also displayed on a map.[1614] Inevitable way of the research progress is to build and analyse large datasets that will identify the strengths and weakness of the data structure available now. Only on the basis of big datasets we can name the caveats of research.

Following the previous chapter on material culture, it is dealt first with the complete tool kits, although very few of them were analysed extensively as a single assemblage. More frequent were analyses of singular tools and in the case of specific tools, it is possible to delineate the main developments in the alloy use. Another question to follow are the contexts of the occurrence of the analysed objects, whether these were settlement, temple, funerary or other. Furthermore, based on the analysis of written sources and the contexts, we can try to identify royal contexts and non-royal, private contexts of the use of copper and its alloys.

6.5.1. Chemical composition and other properties of artisan tool kit and its models

Artisan tools are the objects category most frequently analysed, at most of these sites, full-size artisan tools were targeted (Figure 6.26). However, very few tool kits were analysed and even fewer were analysed completely.

Concerning chisels, 86 were analysed, (Figure 6.27). More than half of the assemblage was made of copper with impurities, many of these models of the functional full-size chisels. 29 chisels were made of arsenical copper. Four Middle Kingdom chisels are harbingers of the new era, being made of tin bronze.

Rather surprisingly, even less was analysed of adzes, only 62 specimens (Figure 6.28). The uncovered pattern of the alloy representation is similar to chisels, with slightly lower

[1614] Following approach in European Bronze Age of (Perucchetti et al. 2015; Perucchetti 2017).

number of tin bronzes (Figure 6.29). Neither chisels, nor adzes provide a number relevant for the statistically significant results.

On the contrary, 115 axes were analysed, thus bearing statistically significant results, with some reservations. All lugged axe blades with a circular blade were included among artisan tools, although they might very well be used also as weapons, and they were used as hunting weapons for killing hippopotami. Only 39 axes are of unknown provenance, therefore thus more axe blades are coming from documented archaeological context. They were analysed throughout the whole course of Nile down to second cataract (Figure. 6.30). Some regions are conspicuously absent, most importantly Memphite region, Thebes, and Delta. Elemental patterns uncovered are more diverse than in case of previous tool classes (Figures 6.31, 6.32). This might lead us to suppose a specific kind of approach to axes by ancient Egyptian metalworkers, but other way of thinking is more probable: more numerous analyses of the chisels, adzes and saws would demonstrate equally diverse picture of alloys. Out of axes made of copper with impurities, more than half was found at Abydos, analysed also in early attempts. Arsenical copper is almost equally, with marginal presence of other expected results of its production: CuAsSb, CuSb, and CuFe, as antimony often accompanies arsenic in the ores and iron was a fluxing agent in the preparation of the ore. Tin bronzes are less numerous. Quite peculiar is a Predynastic axe made of CuNi from Matmar (now in Egyptian Museum, Cairo, JdE 59136).

Only 22 saw blades were analysed, by far the least numerous of the artisan tools categories researched (Figure 6.33). This sample gives again the expected groupings of copper with impurities, arsenical copper and tin bronze, throughout the periods. Rather surprising is only Early Dynastic saw blade with an inscription, made of tin bronze, allegedly coming from Thebes (EA66064). This result is not entirely improbable, while the site provenance appears to be completely false. Early Dynastic Abydos, or another site with Early Dynastic elite tombs is more probable candidate.

Although artisan tool kit is the most numerous being analysed, only axes provide statistically significant counts. Leaving out specimens of unknown provenance, even axes do not comply with more stringent criteria for statistical analysis. Copper with impurities offers relevant number of specimens and might be considered as symbolic representation of practical objects. Predominance of arsenical copper gives its place to the slow increase of the use of tin bronze.

6.5.2. Chemical composition and other properties of cosmetic tool kit

In case of cosmetic tool kits, mirrors were the objects analysed by far the most frequently. Mirrors are bulky objects and it is possible to sample them and then retouch the sampling spot, if necessary. It is possible to delineate their composition from Early Dynastic period until the Second Intermediate Period (Figure 6.34). With 80 specimens, they count among better known object classes. Conspicuous is the absence of copper with impurities, perhaps indicating that there might have been some system behind the use of alloys. On some sites, where copper with impurities is present, this might be "artefact" of the early analyses omitting arsenic (Figure 6.35).[1615] Arsenical copper is predominant in the assemblage, with only meagre number of tin bronzes, on the contrary. Bright arsenical copper might have been preferred to other colour hues, also based on the cultural and technological tradition. Higher contents of arsenic in mirrors must have caused health problems. Limited information on the lead isotopes is available, but a mirror from Grave 1022 at Cemetery 1000 – Qau/Etmaniya was made of Eastern Desert ore, most similar to Wadi Semna III data. Although in the recent publication of the analyses, it was dated to the Dynasty 6, both C. Lilyquist and S. Seidlmayer date this context to the First Intermediate Period.[1616]

Lower number of razors was analysed, only 13, because they were thinner and smaller artefacts (Figure 6.36). Copper with impurities, arsenical copper and tin bronze are rather equally represented, although from the table are e.g. omitted golden razor blades of Queen Hetepheres from early Dynasty 4, mostly because they lack any analytical results. Even with this meagre representation, temporal development is clear, with arsenical copper giving its place gradually to tin bronze.

Just 9 specimens of tweezers were analysed, being nevertheless of the three main group of materials observed also in larger groups. Neither razors, nor tweezers reach the statistical significance of mirrors, although also the corpus of mirrors needs more results, in order to be statistically relevant.

6.5.3. Chemical composition and other properties of personal adornment and ores

Objects of personal adornment were usually of small size and thus were not sampled often (Figure 6.37). In the production of personal adornment, copper served in the smelted state as a supportive metal for the more precious metals and alloys. Copper often served only as a base metal for the gold foil, thus cheapening the whole object. Ancient Egyptian "gold of honour" might be exactly of this type. Even in archaeological contexts with fully preserved bead

[1615] Most of these were published in the study of (Dunham 1943b).
[1616] (Lilyquist 1979, 20, after the end of Old Kingdom; Seidlmayer 1990, 137, Stufe II A)

necklaces, copper (alloy) beads were marginally present. Furthermore, copper was being added to the gold or silver to debase the material and lessen the contents of precious metals. The process was most probably intentional. Alongside personal adornment, green copper ore malachite and black lead ore galena were used in the cosmetics for the application on human faces and skins. In this way, they also bear witness to the mining areas of ancient Egyptians.

Collected 54 specimens cannot be statistically representative, although three main groups of material appear, alongside the malachite and galena. In broad terms, the development elsewhere is reflected also in this artefact category, with earlier use of arsenical copper and later use of tin bronze. Similarly, to the case of vessels, the experimenting with different alloys, as well as covering of the copper core by gold foil, can be expected. Moreover, some studies either yet unpublished or focused rather on precious metals must be mentioned in this regard.

Only recently, Badarian beads and pendants of copper and other materials were analysed by the portable X-ray fluorescence.[1617] None of the Badarian objects was analysed by other archaeometallurgical methods, assumptions about the origin of the ore are just assumptions without any basis. They could have been imports, as complete objects, and producers of them does not need to be inevitably Badarian people. Educated guess might, however, connected the presence of Badarians in Eastern Desert, with the use of malachite and copper in Badarian milieu itself, back in the Nile valley.

Slightly later, on the basis of knowledge about A-Group, it might be assumed that the ubiquitous thin awls, in fact tattooing implements, were locally produced from available metal. The only analysed A-group awl was most probably made of ore from Eastern Desert.[1618]

Scientific studies enabled identification of rare materials, a few uses of the rare copper mineral chrysocolla can be dated to the Early Dynastic Period (and are not included in the table).[1619] Copper and lead minerals found in Dynasty-1 contexts in Abydos and Giza were brought form Eastern Desert sources.[1620]

[1617] Results were not yet published. Maarten Horn (University of East Anglia), pers. comm.
[1618] (Anfinset 2010, 163–165, Figs. 6.49–6.50). Reinterpreted in Kmošek et al. (2018, 205, Fig. 9).
[1619] (Bianucci et al. 2009).
[1620] (Rademakers et al. 2018, 179-180).

In Chapter 5, presumed connection between Old Kingdom headbands and royal "gold of honour" was established. Thus, material coming from the royal workshops might be analysed in the cases of these diadems.[1621]

Ancient Egyptian alluvial gold contains up to 2 % of copper.[1622] Some of the analysed golden objects reveal addition of copper to gold, interpreted as a debasement of the gold or electrum alloy. Documented examples include Middle Kingdom gold objects,[1623] beads and fish pendants from Middle Kingdom Tomb 72 at Haraga.[1624] Two late Middle Kingdom jewellery pieces from Ayn Soukhna, golden pendant and silver ring, have higher percentage of copper, and thus copper might have been added.[1625]

In case of silver objects, the addition of copper has been interpreted as intentional method to harden the bulk metal and thus introduce better resistance of the objects. Higher percentage of copper was detected in Predynastic period and also Old Kingdom.[1626] In a foundation deposit of Senusret I at Lish, a "silver" plaque in a foundation brick was analysed, giving a result of Ag 54%, Au l8%, Cu 28%.[1627]

Other elements are not frequently present. Fragments of bracelet(s) at Tell el-Farkha with higher contents of lead in two fragments and high sulphur in three fragments, interpreted by authors as increasing fluidity of the alloy.[1628]

6.5.4. Chemical composition and other properties of textile- and leather-working tool kit

Positively identified parts of the textile-working (Figure 6.38) and/or leather working tool kit (Figure 6.39) were rarely analysed. 21 and 12 specimens respectively give hardly a significant representation of the alloys used. While more needles analysed were made of arsenical copper, of awls, more were made of copper with impurities and tin bronze. The counts are too low to draw any statistically corroborated conclusion.

In case of needle fragments from Tomb of Khasekhemwy, on the basis of Vickers micro-hardness it was possible to demonstrate that these objects were strong enough to be used practically, as needles or awls, and that they were not necessarily "models". Other

[1621] Unfortunately, both in Leipzig and Vienna, we attempted to include the diadem in the programme of the analyses, but sample taking or non-invasive analyses are for now out of question.
[1622] Ogden (2000, 162); Klemm – Klemm (2013, 42–43).
[1623] Lucas – Harris (1962, 490–491).
[1624] (Troalen et al. 2015, 81, Figs. 7–8).
[1625] (Abd El-Raziq,Castel and Tallet 2016, 109, Fig. 66).
[1626] (Gale and Stos-Gale 1981, 114).
[1627] (Weinstein 1974, 71).
[1628] (Rehren and Pernicka 2014).

objects, cut out from copper sheet, were of lower hardness. If such analyses are absent, the practical usability of the tools cannot be accurately assessed.

6.5.5. Chemical composition and other properties of hunting and food processing tool kit

Harpoons, fish-hooks (Figure 6.40) and knives (Figure 6.41) are rather underrepresented by analyses. For the fishing tool kit, only 15 specimens were analysed, with prevalence of arsenical copper, and expected tin bronze harpoon coming from Tell el-Dab^{c}a. Also, copper with impurities has not a negligible amount of 6 cases.

Knives are a difficult class of object, as they might have been mistaken for saws. The alloy will not help in the distinction, as both classes have similar composition. Tin bronze knife was found at Lahun. 9 cases are very little for any conclusion.

6.5.6. Chemical composition and other properties of vessels and their miniatures

Vessels and their miniaturized forms are intriguing category of the material culture (Figure 6.42, 6.43). Tools and weapons needed to be functional, vessels could be of differing composition and colour. The experimentation with the varied materials might have been more frequent and new alloys were tried.

48 full-size vessels were analysed, and almost half of these was found out to be of copper with impurities. This might be the “artefact” of the early measurements, not reflected by the real past chemical composition. Arsenical copper is slightly less frequent and unique case is a vessel of arsenical copper with nickel.[1629] Bronzes are represented by more diversity of CuSn, CuAsSn, CuSnAs, and CuSnPb. Apart from the tools, combinations with bronzes do occur frequently already in the Early Dynastic Period. Then they disappeared, to appear again in the late Middle Kingdom. This is most probably absence caused by the lower number of analyses in the periods in between, especially of Old Kingdom vessels. Into the category of full-size vessels are included also crucibles, but these are vessels of different purpose.

17 model vessels were analysed, with the predominance of copper with impurities and only seldom arsenical copper (Figure. 6.43). Too few model vessels are analysed, in order to conclude anything representative about the corpus. Often, uncovered model vessels are corroded through and the metal core is entirely absent.

6.5.7. Chemical composition and other properties of furniture, thrones, and hardware

[1629] Although another vessel from Early Dynastic Abusir might have had similar composition, but was too corroded to be analysed (Kmošek et al. 2018).

Not a single fragment of an ancient Egyptian throne was preserved, and nothing can be inferred about the ubiquitous “metal throne” of the Pyramid Texts. What could be analysed are either parts of the furniture, as furniture finials, or pieces of hardware, such as nails and clamps, remains of boxes (Figure 6.44, 6.45, 6.46). Pie chart demonstrates how disparate is this category of only 83 specimens, and thus that the conclusions can be only preliminary. Copper with impurities and arsenical copper are revealed as a most frequent material, tin bronze is rather marginal (Figure 6.45). The assemblage is further skewed by the higher representation of Early Dynastic objects and fragments, and only haphazard presence of other periods (Figure 6.46). Neither for Early Dynastic Period, 47 specimens can be sufficient.

6.5.8. Chemical composition of agricultural tools and musical instruments

No metal agricultural tools were preserved from these periods, and thus none were analysed. Neither was analysed any metal musical instrument or its part, from the periods under study.

6.5.9. Chemical composition and other properties of weapons and their models

Weapons need to be reliable products of metallurgy because the human life of their user is at stake. Arguably, some physical properties of the weapons need to be as good as possible. The weapons are also very frequently analysed, because of this reason, and being again, as tools and mirrors, rather bulky objects (Figure 6.47–6.57).Then there are also models of weapons, being either significantly smaller than functional weapons; or based on their decorated form, representing rather social standing of their owner than an object of defence or attack. This is e.g. the case of the fenestrated lugged axe blades with circular blade, having elaborated scenes where a fully functional blade would be needed. Miniaturized versions of the weaponry need to be similar to them only by form, not by size or other properties.

Pie chart clearly demonstrates that the most frequently analysed artefacts are full-size axes and only in lesser numbers were analysed daggers and spearheads (Figure 6.47). Geographical distribution reveals a wider dispersion of the use of arsenical copper and exceptional prevalence of tin bronze in Tell el-Daba. Underrepresentation of some regions is also visible on the map, e.g. of Memphite and Theban regions, together with Delta (exception is again Tell el-Daba).

176 weapons analysed seems to be a sufficient number, but 94 of these weapons were of unknown provenance. Only Tell el-Daba and Kerma did provide a number of analyses higher than 10 (Figure 6.48). Thus, also in case of weaponry “tool kit”, the results need to be taken with caution. Temporal distribution of the alloys demonstrates earlier use of arsenical copper and later use of tin bronze with several subgroups. But arsenical copper did continue until the late Middle Kingdom, and it was not abandoned also in C-Group and Kerma (Figure

6.50). Only 19 weapons can be defined as models, all three main groups of material did occur in the category (Figure 6.51).

135 battle axes are present in the corpus, 96 of these are of unknown provenance (Figure 6.52, 6.53), most of the table displays the artefacts analysed in the British Museum project. Representation of singular sites is meagre, even in Mostagedda, many small model axes were rather corroded and gave copper with impurities as an analytical result. Therefore, a creation of a statistical model, where unprovenanced axes could be assigned to the provenanced few is for now impossible. Temporal distribution reveals total absence of the Old Kingdom (Figure 6.54). But this can be caused by the presumed dating of all battle axes to the First Intermediate Period or later, while iconographic evidence speaks for a possible earlier dating of elongated epsilon blades. Only addition of lead isotopes to the dataset, alongside other methods of trace elements measuring, might help in distinguishing earlier axes from the later ones. The typological and material division of the finds (Figure 6.55) demonstrates dominance of the arsenical copper and scarcity of the use of tin bronze. M. Cowell and V. Davies categorized arsenical copper axes as artisan tool blades, bronzes as battle axes. Nevertheless, in both groups occurred exceptions.[1630] Thus, further confirmation of the typological and material diversity must wait for statistically significant results of comparable tools and weapons.

Unclear results of the battle axes are surprisingly incomparable to the spearheads (Figure 6.56). Here, distinction is clear between arsenical copper spearheads of the First Intermediate Period and Middle Kingdom. Completely different types of Levantine spearheads were found and analysed in Tell el-Daba, made of tin bronze, and in a single case, from a mixed CuSnAs, perhaps indicating mixing of both materials in further use.

The pattern of the earlier use of arsenical copper and ascent of tin bronze is observable also in case of daggers (Figure 6.57). Most of the 37 analysed specimens are provenanced. Intriguingly, Kerman daggers attracted more attention than the products of ancient Egyptian craft. Revised corpus of daggers, collected by S. Petschel, includes for periods under study 98 specimens (leaving out complete counts of Kerman daggers), thus, the analysed corpus does represent not even a half of the known daggers.

6.5.10. Chemical composition and other properties of statuary and boats

Statues and statuettes are in general bulky artefacts and often it is possible to obtain sample from the part of the object that is not visible, as the feet, stand or the rear side (Figure 6.58).

[1630] (Cowell 1987, 97–101)

Statuettes were more often also involved in the question of the provenance and genuineness of them. However, not many of the statuettes were preserved from the periods under study.

Concerning the alloys, *sfyrelata* from Hierakonpolis were made of copper with impurities, which was probably more malleable than the copper alloyed with arsenic and used for the tools.

Cast statuettes are dated to the late Old Kingdom or later. If analysed, they were cast from arsenical copper, and later on from tin bronze, as well as some alloy combinations peculiar only for statuary (Figure 6.58). Higher contents of arsenic might have caused paler complexion of female statuettes,[1631] but there are male statuettes made of this alloy as well.[1632] The original contents of arsenic in the alloy is not definable, even on the surface, where it evaporated.

[1631] Women nursing children (Romano 1992; Hill and Tourna 2007, 12, Figs. 6-7).
[1632] (Hill 2007, cat. no. 4).

7. Synthesis

Preceding three chapters analysed the existing evidence on the use of copper in the periods under study. At times it was just a synthesis of published results, however, more often it was pointed out that our knowledge is woefully insufficient. New interpretations were also proposed. In this chapter a synthesis of the current state of the knowledge is offered. The footnotes are mostly absent herein, numbers in parentheses refer to the number of a chapter, where the findings presented in the synthesis were discussed and analysed. While *chaîne opératoire* can be almost fully reconstructed for the Old and Middle Kingdoms, other periods have more lacunae in the source preservation.

As it is clearly visible on the regional distribution of the written and iconographic sources (Figure 4.1), most of these, one third, has a provenance in Memphite region. In cases of Thebes and Abydos, many tombs and contexts are until now unpublished. Other regions are represented by a share below 10%, or even 5%. Sources from Delta are almost absent. The temporal and regional distribution (Figure 4.2) demonstrates absence of secure sources from the Predynastic, and a prevalence of the sources from the periods of centralized state and unhindered production of the tombs, images, and texts. While the Old Kingdom sources are clearly skewed towards Memphis, Middle Kingdom sources are well distributed over Egypt (Chapter 4).

Looking on the regional distribution of the 2,253 archaeological contexts with material culture (Figure 5.1), one fifth is concentrated in Memphite region. Significant is also presence of the contexts from sites between Asiut and Abydos, where were excavated burial assemblages by British and American archaeologists. Well represented are Abydos and Delta, with c. 10% of contexts each. Rather surprising is low number of contexts from Theban area, where many tomb contexts are until now unpublished. If we split the regions into the general periods (Figure 5.2), most apparent trend is the increasing regionalization, with the peak in the Middle Kingdom. The previous periods of the centralized state are significant by the apparent centralization of the use of artefacts. Expected is the prevalence of some regions in certain periods, as Abydos in the Early Dynastic and Memphite region in the Old Kingdom (Chapter 5).

A database for the synthesis of the archaeometallurgical information on the periods under study includes 962 items of analysed artefacts and ecofacts, connected to the use of copper. These were gathered from the all accessible published and some unpublished sources, and for the first time, the information is connected back to the archaeological context of the finds, if it was possible to be tracked down from the literature. Only 192 items of the database, 20% of the corpus, is of unknown provenance and in most of these cases, typology can help in the dating of the objects. Therefore, 770 artefacts and ecofacts can be mapped in Egypt and Nubia, located at least on the precision level of a site (Figure 6.1). This corpus enables to assess the use of specific alloys and materials in ancient Egypt from Badarian to the beginning of the rule of Hyksos. Looking on the regions represented, one fifth of the corpus is from Abydos, although most of the analyses were done in earlier studies. Still rather well represented is the region between Asiut and Abydos, with almost one seventh of corpus. Clearly underrepresented is Memphite region, with the most numerous archaeological finds from the periods under study, and the situation is even worse in Thebes, where there is almost total absence of analyses of Middle Kingdom material. The gravest problem causes the low number of the analyses from archaeologically documented Sinai and Eastern Desert contexts, since they were the major sources of the copper ore of ancient Egypt. Current policy of handling with samples in Egypt will impede increase of precisely this number in the future (Chapter 6).

7.1. Copper in the predynastic Egypt

The use of copper was introduced to Egypt in Badarian. Badarian sites are besides Upper Egypt also known from the Eastern Desert, to the north of Wadi Hammamat, in Wadi Atulla and Sodmain Cave, and we can speculate that their presence was also due to the collection and probably mining of minerals. Badarian and Amratian settlement in the region Lakeita of Eastern Desert provided raw fragments of copper and slag (5.1.1). Educated guess might connect the presence of Badarians in Eastern Desert, with the use of malachite and copper in Badarian milieu itself, back in the Nile valley (6.5.3). But it must be confirmed using advanced archaeometallurgical methods. Badarian copper objects are few in number, beads used as personal adornment and a pin or needle. Malachite was used also as a pigment. Copper and malachite were associated with rather rich graves in terms of the burial goods. These “rich” graves were not, however, restricted to men, rich burials were also of women and children. (5.4.3.1). Only recently, Badarian beads and pendants of copper and other materials were analysed by the portable X-ray fluorescence, although the results were not yet published (6.5.3). Also, the problem of Brunton’s determination of “turquoise” in Badarian contexts is being examined currently. It has been shown that so called turquoise is in fact glazed steatite (6.4.1.7). The use of glazed steatite indicates use of pyrotechnology, therefore also the copper objects might be products of early local metallurgy.

Phase Naqada I continued in rather low number of the documented copper objects. The centre of the culture, Naqada, ancient Nubt, was located *en route* to the Eastern desert and thus sources of gold and copper. Naqada II is a breaking point. Main components of the artisan tool kit, chisels, adzes, axes and saws, with presumed use of fifth component, drills, were most probably produced since Naqada II, in copper with impurities and arsenical copper (5.4.1). The metal weapons (and weaponry made of other materials) were found in Predynastic and earliest Early Dynastic contexts. Among the Egyptian copper weaponry were spearheads, arrowheads, daggers, and axe blades. Those are rarely preserved in whole assemblages, usually, one or two weapon blades per context were maximum (5.4.12). fourth millennium BC vessels are rather rare and of limited types represented (5.4.7). Closer look on the published contexts reveals insignificance of the copper beads in Egyptian necklace strings. The beads were more often made of other materials. But malachite was quite widely used as a green colourant, besides as a source of copper (5.4.3).

Transport of the ore over long distances supposed the use of domesticated animals for the moving of heavy loads, especially donkeys, used in Egypt already in fourth millennium BC. Important was also progress in the watercraft technology (5.1). In the Eastern Desert, to the late Naqada IIIB are datable beginnings of site 5A at Wadi Dara. Naqada III mining remains at Wadi Um Balad were already positioned on some earlier mining debris without pottery. Beginnings of mining at el-Urf/Mongul South were also dated to the Predynastic. Further south was exploited site Wadi Semna I (5.1.2.1). The presence of Egyptians on Sinai is confirmed by the inscriptions at Wadi Ameyra and Faras Um al-Zuebin, probably in connection with Naqada IIIA King Scorpion,[1633] certainly with Naqada IIIB Kings Iry-Hor, Ka?, and Narmer, being interpreted as inscribed in the vicinity of an as yet unidentified mining area (4.2.1.1). Predynastic smelting was claimed to be found at Bir Nasib area, at the site 702B (5.1.2.3).

Attribution of site Maadi to a different Maadi-Buto culture was doubted recently.[1634] Therefore, the site might be a centre of the further movement of metals up the stream of Nile. Finds of the ceramic moulds at the site Tell Hujayrat al-Ghuzlan near Aqaba (Jordan) are similar in the shape and dimensions to the two ingots found at Maadi. Copper processing is here dated to the period of 3700/3650–3550 BC. Except of a single copper prill from Tell el-Farkha there is no other evidence about copper metallurgy in the predynastic Delta (5.1.3).

[1633] Based on the analogy of rock inscription in the tomb of U-j, sometimes ascribed to King Scorpion I (Tallet and Laisney 2012, 383–384, Fig. 7).
[1634] (Köhler 2014b).

Most of the fragments from Maadi were presumed to be coming from either Wadi Arabah or Sinai (6.2.5). The origin of ore from Sinai was assumed for artefacts from Tell el-Farkha, and manganese ore from Maadi (6.2.2). A typologically unidentifiable fragment from Maadi was made of Anatolian copper ore (6.2.6).

Most probably already in fourth millennium BC started to be used terms later known from the ancient Egyptian: word *ꜥꜣ.t* covering all minerals, including ores, and similar natural phenomena (e.g. fossilized wood; and probably etymologically connected to the word for a donkey, *ꜥꜣ*, 4.1.1); the word *bjꜣ*, with the wider meaning of other metals, but also specifically meaning copper, as it would be understood today, having a close parallel in pronunciation in another word *bjꜣ* for a mine, originally meaning any "hole in the ground" (4.1.2), and also *bḏ.t* as a crucible (with a bread mould *bḏꜣ* as a word with similar origin) and *bḏ.ty* as a metalworker (4.1.5). The term "Asian copper" seems to represent a different kind of copper than the Egyptians knew originally, thus it might represent arsenical copper with low arsenic, which is slightly different by colour from ordinary copper, but also differs by the garlic-like smell. The point is that it does not differ extremely from "ordinary" copper, requiring a use of a completely different word. Even the hieroglyphic sign for *sṯt* can be interpreted as saddle pack for a donkey, therefore denoting something imported (4.1.3).

Perhaps the most difficult concept to grasp about the periods under study is the use of arsenical copper with the highly toxic arsenic. Egyptologists are slow in accepting this fact, even if hundreds of objects are shown to be made of such material (6.4.1). The material has arsenic as the main other element, which causes the resulting material/alloy to be harder than copper with low impurities of other trace elements, and similar in properties to tin bronze.[1635] However, general properties of arsenical copper were studied only seldom, because this alloy must be nowadays produced under conditions that protect experimenters from the toxic effects of arsenic. As for the colouring properties of the arsenic, c. 2 wt% "draws the alloy towards a greenish color". And if there is more arsenic: "The perceived result is a more white-grayish appearance of copper with increasing arsenic content".[1636] Ancient Egyptian metalworkers must have been aware of the toxic effects of arsenic and they most probably performed crude protective measures. Boiling point of arsenic is 615 °C, thus during smelting, metalworkers could have been exposed to arsenic in gaseous state. Nevertheless, they must have been exposed to at least small regular doses of arsenic for the whole active life as craftsmen. Such lives could not last long, most probably (6.1.4.3).

[1635] (Lechtman 1996).
[1636] (Mödlinger et al. 2017, 18)

7.2. Copper in the Early Dynastic period

The system of the hieroglyphic script begun to develop in the Early Dynastic Period. A "drop" shape denotes a "fire" and it became identical with a top part of the hieroglyphic sign U28, read as *ḏꜣ*, but it also could denote the sign of copper, *bjꜣ*, and crucible in a fire (4.1.2). A sign for crucible (N34 in Gardiner's sign list wrongly determined as ingot, although already Champollion interpreted the sign correctly as crucible), denoted a metalworker, *bḏ.ty.* An alternative form of the sign (W13) represents two crucibles side by side. This co-occurrence might be read as a *nisbe* of the word *bḏ.*(*t*), i.e. *bḏ.ty* – creating also a pun on the name of a metalworker, "person of the crucible"/"crucible operator", i.e. a metalworker (4.1.5). It is questionable whether all forms were present already in Early Dynastic hieroglyphs, but not that much written evidence is preserved from the era.

Some of the areas of ancient Egyptian activity were worthy of inscribed commemorations of the expeditions (such as Sinai and Nubia, or the Western Desert without copper sources), while other areas with the mining presence are almost without inscriptional evidence (the middle Eastern Desert areas with copper mines; 4.2). Preserved inscriptions are not the only source for the ancient Egyptian expedition activities. And from the later, more detailed sources, can be inferred that the target of the expeditions was usually to gather as much of diverse available materials in the area as possible. Inscriptions on Sinai were found at Wadi Ameyra and Faras Um al-Zuebin, of Dynasty 1, Naqada IIIC Kings Djer, Djet?, and Den and Dynasty 2, Naqada IIID, King Nebra. Moreover, the year labels of King Den from the year of his sed festival are interpreted as referring to the destruction of the walled settlement *ꜥꜣ ꜥn* (Beautiful Gate), probably site Ayn Fogeya at Sinai, massacring the people Iuntiu (people of the bow) and bringing malachite (*jn.t šśm.t*) to Egypt (4.2.1.1). In the Eastern Desert, Wadi Dara was a mining and copper processing cluster of sites. At Wadi Um Balad, mining activity can be dated to the Dynasty 1, and generally to Early Dynastic at el-Urf/Mongul South. Further south was in Dynasty 1 mined the site Wadi Semna I (5.1.2.1).

Anatolian copper ore sources were after Maadi used also near Memphis, on the basis to the results of the lead isotope and trace element analysis of an Early Dynastic vessel from Abusir, housed now in the Egyptian Museum of Leipzig University, with inventory number ÄMUL 2160, produced out of CuAsNi material. A vessel fragment ÄMUL 2162 from the neighbouring tomb had also presence of nickel, but was too corroded to be properly analysed.[1637] Predynastic axe head from Matmar and needle from Naqada contained high

[1637] (Kmošek et al. 2018).

nickel as well, but there are no lead isotopes for these two objects. One possibility of the presence of Anatolian material is a supra-regional exchange, another is that some of the material was gathered during the incursion of Egyptians in southern Levant in the first half of Dynasty 1 (6.2.6).[1638]

Already in the Early Dynastic Period, there is limited evidence of *pr-ḥḏ* – the Treasury. No evidence connects Early Dynastic Treasury with the storage of metals and metal objects, and we can only infer that metals were also stored by the "White House" or "Red House" and that the situation might have been similar to the later Old Kingdom. Copper tools are associated with weighing stones in the paintings from the Tomb of Hesyra at Saqqara (4.3.1). Copper tool blades were apparently weighed and controlled throughout the whole Egyptian Bronze Ae.

Unique textual indication provides evidence that some Early Dynastic institutions possessed also metal workshops and the products were sent to royal tomb(s). Two vessels, apparently from the burial equipment of King Qaa from Dynasty 1, were, according to their inscriptions, coming from a palace near Buto, another one from a palace in the Memphite area. Thus, this is the singular, but convincing evidence that metal workshops were parts of the domain/palace structure of Early Dynastic Egypt. Moreover, if the presumed location of the workshops is correct, they were located in the area without ore sources, thus they had to be provided by a state distribution network. The circulation of metal must have worked effectively already in Early Dynastic Period (4.4.2). The earliest archaeological evidence of workshop is Dynasty-2 crucible and slightly later remains of metallurgical activity from el-Kab. Contemporary metalworking activity was identified also at Elephantine (5.3.1.1).

The metalworkers did not constitute a special social class; instead, they were a subsection of all other craftsmen, arguably a social group in ancient Egyptian society. Probably only some bearers of overseeing and religious titles were of higher status (e.g. Dynasty-3 Ankhua). C. J. Eyre noted that of the crafts, we have the best information about the structure of metalworkers' workshops;[1639] even so, a reconstruction of the structure is only possible in general terms. As other crafts working with copper objects also have evidence of the workshop structure, these titles reflect the general rules of the structural division of specialised, full-time craftsmen passing the craft from generation to generation (4.4).

The strongest indicator of the existence of at least one Early Dynastic funerary monument of a metalworker is an unprovenanced statue now in the British Museum, a granite

[1638] (Hauptmann,Schmitt-Strecker and Begemann 2011, 72).
[1639] (Eyre 1987, 13, 27).

statue of Ankhua from Dynasty 3, metalworker, property custodian of the king, and shipwright of *śmꜣ*-ships (EA171). The combination of the titles of metalworker and shipwright indicates that the professions of the smelters and other craftsmen could be exercised by the same person (and the subsidiary graves contained persons with the symbols of status – the tools). He must have resided somewhere in the Memphite area. The statue shows clearly that the social status of some craftsmen could be rather high in early Egyptian society. In the provinces, two seal impressions from Elephantine might have named metalworkers, but only one specimen can be explained unequivocally (4.4.2).

Concerning materials used, artefacts made of copper with impurities are spread over Egypt and Nubia, but rather in low numbers. Two larger concentrations of the analytical results are from the Early Dynastic Abydos and Bet Khallaf, but in both cases, these are rather early and insufficient now (6.4.1.1). Arsenical copper was the most frequently used material for full-size functional objects (6.4.1.3).

Already in the Early Dynastic Period, Egyptians certainly knew tin bronze as one of the copper alloys. The earliest tin bronzes were found at Abydos, in royal tombs of Den and Khasekhemwy, Dynasty-3 high official's tomb K1 at Bet Khallaf, and also at Early Dynastic to Old Kingdom strata of Buto (6.4.1.5). The word *ḥsmn*, translated often as tin bronze is used also for other materials and this translation would not explain their mutual connections. Since high-arsenical copper would be whitish-grey, similar to a natron salt and white hues of amethyst (two other meanings of the word *ḥsmn*), its translation is most probably copper with higher content of arsenic (4.1.4).

Many tool kits and artefacts were produced out of copper. Artisan tool kit is depicted in early hieroglyphs, but even in more detail in the tomb of Hesyra at Saqqara. Carpenter Wabkhenemu from the opposing bank of Nile, at Helwan, had several tools and a crucible in his offering list. Tools with inscriptions indicate royal ownership and sometimes also probably private ownership of the tools by the craftsmen (4.5.1.1). If analysed, tools were made of copper with impurities or more frequently of arsenical copper (6.5.1).

Earliest depiction of the cosmetic tool kit with razors and tweezers was found in the tomb of Hesyra (4.5.2). It seems that only in this period was a complete tool kit produced of copper: mirrors, razors, tweezers, hair curlers, and kohl-sticks (5.4.2). Copper furniture finials are as well the creation of the Early Dynastic craft (5.4.10).

Copper vessels are among the earliest artefacts mentioned in offering lists (4.5.7.1). In the Early Dynastic Period, alongside rudimentary evidence for offering ritual, vessel types that were included in the ritual, begun to appear in the archaeological contexts. Clear connection is in the case of spouted jar/ewer and wash basin (5.4.7).

The intricate shapes of the White Crown and the Red Crown of Egypt indicate the use of metal for the production of the crowns in practice: the Red Crown was most probably made of unalloyed copper, the White Crown probably from silver. The earliest Palermo Stone entry on metals concerns the making of a statue of King Khasekhemwy named "High is Khasekhemwy" with an exact measurement of its height: 2 cubits, 6 palms, 2.5 fingers (4.5.12).

7.3. Copper in the Old Kingdom

Ore procurement was taking place under the auspices of some Old Kingdom deities, especially Horus, Thoth, Min, and Ra (4.2.2). Coptos was a departure point for expeditions to Wadi Hammamat, but it obviously also concentrated specialists for the expeditions to Nubia. Two different specializations were focused also on the copper procurement, prospectors (*smn.tjw*), aiming at finding the sources, and metalworkers, able to process the material found. The ore sources, being it for copper, gold, lead, or arsenic, were present in the Precambrian basement complex of the Eastern desert. Early prospectors at work were observed indirectly in the field by R. and D. Klemm and their *modus operandi* can be well described: they were looking for the sulphide copper ore mineralisations and secondary copper oxides, malachite linings, in hydrothermal quartz vein deposits along granodiorite rocks. Copper was most probably the original target of such mining, but its geological association with gold must have been also discovered already in the third millennium BC (6.2.1).

Recently found late Dynasty-5 evidence from Edfu connected the specialization of the prospectors unequivocally also to the copper procurement (4.2.2.1). But the Old Kingdom presence in Eastern Desert is on much wider area. The northernmost cluster of sites in Eastern Desert is in Egyptian Wadi Arabah, three Old Kingdom mining sites have been discovered at Kasr Girgis. Exploitation of Wadi Dara continued from the Early Dynastic Period, as well as Wadi Um Balad in Dynasty 4, and el-Urf/Mongul South. To the south were mined sites Wadi Semna II and III. Other cluster of sites was found by the British mission in Wadi Abu Had (5.1.2.1). Both oxidic and less frequently sulphidic ores were smelted on the sites (6.2.1). None of these archaeologically identified sites provided substantial inscriptional evidence, and they are thus usually dated on the basis of ceramics.

Also the copper sources in Nubia were sought for, although the only archaeological evidence is provided by Buhen, indirectly datable by the sealings from the reign of Khafra to the reign of Nyuserra (4.2.2.2). Overall, Emery's reports created an impression of the industrial scale of copper processing at the site. The actual evidence, presented by D. O'Connor, is much more modest. Traces of metallurgical activity refer rather to processing of copper, with copper ore in quartz, bread mould with a copper stain, eleven moulds for semi-products and pounders. The metal processing took place probably in the second phase of the settlement, in the Dynasty 5. One more malachite mining site was identified at Umm Fahm 1 (5.1.2.2, 5.3.1.2.2). The main copper-bearing ore at Buhen was malachite. Ore contained high percentage of gold and this is interpreted, in absence of analogies from other regions, as a feature of the Nubian ores (6.2.4).

The most frequent motif of monumental inscriptions on Sinai (15 times) in the third millennium BC is a scene of a king smiting a kneeling enemy, who is depicted with a pointed beard of an "Asian" man, as Sinai was clearly out of the Egyptian territory. An inscription from the reign of Sahura on Sinai informs about the subjugation of Asia (*sṯ.t*). It is unfortunate that the Old Kingdom inscriptions do not inform about the presumable cooperation of locals on the expeditions. The first mention of copper is from a fragmentarily preserved and unclear inscription of Nyuserra at Ayn Soukhna, connected to the Sinai expedition. The inscription from Year 6 of Djedkara at Wadi Maghara contains the scribe of metalworkers and the controller of metalworkers – *sš bḏ.tyw* and *śḥḏ bḏ.tyw*. (4.2.2.3). Archaeological evidence of the connection to Sinai was found at the early Dynasty-4 harbour Wadi el-Jarf, with an opposing counterpart of a fortress Tell Ras Budran on the shore of Sinai, at Markha plain (5.1.2.3); and its Old and Middle Kingdom successor, harbour at Ayn Soukhna (5.1.2.1). Stone settlement at Wadi Maghara is most probably of Old Kingdom date. Old Kingdom smelting furnaces have been identified at Bir Nasb and another mining site at Wadi Kharig, with a stone-built settlement. Site Seh Nasb of Dynasty 5 contains on a length of almost a kilometre 27 batteries of copper smelting furnaces with c. 3,000 units. Greater part of the Sinai Peninsula was probably never visited by ancient Egyptians and the Early Bronze Age local inhabitants were living there, named by Egyptians as "Bowmen". Local inhabitants might have helped in the mining operations, and they might exchange materials inaccessible for Egyptians from other parts of Sinai. The most important candidate is a site Wadi Tar, located too far from the Egyptian presence, near the southern tip of peninsula, of its south-east coast, with no ancient Egyptian material culture reported from the site. Yet it is the only known occurrence of ores of copper with arsenic on the whole Sinai (5.1.2.3).

There is no Old Kingdom textual evidence on the imports of copper ore or ingots from Wadi Arabah in contemporary Jordan and Israel to Egypt (4.2.2.4). Neither archaeological evidence does not support connection to Old Kingdom Egypt, as no similar ingots to Khirbet Hamra Ifdan were found in Egypt. Recent development in the ^{14}C dating of the sites in Levant poses serious questions about the coexistence of the sites of Early Bronze Age III and IV and ancient Egyptian Dynasties 5 and 6. Transition of EBA III and IV is now dated to around 2500 BC. New development shifts the context of copper exchange network as imagined by M. Haiman (5.1.3).[1640] Early Bronze Age copper from Feynan was characterised by a low percentage of trace elements. The only element with higher concentration was lead, with up to almost 3%. Lead isotopic signature of the Feynan copper has regular distribution and is well identifiable, but it was not yet identified in contemporary Egypt (6.2.5). The reason might be also that not enough Old Kingdom artefacts were analysed for their lead isotopic ratios (6.1.2.4.1). And, although Dynasty 6 is well-known by the ubiquitous copper artefacts, only a fraction of them was analysed by any method (6.4.1).

Unsuspected early sources might be soon included among the regional providers of copper. A mission of Austrian archaeologists is excavating a site Qurayyah in Saudi Arabia, inland, but in the vicinity of the gulf of Aqaba. The site is datable to the 22nd-20th centuries calBC and a workshop was identified here for the production of arsenical copper (5.1.4). Since the geological origin is the same for the ores of Eastern desert and Saudi Arabia, also their lead isotopic ratios are similar, and when Qurayyah will be published, it might change the interpretation of the currently known lead isotopic ratios, interpreted usually as coming from Eastern Desert (6.2.3).

Inscription of Iny informs about the import of silver and lead/tin from Byblos (4.2.2.5). The information from Palermo Stone on the import of 6,000 units of copper from Punt is unclear. The nearest region with rich copper sources, used also in the Early Bronze Age, is Oman, but there was not yet any copper from Oman identified in Egyptian contexts before the Dynasty 19 of New Kingdom (4.2.2.6).

The "Treasury" remained the main storage centre in the Old Kingdom, written in the dual, *pr.wy ḥḏ*, on the state level. There is no direct Old Kingdom evidence of storing copper in the Treasury. Since Both Golden Houses were part of the institution, it can be inferred that other metals including copper were also stored there. The issuance of various products from the Treasury was recorded. More objects were included presumably under the general term *ḫtm.t* – sealed things (translated in some contexts as funerary equipment or a treasure). Three sources of the procurement of goods for the Treasury were the provinces, the expeditions, and

[1640] (Haiman 1996).

other departments of the administration. The evidence indirectly demonstrates that Old Kingdom Treasury was an institution for passive storage of either the materials or finished objects that might have been royal property. This was a place where the materials were passively stored as either ingots or finished objects. A magazine or magazines existed as subordinate units of the *pr-ḥḏ*, with the name *wḏꜣ,* as reflected in the Old Kingdom title of its intendant. Using the analogy with gold, copper might have been stored similarly, as a title of the keeper of the magazine of gold is known from the Old Kingdom (4.3.2.1). Like with the magazine, the only metal treated separately in the case of sealing is gold, albeit scarcely. The materials were sealed by its weight, i.e. their amount was controlled and sealer was one of the rather important titles of the Old Kingdom, with continuing importance in the First Intermediate Period and Middle Kingdom (4.3.2.2). Metalworking scenes are the only Old Kingdom scenes where an oversight, weighing of material is displayed. Weighing can be both the initial and the final stage of metal production. The objects being weighed are not preserved in all cases. Vessels represent the most frequent finished objects; the only undisputed case of weighing of tool blades is from the Tomb of Kaemrehu (4.3.2.3). The basic Old Kingdom weight unit was reconstructed by M.-A. Cour-Marty as the *deben*, which weighed around 13–15 g (5.2.3.2). from a so called “house-selling” document from Giza (5.2.3.2).

The document of “House-selling” found at the valley temple of Rakhef is a secure evidence that weighing unit *šꜥ.t* connected to copper was being used in the Old Kingdom in private transactions, as a value equivalent. This might be also context of the mention of *šꜥ.t* in the tomb of Nyankhkhnum and Khnumhotep (4.3.2.3). There are also other units discovered on the typologically Old Kingdom weights by M.-A. Cour-Marty, the smallest one, 8–10 g might be the elusive *šꜥ.t* (5.2.3.2). Copper is listed among natural rewards for work on the tomb, but the exact form – the raw material, finished tools or ingots – is unknown. Possibly, there was a difference between copper provided for the construction of the tomb and copper as “a reward/payment” to the builder, like the difference between the texts of Akhetmehu (more probably reward) and Metjetji (rather furnishing during the construction). According to the preserved titles, neither Akhetmehu, nor Metjejti, participated in the processing and use of copper. This means that copper could have been redistributed also to the powerful people outside of the Treasury and the overseeing of the works (4.3.2.4).

The decrees from Coptos, a corpus of royal decrees from Dynasties 6 and 8, provide marginal but valuable information on the administrative control of copper, in the context of royal administration. From the legal point of view, decrees B and C exempted the temple of

Min from compulsory work for the royal administration. Coptos decree C is dated to the year after the 22nd cattle count in the reign of Pepy II, being an updated version of Coptos B. One of the changes concerned a short list of items under the control of the overseer of Upper Egypt: gold, copper and jewellery. Coptos D protected an estate named “Min strengthens Neferirkara” belonging to the *pr šnʿ* estate. Coptos decree D reiterates some of the exemptions, this includes the requirements of the overseer of Upper Egypt, listing only gold and copper. What was preserved in this document is a possible reference to the Residence (*ẖnw*) as the final destination of the overseer’s requirements. What can be inferred from the Coptos decrees is that institutions in Upper Egypt (temples and estates of temples) procured or produced copper, gold and jewellery and that these materials were subject to “taxation” by the overseer of Upper Egypt with the final destination in the Residence. This information goes against the tendency to interpret the procurement of materials as an activity organised exclusively by the royal administration.

The practical consequences of the control over the flow of materials can be traced in the fragmentary inscription of the overseer of Upper Egypt Idu I from Dendera, from the late Dynasty 6. He claimed in his funerary inscription that he possessed “... everything excellent and splendid: oxen, herds, copper ....”. It seems that the overseers were taking some of the revenues destined to be used in the centre of the state, which empowered the regions and weakened the centre. Significantly, but not surprisingly, tomb of Idu I was the largest on this Old Kingdom cemetery (4.3.2.5).

The only deity directly connected to the metallurgy was Sokar, the god of the Memphite necropolis and, based on two mentions from Old Kingdom reliefs, also a deity mentioned by metalworkers. In the Pyramid Texts, Sokar himself produces metal harpoon heads for the deceased king so that he can break the egg in which he is before his rebirth. Two spells of the Coffin Texts demonstrate that metalworkers and “gold workers” were perceived as the Sokar’s craftsmen in particular, and Sokar himself was considered to be a “metalworker of gods” (4.4.1).

Old Kingdom metalworkers were affiliated to several royal institutions: Great House, i.e. palace, Both Houses, *wʿb.t* – workshop, or they were named as craftsmen of the king – *nswt/pr nswt*. A doubling of the institutions while there was a single king would be improbable, therefore some of the different wordings might capture a similar past reality of a large royal “household”. Only a single metalworker, from the tomb of Mehu at Saqqara, was the overseer of the metalworkers of the funerary estate, thus in the clearly private service for the tomb owner. The silence about private/non-royal metalworkers in Old Kingdom sources might have been due to lower importance of this information. It can be assumed that only rather large households or estates could afford their own metalworkers and supply of the material (4.4.3). The papyri from Gebelein named six metalworkers and one director of the metalworkers in papyrus II and grain wages for a metalworker named *Jnw* from a settlement *Jꜥrw* , revealing complex structure of the craft in provinces, already in Dynasty 4 (4.4.3.3).

Several tombs of metalworkers are known from Saqqara and Giza, but none of these reached remarkable size. Only one of them featured a biography, not fully preserved, tomb of Itush from Saqqara. From Saqqara is also a tomb of Ankhi/Intji, metalworking and religious specialist, whose late Dynasty 6 tomb was rather modest, albeit with intriguing inscriptions. We can presume that Ankhi/Intji was literate, and personally involved in the decoration of his tomb and the inscriptions, referring to his arcane knowledge of the metallurgy and its Old Kingdom religious aspects. None of these persons seems to have reached particularly high social status, but these mentioned metalworkers and several of their colleagues were active among the so called "intimates" of the king, including besides craftsmen more importantly the specialists on the personal care for the ruler himself (4.4.3.4). Workshop scenes of metalworking were rather popular in the large tombs and therefore it seems that large estates featured also metalworking specialists (4.4.3.5). Skeletal remains of an Old Kingdom metalworker were found at Giza, East field, by the Russian mission (5.3.4).

The most surprising fact on the Old Kingdom copper metallurgy is that there is thus far no evidence of any large metallurgical installation, with the exception of already mentioned Seh Nasb from Dynasty-5 Sinai. And we must suppose at least one for each part of Memphite necropolis and also for the stone necropoleis in provinces. The original, Early Dynastic (or even predynastic one) could have been in the area of Saqqara or Abusir. The largest known installation was found at Giza, near the Menkaura mortuary temple, but it was not published well. Another workshop was identified at Heit el-Ghurab, from the reign of Menkaura, with the traces of earlier activity from the reigns of Khufu and Khafra at the so-called Kromer settlement debris (5.3.1.2).

Concerning final products of the metalworkers, Old Kingdom artisan tool kit continues to be depicted in the hieroglyphic script, often in great detail (4.5.1.2.1). Frequently neglected is a performative aspect of craftwork, clearly displayed in *mꜣꜣ*-scenes of the tombs. Inscriptions on two false doors, of Nyankhsakhmet and Khufuankh, stated that the false doors were produced on instigation of the king himself and in his presence, for the particular official. A proficiency in the craft might have been a vital aspect of this seeing, an appreciation of the member of the elite who ordered the craftwork and (over)saw its completion. This was most probably also a reason the word *mnḫ* has two meanings: “a chisel” and “to be splendid; to make splendid; to be effective” (4.5.1.2.2). Market scenes from tombs provide evidence of the exchange of copper tools (4.5.1.2.3). Many professions were working with artisan tool kit: quarrymen, architects and builders, sculptors, carpenters, shipwrights, and furniture makers (4.5.1.2.4). A paradox of Old Kingdom sources is that, as we have seen above, the titles of craftsmen provide evidence on the structure of organized craft; the phylae formed the organization system of corvée labour, i.e. of people who were not professionals in craft and could perform tasks requiring little training. The tools were most probably handed over to non-specialized workers performing the tasks as members of the workers’ phylae. If the tools did not contain the title of the person, we might suppose that these are the tools of the craft specialists, and the tools were owned by them (4.5.1.1). Copper tools and weapons were stored at the governors’ palace at Balat (4.5.1.2.6), and the tools marginally appeared as part of the offering lists (4.5.1.2.7). Some titles of craftsmen developed into the priestly titles of “shipwrights” of barques for specific deities (4.5.1.2.9) and some tools, adzes, and saws, figured in Pyramid Texts (4.5.1.2.8). Technological innovations of the Old Kingdom are gradual widening of the blades of adzes, increasing the impact of the tool (5.4.1). If analysed, the full-size functional tools were made either of arsenical copper or copper with impurities (6.5.1).

Cosmetic tool kit was depicted in early object friezes of Dynasty 6, but in early Dynasty 4, two types of razors were registered in an offering list of the lady Nefret at Meidum. Old Kingdom Egyptian distinguished three categories of the professions working with the cosmetic tools: hairdressers, barbers, and manicurists (4.5.2). Arsenical copper is predominant in the assemblage of mirror discs preserved, and the razors were also made of this material (6.5.2).

Personal adornment was produced by jewellers producing necklaces and headbands, those producing beads from (precious) stones using metal drills, and the producers of royal jewellery (part of the regalia). Types of jewellery from iconographic sources that could have been made of copper (or with a copper core) include bracelets, anklets, headbands, and diverse types of necklaces (4.5.3). Existing examples of unique headbands from the Old Kingdom, with a copper core and gold foil covering the core, can be interpreted as royal “gold of honour”. Other objects of personal agency, and also adornment, were seals. Some Old Kingdom cylinder seals were made of copper, as well as circular and pyramid seals (5.4.3.3).

Textile processing tool kit (needles, awls) is not shown in the iconographic sources or described in written sources (4.5.4). Needles were quite frequent as settlement finds, and these were most probably objects made of copper most widely used (5.4.4). Leatherworking was a craft that was represented in the hieroglyphic script by a tool with a metal point, an awl. The evidence is from the Early Dynastic Period and the Old Kingdom (4.5.5). Leather-cutting knives were found only in Old Kingdom contexts (5.4.4).

Copper fish-hooks seem to be artefacts used also by ordinary fishermen. A distinction is made to tomb owners, who spear-fish with harpoons (most probably of copper heads) and their subordinates are depicted as hunting down hippopotami. Elite connotation of both these activities is made clear, as is also probable inspiration in royal iconography of fishing and hunting. Single-handed killing of hippopotamus by a tomb owner is not depicted, as this motif is a prerogative of kings in the Old Kingdom. Knives for killing cattle in ubiquitous butchering scenes in Old Kingdom tombs were depicted as made solely of flint (4.5.6). Fish-hooks are rather frequent as settlement finds, both fish-hooks and harpoons were mostly absent in the funerary contexts (5.4.5).

The most frequent occurrence of copper vessels in Old Kingdom sources was in the so-called offering ritual. In Old Kingdom Egyptian, it was named *pr.t ẖrw,* denoting the words recited during the putting forward of the offering meals. Each vessel had an established name and role in the ritual, being a "tool" actively used in these repeated circumstances. Old Kingdom sources clearly designate diverse materials, also metals, used for production of ritual vessels (4.5.7.1.1). On the contrary, only *nṯr.ty* blades in the other ritual of Opening of Mouth, could have been made of copper (4.5.7.1.3), together with some *h3ṯs* vessels (5.4.8). Fully preserved "tool kits" for offering ritual are from the Old Kingdom Dynasties 5 and 6, and their "standard" set could have been established alongside the standardization of the offering list in the period of the end of Dynasty 4 and early Dynasty 5. Even in the cases, where in undisturbed contexts were only few vessels, they might have been considered as "pars pro toto" representative for the complete offering set and its cheaper alternative.

In the Old Kingdom, the Pyramid Texts provide hints that at least some of the regalia of ancient Egyptian kings were made of metal. The term "metal throne" is the most frequent (4.5.8). The only assemblage indicating use of copper pieces in the more complex specimens of ancient Egyptian furniture is burial equipment of Queen Hetepheres I from Giza (5.4.10). Some architectural elements could have been made of copper, as e.g. bases of columns in the mortuary temple of Raneferef? (4.5.11).

In the Old Kingdom, violent scenes were displayed either in the royal mortuary complexes or outside of Egypt proper, on Sinai. Besides scenes in non-royal tombs, the depiction of weapons was extremely rare. Nevertheless, there are depictions of apparently metal weapons, both in the royal funerary complexes and in a few private tombs. Some of these weapons might have been perceived as foreign products (4.5.10). A specific institution existed for storage of weapons, *pr-ꜥḥꜣ.w* – Armoury (4.5.10.1). Early Dynastic archaeological contexts with weapons are only scarce, while Old Kingdom contexts are non-existent. It was already argued that this does not mean absence of the weapons in the Old Kingdom society (5.4.12).

Coptos decree G is an endowment for a statue of King Pepy Neferkara. In the eighth line of the preserved fragment of the document, the statue is described as being made of copper, coloured pastes and gold. Neferirkara had an evening and a morning barque of copper made for the sun temple Setibra in the Memphite area, according to Palermo Stone (4.5.12). The only extant copper examples of the statuary type of *sfyrelaton*, from the whole history of Egyptian art, are two statues of Pepy I and Merenra found in Hierakonpolis, made of copper sheet, of almost pure copper (6.5.10). The head of falcon (Horus?) made of golden metal sheet and body of the falcon, made of copper sheet, was produced by the same technique (5.4.13).

7.4. Copper in the First Intermediate period

In the Dynasty 8 continued some administration practices of the Old Kingdom. A false door found at Khozam near Naqada belonged to Dynasty-8 overseer of Upper Egypt, overseer of foreign lands and overseer of eastern and western foreign lands named Weser (4.2.3). And pieces of turquoise were dedicated to the temple of Min at Coptos, important as an indication that this material, coming from Sinai, was available in Upper Egypt in Dynasty 8, albeit in the form of pieces. Later, after the disintegration of Egypt, at least two smaller royal courts existed during the First Intermediate Period: one in Heracleopolis Magna (Dynasty 9 and 10) and another in Thebes (early Dynasty 11). Evidence of the overseeing of the circulation of materials is preserved from both, indicating that on the smaller scale, it was "business as usual". Unusual is, however, that many inscriptions, e.g. from Dendera, but also from other sites, stressed the importance of copper in the personal property, which was an issue ignored in the Old and Middle Kingdom inscriptions.

Even further south, Governor Ankhtify, an independent figure in First Intermediate Period Egypt, built a tomb of a peculiar style at Moalla. In his biographical inscription, he claimed: "I have obtained this coffin and burial equipment with my own copper". In nearby Gebelein, Heqaib also boasts of the plentiful copper, unequal to his peers. Further down the social ladder, sole companion Hornekhet from Dendera writes on an architrave from his tomb about the positive deeds that he made during his life, among others: "I gave copper to one who asked for copper." Such statements must be taken with caution, but at least Hornekhet describes the possibility of giving away copper for a person in its need, and presumably of a lower social status that Hornekhet himself.

The evidence enables a conclusion based on both iconographic and written sources that the use of copper was common in the highest echelons of the First Intermediate Period society. The loss of complexity was on the state level, but provincial "kingdoms" repeated the administration model of the Memphite centre, with some newly added features. Small, local "states" needed copper as well. The remarkable absence of expedition inscriptions indicates that smaller administration units, the "states", turned upon the already available or recyclable sources. Incursions into the Eastern Desert cannot be ruled out (4.3.3). First Intermediate Period mirror from Grave 1022 at Cemetery 1000 – Qau/Etmaniya was, based on the trace elements and lead isotopes, made of copper brought from Eastern Desert (6.5.2).

A fragment of a stela from Coptos is datable to Dynasty 8, probably to the reign of King Neferkauhor, a list of offerings donated to the temple of Min and Thoth, presumably in Coptos, by the noble, royal son, stolist of Min, Hetepkamin. A fragment of the annals of Amenemhat II presents the ruler as the primary benefactor of cultic equipment for the veneration of important deities. The donation from Coptos testifies to different social conditions and high official is an unusual donator of the cultic equipment, including many copper vessels (4.5.7.1.6). However, it must be noted that among the scarce inscriptions on the Old Kingdom weighing stones are two stolists of the deities, indicating closeness to the handling of metal even before the First Intermediate Period (5.2.3.2).

No tombs of metalworkers with inscriptions are known, although metalworking scenes were found at Heracleopolis Magna and Moalla (4.4.4). First Intermediate period metallurgical workshop has been excavated at Balat, as part of a governor's palace (5.3.1.3). Grave 4964 was found at Badari and based on the burial equipment of a crucible and two stone pounders, it was a grave of a metalworker (5.3.4).

Probably in the First Intermediate Period were invented the lugs on the axe blades, while in case of adzes the blade widened, and the adze head diminished in size (5.4.1). Seemingly "sudden" appearance of weapons in First Intermediate period is an expression of changed attitude to the presence of weapons in specific cases of decorum. Weapons occurred either as full-size functional objects or as models in the model tool assemblages, alongside artisan tool blades. And the Middle Kingdom society retained weapons as one of the symbols of the high social status (5.4.12). Spearheads of the era were made of arsenical copper, as well as most of the battle axes (6.5.9).

The use of metal statues for persons other than the king or royal family is highly improbable until the end of the Old Kingdom. The statues of officials had copper eyebrows at best, or in one probable case copper earrings. The earliest examples of small copper statuettes are usually dated to the late Old Kingdom and First Intermediate period (5.4.13). If analysed, they were cast from arsenical copper, and later from tin bronze, as well as some alloy combinations peculiar only for statuary (6.5.10).

7.5. Copper in the Middle Kingdom

Prospection for metals was not easy, as the Middle Kingdom Teaching of Vizier Ptahhotep hints at *"Perfect speech is more hidden than malachite, ..."* (4.2). Middle Kingdom literature asserts that the king initiated the expeditions. In contrast to the Old Kingdom, Treasury officials played the main part in the practical organization of expeditions, e.g. to Sinai. Late Middle Kingdom "Duties of the Vizier" preserved in Section 11 an evidence that reports from the mining areas were subjected to the inspection of the vizier, who was required to obtain a written report. Middle Kingdom expedition inscriptions provide specific, unequivocal evidence of the presence of Asians (*ꜥꜣm.w*) – people of Retjenu in the missions. Undoubted mentions of them exist for 13 out of the 42 expeditions on Sinai. From a religious perspective, Hathor, the consort of Ra and the mother of Horus, became a mining deity *par excellence* (4.2.3). Inscription of Mentuhotep IV at Ayn Soukhna lists products from Sinai expected to be delivered: *"turquoise, copper and all good products of the hills"* (4.2.3.2). Idiosyncratic stela of Khety informs in detail about the organization of expeditions to Sinai area at the break of Dynasties 11 and 12. Khety brought three types of copper ore from three different localities and many other materials, which might have been either booty or more probably goods gained by exchange in the foreign lands. Important act of the expeditions is sealing of the material (4.2.3.1). Due to the detailed inscriptions, we have counts of metalworkers present at expeditions: three metalworkers in year 11 of the reign of Amenemhat II, two metalworkers in year 4 of Amenemhat III, three metalworkers in year 40 of Amenemhat III, two metalworkers in an unknown year of Amenemhat III, and sixteen metalworkers in year 9 of Amenemhat IV (4.2.3.2). copper processing sites were located, but not yet definitely published, besides Serabit el-Khadim itself, at Gebel el-Lahian, Gebel Hazbar, and Wadi Kharig (5.1.5.3).

Surprisingly, a metalworker and a ("police") official Renseneb, left his inscription west of the Nile valley, on the recently discovered Gebel Tjauti (4.2.3.3). In Eastern Desert, Middle Kingdom presence is proven on the site Wadi Abu el-Maysa/Wadi Bikheit at the foothills of Galala North range (5.1.2.1). The harbour of Ayn Soukhna was used again in the

Middle Kingdom (5.1.5.1). Moreover, batteries of copper working furnaces as parts of whole workshops were built here, presumed to be working on the copper from Sinai (5.3.1.4). New harbour of Marsa Gawassis was established further south, used for expeditions to Punt, containg at the site remains of the ships' copper hardware (5.1.5.1).

Egyptians sought for copper also from Nubia, 120 deben of malachite were sent from Nubia in the reign of Amenemhat II (4.2.3.5). Copper processing was taking place in late Middle Kingdom Buhen. Copper was presumably also an exchange commodity between Egyptians and Kermans in the Middle Kingdom. While politically, Nubia was then lost to Kerman dominion, exchange with Egypt and even Hyksos continued in the Second Intermediate Period. Both people of C-Group, as well as remaining Egyptians, were supposed to work either for the Kerman rulers or in the interregional exchange (5.1.2.2).

It can be presumed that Early Dynastic and Old Kingdom kings received tributes and booty from the neighbouring foreign countries and the sources hint at such operations. The scale of these activities can be assessed only based on the fragmentary annals of Amenemhat II (4.2.3.5). From Lebanon were brought 4,822 deben of arsenical copper/bronze (*ḥsmn*), 15,961 deben of copper (*bjꜣ*), and booty from Ura in Cilicia and Cyprus included 1,734 deben of malachite. Internal tribute (*gꜣ.wt*) from the Egypt itself included 920 deben in the form of ”new copper” and 25 deben in the form of prills (*nws*). The numbers listed in the annals are generally low compared to the data provided on the Palermo Stone; they most probably reflected actual deeds written down during the reign of the king. Main supplier of the Middle Kingdom state is, according to the annals, Lebanon. The mixing of copper from various sources might have been possible in the Middle Kingdom Egypt, which makes the archaeometallurgical studies of the material even more difficult. High officials might have been involved in procurement of such tributes, and even the reason of the famous Asian procession from the tomb of Khnumhotep II at Beni Hasan is bringing of galena into Egypt (4.2.3.6).

Recent work on the material in the Egyptian Museum of Leipzig University defined a possibility of the use of Cypriot copper in Middle Kingdom and Second Intermediate period Egypt, as objects from C-Group Aniba cemetery and one dagger from Kerma were most probably made of this copper (6.2.7).

The main difference perceptible between the Old and the Middle Kingdoms was that in the latter period, the whole *chaîne opératoire* of (not only) copper could have been organised by the Treasury, and the institution had its own metalworkers. The necessity of storing goods is listed in the negative in the Dialogue of Ipuur, negative description captures the things that were “usually done” in the delayed return economy of ancient Egypt: no product of all works (*k3.t nb.t*) was stored according to the text (3.6-10), the royal house (*pr nsw*) was without its revenues (*ẖm.t-b3k.w=f*) (10.3–10.6), and among the usual former income were named oil and copper. In the Duties of the Vizier is mentioned that the vizier had to collect deliveries from the workshops and open the Gold-House (*pr-nbw*), together with the overseer of the Treasury (4.3.4). Singular sealing from Mirgissa denotes very importantly an “overseer of the house of counting copper Neb...”, thus a specific official destined to be the counter of copper (4.3.4.2). The treasuries of the Middle Kingdom are archaeologically unknown. In the area of the Treasury of Thutmose I at Karnak were found sealings from Dynasty 13, indicating the position of earlier structure. In Nubian fortresses, the hypotheses for the architectural location of the Treasury were proposed at Uronarti, Askut, and Block D at Buhen, similar to the Treasury of Thutmose I (5.2.2).

Weighing of copper was also depicted in the Middle Kingdom scenes of metalworking. From our perspective, the most interesting is scene in the tomb of Amenemhat at Beni Hasan, where on both bowls of balance tool blades are being weighed. Here we can observe how different products of the metallurgical workshop could have been weighed at once. In jewellery production scene of tomb of Baqet III, co-occurring weighing of gold and copper is depicted (4.3.4.3). Weighing sets for gold and copper were found at Nubian fortress Mirgissa. J. Vercoutter established that the copper deben in the Middle Kingdom was c. 27.5 g. On the contrary, unit for gold was about a half, with a value of c. 13 g (retaining the original Old Kingdom deben; 5.2.3.3).

A Dynasty-11 text from Qubbet el-Hawa, found in Tomb 30b and written in hieratic on the inner side of a semi-circular bowl is a document dealing with a transaction, the payment for the burial of Sobekhotep’s father within a tomb. The valuables listed were grain, fruit, textile and a copper axe. Moreover, Heqanakht in his correspondence used 24 copper deben for a lease of land. In the Second Intermediate Period, even gold is mentioned in a private transaction (4.3.4.4).

From the Middle Kingdom are known metalworkers of Treasury and a single metalworker of a House of *šm3*, probably a place name on Sinai. Papyrus Reisner II provides evidence of at least three-year the existence of a copper workshop in This, associated with a dockyard (4.4.5.1). Not a single tomb of metalworker is known, only private stelae, dedicated to the metalworkers as the main recipients of the funerary cult (thus some tombs of the metalworkers must have existed), or metalworkers as participants in the cults of others. A stela from Louvre (C 14) claims for the craftsman ability to work with many varied materials, including metal, in one of the most complicated Middle Kingdom texts (4.4.5.2). Dynasty-13 stela of a King Khasekhemra Neferhotep demonstrates the function of the king as a patron and instigator of the production of cultic/"artistic" work, overseeing its completion, including work with copper (4.4.5.2.2). Middle Kingdom workshop scenes of metalwork occurred in Theban tombs of high officials and nomarchs of Beni Hasan, but they are only partially published (4.4.5.3). Metalwork is, among many crafts, derided in the Teaching of Khety, which might be perceived also as a satire of well-organized craft scenes in tombs.[1641] The metalworker's duty was described as "service/servitude", *b3k,* and the distinct smell of metalworkers might be a reference to the use of arsenic (4.4.5.4).

Middle Kingdom metallurgical workshop with tool moulds was found at Kahun. The knowledge about Middle Kingdom copper production was significantly improved recently by the excavation and publication of the metallurgical workshops at Ayn Soukhna. Five workshops have been excavated on the site, with 40 copper ore reduction furnaces. They are datable to the Dynasty 12 according to the pottery (5.3.1.4). Two skeletons of probably local metalworkers were found at the site (5.3.4).

Middle Kingdom moulds from Nubian fortresses Buhen and Askut, and moulds from the state centre at Kahun are an evidence of an approach, where the final form of the object is already present in the mould and casting takes the shape of the final product. The product requires further shaping and hardening of the blade edge, but the final product is clearly defined. Same approach can be observed also on the corpus of predominantly stone moulds from Tell el-Dabᶜa, producing artefacts typologically Egyptian and non-Egyptian (5.3.2).

During the Middle Kingdom, we can observe an increase in the use of tin bronze, used alongside arsenical copper. C-Group and Kerman patterns of the alloy use repeat in lower counts the pattern apparent in late Middle Kingdom, as a part of the same regional group (6.4.1). Tin bronzes became more frequently used in the late Middle Kingdom at Tell el-Dabᶜa, where Middle Bronze Age Levantine population used the material, which was by them commonly used, alongside arsenical copper. The statistical representation of the whole situation is here better, as several tens of analyses were already done (6.4.1.5).

Middle Kingdom artisan tool kit was used by many craftsmen as well: quarrymen, architects and builders, sculptors, carpenters, shipwrights, and furniture makers (4.5.1.4). Artisan tool kit does appear quite often in the object friezes, on the inside of Middle Kingdom decorated elite coffins, being an evidence of the patron-craftsman dependence, in similar way

[1641] Directly juxtaposed are excerpts from the Teaching of Khety written on the paintings of the tomb of Itibiqer at Asiut from the First Intermediate Period (Khadragy 2007, 116, 134, Taf. 4; Quirke 2018, 188–189).

as model tools and model workshops of the era (4.5.1.4.2). The most important evidence of the handling with copper tools is papyrus Reisner II, the accounts of a dockyard workshop at This, processing metal tools. The This workshop (*wḫr.t*) was building ships and subjected to the palace (*pr-ꜥꜣ*). The tools were categorized by quantitative and qualitative measures. The most important was the weight of the tools, interpreted by Simpson as written down in debens. The workshop was most probably engaged in repairing and recasting the metal blades from a wide geographical area of Upper Egypt. The recycling of some tools is denoted by the phrase *jr m* – "made in(to)" with another tool cited in the last column of the entry. In total counts, we can observe prevalence of certain types and sizes of the tools, 50 deben axe blades, 15 deben adze blades, and two forms of *mnḫ*-chisel, 20-deben and 14-deben. Thus, the standard shipwright kit might have consisted of axe blades weighing 1,375 grams, adze blades of 412.5 grams, and *mnḫ*-chisels of 550 grams and 385 grams. In all cases, tools are considerably heavy. Fragments of papyri from Lahun provide evidence of similar approach to the administrative control of metal tools elsewhere in Egypt (4.5.1.4.4). Coffin Texts preserved earliest unequivocal evidence that artisan tool kit was connected in its context also to the Opening of the Mouth ritual, and production of an image of a deceased by his son/a craftsman (4.5.1.4.7). Although artisan tool kit is the most numerous being analysed, only axes provide statistically significant counts. Leaving out specimens of unknown provenance, even axes do not comply with more stringent criteria for statistical analysis. Copper with impurities offers relevant number of specimens and might be considered as symbolic representation of practical objects. Predominance of arsenical copper gives its place to the slow increase of the use of tin bronze in the Middle Kingdom, predominantly in its later phases (6.5.1).

Cosmetic tool kit was continued to be used by hairdressers and barbers. Palaeography and iconography reflect a change of a shape of razor already in Dynasty 11. Again, mirror could have been a funerary offering both for men and women, thus it was not perceived as gender specific. But Dialogue of Ipuur a mirror is described as an artefact of social distinction among the social strata: „… she who looked at her face in the water is the owner of a mirror" (4.5.2). Also, in the material culture, only razor underwent significant changes of shape, not the other tools of the cosmetic tool kit (5.4.2). And they gradually became produced of tin bronze (6.5.2).

The division between the "necklace-makers" and "bead-makers" continued in the Middle Kingdom (4.5.3). Collected 54 specimens of analysed personal adornment altogether cannot be statistically representative, although three main groups of material appear, alongside the malachite and galena. In broad terms, the development elsewhere is reflected also in this artefact category, with earlier use of arsenical copper and later use of tin bronze (6.5.3).

Textile processing tool kit (needles, awls) is not shown in the iconographic sources or described in written sources (4.5.4). Later, in the Middle Kingdom, the name of the leather working profession, originally written down by an awl, was most probably replaced by "sandal-maker" and written down by the hieroglyphic sign of a sandal. Most probably copper leather-working knives continue to appear in iconography (4.5.5).

Elite connotation of spear-fishing and hunting of hippopotami is again expressed clearly in the Middle Kingdom sources, in tombs but also in Coffin Texts. Harpooning was an allusion to an activity that was not regularly performed and was rather a prerogative of the social elite (4.5.6).

Quite frequent topic of the fragment of annals of Amenemhat II is a donation of the cultic equipment to temples, and often also the material is listed. Among the material, there are many vessels made of copper, arsenical copper/tin bronze, Asian copper and *jwḥw*-copper. These endowment lists refer to one of the ruler's duties: to embellish and provide cultic equipment for the temples, both in the centre of the state and in the provinces (4.5.7.2.1). In a passage of the Dialogue of Ipuur (7.14), metal vessels were the symbols of previous high social status: "Look, the lords of copper offering vessels, / no jar is garlanded for a single one of them" (4.5.7.2.2). Massive pieces of furniture could have been made of copper, as two caskets with the cartouches of Amenemhat II, enclosing silver treasure of el-Tod (5.4.10).

Even in the Middle Kingdom, the use of metal agricultural tools is quite improbable (4.5.9). Agricultural tools made of iron could have been produced on massive scale only in the Ptolemaic Period (5.4.11).

Weapons started to be depicted among the burial equipment in the so-called *frises d'objets*. We can assume that daggers had metal blades, whereas arrows were equipped with points made of lithics. Battle-axe blades occurred as well. The use of weapons is mentioned in several *loci* in the well-known Tale of Sinuhe. Several scenes of siege of fortresses and other scenes of personal guards of nomarchs depicted the usual weapons of Middle Kingdom infantry, battle axe, spear, and a dagger. A troop of model wooden Egyptian soldiers from Asiut is equipped with spears (4.5.10.2). The Middle Kingdom range of weaponry included battle axes, spears, and daggers, mirroring thus the Middle Bronze Age Levantine attire. Changing situation in the use of weapons can be observed on Egyptian soil at the late Middle Kingdom site Tell el-Dab^{c}a, with the types of weapons completely foreign to contemporary

Egyptians (5.4.12). But arsenical copper did continue to be used for production of weapons until the late Middle Kingdom, besides the slowly increasing use of tin bronze and it was not abandoned completely also in C-Group and Kerma (6.5.9). In case of spearheads, however, completely different types of Levantine spearheads were found and analysed in Tell el-Dab^ca, made of tin bronze, and in a single case, from a mixed CuSnAs, perhaps indicating mixing of both materials in further use. The pattern of the earlier use of arsenical copper and ascent of tin bronze is observable also in case of daggers (6.5.9).

Mentions of hardware are extremely rare in Middle Kingdom sources (4.5.11). Two pieces of copper were used also as musical instruments, in several passages of Coffin Texts (4.5.13).

In the Middle Kingdom, statue of a deity made of copper was again mentioned, in the Teaching for King Merykara (4.5.12). The most important Middle Kingdom find is a cachette of four statues from Fayum, currently on display in Munich (5.4.13). Two statues from the deposit were made of an alloy of copper and small amount of gold, named “black copper” (*bjꜣ km* in ancient Egyptian; 6.4.1.4).

A Middle Kingdom booty described in detail in the annals of Amenemhat II must have brought a spectrum of foreign objects to Egypt, from Cyprus and Ura in Cilicia. Some metal artefacts were included also in the load of expedition coming to Egypt from Lebanon. The leaders of the Asians were depicted with axes on their shoulders on three stelae from the reign of Amenemhat III, from Sinai. Spears were depicted in the procession of Asians in the tomb of Khnumhotep II at Beni Hasan (4.5.15). Middle Kingdom Egyptians could have known a wide range of material culture produced in the regions neighbouring with their own country. But although the evidence of the presence of foreign material culture is clear in the written sources, only very few foreign objects can be identified in Egypt itself. Bulk of the foreign objects that were exchanged or looted by Egyptians was most probably remelted into ones of Egyptian typology (5.4.17).

8. Ancient Egyptian model of the metallurgical development vs. other Old-World models

The "classical" model was most recently presented by C. Strahm and A. Hauptmann.[1642] The standard model, also known as the "Levantine paradigm", presumes steps of the development of metallurgy, as identified in the Levantine Pre-Pottery Neolithic with the use of natural copper, the Chalcolithic and the Early Bronze Age as gradual steps in the processing of different ores, first oxidic, then sulphidic, with the gradual use of first the arsenical copper, then the tin bronze as the practical alloys used widely.[1643]

Contrary models were presented in the special issue of the *Journal of World Prehistory* and subsequently in an edited volume.[1644] In fact, it was shown that many innovations might have originated already in the Chalcolithic, and possibly in the highland regions rather than in the lowlands.[1645] It might be assumed that Egypt followed the path of its north-eastern neighbours, but very little is actually known. Egypt was before Nubia one of the last regions in the Ancient Near East to adopt metallurgy. Paradoxically, later evidence of the use of copper in the region comes only from Cyprus, where the earliest copper artefacts can be dated to Middle Chalcolithic, to the latter half of fourth millennium BC.[1646]

The etymology of a term for mine, *bjꜣ* is convincingly Semitic, this word could have come with the concept from the north-east. The term *bjꜣ* for an ore and copper is shown to have parallels in the African languages, and probably also in some Semitic ones. According to G. Takács, the terms are etymologically separate.[1647] The first term for a mine originally meant only a "hole in the ground", it probably acquired other meanings gradually, and is certainly being confused in writing, as the determinatives are not always stable. A creation of a word for an ore and copper must have been very early, as only then came another material from the north-east, so called Asian copper, requiring new designation. Since copper was known in Badarian, advent of another significant material was represented by arsenical copper in Naqada II, which might be a suitable candidate for a newcomer. Only statistically significant number of analyses of known objects would bring possible other candidates.

[1642] (Strahm and Hauptmann 2009).
[1643] (Thornton 2014, 667–668).
[1644] (Strahm and Hauptmann 2009; Roberts and Thornton (Eds) 2014).
[1645] (Bourgarit 2007; Yener 2000; Thornton 2014).
[1646] (Knapp 2013, 229–232).
[1647] (Takács 2001, 122–126).

In the fourth millennium BC, Egypt was one of many rich regions of the Eastern Mediterranean with a somewhat belated wide application of metallurgy.[1648] C. J. Davey argued in several papers that the early crucibles used in Mesopotamia and Egypt were quite similar, thus there might be a connection in the transfer of technology. The crucibles retained similar dimensions in the periods under study.[1649]

In the fourth and early third millennium BC, we can observe recurrence of similar phenomena over the Eastern Mediterranean. A particular trait that I would like to mention is the occurrence of the copper artisan tool blades in the rich graves of the social elite. It is difficult to presume that the members of this elite themselves were working with the tools, and the detailed societal context of their occurrence might be slightly different, as well as the particular artefact typology. Nevertheless, it seems connected to the new possibilities of working with newly produced tools, and the tool blades themselves can be regarded as the symbols of the craftsmen producing their work for the social elite.[1650] The overview can start north of Caucasus. In the latter half of the fourth millennium, artisan tools used most probably in woodworking occurred in the settlement and funerary contexts of the Maykop culture, including the Maykop kurgan.[1651] In eastern Anatolia, artisan tool blades were one of the categories of copper artefacts present in the so called Royal Tomb at Arslantepe, datable to the VIB, Early Bronze Age phase of the site, a period around 3000 BC (c. 3000–2900 BC).[1652] In southern Levant, Chalcolithic corpus of artefacts from the cave at Nahal Mishmar, is being interpreted as a burial site (but not unequivocally), and the assemblage includes artisan tools.[1653] In Egypt, Predynastic and Early Dynastic graves of craftsmen were collected and interpreted by W. Davis. Royal tombs and tombs of high officials (Tomb 3471 at Saqqara being the best preserved example) included tool blades and complete tools in their burial equipment, subsidiary graves to the larger structures are most probably the burials of the craftsmen themselves.[1654] Further south, rich burials of Nubian A-Group at Qustul, Sayala and Naga Wadi included also artisan tool blades.[1655]

This tradition of the “veneration” of copper artisan tool blades started apparently in Chalcolithic, but the ancient Egyptian retained the habit throughout the Bronze Age. In the

[1648] (Wilkinson 2014, 289–292).
[1649] (Davey 1988; Davey and Edwards 2007; Claes,Davey and Hendrickx 2020).
[1650] For ancient Egypt in the sense explained by Davis (1983).
[1651] (Betancourt 1970; Courcier 2014, 607–610).
[1652] (Frangipane et al. 2001; Palmieri et al. 2002; Frangipane 2011).
[1653] (Bar-Adon 1980; Tadmor et al. 1995; Golden 2014, 569–574).
[1654] (Davis 1983).
[1655] Naga Wadi, Cemetery 142, Grave 1: Firth (1927, 214, Pl. 22: b 1-4); Qustul, W 11: Williams (1989, 39, 63, Fig. 27c-f, Pl. 36a-d, 37a-d); Sayala, Cemetery 137, Grave 1: Firth (1927, 207-8, Pl. 22: b 8-13).

Old Kingdom, the main evidence of this phenomenon are copper model tools and mAA-scenes of the craft activities in the Old Kingdom tombs.[1656] In the First Intermediate Period, vivid wooden craft workshops were produced for the burial equipment, and artisan tool kit was also often part of the object friezes on the coffins of the elite. Even in the New Kingdom, Tutankhamun possessed for his afterlife also a corpus of iron chisel blades with wooden handles.[1657] An elaborate religious explanation was preserved from the New Kingdom on the meaning of these artisan tools, but its roots can be traced back to the Pyramid Texts and full expression in the corpus of Coffin Texts.[1658]

During the course of the third millennium BC, there were fewer rich regions in the area through time,[1659] and ancient Egyptians luckily invested in stone as elite media presentation, which preserved many details of their culture, yet, again, the phenomena are similar to those found elsewhere in the Early Bronze Age world, with similar uses of the metal objects.[1660] The depictions of the weaponry in the Old Kingdom funerary temples provide evidence that Egyptians had a good idea about the range of weaponry used abroad, and from time to time, as proven by the biography of Weni, militarily intervened north-east of Egypt. K. Sowada characterised the interactions of Old Kingdom Egypt in the Eastern Mediterranean as “state-to-state gift exchange, commodity trade and war booty”.[1661]

In the Middle Bronze Age, Egyptians were aware of the weaponry used in the Eastern Mediterranean and their range of weapons used responded to the wider situation. Weaponry became an important part of the conspicuous display of power by the Middle Kingdom elites. A literary hero, Sinuhe, proved his warrior competence and prowess with a range of weapons in a fight with a giant from Retjenu. The range of artefact classes of the metal weaponry: battle axes, spears, daggers; is similar as in the so-called warrior burials, although the types themselves are mostly Egyptian.[1662]

The annals of Amenemhat II are being treated as a source of completely new approach of an Egyptian king to the “international” presence of Egyptians, “major leap forward in geographical scope and scale”.[1663] What if this is, at least for the Middle Kingdom, the listing of two regular years of the important activities of Egyptian king? The bulk of metal is coming

[1656] (Hampson 2010, 2014; Odler 2016).
[1657] Recently analysed by archaeometallurgical methods in (Broschat et al. 2018).
[1658] (Fischer-Elfert and Hoffmann 1998).
[1659] (Wilkinson 2014, 292–301).
[1660] (Moorey 1999, 258–259).
[1661] (Sowada 2009, 255).
[1662] (Philip 1995).
[1663] (Marcus 2007, 176).

to Egypt from Lebanon and this must appear somewhere in the archaeometallurgical data, if they will be analysed.

One of the stable myths of the popular and semi-popular works on ancient Egypt has to be refuted. The myth sees ancient Egyptians before the Hyksos came into Egypt as a society with somewhat limited worldview, unaware of the world around and its developments. Range of sources presented herein demonstrates that the situation was much more complex, with at least some Egyptians being aware of what was happening beyond their borders. The social context of copper can be used as a set of proxy-data supporting more complex explanations of the phenomena documented inside Egypt.

It is presumed traditionally that craft specialists were of rather low social status. In ancient Egypt, it is possible to be demonstrated that some metalworkers could attain rather high social status, being well represented by their funerary art. These higher officials were able to read and write, and even demonstrate their arcane knowledge of the metallurgy in their tomb inscriptions. Meagre evidence does even enable us to observe common metalworkers, who were able to write down their profession and name in hieroglyphs. The craft specialization was part of their identity as represented in writing. Finally, the new ways of writing are the unexpected side effect of the ancient Egyptian need for copper. Ancient Egyptian interest in the mining of copper ore on Sinai Peninsula, with an intentional integration of local population into the process, stood at the beginning of process of creation the very alphabetical system, which we are currently using.[1664]

[1664] (Morenz 2019).

9. Conclusion

The story of copper in ancient Egypt cannot be written in full yet. Only bits and pieces are clear, and this patchwork of data was represented in the thesis. The thesis was focused on the reconstruction of the *chaîne opératoire* of copper in ancient Egypt from its earliest occurrence in the fourth millennium BC until the end of the Middle Kingdom. Copper represents a material aspect of society, and the social context of copper reflects many important societal components. As copper was the metal most widely used in ancient Egyptian society, its study can offer statistical "big data" otherwise rarely available for ancient cultures.

After defining the subject (Chapter 1) and addressing general theoretical issues (Chapter 2), the history of research in the periods under study from the Badarian culture until the end of Middle Kingdom is discussed in Chapter 3 in the form of a bibliographical essay, dealing consecutively with written and iconographic sources, archaeological sources (material culture, i. e. artefacts), and archaeometallurgical sources. Then the analytical regions in the thesis are presented in the form of an inventory of the sites and sources.

Three large groups of sources are then discussed successively. First, the main terms used for copper are established in Chapter 4. Copper was named *bjꜣ* and read [byr] in the periods under study, while an interpretation as arsenical copper with a low and high content of arsenic, respectively, is proposed for so-called Asian copper and *ḥsmn*. In the Middle Kingdom, the term *ḥsmn* begun to be used also for bronze. The word for crucible was *bḏ*(*.t*) and the word for metalworker (incorporating both metallurgists and smiths) was *bḏ.ty*. There is no substantial Egyptian evidence from the periods under study for the current Egyptological reading of copper as *ḥm.t* and metalworker as *ḥm.ty*, which are both mistaken. Traditional written and iconographic sources (including palaeographic ones) are then divided into several consecutive stages of the *chaîne opératoire*: the procurement, initial processing and transport of the ore through expeditions and exchange; the storage, revenues and transactions with unspecified copper; metalworkers as the social group responsible for copper processing; and, finally, the use, reuse and discarding of copper objects in the periods under study, incorporating professions working with copper artefacts, together with presumed foreign material culture present in Egypt. Gradual regionalization of their provenance can be followed in the sources. The main new findings of this chapter include clear information from the sources that copper was processed not only by craftsmen under the royal administration and its ownership was not restricted to the administration, either. On the other hand, copper was mentioned more frequently in the written sources as an important item of individual property only in periods of social unrest such as the First Intermediate Period. Metalworking specialists could own their tools and enter market exchange with their products. However, metalworkers and other craftsmen were gradually losing their social standing through the periods under study.

Less traditional and seldom studied archaeological sources (artefacts) are discussed in Chapter 5, once again in the order of the *chaîne opératoire*. It is demonstrated that some regions with archaeological evidence of copper mining, especially Egypt's Eastern Desert and Nubia, are lacking written sources, i.e. expedition inscriptions. Known workshops are then briefly discussed. The main technological change in the production had the form of a change in the use of moulds: earlier ones were adapted for the production of copper slabs and sheets, which were then worked into the final shape; later ones already had the shape of the final artefact, which was then further processed. Copper artefacts are treated as a source of a serial nature in the chapter, demonstrating regularization of their shapes. However, a comparison of the dimensions of the artefacts to known ancient Egyptian measures of length shows an unexpected approach to these measures, with dimensions being usually shorter than the expected ancient Egyptian value. This is true not only of artefacts that were practically used and gradually shortened by use (chisels, adzes, axes, saws) but also of artefacts that presumably retained their original size from the moment of production (mirrors, vessels). This approach to the regularization of the artefacts is unexpected and deserves further study.

Finally, Chapter 6 discusses evidence on the provenance of the ores provided by the natural sciences, the chemical composition of the artefacts and their other properties, again divided according to the stages of the *chaîne opératoire*. Although 962 artefacts and ore pieces have been analysed from the periods under study, some of them repeatedly, it is shown that this is only a fraction of the total counts of the objects as presented in Chapter 5. Yet even this fraction gives a statistically sound sample of the analyses, establishing the use of arsenical copper as the main alloy for practically used tools and weapons in the periods under study, with the gradual advent of bronze, used side by side with arsenical copper, during the Middle Kingdom (although ancient Egyptians had known bronze before and used it for the production of vessels). The material was coming predominantly from Eastern Desert and Sinaitic mining regions, and seldom from elsewhere (Feynan, Anatolia, probably Saudi Arabia). The so-called "Hyksos" are not responsible for the introduction of bronze in Egypt; it seems that Cypriot sources played an important role already in the Middle Bronze Age. The lack of a significant number of lead isotope analyses of ores and artefacts and the lack of a significant number of analyses of the artefacts themselves going beyond the present-day focus solely on the provenance and chemical composition are identified as the main problems of the current state of research.

The analysis of these source categories produces a synthesis of the social context of copper. The main findings of the thesis are presented in Chapter 7, a synthesis is chronologically divided according to the periods under study and, within them, according to the stages of the *chaîne opératoire*. Then, the described reconstruction of the past is briefly compared with the models of the development of metallurgy in the ancient Near East and the presumed "Egyptian exceptionalism" is assessed. The thesis is complemented by appendices (photographs, drawings, plots, maps, tables) in which all the sources significant for the analyses are presented and cited.

In conclusion, let me express few remarks about the current state of the research and its inherent problems. I have met with archaeologists that claimed the sole capability of typological and morphological analysis to uncover the "invisible connections" of the ancient cultures. Similarly, there are Egyptologists claiming that every information needed is preserved in the written and iconographic sources of ancient Egypt, there is no need to seek elsewhere. I have tried to demonstrate in the thesis that neither of these approaches is completely true. If we are ignoring either the artefacts or the physical and chemical properties of them, we are losing significant pieces of information on the past.

It was demonstrated that agency of an individual researcher may bring some advancement but uncovering of the past is not an achievement of a single individual. Most difficult endeavour of all seems to be "on the same page" with the current state of knowledge, as the results of the work of Egyptologists, archaeologists and archaeometallurgists in Egypt and Nubia are dispersed in the myriad published and unpublished outputs. Significant energy must be invested into gathering these sources and incorporating them into a comparable structure, all this even before their evaluation and proper study. And many more objects are hidden either in the museum collections or excavation magazines.

Where is the danger? The cost of the analytical methods can be counted, as well as the beam time and other measurable input of scientific methods. But it is difficult to measure the Egyptological and archaeological knowledge. The contextual information often boils down to the site names, dating in the framework of dynasties and bibliographical references, in order to present data concisely. But the human and humanist perspective should not be lost in the process. Balance between these different perspectives is challenging.

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