An Introduction to the Realities of Metalworking on the Elephantine Island in the late Middle Kingdom

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Abstract

The paper offers a preliminary report on the corpus of metalworking material of the Middle Bronze Age / Middle Kingdom from Elephantine Island, located within Aswan in Egypt. Several excavation seasons of the Realities of Life project, led by Johanna Sigl (German Archaeological Institute Cairo), focused on a small part of the Middle Kingdom settlement on the island. The main deposits are datable from the Dynasties 11 to 13, and meticulous excavations allow us to focus on the minute details of the ancient day-to-day reality. Among the uncovered finds were several hundreds of rather small green copper 'blobs', coming from metalworking. The production must have happened elsewhere in the settlement, as no metallurgical installations were identified in the trenches. The true nature of the corpus was uncovered with the use of portable XRF spectrometer Niton XL3. Almost 500 unique spectra were produced, and with the help of archaeometallurgical analysis, we are able to demonstrate that the remains, although insignificant in size, cover the complete *chaîne opératoire* of the copper production, from the ores, through the crucible fragments, prills and slags, i. e. metallurgical waste, to the finished artefacts. The specific alloys represented are predominantly arsenical coppers, with gradually increasing number of early tin bronzes. The paper provides a brief description of methodology, selected initial results, and illustrations of the specific find categories, coming from the largest uncovered structure, House 169 of Dynasty 13.

1 Introduction

Egyptian archaeology is often attuned to the size of things: if something is big, it must be important. That is why Old Kingdom Giza is often considered the most significant site of this period: it is home to the largest pyramids.[1] However, if we would focus on the maximal concentration of the Old Kingdom royal pyramids and contemporary tombs of the high officials, the Old Kingdom central funerary landscape would have clearly been Saqqara.[2]

1 Lehner/Hawass 2017; Manuelian 2017.

2 Including the Abusir area, which was not separated in antiquity: Mariette 1889; Spencer 1974; Roth 1993; Verner 2017; Verner 2021.

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That superficial observation on the deceptiveness of size is also valid for copper metallurgy. Thus, the most relevant findings must surely come from the large, uncovered metalworking installations, such as those found at Old Kingdom Seh Nasb (Sinai Peninsula), Middle Kingdom Ayn Soukhna (near the Red Sea coast of the Eastern Desert), and New Kingdom Qantir/Pi-Ramesse (Nile Delta). They are supposed to provide the main pieces of evidence for the workings and processes of the ancient Egyptian copper metallurgy, as on these sites the highest number of preserved metalworking furnaces was uncovered, as well as other similar installations, and material culture related to copper metallurgy.[3] Yet even here, the most precious products and semi-products are gone, neither ingots nor big metal objects were preserved, at best only fragmentarily. But metallurgical and metalworking remains can be even less conspicuous, if coming from a busy settlement lacking vast spaces, specifically the town on Elephantine Island.

We would like to argue in this paper that regarding the metalworking remains, size is not important. Extraordinary small finds from the settlement debris can contribute to the wider debate as much as, or even more than, big installations, in our case on the metalworking processes in a thriving Middle Kingdom town. The meticulous excavation techniques of the Realities of Life project allow us to ask questions that would have been impossible to pose without its granular, detailed data. The find processing continues, but we enclose the available preliminary results in this paper and synthesize the already available information. Further, more detailed publications are being prepared.

2 The Realities of Life project

Several excavation seasons of the Realities of Life project, directed by Johanna Sigl with the lead archaeologist Peter Kopp (German Archaeological Institute Cairo), focused on a small, selected part of the Middle Kingdom settlement on the Elephantine Island.[4] Archaeological fieldwork from autumn 2013 to the end of 2018 focussed on two squares of 10 × 10 m in the northwestern part of the town. The northern square was excavated down to the archaeological layers of the Old Kingdom and the stratigraphic features prior to mid-Dynasty 12 were reached in the southern trench (Fig. 1). This settlement segment was built above the level of the late Old Kingdom cemetery of the townspeople, adjacent to the Dynasty 3 granite pyramid. These lower layers were not in the focus of the project and thus were left intact.

The researched area was marginally disturbed by French explorations in the early 1900s, but the southern of the two trenches preserved undisturbed ancient deposits. The main layering is

3 Tallet/Castel/Fluzin 2011; Abd El-Raziq/Castel/Tallet 2011; Verly et al. 2021; Pusch 1990; Rademakers/Rehren/Pernicka 2017.

4 Published articles on the project include Kopp 2022; Sigl 2022; Sigl/Kopp 2020; Sigl/Kopp 2022; Warden 2022. Research of the metalworking remains was reported by Martin Odler and Jiří Kmošek in Sählhof et al. 2020: 29–30 and Sählhof et al. 2022: 31–33, and one more, thus far unpublished report. Parts of these preliminary texts are also used herein.

Fig. 1: Aerial photograph of the part of Elephantine Island with the Realities of Life excavation squares highlighted in blue, south-east of the Dynasty-3 granite pyramid, after Sigl 2022: Fig. 1, © German Archaeological Institute Cairo

datable to Dynasties 11 to 13, based on the analysis of excavated pottery and stratigraphy. Scant remains of the earliest houses are dated to the Dynasty 11, and successive phases with new, different houses were from the Dynasty 12. Three further houses built adjacent to each other are datable from the late Dynasty 12 to Dynasty 13. Their ground plans were well preserved, and the buildings were numbered 169, 166, and 73. Above them were remains of two further houses from the Second Intermediate Period. Overall, one of the largest uncovered settlement structures of all the so far excavated late Middle Kingdom houses on Elephantine Island was House 169 with an area of ca. 150 m^2 (Fig. 2). Several published papers already dealt with the evidence found in this particular structure: an impressive range of the disciplines and techniques applied on the material was e.g. recently listed here by Sigl and Kopp.[5] This includes ample, albeit likely secondarily deposited evidence on copper metallurgy. Use and existence of House 169 is estimated to have lasted about a century within the Dynasty 13.

The overarching aim of the Realities of Life project was to understand the daily lives of the settlement inhabitants. Within the material culture, three major research foci were defined:

> "a) the production and storage of food and drink; b) the acquisition and manufacture of other goods or tools, some of which can be used to trade (it has to be noted that raw materials and products of category (a) such as fish and beer may have been used for the same purpose), and c) the building, development, and use of the living and working environment to accommodate all activities of daily life including e.g. sleeping and socializing as well as the impacts of these actions on this environment through, for example, noise or heat."[6]

The second focus directly involves metallurgy. The craft of metallurgy would indirectly influence, often negatively, the quality of the environment and the living conditions in its vicinity. In less attentive excavations, the minute evidence of the copper metallurgy that we were able to study would have been lost or deemed insignificant by the excavators. Research and publication of such material will enhance the identification of similar remains elsewhere, where they might be even less conspicuous than in the Realities of Life project's trenches.

3 Metalworking remains

Among the uncovered finds were several hundreds of rather small, mostly greenish copper 'blobs' related to metalworking. Only with archaeometallurgical analysis, we are able to demonstrate that the remains, although insignificant in size, cover the complete *chaîne opératoire* of the copper production. The total weight of the corpus is 850.5 grams. For comparison, we have

5 Sigl/Kopp 2022: 58–59.
6 Sigl/Kopp 2022: 58.

Fig. 2: Ground plans of the Houses 73, 166 and 169 from the mid Dynasty 13 (above) and late Dynasty 13 (below). After Sigl 2022: 92, Fig. 2, © German Archaeological Institute Cairo

identified altogether 22 crucible fragments, while at the Middle Kingdom copper metalworking centre Ayn Soukhna, the total number of fragments is estimated to be 8,000 to 10,000. Although it has to be noted that the scale of excavations at Ayn Soukhna is larger and the purpose of the sites is different: Ayn Soukhna was near the beginning of the *chaîne opératoire*, while Elephantine was at its end.[7]

The production must have happened elsewhere in the settlement, as no metallurgical installations were identified in both trenches. During the Middle Kingdom, from Dynasty 11 until Dynasty 13, the location and disposition of the houses changed radically. Thus, also the metalworking remains do not have to come from a single metalworking installation. Any small feature that could produce heat of more than 1,100 °C and accommodate a crucible would suffice for secondary metallurgical operations. Evidence from House 169 on the production of bread moulds, as well as heavily vitrified phytoliths, demonstrate temperatures of at least 800–850 °C have certainly been reached.[8]

In general, people do not like to carry their waste too far,[9] and this assumption might also be valid here. Therefore, the metallurgical installations related to the discussed finds could have been nearby the Houses 169, 166 and 73 in the Middle Kingdom. The closest assumed distance to the water was to the northwestern river channel within about a hundred metres.[10] Water would have been important not only for the life of the town's inhabitants, but also specifically for copper metallurgy.[11] Due to the limited space on an island, waste disposal from the regular life activities and crafts could have had different rules than elsewhere in the Nile Valley, and the larger fraction of some of the waste could have been dumped into the river. Although the excavations were not followed to the bedrock, we can be sure that the recovery of the archaeological evidence from excavated layers is likely complete, in that each fragment was preserved and recorded. The completeness of the metallurgical material in the refuse layers is corroborated by our consecutive analysis following the work already done by Martina Renzi (University College London).

4 Work in 2019 with preselected samples

As mentioned, a small part of the material was originally studied by Renzi and analysed by portable X-ray fluorescence spectrometer. She carried out 150 analyses on 85 fragments.[12] On this basis, the first batch of twelve samples was selected and transported by the Ministry of Tourism and Antiquities to the archaeometric laboratory of the Institut français d'archéologie orientale

7 Marouard 2020.
8 Sigl/Kopp 2022: 65–66.
9 Warden 2022: 73.
10 Sigl 2022: 90.
11 As at the Middle Kingdom Ayn Soukhna: Verly et al. 2021: 3.
12 Renzi in Seidlmayer et al. 2016: 18–20. These datasets were not available to us.

du Caire (Le pôle archéométrie de l'IFAO du Caire) and assigned with the IFAO lab numbers from 12532 to 12538. The selection involved the largest pieces of metalworking remains from the whole excavated corpus.

In November 2019 (12^{th} to 21^{st}), among other planned work, these 12 archaeometallurgical samples were processed, enabling initial survey of the corpus. The samples were first documented by photographs and drawings by Martin Odler. Metallographic cross sections were then prepared from the samples by Jiří Kmošek and subsequently measured with the portable X-ray fluorescence spectrometer Bruker Tracer III-SD (property of the University of Pardubice), as well as analysed by the metallographic microscope present at the IFAO laboratory.

Six samples were identified as vitrified fragments of ceramic crucibles. In each of the crucible fragments metallic copper alloy prills were still present, mostly indicating processing of the alloy of arsenical copper and tin bronze, high in arsenic. One vitrified ceramic fragment from Dynasty 11 was newly classified as a fragment of a tuyère (ceramic end of a plant tube, through which the air is blown into the furnace), used in processing of arsenical copper alloy, also rich in antimony. The remaining analysed material consisted of fragments of different types of slags, having mostly amorphous characteristics with the presence of arsenical copper prills. Thus, contrary to the assessment of Renzi, the material contains also slag fragments.[13] Two remaining samples were identified as iron minerals, hematite or goethite with admixtures of silica and manganese. These iron minerals can be used as fluxing agents in copper smelting, melting, or alloying operations.[14] Another emendation of the original report by Renzi is the initial information given on the corroded state of the material. This is indeed the case by the outward appearance of all the fragments, but with the metallographic cross sections, tiny remains of the uncorroded material can be studied within many samples, giving precise information on the Middle Kingdom metallurgy on the island.

5 Methodology for the settlement remains of metalworking

The true nature of the whole corpus, stored in the excavation magazines of the joint German and Swiss archaeological mission on Elephantine Island, was uncovered with the use of portable XRF spectrometer Niton XL3, property of the German Archaeological Institute Cairo. The machine, which was kindly provided by the Institute, permitted sorting of the material not only by the macroscopic observation of its character and typology, but also by its chemical composition. Almost 500 unique spectra were produced with the pXRF, consecutively numbered from 81 to 567. Obtained XRF spectra were subsequently evaluated using integrated standards

13 Renzi in Seidlmayer et al. 2016: 18–20.

14 Ogden 2000. Iron ore is present in the Aswan area, therefore these fragments could have been locally sourced (Johanna Sigl, pers. comm.).

and the concentrations of the major and minor elements present (Cu, Fe, As, Sn, Sb, Pb, Zn, Ni, Bi, Ag, Au, Co, Mn, Ti) were quantified (Tab. 3). These identifications with the metallurgical description are connected with the archaeological numbering of contexts and find groups. Unexpectedly, material from all stages of the metal production was identified: from the ores, through the crucible fragments, prills and slags, i. e. metallurgical waste, to the finished artefacts. The specific alloys represented are predominantly arsenical coppers and there is also a significant amount of early tin bronzes. In combination with the archaeological contexts, a diachronic and synchronic synthesis can be produced. Studied 'blobs' are from well-stratified contexts, allowing a 'time lapse' approach to metallurgy on the Elephantine Island and exceptionally fine chronological divisions.

While analysing the chemical composition, attention was paid to the archaeological context of the corpus: the finds from the floors and 'better' archaeological contexts, such as fireplaces, were prioritized, even though they might be less well preserved than the fragments from the filling of archaeological features. The distinction between finds from these two major deposit types was also made while processing the ceramics of the Realities of Life project by Leslie Anne Warden.[15] As Warden writes, finds from the floors and living surfaces might represent "*de facto* or primary refuse relating to the use of a space".[16] On the other hand, fills or secondary deposits of the artefacts could inform on "different formation processes and thus conflate many activities and people".[17] As an example, in the case of House 169, a much higher percentage of the fine wares was retrieved from the floor assemblages.[18]

In further analysis of the metalworking material, firstly it will be necessary to consider the fragments from the floors and fireplaces as separate categories, and secondly, the material from the feature fillings. Small disturbances and movements of fragments are more likely to occur in the latter case than in the former with fragments trampled into the floors or burnt, unintentionally, within fireplaces.

6 Work in 2022 and 2023

In the days from 19th February to 3rd March 2022, Martin Odler continued the work on Elephantine. The main focus of the 14-day work was photographic documentation of all analysed specimens from 2021 and additional documentation of the selected pieces that were not analysed. A typology of the small metalworking remains within ancient Egyptian and Nubian contexts is, frankly, non-existent. Thus, the fragments measured by the pXRF spectrometry needed to be photographed, their maximal dimensions and weight had to be noted, as well as

15 Warden 2022.
16 Warden 2022: 72.
17 Warden 2022: 72.
18 Warden 2022: 80–81.

a detailed description of their macroscopically apparent characteristics. In addition, two golden finds were documented, a bead from a mortar pit, and a fragment of a golden pendant from the court R08 in House 169. Isolated finds of gold illustrate another metal that was available to the inhabitants of the Middle Kingdom town.

Each fragment was photographed with a Canon EF 180mm f/3.5 L Macro USM lens mounted on a full-frame camera Canon Eos 6D Mark II. Each piece was photographed from several sides, capturing its overall form, shape, and colours. The documentation will ultimately serve for the typological characterization of similar metalworking material from Bronze Age Egyptian and Nubian sites. Based on the evaluation of pXRF spectra, a subset of 48 samples was selected for a detailed study at the IFAO laboratory. The sample transport was approved and carried out by the Ministry of Tourism and Antiquities, eventually reaching the IFAO laboratory in early March 2022.

In the days from 21st to 24th May 2023, both authors continued the study of the samples from Elephantine Island transported to Cairo. These 48 samples were numbered at the IFAO laboratory with consecutive local lab numbers from 13289 to 13336. In May 2023, metallographic cross sections were prepared from almost all samples by the standard procedure, with the exception of ore fragments (Fig. 3). The procedure is based on mounting the samples in epoxy resin, grounding on silicon carbide (SiC) metallographic plates, polishing with 2 and 0.7 μm diamond pastes and etching of prepared metallographic cross-sections of metallic phases by a $FeCl_3$ solution. The sample study was performed using an optical metallographic microscope in bright field observation mode available at the IFAO laboratory. Digital images of the samples' microstructures were taken by the digital camera Nikon D3S and processed by the Camera Control Pro 2.26.0 M software (Fig. 4).

The samples studied in 2019 were then transported to the Desert Research Center, part of the Ministry of Agriculture and Land Reclamation, on 24th May 2023, with the substantial help from the IFAO lab staff, Prof. Sameh Hussein from the Cairo University, and kindly approved by the Ministry of Tourism and Antiquities. There a selection of eight samples was analysed with the Scanning Electron Microscopy and Energy Dispersive Spectroscopy (Fig. 5) which gives much higher resolution for the study and enables to analyse the particular phases of the metallographic samples. The work on the results of these analyses and their eventual publication is still ongoing.

7 A selection of the find categories

The main find categories of the metalworking processes were defined as minerals, crucibles, prills and slags, and finished artefacts. We have selected five examples of such finds, all from House 169, to illustrate the main categories (Tab. 1).[19] Altogether, 551 specific contexts were

19 Kopp 2022; Sigl 2022; Sigl/Kopp 2020; Sigl/Kopp 2022; Warden 2022.

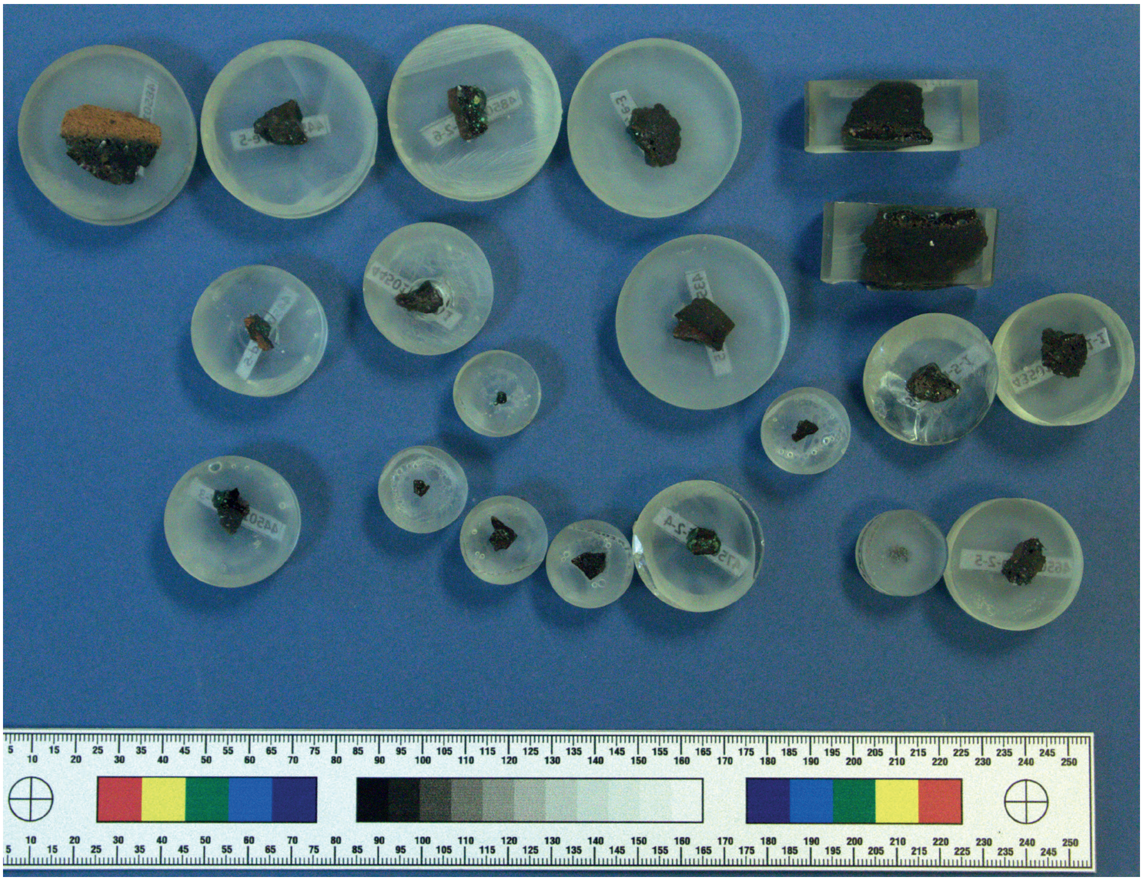

Fig. 3: A selection of samples of the metalworking remains mounted in resin blocks, photo: Martin Odler

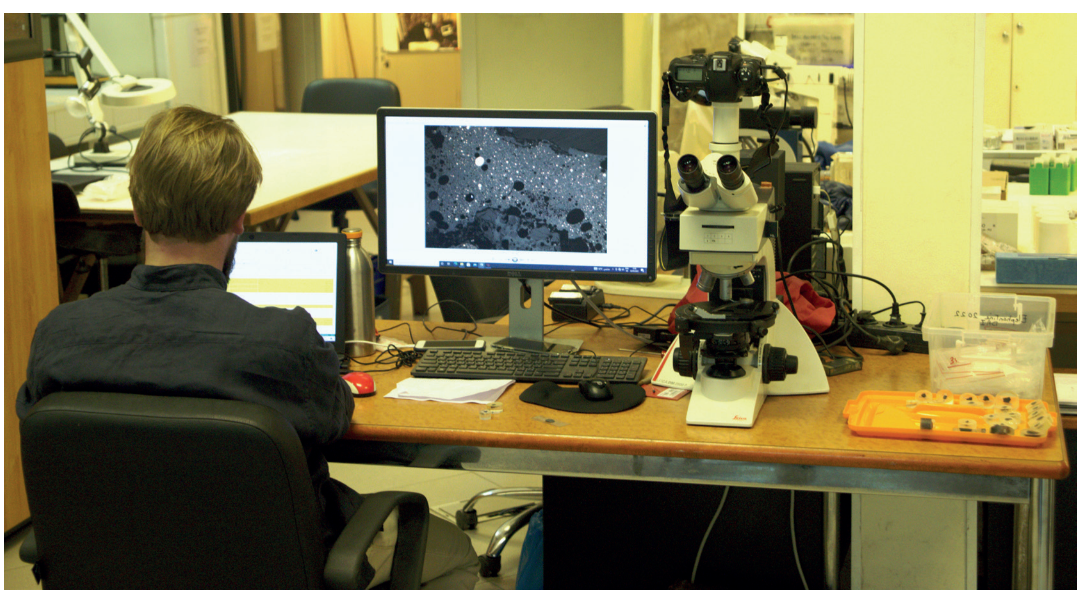

Fig. 4: Study of the mounted samples by Jiří Kmošek, photo: Martin Odler

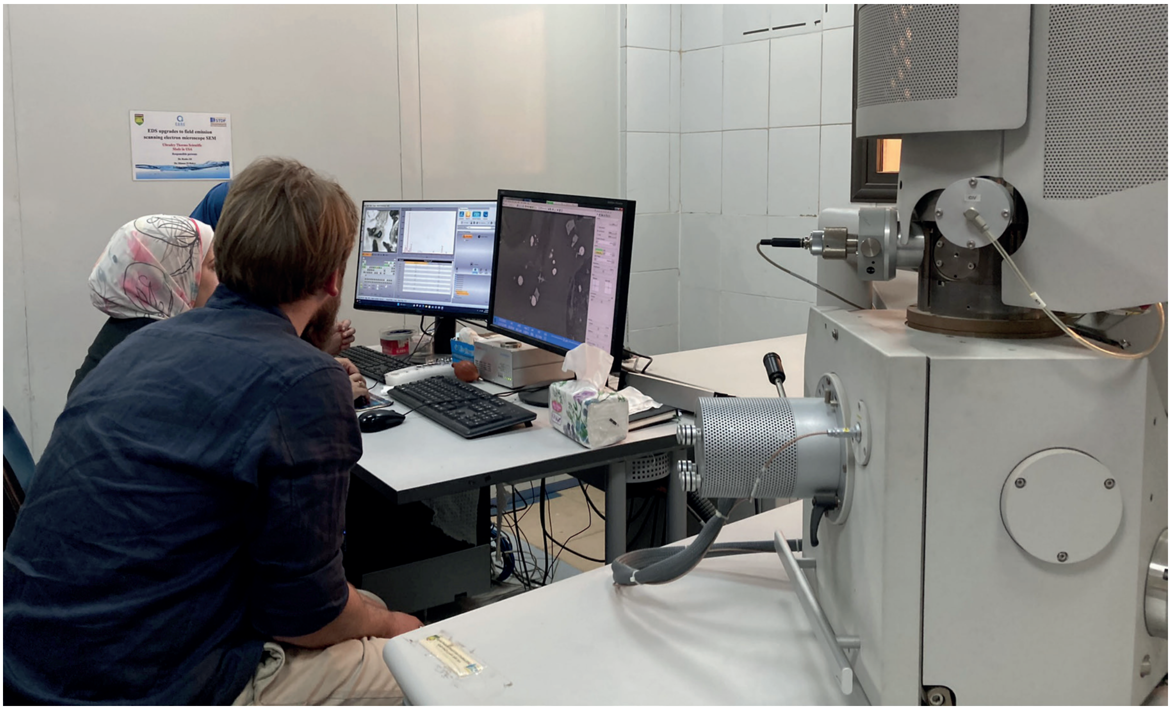

Fig. 5: Analysis of the samples with the SEM-EDS at the Desert Research Center, photo: Martin Odler

numbered in the house, 83 of these are floor levels, and 158 specific fills.[20] An important observation is that only four out of all the contexts contained sherds predating the late Middle Kingdom. The deposition therefore reflects the duration of the existence of House 169,[21] and provides a general dating also for the respective metalworking remains, and thus, the copper metallurgical activity on the site. Metalworking remains present another dimension of the craft activities that might have been happening around the house. Altogether, House 169 provided evidence for the production of food, especially bread,[22] extracting and refining of the pigments,[23] jewellery made of amethyst, ostrich eggshells, gastropod, and bivalve shells.[24] The overall weight of the metalworking remains from House 169 is almost 130 grams (Tab. 2), with the highest concentration in the court R08.

A green and brown mineral fragment with the XRF spectra 190 and 191 was found on one out of more than fifteen floors of the rear northern court R08 in House 169 (Fig. 6).[25] It is coming from the heavy fraction of the flotation. The main elements in the mineral bit were copper and arsenic, with a minor addition of lead. Both the fact that it was a mineral, as well as

20 Warden 2022: 75.
21 Warden 2022: 77.
22 Sigl/Kopp 2022: 62–66.
23 Sigl/Kopp 2022: 66.
24 Kopp 2022.
25 Sigl/Kopp 2022: 61.

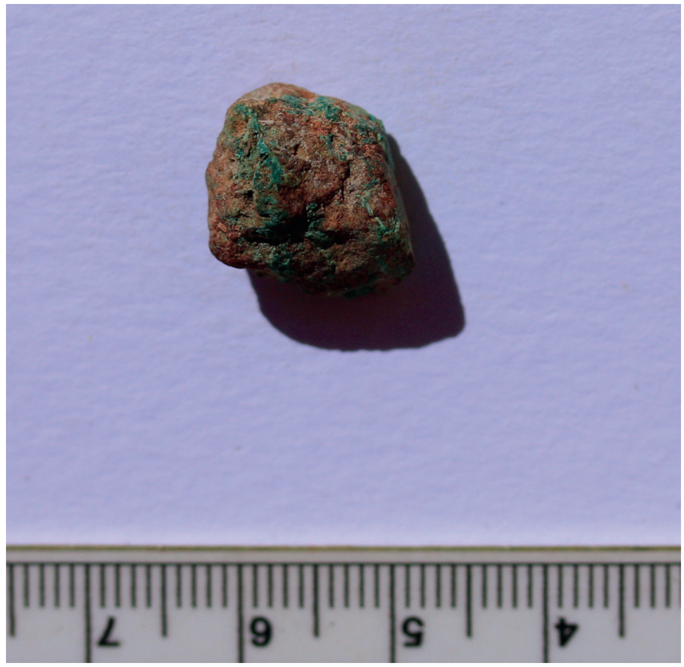

Fig. 6: Mineral fragment 47501Z/d-2-8,
pXRF spectra 190 and 191, photo: Martin Odler

the interesting composition, provided a basis for it to be one of the selected pieces for further study in the IFAO laboratory, under the lab number 13305.

From the same court, and a succession of its floors, a prill with the XRF spectrum 192 (Fig. 7) was retrieved, incidentally having both main elements as the mineral (copper and arsenic), and also a minor addition of lead. The prill is corroded, thus the information on the chemical composition is only semi-quantitative at best. But it gives us a hint that minerals such as the one previously listed were used in the metallurgical operations and not for the pigment production, which was also attested within the house deposits.

The slag fragment of XRF spectrum 223 was found in the flotation of a fill in a presumably roofed room R09, in the western corner of the house. It had the main elements of iron, copper, and arsenic, with the admixture of cobalt. The slag bit was again corroded and also covered by soil, which had attached itself to it in the post-depositional history (Fig. 8).

The only crucible fragment retrieved from the whole of House 169 was a vessel with XRF spectra 290 and 291. It was found in the fill layer of the, most probably open, court R04 (Fig. 9). It was made of coarse ware, and a slaggy layer was on the inside of the vessel. With a weight of more than 10 grams, it was one of the heaviest fragments in the studied corpus. The main elements of the composition were iron, copper, and arsenic, thus similar to the bit of slag, but there were also other trace elements, including tin. This made the crucible fragment another candidate for further study in the IFAO laboratory, where it was registered under the IFAO lab number 13314 (Fig. 10). The inner microstructure of the slag layer on the pottery vessel is almost fully amorphous with the occasional presence of metallic two-phase arsenical

Fig. 7: Prill 47501V/h-2-7, pXRF spectrum 192, photo: Martin Odler

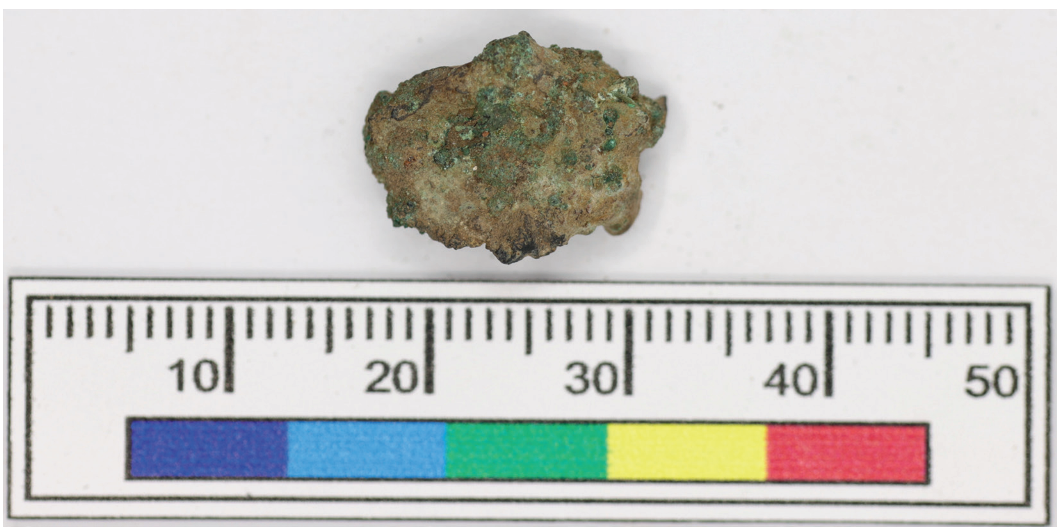

Fig. 8: Slag fragment 47501C/e-2-4, pXRF spectrum 223, photo: Martin Odler

copper micro prills, accompanied by a small amount of iron oxides. Corroded round phases, consisting mainly of iron, are also visible in the microstructure of the sample (Fig. 11).

Finally, a corroded artefact fragment, XRF spectrum 202, was found in the heavy fraction of the flotation from the court R04, in a fireplace (Fig. 12). The main elements were copper and tin, with an admixture of arsenic, but the artefact was heavily corroded. It resembles a fragment of wire. On the basis of the high concentration of amethyst fragments in court R04, Kopp presumes that the production of amethyst jewellery was one of the functions of the area.[26] The drill heads for the drilling of amethyst beads must have been quite thin and could have been made of copper wire, as he proposed.[27] They might have looked just as the artefact fragment with the XRF spectrum 202.

26 Kopp 2022: 256, Fig. 8.
27 Kopp 2022: 259.

Fig. 9: Crucible fragment 46501G/s-21, pXRF spectra 290, 291, photo: Martin Odler

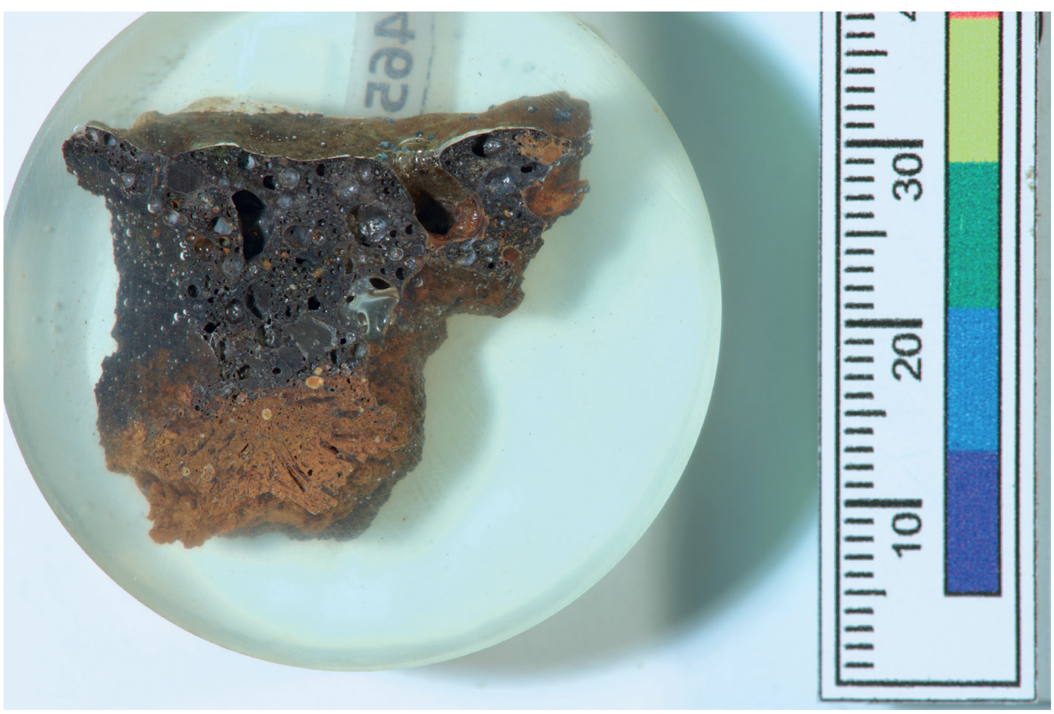

Fig. 10: Crucible fragment 46501G/s-21, under the IFAO lab number 13314 mounted in resin, photo: Martin Odler

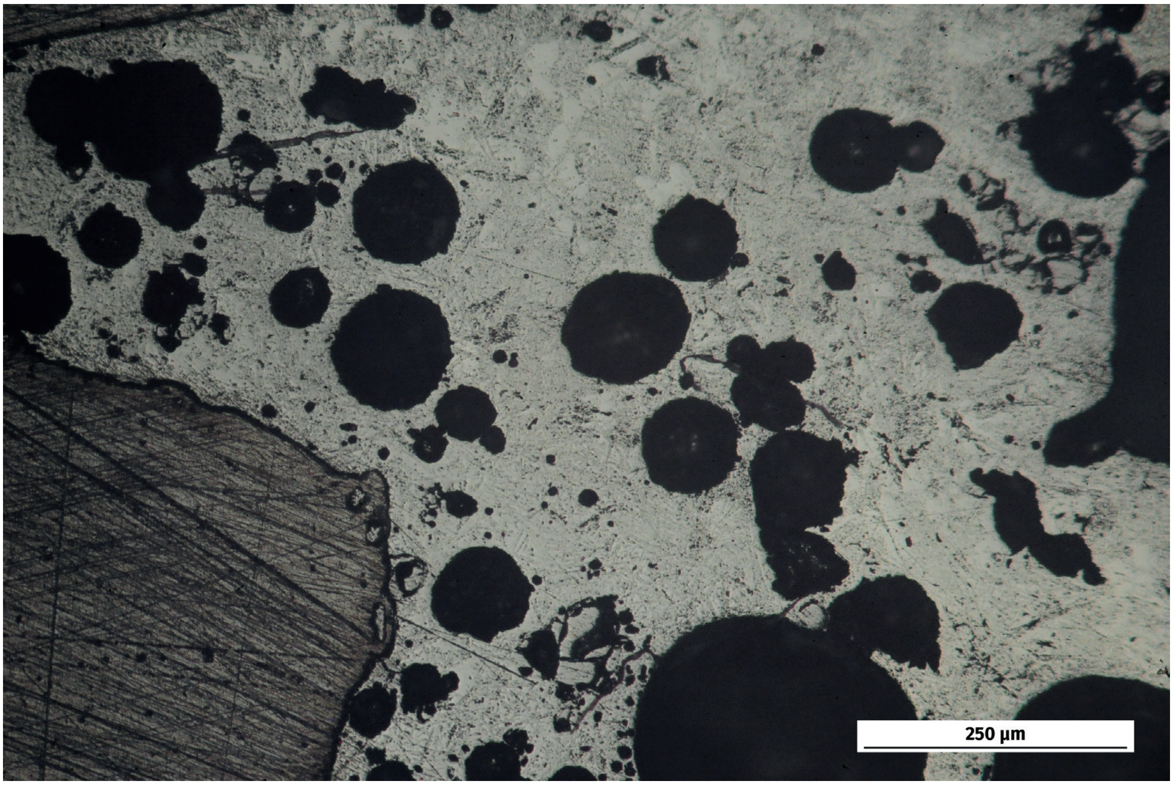

Fig. 11: Microstructure of slag layer present on the analysed crucible fragment (IFAO lab number 13314), photo: Jiří Kmošek

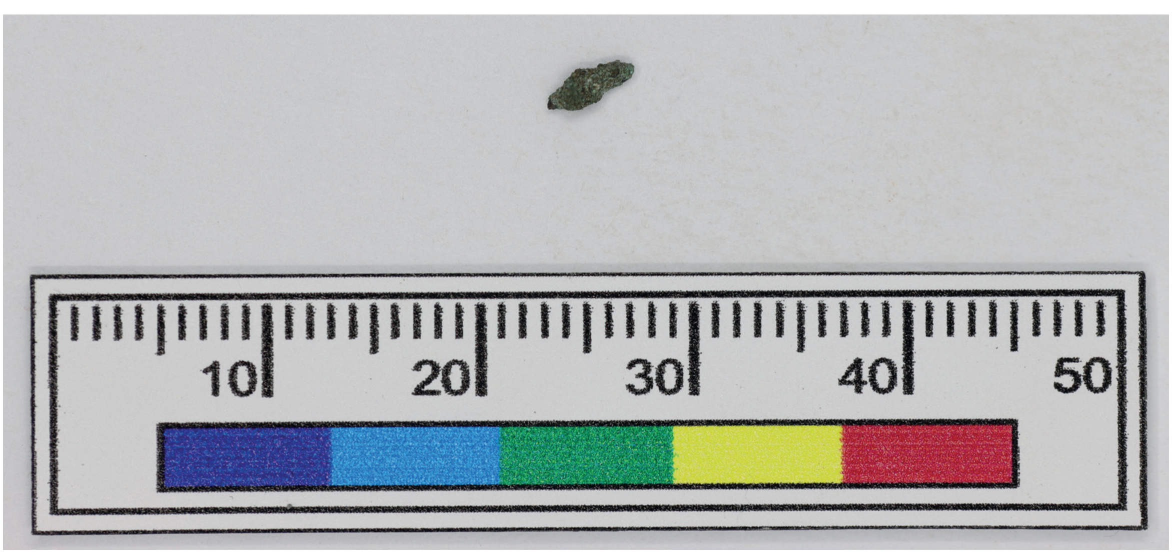

Fig. 12: Artefact fragment 47501Q/f-2-4, pXRF spectrum 202, photo: Martin Odler

These finds alone would provide sufficient evidence of the copper metallurgy happening nearby the house, and there are fortunately hundreds of pieces of evidence to confirm such activities. But only with a further detailed statistical evaluation can they add to the spatial analysis of the household function and use within House 169.[28]

8 General chronological structure and broader significance of the corpus

The main observable development within the corpus is a slow but steady increase of the use of tin bronze, in contrast to the number of the occurrences of arsenical copper, which is gradually decreasing. Unidentified single intrusions and perturbations might be an issue; thus, we are rather depending on the broad data framework within the excavated squares.

The chronological ordering of the initial batch of twelve samples (studied by us in 2019) was confirmed in general terms also with the study of the rest of the material. It enables us to observe the continuous use of the arsenical copper in the Dynasty 11 and 12 (with possible, but marginal occurrence of tin). Rather frequent occurrence of gold among the trace elements may indicate that the metallurgy at the site was connected to the well-documented jewellery production from semi-precious stones, found in Dynasty 12 and Dynasty 13 houses,[29] but it could also be a property of the used ore itself. The traces of gold were demonstrated for copper ore found at Old Kingdom Buhen in Lower Nubia.[30] Only further study of the material stored at Elephantine may demonstrate the validity of one or both of these hypotheses.

The introduction of tin bronze can be dated to Dynasty 13 and the Second Intermediate Period, which is in a broad agreement with observations on other Egyptian and Nubian sites.[31] Of all the results obtained on Elephantine, the simultaneous occurrence of tin and arsenic in analysed fragments of ceramic crucibles is most interesting. This is possibly the consequence of the transition of arsenical copper metallurgy to the tin bronze metallurgy, and of presumed recycling of older material as was also recently documented at C-Group Aniba, contemporary with early Dynasty 12.[32]

The corpus of Middle Kingdom and Second Intermediate Period metallurgical remains from Elephantine is small but significant, as it provides datable comparison to much larger assemblages from the Dynasty 12 Ayn Soukhna and the Dynasty 13 and Second Intermediate Period Tell el-Dab^ca.[33] Intriguingly, a detailed study of Kerma metalwork from Upper Nubia

28 Sigl 2022.
29 Sigl/Kopp 2020; Kopp 2022.
30 el-Gayar/Jones 1989.
31 Gilmore 1986; Odler/Kmošek 2020.
32 Odler/Kmošek 2020.
33 Abd El-Raziq/Castel/Tallet 2011; Verly et al. 2021; Philip/Cowell 2006.

found more mutually exclusive groupings of arsenical coppers without tin and tin bronzes without arsenic.[34]

Our team is also working on the Early Bronze Age Old Kingdom settlement material from Giza and Late Bronze Age material from Tell el-Retaba, completing the survey of the Bronze Age Egyptian copper metallurgy, especially from settlements.[35] The corpus from Elephantine will help to demonstrate, how even the tiniest recovered settlement remains can further our understanding of the ancient *chaîne opératoire*, in this case of copper and its alloys. Returning to the point of size and scale from the beginning, metalworking remains from Elephantine may be tiny, but they are extremely important.

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34 Rademakers et al. 2017.

35 Preliminary reports on Giza: Odler/Kmošek 2019; 2022. A report on Tell el-Retaba is in preparation.

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Tab. 1: Selected finds from the Realities of Life project described in the article

pXRF spectrum no.	Season	Typology	Alloy	Admixtures	Weight (grams)	Context no.	Find no.	sub_ item	Date	Sampling method	House	Room	Context type
190, 191	47	mineral	CuAs	Pb	2.19	47501Z/d	2	8	19.02.2018	floatation (heavy fraction)	H169	R08	Floor
192	47	prill	CuAs	Pb	1.545	47501V/h	2	7	10.02.2018	floatation (heavy fraction)	H169	R08	Floor
223	47	slag	FeCuAs	Co	1.025	47501C/e	2	4	01.11.2017	floatation (heavy fraction)	H169	R09	Fill layer
290, 291	46	crucible	FeCuAs	SnZnNiCo	10.61	46501G/s	21		20.02.2017		H169	R04	Fill layer
202	47	artefact	CuSn	As	0.008	47501Q/f	2	4	01.02.2018	floatation (heavy fraction)	H169	R04	Fireplace

Tab. 2: Total counts and weight of the metalworking remains from House 169

Artefact categories	mineral	prill / mineral	crucible	slag	prill	artefact / prill	artefact	gold	Total Count	Total weight (grams)
Rooms of House 169	4	1	1	16	122	1	35	1		
---				1	3				4	0.971
R02				4	13				17	10.582
R03	1			1	8		1		11	21.063
R04			1	5	21	1	18		46	21.405
R04/R07					1				1	0.155
R05					2		2		4	6.167
R07	1			1	7		2		11	1.749
R08	2			3	50		7	1	63	46.367
R09		1		1	9		5		16	17.067
(blank)					8				8	4.095
Grand Total	4	1	1	16	122	1	35	1	181	129.621

Tab. 3: Results of the pXRF analysis for the metalworking remains, chemical composition, in weight %

Reading No	Typology	Alloy	Admixtures	Cu	Fe	As	Sn	Sb	Pb	Zn	Ni	Bi	Ag	Co	Mn	Ti
190	mineral	CuAs	Pb	87.85	9.59	1.11	< 0.02	< 0.03	0.12	< 0.04	< 0.02	0.02	< 0.02	< 0.03	0.04	0.59
191	mineral	CuAs		87.41	3.01	0.57	0.01	< 0.02	0.03	< 0.03	< 0.01	< 0.01	< 0.01	< 0.01	0.02	0.19
192	prill	CuAs	Pb	90.65	5.43	2.05	< 0.03	< 0.04	0.05	< 0.04	< 0.02	0.01	0.22	< 0.02	0.09	1.07
202	artefact	CuSn	As	62.38	3.34	0.89	32.51	< 0.1	0.03	< 0.08	< 0.09	< 0.02	< 0.04	< 0.07	< 0.08	0.55
223	slag	FeCuAs	Co	79.72	8.83	10.26	0.03	0.03	< 0.01	< 0.02	< 0.02	0.01	< 0.02	0.08	0.12	0.75
290	crucible	FeCuAs	SnZnNiCo	66.43	30.14	0.67	0.26	0.04	0.02	0.08	0.08	0.01	< 0.02	0.36	0.17	1.21
291	crucible	FeCuAs	SnSbZn-NiCo	69.73	26.49	0.79	0.32	0.12	< 0.01	0.07	0.06	0.01	< 0.02	0.36	0.16	1.33