# STANDARDIZATION, CENTRALIZATION AND SCALE: FOCUS ON FAYNAN – CHARACTERISTICS AND KEY FEATURES FOR ECONOMIC AND ORGANIZATIONAL GROWTH

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## Introduction

This research on the development of historical and technical innovations in mining and the associated social aspects in the Faynan district is based on archaeological investigation and archaeometallurgical studies in copper metallurgy (Hauptmann, 2007). Both analytical researches will answer questions concerning the factors influencing the development and innovation of extractive metallurgy at the Faynan mining district in context with the economy, spatial distribution and settlement progression not only in single utilization phases. The settlement pattern and archaeometallurgical installations in this district are unique because the ancient mining sites managed to survive and were not impacted by more recent mining activities. The metallurgical remains include furnace fragments, crucible fragments, casting moulds, prills and lumps of copper, ingots, copper tools, slag, ores and mining tools.

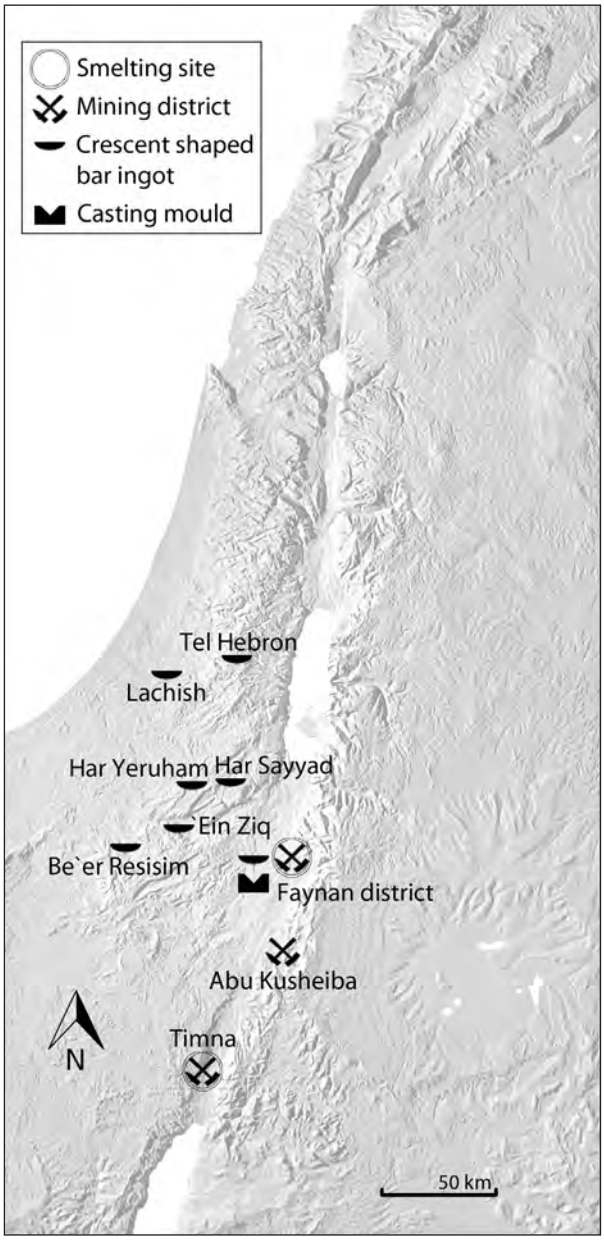
The copper district of Faynan is situated 80 km south of the Dead Sea (Fig. 1), halfway between the Dead Sea and the Red Sea, west of the Jordanian Plateau. The ancient ore district (Fig. 2) is one of the largest copper producers in the Southern Levant. Its long lasting exploitation has spanned from the Pre-Pottery Neolithic-A (Finlayson and Mithen, 2007) until the Islamic period.

The development of the ore district took place in various steps and was concentrated in the late Chalcolithic - Early Bronze Age (mid/end of the 4th and 3rd millennium BC), the Early Iron Age (1000-500 BC) and Nabatanean-Roman time (100 BC-400 AD).

The fundamental investigations for the article were undertaken by the Deutsches Bergbau-Museum Bochum between 1983-1993 under the administration of Prof. Dr. A. Hauptmann in collaboration with Prof. Dr. G. Weisgerber and other Universities and Institutions (Adams and Genz, 1995; Levy, 1995; Engel and Frey, 1996; Weisgerber, 1996, 2002, 2006; Hauptmann, 2000, 2007; Levy, et al. 2002, 2005; Barker, et al. 2007; Ben-Yosef, et al. 2009, 2010; Ben-Yosef 2010).

This study presents an overview of the changing technological innovations of mineral exploitation from the Chalcolithic through the Early Bronze Age (EBA) IV by mining activities as well as of the produc-

Fig. 1: Distribution map of crescent-shaped bar ingots and mining areas in the Southern Levant.



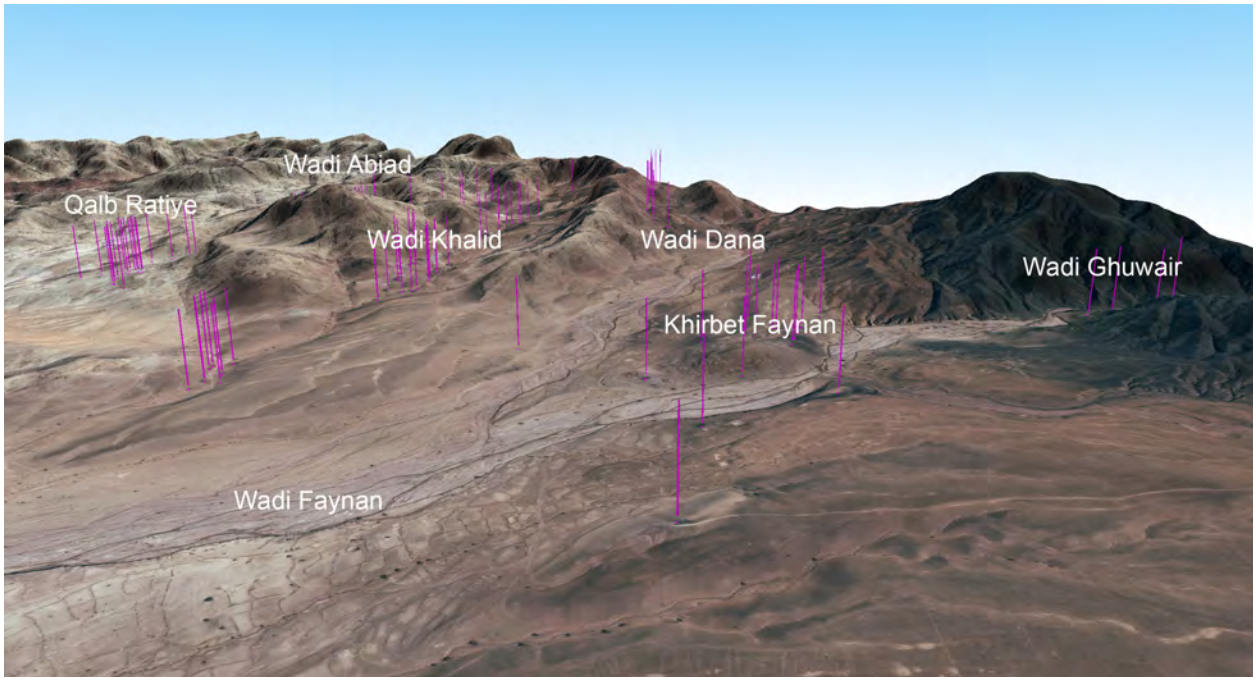



Fig. 2: 3 D perspective overview of the Byzantine ruins of the town of Faynan (middle) and of the mining and smelting sites at Faynan and in its vicinity (red sticks) (Hauptmann, 2007, Fig. 5.4a).

tion of copper in context to standardization, centralization and scale.

## The Chalcolithic metallurgy

In the Southern Levant the Chalcolithic metallurgy was connected to the emergence of the first chiefdom organizations and it seems to have been controlled by social elites (Levy, 1995; Levy, et al., 2002, p.427). They lived in small nucleated villages, situated in a two-tier settlement hierarchy of numerous small villages and larger regional village centres. With the regression of Chalcolithic society during the early fourth millennium, the common pattern of nucleated villages continues into the EBA I (3600- 3300 BC) period. In such a small village community the earliest evidence for small scale metallurgy at Faynan (Hauptmann, et al., 1992) comes from the site of Wadi Fidan 4 (3400/3500 BC) (Adams and Genz, 1995; Adams, 2002, pp.22-23). The village community of Wadi Fidan 4 was only partly specialised in the production of copper by extractive metallurgical processes.

The majority of the crucible-based productions of copper and copper beads were made from several copper mineral deposits from the Faynan region (Hauptmann, 2007, pp.158-163). Just a few kilograms of crushed slag, ash, copper ores, a small number of about 30 crucible fragments and copper prills were discovered mainly in a limited corner of the settlement (Hauptmann, et al., 1993).

The copper and slags were produced under "primitive" conditions (Craddock, et al., 2007) and of low scale. No casting moulds were excavated at Wadi Fidan 4 that might prove the production of copper ingots or end products (Hauptmann, 2007; Hauptmann and Löffler, 2013). The evidence of stone mining hammers and raw material for stone tools and other finds reveals that the occupants have also been involved in mining, trading of ores and copper production activities as a supplement to general subsistence activities (Adams, 2002, p.23).

During the Chalcolithic/EBA I period over 100 small mines were dug. Following the outcrops of the mineralization, these small mines were opened in the solid rock of the Massive-Braun-Sandstone (MBS, Fig. 3) with a lateral enlargement of only a few metres. The mining constructions are simple pit diggings, with an initial development to room-and-pillar constructions (Weisgerber, 2006, p.5). The mining was performed right at the ore deposit, but the main activities of smelting and casting were carried out in different villages somewhere else.

The mined ores were also transported probably by pastoral nomads (Anfinset, 2004) to regional centres of cultural and regional gravity, such as the Beer Sheba valley and the Aqaba region (Hauptmann, 2000, 2007). Tell Abu Matar i.e., in the Beer Sheba valley, is one of the major centres for copper smelting and production of artefacts of the late 5th and 4th millennium BC. It is located some 100 km north of Faynan and produced – in contrast to Wadi Fidan 4 –

tons of copper slags and gives evidence for extensive metals production (Shugar, 2000) using ores from the Faynan copper district (Hauptmann, 1989).

The main topics at this time are the concentration of mining in Qalb Ratiye, Wadi Abiad in the upper part of the Wadi Khalid and the centralization of settlement activities in the Faynan copper district.

## The change in metallurgy at Faynan during the Early Bronze Age II period

In connection with the developments in the Faynan mining district the reduction of number of Levantine settlements in EBA II (Milevski, 2009, p.133), results in the centralization of distributed goods. The growth of the population and a reduction in the actual numbers of sites suggest that larger sites began to play an increasingly important role (Adams, 2002, p.23). Walled towns developed during this period, societal changes took place, with increased centralization and control, and the large-scale building projects evolved (Amiran and Gophna, 1989).

These external political forces seem to have played a major role in altering and enlarging the small-scale metal production as practised in the Chalcolithic/Early Bronze Age I at Faynan to a more organized operation (Dever, 1995).

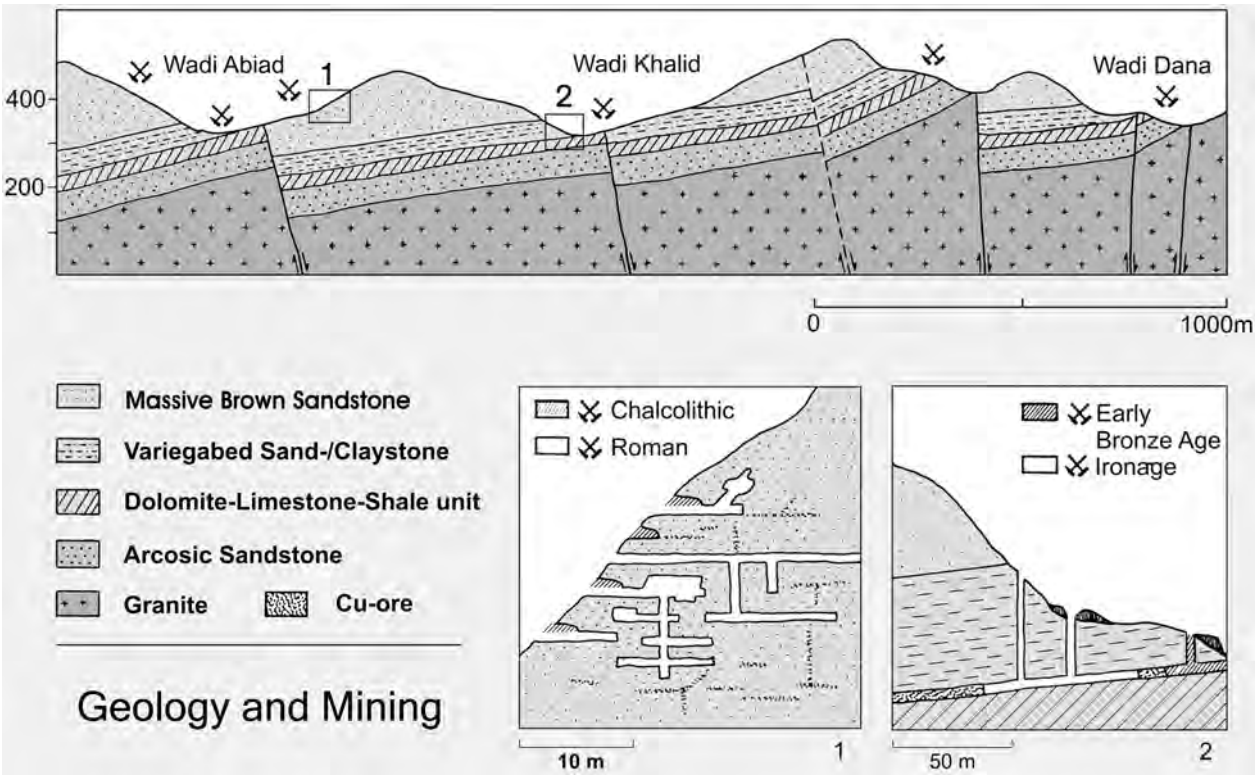
During this time the first evidence for major changes in centralization, scale and standardization of mining and copper production was observed (Hauptmann and Rohden, 1988; Hauptmann, et al., 1992). Adits were applied in the highs and terrace formations of Wadi Dana and Wadi Khalid. The size and number of these mines documented are only in the Wadi Khalid (Weisgerber, 2006), a total of 66 mines were found; suggests a dramatic increase in the scale of mining activities.

The second type of copper mineralization in the Dolomite-Limestone-Shale (DLS, Fig. 3) was exploited for the first time with underground mines; the ores mined in the 4th millennium were totally ignored.

The essential reason to change to the much more difficult mining of new ore deposits is probably not only due to the fact that the copper ore is more plentiful (Hauptmann, 2000; 2007), but it may have been considered a higher quality due to lead impurities that helped in the casting of high-end copper ingots like those (Fig. 4) from Khirbet Hamra Ifdan (KHI). In addition the new copper with higher lead concentration is easier to cast in contrast to other copper sources with fewer trace elements.

The result of the developed smelting process is the smelting of ores at close vicinity to the mines connect-

Fig.: 3 Schematic illustration of the mining development in connection with the different geological sections (according to Hauptmann, 2007, Fig. 5.46).



ed with a movement away from small volume crucible smelting to larger standardized smelting furnaces. These furnaces were used as large scale operations with multiple installations being constructed and rebuilt in close proximity to one another, positioned on the windward side of the high hills to use the wind power for smelting (Hauptmann, 2007, pp.104-108).

To organize the labour and resources needed, a degree of centralization of control as well as manipulation of the labour base would have been essential. The modification from small-scale of specialization in Chalcolithic and EBA I to this highly-sophisticated and extensive production process that happened in Faynan (Adams, 2002, p.24) was based on a growing demand and an evolved superior organization structure.

At this time a new relationship grew between the town centres and their surrounding hinterlands that supported the concept of urbanized and rural space (Joffe, 1993, p.73). The combined evidence from these increased specializations of production and development of technologies suggests changing patterns of consumption and the production of goods for trade (Adams, 2002, 23).

## The copper production at Faynan during the Early Bronze Age III-IV period

The production level of metal increased dramatically in the middle of the 3rd millennium BC, obviously to cover a growing demand for copper not only in the Eastern Mediterranean (Hauptmann, 2007; Hauptmann and Löffler, 2013). Similar activities are observed in Anatolia, Central Asia, the Iranian Plateau, the Mediterranean Basin and Central Europe (Amzallag, 2009).

Analyses of ores found in the settlements Barqua el-Hetiye, KHI (Hauptmann, 2000; 2007) and at the thirteen EBA surrounding smelting sites, and the chemical composition of EBA slags clearly indicate that with the beginning of the 3rd millennium BC the raw ore source at the Faynan mining area had changed. While copper ores were smelted in the 4th millennium BC from the MBS, mixed copper-manganese ores from the DLS were utilized exclusively to produce metal in EBA II-IV. The hub of the DLS mines was in the lower course of the Wadi Khalid and Wadi Dana (Fig. 2), in the eastern part of the Faynan copper district, 1–2 km away from the major EBA slag field at the Khirbe of Faynan (Hauptmann, 2007; Hauptmann and Löffler, 2013).

Fig. 4: Reconstructions of the casting mould and crescent-shaped bar ingots. This type of ingot was traded during the Early Bronze Age III/IV (photo I. Löffler, Deutsche Bergbau-Museum).

In the area around the Khirbe of Faynan 1000 tons of slag were located, and in the lower wadis Khalid, Dana and Ghuwair, where the same amount occurred, and another approximately 500 tons that were left at 13 contemporary EBA II–IV smelting sites (Hauptmann, 2007). At these EBA smelting sites an extraordinary feature that offers not only a view into organisation of metal smelting, but also into the organisation of mining activities can be observed.

The entire of the EBA smelting sites in the Faynan mining area were positioned on slope edges and hills that were exposed to strong seasonal winds blowing from the Jordanian Plateau as well as from the Wadi Arabah. These smelting sites have been identified as the earliest smelting furnaces known so far (Hauptmann, 2000, 2007, Hauptmann and Löffler, 2013). Weisgerber (2006, pp.12-13.) argues that the furnaces were so widely distributed on suitable summits and off-centred production in the hands of several producers can be assumed. Otherwise smelting did not happen in one centralized place but was concentrated on the edges and on several hilltops close to the different mining areas.

## Development of settlements in context to copper production activities

Few settlements in the mining area reveal significant data on this key period with respect to relations between Faynan and the Western/North-Western Levant and beyond during the later Early Bronze Age

(ca. 3000–2000 BC). The first one is Faynan 100, which is situated at the western edge of the antique and present-day irrigation system. This place dates to the end of the 4th millennium BC or Early Bronze Age I period (Wright, et al., 1998; Baker, et al., 2007, p.268).

The magnitude of the site is much greater than that of Wadi Fidan 4. Several crucibles and casting moulds were found there. The settlement of Barqa el-Hetiye is slightly younger (Fritz, 1994, Adams, 2003), which comprises until now of only a few areas and dates to the beginning of the 3rd millennium (3080–2875 BC cal., i.e. EBA II).

The settlement craftsmen here were involved in metal production and processing, just like in KHI (Adams, 2000; Levy, et al., 2002), which held a key position in trade routes crossing the Wadi Arabah rift valley to (north-)western directions.

Khirbet Hamra Ifdan (Levy, et al., 2002; Hauptmann, 2007) is located at a perennial water source and was probably a checkpoint of great strategic importance. Its main occupation phase is the EBA III (ca. 2700–2200 BC). The excavations there revealed a slice of a solid structure containing important quantities of copper production debris. This key settlement represents by far the largest metal workshop of this period in the entire Middle East. It consists of 80 areas, in which more than 600 crucible fragments, more than 800 fragments of casting moulds, copper lumps and prills, slag, ingots and final objects etc. were found. The archaeometallurgical evidence from this site for chaine d'operatoire for the production of copper (Hauptmann, 2007, p.240) advises that the trend of specialization and an increased scale of production continued to the end of the main phase of the Early Bronze Age and further into the Early Bronze Age IV (Adams, 2002, p.24).

The corresponding proof for the final production of copper objects and ingots from this site suggests that this was a highly organized and specialized operation for the conclusive beneficiation of copper, ready for export in the shape of both ingots and finished tools (Hauptmann, 2007, p.242). Due to this evidence of such an industrialized scale of production it has been suggested that this site can be termed a manufactory installation (Adams 1999; 2002; Levy, et al., 2002).

The excavation of ingots and casting moulds at Barqua el-Hetiye (EBA II) and KHI (EBA III-IV) confirmed as well that these ingots had originated from the Faynan district (Adams, 2002, p.25; Hauptmann, 2007). The chemical composition and lead isotope ratios of the KHI ingots and the other analyzed Levantine ingots (Fig. 1) are identical to those from the DLS ore and raw copper production in Faynan (Hauptmann, 2007).

In contrast to the technological developments during EBA IV (ca. 2300–2000 BC), there was a process of de-urbanization and social dissolution with only a few centres left, which had been founded in EBA II. As a result the EBA IV has been defined as a period of ruralisation in past research (Dever, 1995, p.295).

## Discussion

The upcoming questions in context to the archaeological evidence are: Who controls this enormous scale of copper production? Is there a higher administration that controled the production and organizes the trade?

More than 100 crescent-shaped bar ingots of the type found at Barqua el-Hetiye and KHI (Levy, et al., 2002; Hauptmann et al., in prep.) were in the later EBA exported to Levantine sites. They have been excavated in settlements (Tufnell, 1958; Gophna, 1992) of the Early Bronze Age IV in the Southern Levant and the Dead Sea area like Be'er Resisim, En Ziq (Segal, et al., 1999), Har Yeruham and Hebron (Dever and Tadmor, 1976).

Howbeit these Levantine sites were dated to the Early Bronze Age IV period, the shallow stratigraphy and the fact, that most of these finds came from 'ingot hoards' may suggest that the exact dating of these ingots is in dispute, and that they probably date into the EBA III (Adams, 2002, p.25). But the evidence for contact between the Faynan area and Western Palestine is not only seen through the metallurgical finds but also shown by the similarities in ceramics between KHI and the sites En Ziq and Be'er Resisim (Goren, 1996; Adams, 1999). This evidence of a relationship between these sites seems to support direct links between the Faynan area and the Negev.

In addition to the central metallurgical hub of KHI the standardization of smelting, melting and casting, the standardization of ingots accrues. These standardized ingots are an easy to handle means of payment. They are easy to cut and to transport.

The crescent shaped copper ingot appears in a standardized mode (Dever and Teadmore, 1976) established as a "trade mark" in quality and form (Fig. 5), in contrast to other contemporaneous ingots and casting moulds (Müller-Karpe, 1994, pp.131-143; Weisgerber and Yule, 2003) like the associated finds of pin casting and axe casting moulds of the KHI-workshop. The demand for different types of standardized ingots indicates the use of a different weight system. In context to the case of ingot standardization it is the best indicator of a higher administration and

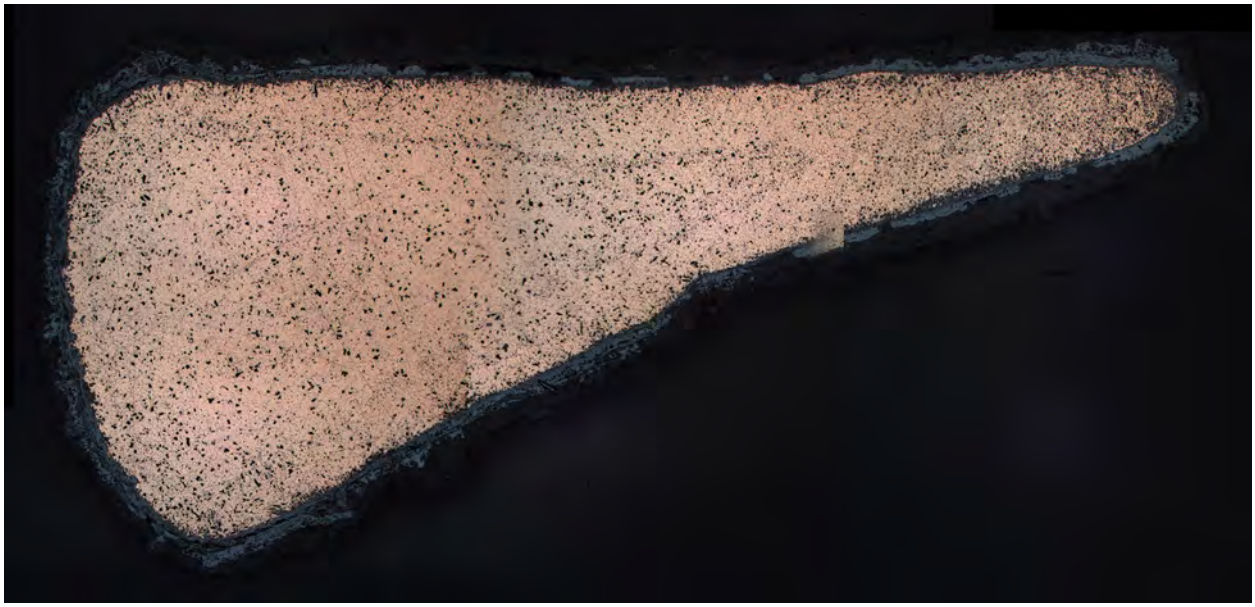


Fig. 5: The polished section of a crescent-shape bar ingot found in the settlement of Khirbet Hamra Ifdan, stratum III (EBA III). The object shows a low porosity and is dotted by only tiny flaws. Gritted inclusions of copper sulphides are visible. The section shows a cooling rim following the incision of the casting mould. The copper contains no slag inclusions, is low in As and contains about 1 wt.-% Pb. In comparison with Late Bronze Age oxhide ingots from the shipwreck of Uluburun the KHI copper is of much higher quality (Hauptmann, et al., 2002; Hauptmann, 2007, Fig. 7.16, p.242).

control inside the production and trading system of copper.

## Conclusion

The first metallurgical phase in the Chalcolithic and EBA I period is evidenced only to a very limited extent at Faynan itself, but far more through studies on the provenance of metal artefacts from other sites, which can be attributed to this copper district by means of analytical measurements of trace elements and lead-isotopic relationships. In contrast, the younger phase of the developed Early Bronze Age shows a fundamental change of development in settlement patterns and metallurgy (Hauptmann, 2000, 2007; Hauptmann and Löffler, 2013) in terms of centralization, standardization and scale.

The technological and cultural progresses in the mining area of Faynan show the centralization of mining and smelting activities on suitable places in context to settlement development, infrastructure and natural resources. All the evident facts about centralization, standardization and scale suggest on one hand a craft specialization and on the other hand a complex social organization of mining, trade and distribution of copper.

It is not clear whether fortified urban centres of the Southern Levant controlled mining and metal production at Faynan directly. One possible scenario is that in EBA II–III the urban centres controlled the production and distribution of the produced metals, or that they only may have had control over the distribution. Perhaps they had control over roads, transportation and distribution routes with an indirect control of copper production (Milevski, 2009, p.135).

The EBA urban centres of the Southern Levant denote a certain concentration of commodities. In this way, rulers of these centres would have had much more economic profit through the administration of exchanges: But there are no administrative records to explain on which basis these commodities were acquired and circulated (Milevski, 2009, p.139). We cannot directly know who the elites or rulers in EB I or the rulers and their administrations in EB II–III were (Milevski, 2009, pp.136-137).

Looking at the long time span and intermittently exploitation of the mining district of Faynan a holistic consideration is necessary to understand regional and superior adjustments. Conclusively the knowledge about the organization of technological and manual processes and of the social environment enveloped in mining and metalworking is the foundation for

any effort to understand and construe the interaction between metallurgy and cultural historical evolutions.

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