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Thomas Stöllner

Enmeshment within resource-scapes – Eastern Alpine copper production of the Bronze and Early Iron Age

ABSTRACT: *The Eastern and Southern Alpine mining regions are conceptualized here as a culturally tightly connected resource-scapes. It was a large region in which a constant flow of ideas and humans lead to the expansion and distribution of the technical knowledge of copper production since the Middle Bronze Age to many ore-deposit-regions. These technical and economic strategies allowed the colonization of Alpine valleys first but also the continuous economic stability and at least a survival within Alpine landscapes. It is shown that the enmeshment of processes and communities led to similar worlds of experiences that allowed different dwellers a necessary exchange and adoption of technical concepts. But this not always went hand in hand with a tighter adoption of cultural habits since the growing of population, the larger demand in copper as well as the different traffic conditions led to different cultural compounds in various regions since the Late Bronze Age.*

KEYWORDS: BRONZE AGE COPPER PRODUCTION, RESOURCE-SCAPES, ENMESHMENT, EASTERN ALPS

Introduction

There is hardly any Bronze Age mining landscape that has been so long and intensively investigated as the Eastern Alpine prehistoric mining districts (Fig. 1). Since the first half of the 19th century, famous sites such as the Mitterberg, the Lower Inn Valley district or the salt mining centers in Hallstatt and Dürrnberg were stimulating us with multifaceted insights into these prehistoric communities (recently various contributions in Stöllner & Oeggl, 2015). These communities acted as producers of a copper-compound, in which copper from various deposits of different chemical composition and quality was produced, consumed and exchanged even far beyond the regional networks. Since the beginning of the late Bronze Age (13th and 12th century BCE), there was a deliberate "blending" of copper-sorts from various deposit zones. Today we know, that copper from the fahlore districts in the Lower Inn Valley was mixed with that from chalcopyrite deposits. This mainly was reasoned in the elevated demand of copper during the Late Bronze Age, but also in the general expectation of a standardised black copper that allowed production of a large series of objects (Sperber, 2004; E. Pernicka, J. Lutz in: Stöllner & Oeggl, 2015, pp.107-111 Fig. 2). This can be shown by investigating the trace-element level of such a copper that was alloyed with tin. Tin and typical fahlore-trace elements such as silver and antimony stand in correlation to each other. The higher the amount of fahlore-components, the smaller the tin-level is (discussion: Stöllner et al., 2016). Since fahlores effects similar material properties as tin, this difference would speak for an interpretation that fahlore could have been used as a substitute for tin that had been delivered from far-distant regions. When exceeding the fahlore-content this would have led to a more silvery greyish surface colour, while tin would have resulted in more shiny golden surfaces. If comparing the hardness of fahlore-copper to tin-bronzes there is not much difference up to levels of 6 to 8%. Therefore, it is likely that tin was replaced by a certain amount of fahlore-copper if tin got sparse. Such an observation makes apparent that societies of the later 2nd millennium BCE kept detailed empirical knowledge that allowed them to produce metal products in relation to their metal properties and their proposed utility. Such required a raw material production that exploited geologically homogeneous ore deposits and practiced technical concepts that could be reproduced in a reliable way in order to meet a wide-ranging metal demand. Studies of the chemical compositions of copper and bronze objects allow the conclusion of a wide-ranging distribution of alpine copper within North-, Central and Central-East-Europe (e.g. Pernicka et al.,

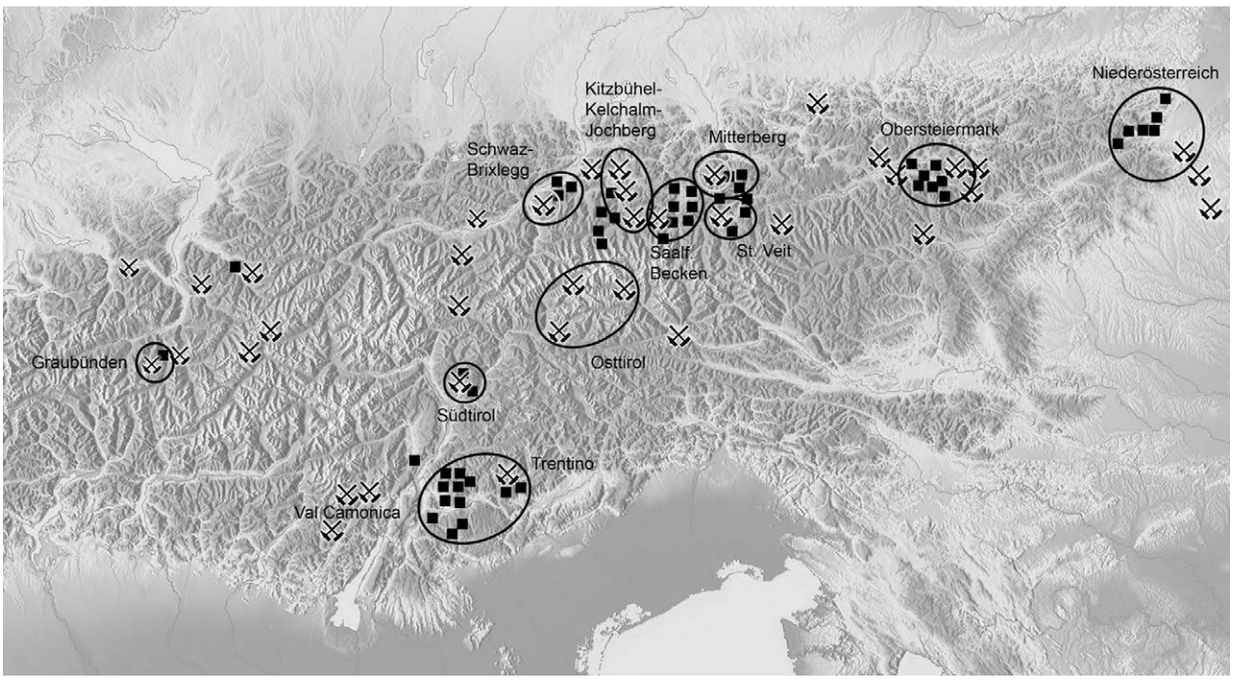


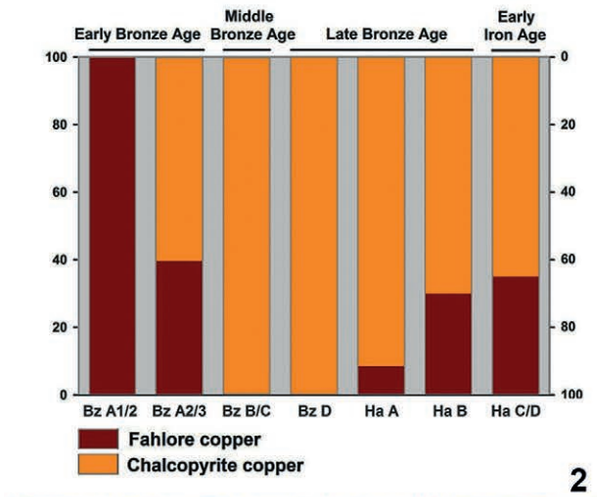
Fig. 1: The Alpine Copper mining districts after Stöllner, 2009, p. 40, Fig. 1.

2016, Fig. 3). During the 18th/17th and the 13th/12th century BCE black-copper produced from the large copper deposits at the Mitterberg-area (Salzburg Alpes) played an eminent role in supplying large areas, while Lower Inn Valley fahlores were of great importance before and during the later phases when they again contributed to the Alpine copper compound during the Late Bronze Age. But if one could get the impression that the production of black-copper would have been developed and directed along a clear technical and economic vision just from the beginning of the early 2nd millennium BCE, this idea only can be discussed with some restraint. Manifold processes of adoption and transformation that seemingly have been dynamic over time, especially in respect of societal, economic and technological processes (e.g. Bartelheim, 2007; Stöllner, 2010), determined the alpine copper-production.

What cannot be discussed in detail here is the question of far-distance-exchange practices in which the Alpine communities certainly were involved and in which copper as a product might have played an important role. There is no doubt that foreign contacts also had altered visions and perspectives and thus far-distant goods and ideas entered the Alpine landscapes: Late Bronze Age Mediterranean glass and Baltic amber were certainly examples, particularly for the transfer into the Alpes. Bellintani (2014, pp.124-125) recently has argued for ports of trade (such as at Salurn/Salorno), in which copper from South-Tyrol and Eastern Trentino was exchanged with prestigious goods such as glass and amber. Such objects likely were only by-products of the exchange as daily subsistence goods perhaps were more important. Such nodules might be assumed for all the large central valleys such as the Inn, Rhine, Adige/Etsch or Salzach and Enns Valley (such as hill-top settlements there).

Temporal, spatial and technical developments

There should be some comments about the temporal development of the eastern and southern alpine copper production before I shall discuss the enmeshment aspects within the mining districts. It has to be emphasized that copper production in the Alps always was determined by regimes of demand from the outside that were active in a supra-regional perspective. This is true already with the first usage of copper within the Münchshofen culture north of the Alps at the end of the 5th millennium when societies practiced the usage of small copper objects for the first time, obviously by supply basically from South-East Europe but also from the Lower Inn Valley (Krause, 2003; Höppner et al., 2005). Indications of metallurgy from the late Vasi a Bocca Quadrata culture (VBQ) are as early as those from the regions north of the Alps (Pearce, 2015). But it is not always clear if copper was exploited from ore-deposits nearby. Most of the provenance data even from sites near or inside the large Alpine valleys (e.g. the Adige, the Salzach and the Inn Valley: Höppner et al. 2005; H. Moesta in Lippert, 1992; U. Tecchiati in Stöllner & Oeggl, 2015, pp. 83-88) cannot be unambiguously traced back to regional deposits. The clearest example comes from the copper-objects of the 4th mill. Mondsee-group in Upper



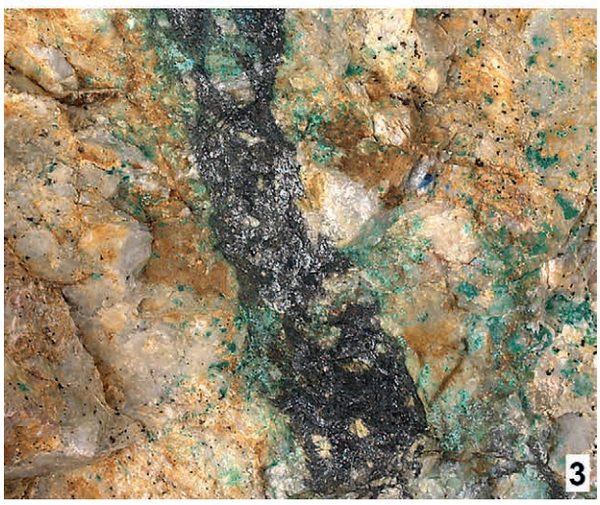


Fig. 2: Chalcopyrite from Mitterberg (1), fahlore in dolomite of the Late Bronze Age to Early Modern Age mine Mauk F, Radfeld, Tyrol (3); copper ore basis of northern alpine to southern bavarian copper and bronze findings (after Lutz & Pernicka, 2013) (2). (photo: DBM, M. Schicht, K. Stange, AVttention, Marienheide).

Austria and Salzburg, whose copper supply always was assumed to be from the Eastern Alpine copper deposits. Most of the provenance data show a clear correlation with Serbian copper ore deposits (E. Pernicka, C. Frank, in: Stöllner & Oeggl, 2015, pp.77-82).

It seems that the largest portion of copper was supplied to Western Austria and South-Germany also around the mid of the 4th mill. BCE from South-Eastern European supply networks. However, this does not mean that there were no attempts within the Alpine valleys. There is the proof of an establishment of younger to late Neolithic settlements alongside larger Alpine valleys that followed seasonal hunter- and gatherer usage strategies particularly in regard to high altitudes, where moving was easier than in Alpine valleys. Lithic resources such as rock crystal, radiolarite or silex became widely distributed within such hunting networks, including also prestigious pieces such as silex daggers, long blades and an axe made of rock crystal (e.g. W. Leitner, M. Brandl and T. Bachnetzer in: Stöllner & Oeggl, 2015, pp.59-69).

What is important in regard to the later development of the copper mining districts is the presumption that hunters and perhaps also herders were important mediators for the development of Alpine landscapes as resource-scapes within the 2nd millennium BCE. However, there were important changes at the main Alpine valleys during this time. Living grounds were continuously occupied since pastures, mineral deposits and cleared acres on terraces became anchors for stable living concepts[1].

In such a perspective, copper exploitation was decisive factor for a successful “colonization” of Alpine landscapes and this is especially visible when regarding these developments at the copper bearing landscape between the Salzach and the Inn Valley (Th. Stöllner; U. Töchterle in Stöllner & Oeggl, 2015, pp.117-124; pp.129-134). The Salzburg valleys of the Pinzgau and Pongau, the landscapes around the Glemm Valley as well as the valleys of the Kitzbühel river stream including the Brixen Valley were settled seemingly together with the advance of copper mining at the greywacke-zone. On the other hand, the Lower Inn Valley in the North Tyrol was settled at an earlier stage from the north. In such an already used landscape the fahlore exploitation led more to an intensification of settlement patterns around Schwaz and Brixlegg (Töchterle, 2015; U. Töchterle in: Stöllner & Oeggl, 2015, Fig. 2).

Such developments began earlier at the Lower Inn Valley, which was more easily accessible than the inner part of the Salzach Valley where the obvious barrier of the Pass Lueg hindered an easy access from the northern Alpine forelands. This barrier was successfully resolved from the 19th to the 18th century BCE when new settling groups founded small hilltop sites along the Salzach stream in rapid succession and began copper exploitation in their surrounding (Fig. 6). That seemingly expeditious process led first to a colonization of the Pongau-part of the Salzach Valley but not much later included also the upstream part of the Pinzgau (in general Stöllner, 2009).

For a long time the Mitterberg/Pongau mining region stayed to be an important producing area for copper before new districts became active around the end of the 14th

Fig. 3: Copper of the Late Early Bronze Age deposit 1 from Obereching near Laufen, Salzburg Austria, consisting of 154 rib ingots (photo: DBM, M. Schicht).

century BCE. We can list the areas around the Kitzbühel Alps (Kitzbühel/Kelchalm: Koch Waldner, 2013; Th. Koch Waldner and M. Klaunzer in: Stöllner & Oeggl, 2015, pp.165-173) and the Upper Styrian districts around the Palten Valley and Eisenerz (S. Klemm in: Stöllner & Oeggl, 2015, pp.195-200) (Fig. 1). All these new districts were based on profitable ore deposits of the Greywacke zone that could be exploited by a similar technical and economic concept (Fig. 8.1). The expansion of copper exploitation certainly was linked to the increased demand in copper during the later phases of the Bronze Age, but definitely led also to a dissemination of all the techniques already established at the upper Salzach Valley and around the Mitterberg. This is remarkable especially in comparison to a later phase of dissemination during the Urnfield period from the 12th century onwards. When recognizing those later examples there were many more adoptions and technical changes that were not known during the older radiation phase. A detailed view shows that our knowledge about those younger districts is restricted, though we only have detailed knowledge from some of them, because parts of the production chain are not known or even not studied. This is true for the eastern Trentino field where smelting is sufficiently studied while the mining is not, or even not known so far (Cierny, 2008; E. Silvestri et al. In: Stöllner & Oeggl, 2015, pp.201-208).

But it is even difficult to compare the technology if the ore-basis is different from the chalcopyrite-based deposits. This is especially remarkable for the fahlore-district between Schwaz and Brixlegg where we can deduce similar structures in organizing the landscape and the prediction process (e.g. at the Mauken Valley district: Goldenberg in: Stöllner & Oeggl, 2015, pp.151-163; G. Goldenberg et al., 2012; 2013) but where operation processes are different in detail because of different ores and host rocks (dolomites) (Fig, 8.2). Recent field-work at the region Oberhalbstein revealed new insights into the Late Bronze to Early Iron Age mining district and its technical solution especially in smelting technique that obviously was inspired by the older chalcopyrite smelting technology of the Mitterberg-process but was variegated (e.g. L. Naef in Stöllner & Oeggl, 2015, pp.215-219). Ethnographic examples show that archaeological sources can be treacherous and even misleading and only allow superficial observations about the manifold social and technical practices of traditional “copper-making” (as recently N. Anfinset reported for Nepalese copper making: Anfinset, 2000; 2011).

The youngest evidence of what we may call an Eastern Alpine production model can be dated to the Early Iron Age and even the developed phases of the Iron Age. It is interesting that during this time small-scaled districts were still in operation, such as the Eastern Tyrol Virgen Valley (concluding Stadler, 1992; for the smelting sites: Eibner & Presslinger, 1991, p.428, Fig. 1). Even though we have no secure dating from smelting sites there is evidence from metallurgical debris found in a Hallstatt period layer at the hill-top-settlement of Burg near Obermauer. These debris indicate a relation to copper-production during that time (Stadler, 1992, esp. p.553).

There is also evidence from the Mitterberg Eastern lodes. This has connection to the Hallstatt period graveyard at the Pestfriedhof near Bischofshofen where an iron pick was even found, whose metallurgical investigation ascertained a relation to mining work at ore-lodes, likely those at the Mitterberg (Stöllner & Schwab, 2009). In this line of evidence, we can also put slags that have been found at the Steinbühel hilltop settlement near Uttendorf at the upper Pinzgau region, near by the mining areas of the Kitzbühl-Jochberg and the Viehhofen mining districts. Some grave-goods of heavy copper and bronze tools from the graveyard indicate a possible connection. The best examples are known from the mining districts at Schwaz-Brixlegg from which dendrochronological dating from charcoal pieces related to fire-setting process allow the interpretation of operation periods till the end of the 8th century BCE (Fig. 8.2, K. Nicolussi, T. Pichler in: Stöllner, Oeggl, 2015, esp. pp.242-245). The same is indicated by ^{14}C-datings from slag-sites in the Oberhalbstein (recently L. Naef in: Stöllner & Oeggl, 2015, pp.215-219). The discussion about Early Iron Age metals provides another level of evidence, as they can be securely linked to a provenance from Eastern Alpine deposits (J. Lutz, R. Schwab in: Stöllner & Oeggl, 2015, pp.113-116). Copper-production obviously

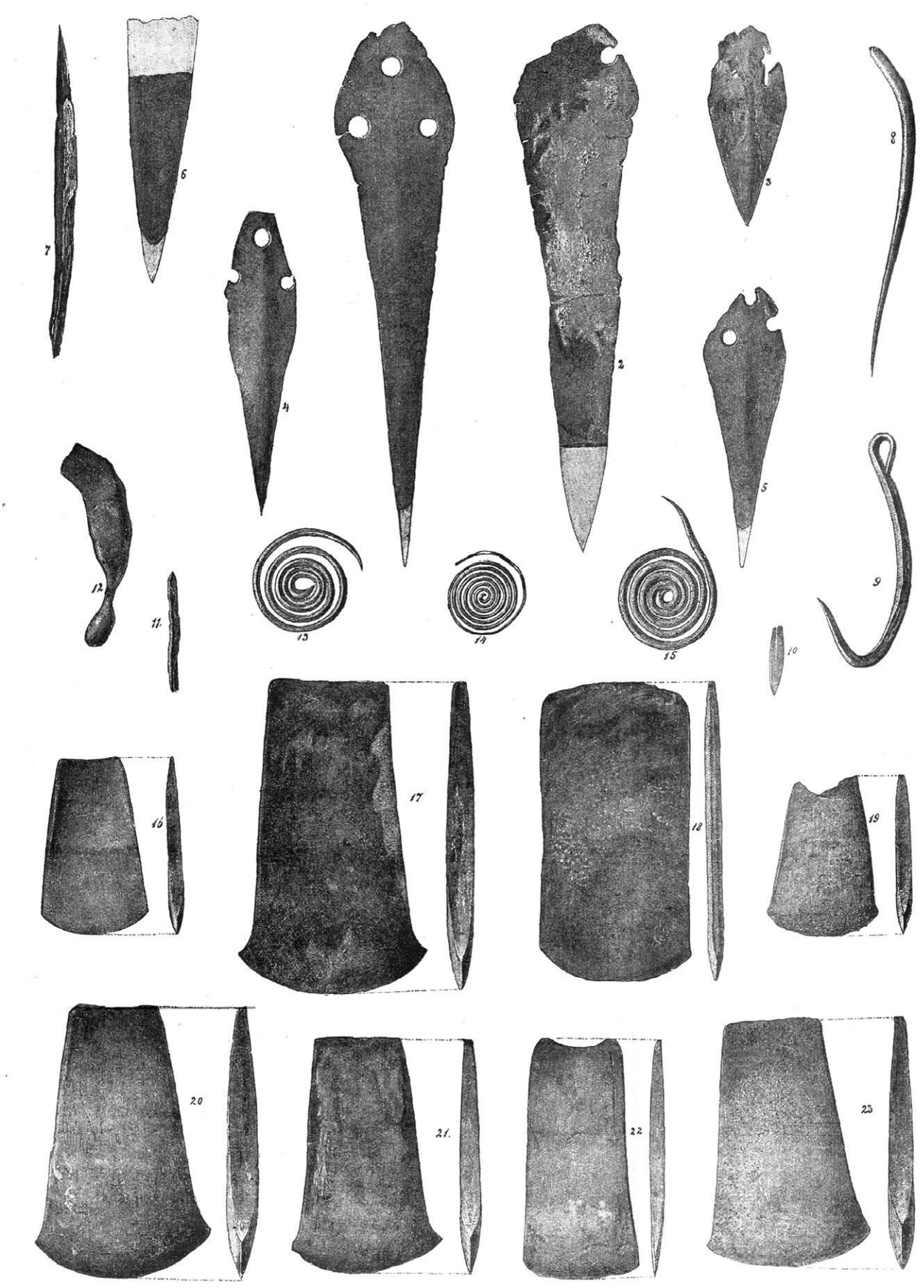


Fig. 4: Copper findings of the Mondsee and Attersee lake dwellings around the mid of the 4th mill. BCE, after Much, 1886, Stöllner & Oeggl, 2015, p.123 Fig.8.

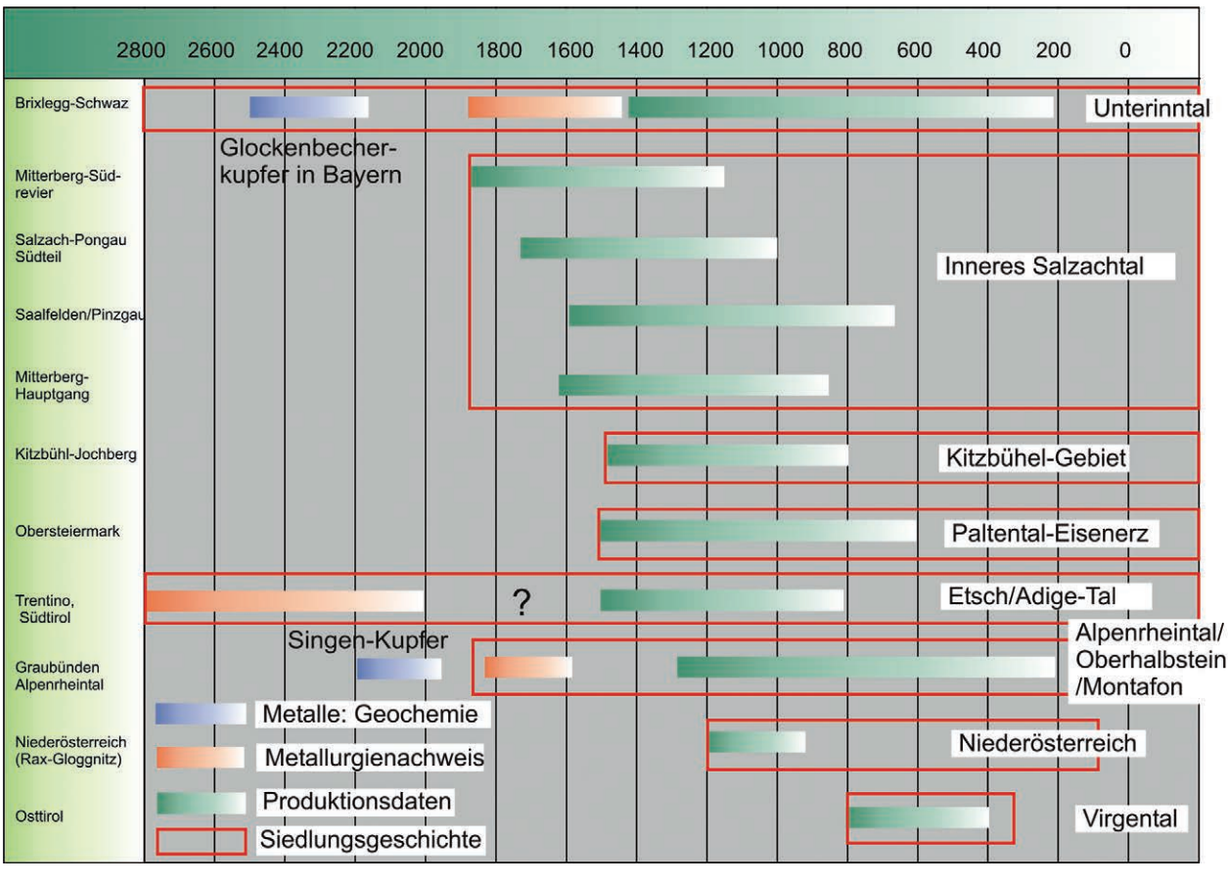


Fig. 5: The temporal development of the Eastern and Southern Alpine Copper ore districts based on chronological data from production sites, on the settlement of the copper ore districts of various valley systems and on different other indications such as the geochemical prove of the exploitation of an ore district or the prove of regional copper metallurgy, after Stöllner, 2010.

has taken a back seat step by step since the beginning of the Early Iron Age when various other activities started to take over the role as the most important economic activity, such as salt mining, the intensified high Alpine pastoralism and the stepwise increase in Alpine farming as well as cross-alpine trading and transport activities.

Comments on the economic and social structure of the copper mining districts

Various results on the Eastern Alpine copper mining districts did also reveal remarkable further insights. Those areas responsible for supply and logistics of the mining districts were situated along the main valleys and particularly on middle range terraces in favorable climatic position. This is different from the mining areas themselves where only campground and mining houses are known (e.g. Krause, 2009; Stöllner, 2011, pp.50-51). It also may seem that supply have been organized from the main-valleys to the Alpine mining hinterland, for instance in organizing the transports of already pre-worked pig meat parts (Stopp et al., 2010, pp.215-219; Goldenberg et al., 2012, pp.102-104). It should be further investigated if there was a connection with Hallstatt and its pork-meat production (Pucher et al., 2013). The slaughtering pattern of a Late Bronze Age copper producing site in Lower Austria indicates some connection between pig husbandry, copper and salt production (Trebsche & Pucher, 2013).

What is not clarified is the role that alpine pastoralism had in all the mining landscapes. There are features from the Kelchalm that indicate the enclosure of dairy cattle and their grazing in the surrounding of the mines. But what cannot be proven yet is a regular complementary pastoral landscape usage in the surrounding of the mines (e.g. also the recent discussion by Viehweider, 2017, pp.166-167).

To get an idea of the economic importance of copper production one simply can imagine the long lasting operation periods in various mining districts. More than 20,000 tons of black copper had been produced between the 17th and the 9th century BCE of which the largest portion was done from the 16th to the 13th century BCE (Zschocke & Preuschen, 1932; Stöllner et al., 2011, pp.115-128; Pernicka et al., 2016, pp.25-28). It would be not fallacious to assume a dominating role of the Mitterberg production especially from the 16th to the 13th century that supplied parts of Europe (see Pernicka et al., 2016).

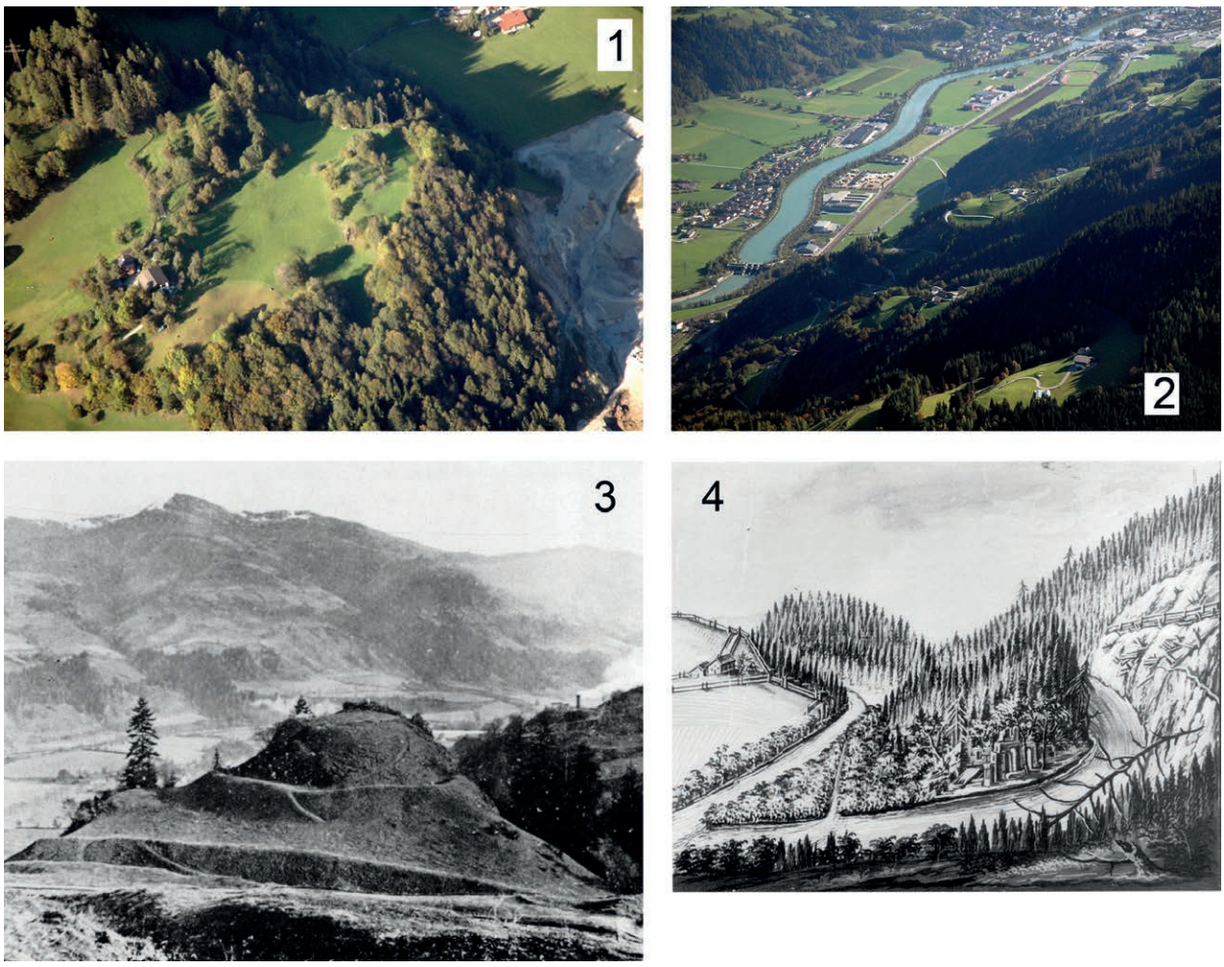


Fig. 6: Typical settlement grounds for the younger Early Bronze Age at the Salzach Valley, 1 Klinglberg near St. Veit, 2 Höchbauer-farmstead at the Einödberg, 3 Götschenberg near Bischofshofen, historical view around 1910, 4 Sinnhubschlößl at the confluent of Salzach-river and Fritzbach-torrent, historical view from North during the time of the entrepreneur Christoph Perner, 16th century AD (1-2, DBM/RUB, Th. Stöllner, 3 after G. Kyrle, 1918, 4 after E. Feldinger and F. Moosleitner, Archive Salzburg Archaeology, Salzburg Museum).

How these supplying networks were organized and how elites of the Alpine forelands were connected to these networks needs more investigation and discussion. What can be supposed is some kind of cooperation in the frame of copper and supply-goods exchange. This for instance can be seen by the already mentioned settlement of Prigglitz Gasteil in Lower Austria (Trebsche et al., 2013; P. Trebsche, in: Stöllner & Oeggl, 2015, pp.209-214; Trebsche & Pucher, 2013) that had presumably tight relations to the salt mine at Hallstatt. Salt certainly was a trade equivalency to transport pig-parts and copper to Hallstatt not only to rework the meat but also to use copper as a work-tool metal. There must have been many cooperations of that kind, which we understand step-by-step nowadays. Although the eastern Alpine mining organization seems well organized, it might have been precarious with respect to daily supply. This is apparent when looking to written sources about supply of Early Modern Times districts such as the Lower Inn Valley and Kitzbühel which always were dependent on outside food supply (e.g. Feichter-Haid, 2013). What had been gained from production had to be invested by the mining communities partly or even fully for food and other daily goods. This became certainly precarious if there was a crop failure that endangered the community and also the mining operation. One has to respect such circumstances when one looks for signs of societal welfare especially during the earlier phases of Alpine colonization and copper production: Within the mining communities a considerable accumulation of wealth cannot be observed (for instance by grave-goods or foreign objects, this already: Shennan, 1995). This might have slightly changed during the Late Bronze Age (13th and 12th century BCE) when larger graveyards such as in Northern Tyrol but also in other valleys (Kitzbühl, Salzach Valley) indicate a broader societal wellbeing. But it would be dangerous to put all the 13th to 11th century grave-equipment (Bz D to Ha A) in a sociological connection with mining operations (e.g. Sperber, 1992; 1999). Burial-customs and the dispersal of rank-indicating grave-goods (e.g. swords) are different between the North-Tyrol urnfields and the copper-districts. The accumulation of swords as grave-furniture is especially

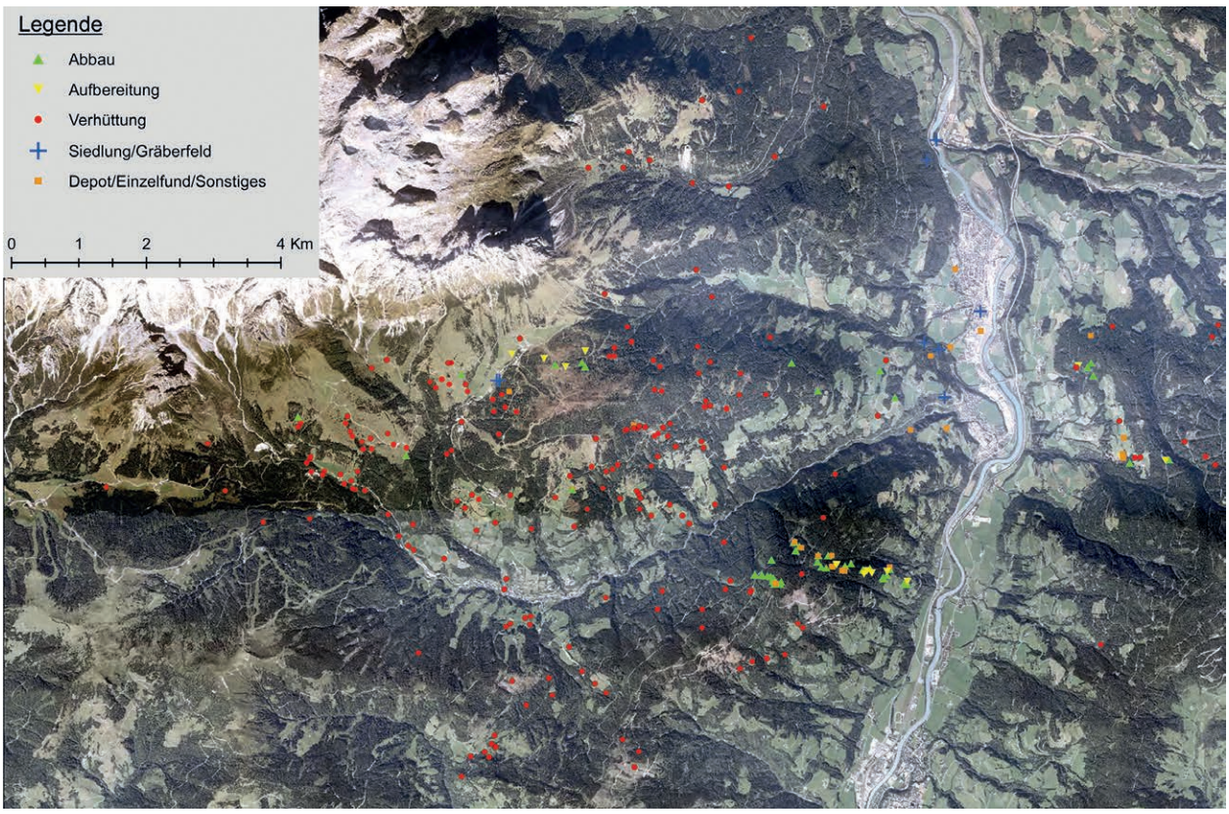


Fig. 7: Example of an alpine large district of the Bronze and Early Iron Age, general map of the archaeological sites at the Mitterberg-district on the basis of all prospections carried out between 2002 and 2016 (map/graphics: DBM/RUB, A. Hornschuch, Th. Stöllner, P. Thomas).

conspicuous and indicates a broader numbered group of sword-bearers and differently structured elite-groups. Such indicates a higher importance of lineage-based societal structure which also would mirror something very typical of a cooperatively organized society as we see in the Alps in general but specifically also in mining districts. Similar patterns had been emphasized for the social structure of the Iron Age salt mining societies of Hallstatt and Hallein (Hodson, 1990; Stöllner, 1998). There, burial customs prove a broader dispersal of wealth and social responsibilities expressed in standardized equipment within various social groups. These harnessments not only display accumulation of riches but also an ostentatious distinction of social status within these groups, sometimes with references to foreign or local identities and origin. This observation reveals a polymorphic social reality and even rivalry and concurrence between single groups.

Enmeshment – theoretical aspects

If we consider the circumstances of living within copper-producing communities, it easily turns out that all of them were confronted by similar challenges. This already was true when these communities first came to remote Alpine valleys at the beginning of the 2nd millennium BCE. Specific practices and activities were linked with provision of subsistence goods, with settling strategies and with difficult traffic conditions. But, it is obvious that experiences were shared in an alpine environment and therefore personal life-worlds were comparable in a specific way. We assume that working environments were variegated and thus produced also moments of identity within specific groups, such as miners and smelters that shared also common and complex cooperation and communication. This is an interesting and ideal arguing ground for archaeology to ask for processes of identity, since they reveal elements of enmeshment of societies with similar technical and economic practices over larger distances. Enmeshment is therefore used as a theoretical approach that follows networks of interwovenness of communities and their daily practices – from living and working to ritual and social spheres.

Understanding the complexity of these relationship and to what extent certain procedures must have been guided by tacit knowledge (Polanyi, 1958) (and hence how it is habitualized and embodied) will help us better understand the character of the contact between these communities and thus approach the social dimension of the above indicated similarities (Ingold, 2000; Von Rüden, 2016). I thus separate it from the concept of human and things entanglement theory in a way it recently was discussed by Hodder (2012; 2016)[2].

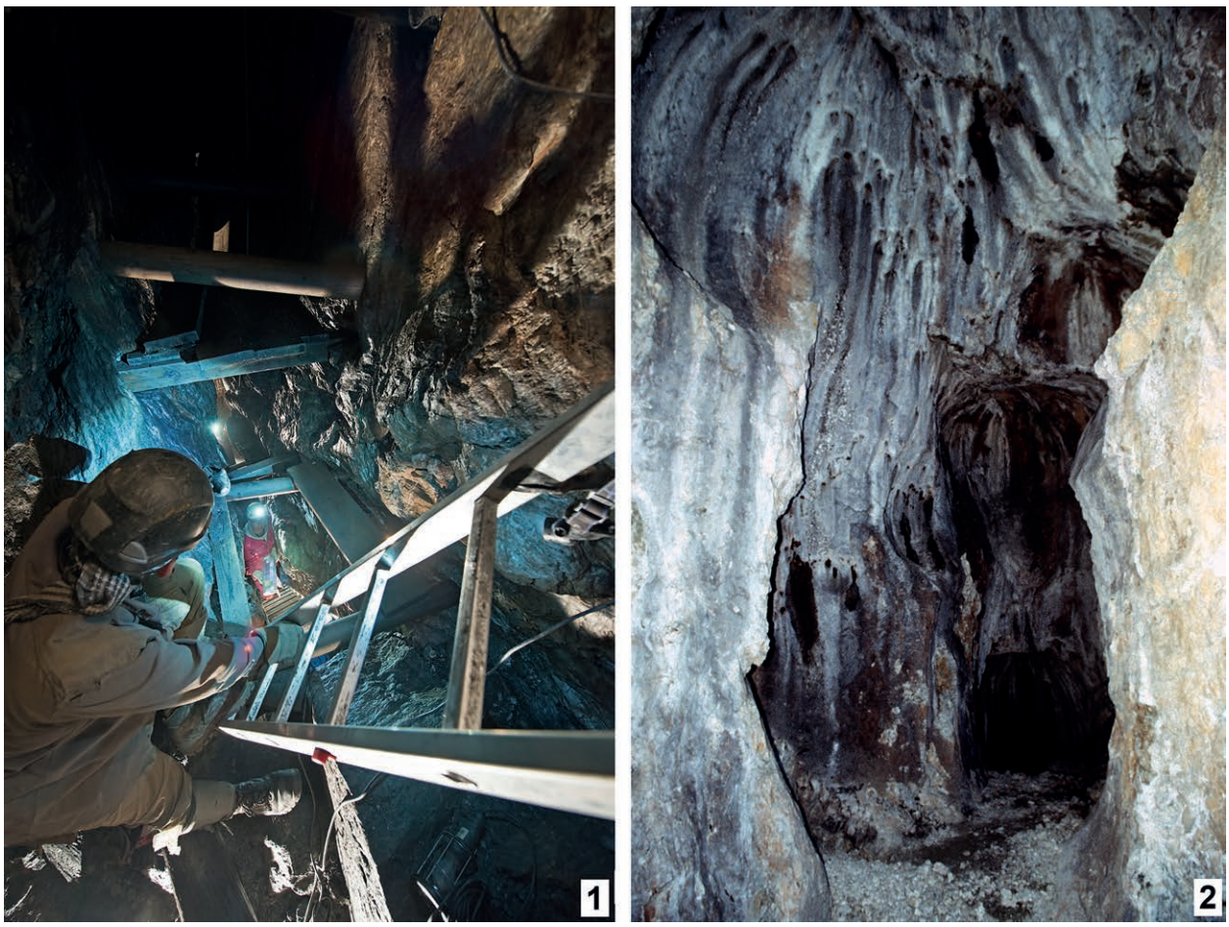


Fig. 8: Prehistoric mine at a chalcopyrite deposit of the type Mitterberg, Arthurstollen, KG Einöden, BH St. Johann (1); surface-near, fire-setted mine at a dolomite based fahlore deposit of the typ Schwaz-Brixlegg, Moosschrofen KG Radfeld, BH Kufstein, (2), (photo: DBM, Klaus Stange, AVttention, G. Weisgerber).

But one who expects that alpine regions of Bronze Age copper production would be manifested by similar material culture may be mistaken. Cultural binding is often linked with single alpine valleys between the early 2nd and the middle of the 1st millennium BCE and it is rather the traffic condition that seems responsible for relations of all kind. Inn, Salzach and Enns drain towards the east and this certainly suggests the strong connection to the Straubing culture of Southern Bavaria, Upper Austria and Salzburg (e.g. Möslein, 1997) (Fig. 3). A similar effect is true for the Upper Rhine Valley and its tributaries farther in the west, for which a tight connection to the South-Western Germany and East Switzerland Early to Middle Bronze Age can be described (e.g. Krause, 2003). Western Alpine Elements of a late Arbon culture became intermingled and also contributed farther in the east elements of an independent Alpine cultural group that were reshaped by the early Urnfield culture since the 13th and 12th century BCE. Such a dynamic is also visible further in the south in Southern Tyrol and Trentino where the Laugen-Melaun societies can be characterized as those who adopted the technics of the "Mitterberg" copper producing process (Marzatico et al., 2010; E. Silvestri et al., in: Stöllner & Oeggl, 2015, pp.225-232). It is interesting to see that Laugen-Melaun communities have produced a very specific ceramic decoration that certainly evoked feelings of affiliation, especially when regarding the Laugen-Melaun jug as a special item of domestic and public ritual practice. On the other hand, Laugen-Melaun communities opened themselves to the influences of the Riegsee-horizon during the 13th century BCE when they were in interregional exchange contacts by help of the copper they produced (in general Gleirscher, 1992)[3].

In the centuries before, these communities had an orientation frame that was focused on the southern primary settlement areas in Upper Italy, an area where many dwellers most likely came from during the late Early and the Middle Bronze Age.

We therefore have to consider three factors of endowing materialized identity. These are the small scaled regional and local life- and labour-environments (copper production, forms of agro-pastoral lives and economy), the interregional exchange processes that were important to enable food supply of alpine communities from the northern and southern alpine forelands by which the copper products were traded. And finally, there are the

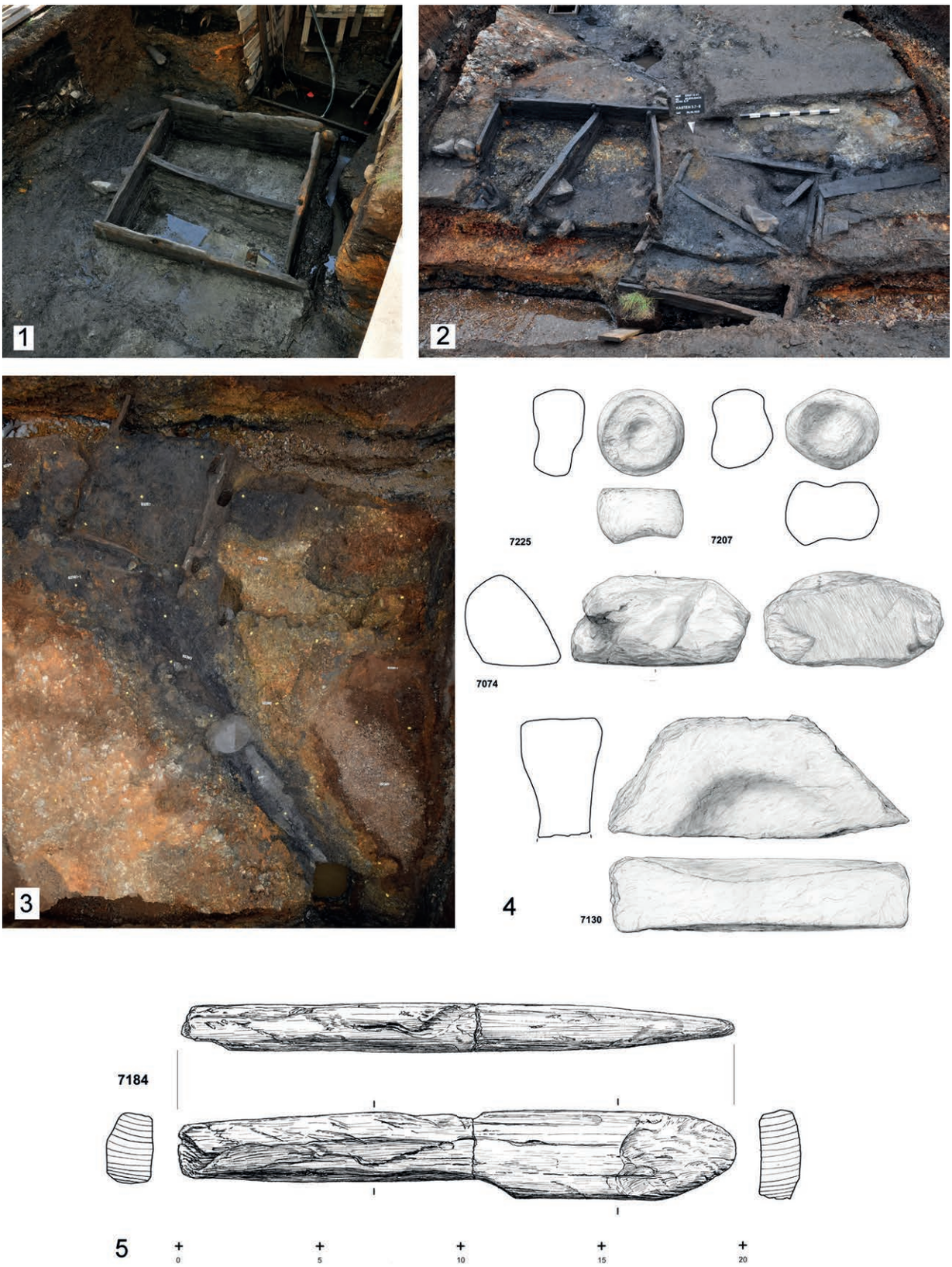


Fig. 9: Troiboden-Sulzbachmoos, excavation DBM/RUB, beneficiation boxes and tools of the Middle to Late Bronze Age at the Mitterberg, Nr 2/2009 (1), Nr 3, 7/2013 (2), Nr 8 plus channel and crushing site from 2014 (3); (4); wooden knife of box 2 (drawing/photos: DBM/RUB, A. Kuczminski, J. Schröder, T. Stöllner).

transversal relations over inner-alpine valleys and heights that led to a distribution and adoption of economic and technical processes, for instance of the copper ore mining or the copper ore smelting. It is therefore possible to consider various levels of identity alongside with further habitualized practices beyond the labour environments. Why, one can ask, is this important for our question about the copper production? Communication and cooperation between different communities were doubtlessly essential preconditions to successfully manage all the difficulties in an Alpine environment. Such cooperation was easier enabled if the relation was natural and confidential to the counterpart (by similar habits, customs, or materialized signs that can be reconstructed by archaeology easier than language).

It is likely that transalpine exchange was the moving factor of a development that helped a sustainable establishment of the copper exploitation strategies from the 14th century BCE in many alpine valleys.

This helped the technical and economic practices, which were basically first established in a successful way at the Mitterberg, to be distributed to a large area between the Grisons (Oberhalbstein) in the west, Trentino in the south and lower Austria/Viennese forest in the east (for the temporal argument: Stöllner, 2009).

That process along the eastern and the southern Alps is in fact a development of European dimension, because the rise of an important area of production was one decisive factor in the late Bronze Age's flush. Alpine copper got distributed since the middle of the 2nd millennium from southern Scandinavia, to central and southern Germany, to Bohemia and the middle Danube zone and northern part of the Carpathian basin (e.g. Krause, 2003; Lutz & Pernicka 2013; E. Pernicka & J. Lutz, in: Stöllner & Oeggl, 2015; Pernicka et al., 2016). In later periods much was also delivered to Upper Italy and part of the Mediterranean Sea (e.g. Jung et al., 2011).

Worlds of experiences between technics and landscape

In order to reconstruct "worlds" of experiences of alpine copper producers, it has to be emphasized, that there were different scapes of experiences that included economically driven exchange networks as well as the enmeshment of daily life practices. At the same moment there were different forms of knowledge transfer and the growth of knowledge to be considered for the different spheres of production, but also further related aspects of usage and consumption of the raw material copper.

The knowledge practiced in copper ore mining and exploiting ore deposits (especially in deep mining), in ore dressing and further beneficiation as well as in copper smelting, is complex. Many processes were practiced in a habitual way; it was embodied knowledge that was transferred via "silent" learning processes over generations. Such most likely included plenty of manually and serially operated work steps such as the hammer and pick-work below ground, the passing and pulling work in hauling loads, crushing and washing work in dressing the ores (Fig. 9), or even driving the bellows and controlling the heat at the smelting furnace (Fig. 10). So-called "tacit" knowledge (e.g. Polanyi, 1958) went hand in hand with externalized forms of knowledge. Ores had to be recognized and discussed with others while preparing different steps of mining and processing. Empirical aspects of touching and recognizing of mineral compositions necessarily had to be shared with others when deciding either upon different ways of further processing (crushing, washing) or dumping. The fabrication of tools for mining, hauling or beneficiation had to be coordinated and agreed upon metal- and wood working groups.

The same is true for charging the furnaces that followed rules of know-how developed over centuries, even more if different components of the charge had been carried to the smelting plant (rich ores, beneficiated concentrates, additional charges). The ways of knowledge transfer were therefore tightly related with the modes of different techniques that were practiced by specialized people and thus transferred by them. The way of transfer is easier to understand if these practices can be archaeologically and experimentally reconstructed and explained in detail according to the theoretical approaches of P. Bourdieu, M. de Certeau and T. Ingold (Bourdieu, 1977; De Certeau, 1988; Ingold, 2000). Bodily practices whose importance were already described by M. Mauss (Mauss, 1934) may have played an important role, if tools were used within the narrowness of a copper mine, or during the washing processes at the washing boxes of the wet beneficiation as well as during the smelting processes at the furnaces. Processes had to be coordinated hand in hand often without detailed explanation to reach a successful (semi) finished product (e.g. C.v. Rüden in Stöllner et al., 2016).

But there are other practical examples of those daily enmeshed practices: Besides technical practice within copper production there are also examples of specifically related daily culture practice. The usage of crushed copper slag pieces as temper for cooking had been reported as typical for the copper mining regions between the Lower Inn Valley and Salzach Valley, even in areas that were not directly located at the copper mining areas. Examples of such pots chronologically range between the late Early Bronze Age and the Late Bronze Age.

Despite a possible thermal effect of this slag temper (for instance in accumulating heat), this temper seems a peculiarity of regions in which a long-lasting "copper economy" could be established stepwise since the Early Bronze Age (e.g. Töchterle, 2015; Stöllner et al., 2016).

Further aspects can be considered for usage of similar tools within this core-region, including tools for winning, hauling as well as smelting (installations such as roasting beds and shaft-furnaces, tuyères/bellows) (Fig. 10) but also instruments for wet beneficiation of

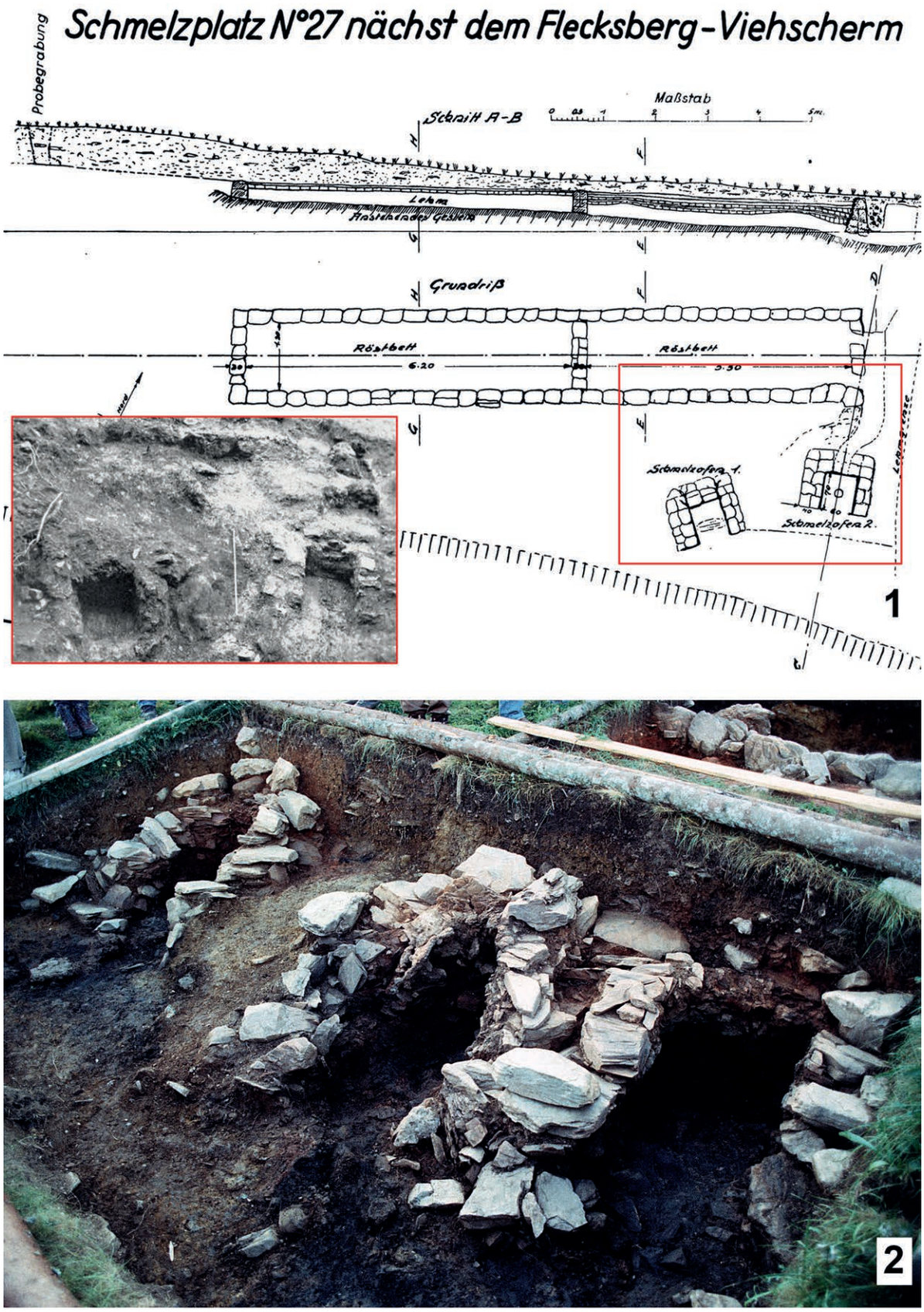


Fig. 10: Typical Eastern Alpine smelting sites from the Mitterberg; a roasting bed is situated above both shaft-furnaces built up in dry masonry while the slag was dumped down the slope beneath (after Zschocke & Preuschen, 1932, Taf. 3 und 5) (1); shaft-furnaces of the older part of the Late Bronze Age from Jochberg at the copper district "Wurzhöhe" within the Kitzbühl mining region, excavation University of Innsbruck (photo: DBM, G. Weisgerber) (2).

chatty ores (e.g. stone tools, wooden spatulas, wooden beneficiation boxes, Fig. 9).

A particularly tight relation can be observed for the districts of Kitzbühel and the older Mitterberg district, although there were smaller differences in technical solutions. One has assumed the knowledge transfer from the Mitterberg area along the river streams Salzach, Saalach and Kitzbühel stream and via mountain passages (the Dienten saddle and the pass Thurn) (discussion see e.g. Th. Koch Waldner & M. Klaunzer in: Stöllner & Oeggl, 2015, pp.165-173; Stöllner et al., 2016).

There is another important aspect to be considered. There could have been a certain amount of societal resilience and persistence especially in regard to technical and economical procedures once they were successfully established. It is astonishing that the prehistoric copper production of the Eastern and Southern Alps lasted over a very long time span, approximately between the 19th/18th century BCE and the middle of the 1st mill. BCE. These processes were not only economically successful and thus practiced over long time, they also held on to the already established technical principles, though some innovations altered them over that long time span. An older research tradition would have described such with a term like "abidance" that in some cases also included a vision to some kind of backwardness, which is simply a narrative construct (for younger periods see the commends of Bätzing, 2015, pp.85-86). But one also could make an effort in using the term "path dependency" by which C. Douglass North has described the consequences of economic paths and directions when it was successfully decided upon (with all the infrastructural and societal adoptions and investments included) (North, 2005). One therefore could argue that opening the copper exploitation around 2000 BCE also produced a certain narrowing in related innovation processes and economic developments.

At the end

All aspects discussed point to a vivid exchange within an Eastern and a Southern Alpine economic and social network. This network was regulated by the mobility of specialists and by various other types/examples of economic cooperation between different groups such as pastoralists, agrarian communities, trading specialists in the frame of good exchanges (subsistence goods versus salt versus metals). Such a development should have led to the introduction of different forms of highly specialized knowledge compounds that included some of the dwelling communities but may have excluded others at the same time. Such aspects also can be observed when looking at the distribution of symbols of an "object language" (Fig. 11) that helped a materialized communication between groups. Since the late Middle Bronze Age this interaction can be described by means of special burial rites or even some artefact groups that are especially known from these mining communities (e.g. helmets of Pass Lueg Type: Lippert, 2011; axes type Gmunden/Freudenberg: Stöllner et al., 2016, Fig. 19). Such artefact-type distributions are mirrors of those cooperation-compounds over a longer time span and provide access to regional identities that could evolve between the 14th and the 6th century BCE. But especially in the Early Iron Age we see cultural variation between the Northern Tyrol Inn Valley, the Kitzbühel region and the inner-alpine Salzach Valley on the one hand, and the Upper Austrian Salzkammergut on the other, as well the more southern Alpine areas in Southern Tyrol and the Trentino.

All these communities living in hazardous landscapes had to manage similar challenges in the frame of copper production and all the accompanying activities. This certainly influenced these communities' world-view. One could assume that they were forced to cooperate, but this is not self-evident at any case. If different communities lived in a valley system in a more precarious environment, this would also produce more concurrency and even hostility between them in order to supply one's own community and the safe-keeping of one's own existence. Thinking along such a line would have certainly supported the development of hostile activities such as combat, or at least habits of showing ostentatious prestige as a mean social distinction and practice. It might have helped to secure one's own group a better starting position in order to handle the precarious alpine life-worlds or to secure communal prosperity (for instance the practice of social signaling described for the high-lands of New-Guinea: Roscoe, 2009). Ritual practice and the involvement of numinous powers would be another. Practices of such kinds are easier to describe anthropologically than to evidence them by materialized practice. We may take the impressive guard weapons, the helmets of the Pass Lueg type (e.g. recently Lippert, 2011; hoard from the Piller Sattel: Egg & Tomedi, 2002). They certainly could be explained as part of a social signaling concept that inspired not only a feeling of perhaps "diffuse" common identity, but also were a prestigious item worn in meetings of all kinds (feastings, rituals, combats or negotiations). What kind of elite they were bound to is nonetheless not clear, in contrast to the rich graves we know from the Northern Alpine forelands (e.g. graves of the Hart a.d.Alz group). All of these were found in ritual contexts (hoards, river-findings)[4].

Materialized signs as such were certainly social signs that also played a role in a culture of remembering, such as frequently used "cult places" like the Alpine "burnt offering sites" also do (recently Steiner, 2010). This trend especially might have got stronger in the younger periods of copper production during the Later Bronze Age. If one considers the increasing frequency of findings of interregional character as well as symbols of social status (such as swords, helmets, metal-rich and heavy female costume gear), one could either argue for higher social control and surveillance or for a higher need in "social signaling" to mark territories of influence (in order to control

Fig. 11: Notched wooden sticks from the MBA-Troiboden beneficiation site (1) and the LBA beneficiation site of the Kelchalm (2) (photos: RUB, H.-J. Lauffer; DBM: M. Schicht).

exchange and the supply of goods). Perhaps the typical Laugen-Melaun jugs could be understood the same way for the late Bronze Age (see recently on the distribution: Gleirscher, 2015)[5].

Especially when considering that during the later 2nd half of the 2nd and the beginning of the 1st millennium BCE higher population rates and social complexity are generally presumed for many parts of the Alps. It is striking how different archaeological groups were developed especially during this time (such as in Hallstatt, in the Inner-Alpine Valleys or in the Tyrolean and Trentino Valleys, the Laugen-Melaun group for instance, see note 3). It seems these were the two side of the coins of the mining and economic as well as social networks related. On the one hand there was an ongoing expansion of similar economic strategies during the later Bronze Age (between the 14th and the 8th century BCE) that went hand in hand with the radiation and adoption of technical practices, while on the other hand an increasing development of regional identities in various alpine valleys can be observed at the same time.

Notes

1 The question if during the 2nd mill. herding and pastures was interrelated with mining is not clear to be answered yet; arguments already been discussed in relation to the east Alpine mining districts by Kienlin & Stöllner, 2009; for the cheese-production also: Jochem-Zimmermann, 2015; some relation to the salt-mining of Hallstatt can be discussed by high-pasture-usage during the late Bronze Age at the Dachstein plateau: Mandl, 2015; Kowarik, 2015. Milk and cheese production is evidenced at Grisons during the Hallstatt-period but yet not in the mining district of the Oberhalbstein: see Reitmaier, 2016.

2 Enmeshment of embodied practices of communities had been discussed also in the article of Stöllner et al. 2016; critics on Hodder's concept: Pollock et al., 2014.

3 Further recent literature on Laugen Melaun and its central Alpine distribution: Steiner, 2007, esp. 208-222; Marzatico, 2012, 177-204; Gleirscher, 2015.

4 Spatial concepts recently were discussed in a convincing investigation on the Alpine Rhine Valley by Ballmer, 2015, pp.71-89.

5 It had long be noted if the long-lasting ceramic traditions would not present also identity processes (such as the Raetian groups: already Gleirscher, 1992) that led to cultural harmonization in respect of tribal and supra-tribal identities. It certainly needs more discussion how daily practices of the sort mentioned here had contributed to such processes in the copper producing regions.

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Author

Thomas Stöllner – Research Departement and Institute, Deutsches Bergbau-Museum Bochum/Department of Archaeological Studies, University of Bochum

Correspondence and material requests should be addressed to: thomas.stoellner@bergbaumuseum.de