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FROM OBVIOUS TO AMBIGUOUS: A COMPARATIVE CASE STUDY OF CRUCIBLE FRAGMENTS FROM A BRONZE AGE SITE IN NORTHERN FINLAND

Abstract
An assemblage consisting of sixteen Bronze Age crucible fragments from the Halosentörmä site, located by the Bothnian Bay in northern Finland, is analysed here using the interpretative framework developed recently by Scandinavian scholars. At least two crucibles, both apparently applied for casting several times due to the amount of use-wear, are first identified. The examination of the interior surfaces of selected fragments with a portable XRF analyser for traces of metal confirms their use in copper-alloy metallurgy. Their find context at the site, however, hints at short-lived experiments rather than the existence of a proper bronze workshop. As such experiments might have had important social and even cosmological functions, the results underline the significance of metallurgical ceramics and their find contexts for archaeological interpretation both in Finland and elsewhere in northern Fennoscandia.

Keywords: Bronze Age, crucibles, metallurgical ceramics, ceramic analysis, contextualization

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INTRODUCTION

The Bronze Age, and Bronze Age metallurgy in particular, has not been in vogue among Finnish archaeologists recently. Much of what has been written on the subject over the past two decades has been authored by Professor Mika Lavento of the University of Helsinki. In his copious writings (e.g. Lavento 2001; 2005; 2009; 2012; 2015; 2018; 2019), he has considered, for example, the appropriate names to be used for this period in Finland. The term Bronze Age has usually been reserved for referring to agricultural societies settling the coastal zone, while the term Early Metal Age has been coined to indicate contemporaneous hunter-gatherer societies that inhabited the inland. Based not only on their presumed subsistence economy but also on archaeological evidence comprising differences in burial customs, dwelling sites, and artefact forms, they have also been used as synonyms to indicate two cultural spheres (e.g. Lavento 2005) that can alternatively be defined as the Scandinavian Bronze culture and the Arctic Bronze culture (see Tallgren 1937), for the latter of which the Volga-Kama area in Russia was an epicentre.

The topic of metallurgy has been approached in Finland mostly through stray finds. These include bronze artefacts, mainly various types of bronze axes (Lavento 2001:120–4; 2019), and soapstone casting moulds (Lavento 2001:124–6). By creating spatio-temporal typologies for this evidence and by pairing it with contemporary pottery, several “cultural subareas” have been distinguished (Lavento 2005: 763–6). Yet there is also evidence on the active manipulation of copper alloys, supposedly based on the recasting of imported objects by local societies (Lavento 2015: 134; 2019: 42), in the form of metallurgical ceramics (see Martinón-Torres & Rehren 2014), but this material has remained virtually untouched (but see Lepokorpi 1987). From this point of view, Finnish scholars have aligned themselves firmly with their Russian colleagues, for whom the systematization of metal artefacts and pottery into spatially and chronologically defined cultures has always been of great interest (e.g. Chernykh & Kuzminykh 1989; Chernykh 1992).

The contrast with the Scandinavian scholarship of the two last decades is particularly stark, as Swedish and Norwegian scholars have not only described and analysed finds related to Bronze Age metallurgy but also formulated interesting theoretically informed approaches to this material. Among the results are a corpus of metallurgy-related bronze finds in Scandinavia (Jantzen 2008), a systematic study and interpretation of the sites yielding this kind of material in Sweden (Sörman 2018), a couple of master's theses approaching the theme from the viewpoint of experimental and experiential archaeology (Nilsson 2008; Eklöv Petterson 2011), and a holistic study in which the Bronze Age world view is examined and interpreted through the Bronze Age metal finds of Norway (Engedal 2010a).

At least three explanatory factors can be offered for this discrepancy. Firstly, most of the finds considered as evidence on Bronze Age metallurgy – bronze axes and soapstone casting moulds – come from the sphere of the Arctic Bronze Age, which has traditionally interested Finnish scholars much less than its Scandinavian counterpart. Secondly, the area with the highest density of metallurgy-related finds is north-eastern Finland, a region that became dry land and was settled by hunter-gatherer groups relatively early after the Scandinavian Ice Sheet had retreated towards the north-west. Due to their advantageous location, some of these sites were settled throughout prehistory. As they were excavated mainly in the 1950s and 1960s, when the research methods used did not yet pay sufficient attention to site stratigraphy, refining their chronology through the resulting documentation is usually difficult, if not altogether impossible. Thirdly, unlike bronze artefacts or soapstone casting moulds, the category of metallurgical ceramics is more ambiguous: fragments of clay casting moulds, crucibles, and tuyéres are not only difficult to identify but often also hard to distinguish from one another. Thus, ceramic fragments showing exposure to elevated temperatures have quite straightforwardly been classified as crucible fragments, while under closer scrutiny they display considerable variation both in raw material and shape.

This paper presents a case study in which the Scandinavian frame of reference is adapted to the examination and interpretation of Bronze

Figure 1. Location of Halosentörmä and other sites mentioned in the text. (Base map: Google Maps/Snazzy Maps [Creative Commons CC0 1.0 Universal Public Domain Dedication].)
1. Halosentörmä & Hangaskangas E
2. Kalmosärkkä
3. Kiikarusniemi
4. Oleneostrovsky
5. Tomitsa
6. Ust Rybizhna 2
7. Viirikallio

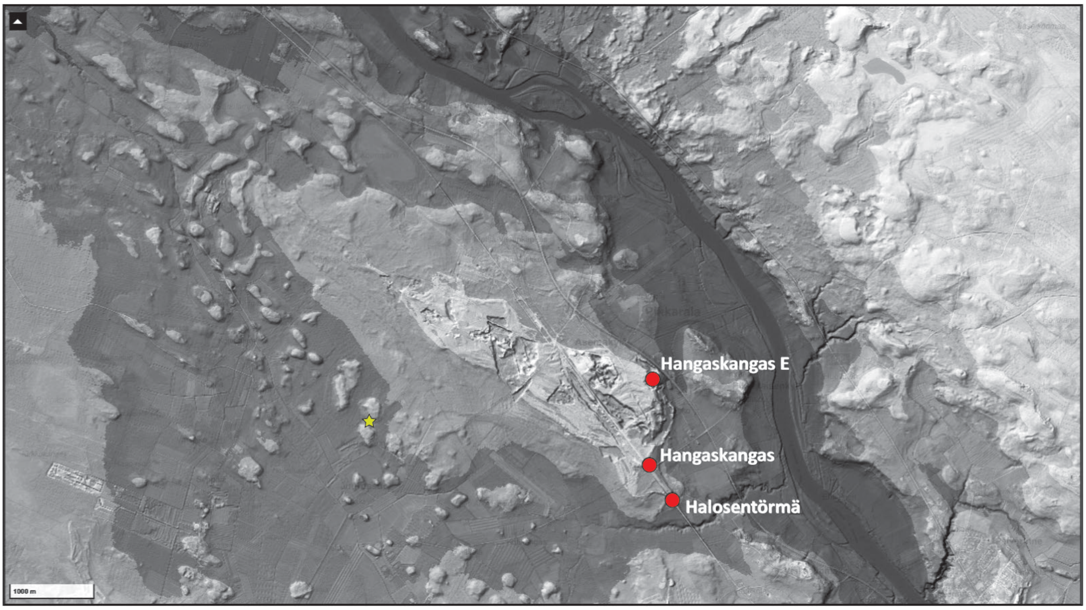

Figure 2. The topography of the Hangaskangas area with the main archaeological sites. A star indicates the spot from which a clay sample was extracted. (Elevation data: National Land Survey of Finland [Creative Commons Attribution 4.0 International License].)

Age crucible fragments found in Finland. It is shown that despite their mundane appearance, these finds form an important group of archaeological source material. They constitute evidence of not only metallurgical practices but also short- and long-distance contacts through which raw materials, artefacts, information, and even (cosmological) ideas might have been transmitted. For this reason, their relevance is not limited to the local context but has wider significance regarding the study and interpretation of early metallurgy in northern Fennoscandia.

From this starting point, the rest of the article is structured as follows: first, the Muhos Halosentörmä site and its crucible assemblage are introduced, and then the assemblage is examined using a combination of both conventional ceramic analysis and X-ray fluorescence spectrometry. After this, these finds are contextualized both regarding their spatial distribution at the site as well as their relations to other find groups of interpretative relevance. To provide a wider context for these finds, a selection of comparanda from both Finland and north-western Russia is introduced, and then the results are interpreted by reviewing them in the light of the current interpretative framework put forward by various Scandinavian archaeologists. In conclusion, further attention is called to this topic due to the underexploited information potential of metallurgical ceramics and their find contexts.

THE MUHOS HALOSENTÖRMÄ SITE

The Muhos Halosentörmä site (known in some publications as Hangaskangas or Halonen, Finnish Heritage Agency site #494010040) is located by the south-eastern tip of an extensive sand esker known as Hangaskangas some twenty kilometres south-east of the city of Oulu in the province of Northern Ostrobothnia (Figs. 1–2). Due to its advantageous topography in the past as a large island by the estuary of the Oulujoki River, the Hangaskangas area hosts a string of chronologically consecutive archaeological sites. These start from the late Neolithic, around the end of the 3rd millennium BC, and continue at the very least to the Middle/Late Bronze Age, ca. 1000–800 BC. Two of these sites, Halosentörmä and Hangaskangas E (FHA site #1000006785), have yielded evidence of Bronze Age metallurgy in the form of metallurgical ceramics that have been tentatively identified as crucible fragments. Their presence distinguishes them from the

Figure 3. A general view of the Halosentörmä site in the beginning of the 2012 excavation campaign. (Photo: Janne Ikäheimo.)

majority of contemporary sites, which lack this type of material (see e.g. Lavento 2015: 201).

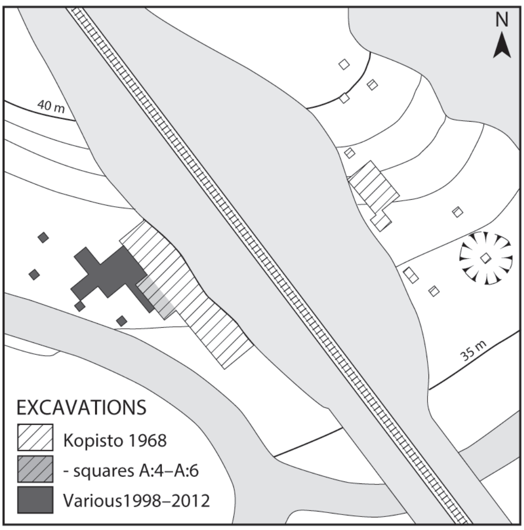

Figure 4. A map of the Halosentörmä site with the locations of excavation areas. (Map: Janne Ikäheimo.)

The Halosentörmä site was discovered in 1926 during the construction of the Oulu–Kontiomäki railroad (Fig. 3), which might have seriously damaged it – archaeological finds have been made from both sides of the railroad cut. For a long time, it was known as one the few Bronze Age dwelling sites – if not the only one – in Finland located on the coast of the Bothnian Bay. Paradoxically, despite its location on the coast, scholars have traditionally attributed it to the inland bronze culture (Huurre 1983: 272), which is an often-used synonym for the Arctic Bronze Age (Tallgren 1937).

The first archaeological excavations at the site took place in 1968 when altogether 140 m^2 were dug in eight days (Fig. 4); the later campaigns of 1998–9, 2002, and 2012 have increased the total area to 187 m^2 (Ikäheimo 1999; 2001; 2003; 2015). While careful field documentation has been identified as a viable way to gain knowledge about the non-material aspects of ancient metallurgy (Budd & Taylor 1995: 141; Melheim et al. 2016: 43; Sörman 2018: 54), the specific find context of most crucible fragments at Halosentörmä is unknown, as they were excavated already in 1968. No excavation report of this campaign was ever prepared, and its field documentation lacks all the other common types of maps save the elevation maps giving the relative elevation of 2-x-2-metre excavation squares. Thus, first-hand information is limited to a few photographs, seven pages of excavation diary in a small notebook kept by Mr Aarne Kopisto, the director of the excavations, and the find catalogue.

On the other hand, the wider context of these crucible fragments is arguably more important than their immediate context at the site for several reasons. Firstly, unlike most crucible fragments in northern Finland that have been found at multi-period sites from the eastern province of Kainuu, these finds pertain to a site that was in use for a relatively short time. As the site is located in an area where post-glacial isostatic rebound results in active land uplift, the seashore moved continuously towards the north-west and so did the people exploiting marine resources (e.g. Hakonen 2017). The land uplift rate provides a proxy for dating the site to the 2nd millennium BC, and this is further corroborated by radiocarbon dates from a piece of chewing resin (Hela-154 3420+105 BP; 2σ 2017–1465 cal AD [OxCal 4.3]) and charred bone (GrA-63888 3000+35 BP; 2σ 1384–1120 cal AD [OxCal 4.3]) from the site. Likewise, the archaeological finds from the site form a chronologically concise entity without a significant residual or intrusive component.

CRUCIBLE ASSEMBLAGE

Description

Of the 16 crucible fragments recovered at the excavations of the Muhos Halosentörmä site (Fig. 5), altogether 12 were found already in 1968 (KM17646: 147, 169, 178). The crucible fragments are quite small in size and weigh only 35.3 grams altogether; that is less than a quarter of the weight of an average Bronze Age crucible of the Scandinavian type (see Melheim et al. 2016: 57). As only two of the fragments can be joined to each other, the resulting assemblage consists of six rim and eight wall fragments. Besides the rim profile, which is rounded and slightly thinned (Fig. 6), and a rough diameter estimate of 5–11 cm, much more cannot be learned about the vessel form, size, or capacity by studying the finds themselves. Usually, Bronze Age crucibles were relatively small open vessels (see e.g. Jantzen 2008: 180–205) that were easily manoeuvrable when liquefied metal was to be cast. Even the number of crucibles to which these fragments pertain is somewhat unclear. Still, in the majority of cases, their identification as fragments of crucibles is not under discussion.

Firstly, these fragments are the only sand-tempered ones among the circa 6 kg of ceramics found at the site. The temper in the pottery vessels – which can, by their typological attributes, be classified as Lovozero Ware (see Carpelan 2004) and textile ceramics (see Lavento 2001) – consists of asbestos, talc, hair, and plant materials, present either alone or in various combinations. At least two crucibles can be identified based on the properties of the sand temper (Fig. 6), although their characterization is hampered by the rather extensive sintering of many fragments (see also Eklöv Pettersson 2013: 5). A single, heavily fused rim sherd (Fig. 5a) displays medium-sized but dense sand temper consisting predominantly of subrounded quartz grains (c. 0.3–0.5 mm). The temper in other fragments is less well-sorted sand characterized by large subangular grains of quartz and other minerals (0.7–1 mm). These results based on macroscopic examination are corroborated by previous Swedish studies making use of thin-section analysis (e.g. Hulthén 1991; Eklöv Petterson 2011). The presence and abundance of the sand temper, which can be approximated as 30–50% and has quartz as its main component, are quite typical features for metallurgical ceramics (e.g. Martinón-Torres & Rehren 2014: 123).

Another feature that makes the crucible assemblage stand out among the ceramic finds of Halosentörmä is the type and amount of use-alteration visible in some fragments. From this perspective, the rim fragments show the most severe signs of use-alteration in the form of heavily reduced and vitrified surfaces (GLEY 1 4–4.5/N [Munsell Color 2000]) with fracture surfaces showing vesicles and smaller air pockets caused by the melting of the ceramic body. Yet the most damaged find (KM17646:178, Fig. 5b) has been fused beyond recognition, and its

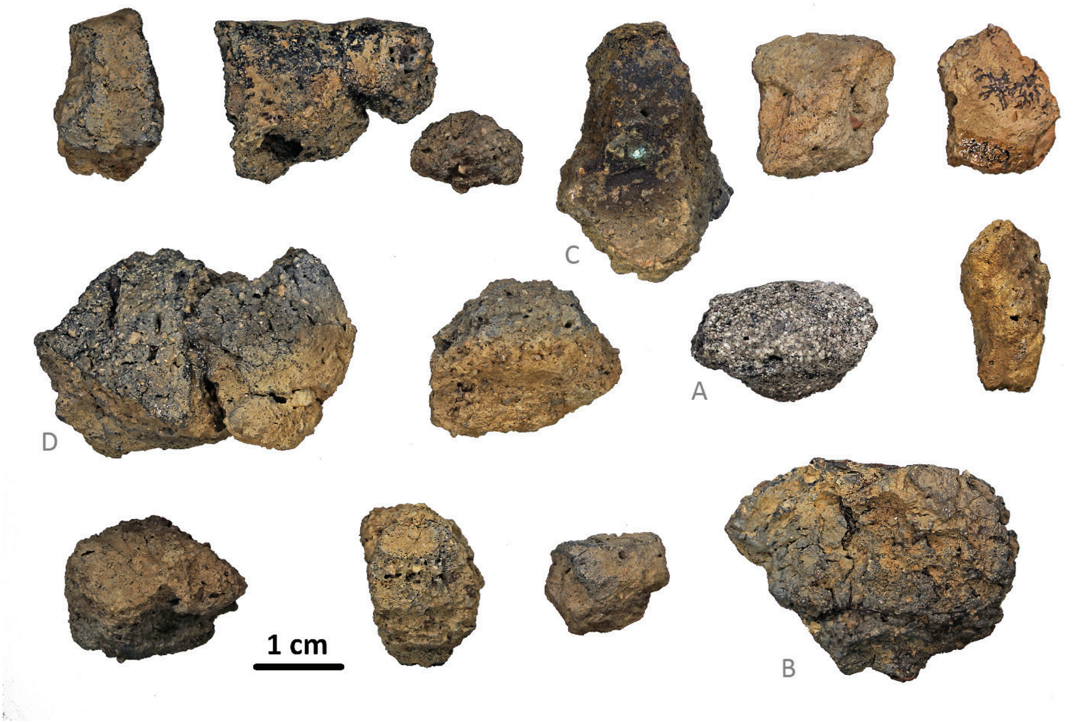

Figure 5. The crucible fragments from the Halosentörmä site. Fragments indicated with letters (a-d) are discussed in the text. (Photo: Janne Ikäheimo.)

identification as a crucible fragment can also be questioned. Still, the majority of rim fragments display just slight traces of exposure to elevated temperatures on the rim and upper exterior. Most body fragments, on the other hand, are hardly more than slightly reduced (10YR 5–6/4 [Munsell Color 2000]), and the assemblage includes a specimen that by colour alone (2.5YR 6/8 [Munsell Color 2000]) would easily pass for ordinary pottery fired in an oxidizing atmosphere.

A layer of reddish-pinkish deposition (2.5YR 5/6–8 [Munsell Color 2000]) can be seen on the interior surface of some sherds. Both empirical and experimental analyses have shown that it results from the deposition of copper oxide (Eklöv Petterson 2011: 25; s.a.: 4). The strength of this deposition and the intensity of its colour correlate with the number of use cycles of the crucible. Besides, there is a small fleck of greenish substance (Fig. 5c), approximately 2 x 1 mm in size, on the interior surface of one rim sherd. It has been identified as a drop of copper-based metal, and due to this particular find, the Halosentörmä site is often included in academic discussions focusing on the earliest occurrences of metallurgy in northern Finland.

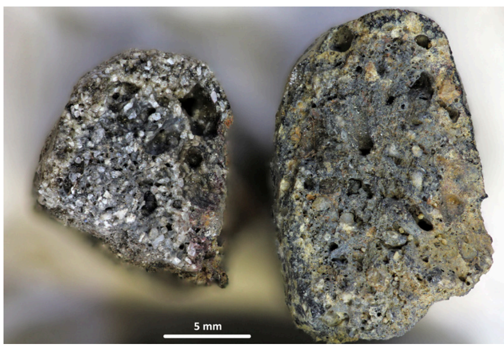

Figure 6. Differences in sand temper distinguish the two crucibles from one another: one with medium, abundant sub-rounded quartz grains (left) and another with large sub-angular grains of quartz and other minerals (right). (Photo: Janne Ikäheimo.)

Figure 7. XRF spectra of selected finds from the Halosentörmä site (exterior surface: blue/dark; interior surface: green/light): A. crucible fragment with a metal droplet (Fig. 5c); B. heavily fused crucible fragment with dense sand temper (Figs 5a & 6 left); C. crucible body fragment with pinkish interior (Fig. 5d); D. hand-held whetstone (Fig. 8).

Analysis

The composition of the pinkish-red copper oxide deposition, as well as the possible drop of metal, were screened with a Bruker IV-SD portable x-ray fluorescence spectrometer (pXRF). The idea was to verify the green drop as metal and to gain some information about the alloy melted in the crucible. It was clear from the beginning that these results would hardly be anything but qualitative and could not be used to infer any specifics about the composition or raw material origins of metal artefacts possibly cast at the site. In addition, the composition of the possible copper oxide deposition on the interior surface was to be compared to the composition of the respective exterior surface (see Kearns et al. 2010: 50; Eklöv Petterson s.a.: 4–5).

The first round of analyses was carried out using the manufacturer's built-in calibration routines, GeoQuant MAJ and Standard Alloys – the latter was used solely to examine the drop of metal on a rim sherd – with the time of analysis set to 60 seconds. The results were both ambiguous and underwhelming. Combined with poor analytical geometry, the porosity of the finds resulted in low analytical totals, which were mainly around 30–40% (see also Kearns et al. 2010: 50). Analytical totals approaching normal values were reached only in measurements taken from the fused exterior surface of the rim fragment containing dense quartz sand temper. Therefore, an alternative strategy based on the comparison of respective x-ray fluorescence spectra was adopted to obtain data on the research questions.

These spectra were gathered with Bruker's PXRF software (S1PXRF) with the time of analysis fixed to 60 seconds and with two different tube settings. The rim fragment with the presumed metal droplet was screened with the x-ray tube set to 40kV and 17µA and with a titanium-aluminium filter (25µm/300µm) applied on the resulting spectra. The settings for the other two crucible fragments were 15kV and 55µA with no filter. The rationale for limiting the voltage up to 15kV during the latter analyses was to enhance the detectability of lighter elements of interest like calcium and phosphorus, while the full analytical capacity of the instrument was explored in the case of the droplet to detect the possible presence of transition and heavy metals. The results are presented in three graphs juxtaposing the two measurements taken from each crucible fragment (Fig. 7a–c).

The interior of the crucible sherd with the metal droplet shows elevated values of copper, tin, and arsenic (Fig. 7a), as well as slightly elevated calcium when compared to the spectrum obtained from its exterior. Thus, the droplet can be identified as arsenical bronze, and a rough estimate for its composition – Cu 88.75%; Sn 9.35%; As 1.90% – can be calculated by using the intensity of the respective Kα peaks in the spectrum. Despite aligning quite well with previous compositional analyses of Bronze Age bronze artefacts in Fennoscandia, this result is highly tentative, as one cannot estimate whether the droplet was formed in a single casting or in multiple casting(s) that may each have involved compositionally different melts of copper-based metal. Differences in the enrichment of common metallic elements in copper alloys on the surface of a crucible or a mould and other factors (see Kearns et al. 2010: 55–6) may also have influenced the result.

Of the other two crucible sherds examined with the pXRF, the heavily fused rim sherd with medium-sized dense sand temper also displayed traces of copper on the interior (Fig. 7b), while the peak for calcium is identical on both fragment sides and phosphorus was not detected at all. On the other hand, the analysis of a body sherd fragment showing the clearest example of pinkish-red deposition on the interior did not yield elevated values of any of the three elements of interest (Ca, Cu, and P, Fig. 7c), the presence of which could have been expected in the light of the results published by Eklöv Petterson et al. (2016: 6–7; see also Eklöv Pettersson s.a.). Several explanations have been put forward for the elevated calcium (and phosphorus values) detected on the crucible interior. The melt might have been stirred with a(n animal) bone to prevent oxidization and to remove slag (Eklöv Pettersson & Lönnberg 2016: 4) before the molten metal was poured into a casting mould. Alternatively, the interior of some crucibles might have been treated intentionally with a calciferous solution to produce a face coating with improved non-stick properties (Hjärthner-Holdar 2011: 125–6). Finally, bone ash might have been mixed into the clay paste to improve the refractory properties of the crucible (Jantzen 2008: 193).

One explanation for these somewhat modest results can be found in the differential preservation of various crucible fragments. As the rim is the part of the crucible exposed to the highest temperatures, it is quite often fused and therefore more likely to be preserved than respective body and base fragments (see also Stilborg 2002: 146). Through casting experiments, Engedal (2010a: 151) has also observed that if the vertical distance between the level of the molten metal and the rim is 10 mm or less, the crucible is very prone to spillage. Thus, as crucibles were hardly filled up to the brim, traces of metal are less likely to be detected on rim sherds than on other crucible fragments that are less likely to be preserved in the sub-Arctic environment due to annually repeated freeze-thaw cycles (see Ikäheimo & Panttila 2002).

The durability of crucibles has been studied by comparing the use-wear on crucible replicas used in casting experiments to archaeological crucibles and their fragments (Eklöv Petterson 2011). As the results are reflected on the crucible assemblage of Halosentörmä, several observations can be made. Firstly, the rim fragments in the assemblage show greater exposure to heat than the fragments from the lower body of the crucible. This indicates that additional oxygen was directed from the bellows to glowing charcoal covering the crucible from above using, for example, an L-shaped ceramic tuyère (Engedal 2010a: 144, 149; Eklöv Petterson 2011: 22; Botwid & Eklöv Pettersson 2016: 24–7). Because they were exposed to the highest temperatures, the rim and the upper wall show the most advanced signs of use-wear (Jantzen 2008: 194–6; Melheim et al. 2016: 55).

In fragments with larger subangular sand temper (Fig. 6), the rim and upper exterior are slightly glassy, while the only body fragment on which the vessel interior is preserved shows traces of a pinkish tinge. Both features have been experimentally shown to appear after approximately five use cycles (Eklöv Pettersson 2011: 35, 41; 2013: 41). The cross-sections of these crucible fragments display a somewhat fused fabric with a few smallish but well-developed vesicles. A crucible published by Eklöv Petterson (2011: 38 fig. 31), which he estimates to have been used for 10–20 times, is quite similar in appearance and thus comparable to this material. Using these indicators, 5–10 use cycles can be put forward as a conservative estimate for the main body of the crucible fragments discovered at the Halosentörmä site.

The other crucible from Halosentörmä, tempered with fine and relatively well-sorted quartz sand (Fig. 6), shows more extensive use-wear, although the judgement is based only on a small rim fragment. Fused and vitrified surfaces with a cross-section characterized by large vesicles indicate repeated exposure to high temperatures. Moreover, there is a good reason to assume that this crucible was repaired at least once. Several scholars (Hulthén 1991: 24; Jantzen 2008: 200–2; Eklöv Pettersson 2011: 26; Eklöv Pettersson et al. 2016: 4; Melheim et al. 2016: 55) have reported the presence of a clay layer added to the interior of a crucible to seal the cracks resulting from intensive heat and to extend its use life. While such layers may number as many as four, the crucible in question has been repaired only once, as its cross-section shows a deep red oxidized surface beneath a reddish-brown layer (Fig. 6). It is possible that such crucible was used at least 20 times (Eklöv Pettersson 2011: 29, 35), but 10–20 times is used here as a more conservative estimate.

The use of at least two clay pastes or fabrics also merits a comment. As the Halosentörmä site is located in a region that is still undergoing post-glacial land uplift at a rate of ca. 0.7 metres per century (see Hakonen 2017), well-sorted quartz sands that would have been deposited on a beach through continuous wave action are nowhere near to be found. Instead, local beach sands connected with the Litorina Phase of the Baltic Basin tend to be less well-sorted and to contain various other minerals. In the area of Hangaskangas, these deposits are partially covered by aeolian sands, which could have been used for the making of the crucible with quartz sand temper. The bimodal size distribution of quartz grains, which is usually interpreted to signify added temper (e.g. Rye 1981: 52; Velde & Druc 1999: 149–50), has previously been observed in thin sections prepared from organic-tempered pottery found at Halosentörmä (Ikäheimo & Panttila 2002: 9). This could also be the case with the sole crucible fragment displaying fairly well sorted and medium quartz sand.

In a 1:20,000 soil map compiled by the Geological Survey of Finland, the closest accessible deposits of clay that have formed a potential resource already during the Bronze Age are located just 3 kilometres north-west of the site. Both of these sites were visited, and clay samples were extracted from a depth of 40 cm. A subsample from the more prominent-looking deposit at the ETRS-TM35FIN-coordinates 7198003 N, 439101E (Fig. 2) was screened for its coarser fraction. It roughly matches the temper characterizing most of the crucible fragments from Halosentörmä: less well-sorted sand composed mainly of sub-angular grains of quartz up to 1 mm in size but containing also smaller grains of darker minerals.

Thus, it seems that some crucibles may have been manufactured locally, while others could also have been imported to the site. In any case, one thing that was most likely imported was the know-how regarding the use of crucibles and associated artefacts like moulds, tuyères, and bellows. However, one must also take into account the possibility that the crucibles arrived at the site from elsewhere but were never put into use in their new location. This viewpoint raises the question of whether there is any other type of evidence corroborating the practice of metallurgy at the Halosentörmä site, and to establish a wider context for these finds, it is also useful to examine the evidence that has been found in adjacent regions and areas.

CONTEXTUALIZATION

Site

Not much is known about the immediate physical context of most of the crucible finds made at Halosentörmä. While the 1968 find catalogue assigns them to excavation squares I:K–M, these squares are absent from the maps sketched in Kopisto's (1968) notebook. However, archaeologist Aimo Kehusmaa has added a note to Kopisto's field diary (Kopisto 1968) pointing out that they should be the same as the squares marked in the notebook with codes A:4–6 (Fig. 4). While square I:L most likely corresponds with square A:5, it is not possible to ascertain whether square A:4 is I:K and square A:6 is I:M or vice versa. Still, judging from the distribution of other finds, these crucible fragments are most likely to come from squares A:4 and A:5. The only additional information concerning the context is that in these squares, the cultural layer was about 35–40 centimetres thick. This is an interesting anomaly because in the follow-up excavations, the thickness of the cultural layer has rarely exceeded 15 centimetres.

It is possible that for A. Kopisto a 'cultural layer' comprised all the altered mineral soil in the podzol profile from the first finds encountered underneath the topsoil in an eluvial layer down to the bottom of the illuvial layer, which is visually discernible from the underlying 'sterile' soil (parent material) due to enrichment of iron and aluminium. Judging by excavation reports from the 1960s (e.g. Björkman 1961), this interpretation seems to have been quite common at the time. Alternatively, one can advance a hypothesis about the existence of a shallow negative feature in the stratigraphy within these squares. While such a feature might be linked to bronze casting, it should be pointed out that the crucible fragments were readily identified as such by A. Kopisto during the excavations (Kopisto 1968). Thus, the excavation crew would have likely paid special attention to any soil anomalies in their vicinity.

I am therefore inclined to propose the former explanation, although a furnace or other similar permanent structure is not necessary for bronze metallurgy. The alternative, a small and shallow pit dug into sandy ground and reinforced with a stone or clay lining, cannot be easily discerned from an ordinary hearth (e.g. Koryakova & Epimakhov 2007: 34; Engedal 2010a: 152–3, 159, 283; Eklöv Petterson 2011: 21; see also Sörman 2018: 50–53, 213). In case a ceramic vessel with a suitable refractory temper like asbestos was used as a sort of a portable furnace, as proposed by Ola George (2001: 111–3), even fewer traces remain to be discovered. However, the asbestos content of such vessels is normally around 90%, and this so-called Asbestos Ware is dated from the Late Bronze Age to the Early Iron Age (Hulthén 1991: 32–5). Neither do the asbestos-tempered vessels recovered from the Halosentörmä show any indication of being exposed to extremely high temperatures.

The other finds from excavation squares A4–6 are typical for a Bronze Age site, consisting mainly of quartz debitage, quartz and quartzite tools (mainly scrapers), and potsherds. Regarding quartz debitage, the squares in question rank among the top four with most finds by weight, while the majority of potsherds come from a single talc-tempered vessel that belongs typologically to the so-called Textile Pottery (see e.g. Lavento 2001). In addition to crucible fragments, the excavation of these squares also yielded somewhat more exotic but less numerous finds: both chewing resin finds of the 1968 campaign, two fragmentary bifacial points, and some twenty smallish sandstone slab fragments that likely belong to whetstones. While the talc-tempered ceramic vessel and whetstone fragments might be related to metallurgical activities, the overall impression regarding the immediate context of the crucible finds is that they belong to the part of the site that had been reserved for practising various handicrafts.

Still, Halosentörmä has traditionally been regarded as a dwelling site, which is a conceptual problem, as the site lacks any undisputed signs of dwellings. The presence of a light rectangular structure that was proposed as such based on the spatial distribution of finds mapped during the excavations of the late 1990s and early 2000s (Ikäheimo 2005: 775–6) has been challenged lately due to results of the latest excavation campaign in 2012 (Ikäheimo 2015). Thus, its identification as a temporary but repeatedly used campsite can also be put forward (cf. Miettinen 1998: 111–4). As the site was located on a large

Figure 8. A fragmentary hand-held whetstone from the 1968 excavations at Halosentörmä (KM17646:180). (Photo: Janne Ikäheimo.)

island by the mouth of the Oulujoki River (Fig. 2), thus offering excellent connections both along the coast as well as into the inland, gift exchange, barter, and/or trade must have played an important role for the people frequenting this location. This is reflected both in the presence of raw materials – asbestos, flint, and talc (Ikäheimo & Panttila 2002; Costopoulos 2003) – and artefacts that must have reached the Hangaskangas area over distances exceeding hundreds of kilometres (e.g. Ikäheimo 2005: 776–7, esp. fig. 1). As these imports found their way to the site from different directions, both northern and southern Scandinavia in addition to the input from the east, the location of the site on an island could have offered a neutral meeting ground, a liminal place for individuals and groups of different backgrounds for their material and intellectual transactions (Herva & Lahelma 2020: 135–7).

While there are no other metallurgical ceramic or metal finds from the Halosentörmä site, indirect evidence indicates the presence of the latter in the past. Large stone tools such as adzes and axes are absent from the site except for a Kiukainen-type stone gouge (KM8746; Huurre 1983: 196 fig.) that led to the discovery of the site in 1926. On the other hand, small stone tools like scrapers, knives, and bifacial points were produced in the Bronze Age with traditional knapping techniques using raw materials like slate (Ikäheimo 2005: 777–8) that was previously reserved for making larger tools. The contrast to the Neolithic period is very stark as if the old shaping technique based on grinding and polishing had been abandoned quite rapidly, but for some reason, the interaction with the old and perhaps also outdated raw material was continued by applying an alternative way of transforming it into smaller utilitarian items. This is also reflected by the absence of whetstone slabs needed for the grinding of larger stone tools as well as by the presence of at least one hand-held whetstone (KM17646:180). By the looks of this object (Fig. 8), it has likely been used to sharpen metal blades, even though the XRF spectra obtained from its flat grinding surface and the lateral side are identical and lack any peaks that could result from the sharpening of copper alloy tools (Cu, Sn, Zn, and Pb, Fig. 7d).

Comparanda from near and far

The immediate surroundings of Halosentörmä are also of great interest when it comes to metallurgy, as the cremation burial site of Oulu Hangaskangas (FHA site #564010051) – the only undisputed Bronze Age burial known to date in northern Finland – which was discovered in 1997 and excavated in 1998 is located just 500 metres north-west of it (Fig. 2; see Forss & Tuovinen 2001). Grave goods from this site included a double-bladed bronze knife of eastern origin or influence and four bronze rivets – two with small triangular blades attached to them – probably representing the scraps of a Scandinavian bronze dagger (Ikäheimo 2019; see also Lundberg 2005: 315–7). This latter group represents a rare verified example of the recycling of metals during the Bronze Age (see also Engedal 2010a: 213–4), which has previously been much hypothesized (e.g. Huurre 1983: 264; Laulumaa 1997: 38). The proximity of the Oulu Hangaskangas site to Halosentörmä also supports the connection that is proposed to have existed between the pyrotechnologies of cremation and metallurgy (Melheim et al. 2016: 44).

Another nearby site of great importance is Oulu Hangaskangas E, located just a kilometre north of Halosentörmä (Fig. 2). It comprises several spatially clustered dwelling sites or campsites on several fossilized littoral sand terraces. Radiocarbon dates indicate that human activity in this area extends from the late third to the early first millennium BC. These sites were extensively excavated in 2012 (Pesonen 2013) and 2014 (Mikkola 2015), and as for their find assemblages, of particular interest are altogether seventeen ceramic fragments enlisted as pieces of crucibles from ’dwelling site 2‘ in the excavation report of the 2012 campaign. This site is located at an altitude of 30 m a.s.l., and two radiocarbon dates suggest the first two centuries of the first millennium BC as the period of its use (Pesonen 2013: 15–7).

If these talc-tempered fragments originate from crucibles, they differ considerably from the finds made at Halosentörmä. Firstly, while the best-preserved examples show a faint layer of reddish colour on the interior surface, they also seem to have a foot of some kind. This feature, in addition to the talc tempering, makes them fairly similar in appearance to the footed objects (Fig. 9) from the Kalmosärkkä site (FHA site # 777010025) in Suomussalmi (Fig. 1; Lavento 2001: 222–3). These objects have also been identified as crucibles (Huurre 1983: 265–6). While examples of footed crucibles are known, for example, from the Abashevo culture dating to the Early Bronze Age in Russia (Koryakova & Epimakhov 2007: 34 fig. 1:2), it is unclear whether the finds from Hangaskangas E or Kalmosärkkä belong to this or a similar type. Still, most of these finds show signs of exposure to considerably high temperatures, and for this reason, their classification as metallurgical ceramics is difficult to question.

Figure 9. Two artefact fragments identified as footed crucibles (KM14830:990 left & :1419 right) from the Kalmosärkkä site in Suomussalmi. (Photo: Janne Ikäheimo.)

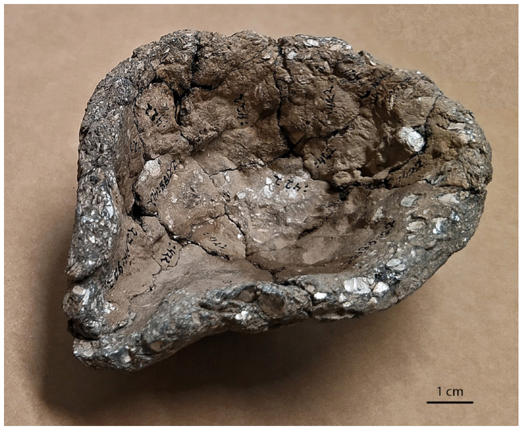

Figure 10. Abundant mica temper characterizes the exceptionally well-preserved crucible (KM22198:422) from the Kiikarusniemi site in Sotkamo. (Photo: Janne Ikäheimo.)

The same comment applies to the Viirikallio site (FHA site #399010108) in Lapua, Southern Ostrobothnia, which is located some 300 kilometres south-west of Halosentörmä and Hangaskangas E (Fig. 1). Together these three sites have yielded all the material related to Bronze Age metallurgy found in archaeological excavations on the Finnish side of the Bothnian Bay. Three finds from the 1988 campaign at Viirikallio (KM24366: 33, 97, 100) are classified as fragments of either crucibles or casting moulds (Miettinen 1994: 50). Under closer examination, this assemblage contains a single fragment of a clay casting mould (:33) and two rim fragments of an object that – judging by its shape, temper, and use-wear – is more likely a tuyére than a crucible (cf. Miettinen 1998: 101). However, a find (: 98) defined in the find catalogue as ’a fragment of burned clay‘ is in all likelihood a piece of a crucible tempered with quartz sand.

On the other hand, the well-preserved and thus almost complete crucible (Fig. 10) put together from a multitude of pieces found at the Kiikarusniemi site (FHA site #765010010) in Sotkamo (Fig. 1; Laulumaa 1997: 40–3; Lavento 2001: 221) leaves no margin for hesitation about its proper identification. In addition to its completeness, this object is remarkable for its mica temper. Mica, alongside with asbestos and talc, was frequently used as temper in crucibles that belong to the sphere of the Arctic Bronze Age (see also Eklöv Pettersson 2011: 7). Examples of crucibles with various tempers but mica are also plentiful in northern Sweden (Hulthén 1991: 24–29, in particular Table X). Crucibles have also been associated with different Bronze Age pottery types based on their temper (Huurre 1983: 266; Lavento 2001: 126; Forsberg 2012: 44; see also Spång 1997: 27, 170; Nyman 2010: 112). Crucibles tempered with quartz sand are marginally present in the north, whereas in southern Scandinavia their use – often prepared from naturally sandy clays – was almost exclusive together with examples in which quartz is present as a part of crushed rock (Sörman 2018: 45).

As there is not yet conclusive evidence on the extraction and processing of local metallic ores during this era, the local metallurgy likely relied on the melting and recasting of imported bronzes. Due to the dominance of western bronze artefact types among the Bronze Age metal finds in northern Finland, they have likely constituted an important source of raw metal (Huurre 1983: 274–5, 278, 309; see also Kuusela 2013: 134). Studies conducted by Ling (et al. 2013; 2014) and Nørgaard (et al. 2019) show that the provenance of metals circulating in southern Scandinavia within the sphere of the so-called Nordic Bronze Age culture was in Central and Southern Europe. Against this background, it would not be a surprise if crucibles, or at the very least the know-how regarding their production and/or use, were gained through contacts of a yet indeterminate type from southern Scandinavia.

However, one should not readily dismiss the importance of eastern contacts, especially when most of the pottery at the site can be classified as textile ceramics, which has a strong eastern connection. The footed crucible found at the famous Bronze Age cemetery on Oleneostrovsky Island in the Kola Peninsula (Fig. 1) has been tempered with 'asbestos or something similar' (Kolpakov et al. 2019: 330 fig.; Kolpakov 2020). Fragments of crucibles have also been found at three dwelling sites in Russian Karelia and four dwelling sites in the administrative region of Leningrad, all associated with textile ceramics (e.g. Yushkova 2011: 39; Yushkova 2015: 304). Unfortunately, the properties of these finds – shape and tempering agent being the most crucial ones – have not been discussed much in the respective publications. A site on which some relevant information is available is Ust Rybizhna 2 (Fig. 1), located in the Leningrad region and excavated in 1954, 1956, and 1958 by N. N. Gurina and in 2008 by M. A. Yushkova. Of the dozen crucible sherds found in these excavations, a photograph (Gurina 1961: 315 fig. 107) and profile drawings of eight rim sherds have been published (Yushkova 2011: 284 fig. 40; 2015: 305 fig. 24). The fabric of these crucibles does not seem to contain any deliberately added tempering agent (Gurina 1961: 482–3).

While much cannot be said about the crucibles themselves, the context of four crucible fragments found at Ust Rybizhna 2 is of particular interest here, as they were found inside a dwelling with a central hearth (Gurina 1961: 454–60; Yushkova 2015: 304). The dwelling had been dug partly into the ground and had a floor area measuring ca. 16 m2. This returns us to the question of whether the depth of 35–40 cm observed by Kopisto for the cultural layer in excavation squares A4–6 could have resulted from a similar feature. But due to the inadequate level of documentation characterizing the 1968 excavations, the question remains unanswered. Another detail of some relevance here is that the metallurgy-related finds made at the Tomitsa site in Russian Karelia (Fig. 1) have been interpreted as the remains of a bronze casting workshop due to the presence of several hearths with crucible and metal fragments, and so on. (Yushkova 2011: 39.) This indicates that more intensive forms of metallurgy were practised also in the sphere of textile ceramics-using groups.

INTERPRETATION

At face value, the crucible fragments from the Halosentörmä site seem to indicate that bronze metallurgy was known and also practised on the eastern shore of the Bothnian Bay at the latest by the middle of the second millennium BC. This would coincide quite well with the views of Lavento (2015: 174–5), who has dated the beginning of domestic production, which started with the so-called Maaninka axes and relied on the recycling of imported bronzes, to around 1300 BC. But why and how was metallurgy that represented an external stimulus accepted by local societies (see also Forsberg 2012: 46), and what kind of social function did it have? These are questions that can be answered differently depending on one's views on the importance of metallurgical knowledge and the status of bronzesmiths during the Bronze Age.

In any case, the factual starting point for the discussion regarding the crucible fragments from the Halosentörmä site is the following: there is evidence of the presence of at least two crucibles, one that has been used at least 5–10 times and another that has been used at least 10–20 times. The temper in both crucibles consists mainly of quartz sand, which, for lack of better knowledge about the temper of the Bronze Age crucibles found in Russian Karelia and the Leningrad region, suggests that they were either imported from southern Scandinavia or manufactured locally using know-how originating in the same source area. In the latter case, the choice of whether naturally sand-rich clays or deliberately added sand temper was used was not dictated by the lack of other suitable raw materials for this purpose. For example, judging by the presence of pottery tempered with talc and asbestos at the Halosentörmä site, both raw materials must have been available also as tempering agents.

A question of great importance in this context is whether the crucibles were used at Halosentörmä or whether they ended up at the site for another reason. Traditionally, crucibles and clay casting moulds, along with spillings of metal, have been interpreted as unmistakable evidence of local metallurgy (Huurre 1983: 309; Miettinen 1998: 111; Ojala 2016: 107; Sörman 2017: 66; 2018: 54), whereas bronze artefacts and soapstone casting moulds have been identified as potential items of trade or exchange. Yet no conclusive argument can be pointed out to support this kind of division. My decision to momentarily downplay the importance of this assemblage as evidence of local production is strongly influenced by contemporary views on Bronze Age metallurgy and its entanglements with themes such as contacts, elites and society, gender, ritual, magic, death, and world view.

The most essential observation in this context has been made by Ørjan Engedal (2009: 40–3; 2010a: 142, 282, 288, 353; 2010b: 150, see also Kuijpers 2013: 143, 146), to whom a crucible represents the nexus of material, sensory, and conceptual entanglements related to Bronze Age metallurgy. Joakim Goldhahn (2007: 222, 228–30), who emphasizes the strong connection between metallurgy and death rituals – particularly ones related to cremation – has previously defined the status of a smith in the Bronze Age as that of a ritual specialist: a transformer and a cosmologist (see also Budd & Taylor 1995: 139, cf. Sörman 2018: 20). Engedal (2010a) has postulated the significance of bronze in this context as follows: 'What if bronze was sun? Not metaphorically, but actually part of the sun? And what if the sun was a lady? [273] … If bronze was considered as actually part of the sun, e.g. actually bodily excretion of a sun with personhood, there would have been a female aspect to bronze. Bronze might thus have been considered fragments of a sun-goddess Sol [277].'

While these ideas are fascinating to ponder, they might also be hard to digest and difficult or even totally impossible to accept or prove. The logical consequence of this reasoning is, however, that crucible fragments might have been imbued with otherworldly powers (cf. Sörman 2018: 150) and might therefore have belonged – similarly to bronze artefacts (Bolin 1999: 13–4) – rather to the realm of magic and ritual than that of the mundane and practical. However, nothing that we know about the context of the crucible fragments at Halosentörmä points in this direction; there is no evidence suggesting their intentional and careful deposition (see Kuijpers 2013: 416).

If the driving force behind the adoption of bronze metallurgy was the need to show affiliation over shorter or greater distances with other groups, in addition to potential cultural and political gains, as proposed by Sandell (2011: 24, 27; see also Spång 1997: 33), the group receiving the crucible might not (at first) have possessed the necessary skills to put it to proper use, but might have been aware of or informed about its potential symbolic value (Eklöv Pettersson 2011: 40). To put it more explicitly, if the people making use of the Halosentörmä site had connections to the central areas of the Scandinavian Bronze Age and received either crucibles or information about their correct manufacture and use (Sandell 2011: 4) from these areas, the related concepts concerning rituals and cosmology were probably transmitted as well.

In a pair of talented hands, a crucible incorporated the potential of otherworldly transformation, the resurrection of scrap pieces of bronze as something new, and was therefore perhaps considered as an object more powerful than any other artefact related to metallurgy. In the archaeological interpretation, such hands have traditionally been thought to belong to an elderly male smith, who learned his trade from someone in his kin (Engedal 2010a: 338, 349) and was highly appreciated by the local society for his knowledge and skill (e.g. Koryakova & Epimakhov 2007: 26, 33; Eklöv Pettersson 2011: 42). The casting of a bronze artefact was both ritualized and nothing short of a semi-public spectacle that served many functions, such as the reproduction of political and social order (Bolin 1999: 12–3; Sörman 2017: 71; 2018: 212) and the maintenance of social identities (Sörman 2018: 212, 215) or cosmological order (Engedal 2010a: 289). From this point of view, different production stages of bronze artefacts might have had non-rational meanings and could have been loaded with symbolism instead of being just unavoidable steps towards the desired goal, the finished bronze artefact (Bolin 1999: 13; Kuijpers 2013: 138).

However, both the ritual nature of bronze metallurgy and the association between the production of bronzes and the ruling class or aristocracy have recently been vigorously challenged (Kuijpers 2012: 416–8; 2013: 138, 140–1). Neither is there any reason to assume that bronze metallurgy would have been reserved a priori for males possessing special knowledge of this craft, while women or other groups of people would have been categorically excluded from it (Budd & Taylor 1995: 138, see also Kuijpers 2012: 414). Against these ideas dismantling the social preconceptions related to bronze metallurgy, the Halosentörmä site with its island location might have doubled as a neutral venue for barter and trade in addition to being a base with a very advantageous location (see also Spång 1997: 197) for the versatile utilization of local resources. When people got together in such places, a ritualized performance centring upon bronze casting might have been performed as a part of or a sort of a feast aimed to tone down the tensions arising from the encounter of groups with different backgrounds (see Bolin 1999: 17; Engedal 2010a: 338; see also Kuusela 2018).

CONCLUSION(S)

While crucible fragments found at Halosentörmä show signs of repeated use when projected against the results obtained with archaeological experiments, the practice of metallurgy at the site was in all likelihood rather short-lived, as it cannot be associated with something that could or should be defined as a bronze casting workshop, foundry, or smithy (see Sörman 2017: 56). Similarly, it would be rather premature to define the area of Hangaskangas as a bronze casting centre (see Koryakova & Epimakhov 2007: 26, cf. Ikäheimo 2019: 37) despite two sites that have yielded finds related to metallurgy: Halosentörmä and Hangaskangas E. Especially the quantity of crucible fragments found at these sites is marginal when compared to the proper bronze casting workshops of southern Scandinavia, where both whole crucibles and hundreds of crucible fragments, with their total weight often measured in kilograms instead of grams, have been found (Melheim et al. 2016: 56 table 2).

Still, the examination of Bronze Age crucible fragments from the Halosentörmä site within the latest Scandinavian interpretative framework has brought to attention several aspects of wider importance that merit to be underlined here. Due to their special status as metallurgical ceramics, crucibles form a much more informative and multifaceted archaeological source material than might be expected. The manufacture and proper use of such artefacts required special know-how that was probably transmitted verbally along with the artefacts. Also, the contexts in which these crucibles were used might have been special in both their physical and spiritual setting to the extent that bronze metallurgy also had entanglements with the contemporary world view. Therefore, the proper documentation and interpretation of the find contexts of crucibles will be of continued importance. The example of the Halosentörmä site shows that relevant information can be extracted even using minimal leads, but it certainly helps if there are many.

Another important observation that arises from the reference material used in this study is the heterogeneity of finds identified as crucible fragments. While some of them certainly belong to crucibles, this identification seems to have served as a sort of dustbin category for all ambiguous and poorly understood ceramic items that look like they have been subjected to extreme temperatures. Similarly, a piece of crucible found at an archaeological site does not automatically signify the local practice of metallurgy, and therefore the environment in which these signs occur should be subjected to closer scrutiny. For example, while researching for this article, the author had a preliminary intuition about the occurrence of complete pottery vessels as if they had been deliberately deposited or abandoned in the area where metallurgy was presumably practised at several of the sites discussed in this article.

The most obvious example is the Kiikarusniemi site in Sotkamo, where three or four substantially complete mica-tempered Sär2 pottery vessels were found in the excavations within the same half square metre as the crucible (Fig. 10) and interpreted as an intentional deposit (Laulumaa 1997: 40, 44). At Hangaskangas E, nearly 2,000 sherds probably belonging to a single talc-tempered ST-pottery vessel with ’slag-like incrustation‘ on its interior were found clustered a few metres away from the concentration of metallurgical ceramics (Pesonen 2013: 16–7). Especially the latter find recalls Hulthén’s (1991: 16–7, esp. fig. 11) reconstruction, in which an asbestos-tempered vessel is used as a glowing charcoal container to keep the moulds that will soon be used in casting sufficiently hot. As the closer examination of this interesting topic now has to be put aside to wait for the future, a modified quote from Engedal (2010a: 357), ’The [idea about] Bronze Age metallurgy in Finland [orig. Nordic Bronze Age] has become stabilized, self-evident and taken for granted. It simply needs to be rediscovered and retraced’, serves as a good guideline for what should be done next by domestic archaeologists interested in the Bronze Age.

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