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## Iron Age metalworking at Masafi-1? A reconsideration of the metal hoards discovered in the collective buildings

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### Summary

Excavations in a series of superimposed Iron Age II collective buildings located at Masafi (Fujairah, U.A.E.) by the *French Archaeological Mission in the U.A.E.* allowed the discovery of two deposits of copper metal buried in two jars. Copper smelting was playing a major role in the economy and the society of the region and several evidence suggest that it also had a symbolic importance. The context of these two discoveries is discussed in this contribution, in order to precise the nature of these two hoards and the function of the buildings.

### Introduction

Masafi is a mountain oasis in the northern part of the Hajar range (Emirate of Fujairah, UAE). Excavations and geo-archaeological work carried out in this region by the French Archaeological Mission to the United Arab Emirates (FAMUAE) under the successive directions of Anne Benoist and Julien Charbonnier have revealed an occupation dated to the Iron II period (1100-600 BC), which was organized in two clusters installed on either side of an ancient oasis: to the west, a fortified village was built on the slope of a rocky hill (Masafi-2); to the east, a complex comprising a succession of collective buildings built and rebuilt on the same site (Masafi-1) and a sanctuary (Masafi-3) extended along the periphery of the oasis (Benoist, 2010a, 2013b, Benoist *et al*, 2012a, 2012b, Charbonnier *et al*, 2017).

During the excavations, an exceptional discovery was made at Masafi-1, in two of the collective buildings (Masafi 1, Level 1b and Masafi 1, Level 2): two buried jars containing a large number of ingots and furnace bottoms made of copper or copper alloy. These findings prompted a program of archaeo-metallurgical studies, which was carried out by Julie Goy, as part of a PhD thesis<sup>1</sup> (Goy, 2019). This article revisits this discovery and its context, based on a re-examination of the data.

### **Geological background.**

Southeast (SE) Arabia includes the current territories of the Sultanate of Oman and the United Arab Emirates. It is a roughly triangular territory, covered in the west by a field of dunes that marks the eastern end of the Rub al Khali, and occupied in the east by the Hajar mountain range, that forms an arc c. 700 km long and 50 to 140 km wide from the Musandam peninsula to the Ja'alan plain, with the highest peaks in central Oman at a height of 3000 m.

The central formation of the Hajar range is composed of a massive set of metamorphic and eruptive rocks and it is especially rich in various ores (copper, nickel, chromium, asbestos, tin, tungsten). Copper was mined as early as the 3rd millennium BC (Weisgerber, 1980, 1981, Hauptmann *et al*, 1988) also to be exported to Bahrain and Mesopotamia (Glassner, 1989, Potts, 1990), a pattern that continued, probably less intensively, during the whole second millennium BC (Weeks, 2003).

Fujairah is located in the northern part of the al Hajar range, where the mountains are lower and the copper ore formations less massive. Local resources in copper are anyhow present, and have been exploited in the past, as evidenced by the number of copper smelting site recorded during the survey carried out within the scope of the FAMUAE (Goy *et al*, 2013, 2018).

### **Iron Age copper production**

The beginning of the Iron Age in SE Arabia (last centuries of the 2nd millennium BC) was marked by an expansion of oases favoured by the development of the *falaj*, a system of underground draining galleries allowing the transport of irrigation water by gravity (al Tikriti, 2002, Boucharlat, 2003, Charbonnier, 2011) and by the domestication of the camel, which allowed for a better circulation of products and techniques (Magee, 2014). Iron remained marginal (Lombard, 1989), but the production and transformation of copper underwent a revival, not only intended for export, but mainly to answer an expanding local demand: copper and copper alloys objects appear on numerous sites, in varied contexts and sometimes in large numbers. They are mainly weapons (arrowheads, daggers, axes), some tools (hoes, chisels, knives), vessels (bowls, long-spouted ewers), elements of adornment (massive bracelets). In addition, at cultic sites, snake figurines and miniature weapons were found (Benoist, 2010).

Copper working sites marked by slag spreads, furnaces, ore or metal fragments, unfinished objects, and anvil- and hammer-type stone tools were discovered in different parts of SE Arabia (Fig. 1), not

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<sup>1</sup> Supervised by C. le Carlier from 2012 to 2019.

only in the mountains of Oman (Raki-2: [Weisgerber and Yule, 1999](#)), but also in oasis settlements in foothill areas (Bin 'Ātī House in Qattarah, al Ain: [Power and Sheehan, 2011](#)), at coastal sites (Tell Abraç: [Weeks, 1997](#)), and in desert regions, away from ore areas (Uqdat al Bakhra: [Genchi and Giardino, 2018](#), [Goy, 2018](#); Saruq al Hadeed: [Qandil, 2003](#); [Nashef, 2010](#) ; [Weeks et al, 2017](#), Muwailah: [Magee, 2003](#)). The remains vary in size and nature from large industrial smelting or melting sites almost entirely devoted to metallurgy (Raki-2, Uqdat al Bakhrah), to smaller refining sites within a settlement area (Bin 'Ati in Qattarah). The wide distribution of metallurgic activities in SE Arabia during the Iron Age suggests an intense circulation of more or less refined raw materials from the extraction and reduction areas to the workshops, where objects were casted or moulded.

Attempting to detail the organization of copper working in this region, without the help of written and administrative sources, remains a difficult exercise. Proposals were made by several scholars about the role of certain buildings in the control and redistribution of copper and other locally exploited resources on a regional scale ([Benoist, 2010](#)). These buildings include fortresses established near copper smelting sites, such as Lizq in central Oman ([Kroll, 1981](#)) or Husn Madhab in the Emirate of Fujairah ([Corboud et al, 1994](#)), where traces of copper were found on ceramic containers. They also include collective buildings comprising a reception hall with wooden posts installed on mud-brick bases. Perhaps the best example is the columned hall at Muwailah (Building II), which P. Magee described as a building that played a central role in the control and redistribution of copper and in which copper objects were found as well as a large number of copper fragments, which testify to a metallurgical activity carried out on site ([Magee, 2003](#)).

An element that complicates the question is the particular place that seems to be given to metallurgy and its products. Collective buildings with a pillared reception room were also places of representation, where rituals could occur. Copper objects and copper products could be deposited in or around these places. This is the case of Mudhmar East ([Gernez et al, 2017](#)) and Salut in central Oman ([Avanzini and Degli Esposti eds, 2018](#)), and Bithnah in the Emirate of Fujairah ([Benoist, 2013a](#)), where buildings comprising a meeting room possibly for gatherings and banquets are strongly connected with elements that also speak in favour of a symbolic or religious role. Among other things, we find copper snake figurines, vessels decorated with snakes, and sometimes ingots ([Sasso, 2018](#)) in ritual contexts than can be interpreted as (foundation deposits, offerings placed in pits or on altars). At these sites, where gathering places, possible administrative functions and ritual practices are mixed, it is difficult to disentangle what is connected with the organization of metallurgy and the control /preservation of its products and what is related to offering practices, including deposits dedicated to a deity symbolized by a snake. Masafi-1 with the small sanctuary of Masafi-3 erected nearby, is one of those places where these different aspects of collective life interpenetrate ([Benoist et al, 2015](#)).

[[Fig. 1. Near here](#)]

### **The collective buildings of Masafi-1**

Excavations at Masafi-1 revealed five Iron Age building phases: Phases 0, 1a, 1b, 2 and 3. Only phases 1a, 1b, and 2 are concerned in this paper.

**Phase 1A** saw the construction of a first collective building in white mud bricks (Building 1: [Fig.2](#)), From the beginning this building included a reception room with a floor and walls covered with white plaster (P. 266). It contained four mud-brick bases that probably supported four wooden posts arranged in two rows of two in the central part of the room. A series of wooden posts also reinforced the north, east, and south walls.

The reception room was accessed from the east through a courtyard with a gravel floor, (P. 1201). To the north, the central room P. 266 communicated with two small rooms (P. 425, P. 468). One of them (P. 468) contained a large ceramic basin half-buried in the ground and filled with ashes and coals, interpreted as a "*tannur*". From the courtyard P. 1201, a long corridor, perhaps uncovered (P. 220), led to a small corner room (P. 219). To the west, room P. 266 opened onto two parallel elongated rooms (P. 100, P. 101), with very smooth whitish plastered floors.

[Fig. 2 near here]

Modifications were made to the building during **Phase 1B** (Fig. 3). The two small rooms immediately north of the reception hall P.266 were combined into one (P. 228), and a new "*tannur*" was installed outside the building to the west (C. 483). The former courtyard P. 1209 to the east was transformed into two very long rooms, P. 219 and P. 229. The former corridor P. 220 was covered during this phase of reconstruction. It was closed to the east and became accessible from room P. 228. It was provided with a whitish clay floor. It was in this corridor that the first jar containing ingots was buried (MSF-2098). The reception room (P. 266) and the small overhanging room to the northwest (P. 219) remained unchanged, but received a new floor covering.

[Fig.3 near here].

During **Phase 2**, Building 1 was demolished and a new building of yellow, irregular, gravelly mudbrick was constructed above it (Building 2: Fig. 4). A new reception hall was built (P. 107). Larger than the previous hall, it extended from the north to the south of the building. It was accessed directly from the outside, through an entrance opening to the south. It was irregularly shaped, and contained seven rounded post bases, five arranged in the central part of the room, the last two reinforcing the north wall. A bench extended along this wall. The reception room P. 107 contained an abundance of furniture with some exceptional pieces (e.g., Benoist *et al.* 2012: fig. 7). In the eastern part of the room, a pit was dug in which a second jar containing ingots was buried (MSF-955).

The reception room P. 107 also opened to the northwest into a small corner room, P. 128, built over the former corner room P. 219. The exceptionally thick west wall of the reception room (M. 061) separated it from two oblong rooms, P. 033 and P. 038, built above the former rooms P. 100 and P. 101. Only the northern part was preserved. Room P. 038 revealed the remains of two mud brick installations forming small niches, each of which housed the lower part of a jar or a deep basin. Room P. 033 contained fragments of at least three jars lying on the floor. These rooms may have opened out to the south or southwest, without communicating with the reception room, or the entrance connecting room P. 107 and room P. 038 may have been located in the southern part of the poorly preserved wall M. 061.

[Fig. 4 near here]

After a violent fire, the building was partially demolished and a third building, now made of stone, was erected on the same spot (**Phase 3**, Building 3). Only the northern part is preserved. It contained a large reception room, with three rows of wooden posts set in simple holes dug into the ground. To the northwest, a new corner room was rebuilt over the previous one (P. 016). To the west of the reception room and to the south of this corner room, two small niches opened to the west, perhaps to the outside.

[Fig. 5 near here]

**The metal "hoards" in the buried jars at Masafi-1.**

A total of 181 metallic masses were inventoried on the Masafi-1 site. They are mainly distributed in two jars buried in two niches in the floor of buildings 1 and 2.

Jar MSF-2098, buried in the eastern end of room P. 220, in the northern part of Building 1 (level 1b), contained 139 metallic masses that form sample 156. There are 69 ingots or fragments of ingots (38 complete ingots and 31 fragments) and 70 furnace bottoms or undetermined fragments.

The jar is a short-necked storage jar of local or regional origin with a thickened lip decorated with geometric incised decorations common in the region (Fig. 6). The jar, buried in an 80 cm deep pit, had its wall partially soaked with copper oxide and rust, perhaps due to heavy heating at the time of the fire in Building 2, or perhaps to episodes of humidity during violent runoff. Traces of a major runoff run, in fact, alongside the ruins of Building 1 to the north (Fig. 2). The jar was closed by a plug of raw earth, held in place by two flat stones. The buried jar was covered and sealed by a bench built against the north wall (ST. 106, built against wall M. 108, Fig. 3), during Phase 2.

[Fig. 6 near here]

The jar MSF-955 from Phase 2 contained 24 furnace bottoms and 18 ingots or fragments of ingots. It is a neckless, undecorated jar of a type also very common during the Iron Age, with a folded rim. The jar had been buried in a square pit dug into the ground in the eastern part of the reception room P. 107 of Building 2 (Phase 2). The jar was disturbed at the top by the digging of a pit for installing a dwelling during the recent Islamic period: the rim was broken and some ingots were scattered around it, in the pit and in the floor of the Islamic dwelling (Fig. 7).

[Fig. 7 near here]

All of the ingots and copper masses found in the two jars were studied by Julie Goy as part of her PHD (Goy 2019). The ingots are mainly of discoidal shape, with two flat faces (Fig. 8. Samples 156-30 and 22-14). The underside of the ingots is flat but slightly irregular, with rounded impressions that suggest that the metal was poured into a hole in the ground, which served as a mould. The edge of the ingot is vertical. The upper surface is often smooth, with some vacuoles, and sometimes with a slight rib around the top that may have formed when the metal was too abundant and flowed out. Their size and weight vary, without any identifiable cluster. The smallest have a diameter of 6.8 to 8 cm and a thickness of 2.2 to 3.7 cm. They weigh between 450 and 740 grams. The largest have a diameter ranging from 12.5 to 16.5 cm a thickness between 2.7 and 5.6 cm and a weight ranging from 1.8 to 3.3 kg (Goy, 2019, p 227-228). Other ingots appear in small quantities. Five are circular plano-convex ingots, with a flat upper surface, a few porosities, and a convex, relatively regular lower surface. This shape, which is reminiscent of the ingots found in SE Arabia during the Bronze Age, is also found at the Iron Age site of Salut (Sasso, 2018:311-312, cat. 133-148 and plates 87-88). Two other ingots have a plano-convex oval shape.

The copper scrap from Masafi also include a large quantity of furnace bottoms more irregular in shape (Fig. 8: samples 156-055 and 22-002) and a few fragments resulting from accidental spillage of molten metal from the furnace or crucible, and some undetermined metal fragments.

[Fig. 8 near here]

**Analytical programs performed on Masafi deposits.**

Several series of analyses were carried out on a selection of ingots and furnace bottoms from Masafi-1<sup>2</sup>. The first ones combined X-ray fluorescence<sup>3</sup> and ICP-AES (Inductively Coupled Plasma - Atomic Emission Spectrometry)<sup>4</sup>, the results being largely published (Goy et al, 2013, 2018, Benoist et al, 2015). Additional analyses were carried out later by Julie Goy combining elemental analyses by ICP-AES and X-ray fluorescence using a portable XRF machine<sup>5</sup> (Goy, 2019).

Analyses of Masafi-1 ingots and furnace bottoms were compared with those of other metallurgical products from Masafi in order to establish their place within the metallurgical process going from ore smelting to the finished object: slag collected from smelting sites identified during the regional survey<sup>6</sup>, copper prills contained in slag<sup>7</sup>, and a few objects (including a knife<sup>8</sup> and a bowl<sup>9</sup> found at Masafi-1 and four snake-shaped figurines<sup>10</sup> and one spear point<sup>11</sup> found at Masafi-3) (Fig. 9).

[Fig. 9 near here]

The homogeneity of the ingots was verified by sampling several points of the same ingot. This confirmed the co-existence of copper-coloured ingots and some rarer silver-grey ingots. The different compositions recorded from one ingot to another are therefore not due to dis-homogeneity within an ingot but to variations in the melting process.

The ingots found in the jars are primarily unalloyed copper with contents ranging from 58% to 99%. Two ingots have a different composition, one with a nickel content of 57% and the other with 20% lead and 18% arsenic (Goy, 2019, p 378).

No ingot nor furnace bottom is made of bronze, tin content being always very low (0.07% max). Iron is conversely often present in varying and high levels (<5 to >30%), suggesting the use of iron-rich flux to facilitate slag removal during reduction. This addition was either not systematic or furnace bottoms and ingots are not systematically the result of two distinct stages in the metallurgical process. Arsenic is also usually present in low quantities with few higher exceptions. The same applies for nickel, with the exception of the ingot mentioned above for which a safe explanation is still lacking (Benoist et al 2015, Goy et al, 2018).

The finished objects found at Masafi-1 and -3 reveal a much higher and more homogeneous copper content, around 95-98%. Only one object is tin-bronze, the knife fragment m. 009, found in a pit dug

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<sup>2</sup> Analysed corpus includes 40 ingots, 34 furnace bottoms, 5 fragments resulting of a flow of metal outside the furnace and 5 undetermined fragments. (Goy, 2019).

<sup>3</sup> Carried out by Gaffar Attaelmanan at the U.A.E. *National X-Ray Fluorescence Laboratory* in the University of Sharjah

<sup>4</sup> Carried out at the laboratory *Archéosciences* of Rennes

<sup>5</sup> Carried out at the laboratory *Archéosciences* at Rennes and at the Laboratory *Geosciences Océan (LGO)* in Brest

<sup>6</sup> These slags come from two sites dated from the Iron Age (the workshop of Bin'Ati in Qattarah, and a copper smelting site identified near the Iron Age III site of Rafaq-2 in the wadi al Qawr), but also from other sites of later date or undated located during the survey (Aswani-1, Aswani-169, *Anonymus* 1, Esfini-1, Awhalah-1 and -3, AND). Polished sections were studied with a metallographic microscope and with a SEM-EDS at the *Centre de Microscopie Électronique à Balayage (CMEBA)* of Rennes. A selection was also analysed by p.XRF at the laboratory *Archéosciences* of Rennes.

<sup>7</sup> These prills come from the same sites as the ones mentioned in the previous note.

<sup>8</sup> m. 009 in the excavations' archives (sample 214 in Goy, 2019).

<sup>9</sup> m. 002 in the excavations's archives (sample 213 in Goy, 2019).

<sup>10</sup> These snakes include three moulded snakes: m. 016 (sample 217 in Goy, 2019), m. 056 (sample 150 in Goy, 2019) and m. 044 (sample 24 in Goy, 2019), all from layer 2 in Masafi-3. The last snake is a hammered snake, m. 060 (sample 251 in Goy, 2019), collected in the first level in Masafi-3.

<sup>11</sup> m.015, collected in the second level of Masafi-3.

in the floor of room P. 100 during Phase 1b, which has a tin content of 15%. The finished objects deposited in the nearby Masafi-3 shrine are all of near-pure copper (98-99% copper content).

It is, therefore, evident that the ingots and furnace bottoms are made of a raw material which would have needed to be remelted and refined to produce similar finished objects (Goy, 2019, p387-389). Their somewhat disparate character (variations in size, composition, and associations between ingots and furnace bottoms of various shapes) suggest they came from different melting workshops, or that from one melting operation to another the recipes could vary in the same workshop. It is not excluded they could belong to different stages in the refining process of the metal. All, however, are well ahead of the object stage in the *chaîne opératoire*.

The first analytical results had led some of the present authors to suggest that furnace bottoms and ingots could reflect two distinct stages of the melting process - a first smelting yielding furnace bottoms, a re-melting yielding the ingots (Benoist et al, 2015). A larger sample showed that this is not the case and led J. Goy to hypothesize that ingots were masses of raw material that were both usable locally and exchangeable, and furnace bottoms were instead intended for local metalworking. Perhaps ingots offered a better calibration in terms of size and weight, despite their variations, which could facilitate exchange (Goy, 2019, p. 387).

The objects (snakes, miniature daggers, spearheads, and arrowheads) found in the nearby shrine were studied by B. Armbruster (Benoist et al 2015), who highlighted different manufacturing techniques: lost wax casting, hammering and folding metal sheets, cutting and shaping from thicker metal sheets. Some objects were incised with a point or a punch. It is not known where these objects were shaped, and how they might relate to the masses of raw or refining metal found at Masafi-1. According to B. Armbruster, these techniques could have been used in a workshop of modest size, with relatively limited tools. What traces could such a workshop have left behind? Can we highlight the presence, even occasional, of copper craftsmen in the buildings of Masafi-1?

### **Combustion structures and ash levels at Masafi-1.**

In addition to the jars buried in niches, one or more installations comprising domestic ovens ("*tannurs*") and storage places consisting of jars set into niches in the masonry of the building were found in the different levels of Masafi-1.

In level 1A such a feature was located in a small room measuring 1.70 x 1.40 m, to the north of the reception room (room P. 468). It was accessed from the west through room P. 425, which was itself connected to the reception room by an entrance. Room P. 468 did not have a white plastered floor, like the others, but a simple, slightly gravelly and compacted earthen floor. It was covered with a light grey, loose, slightly gravelly ashy layer. A pit 85 cm in diameter and 60 cm deep was dug inside the room to host a deep basin, made in common ware (MSF-2133). It was filled with a loose sediment of ash and gravel, quite similar to that which covered the surrounding soil. The walls of the basin were slightly blackened by fire (Fig. 10). The rim was broken in places, and fragments of the basin were missing. One of these was found in jar MSF-2098 in level 1B. Three copper ingots were stuck to it (Fig. 10). No copper fragments were found in room P. 468, nor were any animal bone fragments and no date stones or seeds (which might have been expected from a domestic oven). However, charcoal was abundant. The pit and the basin were covered by a new floor and rooms P. 425 and P. 468 were transformed into one (level 1B). It was then that jar MSF-2098 and its ingots were buried, in an elongated room further north, together with a fragment of the basin MSF-2133.

[Fig. 10 near here]



In level 1B a “*tannur*”-like combustion structure was also found. It was located in a pit (C. 483) dug into the ground outside the building to the west. Here as well, a fairly large bowl (80 cm in diameter) was set into the pit. During the first phase of use, it was gradually filled with ashy earth and coals. In a second phase, the edge was raised by the addition of two layers of stones. The pit filled up again with ashes and coal until the contents overflowed around it. (Fig. 11). Above the pit, a grey-white, indurated ash layer was finally deposited. Two samples were taken, each consisting of several bags of ash and mixed coals (samples 205 and 211).

Around this installation, the level of occupation associated with phase 1b consists in a vast loose, powdery and ashy layer, with abundant charcoal, sometimes interspersed with clay lenses, in which a few shallow pits were dug (C. 476, C. 479, C. 490), all filled with ashes mixed with silt or small reddened stones. As in the previous level, no copper fragments were collected. However, a small bag of bones and 3 shells were found.

[Fig. 11 near here]

During phase 2, two niches of about 1 m on each side were installed in room P. 038, in the western part of the building. In the northernmost niche (St. 058) an almost complete jar was set in a loose gravelly sediment (MSF-856: Fig. 12). It contained a filling of gravel, ash, and some charcoal. Small copper fragments were found at the bottom of the jar. Associated with this jar was a vessel with a bridged spout decorated with painted wavy lines (MSF-857). The adjacent niche to the south (St. 120: Fig. 13) yielded the bottom of a second jar wedged with fragments of mud brick, and another bridge-spouted vessel with a snake decoration in relief (MSF-957). No copper fragments were found inside this second jar but small fragments of copper were scattered on the ground in room P. 038 (Fig. 13), while the mentioned bronze knife was found in a shallow pit (m. 009, n° 214 in Julie Goy, 2019: Fig. 8). Animal bones and shells were also found in this area (Decruyenaere et al., 2022).

[Fig. 12 near here]

[Fig. 13 near here]

Three other jars, one of which was complete, were found broken on the floor of the adjacent room, P. 033. This floor, made of yellowish clay, also yielded a few bones, numerous charcoal fragments, small scattered fragments of copper (Fig. 13), and a fragment of a plano-convex copper ingot (m. 010: Fig. 8).

These small scattered copper fragments would speak in favour of copper working on site. But while an activity involving the action of fire seems obvious in the installations of levels 1a and 1b described above (where no copper was found, however), the entire western half of Building 2, including the western half of the reception room, bore the traces of a violent fire (rubbed floors, ashen and charred lenses, burnt objects): we do not know whether the niches containing the jars were simple storage places or whether they may have housed combustion structures. One element that could speak in favour of a heating activity in this part of the building could be the thickness of the wall that separated it from the reception room, which is twice as thick as the other walls of the building, including the external walls. An argument that remains weak in the absence of additional elements.

Outside, above the former combustion structure C. 483, buried under a layer of indurated ash, new soil was deposited. In this area, Level 2 was located at a shallow depth below the present surface. Poorly preserved, in tatters, it consists in a beige to brown crust and contained two small pits filled with charcoals and ashes dug in the immediate vicinity of the old “*tannur*” C. 483: this space could have maintained the same function from level 1b to level 2. The remains of the subsequent Level 3

hardly extended into this area, being limited to a layer of stones and earth with collapsed mud brick fallen along the walls. A few copper fragments are still found in the same area just below the surface (sample 042).

Is it possible to envisage metal working in this sector, in a way that would make the buildings comparable with Building II at Muweilah? The evidence seems weak. The quantities of charcoal associated with the “*tannurs*” of levels 1A and 1B, a sherd from the “*tannur*” of level 1A found in a jar containing ingots from level 1B, small fragments of copper collected in the western part of the building on level 2, and the thickness of the wall separating the western part of the building from level 2 all raise questions. At the same time, nowhere did we find any stone tools such as hammers or anvils, fragments of crucibles, slag, or moulds for objects. In levels 1A and 1B, no copper fragment inside the “*tannurs*” or in their vicinity speak for a specific metallurgical activity, unless we consider that they were only used to produce charcoal, which seems improbable in this type of building. Copper fragments do appear in level 2, a context that hampers the identification of possible combustion structures since the entire western part of the building was burned. At most, one can envisage the hoarding of copper and possibly the handling of copper during exchanges.

### **Conclusion.**

The two buried jars at Masafi-1 have been interpreted as caches containing a supply of raw copper, which may have been intended to be re-melted to produce objects. They suggest that the collective buildings of Masafi-1, like that of Muweilah, played an active role in the control or distribution of copper, which, despite its relative frequency in the region, was probably a valuable product. They most probably testify to the presence of a metallurgical activity in the vicinity of the site, a production from which the community of Masafi benefited. Small copper fragments are found in the western part of Building 2. However, contrary to Building II at Muweilah, there is insufficient evidence of an on-site metallurgical workshop, whether for metal refining or artefact making, rather than simply a place to store material recovered from nearby.

Did the two jars with the Masafi-1 ingots form a simple forgotten reserve of raw material, or did they play the role of foundation deposits, or symbolic offerings? The question remains open. Offering deposits including raw products or even wastes of copper production have been seen on other sites. At Bithnah they included a deposit of copper prills probably recovered from the furnace itself, buried in a jar decorated with snakes in front of a low altar shaped as a coiled snake (Pillaut, Le Carlier, Ploquin 2013). It was also accompanied by a small pile of slag placed in front of the head of the snake. But symbolic deposits at Bithnah were of relatively small size, whereas at Masafi-1, the quantity of hidden metal seems important to us, for a simple “symbolic” foundation deposit (around 120 kg of raw metal in Jar MSF-2098, not far from 40 kg left in jar MSF-955).

As a whole, a detailed review of the context of discovery of these two buried jars only confirms the position of the building in the organisation of the distribution of copper, but doesn't provide any clear probe of any metalworking on place. It is tempting to believe that workshops were located in the vicinity, but there is no evidence of their presence inside the building, within the excavated area. Further work in Masafi area might bring new light on this question.

### **Bibliography**

Al Tikriti, W.Y., 2002. The south-east Arabian origin of the *falaj* system. Proceedings of the Seminar for Arabian Studies, vol. 32, p. 117-138.

- Avanzini, A., Degli-Esposti, M. eds. *Husn Salut and the Iron Age of South-East Arabia. Excavations of the Italian Mission to Oman, 2004-2014*. L'Erma di Brettschneider, Roma
- Benoist, A., 2010a : Fouilles à Masafi-3 en 2009 (Emirat de Fujairah, E.A.U.): Premières observations à propos d'un espace culturel de l'Age du Fer nouvellement découvert en Arabie Orientale. *Proceedings of the Seminar for Arabian Studies* vol. 40 : 119-130.
- Benoist, A. 2010b. Authority and religion in eastern Arabia during the Iron Age (1150-250 BC). In L. Avanzini ed *Eastern Arabia during the First Millennium BC*. L'Erma di Brettschneider, Roma : 109 – 143.
- Benoist, A. 2013a. *La vallée de Bithnah au cours de l'Age du Fer*. BAR international Series, 2510, Oxford.
- Benoist, A., 2013b. A small green Paradise. Economic strategies, ritual practices and local ancestors of the Iron Age community of Masafi (Fujairah, United Arab Emirates). *Proceedings of the Seminar for Arabian Studies* 43: 47-62.
- Benoist, A., Bernard, V., Brunet, O., Hamel, A., 2012a. The Iron Age occupation in Masafi: report on two seasons of excavations, pp. 149-161 in Potts D. et Hellyer P. (eds), *Fifty years of Emirates archaeology. Proceedings of the second International Conference on the archaeology of the United Arab Emirates*. London, Dubai, Abu Dhabi: Motivate Publishing.
- Benoist, A., Bernard, V., Charbonnier, J., Goy, J., Hamel, A., Sagory, T., 2012b. Une occupation de l'Age du Fer à Masafi. Travaux récents de la Mission Archéologique Française aux EAU dans l'Emirat de Fujairah (Emirats Arabes Unis). *Chroniques Yéménites* 17. <http://cy.revues.org/1803>; DOI: 10.4000/cy.1803.
- Benoist A., Le Carlier, C., Goy, J., Degli Esposti, M., Armbruster B and Attaelmanan, G. 2015. Snake, copper, and water in north-eastern Arabian religion during the iron Age: the Bithnah and Masafi evidence. *Proceedings of the 17<sup>th</sup> Rencontres Sabéennes*, Paris, 6-8 Juillet 2013, Oxford, p. 21-36.
- Boucharlat, R., 2003. Iron Age water-draining galleries and the Iranian *Qanāt*. In D.T. Potts, P. Hellyer and N. al Naboodah eds, *Archaeology in the U.A.E*, Trident Press, London. p. 162-172.
- Charbonnier, J., 2011. *Les systèmes d'irrigation en Arabie méridionale (IVe millénaire avant J.-C. – Ier millénaire après J.-C.)*. PhD Thesis, University of Paris I.
- Charbonnier, J., Purdue, L., Benoist, A., 2017. Taming surface water in pre-Islamic South-east Arabia. Geiarchaeological and chronological evidence of runoff water channeling in Masafi(U.A.E.). *Journal of Field Archaeology* 42. <https://www.tandfonline.com/doi/full/10.1080/00934690.2016.1256172>
- Corboud, P., Castella, A.C., Hapka, R., Im Obersteg, P., 1994. *Archaeological Survey of Fujairah 3 : 1993. Preliminary report on the 1993 campaign of the Archaeological Survey of Fujairah (United Arab Emirates)*. Swiss-Liechtenstein Foundation for Archaeological researches Abroad. Genève.
- Decruyenaere, D., Mashkour, M., Lidour, K., Debue, K., Sagory, T., Pellegrino, M.P., Charbonnier, J., Benoist, A. 2022. Late Bronze Age and Iron Age animal exploitation in Masāfi, Fujairah, U.A.E. *Proceedings of the Seminar for Arabian Studies* 51, p. 123-140.
- Genchi, F. et Giardino, G, 2018. « The Field work ». In P. Yule an G. Gernez eds. *Metal Working workshop in the empty quarter. Sultanate of Oman*. Rudolf Habelt gmbh.

Gernez, G., Jean, M., Benoist, A., 2017. The discovery of a new iron Age ritual complex in central Oman. recent excavations near Ādam. *Proceedings of the Seminar for Arabian Studies* Vol. 47, p. 101-116.

Glassner J. J., 1989. Mesopotamian textual evidence on Magan/Makan in the IIIrd millennium BC. In Costa P.M. and Tosi M. eds. *Oman Studies. Papers on the Archaeology an History of Oman*. Rome. P. 181-191;

Goy, J., 2019. *La métallurgie du cuivre à l'Age du Fer en péninsule d'Oman. Organisation et caractéristiques techniques*. PhD Thesis, University of Paris I, Paris.

Goy, J., Le Carlier, C., Degli Esposti, M., Attaelmanan, A. G., 2013. Archaeometallurgical survey in the area of Masafi (Fijairah, U.A.E.). Preliminary data from an integrated program of survey, excavations and physicochemical analyses. *Proceedings of the Seminar for Arabian Studies*, vol. 43, p. 127-144.

Goy J., Degli-Esposti M., Le Carlier de Veslud C., Benoist A, 2018. Archaeometallurgical research on Iron Age (1250-250 bce) copper production in E. ben Yosef ed. the northern al Hajjar montains (Oman peninsula). In *Mining for ancient copper. Essay in memory of Beno Rothenberg*: 371-389. Tel Aviv.

Hauptmann, A., Weisgerber, G., and Blackmann, H.G., 1988. Early copper metallurgy in Oman. In R. Main ed. *The beginning of use of metals and alloys*. Papers from the second international Conference, Zhangzhou, China, 21-26 october 1986. The MIT Press, Cambridge, p. 34-51.

Kroll, S., 1981. Die Bergfestung Lizq-1. In. G. Weisgerber éd. *Mehr als Kupfer in Oman. Ergebnisse des Expedition 1981. Der Anschnitt* vol. 32 : 174-263.

Lombard, P., 1989. Age du Fer sans fer. Le cas de la péninsule d'Oman au premier millénaire avant notre ère. In T. Fadh ed. *L'Arabie pré-islamique et son environnement historique et culturel*. Travaux du Centre de Recherches sur le proche Orient et la Grèce antique de l'Université des Sciences Humaines de Strasbourg. Vol 10, Leiden, p. 25-27.

Magee, P., 2003. Columned halls. Power and Legitimation in the south-east Arabian Iron Age. In D.T. Potts, P. Hellyer and N; al Naboodah eds, *Archaeology in the U.A.E*, Trident Press, London. p.181-191.

Magee, P., 2014. *The Archaeology of prehistoric Arabia*. Cambridge University Press, Cambridge.

Nashef, K., 2010. Saruq al Hadid. An industrial Complex of the Iron Age II Period. In Avanzini A. ed. *Eastern Arabian in the first millennium BC*. Rome, p. 213-226.

Pillaut, S., Le Carlier, C. Ploquin, A., 2013. Quelques interprétations paléométallurgiques à partir de l'analyse macroscopique, microscopique et chimiques de spécimens métalliques et scorifiés de Bithnah. Chapter 12 in Benoist, A. ed. *La vallée de Bithnah au cours de l'Age du Fer*. BAR international Series, 2510, Oxford.

Potts, D.T., 1990. *The Arabian Gulf in Antiquity*, Oxford.

Power, T.C. & Sheehan, P.D., 2011. The Bayt Bin 'Ātī in Qaṭṭārah Oasis: A Prehistoric Industrial Site and the Formation of the Oasis Landscape of al-'Ain, UAE. *Proceedings of the Seminar for Arabian Studies* 41: 267-282.

Qandil, H., 2003, Survey and excavations at Saruq al Hadeed, 2002-2003. In P. Hellyer and M. Ziolkowski eds, *Emirates Heritage* Vol. 1. Proceedings of the first annual symposium on recent Palaeontological and archaeological Discoveries in the Emirates. Al Ain, p. 121-139.

Sasso, M., Metal Objects. Chapter 7 p 301-323, In Avanzini A. and Degli-Esposti eds. *Husn Salut and the Iron Age of South-East Arabia. Excavations of the Italian Mission to Oman, 2004-2014*. L'Erma di Brettschneider, Roma

Weeks, L., 1997. Prehistoric metallurgy at Tell Abraç, U.A.E. *Arabian Archaeology and Epigraphy* Vol 8. P. 11-35.

Weeks, L., 2003. *Early Metallurgy of the Persian Gulf. Technology, Trade and the Bronze Age World*. Brill Academic Pub., Boston.

Weeks, L., Cable C., Franke, K., Karacic, S., Newton, C., Roberts, I., Stepanov, I., David-Cuny, H., Price, D. Bukhash, R.M., Rawan, M.B., Zein, H., 2018. Recent archaeological research at Saruq al Hadid, Dubai, U.A.E., *Arabian Archaeology and Epigraphy*, vol. 28, p. 31-60.

Weisgerber, G. 1980. ... Und Kupfer in Oman. Das Oman projekt des Deutsches Bergbau Museum. *Der Anschnitt* 32, p. 62-110.

Weisgerber, G. 1981. Mehr als Kupfer in Oman. Ergebnisse des Expedition 1981. *Der Anschnitt* 33, p. 174-263.

Weisgerber, G, Yule, P. 1999. Preliminary report on the 1996 Season of excavations in Oman. *Orient Archäologie* Band 2. P. 97-117.

## Figures Captions

Fig. 1. Map showing the Location of Masafi within the Iron Age occupation in SE Arabia with copper workshops and smelting sites and Iron Age sites including copper offerings (Map: A. Emery, A. Benoist).

Fig. 2. Masafi-1. Phase IA (Map: Vincent Bernard)

Fig. 3. Masafi-1. Phase 1B (Map: Vincent Bernard)

Fig. 4. Masafi-1. Phase 2 (Map: Vincent Bernard)

Fig. 5. Masafi-1. Phase 3 (Map: Vincent Bernard).

Fig. 6. Masafi-1. Jar MSF-2098 *in situ*. (Drawing: Vincent Bernard. Photo: Aurélien Hamel).

Fig. 7. Masafi-1. Jar MSF-955 *in situ*. (Drawing: Vincent Bernard. Photo: Aurélien Hamel).

Fig. 8. Ingots and furnace bottoms of Masafi-1. (Sample 156-30: Ingot from Jar MSF-2098; Sample 156-55: Furnace bottom from jar MSF-2098 ; Sample 22-14: Ingot from Jar MSF-955 ; Sample 22.02: Furnace bottom from Jar MSF-955.)

Fig. 9. Copper and copper alloy objects from various places inside Masafi-1 and from Masafi-3 submitted to analysis.

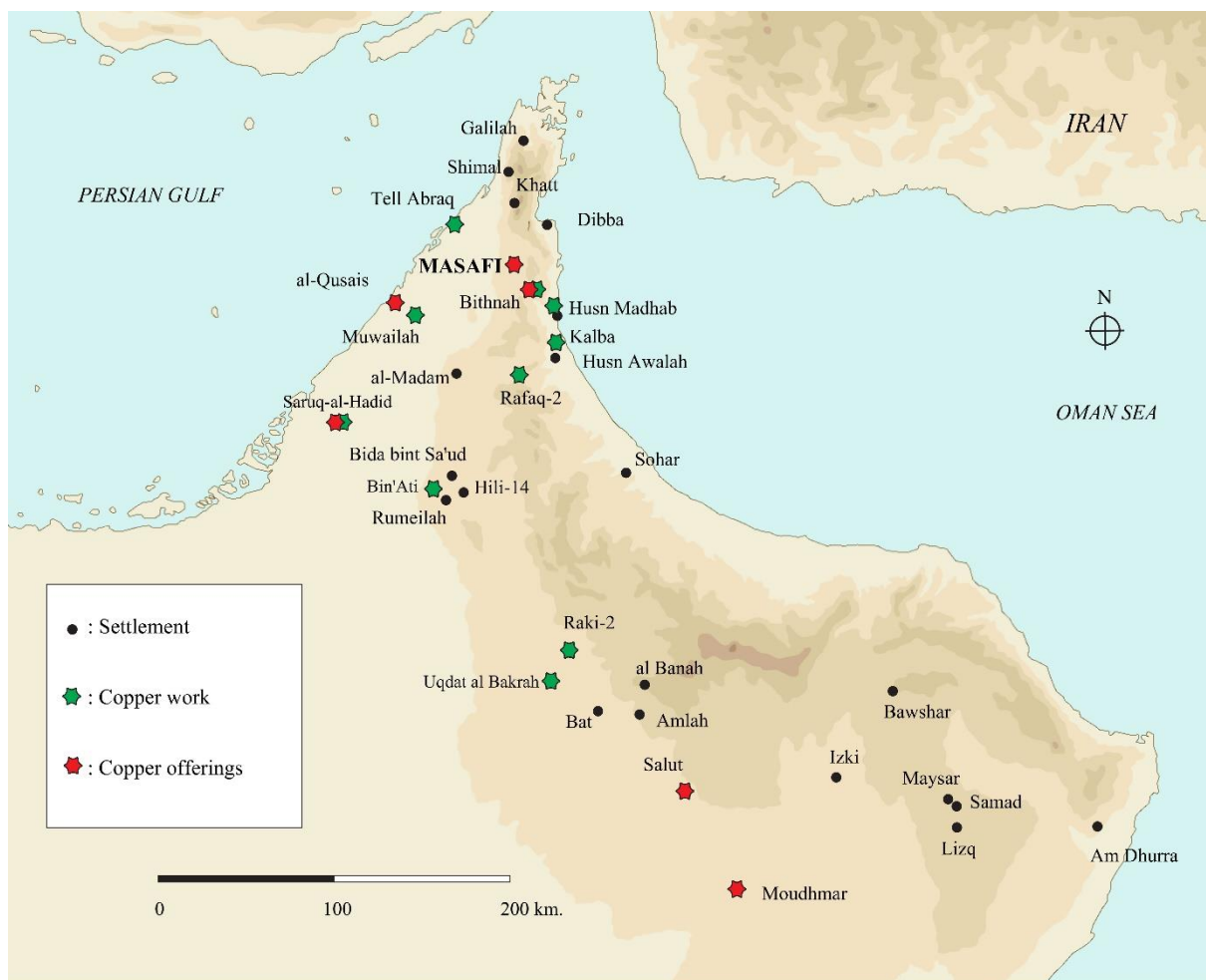
Fig. 10. Masafi-1, level 1A. « Tannur » MSF-2133 in room P. 468 and sample 156-44 including a fragment of the "Tannur" with three ingots stuck to it found in Jar MSF-2098. (Photos: A. Hamel, C. Le Carlier. Drawing: V. Bernard).

Fig. 11. Ashy layer in level 2b to the west of the collective building, with « *Tannur* » C483 and Pit C.479. (Photo and sketch drawing: A. Hamel)

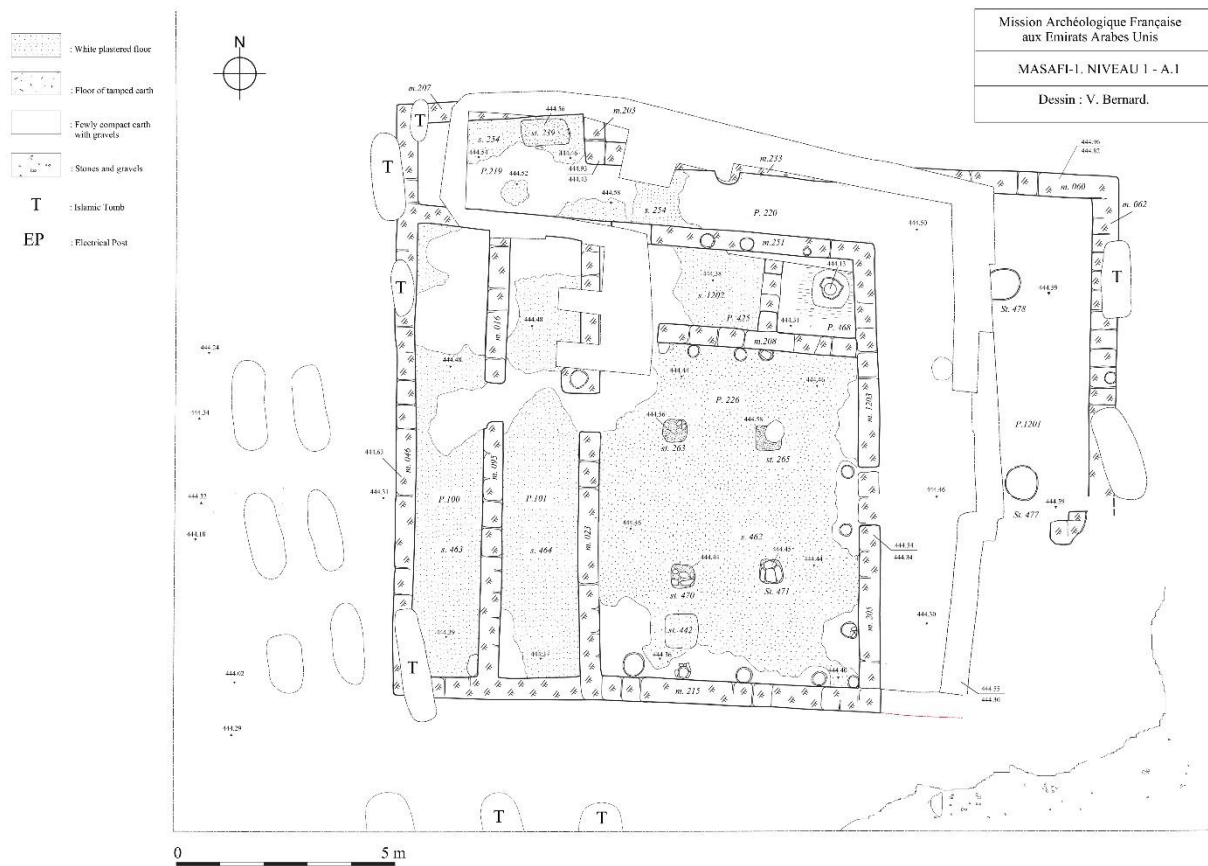
Fig. 12. Niche St. 058, Jar MSF-856 found inside and sample of copper fragments collected in the jar. (Photos: A. Hamel ; Drawing: V. Bernard).

Fig. 13. Rooms P.038 and P033, Niche St. 120, details of a jar bottom in room P.033 and samples of copper fragments collected in both rooms on the floor (photos: A. Hamel, C. Le Carlier and J. Goy).

**Figures :**



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**Fig. 2. Masafi-1. Phase IA (Map: Vincent Bernard)**



Fig. 3. Masafi-1. Phase 1B (Map: Vincent Bernard)







Masafi-1. Jar MSF-2098



Fig. 6. Masafi-1. Jar MSF-2098 *in situ*. (Drawing: Vincent Bernard. Photo: Aurélien Hamel).

Masafi-1. Jar MSF-955

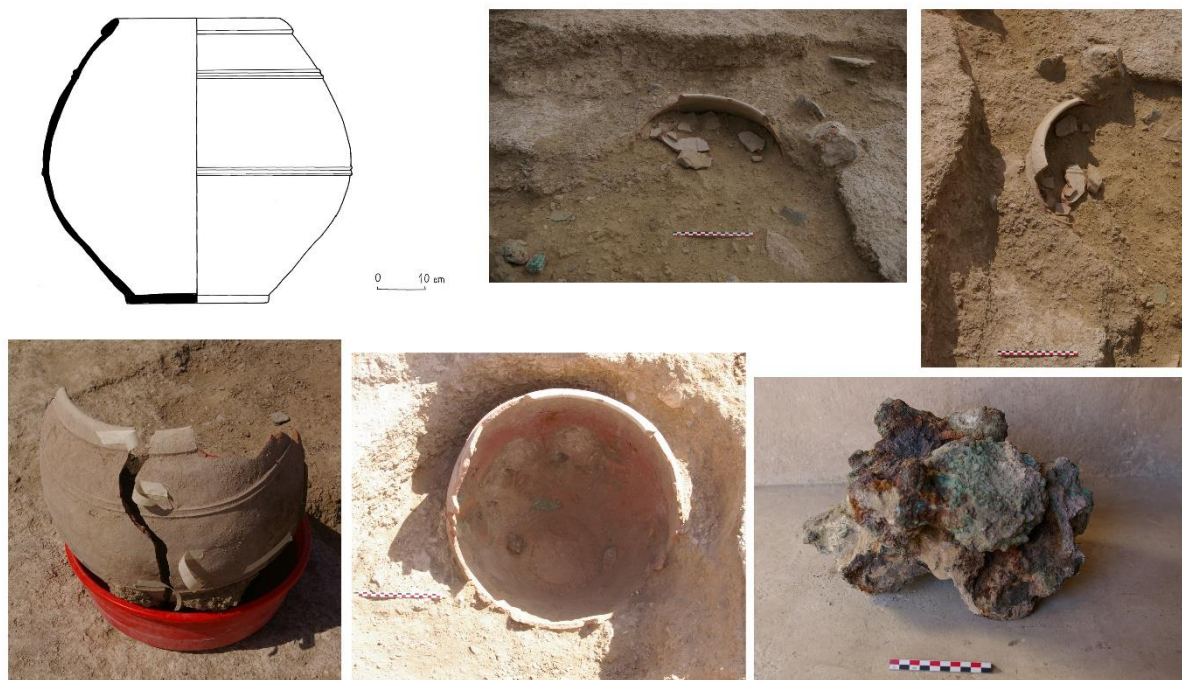
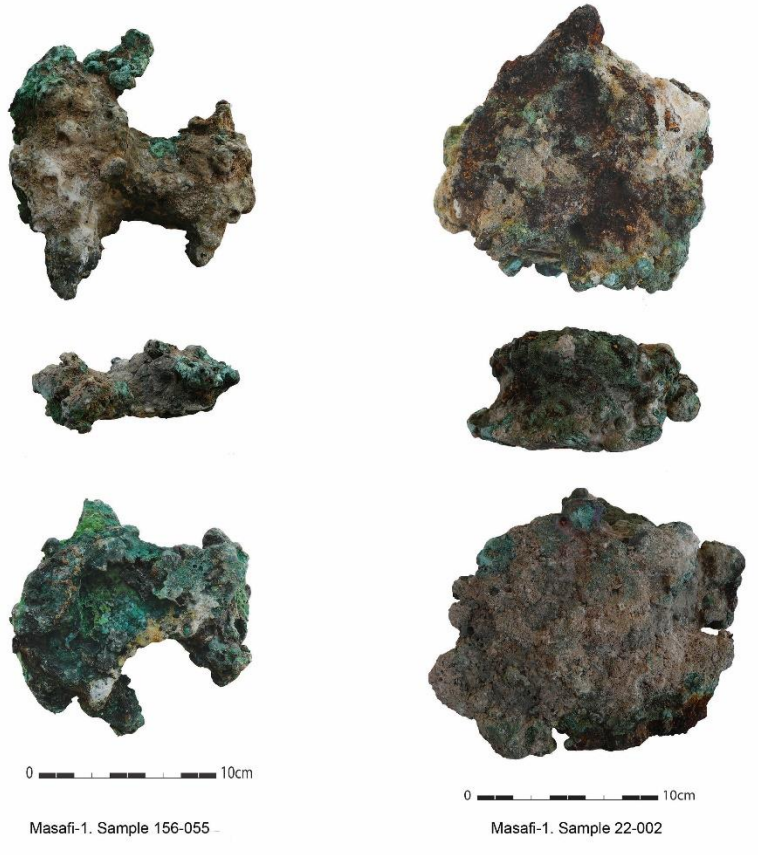
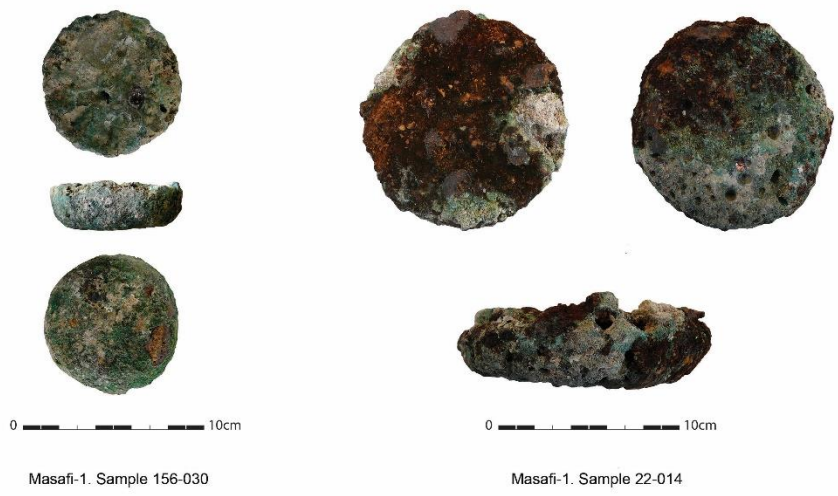
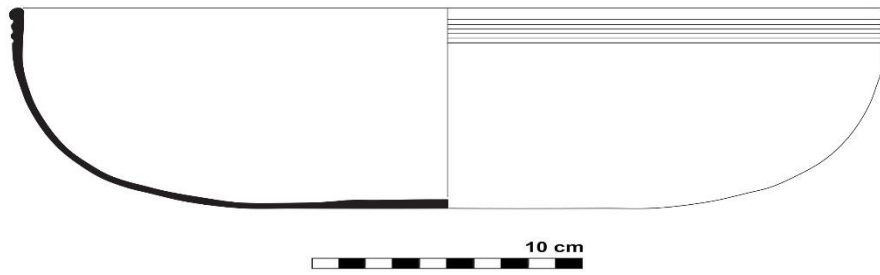


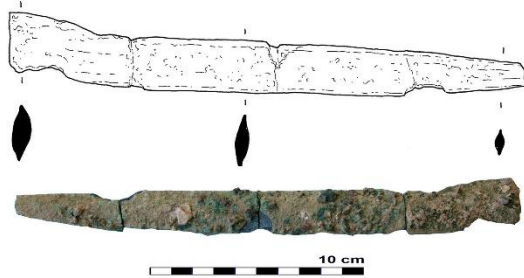
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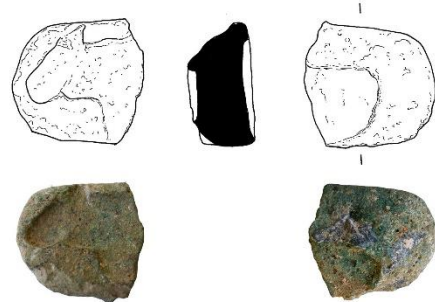
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Masafi-1. m.002



Masafi-1. m. 009



Masafi-1. m.010



Masafi-3. m.016



Masafi-3. m.060



Masafi-3. m.015

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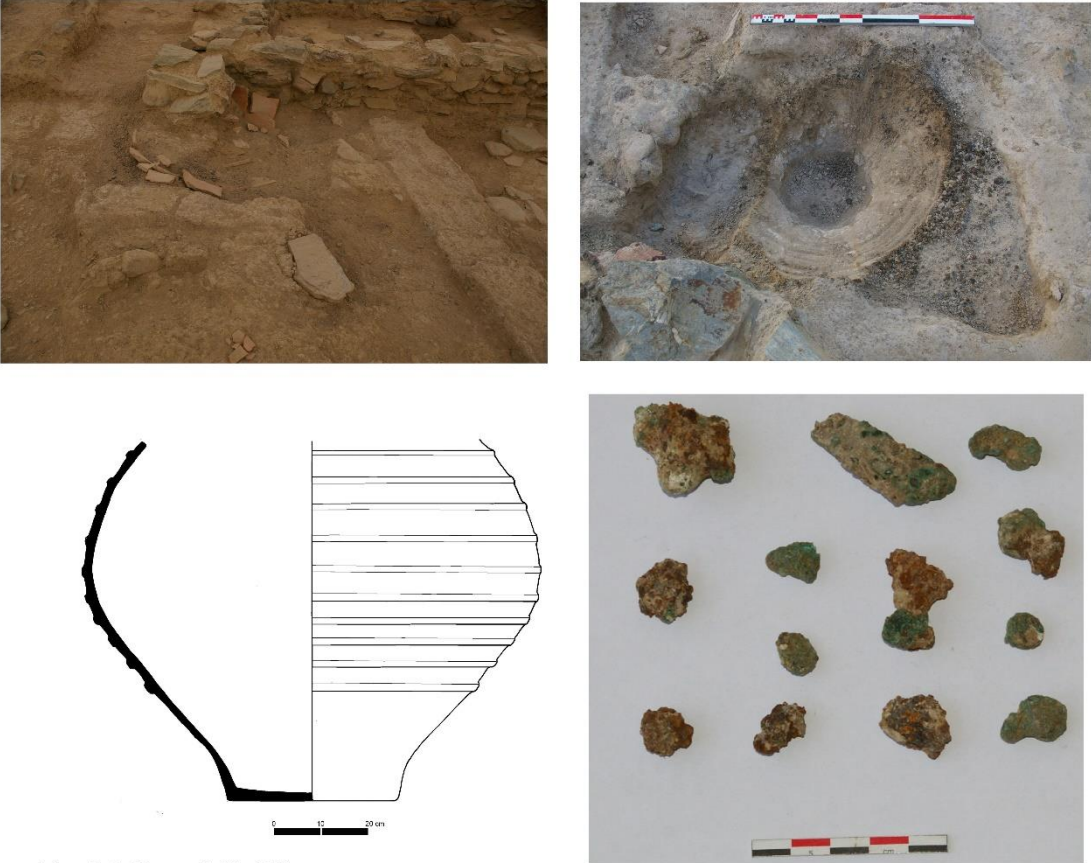
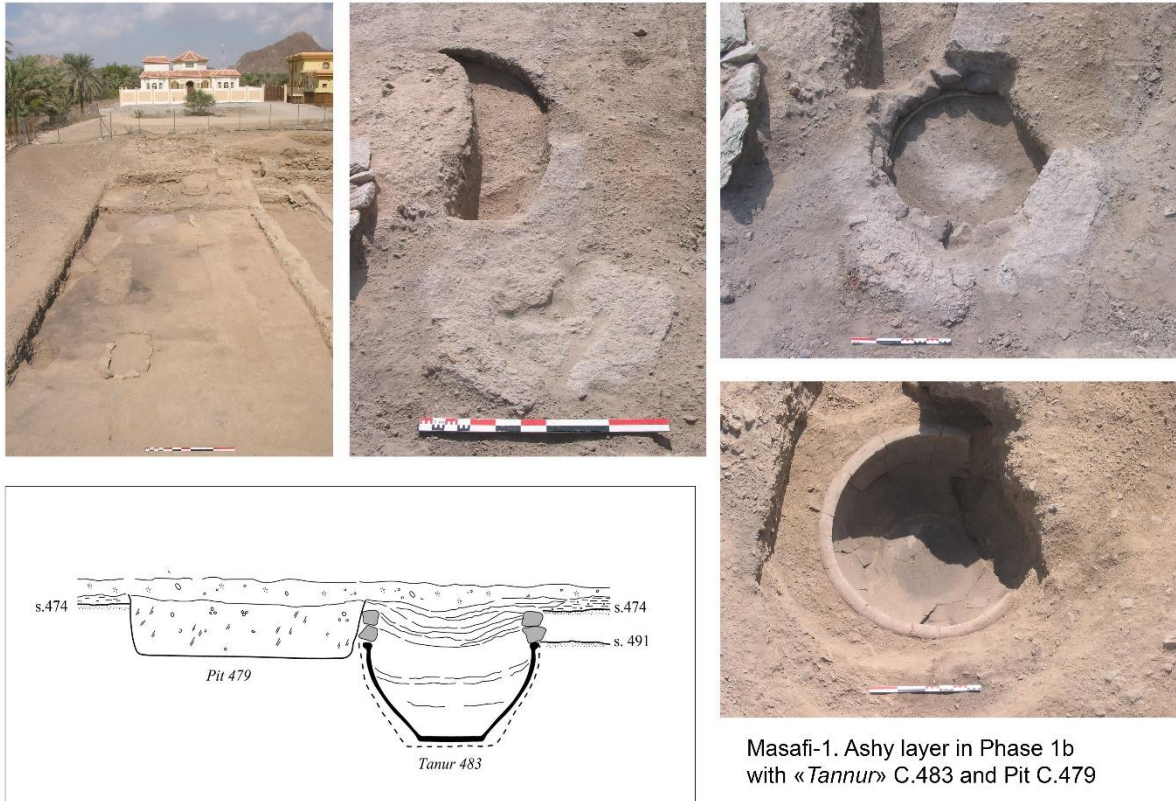


Fig. 11. Ashy layer in level 2b to the west of the collective building, with « Tannur » C483 and Pit C.479. (Photo and sketch drawing: A. Hamel)



Masafi-1. Rooms P.033 an P.038, Niche St.120, a jar bottom on the floor in Room P.033 and copper samples from Rooms P.033 and P.038

**Fig. 12. Niche St. 058, Jar MSF-856 found inside and sample of copper fragments collected in the jar. (Photos: A. Hamel ; Drawing: V. Bernard).**



Masafi-1. Ashy layer in Phase 1b with «Tannur» C.483 and Pit C.479

**Fig. 13. Rooms P.038 and P033, Niche St. 120, details of a jar bottom in room P.033 and samples of copper fragments collected in both rooms on the floor (photos: A. Hamel, C. Le Carlier and J. Goy).**