Conservation of metal artifacts from the Polish Mission excavation at Saruq al-Hadid (UAE)

Abstract: The article documents and discusses field conservation methods and procedures applied to metal artifacts, both copper and iron, discovered by the PCMA team working at the Saruq al-Hadid archaeological site in the UAE (Emirate of Dubai) in 2016/2017 and 2017/2018. An overview is given of the conservation challenges that the state of preservation of the metal finds presented and the methods and procedures that were applied on the site, including brief case studies of the most important finds and treatments.

Keywords: Saruq al-Hadid, weaponry, copper, iron, conservation

The Saruq al-Hadid site in the Emirate of Dubai (United Arab Emirates) is located in the desert some 70 km outside of the city of Dubai. The site, a large mound covered with ancient metal slag, was discovered in 2002 by Sheik Mohammed bin Rashid Al-Maktoum, the Ruler of Dubai. A joint Dubai–Jordanian mission headed by Hussein S. Qandil embarked on an investigation of the remains of metallurgical activities and established site occupation mainly in the Iron Age II period, that is, around 900–600 BC (Qandil 2005: 138). The site also proved to be rich in metal artifacts, usually made of copper and copper-based alloys, as well as of iron, silver and gold.

At the invitation of the Dubai authorities, a team from the Polish Centre of Mediterranean Archaeology University of Warsaw carried out two seasons of research at the site in 2016/2017 and 2017/2018. The Polish sector (other exploration of the site during these seasons included a national Dubai team, the SHARP Project from the University of New England in Australia,

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The Authors and the Project acknowledge their deep gratitude to the Dubai Municipality, the Director General of the Architectural Heritage and Antiquities Department Dr. Ahmad Mahmoud Ahmad, and in particular Mr. Yacoub Yousif Al Ali and Dr. Mansour Boraik for the privilege of working at Saruq al-Hadid and for their generous assistance in every aspect of the work. Our thanks extend to all members of the greater Saruq team, both Dubai and foreign, who devoted their time, effort and expertise to ensuring the success of the conservation part of the Polish project.

a Spanish team from Sanisera Archaeology Institute and a German team from Thomas Urban and Partners) is located in the northern part of the slag-covered mound and has produced, expectedly, an abundance of metal artifacts (for an overview of the archaeological excavation project, see Zych and Wygnańska forthcoming) [*Fig. 1*]. The state of preservation of these finds varies significantly, hence the express need to preserve and conserve objects for study as well as for display in the site-dedicated Saruq al-Hadid Archaeology Museum in Dubai.

Conservators working with artifacts during archaeological missions in countries of the Near East are continuously challenged with difficulties of varying degree of complexity, not the least being to ensure a supply of essential chemical agents and appropriate specialist devices and apparatus. Conservation procedures and treatment have to be planned to address these issues, "organizing" the needed equipment and materials, even if the only effective solution is transport by air from home. Consequently, having at hand a vast array of conservation methods, conservators must choose the procedures that will prove feasible in given circumstances, depending on the type of archaeological site and the digging situation. At Saruq al-Hadid, it was the inventiveness of the present authors, coupled with the efforts of the Dubai side, that enabled the conservation of metal objects from the Polish sector of excavations. The paper discusses the conservation procedures that were effectively applied during the project, presenting in exemplification case studies of selected artifacts from the metal finds collection.

Fig. 1. The Polish sector at the site of Saruq al-Hadid: excavation in Squre V8 in the earlier stages of the project, looking east (2017) (PCMA UW PMSaruq Project, Dubai Municipality/photo J. Rądkowska)

STATE OF PRESERVATION OF METAL ARTIFACTS

The state of preservation of the artifacts was dependent on the kind of metal, of which they were made. Fragments of gold tape did not need to be conserved or even cleaned, whereas iron artifacts were in the worst possible condition, layered, swollen and cracking. Sword SAH17-V8/6515/001 was in the best state, being found in one piece, but could not be lifted whole [see *Fig. 11*]. The pieces could be glued together, as was frequently the case with other finds, but most of the time sieving techniques of excavation brought up splinters and corroded dust well beyond any attempt at shape identification.

The high salinity of the dune sand matrix affects the metal objects, those made of iron in particular, but also copper and even silver pieces. In extreme cases, salt efflorescence was present on the surface of the objects. Artifacts from the upper layers, near the sand surface, are usually in better condition than those found in the lower-lying strata. Copper-based items from the dune top are just weakly corroded on the very surface and this regardless of their size; the core is untouched and cleaning usually gives spectacular results. However, the thin-walled artifacts and sometimes even the thick arrowheads, especially from the bottom layers of the dune, may be corroded completely, the oxide, chloride and sulfide compounds having eaten away the metal. At first glance, the shape of the object is evident, but cleaning will reveal a hollow where the metal core should be. In contact with air, the chlorides under the relatively weakly active surface corrosion in such artifacts will trigger more intensive corrosion, dissolving anything of metal that is still inside. The larger and thicker artifacts tend to be better preserved than the small objects.

Another issue at Saruq is the evidently intentional damage of the artifacts by their users, particularly in the case of finds from the topmost layers of the dune. Saruq has been proved to be a smelting and metallurgical center and, in its latest phase, it was remelting copper scrap. Apart from remains of furnace bodies, the evidence of these processes comes in the form of objects that had been recovered from the sand layers of the dune and portioned or broken, followed by secondary processing: cutting, forging, bending, hammering, fusing and melting together with other artifacts. Ingots have also been found, as well as copper scrap of all sorts, all a semi-product of the remelting process.

CONSERVATION METHODS

The only way to expose and preserve the original metal surface or whatever is left of it, along with ornaments and post-manufacturing traces, is to stabilize the products of corrosion. For study purposes, the artifacts had to be examined macro- and microscopically and the requirements of these techniques largely determined the choice of conservation methods. Exposing the original surface was a way of checking for the presence of ornamentation; finding decoration led to further treatment in order to uncover it fully and make it more pronounced.

Mechanical cleaning is the main procedure for removing dirt and corrosion products. Initial surface cleaning of the artifacts was carried out with a micro-engine fitted with appropriately selected diamond milling cutters. Precise manual tools, such as scalpels, hand scrapers, needles, tiny chisel-shaped scrapers, were used for the less easily reached spots. Tool tips were adjusted to the shape of the cleaned surface (Safarzyński and Weker 2010: 35) [*Fig. 2* top].

The recorded high salinity also required that the artifacts be protected against secondary corrosion. Testing of different desalinization procedures on the objects from the Saruq excavation allowed specific procedures to be chosen depending on the metal. For corroded iron artifacts, it was desalinization in a sulphite bath. For artifacts made of copper and its alloys, active corrosion was neutralized by electrochemical reduction using Rosenberg's method [*Fig. 2* bottom] (Safarzyński and Weker 2010: 38), followed by stabilization in a sodium sesquicarbonate solution (Cronyn 1990).

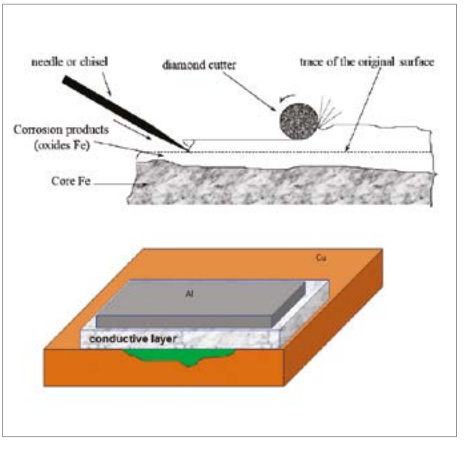

Fig. 2. Conservation procedures: top, mechanical cleaning; bottom, Rosenberg's method of electrochemical reduction (After Safarzyński and Weker 2010: 35 and 38)

STABILIZATION IN AN ALKALINE SULPHITE BATH

The process chosen for stabilizing corroded iron artifacts consists of washing out chemical salts from the corroded layers to prevent secondary corrosion of an artifact that has undergone full and complete conservation when it comes in contact with moisture. The most common salt is the commonly encountered sodium chloride (NaCl). Chloride ions are bound with iron ions. The resultant highly hygroscopic $FeCl_3$ catalyzes the iron corrosion process, leading to rapid chemical reactions which are dangerous for the object.

An alkaline sulphite bath is a mixture of 0.1 M NaOH and 0.1 M Na_2SO_3. The corroded item is placed in the solution, which is heated to a temperature of 65ºC. Chemical reactions cause decomposition of the iron oxides and chloride salts; they are washed out from an object and removed with each change of the bath. After several changes, the salt concentration in the bath drops below 20 ppm and the chloride content in the corroded layers is so low that it no longer constitutes a threat to the artifact [*Fig. 3* bottom].

The sulphite bath process was performed in a custom-built container made of stainless steel with automatic temperature regulation. The tub was prepared to fit the length of the iron sword that was discovered earlier in the season. It was deemed more time- and effort-effective to have the container produced to order in Poland and brought to Saruq by the conservation team [*Fig. 4*].

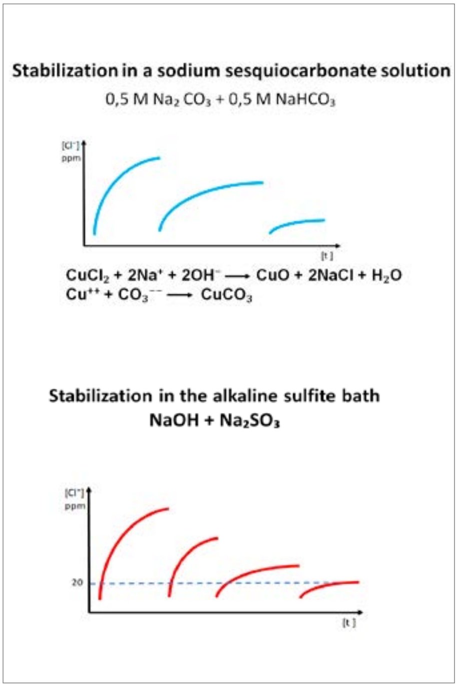

Fig. 3. Stabilization variants charting concentration of chloride ions washed out in subsequent baths: top, sodium sesquicarbonate solution for corroded copper and copper-alloy products; bottom, alkaline sulphite bath for corroded iron objects (Chart W. Weker)

STABILIZATION BY MEANS OF ELECTROCHEMICAL REDUCTION

The method assumes the creation of a galvanic cell in the place where active corrosion occurs. This is achieved by placing a zinc or aluminium foil on the treated fragment of the object. A layer of conductive gel (e.g., agar-agar) between the foil and the object acts as an electrolyte. As a result, the undesirable compound containing chlorides, i.e., paratacamite $Cu_2(OH)_3Cl$, is decomposed. The foil dissolves during the process. Harmful chlorides are removed along with the layer of used gel when the foil is replaced. The procedure frequently needs to be repeated several times. A modification of this method, known as Krefting's method, consists of total immersion of an object wrapped in foil in the electrolyte solution (weak base or weak acid).

STABILIZATION IN A SODIUM SESQUICARBONATE SOLUTION

Sodium sesquicarbonate is a mixture of 0.5 M $NaHCO_3$ and 0.5 M Na_2CO_3. Its reaction with paracatamite (MacLeod 1987): $Cu_2(OH)_3Cl + 4\,CO_3^{2-} \rightarrow 2\,Cu(CO_3)^{2-} + 3\,OH^- + Cl^-$ results in the creation of a soluble calcium carbonate ($Cu(CO_3)^{2-}$) which

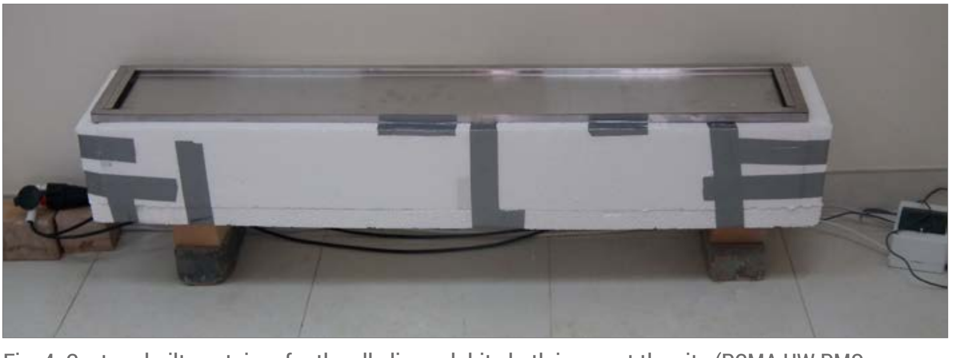

Fig. 4. Custom-built container for the alkaline sulphite bath in use at the site (PCMA UW PMSaruq Project, Dubai Municipality/photo W. Weker)

dyes the bath blue. The chloride ions (Cl^-), which permeate into the solution, are removed along with the used solution. The object concerned is placed in a sodium sesquicarbonate solution for 24 hours. The change of color of the solution means that paratacamite, a dangerous component of corroded layers of artifacts made of copper alloys, is decomposing. The bath should continue to be changed until the sesquicarbonate solution ceases to change color. A deposit of carbonates formed on the surface of the object acts as a stabilizing layer, insulating the deeper layers of corrosion products against the impact of the environment.

After exposing the original surface of copper or copper-based objects (laboratory tests for composition were not an option at the time), a test for the presence of active corrosion was performed. It consisted in observing the state of the artifact placed in a chamber with humidity at nearly 100%. Bright green efflorescence indicated the presence of salinated areas requiring particular attention on the part of the conservator. Objects with active corrosion were subjected to further treatment by the stabilization methods described above. If there was no active corrosion, the object underwent further conservation procedures depending on its state of preservation. In some cases, corrosion products were removed chemically in a bath consisting of a 5% solution of sodium edetate (EDTA). After completion of the surface treatment, the surface was degreased and the object dried in order to protect it against further corrosion. A bath in a 2% alcohol solution of benzotriazole (BTA), used as a corrosion inhibitor for copper-based artifacts, was applied. Conservation was finished with the artifact surface being coated with a thin transparent layer of Paraloid B44 to protect against changes of environment parameters. The thin layer that is formed protects the object against pollution and contact with certain materials, and consequently against tarnishing.

CONSERVATION AND METAL ARTIFACT STUDIES

In the course of two seasons at Saruq al-Hadid, 131 metal artifacts were conserved out of a total of almost 900 registered items from the excavation. Initial examination allowed the restorers to classify the finds to three groups depending on their state of preservation:

• requiring immediate conservation;
• suitable only for preventive conservation (objects too corroded to sustain any kind of conservation treatment);
• small and/or completely corroded fragments of objects with no study value; this group had the lowest level of priority, to be treated more extensively at a later date.

The latter were usually artifacts with damaged structure, threatening to disintegrate should cleaning be undertaken. In these cases the layer of oxides was not removed and the objects were preserved in EDTA baths, then soaked with BTA corrosion inhibitors and coated thinly with Paraloid B44. Mechanical cleaning was carried out strictly for the purpose of rendering the original appearance as much as possible.

Finds coming in from the field were segregated first as either worked or unworked metal. Amorphous pieces of metal were not taken into consideration at this stage in the research. The worked finds were classified by form and function into the following broad categories: semi-products (mainly copper tape); weaponry including arrowheads, daggers, knives, swords; utilitarian tools, like axeheads, tweezers, rings; vessels; jewelry, e.g., bracelets, rings; ritual objects, i.e., snake representations; and the fairly large group of mystery objects for which a secure interpretation has yet to be found. An extensive category consisted of scrap metal, objects frequently cut assumedly for remelting, which cut across practically all other categories as these late craftsmen were obviously digging the dunes in search of valuable metal. A division by the kind of metal was also recorded, this again cutting across the functional and formal categories in some cases. There were also products of the furnaces, like ingots and copper and iron slag, but these will not be referred to in this paper.

Preliminary mechanical cleaning of the artifacts allowed the restorers to single out the objects with well preserved surfaces. From the point of view of research into metal-working technologies, these objects offered the greatest promise of marks that could be studied. Thus, the presence of technological and use-wear traces were the first criterion for selecting artifacts for full conservation treatment. Decoration also fell into this category; for instance, once a snake figure was found to bear incised decoration, all the other serpent bodies were tested to see whether they should be cleaned and preserved more extensively (without finding any further decorated pieces, however).

The Dubai Municipality authorities were also instrumental in selecting objects for conservation, their aim being to prepare a wide range of interesting artifacts for future museum display. This was not always in line with research objectives, but was respected by the conservation team.

Last but not least, the conservators also followed the mission's agenda focused on the most important and prestigious finds from the Polish sector. Among these was the iron sword, the only artifact of its kind found complete in the trench excavated by the Polish team (complete iron swords have been picked up from other sectors in Saruq al-Hadid).

TECHNOLOGY, FORM AND FUNCTION

First and foremost, mechanical cleaning gave the chance of isolating finds that were fused together. This was the case of a bunch of arrowheads from Square V8 that had probably been deposited together in a quiver made of organic material. Careful separation of individual points allowed a full study of the content of this receptacle as well as permitting all the arrowheads (SAH18-V8/6515/002–019, 024, 025) [*Fig. 5*] to be cleaned and conserved. But these objects were in fair condition. The much poorer state of preservation of arrowhead SAH18-S7/7403/007 required far more precise action in order to preserve it, a decision justified by the fact that it represented a rather uncommon type, of which there was only this one example in the Polish sector.

Very poorly preserved and troublesome to clean and protect was a piece

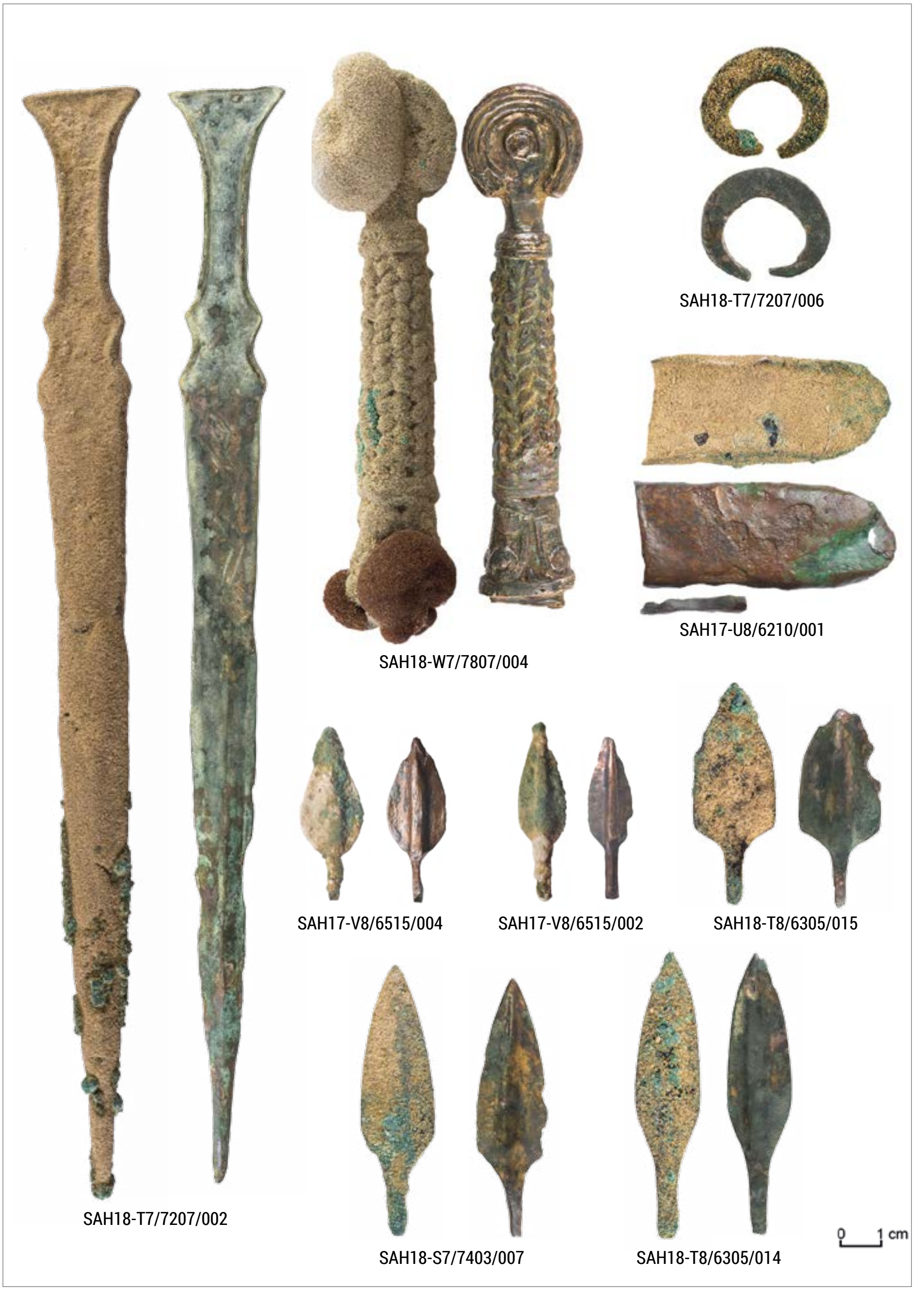

Fig. 5. Selection of copper and copper-based artifacts from Saruq al-Hadid conserved in 2017–2018 (views before and after conservation): left, small dagger; top center, handle of Luristan dagger; top right, crescent-shaped clasp(?); center right, copper-sheet belt(?) fitting; bottom right, selection of arrowheads (PCMA UW PMSaruq Project, Dubai Municipality/photos J. Kurzawa)

of copper metal SAH17/U8/6210/001 [see *Fig. 5*]. This piece without a parallel anywhere else in the United Arab Emirates could have been the end fitting of a leather belt. At first glance the fitting seems complete, but the thinness of the sheet metal (barely 1 mm) has resulted in the metal being corroded all the way through. Despite utmost care, one of the side surfaces broke off at the bending, losing also the joining surface. Nonetheless, cleaning helped to establish the thinness of the piece and excluded the presence of any rivets or other fastening devices suspected initially in the thick deposits covering it. The only way it could have been fastened to the belt was by clamping the sides and using perhaps some kind of adhesive (of which there was no trace).

Another curious object that revealed technological traces after cleaning was a crescent-shaped copper piece SAH18-T7/7207/006 [see *Fig. 5*]. This artifact, almost 2.5 cm thick, was preserved in very good condition. Once it was cleaned, the surface demonstrated marks that evinced hammering with a flat hammer at different angles and bending of the original cast element. No parallels are known from the site in general and knowing how it was made did not help in identifying its function. It may be a kind of crude buckle from a horserider's harness.

The handle of a dagger, SAH18-W7/7807/004 [see *Fig. 5*], was a particularly interesting piece to clean and conserve as it combines two different metals, that is, an iron blade fitted into an intricate handle made of a copper-based alloy. Only a minute piece of the blade was preserved by the end of the handle, the copper oxides from the handle weakening the corrosion of the iron at this point. However, the proximity of the iron caused the copper-based handle to corrode more heavily. The presence of iron suggests that the dagger was brought in, perhaps from Iran, as it is from there that iron was imported at this time in the history of the region. The antennae-like shape of the handle terminal points to a Luristan origin of this piece. Interestingly, a few others of the same kind are known from Saruq al-Hadid, but none from other sites in the United Arab Emirates.

DECORATED OBJECTS

The presumed Luristan dagger described above presented a richly decorated form. Cleaning of the surfaces articulated and enhanced it. In many cases, however, decoration was not immediately visible and only cleaning of the surface could bring it to light. This was the case of a copper snake SAH17-V8/6516/004+005, one of a triad found with the deposit of weapons and vessels in Square V8 (context 6515) [see *Fig. 8*]. This particular snake had been doubled over, the tail bent back over the head and upper part, probably until it had broken. It had been deposited in this condition and products of corrosion had fused together the side edges of the doubled body. The pieces were separated and cleaned, revealing decoration in the form of a line of irregularly spaced, incised circles. The two ends of the representation were then carefully recomposed and set together with an adhesive.

A bowl, SAH17-V8/6517/001, found in the same deposit turned out after cleaning to be decorated with incised ornaments on the flat rim [*Fig. 6*]. This ornament consisted of dotted triangles and herringbone pattern. The decoration was consistent with parallels known from the site for this bowl, but conservation of this vessel proved extremely difficult. The thin walls were completely corroded, so despite the appearance of being complete, the inner metal had been attacked and destroyed by active corrosion operating under the surface coat of less active corrosion. The size of the vessel and difficult access to the inside surface made the conservation treatment laborious and unrewarding. Careful observation revealed more decoration around the circumference and on the floor. It turned out that the decoration had not only been incised, but also cast in some places, and required meticulous cleaning not to be destroyed. The best solution

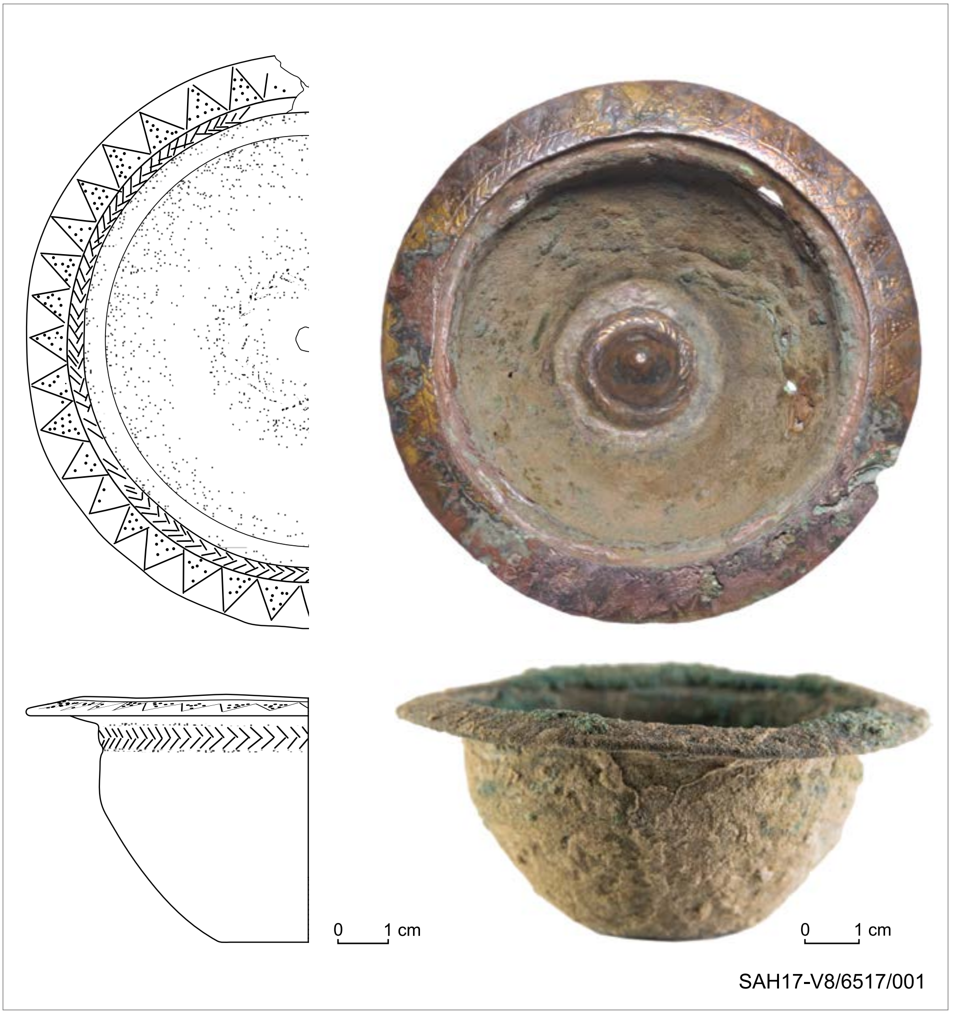

Fig. 6. Copper bowl: side view before conservation; top view after cleaning of the rim decoration and conservation; drawing shows the full extent of the decoration found on the bowl (PCMA UW PMSaruq Project, Dubai Municipality/photos J. Kurzawa, drawing M. Momot)

Fig. 7. Utilitarian copper tools: top, axehead with incised snake motif (view before and after conservation); bottom right, small scraper conserved as found (view after conservation); bottom left, anklet with parallel incisions on the terminals (view before and after conservation) (PCMA UW PMSaruq Project, Dubai Municipality/photos J. Kurzawa)

was to clean the decoration section by section. Action on the thin walls was reduced to a minimum. Stabilization in an electrochemical bath left empty spaces where active corrosion had operated. As explained in the methods section, the object was stabilized in a BTA inhibitor and coated with Paraloid B-44 to prevent further degradation. The gaps in the body of the bowl should be filled in, but this can be done in the course of a longer season.

Decoration in the form of an incised snake motif was revealed by surface cleaning of an axehead SAH18-W7/7807/005 [*Fig. 7* top], a dagger SAH18-T7/7207/002 [see *Fig. 5*], and a flat triangular object, SAH18-U8/6216/006 [*Fig. 8*]. The snake has symbolic significance in late Bronze and Iron Age I–II Saruq al-Hadid as well as the region in general (Benoist 2007), the copper snake representations counted in the hundreds, if not thousands, being just one example. The presence of this decoration on other objects of different function (both utilitarian and ritual/symbolic) should be considered as telling. Both dagger and axehead also yielded technological traces associated with their making. Casting seams were revealed on the axehead, making it clear that it had been cast in a two-part mold. The dagger was cast in a much simpler mold (possibly openface one-part).

Another piece, a small sword SAH18-V8/6517/002, had a decorated handle and copper tape carefully soldered around the edges [*Fig. 9*]. These became obvious only after the handle had been cleaned. The dagger was a unique piece in terms of its preservation. Similar dagger handles with bone inlay had been found earlier at Saruq al-Hadid, but never complete on two sides and with the blade preserved. in this case there was strong pressure from the Dubai authorities to complete a full conservation program which involved not only the copper parts, but also the bone inlays. The latter had to be removed, cleaned with ethyl alcohol, recomposed where cracked or split by the rivets, and set together with an adhesive (5% Paraloid B-44).

Last but not least, there were two anklets (SAH18-T7/7207/011) [see *Fig. 7*

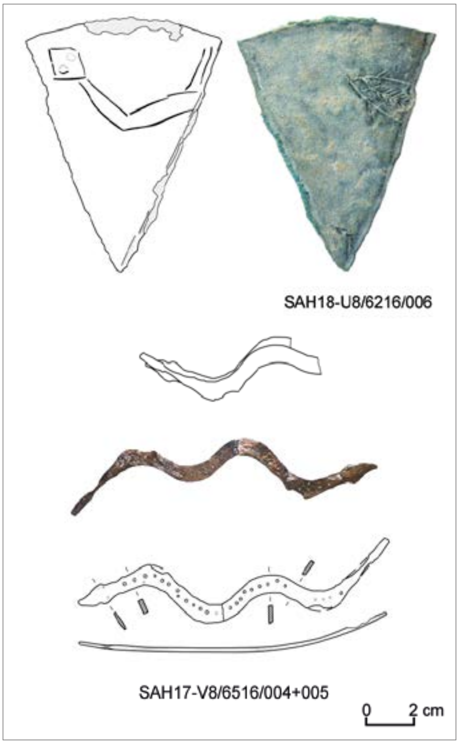

Fig. 8. Conserved decorated copper finds: top, triangular object with incised decoration, including snake motif (view after preliminary cleaning of the surface); bottom, snake figure decorated with incised dots along its back (view and drawing after conservation; at the top, drawing of the snake figure as found doubled and fused by corrosion at the edges) (PCMA UW PMSaruq Project, Dubai Municipality/photos J. Kurzawa, drawing M. Momot)

bottom left] with much simpler decoration in the form of four parallel incisions at each end. More interestingly, conservation in this case revealed three equally spaced incisions, but much shallower, on the inside. These had not been visible before cleaning. It is not clear whether this is aborted ornamentation or it had some practical function. Interestingly, the same sets of four incisions can be observed on the ends of the much larger so-called camel anklets (discovered in other

Fig. 9. Small sword with bone-inlay handle SAH17-V8/6517/002: left, object after conservation; bottom center, pieces of bone inlay after conservation; top center, the bone inlays fitted back into the handle; top and bottom right, incised decoration of the blade below the handle on two sides of the weapon (PCMA UW PMSaruq Project, Dubai Municipality/photos W. Weker and J. Kurzawa, drawing M. Momot)

sectors of the Saruq al-Hadid site and now on display in the museum in Dubai).

SILVER JEWELRY

The two small silver beads, from two different squares SAH17-T7/7201/012 and SAH17-T8/6301/007 [*Fig. 10*], were cleaned in order to study the techniques production. Microscopical examination of the two beads (they are each the size of a small green pea, 4 mm in diameter) have not provided any conclusive evidence in this regard. Granulation technique was used in their production, but the granules are not typical; they are flattened and irregular compared to the golden granules of European medieval artisans. The technique called for drops of silver being rained from a brush to cool in a vessel full of water. This gave them a round shape. But the granules in the two beads from the Polish sector of excavations at Saruq al-Hadid were made in a different way. Moreover, the joining between the granules was not discernible, thus giving the impression of a polished openwork wire. Microscopic examination has suggested that the granules were soldered together with silver. Using the same material that the granules were made of obscured all traces of potential tools. The appearance of the granules and the technology are identical with that of the mainly golden granulated jewelry from Iron Age sites in the United Arab Emirates.

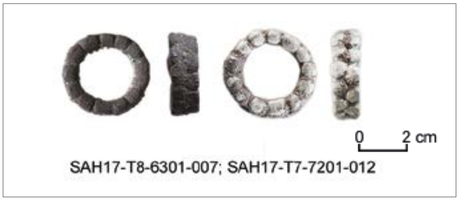

Fig. 10. Two silver rings: left, one ring before conservation; right, another ring after conservation (PCMA UW PMSaruq Project, Dubai Municipality/photos M.Sita)

PRESERVING THE STATUS QUO

Little more than preservation of the status quo was possible for the long iron sword SAH17-V8/6515/001 [*Fig. 11*] discovered in a deposit in Square V8. Conservation in this case had to deal with the extraordinary size of this object, which had made its transport from the site, and storage until conservation could be arranged, troublesome and which required a custom-built receptacle for the bath. The process of stabilization of the piece was conducted in a sulphite bath; corroded and displaced fragments were reattached in place. There was no hope of cleaning the original surface owing to its considerable deformation [see *Fig. 11: a, b*]. Little could be done for the blade, which slowly disintegrated into several pieces and splinters, but careful treatment of the handle allowed a reconstitution of its structure [see *Fig. 11: d*]. In effect, it was possible to identify the origins of this sword as most likely coming from Luristan (Overlaet 2003).

The same restricted preservation process was applied to the small scraper SAH17-V8/6515/020 [see *Fig. 7*]. It was heavily damaged and delaminated, making any attempt at standard cleaning unfeasible. It was clear from the start that it would not yield the same kind of in-depth information as the axehead discussed above. It was conserved as is, primarily to preserve the artifact, the only intervention being to glue a few fragments that were breaking off. It is not always possible in such cases to observe production technique.

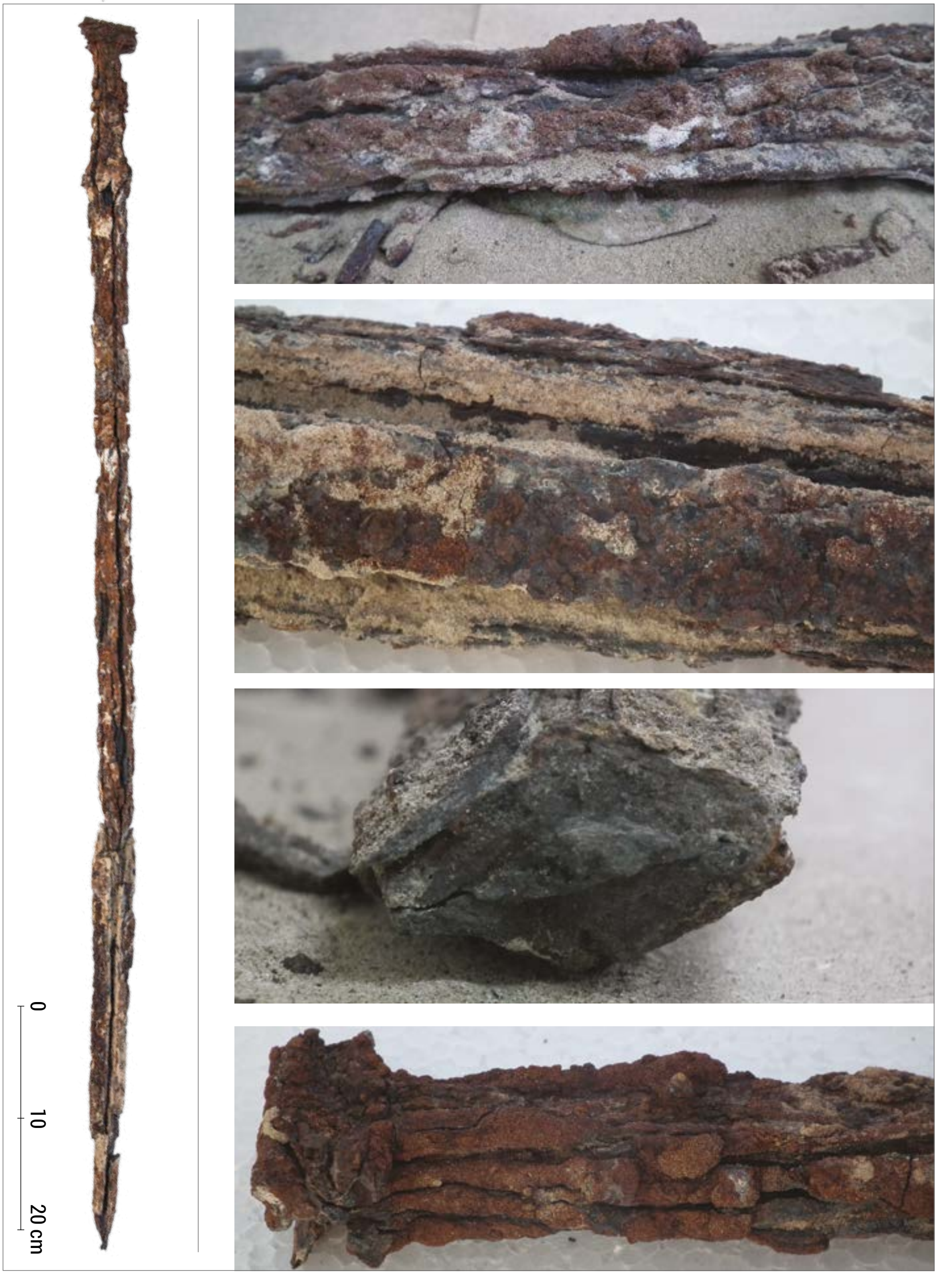

Fig. 11. Iron sword SAH17-V8/6515/001: left, state after conservation; right from top, a – condition of the blade after discovery; b – another fragment of the same blade before treatment; c – section through the blade, after stabilization in alkaline sulphite solution; note complete absence of iron core; d – handle after stabilization, cleaning and consolidation. The degree of damage (deformation, numerous cracks) prevented a reconstruction of the original surface (PCMA UW PMSaruq Project, Dubai Municipality/photos W. Weker and J. Kurzawa)

CONSERVATION MONITORING

Monitoring is a requisite when artifacts that have undergone conservation treatment are kept in storage. For one, it was a way of checking on procedures applied in the first season to see how effective they were following a full year cycle in the conditions present at the site. There was only one case that necessitated repeated treatment and these were tweezers SAH17-U7/7602/001 recovered from lower layers and hence more likely to be deeply corroded. Corrosion appeared inside the hard to access bend, which had not been cleaned sufficiently the first time around.

SUMMARY

The task of all conservators, regardless of the material they are dealing with, is first of all to save historical artifacts that constitute man's heritage. In the two seasons at Saruq al-Hadid, the authors protected and conserved several hundred metal objects from the Polish sector, some of these unique. After conservation, these artifacts may be exhibited at the Saruq al-Hadid Archaeological Museum in Dubai, which was one of the objectives set for the team by the Dubai authorities.

A prime objective for the specialist, however, was to study artifacts under a microscope to examine production techniques in an effort to expand the current technological knowledge of Bronze and Iron Age metal production in southeastern Arabia and the region. This was achieved to a large degree. The applied conservation methods allowed traces of ornaments and various technological and ornamentation processes to be revealed on the surface of the artifacts. They were documented and may serve as reference for further research regarding not only the collections from Saruq al-Hadid, but also metal artifacts from the region.

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