Preliminary Archaeometallurgical Investigations of Bronze Age Metal Finds from Shahdad and Tepe Yahya

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Shahdad and Yahya which are two important prehistoric sites in the Kerman Province, are of most importance for Archaeometallurgical studies. During excavations at these sites a number of metal objects have been discovered. Moreover, evidence of metal working on the surface testify to manufacturing of metal objects. This also shows that the site might have experienced craft specialization.

The following contribution is representing results of archaeometallurgical investigations on several metal artifacts from prehistoric contexts from the sites of Tepe Yahya and Shahdad which are situated in Kerman Province. The aim of this research is to investigate the provenance of the raw materials which had been used. Further some new observations concerning the distribution of artifacts will be presented.

Keywords: Bronze Age; Shahdad; Tepe Yahya; Ur; Metal Artifacts

Introduction

During the find registration in the National Museum of Iran in Tehran (May-June 2006), nineteen metal artifacts from the Bronze Age settlements of Shahdad\(^2\) and Tepe Yahya\(^1\) in southeast Iran were sampled. Three of them came from prehistoric layers IVC2-IVB at Tepe Yahya\(^4\), and sixteen came from graves of periods TAK III-TAKII, from Shahdad (Hakemi 1997: 83, Table 2).

This paper presents research results reached by utilizing energy dispersive X-ray fluorescence (EDXRF), which determines the chemical content in order to assess the origin of raw materials (Lutz & Pernicka 1996: 313-23). The main requirement is that the artifacts analyzed are primary artifacts and not made from reused metal. The analysis was conducted at the Curt Engelhorn-Zentrum Archäometrie in Mannheim, Germany.

Sampling\(^5\)

The metal artifacts from Tepe Yahya are referred to here as MT01-MT03. MT01 (fig. 1) is a copper shaft-hole axe from layer IVB5 (Lamberg-Karlovsky & Potts 2001: 115, fig.4.44 (SF3756); Lamberg-Karlovsky and Thornton 2004: 52; Stöllner et al. 2004: 582, no.55). It has parallels with other copper axes from Shahdad (Hakemi 1997: 636, Gp.3), Damin (Tosi 1970: 46-47, fig.17a) and Susa (Tallon 1987: vol. I, 96, no.73[Sb821]). MT02 (fig. 2) is a remarkable theriomorphic figurine, first described as a capride.\(^6\) Subsequent to the recent examination, it seems more likely to represent a felid. The dating of this figurine is unclear, because the results of the archaeometallurgical investigations contradict the previous dating to layer IVB. MT03 (fig. 3) is an unregistered copper spearhead (Lamberg-Karlovsky and Potts 2001: 9, fig.1.26) from layer IVC2, which shows some parallels with Susa III artifacts from Susa (LeBrun 1971: fig. 67.1-3).

The artifacts from Shahdad are referred to as

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\(^1\) This is a revised version of the archaeometallurgical chapter from my Masters thesis, first presented at the "Second International Workshop on Early Iranian Metallurgy (19-21 September 2007)" at the Department of Archaeology, University of Nottingham, England.

\(^2\) Shahdad is located on the western margins of Dasht-e Lut, about 75 km east of Kerman.

\(^3\) Tepe Yahya lies in the Soghun Valley, approximately 225 km south of Kerman and 30 km northeast of Doulatabad.

\(^4\) Unanimity regarding the dating of Strata IVC-IVB is summarized in Lamberg-Karlovsky & Potts 2001, ch. 8 and following.

\(^5\) All photos of sampled artifacts were taken by the author in June 2006, at the National Museum of Iran.

\(^6\) This artifact was first presented as a steatite animal head (Lamberg-Karlovsky 1970: Fig. 21W). After the find registration at the National Museum of Iran and the subsequent archaeometallurgical analysis, it became obvious that this animal figurine was made of a copper alloy.
MT04-MT19. MT04 and MT05 (figs. 4, 5) are copper adzes, which can be compared to type Gp.12 (Hakemi 1997: 638, Gp.12); on this basis, they are dated to TAKIII₂-TAKIII₁, the second half of the third millennium B.C. MT06 (fig. 6) is a copper dagger roughly dated to the period of TAKIII₂-TAKIII₁, due to other finds from Grave 142 (Hakemi 1997: 301, object no. 1494; 639, Gp. 2). The tapering bar MT07 (fig. 7), which was first presented in an unpublished Doctoral dissertation (Vatandoost-Haghigi 1977: 92, no. 12; 1999: 128, no. 12), and in the catalogue of the Bochum exhibit catalogue Persiens Antike Pracht, also dates to this period (Stöllner et al. 2004: 591, no. 63). Samples
MT08 (fig. 8) and MT19 (fig. 19) are derived from small copper shaft-hole axes which have parallels at Mundigak Level III6, the transition from the Late Chalcolithic to the Early Bronze Age (Casal 1961: vol. I, 249; Vol. II, plate XXXIX.B.10a). MT09 (fig. 9) likewise derives from a copper shaft-hole axe, which based on its shape, can be compared to MT01 from Tepe Yahya and to the above-mentioned parallels from Shahdad, Damin and Susa. A previously unpublished sickle blade-shaped knife, MT10 (fig. 10), has some parallels at Susa, although they lack such elaborate hilts (Tallon 1987: vol. l, 181, 595 [Sb9627]). An almost identical knife with a thickened hilt was found in Grave 80 in Cemetery A at Kiš and is dated to the end of the third millennium B.C. (Hauptmann and Pernicka 2004: plate 39, 657). MT11 (fig. 11) and 18 (fig 18) are copper chisels with parallels at Susa, from the transition from the third-second millennium B.C. (Tallon 1987: vol. I, 163, 462-70). Parallel finds of copper chisels are documented in Mesopotamia (Hauptmann and Pernicka 2004: plate 32, no. 498, 499; plate 86, 1321, 1322). MT12 (fig. 12), MT13 (fig. 13), MT14 (fig. 14), MT15 (fig. 15) and MT16 (fig. 16) are from copper pins, which correspond with the form variant I.1.3. MT17 (fig. 17), likewise a copper pin, belongs to the variant I.1.2.¹

Archaeometallurgical Results (Table. 1):

Copper (Cu):

The highest copper content measured was 98%, in samples MT01 and MT10; the lowest was 85%, in MT02. The following discusses whether this should be considered pure copper or arsenic copper.

Tin (Sn):

MT02 with 0.96%. In the majority of the sampled items (MT03, MT04, MT05, MT07, MT08, MT09, MT13, MT14, MT15, and MT18), no trace of tin measured above 0.005%. The lack of tin in the other objects was also remarkable. Only two objects, each with a tin content of nearly 1%, can be called bronze, although such small amounts of tin do not measurably affect the properties of alloys.

**Lead (Pb):**

The highest content of lead, 11.6%, was measured in MT02. This strongly indicates that this artifact did not originate in Bronze Age cultural
All artifacts other than MT02 can be designated as arsenic copper, because their average copper content is over 95%, with the arsenic content varying from 0.5%-6.5%. This is considered an unintentional addition of arsenic, or else natural impurities. There is no unanimity among scholars about the highest amount of arsenic allowable in arsenic copper (Charles 1971: 21-24; Lechtman 1996: 481, 501; Pernicka 1995: 47-56).

MT02 has an unusually high lead content (11.6%), which was added to improve the flowing of the copper (Rapp 1988: 24; Reiter 1997: 113). This artifact also has a tin content of almost 1%, which is a typical for locally produced artifacts, copper with lead added in such a high concentration was very common in Mesopotamia and Susiana in this period, and is unknown in locally produced south Iranian metal artifacts, suggesting that MT02 was an import. MT10 and MT11 differ from the remaining samples, which were taken because of their high concentration of nickel in combination with their high arsenic content. This leads to the assumption that the ore body was As-Ni-minerals, like Gersdorffit (NiAsS; Pernicka 1999: 164). MT10 also contains tin (0.84%).

With regard to MT12-MT16, and all the variants I.1.3., only one well stratified parallel was found outside Shahdad, in Pit X, Grave B.64 in the Royal Cemetery of Ur (Wolley 1955: 131, 201, Table 29, U19191). Archaeometallurgical investigations conducted by E. Pernicka and J. Lutz (Hauptmann and Pernicka 2004: 76, 1864, table 120) indicate that the needle found at Ur might be imported. Beyond the technical and formal similarities and the uniqueness of that item at Ur and other Mesopotamian sites, the comparison of their chemical contents is most striking. The “Ur”-needle (fig. 20) is about 98% copper and 1.38% arsenic (Hauptmann and Pernicka 2004: 138), which fits perfectly with the average values of 95% copper and 4.4% arsenic in the samples from MT12-MT16. The differences are negligible, supporting the hypothesis that it was imported. Based on the logarithmic table of all sampled items based on their arsenic and nickel content, a division of the “Shahdad” (MT04, MT06, MT08, MT09, MT10, MT12, MT13, MT14, MT15, MT16, MT17, MT18) and “Tepe Yahya” material (MT 01, MT03) can be discerned. This suggests that the raw materials needed for the production of the metal artifacts belong to one deposit area. However, due to the comparatively small sample of artifacts and our limited knowledge about the situation of mining archeology in

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1 This drawing is reproduced with the permission of E. Pernicka.
Southeast Iran, this hypothesis remains unproven.

The results of the analysis of MT02 from Tepe Yahya emphasize its exceptionality and suggest that it was imported.

MT05, MT11 and MT19, all from Shahdad, appear outside the cluster of Shahdad artifacts on the right of the diagram (fig. 21). This suggests that these artifacts were not made of local raw materials, but the provenience of the deposits from which they were made remains uncertain.

Data comparable to the Shahdad material was published in 1999 by A. Vatandoost-Haghighi (Vatandoost-Haghighi 1999: 128-131, table 2, 1-16d); the first presentation of this material was in his 1977 doctoral dissertation. In it, he analyzed 164 Bronze and Iron Age metal artifacts from Iran (Vatandoost-Haghighi 1977: 81-96, table 1, 225-226). The results of his nineteen analyses on needles and axes from Shahdad support the recent analysis, as there is no deviation. The only difference is due to limitations in the earlier methods of measurement. Cobalt, zinc and gold could not be detected; antimony and tin could only occasionally be detected. It is, therefore, hardly surprising to find just a few of Vatandoost-Haghighi’s results displayed in the plotted diagram (see figs. 22, 23). Instead, all results of analyzed artifacts from Shahdad are shown on the diagram that presents the relation between the elements Ag and Sb. This confirms the homogeneous character of the Shahdad metal materials.
Conclusion:

Since the investigations of D. Bazin and H. Hübner, T. Berthoud and more (Bazin and Hübner 1969; Berthoud et al. 1982; Pigott 1999: 113-14; Schürenberg 1963: 200-30), scientists have determined that the copper ore deposits from Talmessi and Meskani in the region of Anarak contain arsenic-enriched copper minerals like Domeykite (Cu$_3$As) and Algodonite(Cu$_{5.2-8}$As), which had been exploited in prehistoric periods (Pigott 2004: 30; Heskel and Lamberg-Karlovsky 1980: 258-59). Dasht-e Lut is surrounded by rich copper ore deposits, at which traces of ancient metallurgical activities can be documented (Abbasnejad-Sereshti 2003/1382: 68-72). It seems likely that the people of the Shahdad region exploited nearby deposits rather than traveling hundreds of kilometers through the desert to the copper deposits from Talmessi and Meskani.

Unfortunately, most of the more recently discovered areas of mining and metallurgical
activities in the region of Dasht-e Lut have not been studied. Only R. Abbasnejad-Sereshti, an archaeologist from the University of Mazandaran (Iran), utilized a new approach to southeast Iranian archaeometallurgy. For his Masters thesis, he surveyed the area, investigating prehistoric metallurgical activities at sites with traces of mining, or with traces of workshops, or with traces of both activities (Abbasnejad-Sereshti 1994). Further archaeometallurgical research is desirable. Recent studies of the deposits from Sheikh Ali, in the region surrounding Tepe Yahya, confirm the occurrence of copper minerals exploited during prehistoric periods (Rastad et al. 2002). Lead isotope analysis of this material is not complete and the connections between the metal artifacts from Tepe Yahya and the ore deposits from Sheikh Ali remain uncertain.

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