



# Copper processing in the oases of northwest Arabia: technology, alloys and provenance



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## ARTICLE INFO

### Article history:

Received 19 December 2013

Received in revised form

21 October 2014

Accepted 25 October 2014

Available online 11 November 2014

### Keywords:

Archaeometallurgy

Copper smelting

Arsenical copper

Bronze alloying

Saudi Arabia

Late Bronze Age

Roman

Arabian Peninsula

## ABSTRACT

Very little is known about early metallurgical activity in the north-western part of the Arabian Peninsula, despite the region's cultural importance. To begin to address this research lacuna, metallurgical remains including crucible fragments, metal dross and a copper artefact were sampled from two oases in northwest Arabia, Qurayyah and Tayma. The metallurgical activity in Qurayyah is dated to the Late Bronze Age, and in Tayma to the Roman/Late Roman period. At both sites we identified evidence for copper alloying and refining. Small scale copper smelting might also have been practiced in Qurayyah. Arsenical copper was processed at both sites, but in Tayma tin bronze and leaded tin bronze dominated. The chemical analysis of metal prills in crucible linings showed that fresh copper and tin instead of scrap metal were employed in these processes. Lead isotope analysis indicates that at least some of the Tayma metal was imported. Access to raw materials from remote areas is consistent with the importance of Tayma in the trading network of northwest Arabia.

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## 1. Introduction

The oases of northwest Arabia were important nodal points in the overland caravan routes between south and north Arabia, acting also as markets for the exchange of goods (Macdonald, 1997). The emergence and development of the Arabian incense trade route from around 1000 BC (Finkelstein, 1988; Macdonald, 1997; Byrne, 2003; Jasmin, 2005; Hausleiter, 2012) made this region a crucial junction between the southern Arabian Peninsula and cultures and states in Mesopotamia, the Eastern Mediterranean and the Arabah (Edens, 1992). Besides aromatics, copper is recognised as one of the main goods flowing along this route (Edens and Bawden, 1989; Rothenberg and Glass, 1983; Finkelstein, 1995, 103–126; Tebes, 2007). Despite its importance, copper metallurgy in this area has been rarely studied, and relatively little is known about the origin of the metal and the types of alloys used in northwest Arabia, and more generally about metallurgical processes in oasis settlements.

Since 2004 a joint multidisciplinary research project between the Saudi Commission for Tourism and Antiquities and the German Archaeological Institute sheds new light on these issues. The archaeological findings from two oasis sites, Tayma (Eichmann et al., 2006a, 2010, 2011, 2012; Hausleiter, 2010; Hausleiter, 2011; Hausleiter et al. forthcoming) and Qurayyah (Hanisch-Gräfe et al., 2008), have revealed the first evidence for copper metallurgy in this area. Selected crucible fragments, a metal artefact, slag pieces and metal dross have been analysed in order to reconstruct the metallurgical activities.

### 1.1. Archaeological background of Qurayyah and Tayma

The site of Qurayyah lies 70 km northwest of Tabuk in northwest Saudi-Arabia (Fig. 1), on the pilgrim and trade route connecting Yemen with the Levant (Parr, 1997). Previous archaeological research at the site was limited to survey activities in 1968 by Parr et al. (1970) and by Ingraham et al. (1981) in 1980. Important findings at this site include multi-chrome Qurayyah Painted Ware (QPW), which was also widely identified across northwest Arabia, Jordan (including the Wadi Arabah) and the Southern Levant (Intilia, forthcoming). It has been dated to the late 2nd millennium

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Fig. 1. Map of northwest Arabia, the Eastern Mediterranean and Mesopotamia, with sites mentioned in the text highlighted.

BC (usually to the 13th/12th century BC). Local production of QPW at Qurayyah and Tayma has now been confirmed by archaeometric analysis (Daszkiewicz, 2014). Significantly, the same type of pottery was identified in the Egyptian mining and smelting site at Timna and a number of sites in the Negev. Timna is located less than 150 km north of Qurayyah, and the Egyptian mining activities there were dated to the nineteenth dynasty (1300–1150 BC), until very recently providing the main basis for the dating of QPW (Rothenberg, 1972, 1988; see however Ben-Yosef et al., 2012). This date has now been confirmed by stratigraphic evidence and  $^{14}\text{C}$ -dates at Tayma, although the end of QPW remains a matter of debate (Hausleiter, 2014). According to Avner (2014) mining at Timna may have started earlier than the Egyptian presence. The people then living in Qurayyah might have been involved in the production and circulation of Timna copper (Rothenberg and Glass, 1983; Parr, 1997).

Tayma, located c 300 km south-east of Qurayyah, was a key stop on the incense road and is one of the most important archaeological oasis sites in northwest Arabia (Hausleiter, 2012). Ground water availability is believed to have been one of the main attractions for agricultural residents and caravan travellers (Fachhochschule Lübeck, 2014). The oasis had a wall system more than 18 km in length (Bawden et al., 1980; Schneider, 2010; Hausleiter, 2011, 107 Fig. 4) and its northern part probably protecting arable soils from erosion into the surrounding sabkha (salt flats). Six different occupational periods have been recognised at Tayma (Hausleiter, 2011), with the earliest dated not later than the 4th millennium

BC (Engel et al., 2011). The new evidence from the Saudi Arabian–German project suggests that, contrary to previous hypotheses, the occupation of Tayma was continuous. Since the Middle Bronze Age, Tayma was in contact with Syria and the Levant (Al-Hajiri, 2011); from the Late Bronze Age onwards, political and then commercial contacts with many other cultures including Egypt, the Mediterranean, Assyria and Babylonia are attested. The ten-year residence of the Late Babylonian king Nabonidus (556–539 BC) is evidenced by a stele with a Babylonian cuneiform inscription as well as some other fragmentary texts (Eichmann et al., 2006b; Hausleiter, 2011; Schaudig forthcoming). This episode was followed by the rule of the Achaemenids, at Tayma most prominently represented by the ‘Tayma Stone’ (Stein, 2014), before the Lihyanite Kingdom and then the Nabatean Kingdom took control of the site (Hausleiter, 2012) until its incorporation into the Roman Empire as part of *Provincia Arabia* (Tourlet and Weigel, 2015). During these later periods, the extent of the settlement was much reduced (Edens and Bawden, 1989; Hausleiter, 2011) but substantial architectural remains survived.

## 2. Samples and research question

The research presented here is a pilot project providing the first analysis of pre-Islamic metallurgical remains from this area, highlighting the potential contribution of these analyses to research concerning metallurgical tradition, metal trade, and other economic activities in this area. It is expected that our research will

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