Ur, Mesopotamia: The Lead Metal from Pit X

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Introduction

The very last effort of Sir Leonard Woolley in Ur was the excavation of additional graves from the transition period between Late Uruk and the Early Dynastic Period, the Jamdat Nasr period (c. 3100 – 2900 BC). Pit X was the excavation site of his last season, and it brought out a total of 84 metal objects: 4 silver objects, 42 copper objects, and 38 lead objects (Woolley, 1956, pp.104 ff.). Regardless of the archaeological fact that most of the objects from Ur turned out to be later, dating mostly to the Early Dynastic rather than to the Jamdat Nasr period, [1] the present study focuses specifically on the lead objects from Pit X dated to the Jamdat Nasr period.

In the University of Pennsylvania Museum of Archaeology and Anthropology (Penn Museum), the lead metal from the Jamdat Nasr period of Ur is represented through a small variety of object types such as a flat bowl, a table or tray, or a number of lead metal sheet covering small ceramic cups (Figure 1).

Context of lead metal in Early Bronze Age

The use of lead metal is known for cast objects from other sites earlier than Ur, for instance in filigree seals from Central Asia.[2] The earliest lead metal finds are scarce, but individual finds have been identified in western Asia, e.g. in the Levante (Ashalim Cave, late 5th Millenium, Yahalom-Mack, et al., 2015), in Anatolia (Demircihöyük, EBA Ib / 1a, 2700 / 2900 BC) with lead bottles and decorated lead strips, the "Syrian bottles" from Sarıket & Kücükhöyük (EBA II), and the tall lead vessels / bottles with narrow openings from Tepe Hissar in North Iran (Efe and Fidan, 2006).

In regard to the copper / bronze metallurgy from the Royal Tombs of Ur in the Early Dynastic III, lead was not used as an intentionally alloyed component. It appears as vessels (bowls, tumblers, trays) to a significant extent only in the later phases of the prehistoric period at Ur. It is important to keep in mind for future interpretation that there may be correlations among metals with a possible common source, for example the lead bottles from Demircihöyük were not associated with copper objects (except one), but always with silver objects (Durgun, 2012). Yahalom-Mack, et al. (2015) discuss a correlation in the rise of silver and lead objects during the 4th millennium B.C. The typology of the "Syrian bottles" from Sarıket & Kücükhöyük indicate trade relations between inland Anatolia and southeastern Anatolia or the north of Syria (Efe and Fidan, 2006). This might be a hint towards the source regions for the lead of the Pit X lead objects, as well.

Function of the wrapped cups from Pit X

The function and use of the small ceramic cups wrapped with lead sheets appeared unclear to the authors at first, but after seeing the full spectrum of lead objects from the Penn Museum's Ur collection it began to be clear. Further comparison with the inventory of Ur material of other museums shed more light on the riddle: The small ceramic cups were used as lids for large ceramic bottles. The lead sheet that was wrapped around the inverted cups tightly and functioned as a seal. It is safe to assume that these seals were used for the safe transport of bottled liquids. Three complete bottle-wrapped seal combinations were found in the various Ur collections: Two in the Penn Museum's collection[1], and a third one in the Birmingham Museum's collection from Ur (Figure 2).

Analysis of the Elemental and Lead Isotope Composition of the Lead Metal Wrappings

The two museums permitted the sampling of lead metal sheets in order to perform geochemical analysis. Because the metal is very soft and easy to cut, a small piece of a few milligrams was chipped from each object. The metal samples were then used for elemental analysis by wet

Figure 1. Lead metal sheets used to cover small ceramic cups. The first one is flattened. (Penn Museum collection, Pictures taken by A. Hauptmann and S. Klein).

chemical ICP-MS in Bochum (DBM) and lead isotope analysis in Frankfurt am Main (Geochemistry laboratory of the Goethe University).

Elemental Compositions

Two assay analyses were obtained for their silver content prior to this study by E.C. Padgham. The results were presented by H. Plenderleith (Woolley, 1934, p.295): Two lead tumblers each had a quantity of 0.07 % (700 ppm) silver in the lead metal.

The present analyses of chemical composition were performed on the nine samples from Penn Museum. They comprise of 14 elements that were detectable in the sample solutions (Table 1). The Birmingham sample is not included.

The result of the chemical analyses can be summarized as following: The two lead tumblers (analysis by E.C. Padgham) have silver contents of 700 ppm each. One of the present cups has a comparable high level of silver with 500 ppm, a second one is with 110 ppm and all others (8 cups) contain 80 ppm Ag or less. Elements such as antimony, bismuth, copper, iron, sulfur, arsenic

Table 1. Trace element analysis of the lead samples from Ur, Pit X, by ICP-MS from solution. Analyses are normalized to 100% lead and are given in ppm (parts per million). [PM = Penn Museum]

Lab.-Nb.	Inv. Nb. PM	Ag	Sn	Sb	Te	Bi	Co	Ni	Cu	Fe	P	S	Zn	As	Se
4823_13	35-1-224	110	5	440	30	10	0.01	0.6	250	30	45	200	75	40	<4
4824_13	35-1-225	15	2	370	15	10	0.02	2	640	2	20	3100	15	15	<4
4825_13	35-1-226	500	220	210	10	170	<0.01	0.3	660	8	300	1300	7	4	<4
4826_13	35-1-227	40	6	360	6	20	0.05	7	830	50	120	320	6	60	<4
4827_13	35-1-228	75	<1	410	55	50	0.2	8	520	260	2600	1300	6	140	6
4828_13	35-1-229	30	2	280	20	60	0.03	4	390	20	370	450	15	110	<4
4829_13	35-1-230	80	2	260	10	120	0.02	3	380	2	1000	5700	5	35	<4
4830_13	33-35-97	15	<1	2100	10	110	0.08	8	910	60	230	4700	7	15	5
4831_13	31-17-12	15	15	860	40	35	0.02	4	340	15	60	4600	7	240	<4

Figure 2. Lead wrapped-seal on a jar from Ur, Birmingham Museum (Picture taken by A. Hauptmann and S. Klein).

and phosphorus are present, but statistically variable (heterogeneous) in concentration. As for the other elements, tin is individually high in the silver-rich cup (500 ppm Ag) with 220 ppm Sn, all others contain tin in the low ppm-level only. Concentrations of nickel and zinc are detected in low ppm-level.

Lead Isotope Compositions

Lead isotope analysis of the lead samples was performed using a inductively coupled plasma multicollector mass spectrometer (ICP-MCMS). The analyses were performed at the geochemical laboratory of Goethe-University, Frankfurt am Main.

In general, the lead isotope ratios are very widespread with ^{207}Pb / ^{206}Pb ratios between 0.828 and 0.883, and also with ^{208}Pb / ^{206}Pb spreading between 2.062 and 2.126. The same variability is true for the lead isotope ratios in respect to ^{204}Pb. However, the majority of the lead samples form a more homogeneous isotope cluster with smaller ranges. Three samples are outliers: Two lead sheets plot at higher ratios, and the lead sheet with the highest silver content (500 ppm) differs significantly having highest lead isotope ratios. The lead sample with the second highest silver content (110 ppm) plots within the major group. Although the individual sample with the highest silver content has the highest lead isotope ratios, with all the other lead samples there is no correlation between silver content and lead isotope ratio.

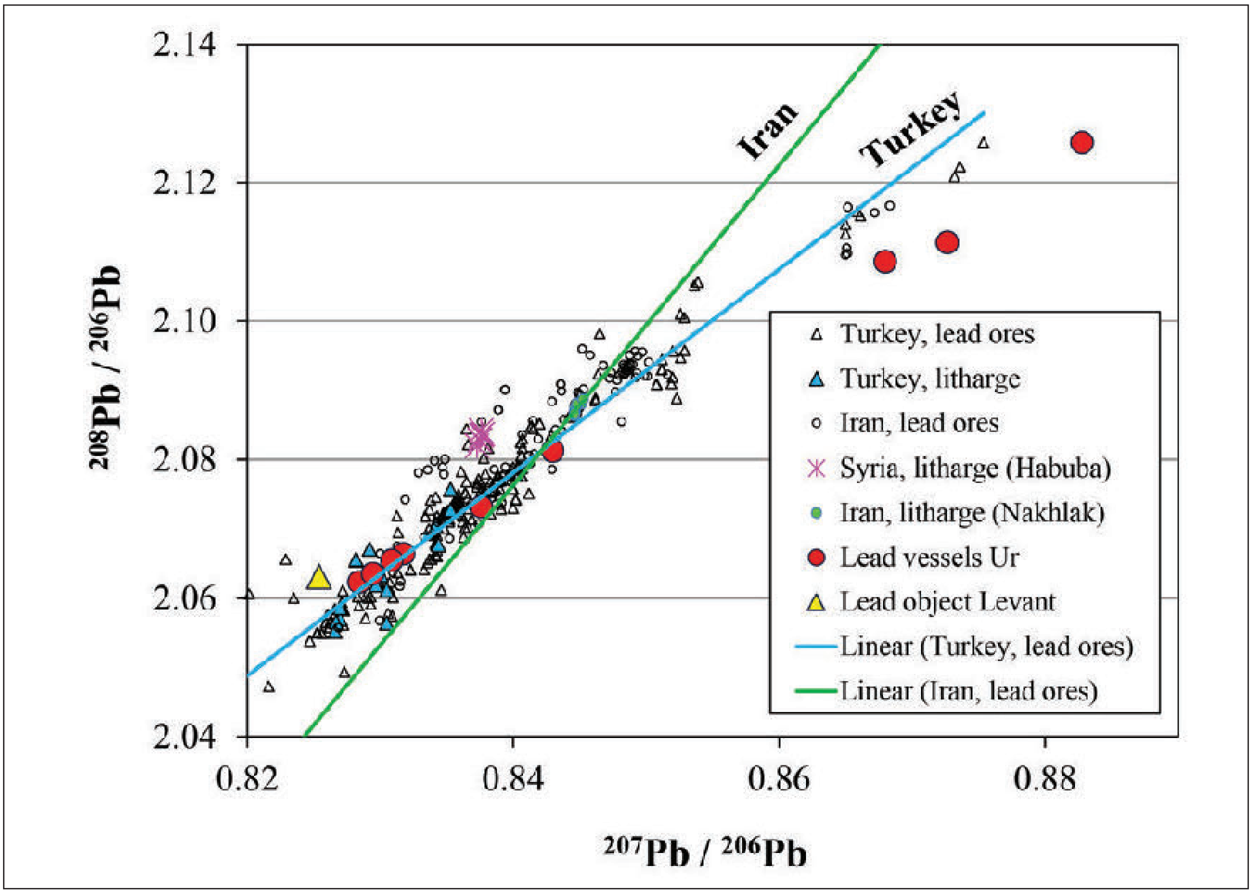

Figure 3. Lead isotope results of lead sheets compared with ore minerals and litharge from literature. Included are Turkish, Iranian and Syrian lead minerals and litharge from Turkey, Habuba Kabirah (Syria), and Nakhlak (Iran). Yellow triangle: Lead object from the Levant (Yahalom-Mack, et al., 2015). Linear trend lines based on the total of data points for each region. [Turkey, litharge: Arslantepe, Bolgardag. Turkey, ores: Hauptmann, et al., 2002; Lehner, Yener and Burton, 2009; Sayre, et al., 1992 ; Wagner, et al., 1986 ; Wagner, et al., 2003; Yener, et al., 1991].

Comparison with Minerals and Litharge from Potential Source Regions

When comparing the lead isotope signatures of the lead samples with minerals from potential geological units and with litharge as by-products remaining from lead-silver extraction processes of known locations, the following conclusions can be drawn: Litharge (PbO) match in all cases (Syria, Iran, Turkey) with the minerals from the same region. The major group of the lead samples plot with both Turkish and Iranian lead minerals (and consequently with their litharge), because the two overlap partially with their lead isotope fields. The sources in the two regions are difficult to distinguish as potential candidates for the Pit X lead sheet cup covers (Figure 3). If based on a linear trend line that is calculated for each region, a differentiation can be cautiously attempted: The lead sheets follow the trend line for Turkish lead ores (Anatolia, Taurus Mountains) rather than the Iranian trend line.

For comparison, also the early lead object from Ashalim Cave is plotted. Its lead isotope signature (Yahalom-Mack, et al., 2015) lies close to the present lead objects from Ur. It is interpreted by the authors as having its mineral source in the Taurus range in Anatolia. This collection of evidence strengthens Turkey as potential source region for the lead metal from Ur.

Conclusions

The lead sheets from Pit X in Ur were used as wrapping / sealing material for bottles. They are unique and appear only for a very short period of time.

The interrelationships between the silver contents and other trace elements and the copper isotope ratios will be sought in the future to discuss the mineralogical origin of the ore and explore the possible connection between silver and lead metallurgy. Concerning the lead isotope ratios, the objects show a variability of silver contents and there is an absence of a silver content to lead isotope correlation in most objects.

So far, the lead isotope signatures indicate that Turkey, more precisely Anatolia and the Taurus ore deposits, is the most likely mineral supplier for the lead metal from Ur. However, Iranian deposits have still to be taken into account in future discussions on the origin of these objects.

Notes

1 R. Zettler, Penn Museum, personal communication

2 N. Boroffka, personal communication 2015

3 http://www.penn.museum/collections/

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