Lead Isotope Ratios of Lead Objects Excavated from Kaman-Kalehöyük

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INTRODUCTION

In this study, lead isotope analysis was applied to lead artifacts excavated from Kaman-Kalehöyük. The purposes of this study are to understand the nature of these metal products and how they were processed, to determine which mines the raw materials originated from, and to propose trading systems of these materials.

Lead isotope analysis has proved to be a useful tool for provenance studies of archaeological copper and lead objects. Lead isotope ratios in copper and lead ores are influenced by the geologic history of each ore deposit, such as ore forming processes or crust forming processes. Therefore, lead isotope ratios of ores from different copper or lead mines will differ from each other according to the different geologic history of each mine. In addition, as lead isotope ratios do not change by heating, oxidation and reduction, the values in processed copper products will suggest the mine from which the raw material originated.

The Kaman-Kalehöyük site is divided into four main stratigraphic sequences. In previous studies, copper objects from the different levels were sampled for lead isotope analysis, and a hypothetical diagram was postulated from the results (Fig.1: Hirao and Enomoto 1993). Since that time, as excavation has proceeded and more data of lead isotope ratios has been accumulated (Fig.2), data distribution has become too complicated to understand. Therefore, in order to better understand the data trends, we decided to measure lead isotope ratios of only the lead artifacts from the site, as a precursor to the study of copper products. Analysis of the lead items is somewhat more straightforward than analysis of the copper artifacts:

(1) Only a small sample size is required (less than 1mg) for the analysis.

(2) There is little risk that the lead isotope value will be changed by contamination from soil and other materials.

(3) The different lead isotope ratios reflect different

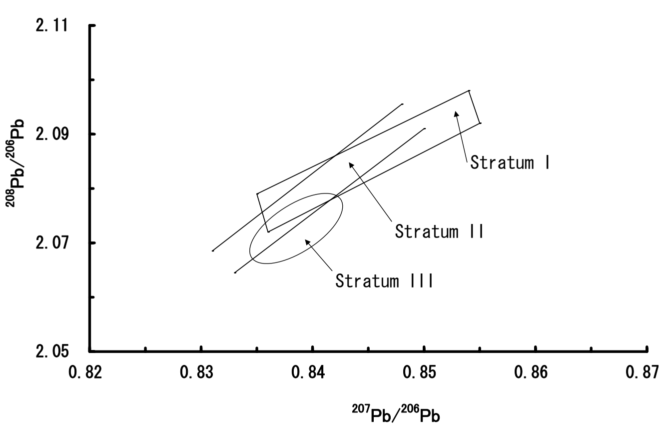


Fig.1 Generalized lead isotope diagram for the distribution of copper objects excavated from Kaman-Kalehöyük ('A' type figure).

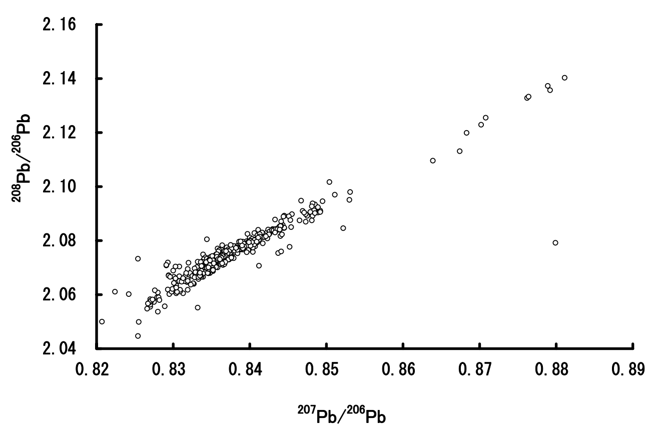
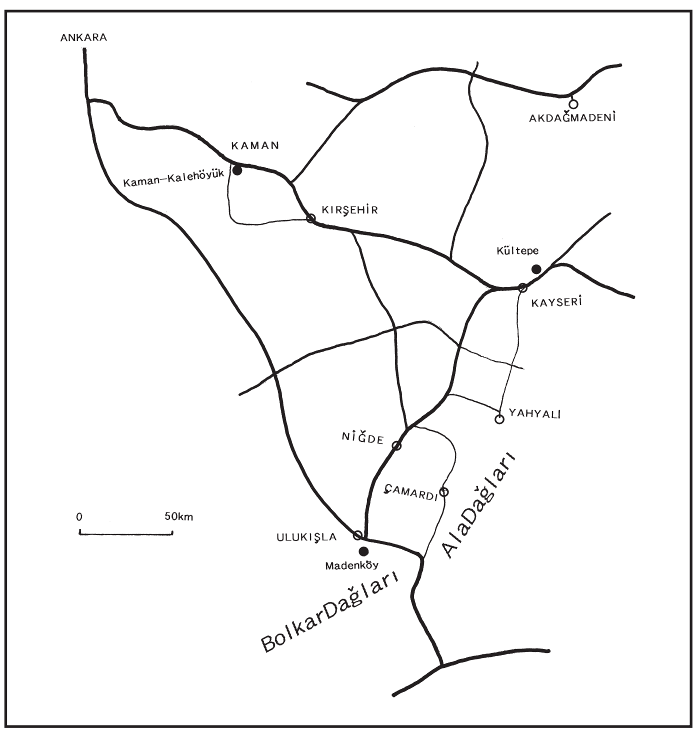


Fig.2 Distribution of lead isotope ratios of copper, bronze, and lead objects excavated from Kaman-Kalehöyük between 1986 and 2002 ('A' type figure).

Present names of large towns and cities in Turkey.

Map 1



Map 2

mine proveniences. In other words, only the ores that have experienced the same geologic history show similar values. Different geological sites are unlikely to show the same isotope ratios.

(4) The lead samples do not require pre-treatment in the chemical analysis process, such as removal of other elements, which takes hours and may cause errors.

The present paper includes new results, and the results from previous studies (Enomoto and Hirao 1992; 1999; 2001).

SAMPLES

All samples are from lead artifacts excavated at Kaman-Kalehöyük. A small sample was removed from each object and brought to Japan with permission from the Turkish government. Previous analysis includes: 24 samples in 1997 (Enomoto and Hirao 1999), 25 samples in 1998 (Enomoto and Hirao 2001), and 1 sample in 1989 (Hirao *et al*. 1992).

ANALYSIS

Measurement of lead isotope ratios

Lead isotope ratios of the samples excavated from Kaman-Kalehöyük were measured using a surface ionization mass spectrometer after the lead was purified by the following chemical procedure (Hirao *et al*. 1992).

A small part of each sample was dissolved with 5 to 6 drops of nitric acid and then diluted to 5 to 10 ml. Lead in the solution was separated by an electro-deposition method using 2V and approximately 10 mA of direct current and using platinum electrodes. Lead accumulated on the platinum plate anode as lead peroxide in a few hours, then was dissolved with a few drops of nitric acid and hydrogen peroxide in a different bottle. The lead solution was diluted to 2 to 10 ml and the lead concentration was measured with a graphite furnace atomic absorption spectrometer. Then about 0.1 microgram of lead was taken out and placed on a rhenium filament for mass spectrometry with a phosphoric acid - silica gel method. Lead isotope ratios were measured with a Thermo-Electron MAT262 surface ionization mass spectrometer equipped with multiple collectors. The rhenium filament with the lead sample was placed in the machine and evacuated to high vacuum. The filament was gradually heated passing current through it. At a temperature of approximately 1200 degrees C, the beam conditions settled, 20 lead isotope ratios were measured three times, and all the ratios were calculated for the averages. The isotope ratios obtained were normalized to the lead standard NBS-SRM-981 for each run (Hirao and Mabuchi 1989).

RESULTS AND DISCUSSION

Lead isotope ratio values of the 97 new samples and 50 previously published samples are listed in Table 1. The first two numbers of each sample number indicate the year in which the sample was excavated; "L" signifies a lead product. Maps 1 and 2 show lead ore sample locations. Photos 001 through 096 show the unpublished samples.

In this study, the lead isotope ratio values are plotted in A and B type figures: in an A type figure, the horizontal axis is $^{207}Pb/^{206}Pb$ and the vertical axis is $^{208}Pb/^{206}Pb$, and in a B type figure, the horizontal axis is $^{206}Pb/^{204}Pb$ and the vertical axis is $^{207}Pb/^{204}Pb$. These two types of figures show the relationship between four lead isotopes.

All of the lead isotope ratio values of the samples analyzed are plotted in Fig. 3 in an A type figure. In this figure, the samples mainly concentrate in four groups. However, in a B type figure, Fig. 4, five to seven groups can be identified. Therefore, it is proposed that in the Kaman-Kalehöyük sample set there are five to seven distinct lead material types. These seven groups are labeled areas A to G in Fig. 5 and in all the other A type figures, corresponding to areas A' to G' in Figure 4 and in all the other B type figures in this report.

In the first series of figures in this report, areas A (A') to G (G') are compared to published values of lead ore (e.g., galena, sphalerite) and slag from Turkey, in order to estimate the sources of the Kaman-Kalehöyük lead materials. Hirao *et al*. (1995), Enomoto *et al*. (1999) and Yener *et al*. (1991) have

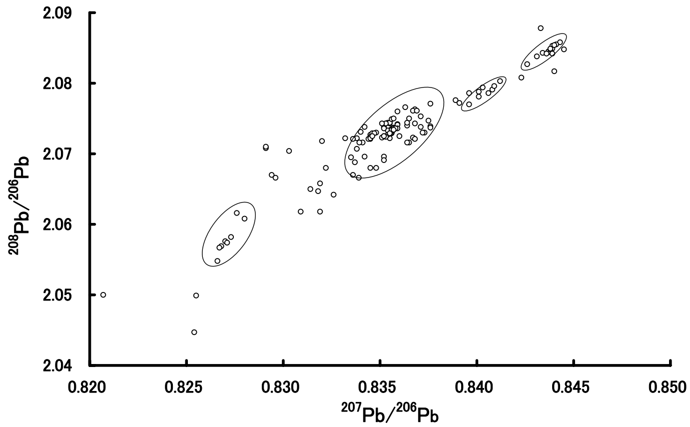


Fig.3 Distribution of lead isotope ratios of lead objects excavated from Kaman-Kalehöyük between 1986 and 2000 ('A' type figure).

reported on the lead isotope values of slag and ore samples from mines in Turkey. As these mine samples were collected from only a few areas of Turkey, it will be difficult to conclude the origins of the Kaman-Kalehöyük samples with certainty, but some possibilities can be proposed. Lead isotope ratios of the lead ores and slag examined for this study are shown in Fig. 6 (type A) and Fig. 7 (type B). Table 2 indicates how many samples were obtained from each area.

In an A type figure plotting lead ore samples, ores from Çanakkale in western Turkey, the North Anatolian Mountains, and the area from Kozan to Tufanbeyli east of the Ala Mountains (Aladağları) have a $^{207}Pb/^{206}Pb$ value higher than 0.85. None of the lead

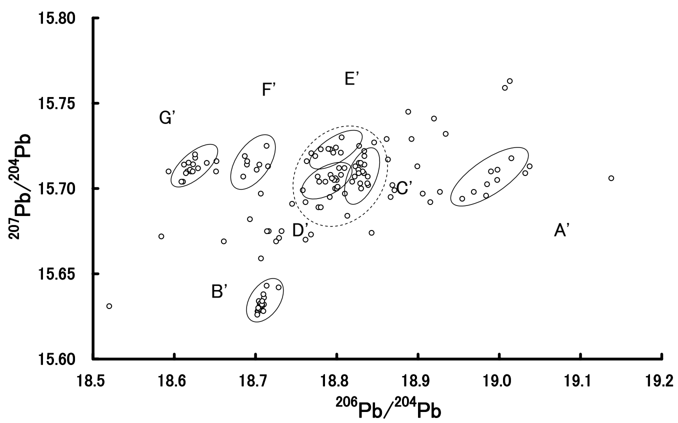


Fig.4 Distribution of lead isotope ratios of lead objects excavated from Kaman-Kalehöyük between 1986 and 2000 ('B' type figure).
Five to seven groups are indicated (areas A'~G').

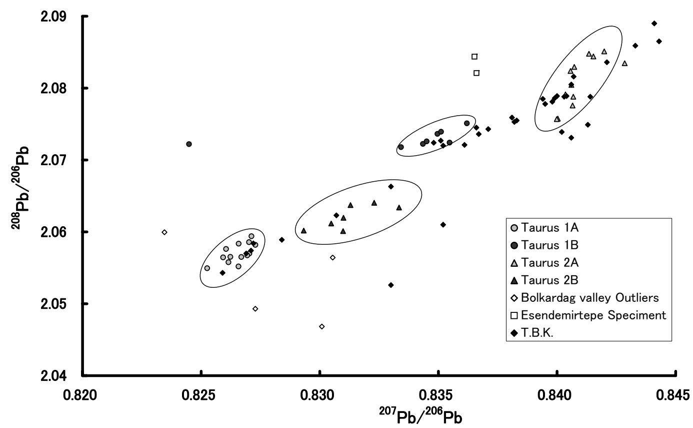


Fig.6 Distribution of lead isotope ratios of lead minerals in Turkey ('A' type figure).
The values of ○●△▲◇□ are from Yener *et al*. (1991). T.B.K. (◆) are obtained by our measurements (1999).

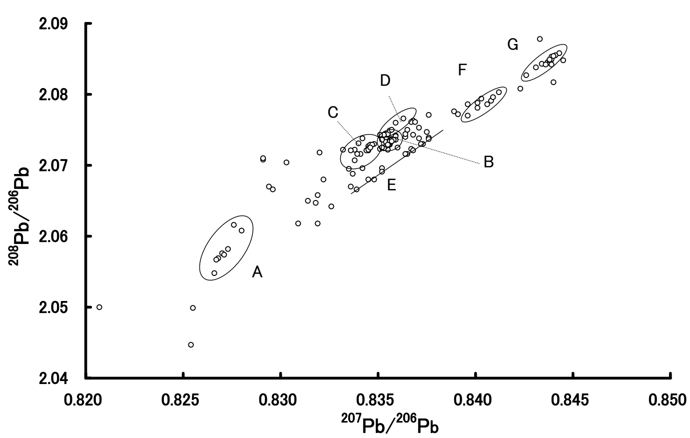


Fig.5 Distribution of lead isotope ratios of lead objects excavated from Kaman-Kalehöyük between 1986 and 2000 ('A' type figure).
Groups A - G correspond to areas A' - G' in Fig. 4.

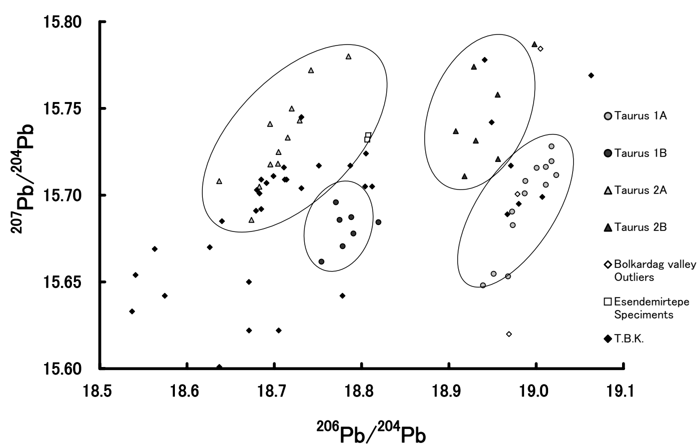


Fig.7 Distribution of lead isotope ratios of lead minerals in Turkey ('B' type figure).
The values of ○●△▲◇□ are from Yener *et al*. (1991). T.B.K. (◆) are obtained by our measurements (1999).

items from Kaman-Kalehöyük have these high values, so it is thought that Kaman-Kalehöyük did not have a deep relationship with the North Anatolian Mountains and areas over the Ala Mountains. The lead samples excavated from Kaman-Kalehöyük are distributed mainly in the range of 0.825 to 0.845 in the $^{207}Pb/^{206}Pb$ of a type A figure, so this range was looked at in detail.

In the second series of figures, the relationship between lead isotope ratio and date was examined by plotting the samples according to the excavation stratum in which they were found. The site of Kaman-Kalehöyük has four main stratigraphic levels. From the top, Stratum I is Ottoman period, Stratum II is Phrygian period, Stratum III is Hittite period and Stratum IV is the period before the Hittites. The number of samples from Stratum I was so small that those samples are excluded from the discussion in this article. In the figures, □ or ■ indicates ores or slag, ○ indicates samples from Stratum II, △ indicates samples from Stratum III, ◇ indicates samples from Stratum IV and × indicates samples whose classification is still unclear.

Kaman-Kalehöyük Samples Compared to Ore Samples

Area A in Fig. 5 (area A' in Fig. 4)

Area A in Fig. 5 (area A' in Fig. 4) is enlarged in Fig. 8 (Fig. 9). Samples from Kaman-Kalehöyük (solid line) are closely distributed within the range of ore samples from the Bolkar Mountains (Bolkardağları) (dotted line) which is called Taurus 1A by Yener. Samples indicated with a black square ■, gray and white square in Fig. 8 and Fig. 9 include the Taurus 1A group and ores and slag from Ulkışla/Madenköy and the Bolkar Mountains (Yener *et al*. 1991; Hirao *et al*. 1995). This may indicate that Kaman-Kalehöyük received raw lead materials from an area in the Bolkar Mountains. Yener *et al*. (1991) reported that four samples in their analysis were slag samples found at ancient metal working sites near Ulkışla. In Fig. 8 and 9, these slag samples are indicated with a white square □. On the other hand, ores from Ulkışla/Madenköy analyzed by TBK (Tokyo Bunkazai Kenkyujo (in Japanese) or Tokyo National Research Institute of Cultural Properties) are indicated with a gray ▒ (Hirao,Y., J. Enomoto and H.Tachikawa 1995). The isotope ratios of ores near Madenköy coincide with those of slag collected from the metal working sites and of samples excavated from Strata between IIa and IIIb at Kaman-Kalehöyük.

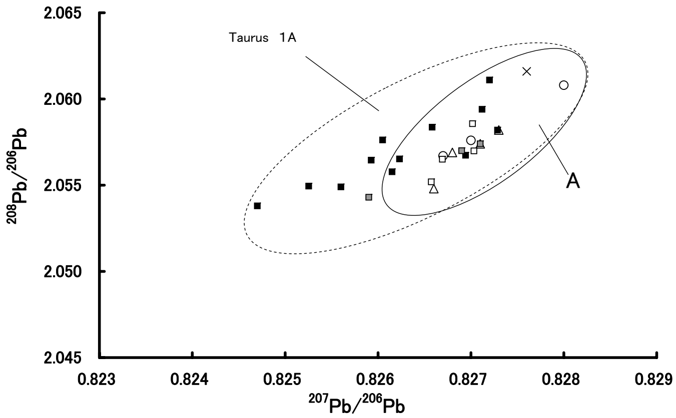


Fig.8 Area A of Fig. 5 is enlarged ('A' type figure).
○, △, and × indicate samples excavated from Stratum II, III, and undecided, respectively. □(white square) indicates minerals obtained from a metalworking site by Yener *et al*. (1991). ▒ (gray square) indicates minerals obtained from Ulkışla by T.B.K. ■ (black square) indicates the other minerals. The dotted line area indicates Taurus 1A reported by Yener *et al*. (1991). The solid line area indicates excavated samples from Kaman-Kalehöyük.

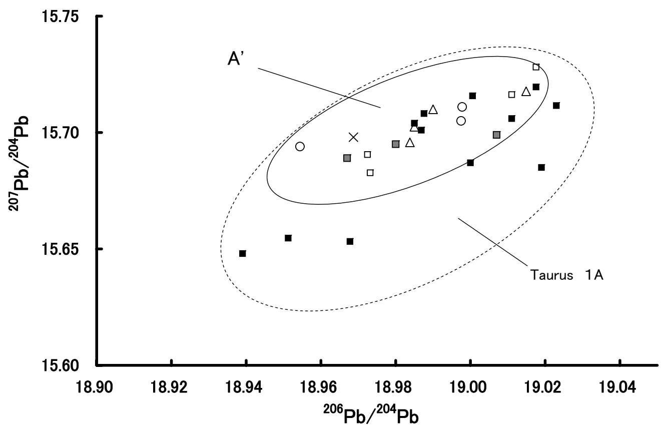


Fig.9 Area A of Fig. 4 is enlarged ('B' type figure).
○, △ and × indicate samples excavated from Stratum II, III, and undecided, respectively. □(white square) indicates minerals obtained from a metalworking site by Yener *et al*. (1991). ▒ (gray square) indicates minerals obtained from Ulkışla by T.B.K. ■ (black square) indicates the other minerals. The dotted line area indicates Taurus 1A reported by Yener *et al*. (1991). The solid line area indicates samples excavated from Kaman-Kalehöyük.

Area B in Fig. 5 (area B' in Fig. 4)

Area B in Fig. 5 (area B' in Fig. 4) is enlarged in Fig. 10 (Fig. 11). In Fig. 5, area B is included in a larger unit with areas C, D, and E, but in Fig. 4, area B is clearly different from the other areas. Area B is made up of 27 samples closely clustered together, and as Table 2 shows, 22 of the samples were excavated from early periods, Strata between IV and IIIb.

It is not yet clear where these lead materials originated. However a piece of slag obtained from Kültepe included in this area was observed in a report by Hirao,Y., J. Enomoto and H.Tachikawa (1995). This may indicate that the lead of this isotope composition (area B) reached Kaman-Kalehöyük through a relationship with Kültepe, a major site not far from Kaman-Kalehöyük. The Kaman-Kalehöyük samples are mainly between Stratum IV and IIIb. Only a few samples were excavated from the later level, raising the question as to why the supply of this lead material stopped after the Stratum IIIb period. Analysis of more samples from Kültepe may provide further information on the trade relationships between Kaman-Kalehöyük and Kültepe.

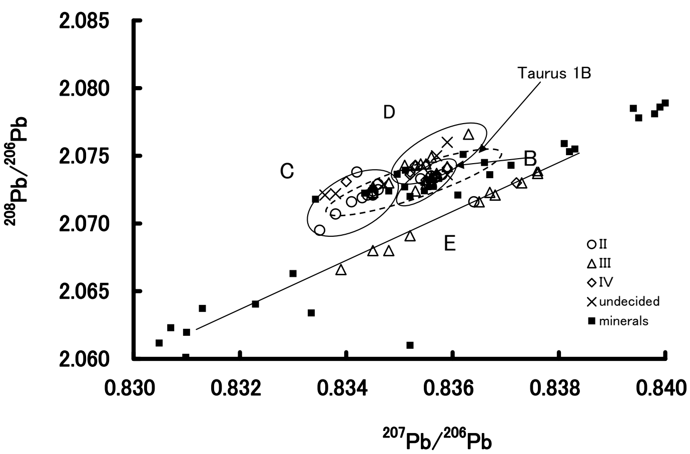


Fig.10 Areas B - E of Fig. 5 are enlarged ('A' type figure). ○ , △, ◇ , × indicate samples excavated from Stratum II, III, IV, and undecided, respectively. ■ indicates minerals. The dotted line area indicates Taurus 1B from Yener *et al*. (1991).

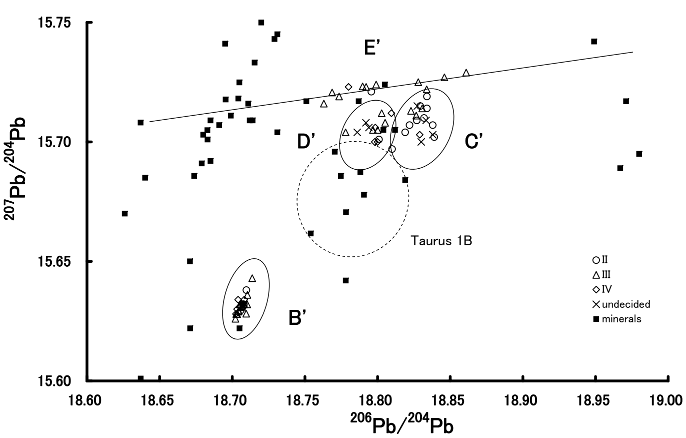


Fig.11 Areas B' - E' of Fig. 4 are enlarged ('B' type figure). ○ , △, ◇ , × indicate samples excavated from Stratum II, III, IV and undecided, respectively. ■ indicates minerals. The dotted line area indicates Taurus 1B from Yener *et al*. (1991).

Area C in Fig. 5 (area C' in Fig. 4)

Area C in Fig. 5 (area C' in Fig. 4) is enlarged in Fig. 10 (Fig. 11).

In Fig. 5, it is difficult to delineate area C, because the sample distribution forms a relatively large domain together with areas B, D, and E. However, when Fig. 5 is enlarged to Fig. 10 and area B is excluded, it becomes clear that area C distributes to the left of area B, and in Fig. 11, a clear grouping is apparent. In Fig. 10, area C partially overlaps the area reported as Taurus lB by Yener, while in Fig. 11, area C' is distinct from Taurus lB, so the samples are not included in Yener's classification. In other words, none of the analyzed ores match this group of samples. The Kaman-Kalehöyük samples of this group are mainly from Stratum IIa. In general, area C samples are from a later period than area B samples.

Area D in Fig. 5 (area D' in Fig. 4)

Area D in Fig. 5 (area D' in Fig. 4) was enlarged in Fig. 10 (Fig. 11).

In Fig. 5 (Fig.10), area D is not clear enough to judge it to be a distinct area because it seems to overlap areas B and C. In Fig. 11, area D' is to the left of area C'. At first sight, it seems that this area partly overlaps with Taurus lB of Yener, but the plotted values of each ore in both Fig. 10 and Fig. 11 (Fig. 4 and Fig. 5) do not coincide with the Kaman-Kalehöyük samples. Two ore samples from Akdağmadeni fall near the area D samples. Most of the area D samples are from Stratum IIIb and Stratum IV. There was a transportation network from the Akdağmadeni area to the Kayseri (Kültepe) area during those periods and lead materials from near Akdağmadeni may have been brought to Kaman-Kalehöyük through Kültepe. Areas C and D are close to each other in Fig. 4 and Fig. 5, and may be from the same system of ores.

Area E in Fig. 5 (area E' in Fig. 4)

Area E in Fig. 5 (area E' in Fig. 4) is enlarged in Fig. 10 (Fig. 11).

In Fig. 5 (Fig. 10), area E distributes on a straight line somewhat below areas C and D. In Fig. 4 (Fig. 11), it distributes on a straight line above areas C' and D'. Although none of the ores correspond to this distribution, some ore samples that are distributed on the extension of this line will be explained in the discussion of area G.

Area F in Fig. 5 (area F' in Fig. 4)

Area F in Fig. 5 (area F' in Fig. 4) was enlarged in Fig. 12 (Fig. 13)).

In Fig. 5, area F centers around a $^{207}Pb/^{206}Pb$ value of 0.84 and a $^{208}Pb/^{206}Pb$ value of 2.078. In Fig. 12 (Fig. 6), this area corresponds to the lower part of the Taurus 2A field distinguished by Yener et al. (1991). However, in area F and the left of area F there are ore samples from Alada (shown as □) and samples from Kaman-Kalehöyük Stratum IV distribute among these ore samples. Therefore, it is possible that area F extends further to the left. In Fig. 13, the ore samples from Alada and samples from Kaman-Kalehöyük Stratum IV are in the lower part of area F', and it is possible that the lower part of area F' should also be wider.

This area includes many ores from the Ala Mountains and many excavated samples from Kaman-Kalehöyük Stratum IIIc; this is a characteristic feature of this stratum. These results are discussed in more detail below.

Area G in Fig. 5 (area G' in Fig. 4)

Area G in Fig. 5 (area G' in Fig. 4) is enlarged in Fig. 12 (Fig. 13). In Fig. 5, area G is a relatively small cluster. An ore sample from Galena mine in Aladağ /Yahyalı analyzed by Yener *et al*. (1991) corresponds to this area. This ore was collected northeast of

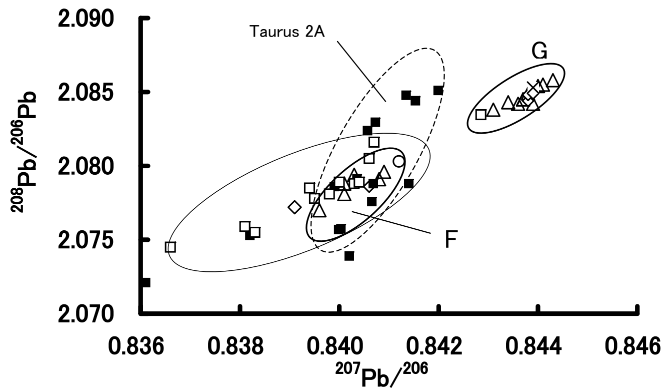


Fig.12 Areas F and G of Fig. 5 are enlarged ('A' type figure). ○, △, ◇, × indicate samples excavated from Stratum II, III, IV and undecided, respectively. □ indicates minerals obtain from Aladağ and Yahyalı near Aladğ. ■ indicates the other minerals. The dotted line area indicates Taurus 2A reported by Yener *et al*. (1991). The solid line area indicates areas F and G. The slender line area may indicate area F in the future.

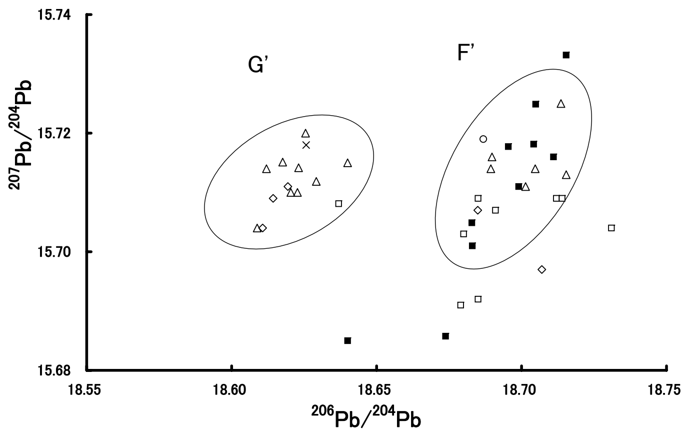


Fig.13 Areas F and G of Fig. 4 are enlarged ('B' type figure). ○, △, ◇, ×indicate samples excavated from Stratum II, III, IV and undecided, respectively. □ indicates minerals obtained from Aladağ and Yahyalı near Aladağ. ■ indicates the other minerals.

Yahyalı, approximately 30 km from the other ores in the Taurus 2A group, which are from the south and southwest of Yahyalı. Area G samples are mainly from Kaman-Kalehöyük Stratum III and Stratum IV, with only one sample from Stratum II.

As seen in Fig.14, some samples from Kaman-Kalehöyük are on the straight line which connects L9606 (indicated with a black square ■), slag obtained at Çamardı by Yener (indicated with a black square ■) and ore belonging to area G (indicated with

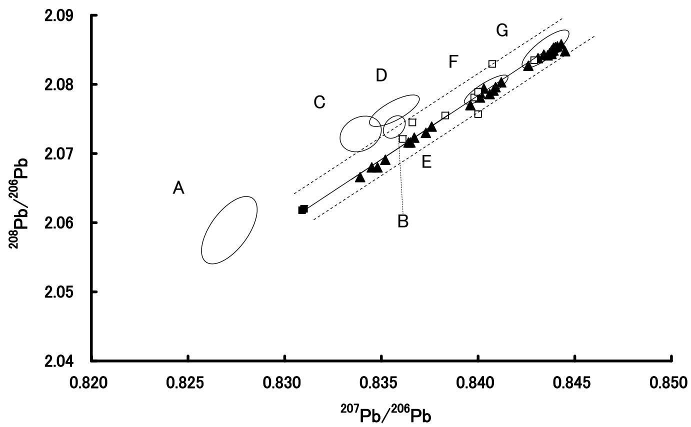


Fig.14 Distribution of samples on a straight line ('A' type figure).
▲indicates samples excavated from Kaman-Kalehöyük. □ indicates minerals obtained from Aladağ and Yahyalı near Aladağ. ■ indicates slag obtained form Çamardı and L9606 excavated from Kaman-Kalehöyük.

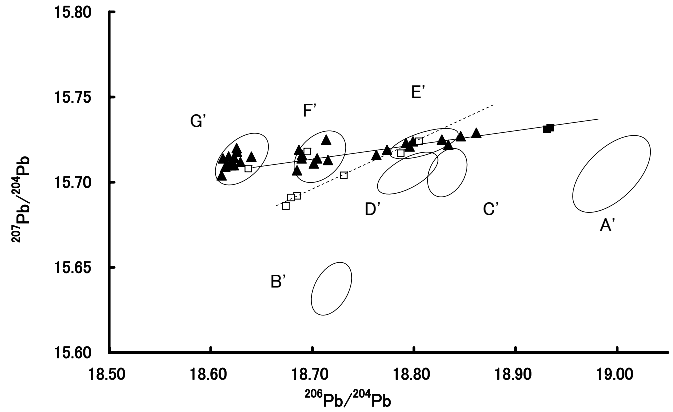


Fig.15 Samples excavated from Kaman-Kalehöyük and ores obtained from Yahyalı ('B' type figure).
▲ indicates samples excavated from Kaman-Kalehöyük. □ indicates minerals obtained from Aladağ and Yahyalı near Aladağ. ■ indicates slag obtained form Çamardı and L9606 excavated from Kaman-Kalehöyük Stratum IV.

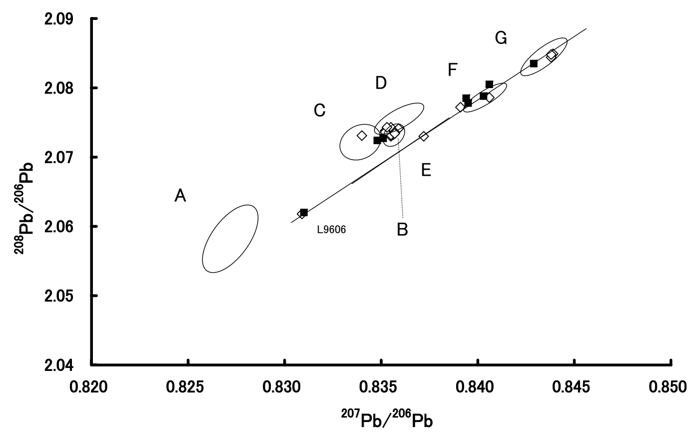


Fig.16 Distribution of lead isotope ratios of lead objects excavated from Stratum IV ('A' type figure).
◇ indicates samples excavated from Stratum IV. ■ indicates minerals.

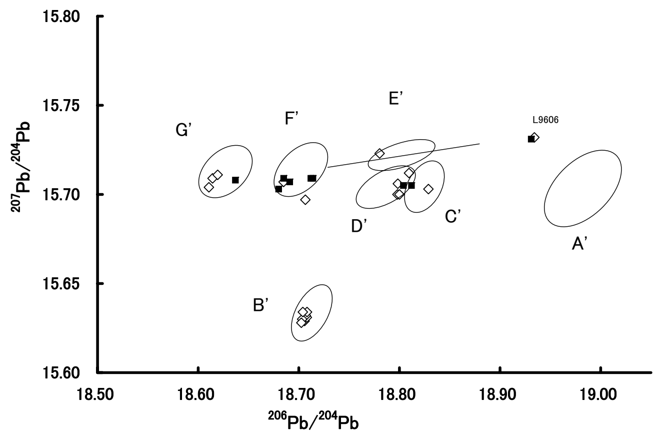


Fig.17 Distribution of lead isotope ratios of lead objects excavated from Stratum IV ('B' type figure).
◇ indicates samples excavated from Stratum IV. ■ indicates minerals.

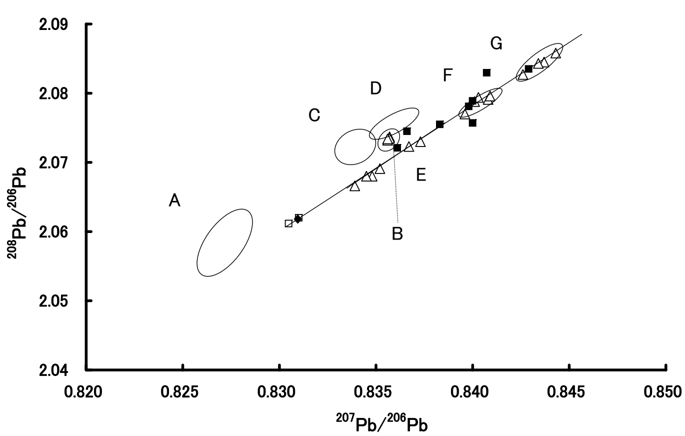


Fig.18 Distribution of lead isotope ratios of lead objects excavated from Stratum III ｃ ('A' type figure).
△ indicates samples excavated from Stratum IIIc. □indicates slag from Çamardı. ■ indicates the other minerals. ◆ indicates sample L9606 excavated from Stratum IV.

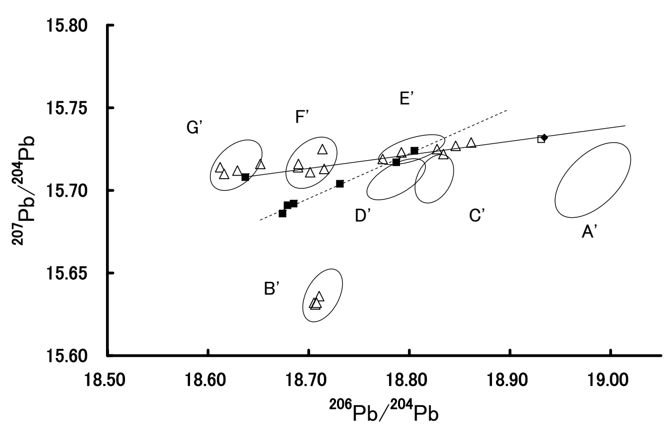


Fig.19 Distribution of lead isotope ratios of lead objects excavated from Stratum IIIc. (' Ｂ ' type figure).
△ indicates samples excavated from Stratum IIIc. □ indicates slag from Çamardı. ■ indicates the other minerals. ◆ indicates sample L9606 excavated from Stratum IV.

a white square □). All ore samples from Aladağ are indicated with white squares □. This straight line is an extension of area/line E mentioned above.

The lead isotope ratios of area E, F, and G (E', F' and G') samples are distributed along the lead evolution curve of Dalrymple (1991). Therefore, it is possible that the original source rocks that produced the lead in areas E, F, and G are related to each other through the evolution of a single rock system.

Since ores obtained at Aladağ and Yahyalı (indicated with a white square □) coincide with samples from Kaman-Kalehöyük, the relationship between them was investigated. As seen in Fig. 15 (the B type counterpart of Fig. 14), there is a distribution of Kaman-Kalehöyük samples on the solid line which connects black squares ■ and area G', but as the dotted line shows, many of the ores obtained at Yahyalı are on a line with a different slope.

It is possible to propose that samples in areas C and D (C' and D') also situate on a lead evolution curve, but a different one from that of areas E, F and G.

Kaman-Kalehöyük Samples Grouped by Stratum

Samples from Stratum IV (19 samples) (Fig. 16 and Fig. 17)

Samples from Stratum IV are mainly concentrated in areas B, D and G in Fig. 16 (see Table 2). There is only one sample (L9606) which is apart from others, to the upper right of area A; the lead isotope ratio of this sample agrees with that of a sample from Çamardı area (Yener *et al*. 1991). Ore from a mine in Yahyalı is included in area G. Ore samples from mines situated around the Ala Mountains about 200 km southeast of Kaman-Kalehöyük are included in area F. Area D values are similar to those of ores from Akdağmadeni about 200 km east of Kaman-Kalehöyük. Most of the samples of this period are distributed in area B. It is not yet clear where the ore of area B samples originated, but slag from Kültepe plots in area B. It appears that the people in Kaman-Kalehöyük obtained lead materials from relatively near places, possibly by way of Kültepe or other cities, in this period.

Samples from Stratum IIIc (19 samples) (Fig. 18 and Fig. 19)

The characteristic of this stratum is that there are no samples in areas A, C, and D. Most of the samples of this period distribute on a line that connects L9606 (indicated with a black diamond ◆) and slag (indicated with a white square □) to area G. This straight-line distribution of the samples is not seen in the other periods. As shown in Fig. 18, a group of lead ores (indicated with a black square ■) from near Yahyalı distributes near this line. However, as Fig. 19 shows, the distribution slopes of the ores and the Kaman-Kalehöyük samples differ from each other, so it is unlikely that the Stratum IIIc samples are from Yahyalı. The straight line distribution of the samples can be explained by at

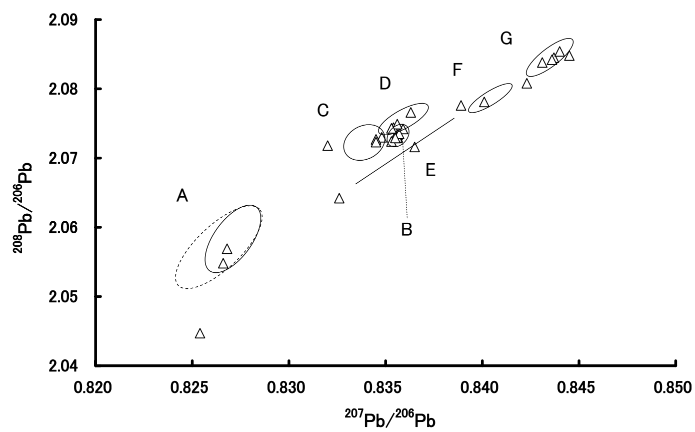


Fig.20 Distribution of lead isotope ratios of lead objects excavated from Stratum IIIb ('A' type figure).
△ indicates samples excavated from Stratum IIIb. The dotted line area indicates Taurus 1A reported by Yener *et al*. (1991).

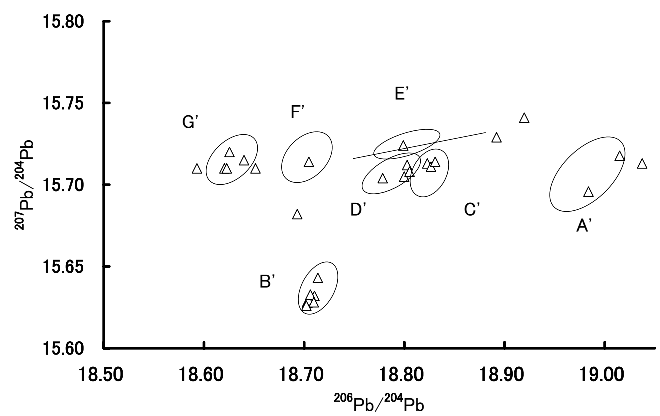


Fig.21 Distribution of lead isotope ratios of lead objects from Stratum IIIb ('B' type figure).

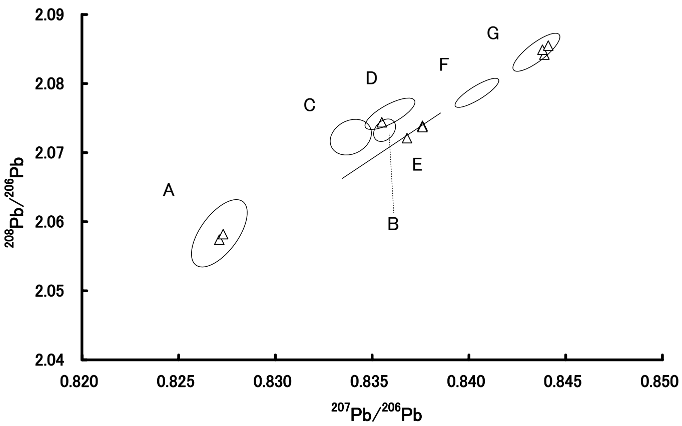


Fig.22 Distribution of lead isotope ratios of lead objects from Stratum IIIa ('A' type figure).

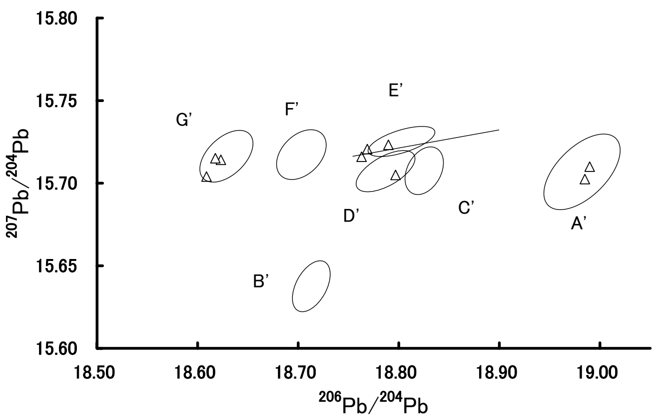


Fig.23 Distribution of lead isotope ratios of lead objects from Stratum IIIa ('B' type figure).

least two possible factors. One is that lead isotope ratios of ores in the same mine can have different values due to the different influence of geological diastrophism that formed the ore system. The second is that lead originating from more than one mine may have been mixed together when objects were manufactured. In this case, the lead isotope ratios of the objects would be plotted between those of the constituent ores.

Samples from Stratum IIIb (31 samples) (Fig. 20 and Fig. 21)

Samples from this layer are plotted in areas A and A' in Fig. 20 and Fig. 21. The samples in area A in Fig. 20 are the same as Galena ore minerals from the Bolkar Mountains. The most notable feature of this stratum that 11 of the 31 samples are in area B, similar to the case for Stratum IV; it is supposed that there was a certain relationship with Kültepe. The distribution of the Stratum IIIb samples is wider than that of Stratum IIIc samples, which may indicate that the exchange of materials took place across a wider geographic range in this period.

Samples from Stratum IIIa (9 samples) (Fig. 22 and Fig. 23)

In Fig. 22, samples are somewhat concentrated in area G. There are no samples from this period in areas B, C and F. The sample size is too small to provide valuable information.

Samples from Stratum IId (9 samples) (Fig. 24 and Fig. 25)

There are no Stratum IId samples in areas E, F, and G, and after this period no samples can be observed in areas E and G, but the number of samples from this stratum is too small to provide any conclusions. Of the nine samples, four are outside of our seven main groupings. Some of the samples are near area D, and may belong to that area.

Samples from Stratum IIc (8 samples) (Fig. 26 and Fig. 27)

There are no Stratum IIc samples in areas A, B, E, F, and G. The number of samples is too small to provide valuable information.

Samples from Stratum IIb

There are no analyzed samples from Stratum IIb.

Samples from Stratum IIa (19 samples) (Fig. 28 and Fig. 29)

Samples from this period are mainly distributed in area C in Fig. 28 (Fig. 29). Some are situated between areas B' and D' in Fig. 29. Ore corresponding to these samples has not been found yet. There are two samples in area B. Many samples from Stratum IV through IIIb belong to area B, and may share a similar origin with these two Stratum IIa samples.

In this study, 147 lead samples excavated at Kaman-Kalehöyük were summarized according to the

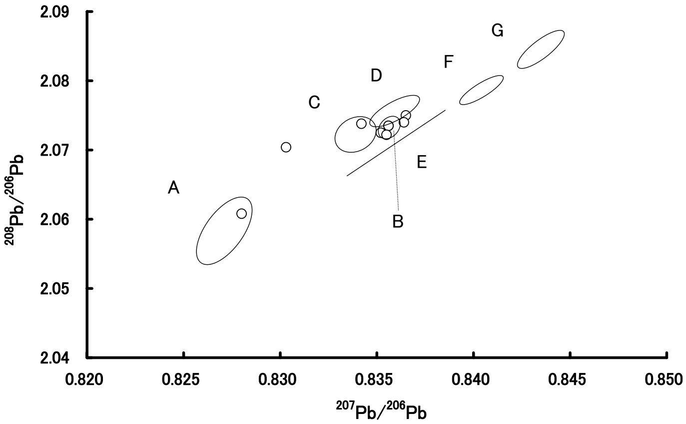


Fig.24 Distribution of lead isotope ratios of lead objects from Stratum IId ('A' type figure).

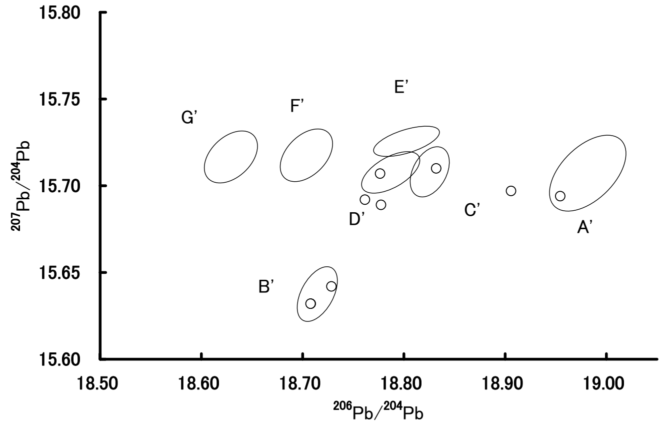


Fig.25 Distribution of lead isotope ratios of lead objects from Stratum IId ('B' type figure).

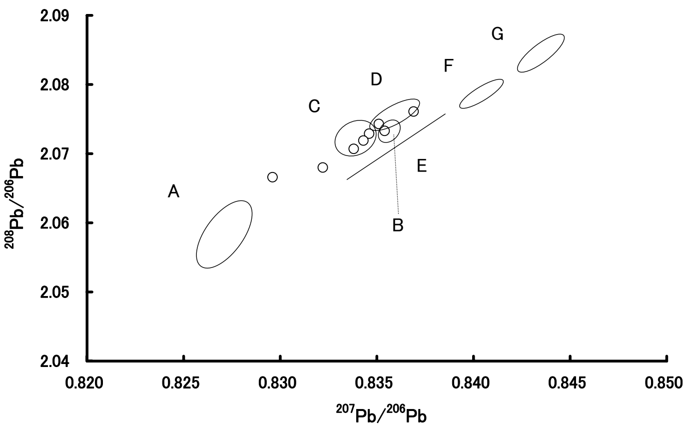


Fig.26 Distribution of lead isotope ratios of lead objects from Stratum IIc ('A' type figure).

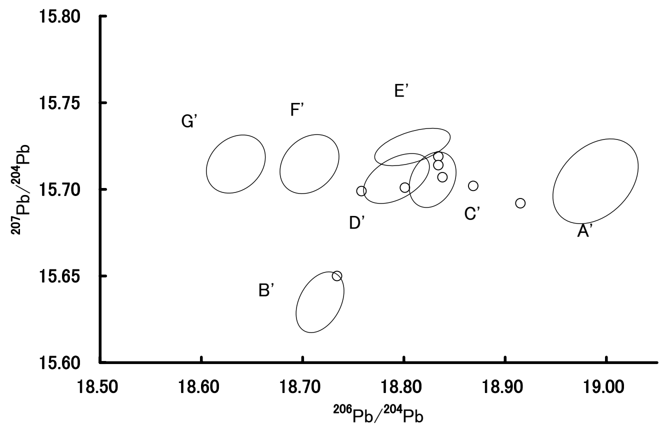


Fig.27 Distribution of lead isotope ratios of lead objects from Stratum IIc ('B' type figure).

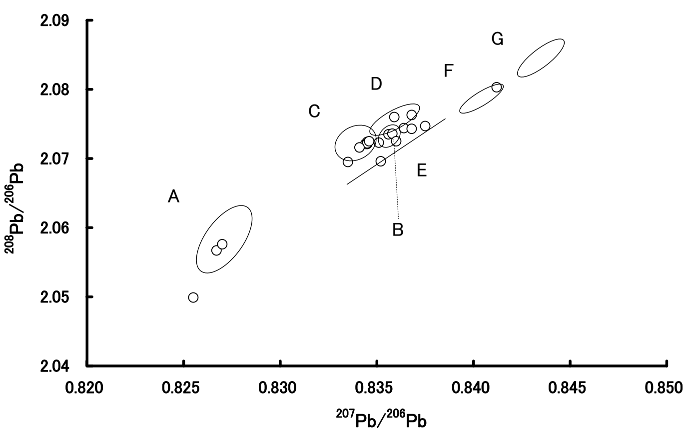


Fig.28 Distribution of lead isotope ratios of lead objects from Stratum IIa ('A' type figure).

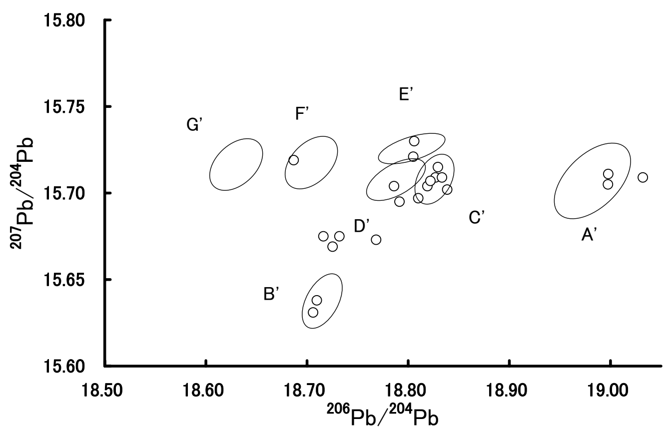


Fig.29 Distribution of lead isotope ratios of lead objects from Stratum IIa ('B' type figure).

results of lead isotope ratio analysis. Isotope ratios of lead ore from Turkey were compared with those of the excavated samples in order to determine provenance, but there are too few mine samples analyzed to allow definitive conclusions. Therefore, it will be necessary to analyze much more ore samples from Turkey. With lead isotope ratio measurements from many other sites, it will become possible to better understand the ore sources of the artifacts, and the processing sites, trade routes, and perhaps the movement of people and their technological skills.

ACKNOWLEDGMENTS

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Table I Lead isotope ratios of lead objects excavated from Kaman-Kalehöyük

Sample No.	Sector		Grid	Stratum	Provisional Layer (PL)	Note	Year No.	Date
L8601	North (N)	III	XL-54	IIa1	⑬	No.6	86000720	860722
L8701	N	IV	XXXIX-55	IIa	⑤-⑦	P88, No.27	87000675	870819
L8702	N	IV	XXXIX-55	IIa	⑤-⑦	P68, No.6	87000612	
L8703	N	IV	XXXVIII-55	IIa	③-④ⓐ ⑱	No.18	87000619	870827
L8704	N	III	XL-54	IIa	④-⑦ ㉖	No.42	87000933	870812
L8705	N	III	XL-55	IIa	③ ㉓	No8	87000496	870801
L8706	N	V	XXXVII-54	IIa	⑥-⑦ ⑱or㉘	No.33	87000752	870729
L8834	N	IV	XXXVIII-55	IIa	③-④ⓐ ㉑		88000452	
L8835	N	V	XXXVI-54	IIc	㉛		88000453	
L8836	N	VII	XXXII-54	Surface	①		88000478	
L8924	N	IV	XXXVIII-54	III	㊺ⓑ			890828
L8938	N	VII	XXXIII-54	Ib	⑤		89000665	
L8939	N	VII	XXXII-54	Surface	①		89000390	
L9126	N	III	XLI-54	IIIc	(54)		91000655	910731
L9127	N	IV	XXXIX-54	IIIc	(57)	R66, No.4	91000664	910820
L9128	N	III	XL-55	IIIc	(55)ⓔ	No.10	91000665	910812
L9129	N	IV	XXXIX-54	IIIc	(57)ⓑ	R76, No.11	91000666	910822
L9130	N	IV	XXXIX-55	IIIc	㊽ⓑ	No.17	91000667	910815
L9131	N	III	XL-54	IIIc	㊿ⓐ	No.14	91000668	910814
L9132	N	IX	XXVIII-55	Surface	②	No.1	91000669	910722
L9133	N	III	XL-54	IIIc	㊿ⓐ	kurtz	91000670	910809
L9134	N	III	XLI-54	IIIc	(57)		91000671	910903
L9251	N	V	XXXVI-54	IIIb	(52)ⓖ	No.17ring	92000876	920818
L9252	N	V	XXXVI-55	IIIb	㊼ⓓ	No.12	92000875	920818
L9253	N	VI	XXXV-55	IIIc	(59)ⓙ	No.39ring	92000871	920826
L9254	N	VII	XXXIII-55	IId	② ⑫ⓐ	No.3	92000870	920805
L9255	N	V	XXXVI-54	IIIb	(52)ⓖ	No.16	92000872	920817
L9256	N	VI	XXXIV-55	IId	①-③ (51)	No.2	92000874	920716
L9257	N	IV	XXXIX-55	IIIc	(51)	No.15P657	92000873	920702
L9258	N	V	XXXVI-54	IIIb	(53)ⓖ	No.13	92000384	920727
L9259	N	V	XXXVI-55	IIIb	㊾ⓔ	No.10	92000386	920722
L9339	N	XIII	XL-52	I	③	No.22	93000920	930712
L9340	N	II	XLIII-54	IIIa(?)	㉔ⓐ	No.15	93000921	930902
L9341	N	I	XLIV-55	IIIc	⑮	No.28	93000922	930805
L9465	N	II	XLIII-55	IIIa(?)	㉕	No.10	94000217	
L9466	N	II	XLII-55	IIIa(?)	㉕	No.84	94001450	940905
L9467	N	VII	XXXIII-55	IId	⑤ ㉔ⓑ	No.44	94001451	940909
L9468	N	VII	XXXII-54	IId	⑥		94001452	940906
L9469	N	VII	XXXIII-55	IIIb	㉓	No.27	94001453	
L9470	N	VI	XXXV-55	IIIb	(60)	No.4	94001454	940830
L9471	N	II	XLII-55	IIIa(?)	㉔	No.81	94001455	94024
L9472	N	V	XXXVI-55	IId(?)		W2take out, No.1	94001456	940824
L9473	N	II	XLII-55	IIa(?)	㉒		94000352	940630
L9474	N	VI	XXXV-55	IIIb	(61)	No.6	94001457	940901
L9475	N	VII	XXXIII-54	IId	③ ⑯	No.9	94000350	940718
L9476	N	II	XLII-54	IIIb		P1071	94000220	940715
L9539	N	VI	XXXIV-54	IIIb	(62)	No.17	95001409	950830
L9540	N	VI	XXXV-55	IIIb	(59)	No.4	95001410	950822
L9541	N	VI	XXXIV-55	IId	⑤ (61)ⓐ		95001411	950815
L9542	N	VI	XXXV-55	IIIb	(62)	No.11	95001412	
L9543	N	VII	XXXIII-55	IIIb	㉖		95001413	
L9544	N	VII	XXXIII-55	IIIb	㉖		95001414	950905
L9545	N	II	XLII-55	IIIb	㉘	No.48	95000838	950725
L9546	N	II	XLII-55	IIIb	㉘		95000830	
L9547	N	VI	XXXIII-55	IId	⑤ ㉕	No3	95000831	
L9548	N	II	XLII-54	IIIb	㉓ⓑ		95000833	
L9549	N	VI	XXXIV-55	IId	⑤ (62)	No.7	95000835	
L9550	N	II	XLIX-54	IIIb	㉛		95000840	950810
L9601	N	III	XL-54	IVa	(55)		96002268	960903
L9602	N	V	XXXVI-55	IIIb	(53)	No.13	96002269	
L9603	N	III	XLI-55	IV	(72)	No.4	96000829	960830
L9604	N	V	XXXVI-54	IV	(56)ⓑ	R217, No.2	96000830	
L9605	N	V	XXXVII-55	IV	㉘ⓐ	No.4	96000831	960823
L9606	N	III	XL-55	IV	(59)ⓑ		96000832	960821
L9607	N	IV	XXXVLLL-55	IIIc	(52)		96000833	960820
L9608	N	III	XL-55	IV	(58)ⓐ		96000838	
L9609	N	III	XLI-54	IV	(61)	No.5	96002271	960731
L9610	N	III	XL-55	IV	(58)	No.3, P1513	96002272	960801
L9611	N	III	XL-54	IV	(55)		96002273	960904
L9612	N	III	XLI-54	IV	(62)		96002274	960902
L9701	N	XXX	XLIX-51	IIIa	㉔		97002027	970821
L9702	N	XXX	XLVIII-51	IIc	㉑ⓐ	R234	97002028	970828
L9703	N	XV	XXXVI-52	IIa	⑩	No.5	97000694	970710
L9704	N	XIV	XXXVIII-52	IIa	⑭		97002029	970829

$^{207}Pb/^{206}Pb$	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$	Photo No.	AASVol. Sample No.	Analysis No.
0.8352	2.0696	18.791	15.695	38.891	001	new data	KP1766
0.8375	2.0747	18.716	15.675	38.831	002	new data	KP1767
0.8270	2.0576	18.998	15.711	39.090	003	new data	KP1768
0.8360	2.0725	18.805	15.721	38.973	004	new data	KP1769
0.8368	2.0763	18.725	15.669	38.879	005	new data	KP1770
0.8341	2.0716	18.833	15.709	39.015	006	new data	KP1771
0.8335	2.0695	18.839	15.702	38.986	007	new data	KP1772
0.8351	2.0723	18.768	15.673	38.894	008	new data	KP1775
0.8322	2.0680	18.869	15.702	39.020	009	new data	KP1776
0.8440	2.0817	18.520	15.631	38.553	010	new data	KP1777
0.8396	2.0786	18.661	15.669	38.789		Vol.1, 8924	CP123
0.8319	2.0658	18.866	15.695	38.974	011	new data	KP1778
0.8318	2.0647	18.843	15.674	38.905	012	new data	KP1779
0.8396	2.0770	18.715	15.713	38.872	013	new data	KP1780
0.8373	2.0730	18.774	15.719	38.917	014	new data	KP1781
0.8367	2.0723	18.792	15.723	38.943	015	new data	KP1782
0.8426	2.0827	18.652	15.716	38.846	016	new data	KP1783
0.8348	2.0680	18.834	15.722	38.948	017	new data	KP1784
0.8339	2.0666	18.861	15.729	38.979	018	new data	KP1785
0.8207	2.0500	19.138	15.706	39.233	019	new data	KP1786
0.8408	2.0791	18.689	15.714	38.857	020	new data	KP1787
0.8443	2.0858	18.612	15.714	38.821	021	new data	KP1788
0.8356	2.0729	18.704	15.629	38.772	022	new data	KP1789
0.8345	2.0723	18.831	15.714	39.023	023	new data	KP1790
0.8437	2.0845	18.616	15.710	38.805	024	new data	KP1791
0.8280	2.0608	18.954	15.694	39.061	025	new data	KP1792
0.8363	2.0766	18.778	15.704	38.995	026	new data	KP1793
0.8303	2.0704	18.906	15.697	39.143	027	new data	KP1794
0.8401	2.0788	18.701	15.711	38.876	028	new data	KP1795
0.8359	2.0742	18.714	15.643	38.816	029	new data	KP1796
0.8365	2.0716	18.799	15.724	38.944	030	new data	KP1797
0.8314	2.0650	18.899	15.713	39.027	031	new data	KP1906
0.8319	2.0618	18.871	15.699	38.908	032	new data	KP1907
0.8357	2.0737	18.710	15.636	38.800	033	new data	KP1908
0.8439	2.0853	18.626	15.718	38.840	034	new data	KP1909
0.8431	2.0838	18.640	15.715	38.842	035	new data	KP1910
0.8365	2.0750	18.777	15.707	38.961	036	new data	KP1911
0.8355	2.0722	18.777	15.689	38.911	037	new data	KP1912
0.8437	2.0845	18.620	15.710	38.814	038	new data	KP1913
0.8353	2.0743	18.805	15.708	39.008	039	new data	KP1914
0.8355	2.0732	18.710	15.632	38.790	040	new data	KP1915
0.8354	2.0727	18.780	15.689	38.926	041	new data	KP1916
0.8371	2.0738	18.745	15.691	38.873	042	new data	KP1917
0.8445	2.0848	18.593	15.710	38.763	043	new data	KP1918
0.8342	2.0738	18.832	15.710	39.054	044	new data	KP1919
0.8348	2.0730	18.823	15.713	39.020	045	new data	KP1920
0.8423	2.0808	18.651	15.710	38.810	046	new data	KP1921
0.8354	2.0744	18.800	15.705	38.999	047	new data	KP1922
0.8356	2.0735	18.708	15.632	38.791	048	new data	KP1923
0.8356	2.0731	18.703	15.628	38.774	049	new data	KP1924
0.8345	2.0727	18.827	15.711	39.022	050	new data	KP1925
0.8356	2.0734	18.707	15.631	38.786	051	new data	KP1926
0.8320	2.0718	18.920	15.741	39.198	052	new data	KP1927
0.8356	2.0731	18.703	15.628	38.773	053	new data	KP1928
0.8364	2.0740	18.762	15.692	38.911	054	new data	KP1929
0.8389	2.0776	18.693	15.682	38.837	055	new data	KP1930
0.8352	2.0725	18.728	15.642	38.815	056	new data	KP1931
0.8254	2.0447	19.037	15.713	38.926		new data	KP1932
0.8356	2.0732	18.703	15.628	38.774	057	new data	KP1948
0.8356	2.0730	18.703	15.628	38.772	058	new data	KP1949
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0.8372	2.0730	18.780	15.723	38.932	061	new data	KP1952
0.8309	2.0618	18.934	15.732	39.038	062	new data	KP1953
0.8357	2.0735	18.705	15.632	38.785	063	new data	KP1954
0.8355	2.0730	18.706	15.629	38.777	064	new data	KP1955
0.8438	2.0848	18.619	15.711	38.818	065	new data	KP1956
0.8355	2.0732	18.708	15.631	38.785	066	new data	KP1957
0.8340	2.0731	18.829	15.703	39.034	067	new data	KP1958
0.8355	2.0743	18.798	15.706	38.994	068	new data	KP1959
0.8376	2.0739	18.763	15.716	38.913		Vol.8, L9701	KP1111
0.8346	2.0729	18.834	15.719	39.041		Vol.8, L9702	KP1112
0.8345	2.0721	18.819	15.704	38.995		Vol.8, L9703	KP1113
0.8364	2.0744	18.806	15.730	39.011		Vol.8, L9704	KP1114

Table I Lead isotope ratios of lead objects excavated from Kaman-Kalehöyük

Sample No.	Sector		Grid	Stratum	PL	Note	Year No.	Date
L9705	N	XIV	XXXVIII-52		(13)	W10	97002030	970808
L9706	N	XIV	XXXIX-53	IIa	(8)	No.9	97000950	970721
L9707	N	XIV	XXXVIII-53	IIc	(9)(a)		97000969	970729
L9708	N	V	XXXVII-54	IIIb<	(61)		97002031	970731
L9709	N	V	XXXVII-54	IIIc	(61)		97000887	970728
L9710	N	V	XXXVII-54	IIIb<	(61)		97002032	970731
L9711	N	VII	XXXII-54	IIIb<	(24)		97002033	970813
L9712	N	IV	XXXVIII-54	IVa	(54)(a)		97000697	970717
L9713	N	III	XL-54	IV	(56)		97002034	970818
L9714	N	III	XLI-54	IV	(63)		97002035	970815
L9715	N	III	XLI-54	IV	(63)(b)		97002036	970819
L9716	N	XIV	XXXVIII-53	IIa	(9)(b)	No.11	97000952	970724
L9717	N	III	XL-55	IId		P1829No.10	97002037	970827
L9718	N	XV	XXXVI-53	IIa	(8)	No.20	97002038	970819
L9719	N	XV	XXXVI-52	IIc>	(10)	10	97000695	970710
L9720	N	XIV	XXXVIII-53	IIa	(6)	No.3	97000696	970710
L9721	N	XIII	XLI-52	IIa<	(18)		97002039	970820
L9722	N	XIII	XLI-52		(15)		97000951	970724
L9723	N	XV	XXXVI-53	IIa	(8)	No.18	97002040	970801
L9724	N	XXVI	XLVII-53			W4	97002041	970808
L9725	N	XXX	XLIX-50		(27)(a)		97002042	970903
L9726	N	XXX	XLIX-50	IIIa	(28)(a)	No.36	97002043	970908
L9727	N	XXX	XLIX-50	IIa	(28)(a)	No.36	97002044	970908
L9728	N	XXX	XLVIII-51		(19)(b)		97002045	
L9729	N	XXX	XLVIII-51	IIIa	(19)(b)		97002046	970911
L9730	N	XXX	XLVIII-51	IIIc	(19)(b)	No.30	97002047	
L9731	N	XXX	XLVIII-51		(19)(b)	No.31	97002048	
L9801	N	IV	XXXVIII-55	IVa	(58)	P1964	98000534	980812
L9802	N	VI	XXXIV-55	IIIb	(70)(a)	1989	98000535	980825
L9803	N	VI	XXXIV-55	IIIb	(68)		98000562	980818
L9804	N	VI	XXXV-55	IIIc	(71)(b)		98000563	980721
L9805	N	VII	XXXII-54	IIIb	(27)(a)		98000564	980715
L9806	N	VII	XXXII-55	IIIb	(24)	No.1	98000565	980731
L9807	N	XXI	XLVII-56	IIIc	(29)(a)		98000566	980818
L9808	N	XXIV	XLVIII-57	IIIc	(24)	No.3	98000567	980827
L9809	N	XXV	XLIII-52	IIc?	(13)(b)		98000569	980821
L9810	N	XXVI	XLIV-52		(11)(a)	No.2	98000570	980630
L9811	N	XXVI	XLVII-53		(22)		98000573	980629
L9812	N	XXVI	XLVII-53		(22)		98000573	980629
L9813	N	XXX	XLIX-50	IIIa	(32)		98000574	980818
L9814	N	XXX	XLIX-50	IIIa	(32)		98000575	980820
L9815	N	XXX	XLIX-50	IIIa	(34)		98000576	980825
L9816	N	XXX	XLIX-51		(32)		98000577	980825
L9817	N	XXX	XLIX-51	IIIa	(30)	No.3	98000578	980731
L9818	N	XXX	XLIX-51	IIIa	(29)	No.2	98000579	980728
L9901	N	VII	XXXII-55	IIIb	(31)(b)	No.3	99000105	
L9902	N	XVII	XLI-56	IIIb-c	(21)(a)		99000106	
L9903	N	VII	XXXII-55	IIIb	(35)	35	99000107	
L9904	N	I,XXII	XLV-55,56	border	(7)	No.2	99000108	
L9905	N	XV	XXXVI-52	IIc	(14)	P2100, No.1	99000109	
L9906	N		XLIII-52,53	unknown		kuzey kesit temizleme	99000799	
L9907	N	III	XL-55	IV	(75)		99000800	
L9908	N	XIV	XXXIX-52	IIa	(27)		99000801	
L9910	N	XXIV	XLIV-53	IIc-IId	(22)		99000803	
L9912	N	VII	XXXIII-54	IIIc	(62)		99000805	
L9913	N	XXVI	XLV-53	IIa	(16)		99000806	970803
L9914	N	VII	XXXIII-54	IIIb	(46)	No.7	99000807	
L9915	N	XXVII	XLVI-52	IIIb	(30)		99000808	990714
L9916	N	XXIII	XLIII-56	IIIb	(5)		99000809	990722
L9917	N		XXIII,XLIV-57	IIIa	(13)(a)		99000810	
L9918	N	III	XLI-54	IV	(68)(a)		99000811	
L9919	N	XVIII	XXXVIII-56	IIa	(20)		99000812	
L9920	N	XXVI	XLV-52	IId-IIIb	(23)	No.22	99000813	
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L9925	N	XXVII	XLVI-52	IIIb<	(31)	No.9	99000821	
L9926	N	XXVIII	XLIX-52	IIIc	(47)	No.15	99001097	990817
L9927	N	XVI	XXXV-52	IIa	(18)		99001098	990910
L9928	N	XV	XXXVI-53	IIc	(28)		99001099	990910
L9929	N	XV	XXXVII-52	IIc	(38)	No.37	99001100	990910
L9930	N	III	XL-54	IV			99001101	990901
L0005	N	III	XL-54	IV	(70)	No.17		000918

$^{207}Pb/^{206}Pb$	$^{208}Pb/^{206}Pb$	$^{206}Pb/^{204}Pb$	$^{207}Pb/^{204}Pb$	$^{208}Pb/^{204}Pb$	Photo No.	AASVol. Sample No.	Analysis No.
0.8367	2.0761	18.729	15.671	38.883		Vol.8, L9705	KP1115
0.8344	2.0721	18.827	15.709	39.011		Vol.8, L9706	KP1116
0.8354	2.0733	18.734	16.650	38.841		Vol.8, L9707	KP1117
0.8342	2.0696	18.806	15.804	38.921		Vol.8, L9708	KP1118
0.8345	2.0680	18.846	15.727	38.974		Vol.8, L9709	KP1119
0.8337	2.0688	18.813	15.684	38.920		Vol.8, L9710	KP1120
0.8291	2.0708	19.007	15.759	39.360		Vol.8, L9711	KP1121
0.8359	2.0741	18.704	15.634	38.794		Vol.8, L9712	KP1122
0.8352	2.0738	18.798	15.700	38.983		Vol.8, L9713	KP1123
0.8352	2.0736	18.800	15.700	38.984		Vol.8, L9714	KP1124
0.8357	2.0734	18.707	15.632	38.787		Vol.8, L9715	KP1125
0.8345	2.0724	18.822	15.707	39.007		Vol.8, L9716	KP1126
0.8356	2.0735	18.708	15.632	38.791		Vol.8, L9717	KP1127
0.8255	2.0499	19.032	15.709	39.014		Vol.8, L9718	KP1128
0.8359	2.0760	18.786	15.704	39.000		Vol.8, L9719	KP1129
0.8345	2.0722	18.810	15.697	38.978		Vol.8, L9720	KP1130
0.8294	2.0670	18.927	15.698	39.122		Vol.8, L9721	KP1131
0.8338	2.0722	18.830	15.700	39.020		Vol.8, L9722	KP1132
0.8356	2.0735	18.706	15.631	38.787		Vol.8, L9723	KP1133
0.8332	2.0722	18.863	15.717	39.088		Vol.8, L9724	KP1134
0.8356	2.0735	18.708	15.632	38.791		Vol.10, L9725	KP1381
0.8355	2.0744	18.797	15.705	38.992		Vol.10, L9726	KP1382
0.8412	2.0803	18.687	15.719	38.874		Vol.10, L9727	KP1383
0.8359	2.0736	18.792	15.708	38.968		Vol.10, L9728	KP1384
0.8439	2.0842	18.609	15.704	38.784		Vol.10, L9729	KP1385
0.8352	2.0691	18.828	15.725	38.956		Vol.10, L9730	KP1386
0.8291	2.0710	19.013	15.763	39.376		Vol.10, L9731	KP1387
0.8406	2.0786	18.685	15.707	38.838		Vol.10, L9801	KP1418
0.8268	2.0569	18.984	15.696	39.048		Vol.10, L9802	KP1419
0.8356	2.0730	18.704	15.629	38.774		Vol.10, L9803	KP1420
0.8356	2.0732	18.707	15.631	38.783		Vol.10, L9804	KP1421
0.8266	2.0548	19.015	15.718	39.072		Vol.10, L9805	KP1422
0.8357	2.0735	18.706	15.633	38.787		Vol.10, L9806	KP1423
0.8434	2.0843	18.629	15.712	38.829		Vol.10, L9807	KP1424
0.8356	2.0734	18.708	15.632	38.789		Vol.10, L9808	KP1425
0.8343	2.0719	18.834	15.714	39.022		Vol.10, L9809	KP1427
0.8336	2.0721	18.838	15.703	39.033		Vol.10, L9810	KP1428
0.8376	2.0771	18.714	15.675	38.871		Vol.10, L9811	KP1431
0.8433	2.0878	18.584	15.672	38.800		Vol.10, L9812	KP1431B
0.8368	2.0721	18.790	15.723	38.934		Vol.10, L9813	KP1432
0.8438	2.0849	18.623	15.714	38.827		Vol.10, L9814	KP1433
0.8441	2.0855	18.618	15.715	38.827		Vol.10, L9815	KP1434
0.8336	2.0670	18.888	15.745	39.042		Vol.10, L9816	KP1435
0.8271	2.0574	18.985	15.703	39.060		Vol.10, L9817	KP1436
0.8376	2.0737	18.769	15.721	38.921		Vol.10, L9818	KP1437
0.8440	2.0854	18.626	15.720	38.842	069	new data	KP1983
0.8371	2.0753	18.707	15.659	38.822	070	new data	KP1984
0.8356	2.0749	18.803	15.712	39.014	071	new data	KP1985
0.8276	2.0616	18.969	15.698	39.106	072	new data	KP1986
0.8338	2.0707	18.838	15.707	39.008	073	new data	KP1987
0.8347	2.0729	18.827	15.715	39.027	074	new data	KP1988
0.8357	2.0736	18.708	15.634	38.793	075	new data	KP1989
0.8358	2.0736	18.710	15.638	38.796	076	new data	KP1990
0.8364	2.0716	18.796	15.721	38.937	077	new data	KP1992
0.8403	2.0794	18.714	15.725	38.913	078	new data	KP1994
0.8346	2.0725	18.829	15.715	39.024	079	new data	KP1995
0.8326	2.0642	18.892	15.729	38.997	080	new data	KP1996
0.8353	2.0724	18.710	15.628	38.774	081	new data	KP1997
0.8401	2.0781	18.705	15.714	38.870	082	new data	KP1998
0.8273	2.0582	18.990	15.710	39.085	083	new data	KP1999
0.8353	2.0743	18.810	15.712	39.017	084	new data	KP2000
0.8267	2.0567	18.998	15.705	39.072	085	new data	KP2001
0.8357	2.0750	18.794	15.706	38.998	086	new data	KP2002
0.8436	2.0842	18.623	15.710	38.813	087	new data	KP2003
0.8351	2.0743	18.801	15.701	38.999	088	new data	KP2004
0.8355	2.0729	18.702	15.626	38.768	089	new data	KP2006
0.8352	2.0725	18.762	15.670	38.883	090	new data	KP2007
0.8409	2.0796	18.690	15.716	38.867	091	new data	KP2008
0.8368	2.0743	18.732	15.675	38.856	092	new data	KP2009
0.8296	2.0666	18.915	15.692	39.090	093	new data	KP2010
0.8369	2.0761	18.758	15.699	38.944	094	new data	KP2011
0.8357	2.0734	18.703	15.630	38.779	095	new data	KP2012
0.8391	2.0772	18.707	15.697	38.857	096	new data	KP2214

Table II Numbers of samples excavated from each stratum and area in Kaman-Kalehöyük

Stratum \ Area	A and A'	B and B'	C and C'	D and D'	E and E'	F and F'	G and G'	Subtotal	Outlier	Total
IV	0	7	1	4	1	1	3	17	2	19
IIIc	0	4	0	0	6	5	3	18	1	19
IIIb	2	11	3	4	1	1	4	26	6	32
IIIa	2	0	0	1	3	0	3	9	0	9
IId	1	2	1	1	0	0	0	5	4	9
IIc	0	0	3	1	0	0	0	4	4	8
IIa	2	2	7	1	0	1	0	13	8	21
Surface or I	0	0	0	0	0	0	0	0	5	5
Undecided	1	1	3	2	1	0	1	9	16	25
Total	8	27	18	14	12	8	14	101	46	147

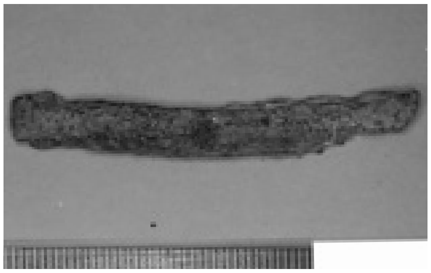


Photo 1 L8601

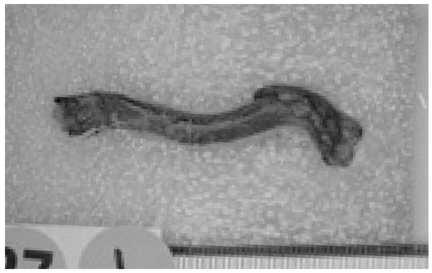


Photo 2 L8701

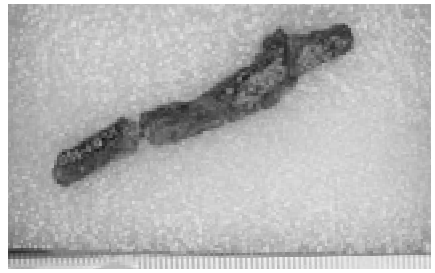
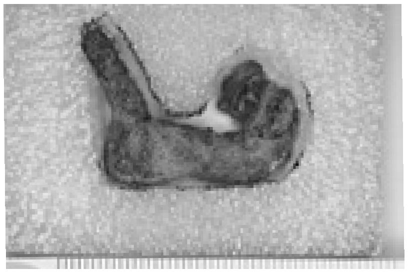


Photo 3 L8702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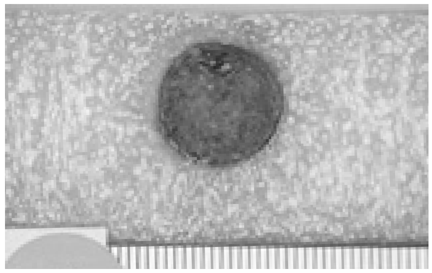


Photo 5 L8704

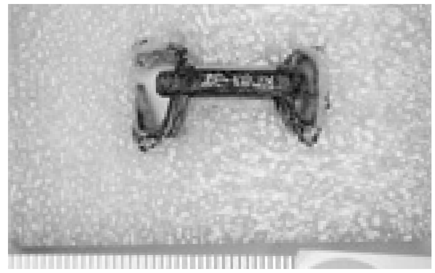


Photo 6 L8705

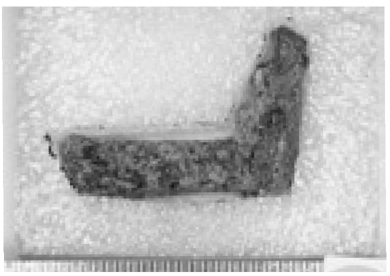


Photo 7 L8706

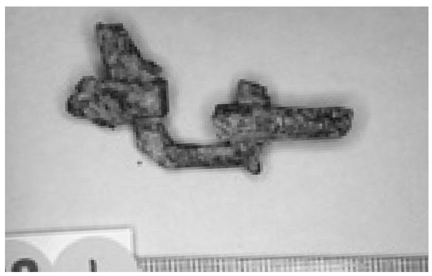


Photo 8 L8834

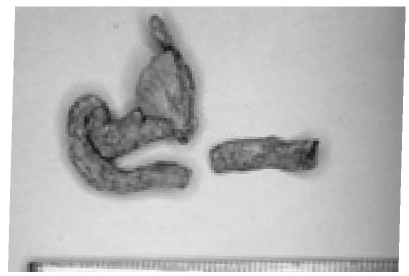


Photo 9 L8835

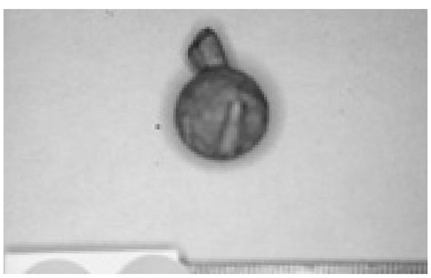


Photo 10 L8836

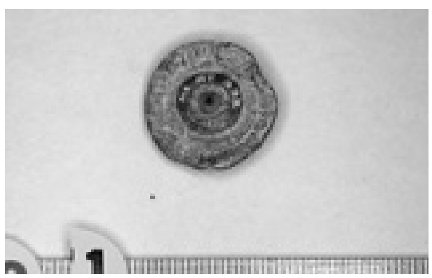


Photo 11 L8938

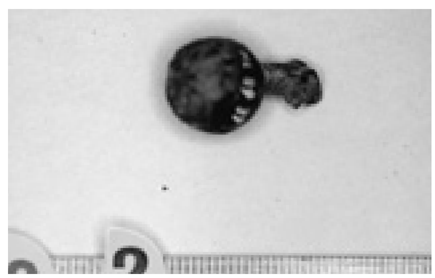
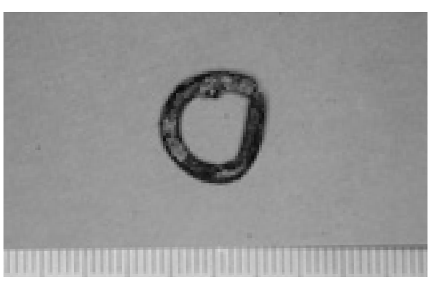


Photo 12 L8939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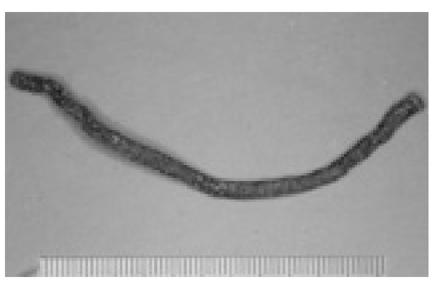
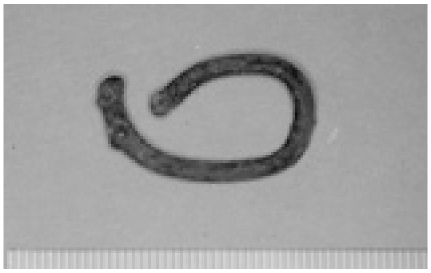


Photo 14 L9127


Photo 15 L9128

*Photo 1-96 The smallest scale in the photos is 1 mm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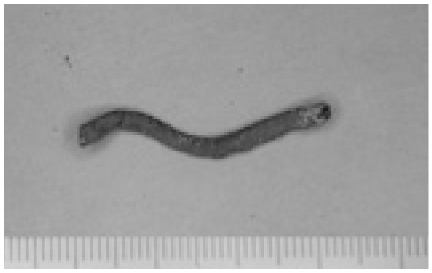
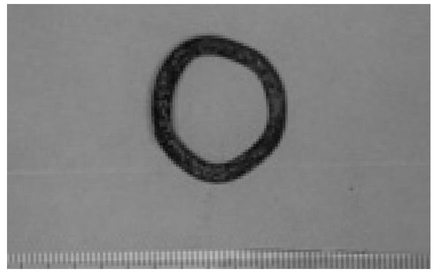


Photo 17 L9130


Photo 18 L9131


Photo 19 L9132


Photo 20 L9133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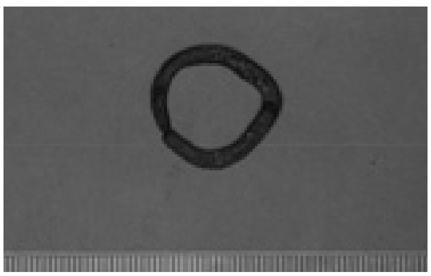


Photo 22 L9251

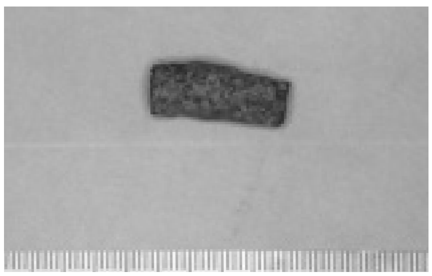
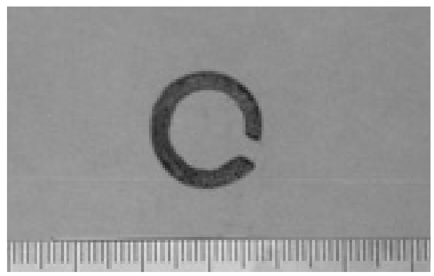


Photo 23 L9252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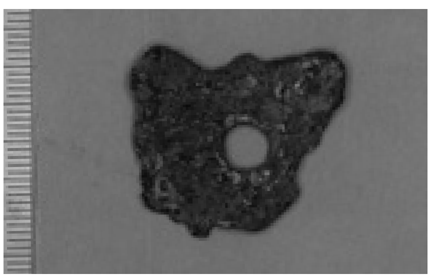
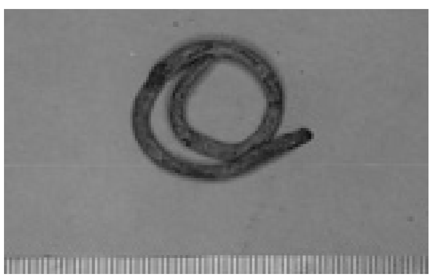


Photo 25 L9254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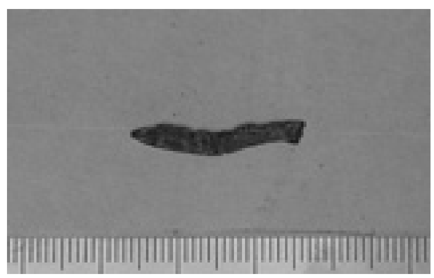
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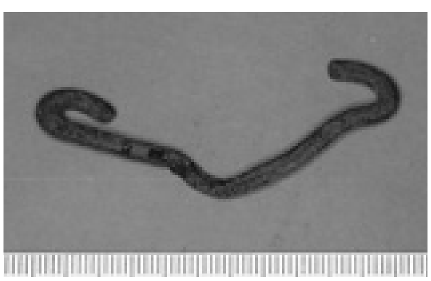
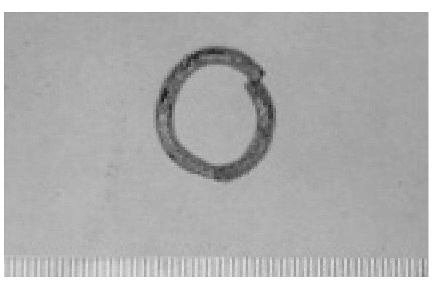


Photo 28 L9257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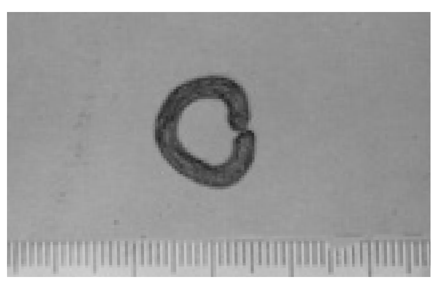
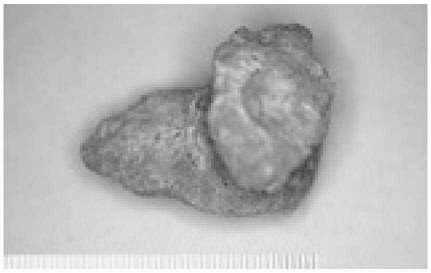


Photo 30 L9259

*Photo 1-96 The smallest scale in the photos is 1 mm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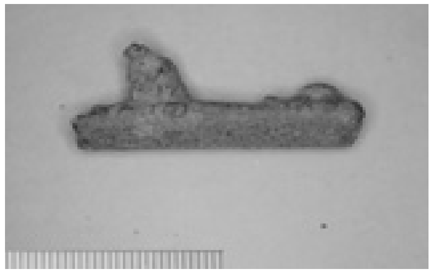


Photo 32 L9340

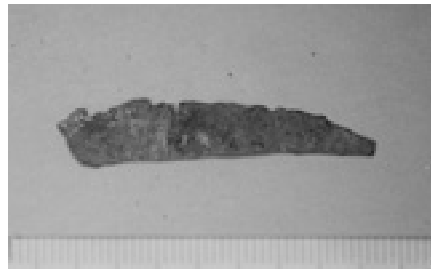


Photo 33 L9341

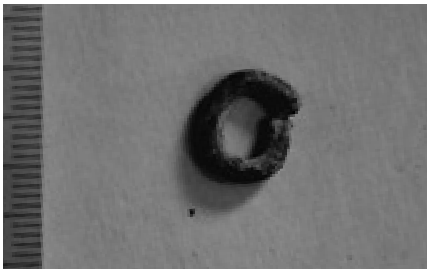


Photo 34 L9465

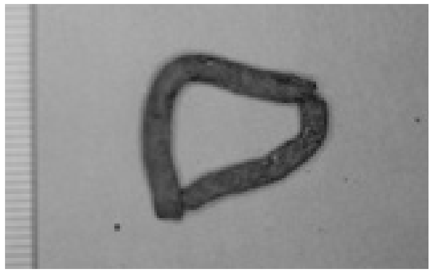


Photo 35 L9466

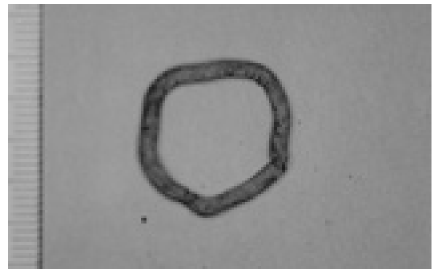


Photo 36 L9467

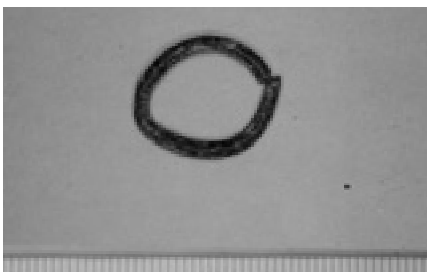


Photo 37 L9468

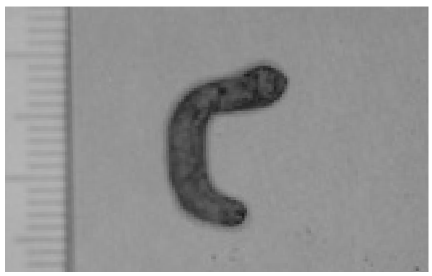


Photo 38 L9469

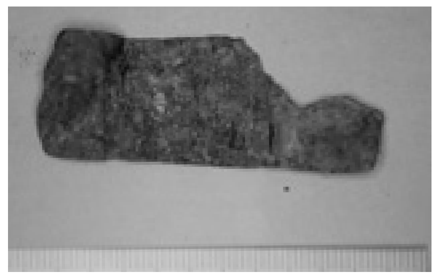


Photo 39 L9470

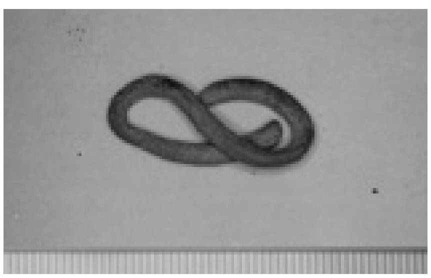


Photo 40 L9471

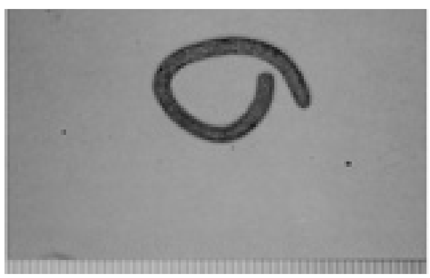
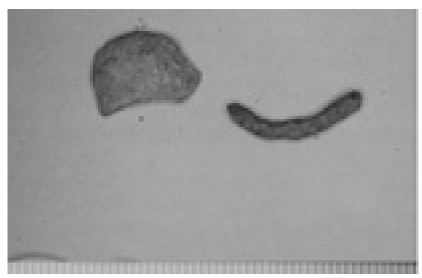


Photo 41 L9472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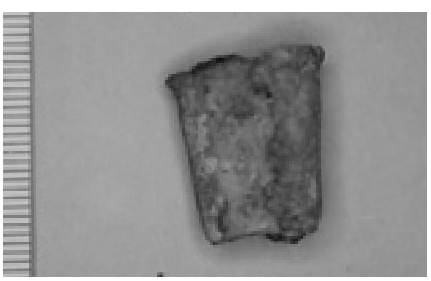
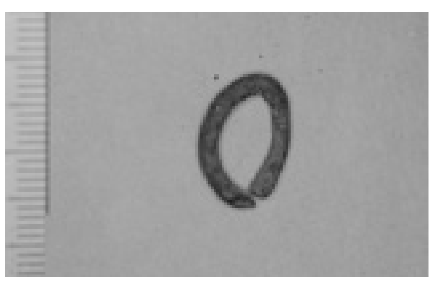


Photo 43 L9474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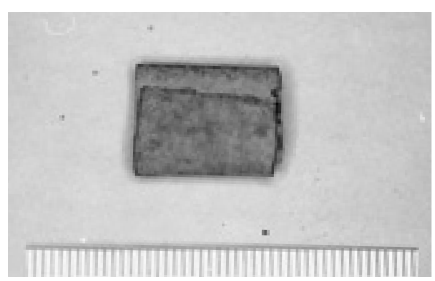
Photo 45 L9476

*Photo 1-96 The smallest scale in the photos is 1 mm

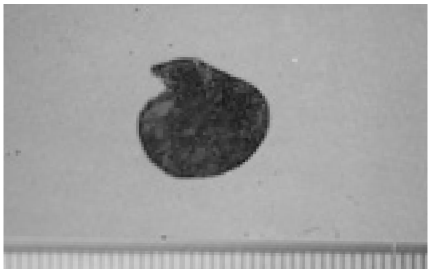

Photo 46 L9539

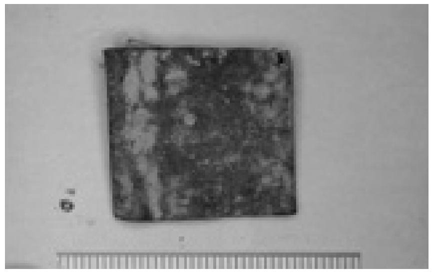

Photo 47 L9540

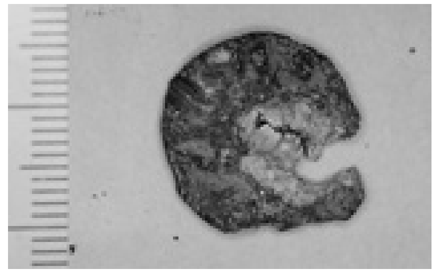

Photo 48 L9541

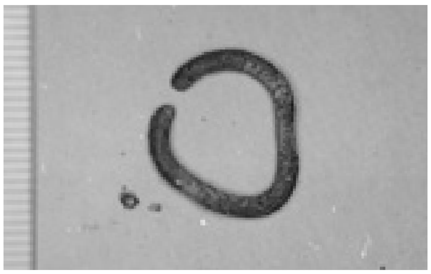

Photo 49 L9542

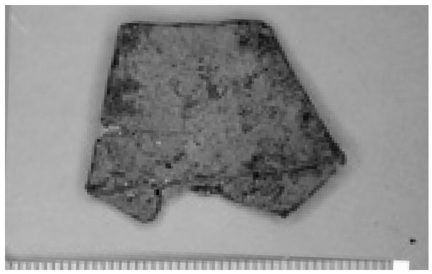

Photo 50 L9543

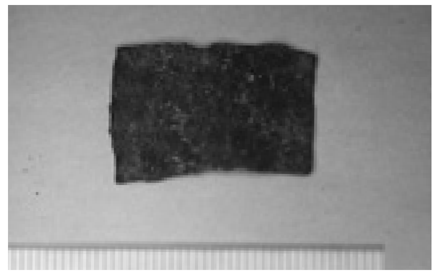

Photo 51 L9544

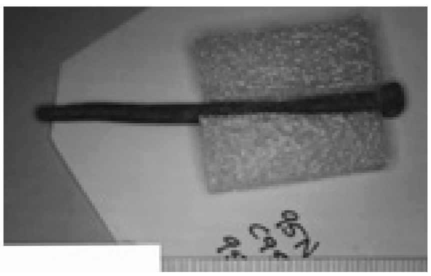

Photo 52 L9545

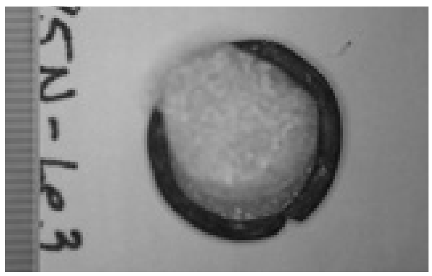

Photo 53 L9546

Photo 54 L9547

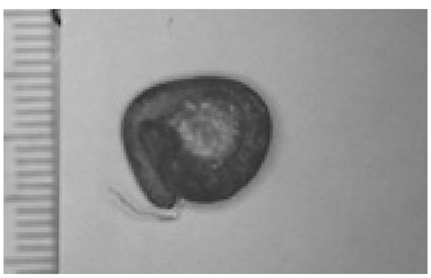

Photo 55 L9548

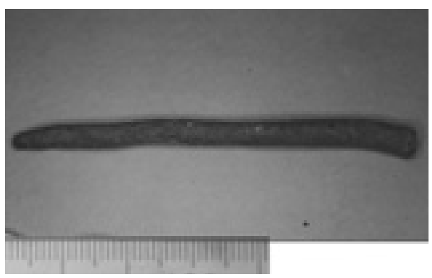

Photo 56 L9549

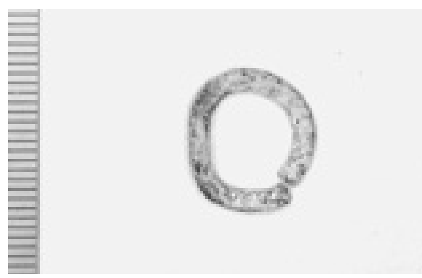

Photo 57 L9601

Photo 58 L9602

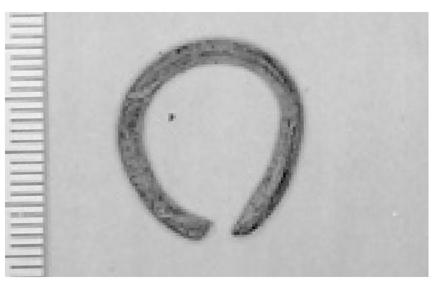

Photo 59 L9603

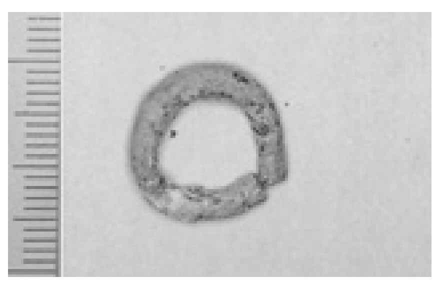

Photo 60 L9604

*Photo 1-96 The smallest scale in the photos is 1 mm


Photo 61 L9605


Photo 62 L9606


Photo 63 L9607

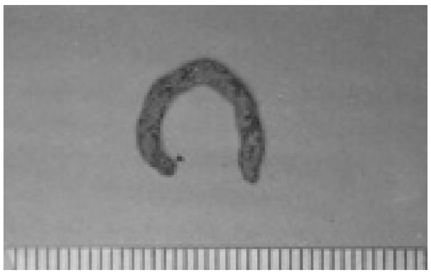
Photo 64 L9608

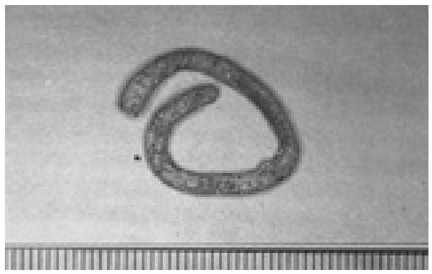
Photo 65 L9609

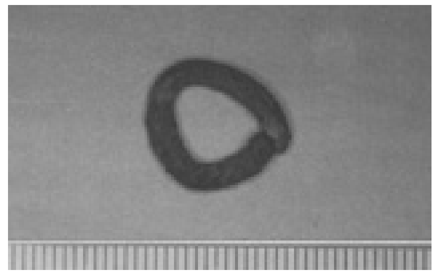
Photo 66 L9610

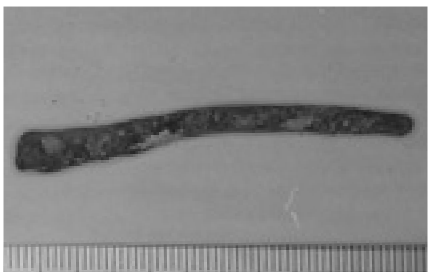
Photo 67 L9611

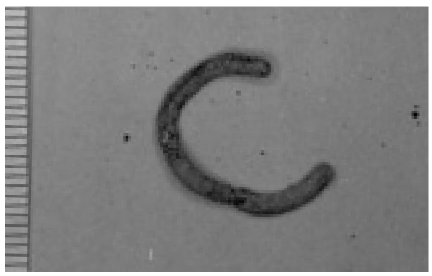
Photo 68 L9612


Photo 69 L9901


Photo 70 L9902


Photo 71 L9903

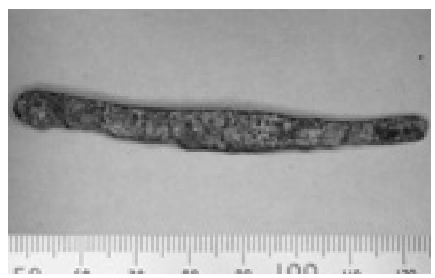
Photo 72 L9904


Photo 73 L9905

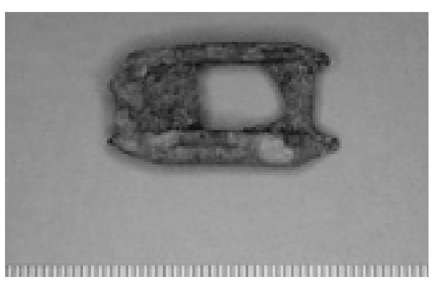
Photo 74 L99067

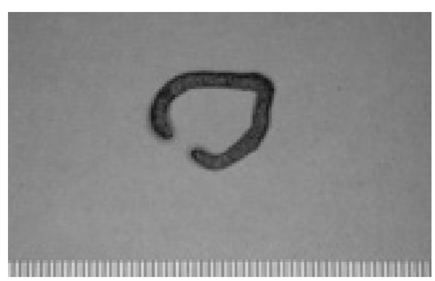
Photo 75 L9907

*Photo 1-96 The smallest scale in the photos is 1 mm

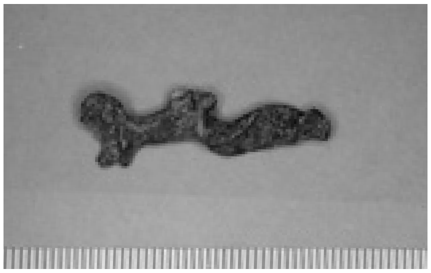

Photo 76 L9908

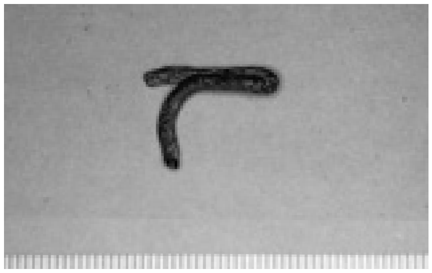

Photo 77 L9910

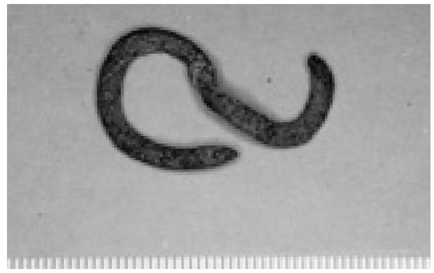

Photo 78 L9912

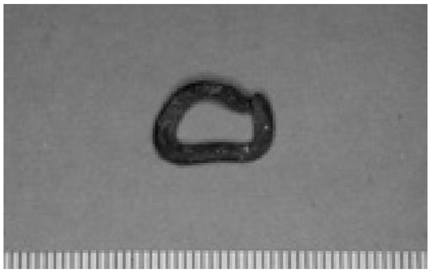

Photo 79 L9913

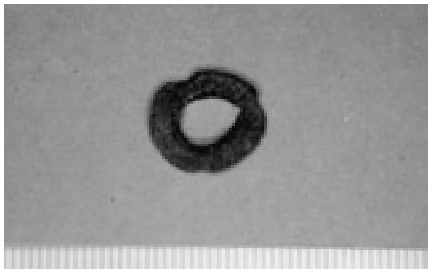

Photo 80 L9914

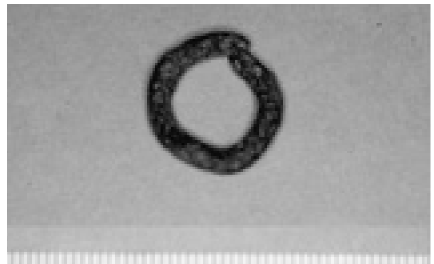

Photo 81 L9915

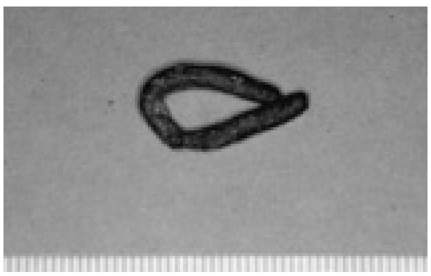

Photo 82 L9916

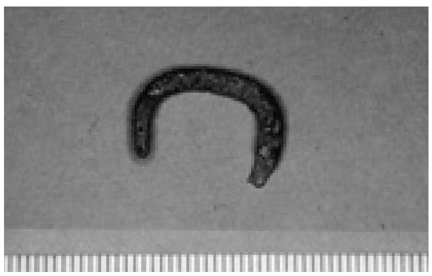

Photo 83 L9917

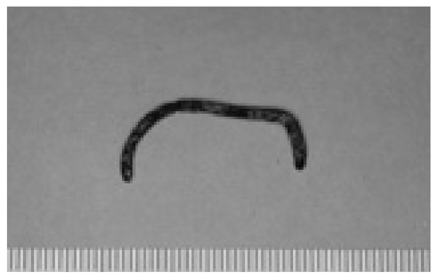

Photo 84 L9918

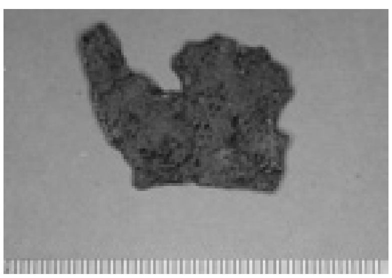

Photo 85 L9919

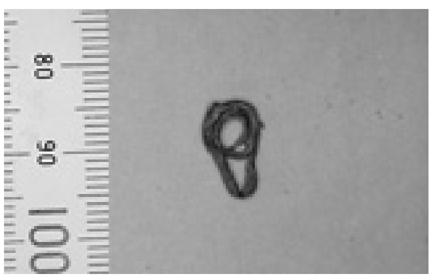

Photo 86 L9920

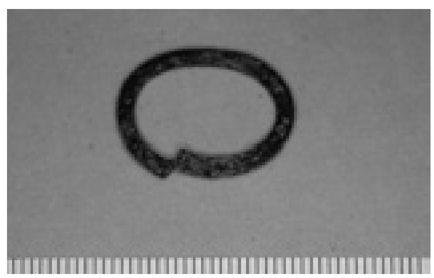

Photo 87 L9921

Photo 88 L9922

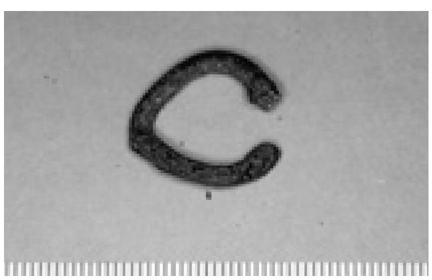

Photo 89 L9924

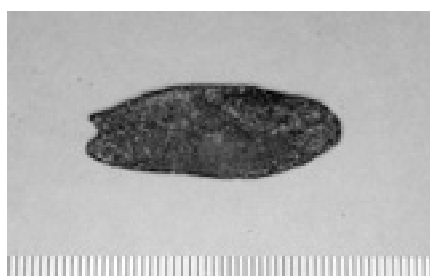

Photo 90 L9925

*Photo 1-96 The smallest scale in the photos is 1 mm

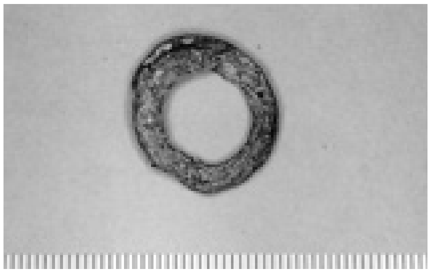
Photo 91 L9926

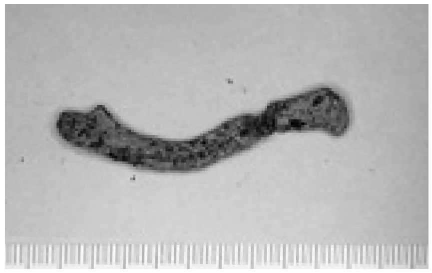
Photo 92 L9927

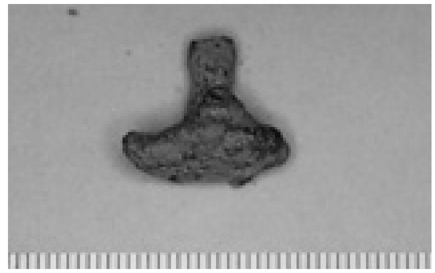
Photo 93 L9928

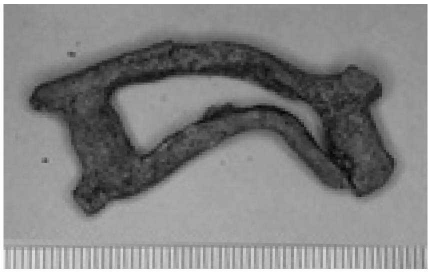
Photo 94 L9929


Photo 95 L9930


Photo 96 L0005

*Photo 1-96 The smallest scale in the photos is 1 mm