Scientific evidences to show ancient lead trade with Tissamaharama Sri Lanka: A metallurgical study

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The location of Sri Lanka in the Indian Ocean opened her many opportunities to interact with foreign trade links at the historical time. Archaeologists have established a knowledge regarding the ancient trade links that Sri Lanka had with the out side world by mostly studying the visually identifiable foreign made archaeological objects such as coins, ceramics, beads etc. in addition to using information from the written sources. It is evident all such foreign made archaeological objects discovered so by archaeologists were finished objects most probably exchanged for local trading goods.

Even though Sri Lankan ancient metallurgists had produced leaded bronze icons and other artefacts containing lead probably from circa 4^{th} – 5^{th} Century AD onwards, strikingly lead is totally absent in the protohistoric context metal artefacts of Sri Lanka, where we see only copper and iron artifacts implying lead may have not been known to the country during those periods. (Thantilage 2008 (b): 200-210). To date there is no known lead source within the island. Hence the existence of lead and leaded bronze artefacts produced during the ancient times within the county compels us to think that lead was obtained most probably through the foreign trade that existed during that period. The advance methods of scientific analysis such as stable lead isotope ratio analysis have opened the opportunities to address this type of question.

Stable lead isotope investigations of two Gajalakshmi coins made with the two different methods stuck technique (figure 1) and cast technique (figure 2), a fake Roman coin (figure 3), a lead disk (figure 4) and two pieces of pure lead ingots discovered from an illegal excavations done by villagers and subsequently acquired by the author from Akurugoda, Tissamaharama in southern Sri Lanka, revealed an extremely important result on resource utilization for their production. By plotting the stable lead isotope ratios values in the scatter plot of Pb 207/206 Vs Pb 208/206 showing the already identified lead isotope groups (MLG1 to MLG6) of Sri Lankan historical leaded bronze icons (Thantilage 2008 (a): 62) the Tissamaharama atefacts were grouped as follows (figure 5).

In MLG2 group – a piece of lead ingot.
In MLG4 group – Two Gajalaksmi coins and a pure lead disk.
In MLG6 group – Fake Roman coin and a peace of lead ingot.
All the groupings of Tissamaharama artefacts in the scatter plot of Pb 207/206 Vs Pb 208/206 were confirmed by getting the same lead isotope groupings in the scatter plot of Pb 207/206 Vs Pb 206/204 (see figure 6).

By plotting the published stable lead isotope ratio values of the ancient lead mines and some published values of the stable lead isotope ratios of ancient lead artefacts from the different part of the world on Tissamaharama artefacts in a scatter plot of Pb 207/206 Vs Pb 208/206 revealed striking results and the results were again confirmed by getting the same groupings in the scatter plot of Pb 207/206 Vs Pb 206/204. It was found that stable lead isotope ratio values of the ancient Mediterranean lead mine from Sardinia Fluminese (Stose-Gale et el. 1995: 411) matched with the Sri Lankan lead isotope group MLG4, in which the two Tissamaharama, Akurugoda made Gajalaksmi coins and a lead disk were grouped (figure 7 and figure 8). A closely matching of leaded artefacts lead isotopically could happen either due to the use of the same batch of metals for their production or made using lead from the same mine. But in this case a piece of pure lead was closely matched with the leaded coins in the MLG4 group, so it is most reasonable to think that the close matching is due to the use of lead from the same mine.

From this it can be inferred that Industries in Akurugoda at Tissamaharama in Sri Lanka had imported lead metal from the Mediterranean region, through ancient trade. This is very important and perhaps this would be the first time that we have got definite information on the importation of raw materials in ancient times for the productions of the local industries. The lead isotope ratio values of the same Mediterranean lead source Sardinia, Fluminese had matched with the Sathavahana period lead coins of India (Sirinivasan 1999b: 206) indicating that lead had also been obtained from the same region by India during that period.

Lead isotope values of several Han mirrors of China and several Chinese Bu coins found in Japan (Mabuchi et el. 1985: 150) somewhat match** with the above Sri Lankan objects in MLG5 and MLG6 (figure 7 and figure 8), though this is not a perfect match, however, the lead isotope values of these Chinese artefacts show a considerable difference from the values of the western world. The lead sources that correspond to Sri Lankan lead isotope groups MLG5 and MLG6 are very special since these are the only sources that have a $Pb^{206/204}$ ratio value less than the 18.0 in all the lead isotope values of Sri Lankan artefacts (figure 7). This $Pb^{206/204}$ ratio is a better indicator of the provenience. So there would be a possibility of the origin of MLG5 and MLG6 (in which the Tissamaharama samples grouped) lead sources being in China. This would be an example of the trade links with China that Tissamaharama had during the period to which the samples should belong.

The closely isotopically matching of the two Gajalakshmi coins made by two different techniques (cast and stuck) in the lead isotope group MLG4 group also tells us a different story. As mentioned earlier a closely matching of leaded artefacts isotopically could happen either due to the use of same batch of metals for their production or made using lead from a same mine. In the first case the above coins must essentially be contemporarily made while for the latter case, since the lead was not from locally supplied, coins it may also be contemporary or may have a slight chronological difference. This is because obtaining of lead from an exact place through long distance trade for a long period of time would be not an easy task. It has also been shown that the lead taken to the country by traders during the latter part of the Anuradhapura period were from different places even though they were from the same region (Thantilage 2008 (a):86). Hence the two Gajalakshmi coins would belong to a contemporary period which have been made using two manufacturing techniques and found from the same place. This is very interesting since it is generally believe of that Gajalaksmi coins made by the stuck technique are older than the same type cast coins.

** Please note that the lead isotopes values of Chinese artifacts found in Japan are not from the Isotrace laboratory where the lead isotope ratio values for the ancient Mediterranean lead mines were obtained or the Swedish laboratory where the Tissamaharama samples were analysed for which the comparison of the results obtained from the two laboratories for the same samples and got extremely comparable results within at the standard error limit of 0.005% (Thantilage 2008 (a): 78).

Conclusion

This metallurgical study gives evidences to suggest that the ancient metal industries in Tissamaharama had obtained lead from outside through trade. This indicates ancient local industries may have imported their needed raw materials especially not available in the country. The same arguments above would also apply to the tin metal which is the main ingredient needed to produce bronze with copper. Tin metal was also not seen in the protohistoric contexts in Sri Lanka as in the case of lead and so far no known source of cassiterite (tin ore) has been found within the country. But it has been found that Sri Lankan metallurgists had produced high tin bronze as early as the latter part of the Anuradhapura period (Thantilage 2008 (a): 45-53). Manufacturing of high tin bronze indirectly tells us the use of metallic tin for their productions, most probably obtained through the foreign trade in the same way as the lead. But it is not known exactly from where it came. But since the lead had been imported from the west there is a possibility of one source being west through the same trade routes.

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Figure 1: Gajalakshmi coin made with stuck technology

Figure 2: Gajalakshmi coin made with cast technology

Figure 3: A Fake Roman coin made in Tissamaharama

Figure 4: A lead disk

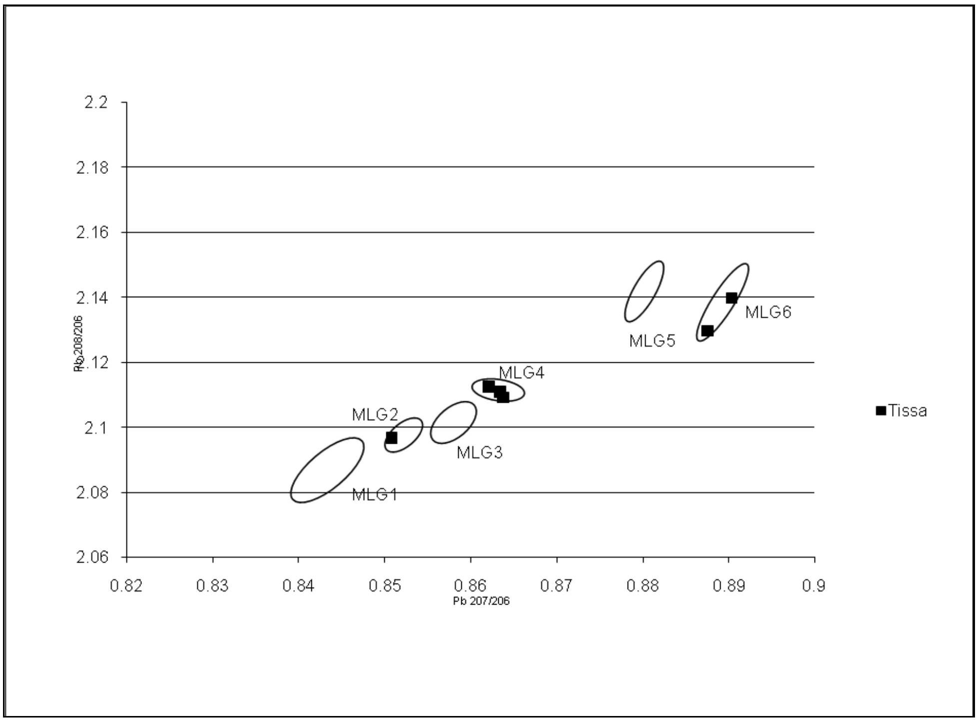

Figure 5: Lead Isotope ratio scatter plot Pb 207/206 Vs Pb 208/206 of Tissamaharama artefacts

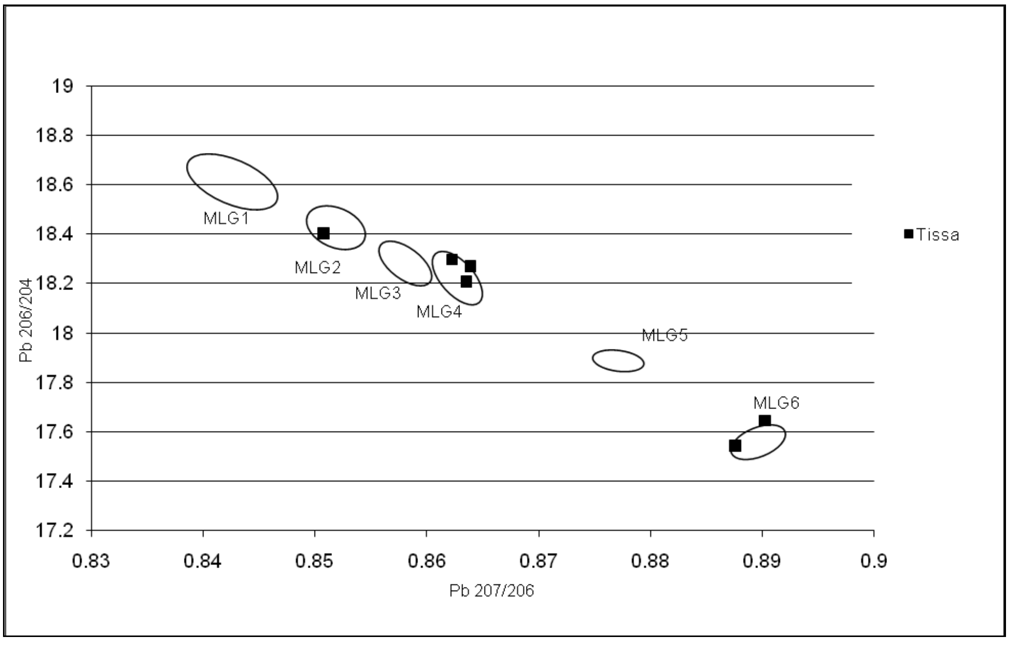

Figure 6: Lead Isotope ratio scatter plot Pb 207/206 Vs Pb 206/204 of Tissamaharama artefacts

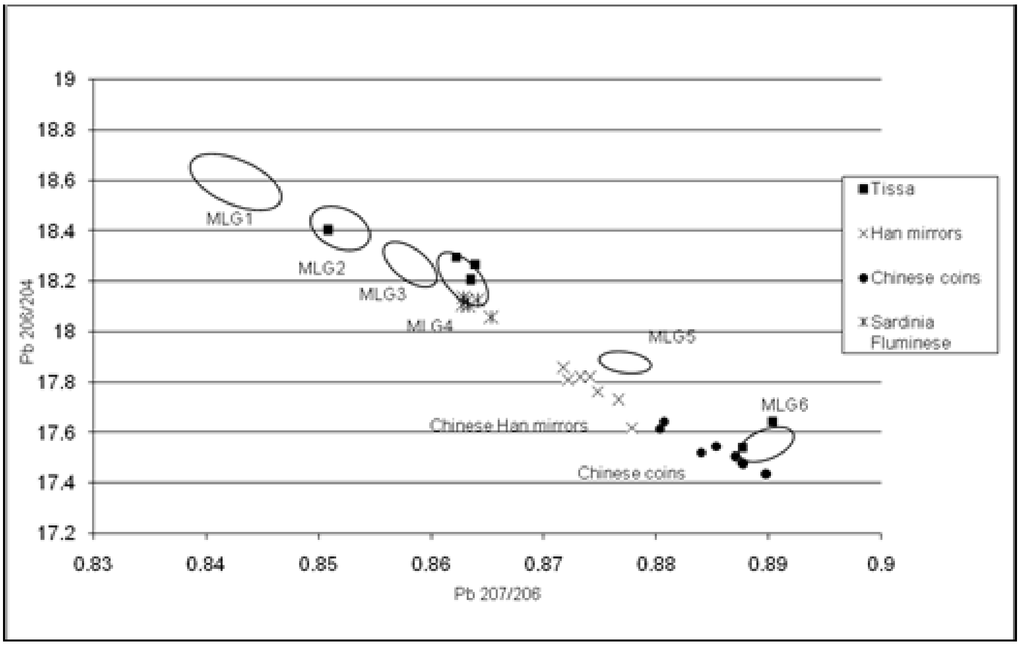

Figure 7: Lead Isotope ratio scatter plot Pb 207/206 Vs Pb 208/206 of Tissamaharama artefacts, Ancient Mediterranian lead source Sardinia Flumanse and some Chinese coins and artefacts on the graph showing Sri Lankan lead isotope groups of historical leaded bronze icons.

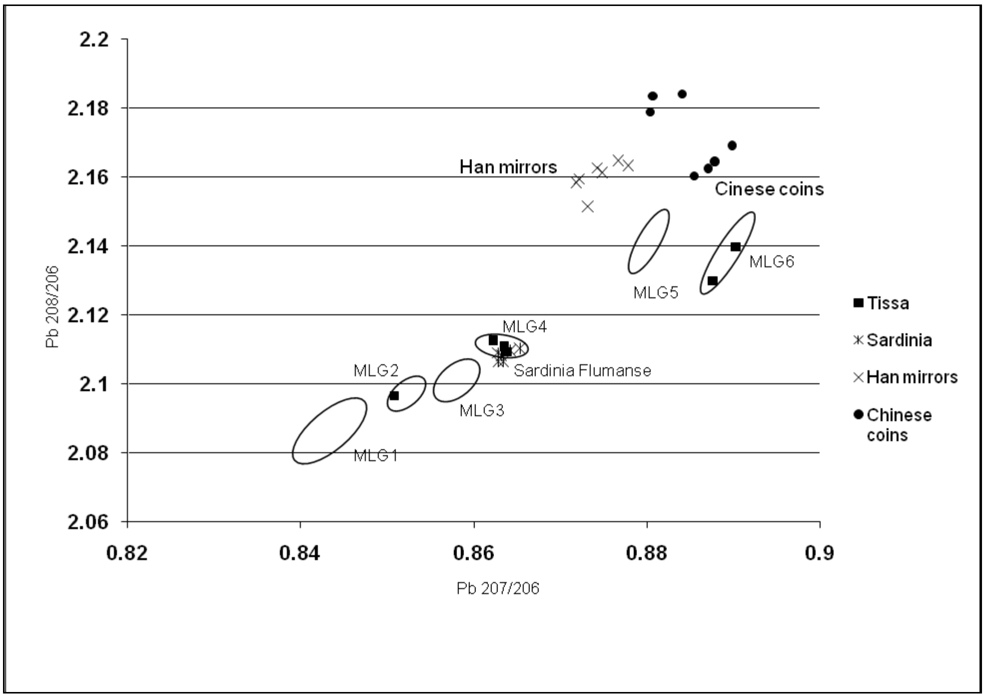

Figure 8: Lead Isotope ratio scatter plot Pb 207/206 Vs Pb 206/204 of Tissamaharama artefacts, Ancient Mediterranian lead source Sardinia Flumanse and some Chinese coins and artefacts on the graph showing Sri Lankan lead isotope groups of historical leaded bronze icons.

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