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A Scientific Study of the Bronze Tara image from Sri Lanka at the British Museum for evaluating its provenance

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Abstract

This paper discusses the recent controversy on the provenance of the Life Size Tara image found in Sri Lanka and now deposited at the British Museum. The Tara image was first studied using stable lead isotopic methods during a study on South Indian bronze images by an Indian scholar. By comparing Stable Lead Isotopic Ratio Values and trace elemental values of South Indian images with the Tara image, the present idea of the possible South Indian origin of this Tara image has emerged. Unfortunately, by that time, no Sri Lankan historical bronze images had been studied with Stable Lead isotopes or Trace elements for any comparison of the Tara image with other contemporary Sri Lankan bronze images. This study uses later obtained Stable Lead Isotope and Trace element values of Sri Lankan historical bronze images by the author to address the controversy on the provenance of the Tara image found in Sri Lanka and now deposited at the British Museum by critically evaluating the Tara image that to the Stable Lead Isotope and Trace elemental trends of Sri Lankan bronze images. This study shows that the Tara image closely matches four Sri Lankan images as a group, and the source of lead that had been used to make the Tara image is also known in the country. This paper also suggests that the Tara image may have belonged to the MLG2 School of image production that existed during the latter part of the Anuradhapura period in Sri Lanka. Furthermore, this study argues that the Tara image is incorporated more into the Sri Lankan context through Stable Lead Isotope values, and matched with the four Sri Lankan images closely, rather than to the South Indian Context.

Keywords: *Bronze, Lead Isotope, Trace elements, British museum Tara, Buddhist Icons*

Introduction

The Theravada Buddhist traditions mainly influenced the inception of Sri Lanka's historic art and architecture. But beyond the 6th–7th Century BCE, archaeological and historical evidence shows that Mahayanism started to influence the existing Theravada ideology in Sri Lanka. The Mahayanism ideology was a pan-regional ideology during that period, and inevitably, Sri Lanka may have been subjected to that ideology with the new maritime trade linking South East Asia, China, and India. Historical records indicate Sri Lankan King Mahasena (274 – 301 CE) even patronized the Mahayana ideology (Wickramagamage 1990). Archaeological evidence shows that Theravada monasteries had absorbed Mahayana art and architectural features widespread in the country. Hence, Sri Lanka possesses a rich collection of sculptures depicting Mahayana deities as stone or metal sculptures, carvings in rock faces, etc., throughout the country, and some of them were world-famous masterpieces Kurunegala Tara, Avalokitesvara Veheragala (Photographs 1 & 2). Tara is a female Bodhisattva Deity in the Mahayana Buddhism. Tara images, specially made out of copper alloys, were dated to the 7^{th} – 9^{th} Century AD and have been found in different parts of Sri Lanka (Schroeder 1990)

The life-size gilded Tara image exhibited at the British Museum (acc. no. OA-1820-6-12-14, see photograph 7) had been found in the 1800s somewhere between Trincomalee and Batticaloa on the eastern coast of Sri Lanka, and then the governor Sir Robert Brownrigg later donated it to the British Museum. Sharadha Srinivasan analyzed this Tara image for stable lead isotope and trace element while doing the metallurgical study on South Indian bronze images (Srinivasan 1999 (a): 95). Comparing stable lead isotope ratio values and trace element values of this Tara image with values of some South Indian Bronzes, she argues the possibility of it having a South Indian origin. She further stated that the trace element trends of Tara's image fit Pallava's trend and suggested perhaps the re-use of Pallava metal (Srinivasan 1999 (b): 204). She referred to Tara's image's already published compositional analysis results (Schroeder 1990). When Srinivasan conducted a lead isotope and trace element study for South Indian bronze images, no Sri Lankan bronze

image was studied with such analyses. The author was able to conduct a lead isotopic and trace element study for Sri Lanka's historical bronze icons in 2003 at the Natural History Museum in Stockholm, Sweden. This analysis result has opened up a new opportunity to study the South Indian and British Museum Tara image's lead isotopic and trace elemental results in the Sri Lankan context.

This paper aims to compare the lead isotope results of the Tara image with those of Sri Lankan bronze images, address the existing controversy regarding the provenance of this Tara image, and open up a discussion.

Lead Isotope Analysis Method

There are four stable isotopes of lead metal present in the world. i.e., lead-206, lead-207, lead-208 and lead-204. It is a known fact now that the isotopic composition of lead in minerals from different parts of the world has distinct values and is the basis for lead isotope geochronology and lead isotope geochemistry. Generally, the minerals contain minute amounts of lead as an impurity. The isotopic composition of lead varies in nature over a range of up to 5 percent (Gale et al. 1982: 12), which is much higher than the analytical precision of the scientific methods used to measure the isotopic compositions in the minerals, enabling the isotopic composition of lead to be used as an indicator of the provenance of the ore sources. The advantage of looking at the isotopic composition of an element rather than at the abundances, or the abundance pattern, of minor and trace elements is that the isotopic composition of an element does not change from ore to artifact, regardless of the metallurgical processes used. (Begemann et el.1987: 269) The isotopic compositions of the four stable isotopes are usually expressed as abundance ratios of $Pb^{208/206}$, $Pb^{207/206,}$ and $Pb^{204/206}$.

Lead isotopic composition of unalloyed copper gives isotopic characteristics of the copper source (Gale et el.1982: 12). The isotopic matching of leaded artifacts may be due to the lead coming from a single common source or due to the objects having being made from the same batch of metal containing lead from mixed sources which may have archaeological significance for shared geography or chronology.

(Sirinivasan 1999(a): 93) The thermal ionization mass spectrometry (TIMS) method was used for the lead isotopic analysis of this study. The lead isotopic analysis was carried out using the facilities at the lead isotopic laboratory, Natural History Museum, Stockholm.

Stable Lead Isotope ratio and trace element analysis of Sri Lankan images

The results of the lead isotope analysis of Sri Lankan late Anuradhapura period Buddhist, leaded bronze images representing 6^{th} – 9^{th} Century BCE, and Polonnaruwa period Hindu images (11^{th} - 13^{th} Century BCE) were summarized here to consider the Tara image's values. The stable lead isotope ratio values of Pb 207/206, Pb 208/206, and Pb 206/204 were obtained. By plotting the lead isotope ratio values, Pb 207/206 Vs Pb 208/206 in a scatter plot (see Graph 1), the distribution of values in the scatter plot showed that they were grouped into six different lead isotope groups named MLG1 to MLG6. These same lead isotopic image groups were confirmed by the scatter plot of Pb 207/206 Vs Pb 206/204 indicating the validity of such lead isotope grouping among the images (Thantilage 2008 (a): 62). This may have been mainly due to the differences in origins of lead from where the lead was obtained for the production of images time to time. For ease of visualizing Sri Lankan results and parallel South Indian bronze images, only the South Indian images are shown, and Sri Lankan results are represented by their isotopic group boundaries (Graph 2 and Graph 3).

The scatter plot of Pb 207/206 Vs Pb 208/206 (Graph 1) shows the lead isotopic ratio distribution of Sri Lankan Anuradhapura and Polonnaruwa period Buddhist images (7^{th} – 11^{th} Century AD). It shows that the majority of the Sri Lankan images were grouped within the group MLG1. Apart from that, a few images were closely grouped in the MLG2 group and the MLG4 group. All the images in Graph 1 were subjected to trace element studies, and the results will be discussed in the next paragraph.

Trace element Study of the Sri Lankan images

The recent archaeological studies in the Seruwila area, on the East coast of Sri Lanka, south of Trincomalee, have identified the historical mining and smelting of copper ore on an industrial scale from the 4th Century BCE to the 12th Century BCE (Thantilage, A and Vithanage, I). The trace elemental studies conducted by the Geological Survey of Sri Lanka on this copper deposit had identified certain trace elemental ratio characteristics. They have shown that the deposit contains characteristically high Nickel and the ratio of Cobalt/Nickel is greater than 0.43 (Jayawardhana and Padmasiri 1977). Interestingly, the trace element analysis of Sri Lankan bronze images shows the majority of Anuradhapura period bronze images have their Cobalt/Nickel ratio greater than 0.43 and make a separate group with the Cobalt/Nickel vs. iron/Nickel scatter plot and has been attributed to the bronzes made out of copper obtained from the Seruwila deposit (Thantilage 2008 (a):86)). (In the Seruwila copper deposit copper ore found along with the magnetite)

Nevertheless, the majority of the images in the MLG1 lead isotopic group had their Cobalt/Nickel ratio greater than 0.43, and the same images make a separate image group in the trace element scatter plot of the Cobalt/Nickel vs. iron/Nickel, indicating their possible origin of copper as the Seruwila deposit. Three images seen on the left side of the MLGI group in Graph 1 also had Cobalt/Nickel values greater than 0.43, indicating the origin of copper could have been similar to that of MLG1 images, but lead may have come from a different origin. The author has shown elsewhere that the lead isotope values of the MLG1 group matched the lead source of the Mediterranean region. Hence, the difference may be due to the different batches of lead obtained, possibly through the Roman trade. (Thantilage 2008 (a):86)

The stable lead isotope ratio values of the British Museum Tara image grouped well within the isotopic group of MLG2, in which Sri Lankan images and some lead ingots (found from Tissamaharama, in Southern Sri Lanka) grouped closely (Graph 1 and Graph 2).

Lead isotope ratio value of British Museum Tara with Lead ingots and lead coins from Tissamaharama, Sri Lanka

As mentioned earlier, the British Museum Tara image is grouped with the Sri Lankan image group MLG2. The Sri Lankan sample of objects selected for lead isotopic analysis not only contained leaded bronze images but few Gajalakshmi lead coins and also pieces of lead ingot found from Akurugoda, Tissamaharama found accidentally from an illegal gem mining in an ancient settlement mound. Graph 2 shows the distribution of lead isotope values of Tissamaharama lead coins and ingots over the Tara image. A piece of lead ingot from Akurugoda, Tissamaharama, closely matches the British Museum Tara in the MLG2 group. Apart from that, four Sri Lankan bronze masterpieces, dated to the latter part of the Anuradhapura period, as of the Tara image, were also grouped with the Tara image in the MLG2 group (Graph 1), indicating the use of that particular source of lead for the production of Sri Lankan bronze images. This matching indicates that the particular source of lead from which the lead had been obtained to make the British Museum Tara's image was known in Sri Lanka. The Sri Lankan bronze images closely matched with the Tara image in the MLG2 group will be discussed next.

Anuradhapura period images that are grouped with the Tara image in MLG2 lead group

The majority of the Anuradhapura and Polonnaruwa period Bronze images studied here were lead isotopically grouped in the MLG1 group. Most of the icons in the MLG1 group had a Cobalt/Nickel ratio greater than 0.43 and made a separate group in the trace element scatter plot, indicating the copper may have been obtained from the local Seruwila copper deposit. This image group consists of world-class masterpieces such as the Avalokiteswara image from Veheragala (photograph 1)

The lead isotopic group, MLG2, consists of four Sri Lankan images belonging to the latter part of the Anuradhapura period (7^{th} – 9^{th} Century AD), which are more or less contemporary to the Tara image(see Photographs 3 – 6). They have closely grouped with the Tara image and the piece of lead ingot from Akurugoda. The Buddha image

in photograph 2 was found in Batticaloa in the same area as where the Tara image was found, in the Eastern region of the country. The other images were the famous Buddha image found in the Badulla area in the South Eastern part of the country, the Buddha image found in Thiriyaya Monastery in the Eastern region, and the Vajrapani Bodhisattva image found in the Kurunegala area, in the North Central region of the country. Notably, the images in MLG1 and MLG2 groups have differences in resource utilization, technology, and stylistic features. The Author elsewhere had suggested that these images in the two isotopic groups may have represented a different school of image production during the Anuradhapura period, especially considering similarities within each group of images (Thantilage, A. 2008). By considering the stylistic and technological features of the recently discovered life-size Buddha image from Pallama in Puttlam District (Photograph 8), the north-western part of the country, the author suggested the possibility of relating, to the MLG2 group of image productions. (Thantilage, A. 2010 (b)). In the backdrop that Life-size bronze images are extremely rare in the Sri Lankan historical context, this would be an important piece of information since Tara is also a life-size image, and no life-size image is seen in the MLG1 image group. If that is the case. it shows that the production of life-size bronze castings is known to the MLG2 group of image production.

Reasons for assigning the latter Anuradhapura period images representing two schools of image production could be summarized as follows.

MLG1 school:

Only use copper from the local Seruwila source

Only use a lead source (MLG1) throughout

They have been found mainly in and around the Anuradhapura area

Image features/ Technology (casting/gilding, etc.)

MLG2 school:

Use of copper from a source other than the local Seruwila source

Only use lead source MLG2 throughout

They have been found outside the Anuradhapura area

Image features/ Technology (casting/gilding, etc.)

The Tara image satisfies the three main criteria in the MLG2 School image production mentioned above. (The trace element results of the Tara image do not match the Seruwila deposit.) Of the four images with which the Tara image was isotopically grouped, only the Tara image has been gilded. All the images were cast with hollow cast technology. Other than that, image features and technology more closely match the MLG2 School of Images.

Comparison with Indian images

Graph 3 shows the South Indian chronologically parallel images to the Tara over the Sri Lankan lead groups (MLG1 – MLG6), determined by the mean values of closely grouped Sri Lankan images.

In the Indian context, the Tara image is closely matched with only one gilded Buddha image from Nagapattainam (Sirinivasan 1999 (b): 202 – 204). (see graph 3). In the Sri Lankan context, Tara's image closely matches the Sri Lankan MLG2 group icons as a group, rather than that of the image from Nagapattainam, which has fallen outside the boundaries of the MLG2 lead isotope group. This emphasizes that Tara's image would have been closely incorporated with the Sri Lankan images in the lead isotope group MLG2. Further, in the Indian context, there is only one later Pallava period image (which may be more or less chronologically parallel to the Tara) grouped in the Sri Lankan lead isotope group MLG2 in comparison to the four Sri Lankan images that closely match Tara within the group. Interestingly, out of those five images in the MLG2, three images were found from the same Eastern coastal area of the island.

Notably, Later Pallava and Early Vijayala Chola images, the images that are more or less chronologically parallel to that of Tara in the Indian context, have been closely grouped with the Sri Lankan image group MLG1, in which 90% of the Sri Lankan Anuradhapura period images have been grouped. This indicates a very interesting fact: until about the 9th Century AD, Sri Lanka and India had obtained lead from a common source. It has been shown elsewhere by comparing the lead isotope values from the ancient mines and artifacts from the Mediterranean region that it is most probable that this lead may have been from the Mediterranean region and obtained through ancient long-distance trade with the Romans (Thantilage 2008 (a):86).

The lead isotopically overlapping of South Indian Later Pallava and Early Vijayala Chola images that are parallel to the late Anuradhapura period, with the Sri Lankan images in the group MLG1, indicates that resource utilization for the production of those images may have some common ground, i.e., both countries may have obtained lead from the same Roman trade. However, it seems this trend had changed after the early Calukya-Chola period (1070 -1125 AD) since later South Indian images do not match the Sri Lankan groupings.

When considering the four late Anuradhapura period images closely matched with the Tara image in the MLG2, those four Sri Lankan images match each other not only with lead isotopically but with trace elementally, showing that they may have a common origin.

In the Indian context, only one middle Pallava image, more or less chronologically parallel to the Tara, matches the Sri Lankan lead group MLG2. It is clear, at least with the Sri Lankan results, that the use of MLG2 lead source would have been more intense in the Sri Lankan context during the latter part of the Anuradhapura period, as five images closely matched with that group.

Later Polonnaruwa Hindu bronzes

When considering later Polonnaruwa period images (12 – 13th Century AD), the four Hindu Bronze images, which were chronologically later than the Tara grouped in the MLG2 lead isotope group (Graph 4). Interestingly, one Hindu image made with local

Seruwila copper is thought to belong to the Sri Lankan school of Hindu Sculptures (Lakdusinghe, S). When overlapping lead isotope ratio values of the South Indian images (Sirinivasan, S. 1999 (a) 95 – 97), there are three Chalukya Chola images grouped with the Sri Lankan image group MLG2. This might have shown that both Sri Lanka and India may have used lead from this common source until the 12^{th} – 13^{th} Century AD. It seems Polonnaruwa Hindu bronzes have shown some distinct lead isotope signatures, showing some uniqueness of them, as there are no South Indian contemporary images in MLG3 and MLG5 lead groups, in which groups there are a considerable number of Polonnaruwa Hindu bronzes were present. Further, there are two South Indian later Chalukya Chola images grouped in the Sri Lankan lead isotope group MLG4, but notably no Sri Lankan Polonnaruwa period Hindu bronze fell within that group.

Conclusion

In the Sri Lankan context, the Tara image more closely matches lead isotopically with the group of four late Anuradhapura images, in which three of them have been found in the same area as that of the Tara image, in contrast to the Indian context, where lead isotopically matched only with one Buddha image from Nagapattinam. However, it is important to consider that this particular Nagapattinam Buddha image does not match the Sri Lankan lead isotope group MLG2, in which the Tara image is closely grouped with four other Sri Lankan images. Nevertheless, a closely matching piece of pure lead ingot (a piece of a lead ingot, that had been found in the soil layer along with the leaded Gajalakshmi coins made in the same Tissamaharama, Akurugoda area) with the MLG2 group would undeniably indicate that this MLG2 lead source would have been known to Sri Lanka during the latter part of Anuradhapura period contemporary to the Tara. The Gajalakshmi coins were well-dated to the Anuradhapura period. In other words, this indicates that the lead from this particular lead source that had been taken to make Tara was also known and utilized during the contemporary or even earlier time in Sri Lanka.

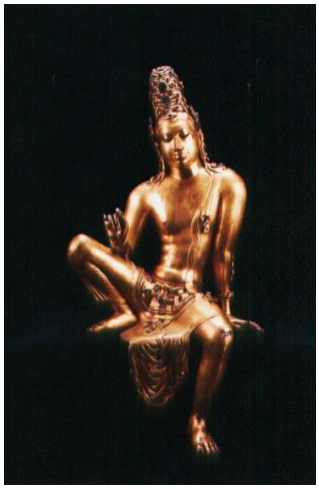
Trace elementally, none of the MLG2 group images were matched with the trace element trends of the local Seruwila copper source. This has been attributed to the existence of a possible second school of image production during the Anuradhapura period (Thantilage, A. 2010 (b)). Unfortunately, the trace element results of the Tara image published in the study by Schroeder (Schroeder 1990: 551) gave a very unusual value of the Cobalt/Nickel element ratio of 2.65, which is not even consistent with the South Indian image values either. So doubtful about the amount of accuracy of those results for conducting any comparison.

When considering the five images in MLG2, out of these five images, there are three images, including Tara have been found in the same eastern coastal area. All four images that the author was able to analyze and attribute to the MLG2 group matched each other very closely, not only with the lead isotopically but also with trace elementally. Because of this close matching in different dimensions, we may strongly argue the possibility that these four images could have a common origin. Three images out of four images in the MLG2 have been found in the same area as the Tara image. The four images in the group match closely with each other both isotopically and trace elementally. Since two images in the group were discovered from the Badulla and Kurunegala areas outside the eastern region (Photographs 4 & 6), we may conclude that this image school may have also been known to other parts of the country.

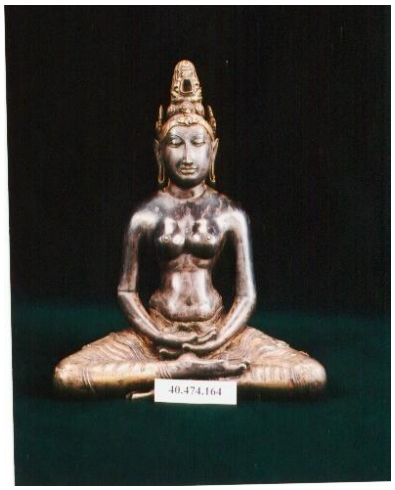
Accordingly, it is clear that the Tara image closely matched and made a group with some Sri Lankan late Anuradhapura period Buddhist icons, unlike in the Indian context, where it had only lead isotopically grouped with one image, and even that particular image does not match with the MLG2 image group, in which Group that theTara image closely group with four Sri Lankan images.

Finally, as concluding remarks, we may argue that there is a good possibility of having all five images in the lead isotope group MLG2 share the same common origin. Hence, in the Sri Lankan context, there is not enough evidence to suggest the Tara image may have a different origin than the closely matching others in the same group.

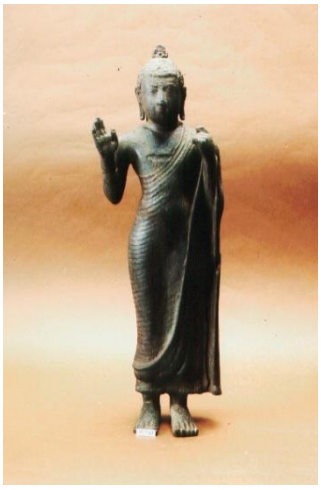
Unfortunately, the trace elemental results of the Tara image have a very high Co/Ni value that cannot compare with any of the images in this study, raising doubts about the results. It is extremely essential to take into account all five images together in the MLG2 group before any provenance attribution in the future. Further stylistic and art historical studies on these five images would have also been helpful in this endeavor.



Photograph 1: *Avalokiteswara image from Veheragala, Anuradhapura*



Photograph 2: *Tara image late Anuradhapura period found from Kurunegala*



Photograph 3: *Buddha Image Late Anuradhapura Period Kankayanodai, North Batticaloa*

National Museum, Colombo Museum Reg. No.: 35.77.12

Photograph 4: *Buddha Image 5th - 6th Century AD Baddulla*

National Museum, Colombo Museum Reg. No.:13. 11 . 289

Photograph 5: *Buddha Image 7th Century AD Thiriyaya*

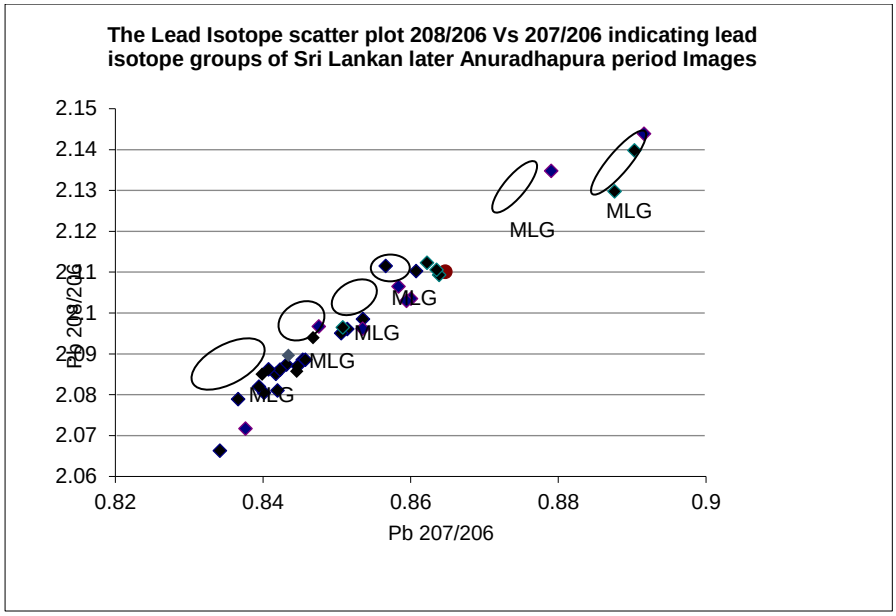
Archaeological Museum, Anuradhapura

Photograph 6: *Vajrapani Bodhisattva, 9th Century AD, Kurunegala District*

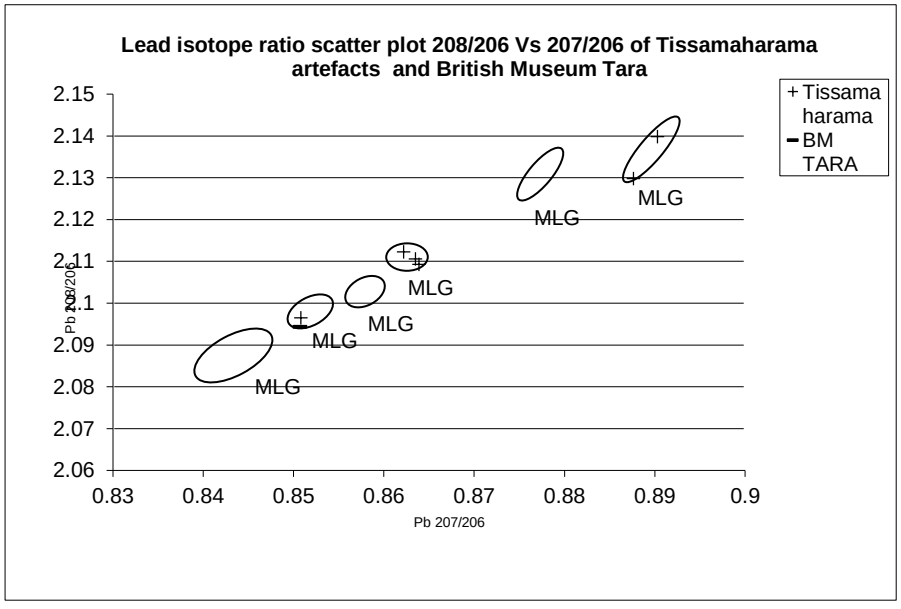
Department of Archaeology, Sri Lanka

Photograph 7: *Tara's image was found in Sri Lanka and is now deposited at the British Museum*

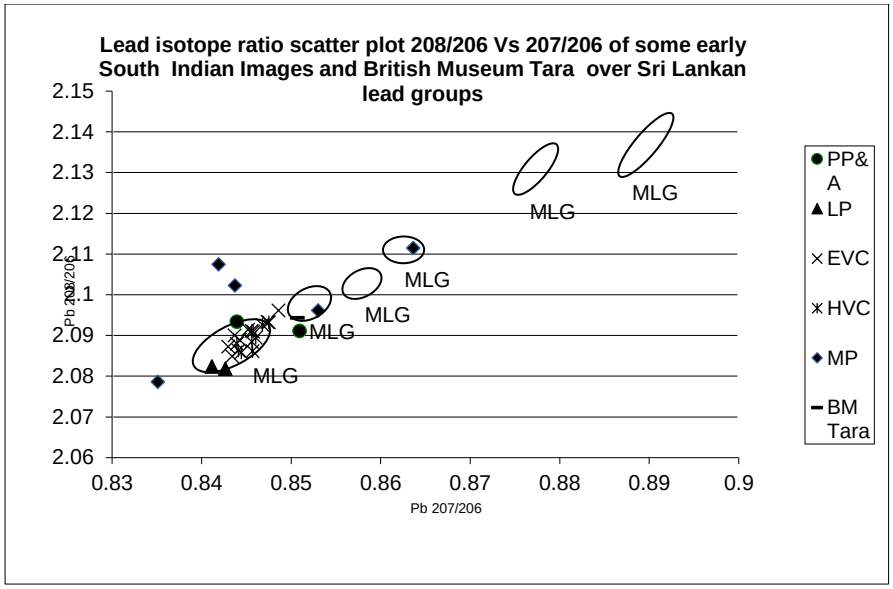
Photograph 8: *Life-size Buddha image discovered in Pallama in Puttlam District*



Graph 1: Lead isotope scatter plot showing lead isotope groups (MLG1 – MLG6) determined by the lead isotope ratio distribution of the Sri Lankan later Anuradhapura period images

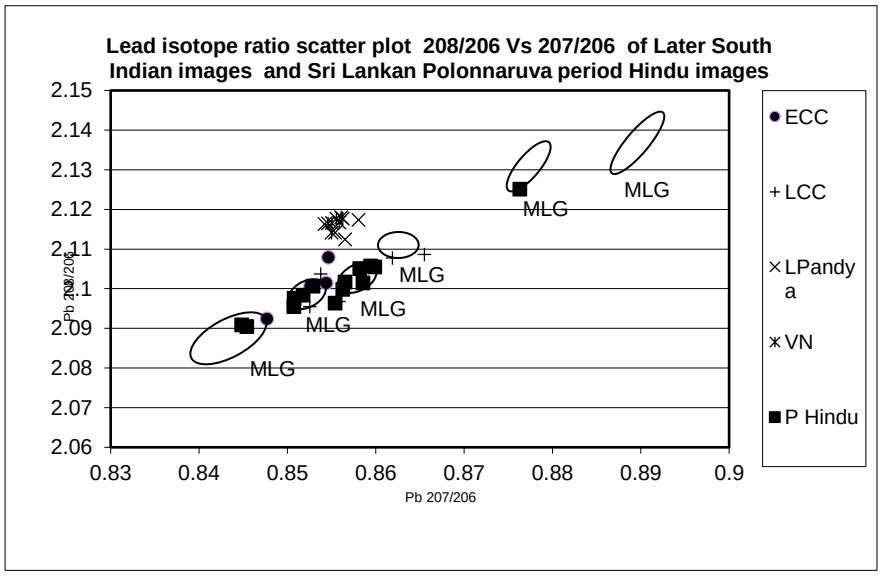


Graph 2: A piece of pure lead ingot from Tissamaharama is closely grouped with the Tara image at the British Museum, inside the Sri Lankan lead isotope group of MLG2. (Only the Tissamaharama artifacts in the graph1 are indicated in Graph 2 for convenience)



Graph 3: *Lead isotope ratio distribution of early South Indian images (Sirinivasan 1999a), contemporary to the Latter Anuradhapura period, and British Museum Tara image over Sri Lankan lead groups. Note that one middle Pallava image has been grouped with MLG2.*

PP&A – Pre Pallava and Andra (c. 200 – 600 AD), MP – Middle Pallava (c. 600 – 850 AD), LP – Later Pallava (c. 850 – 875 AD), EVC – Early Vijayala Chola (c. 875 – 940 AD, HVC High Vijayala Chola (c. 940 – 1070), BM Tara - British Museum (as in Sirinivasan 1999b: 207)



Graph 4: *Lead isotope distribution of Plonnaruva period (12 – 13 Century AD) Hindu images and later South Indian images (Sirinivasan 1999a) over Sri Lankan lead isotope groups. Please note that some later Chalukya-Chola images have been grouped with the Sri Lankan lead isotope group MLG2.*

ECC – Early Chalukya –Chola (c. 1070 – 1125 AD), LCC – Later Chalukya – Chola (c. 1125 – 1279 AD), L Pandya – Later Pandya (c. 1279 – 1336 AD), VN – Vijayanagara

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