TECHNICAL STUDY ON THE WHITE-GLAZED WARES WITH GREEN PATTERNS EXCAVATED IN THE TAK AREA IN THAILAND

A Preliminary Report

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I. Introduction

In 1984 burial sites were discovered high in the mountains along the Thai-Burmese border in the area of Tak. Amongst the many artifacts excavated was one group of ceramics not previously reported (although occasional pieces had been found earlier in Indonesia and Thailand). These wares were the subject of much interest as their provenance was not known and as many pieces are beautiful white lead-glazed dishes decorated with green floral and animal motifs.

It has long been known that green-glazed plaques were used to decorate temples at Pagan, Burma, and that green, white and brown glazed plaques were used at Pegu, Burma, particularly on the Shwegugyi pagoda built by King Dhammazedi in 1476. It is almost certain that so many large plaques must have been made near the temples.

The finding of lead-glazed, copper-coloured ceramics at Kalong in 1985 caused some scholars to speculate that the lead-glazed wares found at the Tak hilltop burial sites were produced at Kalong. Studies of lead isotope ratios confirm that, as others believed, this speculation was not correct.

The results presented in this paper make it highly probable that this group of ceramics found at Tak were produced in the vicinity of Pegu.

II. Samples

The glazes of a plate, two bowls and a plaque, and the body clay of a bowl were studied by chemical analyses and lead isotope determination. Several galena ores of Thailand and Burma were examined and their lead isotope ratios were compared with those of the above - mentioned glazes.

1. Sample A. A fragment of a white-glazed bowl with green patterns which was collected at a digging site in the Tak area by the research group of Chiang Mai University and is

See the article "Burmese Mon Tin-Glazed Wares in the Tak Finds and Influences from the Middle East," Virginia M. Di Crocco and Doris Schulz, *The Siam Society Newsletter*, Vol. 1, No. 4, 1985, pp. 6-13. The green and white tin-glazed wares from the Tak finds are there identified as Burmese Mon products stemming from the Mon sectors of Lower Burma, and having lead glazes opacified by tin.—Ed.

now in the collection of the University. (Color plate, p. 40. See also a complete specimen of the ware, same page.)

2. Sample B. A white-glazed plate without green patterns in a private collection. Only the isotope determination was made.

3. Sample E. A small fragment of a glazed plaque which was reported to have been brought from a temple in Pegu, Burma. The glaze remaining on the fragment is green. Only the fragment was obtained, and the whole figure is unknown, but it is similar to the plaques which are decorated with two figures having animal heads and human bodies.

4. Sample G. A white-glazed bowl with green patterns in a private collection. The white part of the glaze was studied.

5. Galena ore from Lamphun, Thailand.[1]

6. Galena ore from Mae Hong Son, Thailand.[2]

7. Galena ore from Mae Taeng, Chiang Mai Province, Thailand.[3]

8. Galena ore from Hatyai, Thailand.[4]

9. Galena ore from Mergui, Burma.

10. Galena ore from Tenasserim, Burma.

III. Analytical methods

Chemical analyses of the glaze were made by using the so-called ICP spectrometry (*i*nductively *c*oupled *p*lasma as the light source) after decomposing the samples with acids. The body clay was analysed by the commonly used method of silicate analysis. The distribution of copper, lead and tin in the glaze layers was determined by an electron-probe microanalytical method. The lead isotope determination was carried out in the laboratory of the Muroran Institute of Technology using a Hitachi RMU-6 mass spectrometer. For a more detailed description of the determination see the report on the metal objects unearthed in the Tak area by Y. Kuno et al., publication of which is forthcoming.

Preliminary experiments on the glazed wares found in the Tak area were carried out in the Fast Neutron Research Facility by using X-ray fluorescence analysis.[5]

IV. Results

1. Chemical compositions. Results of chemical analyses of the glazes are given in Table 1.[6] The standard deviation of the data determined by ICP is about ±5%

Table 1. *Chemical compositions of glazes*

Constituent	Sample A		Sample E	Sample G
	White	Green	Green	White
SiO_2	61.9%	51.8%	43.2%	41.3%
Al_2O_3	5.41	6.70	3.19	11.0
Fe_2O_3	0.96	0.82	2.20	1.06
CaO	6.01	3.90	1.16	3.28
MgO	0.66	0.73	0.50	1.27
Na_2O	0.51	0.23	1.36	0.14
K_2O	0.29	1.00	0.30	2.65
PbO	25.3	28.6	46.6	37.3
CuO	0.085	2.66	1.30	0.038
SnO_2	0.58	1.60	0.38	0.18

The chemical composition of the body clay of Sample A is given in Table 2.

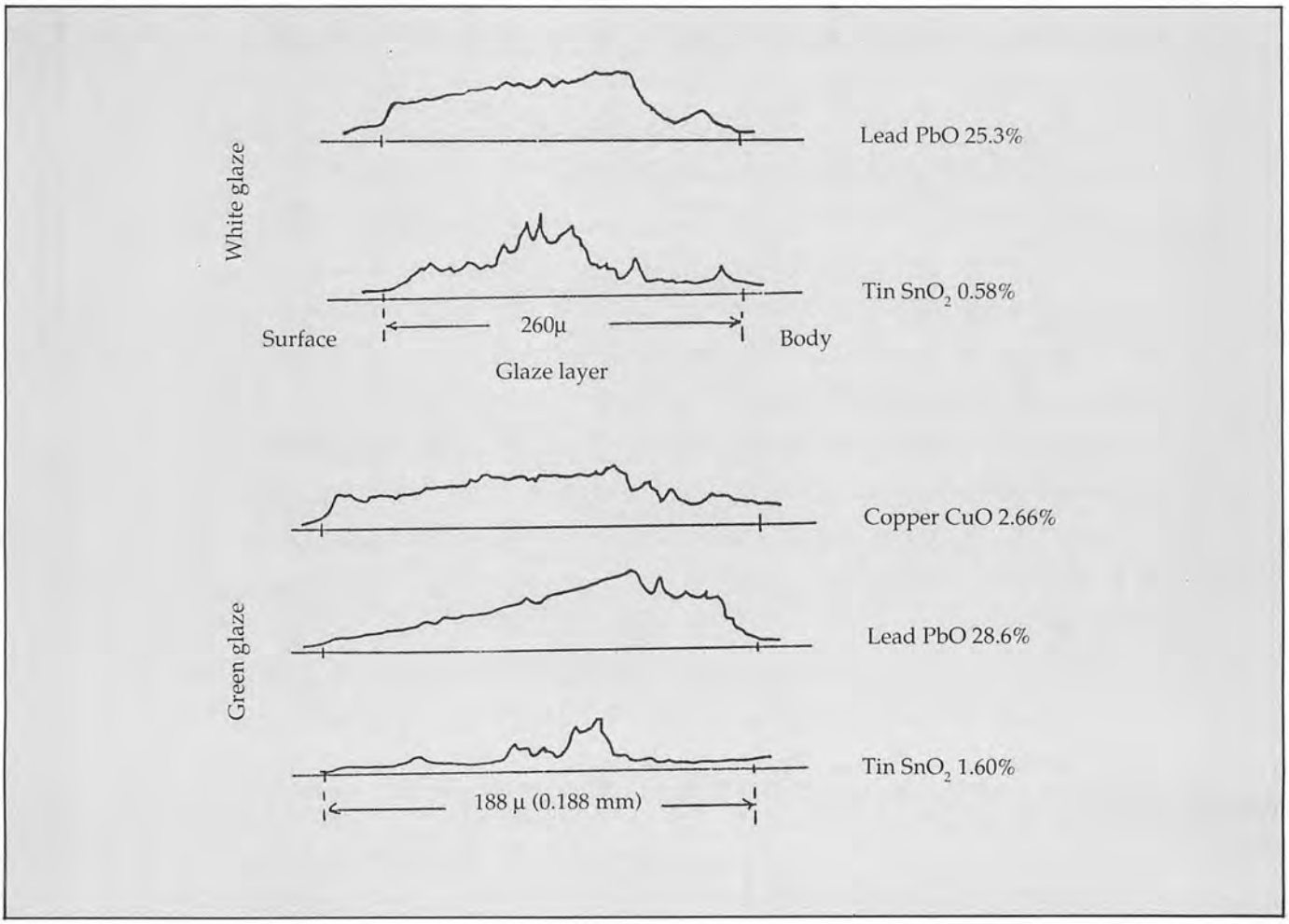
Table 2. Body clay of Sample A

SiO_2	78.9%
Al_2O_3	15.2
Fe_2O_3 (total iron)	2.3
TiO_2	1.1
CaO	0.029
MgO	0.44
Na_2O	0.099
K_2O	1.4
Ignition loss	0.96

2. *Distribution of copper, lead and tin in the glaze layers.* The distribution was determined by an electron-probe microanalyzer on the white and green glaze layers of Sample A. The results are shown in Fig. 1. Lead and tin show maxima in both glazes, whereas copper is distributed almost uniformly in the green glaze. The uniform distribution of copper over the whole cross section of the glaze indicates the so-called in-glaze method. The close similarity of the chemical compositions of the white and green glazes of Sample A also explains mixing of two glazes and diffusion of the green part into the white part.

3. *X-ray diffraction of the clay of Sample A.* The body clay was examined by X-ray diffraction, and formation of a small amount of mullite during firing was found. Quartz was present in the original clay used, but no formation of cristobalite from quartz during firing was found. This means that the firing temperature was about 1000-1100°C. As the softening temperature of the glaze is yet to be determined, we have discussed the problem of firing temperature with potters, and have come to the conclusion that these white-glazed wares were fired with glaze on air-dried bodies without biscuit firing. This problem will be studied again when the softening temperature of the glaze is known.

Fig. 1 *Distribution of Copper, Tin and Lead in the Glazes of Sample A (bowl)*



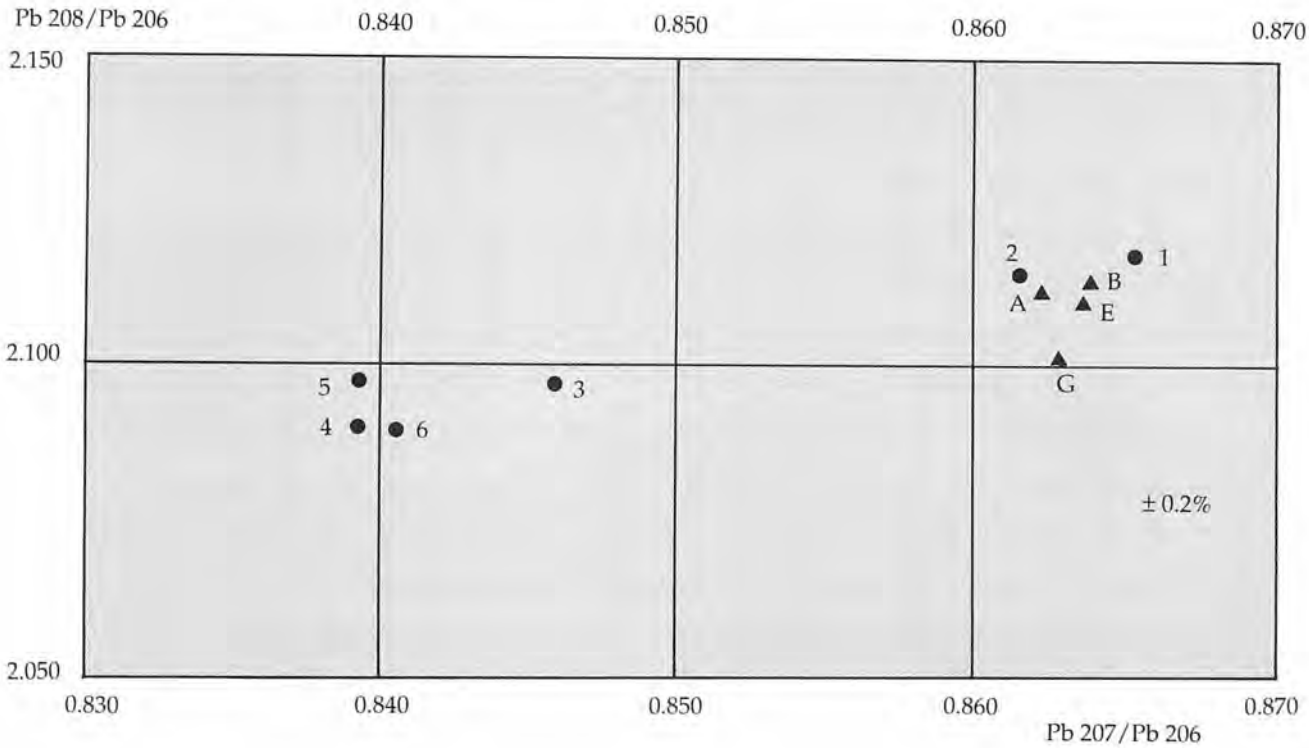
4. Lead isotope ratio determination. The lead isotope ratios of the glazes were determined by using a mass spectrometer, and the results were compared with those of the galena ores of Thailand and Burma. The results are shown in Table 3 and Fig. 2. The lead isotope ratio determination is useful to study the provenance of glazed wares containing lead. [7] The isotope ratios of three galena ores in the Malay peninsula, Hatyai, Mergui and Tenasserim indicate that these ores may have different geological ages compared with those of Lamphun and Mae Hong Son.

Table 3. *Lead isotope ratios of the glazes and the galena ores*

Sample	Pb 206/ Pb 204	Pb 207/ Pb 204	Pb 208/ Pb 204	Pb 207/ Pb 206	Pb 208/ Pb 206
Sample A, bowl, white glaze	18.19	15.67	38.28	0.8621	2.112
Sample B, plate, white glaze	18.21	15.72	38.46	0.8639	2.113
Sample E, plaque, green glaze	18.16	15.69	38.34	0.8636	2.111
Sample G, bowl, white glaze	18.35	15.85	38.40	0.8629	2.100
Galena ore, 1 Lamphun	18.26	15.76	38.65	0.8654	2.118
Galena ore, 2 Mae Hong Son	18.32	15.78	38.72	0.8615	2.115
Galena ore, 3 Mae Taeng	18.61	15.75	39.05	0.8458	2.097
Galena ore, 4 Hatyai	18.75	15.75	39.19	0.8394	2.091
Galena ore, 5 Mergui	18.73	15.72	39.29	0.8391	2.098
Galena ore, 6 Tenasserim	18.52	15.57	38.67	0.8402	2.089

The coefficients of variation of the ratios Pb 207/Pb 206 and Pb 208/Pb 206 are ± 0.2% and those of other three ratios are ± 0.4%, respectively.

Fig. 2 Lead isotope ratios of samples A, B, E and G, and galena ores. Galena ores 1, 2, 3, 4, 5 and 6 stand for the same ores in Table 3. ▲ and ● indicate Samples and galena ores, respectively.



V. Discussion

As is clear from the results in Table 1 the white and green glazes are lead glazes opacified by tin. The green colour is due to copper. The tin contents are rather low compared with the bluish green glazes of the sherds found in the Fustat site, Cairo, Egypt. One of the unpublished data by K. Yamasaki shows the tin content to be 2.82% SnO_2. The comparison was made because Islamic influence seems to have been exerted on the white-glazed wares found in the hilltop burial sites. The body clay of Sample A contains much iron, 2.3% as total iron, and this is the reason for the red colour of the body. The body clay is poor in alkaline earth and alkali metals, and rich in quartz.

Besides the white-glazed plates and bowls, chocolate brown coloured wares are rarely found. One of them, a bowl, was examined by the X-ray fluorescence method in the Fast Neutron Research Facility in Chiang Mai University, and the presence of lead and tin was confirmed. The colour was due to iron. Another bowl of similar colour was also studied by the same technique in Nagoya, and it contained lead, tin and iron like the other one. In both cases no sample for the quantitative analysis of the glaze was available because they were in private collections.

The results of lead isotope ratio determination show an interesting and important fact. The isotope ratios of Samples A, B and G are close to those of galena ores of Lamphun and Mae Hong Son. The latter is supposed to have been brought from Burma. It is not clear why Lamphun galena ore mined in Thailand shows similar values with a Burmese galena. Probably these two galena ores belong to mines with similar geological ages. As we have very little knowledge about the lead mines in Burma, especially in the central part, no more information is obtained at the present moment. The fact, however, that Samples A, B and G have similar isotope ratios with those of a glazed plaque, E, which is supposed to have come from Pegu, Burma, suggests a possibility that these white-glazed wares and plaques were all made in Burma. Our unpublished results show that several more plaques of Pegu and sherds found in Pagan, Burma have similar isotope ratios with the above three samples. It is highly probable that all these were made in Burma. It may be difficult to suppose that numerous plaques found near Pegu were produced in Thailand and sent to Burma. More samples are under investigation.

In 1985 George and Shaw, two of the present authors, reported that small numbers of green-glazed wares were fired in a kiln at Tung Man, Kalong kiln complex, in Ampur Vieng Papao, Chiang Rài Province, and these wares were different from the green-glazed wares found in the hilltop burial sites.[5] Our studies now under way show that the wares found in Tung Man have entirely different isotope ratios from those of the wares found in the hilltop burial sites, indicating that the latter wares were not produced in the Tung Man kiln.

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REFERENCES

1. According to Mrs. Pailin Rerkjirasawad there are two mines at Tambon Tha Taen, Amphur Li, Lamphun Province, which produce lead ores commercially. They are Kit Thong Kao Maen and Maung Rae Phan Maun Charoen.
2. According to Mrs. Pailin Rerkjirasawad the sample from Mae Hong Son is believed to have come from Burma, because there is no lead mine in Mae Hong Son Province (Department of Mineral Resources Report).
3. The sample from Mae Taeng was collected by a student of Mrs. Pailin Rerkjirasawad.
4. According to Mrs. Pailin Rerkjirasawad the ore sample from Hatyai seems to have come from Kitchong mine at Amphur Chana (near Amphur Hatyai), Songkhla Province.
5. George, Alan R. and John C. Shaw, *Thai Journal of Physics*, 2, 39 (1985).
6. In 1986 Hasebe and Emoto confirmed by X-ray fluorescence analysis the presence of lead and tin in one of the white-glazed wares found in the Tak area. G. Hasebe and Y. Emoto, *Tosetsu*, No. 336, 23 (1986) (in Japanese).
7. R.H. Brill and J.M. Wampler, *Amer. J. Archaeology*, *71*, 63 (1967); R.H. Brill, K. Yamasaki, I.L. Barnes, K.J. Rosman and M. Diaz, *Ars Orientalis*, *11*, 87 (1979).

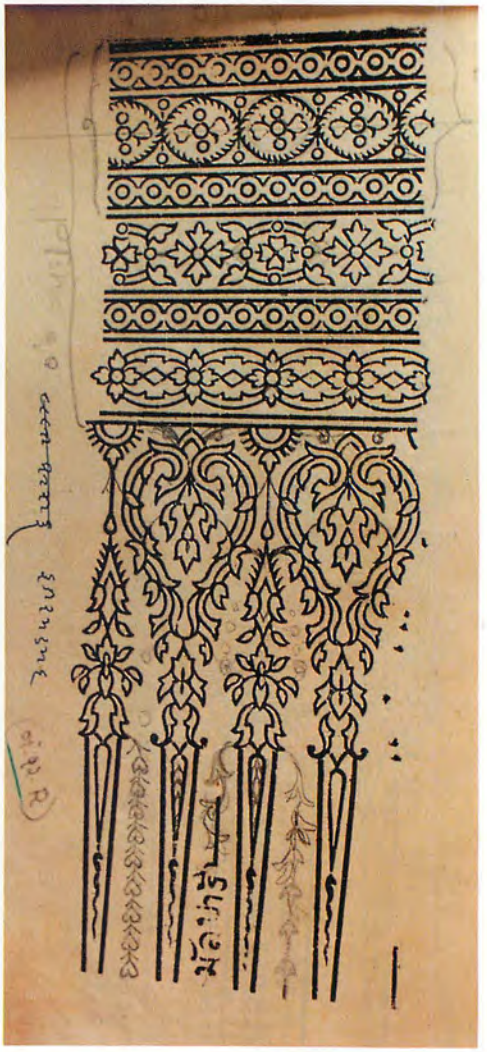
COLOR PLATES FOR "TAK GREEN AND WHITE WARES," p. 43.
AND "BLOCKPRINTED FABRICS OF GUJARAT," p. 71.

A fragment of a white-glazed bowl collected at a digging site in Tak by the research group of Chiang Mai University and tested for the report on white-glazed wares with green patterns (p. 44).

An example of the white-glazed wares with green patterns excavated in the Tak area in the mountains along the Thai-Burmese border (p. 43).

Smoothing the block with chalk to print saudagiri fabrics (p. 71).

Drilling holes to outline the design for saudagiri fabrics (p. 71).



Sample design for saudagiri wood blocks. Note the word "Malabari" in vertical Thai letters at the bottom (p. 71).