

ARCHAEOMETALLURGICAL STUDIES IN THE KHAO WONG PRACHAN VALLEY, CENTRAL THAILAND

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Recent archaeological research projects conducted in the upper tributary basins of the Lopburi River in Central Thailand have identified over 50 archaeological sites with remains of prehistoric societies possibly dating to between the third millennium BC and the early first millennium AD. Some of these sites are located in the area called the Khao Wong Prachan Valley and these have yielded material relating to ancient copper smelting. The Thailand Archaeometallurgy Project (TAP), a joint project between the Thai Fine Arts Department and the University Museum of the University of Pennsylvania, has been developed since 1984 as a research project for the investigation of the origin and development of metal use in Thailand. TAP started studying the archaeological sites in this area in 1986.

ARCHAEOMETALLURGICAL RESEARCH IN THE KHAO WONG PRACHAN VALLEY

The Khao Wong Prachan Valley is an area of undulating terrain lying to the west of the Wong Prachan and its related mountains. Most of the area is characterized by a series of stream terraces lying above small alluvial flats. This valley is a small part of Lopburi Province located in the Central Plain of Thailand.

Up to the present, TAP, co-directed by Dr Vincent Pigott of the University of Pennsylvania Museum and Mr Surapol Natapintu of the Fine Arts Department, has conducted four seasons of fieldwork in the valley. These seasons include test excavations in 1986 at the sites of Non Pa Wai, Non Kok Wa and Nil Kham Haeng, systematic site surface survey in 1987 at the sites of Nil Kham Haeng, Non Pa Wai, Non Mak La and Huai Yai, geological surveys in 1988 at the known copper deposits in the area, and an excavation in early 1990 at the site of Nil Kham Haeng.

This paper will review the results obtained by excavations and surveys at three sites that have received the most attention. These are Non Pa Wai, Nil Kham Haeng and Huai Yai. However, it should be noted that brief descriptions of the sites in the Khao Wong Prachan Valley and some observations on the archaeological evidence found at these sites

have already been presented elsewhere (see Pigott 1989; Pigott and Natapintu 1988, in press; Natapintu 1988).

Non Pa Wai

The site of Non Pa Wai is located in the village of Ban Huai Pong, Khok Sam Rong District, Lopburi Province. It is a large mound about 5 hectares in area and about 4 meters high, situated in undulating terrain associated with the plains lying below Wong Prachan Mountain. This site was preliminarily surveyed in 1984 by a team of the Central Thailand Archaeological Project (CTAP) of the Thai Fine Arts Department. However, the first archaeological excavation at this site was conducted by the Thailand Archaeometallurgy Project in 1986.

The excavations revealed that the site is composed of three major soil units. The lowermost, which overlies the bedrock, is a dark clayey soil rich in organic materials, containing the remains of the initial occupation activity at the site. This basal deposit is sealed by a second unit which is a thin, but well defined, hard layer of calcium carbonate nodules (caliche). Geoarchaeological studies conducted by Dr Mauro Cremaschi, a geomorphologist from the Centro di Studio per la Stratigrafia e la Petrografia della Alpi Centrali, Milan, Italy, suggests that this caliche layer was produced by a significant period of increased aridity following abandonment of the site after the initial period of use. The third major soil unit is about 2 meters thick and covers an area of about 5 ha. This deposit is comprised mainly of various types of debris associated with copper production. Thus, the stratigraphy points to two major phases of site utilization at Non Pa Wai.

Non Pa Wai Phase 1

The archaeological evidence recovered from the basal deposit of Non Pa Wai includes potsherds, ground stone adzes, stone and marine shell bracelet fragments, animal bones, and freshwater as well as land snails. Small quantities of copper smelting slag and ceramic smelting crucible fragments were also found in this lower deposit and indicate that copper smelting was practised by the early inhabitants of Non Pa Wai. However, the relatively light density of such metallurgical remains in this lower deposit suggests that such production occurred on a small scale. A diagnostic type of pottery from the basal deposit is a possibly basket-impressed ware which, because of its exterior surface appearance, is termed "elephant hide" pottery.

There were 14 burials excavated in this deposit. One notable burial contained an adult skeleton accompanied by a pair of ceramic bivalve casting moulds that had been broken in pieces and distributed around the body. The moulds were for a socketed axe. Another burial was found in association with a socketed copper-based metal axe. A carved disc of red ochre was found on top of this metal artifact.

At present there are two radiocarbon dates for the initial phase of occupation at Non Pa Wai. The only large intact piece of charcoal extracted from the Phase 1 deposit yielded a calibrated date (one sigma range) of 2565-2146 BC (B-24455). Another

charcoal sample from the same phase gave a calibrated date of 2456-1750 BC (TAP86-70)¹.

Non Pa Wai Phase 2

The upper grey ashy silt deposit of Non Pa Wai Phase 2, about 2 meters thick, yielded enormous quantities of debris from large-scale copper production. This debris included fragments of copper ore, great quantities of ceramic smelting crucible fragments, cup and conical moulds for the casting of copper ingots, ceramic bivalve moulds for casting small artifacts, and many tons of copper smelting slag. The ores excavated at Non Pa Wai have been identified as both oxide (malachite and chrysocolla) and sulfide (chalcopyrite) types of copper ores. These two types of ores co-occur in weathered copper-sulfide ore deposits present in the Khao Wong Prachan region. The Phu Kha and Tab Kwai mountains are two copper ore deposits in the region where ancient copper mining adits and shafts have been found. An analysis by Dr William Rostoker, as well as that by Anna Bennett (1989), on the slag and crucibles from Non Pa Wai suggests that the ancient copper production technique here involved the co-smelting of oxide and sulfide ores, with an iron oxide flux, in "U" shaped ceramic crucibles about 15-25 cm in diameter and about 15-20 cm deep, each with a potential volume between 200 and 1,200 cc. Although there are bivalve moulds for casting small artifacts found at this site, metal artifacts are absent. The great quantities of cup and conical moulds as well as the virtual absence of metal artifacts support the idea that this site concentrated principally on the production of "button" ingots of copper, ranging in size from 1 to 10cm in diameter. These small ingots would have been suitable for counting, weighing, bagging and transporting, characteristics which would have facilitated the distribution of the metal as well as the proper "measuring" of proportions in the process of making copper alloy objects.

Thus, the very high density of materials relating to copper production, combined with preliminary analysis and observation, suggests that during this second phase Non Pa Wai was the site of large scale copper production. The use of vast quantities of ores, wood for fuel, ceramic smelting vessels, ceramic moulds and the great amount of ingots that were apparently produced indicate that the site was part of a substantial system which moved raw materials into the site and took the finished products away.

Apart from the debris from copper production, the upper deposit also yielded evidence of domestic activity, including cord-marked and red-slipped potsherds, some of the latter with incised "hanging triangle" decoration. These sherds are clearly different in form and decoration to those from the earlier phase. Faunal remains extracted from this upper deposit have been preliminary studied by Ms Karen Mudar, who has identified fish, turtle, pig and bovinds.

Four radiocarbon dates have so far been obtained from Non Pa Wai Phase 2. Three charcoal samples from the lower levels of the upper Non Pa Wai deposit have yielded dates of 1690-1225 BC (B-27364), 1450-1136 BC (B-24453), and 1270-800 BC (B-27365). One charcoal sample from the middle level of the upper deposit has been dated to 834-530 BC (B-24452).

Nil Kham Haeng

The site of Nil Kham Haeng is located in the grounds of the Army Aviation Centre, Khok Sam Rong District, Lopburi Province. It lies about 3km southwest of Non Pa Wai at the foot of Phu Kha Mountain, one of the copper ore sources in the Lopburi Region.

The Thailand Archaeometallurgy Project has excavated this site twice, in 1986 and in early 1990. Most of the evidence from the excavations is still being analysed, as is that from the other sites in the Wong Prachan Valley. However, the site seems to have at least 2 major periods of occupation.

Nil Kham Haeng Phase 1

The clayey soil of the deposit of Nil Kham Haeng Phase 1 has yielded some copper production debris, charcoal, potsherds and animal bones. Some ceramics from the basal levels are quite similar to the red-slipped pottery of Non Pa Wai Phase 2. The evidence so far recovered indicates that the early phase of Nil Kham Haeng is possibly contemporary with the early part of Phase 2 of Non Pa Wai. A charcoal sample extracted from this basal deposit has been dated to 1301-900 BC (B-24459).

Nil Kham Haeng Phase 2

The upper deposit of Nil Kham Haeng consists of numerous thin layers of crushed rock/ore and slag. At certain levels, mostly at intervals among the thin layers, were well defined working/living surfaces. A few bivalve moulds, cup moulds and some slag cast produced from the cup moulds were also found within the layers of crushed rock and slag. Since the site covers about 3 hectares and contains about 5 meters thickness of debris from copper production, it was clearly the location of another major copper industry in the Khao Wong Prachan Valley.

The characteristic pottery of Nil Kham Haeng Phase 2 is a buff earthenware, although red-slipped pottery also occurs. The test excavation here in 1988 yielded 2 burials, of which one, labelled Burial 1, was accompanied by a mass of powdery copper ore and some metal bracelets, including two of copper-base metal and one of iron. A charcoal sample from a layer that sealed the burial yielded a date of 900-400 BC, while another charcoal sample from a layer cut by the burial has been dated to 800-380 BC (B-24457 and B-24458 respectively). Thus, the burial is securely dated to ca. 700-500 BC, by which time iron had already appeared in the site.

More burials were encountered in the second excavation by the Thailand Archaeometallurgy Project at Nil Kham Haeng in 1990. Most were accompanied by metal artifacts. One notable burial contained an adult skeleton buried in association with a bronze spearpoint of socketed type. Another distinguished burial found in the upper portion of the deposit of Nil Kham Haeng 2 comprised an adult skeleton accompanied by a pot containing a number of small copper socketed artefacts, probably projectile points, near its skull. On both lower arms of the skeleton were numerous iron bracelets. This

burial also produced five spherical carnelian beads, strong evidence for the existence of a long distance exchange network.

Huai Yai

The Huai Yai site is located about 10 km to the southeast of Non Pa Wai in the undulating terrain found at the foot of Sung Nam Mountain (or Khao Sung Nam), an outlying feature of Khao Wong Prachan. A team from the Thai Fine Arts Department conducted a test excavation here in 1984 and the Thailand Archaeometallurgy Project undertook a systematic surface survey in 1988. The site comprises two juxtaposed mounds which are divided by a small perennial stream called Huai Yai. The northern mound was previously labelled the "Huai Yai Reservoir" site while the southern mound was called the "Huai Yai" site (Natapintu 1988). However, they are now considered to be one site, given the name of Huai Yai. Of the 2 phases of use found in the site, remains from the earlier are found exclusively within the southern mound, whereas those from the later phase are found in the northern mound.

Huai Yai Phase 1

A test excavation in 1984 in the southern mound found, within a one meter thick deposit, great quantities of copper smelting slag, smelting crucible fragments, stone adze roughouts, polished stone adzes, stone and giant clam shell bracelet roughouts, bracelet blank cores, and stone and marine shell waste flakes. These materials point to the on-site production of copper, stone adzes, stone bracelets and marine shell bracelets during the early phase.

Burials from this early Huai Yai phase were furnished with ceramic vessels with carinated shoulders. Their upper parts are decorated with curvilinear incised and rouletted designs. Their lower parts, which are ovoid-vertical in form, are basket-impressed. This type of pottery is similar to the "elephant hide" ware found in Non Pa Wai Phase 1 (see above). One particularly richly furnished burial contained a polished stone adze, an animal metacarpal, a piece of freshwater bivalve shell, a pedestal bowl, and numerous marine shell disc-shaped and "H"-shaped beads. The "H"-shaped beads are similar to those found in second millennium BC contexts at Khok Phanom Di (Higham *et al.* 1987). The parallels for the pottery and the shell ornaments suggest that Huai Yai 1 probably dates to the late third-early second millennium BC.

Huai Yai Phase 2

During the second phase, activity at Huai Yai apparently shifted to the northern mound. Unfortunately, much of this area has been extensively destroyed by modern construction activity. Because only a limited amount of the deposit was left intact, test excavations yielded only fragmentary data.

The principal artifacts found in these deposits were glassy-looking pieces of copper smelting slag, potsherds, and some animal bones and freshwater shells. Although limited in scope, the ceramic assemblage is clearly different to that found in the earlier deposits

of the southern mound. The appearance of the slag from the two mounds is also markedly different. However, local residents report having found numerous burials in the mound which contained whole ceramic vessels and beads of glass and semi-precious stones (carnelian and agate). Some burials were accompanied by a type of iron implement similar to one found in the site of Ban Don Ta Phet, now dated to c.300 BC (Glover 1989: 18). This suggests that Huai Yai Phase 2 possibly dated to the second or third centuries BC.

CONCLUSION

The results so far obtained from the archaeometallurgical studies in central Thailand are still very limited. The evidence suggests that small-scale copper production was undertaken by a society already involved in inter-regional exchange, at least with a coastal society, around the late third millennium BC. Later, in the middle of the second millennium BC, large-scale copper production was developed, probably to fulfil a strong demand for such material from markets not yet confidently identified. The industrial activity continued up to probably the last few centuries BC. The socio-cultural development that would have occurred, either as a cause or consequence, of the intensification of copper production in the Khao Wong Prachan Valley is not well understood yet. However, it is believed that a clearer picture of such developments will emerge when the study and analysis of evidence from the sites investigated by the Thailand Archaeometallurgy Project, as well as those studied by other researchers, are completed.

NOTE

1 All dates in this paper are given as a calibrated one-sigma range.

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