The MIT Press
Cambridge, Massachusetts
London, England

The Beginning of the Use of Metals and Alloys

Papers from the
Second International Conference
on the Beginning of the
Use of Metals and Alloys,
Zhengzhou, China,
21–26 October 1986

Edited by
Robert Maddin

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Early East Asian Metallurgy: The Southern Tradition

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The development of metallurgy can be addressed from several points of view, many of which are represented in this volume. One approach to the topic is summarized in the subtitle of a recent synthesis for a lay audience entitled *Out of the Fiery Furnace: The Impact of Metals on the History of Mankind*, by Robert Raymond (1984). Although a valid point of view not only for writers for the public but also for scholars, the book has latent biases and limitations. The underlying historical inquiry focuses on where and when certain developments that in hindsight have proved significant to the use of metals today came about. Data not fitting into some sort of a progression to today's use of metals may be treated covertly or overtly as less important or peripheral.

An inquiry on metallurgical development from the viewpoint of an anthropologist might focus on the hows and whys or what archaeologists like to call the "processes" of metallurgical development. The hows and whys of any expression of metallurgical use, and even nonuse, would be examined in the contexts of specific cultures. In other words, the anthropologist might ask, What was the impact of humankind on the history of metals?

Southeast Asia is a relative newcomer in the discussion of the beginnings of metallurgy. Here I try to place into anthropological perspective the general significance of the early metallurgy that has been found recently in Southeast Asia to the study of early metallurgy as a whole. In this discussion the phrase "Southeast Asia" will refer to mainland Southeast Asia, including the southern portion of China. The data with which I have firsthand familiarity are from northeast Thailand, particularly the site of Ban Chiang.

Over the past few years the chronology of Southeast Asian metals has undergone detailed reevaluation (Bayard 1984; Higham 1984; Higham and Kijngam 1984; White 1986). The current consensus on the dating of bronze and iron at least for northeast Thailand is that bronze appears around 2000 B.C., give or take a couple hundred years. Iron appears in the first millennium B.C. with some disagreement as to whether it appears before or after 500 B.C. These current best estimates are not to my knowledge seriously out of phase with the limited Southeast Asian evidence outside of northeast Thailand, primarily Vietnam. Readers interested in a detailed discussion of the chronology for the controversial site of Ban Chiang can see White (1986).

It should be emphasized that current chronological understanding is based on excavations of only a few sites and on minimal data on metals. Refinements, revisions, and amplifications should be expected in the future as archaeological research in Southeast Asia expands. I challenge those working in other areas to examine their chronological data with the detail and

rigor that we who have worked in northeast Thailand have been forced to do. In particular, the stratigraphic relationship between dated samples and metal artifacts needs to be explicitly demonstrated, and individual site sequences should be supported with regional evidence.

How does the revised chronology for metals in northeast Thailand affect the significance of early metallurgy in Southeast Asia for the study of early metallurgy in general? Back when the date for the appearance of bronze in northeast Thailand was suggested to be in the fourth millennium B.C., some speculated that Southeast Asia was the source for Chinese and even Near Eastern bronze (Solheim 1970; Muhly 1976). Obviously the current dating does not support any claims that Southeast Asian bronze is earlier than Near Eastern. Nor is there any firm archaeological basis to claim that Southeast Asia was the primary source for the early bronze of northern China. Does this put us back to the picture two decades ago of Southeast Asia as a retarded cultural backwater that passively received technological advances from outside, invented nothing on its own initiative, and had no influence on any other region? If Southeast Asian bronze was not earlier than bronze in one of the major Asian urban civilizations, does it have any significance to the understanding of the development of metallurgy?

To broach this topic, let us examine some of the details that are emerging on the early Southeast Asian metals and their cultural context. Two points can be made on the general significance of the dating of metals in Southeast Asia as we now understand it. First, I think it is fair to say that the bronze-producing period in Southeast Asia is approximately contemporary with that of northern China. At present there may be a clearer case for third millennium B.C. copper-based artifacts in China (Ko 1986) than there is for Southeast Asia. The third millennium copper and copper alloy objects from China are described as smallish flat cast items, such as knives and awls. These third millennium copper-based objects have come to attention only fairly recently as archaeology in China has expanded in areal and temporal scope.

In northeast Thailand, so far the oldest metal artifacts are relatively sophisticated socketed bronze tools cast in bivalve molds. Two of the main objects of concern are the tool from burial 90 of the 1968 excavation at Non Nok Tha and the spear point from burial 76 of the 1975 (BCES) excavation of Ban Chiang. [Photographs of both can be found in White (1982).] Given that the sophistication of these items is unlikely to have appeared spontaneously, it seems probable that in the future bronze items that were cast using simpler techniques or even artifacts of hammered copper will be found somewhere in Southeast Asia with dates in the third millennium. That a cultural horizon with such items has not been identified to date is not surprising, considering that southern China and Southeast Asia probably are less well covered in terms of archaeological research relative to northern China. For vast portions of the southern region nothing is known of the prehistoric life for the time period of concern. Considering that our current understanding is based on so few sites and such a tiny proportion of the region and given the known antiquity and relative sophistication of the earliest known metal artifacts of the south, it seems reasonable to propose for the time being that in both the south and the north of east Asia we have approximately contemporary metallurgical traditions. Therefore the Southeast Asian metal tradition need not be viewed as delayed or retarded but rather as not significantly out of step with the metallurgical tradition to the north.

This point is important because up until recently the appearance of metals in Southeast Asia was considered to be much later, in the realm of 500 B.C. (Clark 1971, p. 238). Thus recent excavations have shown that bronze was present on the order of 1,500 years before this estimate. The revision in date for the appearance of bronze has considerable significance for the general interpretation of Southeast Asian prehistory in that formerly it was thought that metal technology appeared at the same time as the Dongson decorative motifs—perhaps both brought simultaneously by western barbarians according to Heine-Geldern's interpretation [summarized in van Heekeren (1958)]. We now know that bronze technology was locally established for a considerable time period before the classic Dongson civilization. It is the metallurgy before the classic Dongson civilization that is my main interest and the main focus of the following discussion.

The early metallurgy found in southern east Asia is beginning to show distinctive patterning, even though the research is in the preliminary stages. Metallographic studies show that certain attributes that characterize the bronze tradition as a whole are present from even the earliest bronze artifacts recovered thus far, such as the socketed bronze spear point from BCES burial 76, the lowest metal grave good recovered from Ban Chiang during the Penn/FAD excavations. This socketed spear point (found in phase III from the Early Period) is older than 1500 B.C. and may be as old as 2000 B.C. [See White (1986) for a detailed discussion of the dating.] Stech-Wheeler and Maddin (1976) have reported that this implement was cast in a bivalve mold, is composed of a deliberate tin bronze, and shows evidence of cold-working and annealing along the edge.

The socketed tool from Non Nok Tha burial 90 was initially reported as composed of copper, but subsequent examination by Maddin has revealed that this corroded object probably included tin and probably was worked along the edge. A socketed ax from Non Nok Tha burial 69 that may be broadly contemporary with the Ban Chiang spear point from burial 76 shows

similar characteristics. That is, it was cast in a bivalve mold from a tin-bronze alloy, and it has evidence of post-casting working along the edge (Smith 1973).

Metallurgists claim that these early objects show a competent and sophisticated array of basic bronze casting and working technology (Smith 1973, pp. 28, 32; Stech-Wheeler and Maddin 1976, p. 49). The combination of techniques employed in making the second millennium socketed objects from northeast Thailand would not be expected in an incipient stage of metals experimentation or an amateurish attempt to copy without comprehension a trade item that happened to find its way into the area. Because the same types and techniques and the same types of crucibles and molds show up over broad spatial and temporal ranges in Southeast Asia (Murowchick, this volume), I would argue that not only does bronze appear c. 2000 B.C. but also that a technological tradition has appeared by that time.

What other kinds of objects are found among the early bronze artifacts? From a slightly later burial phase dated to the mid-second millennium B.C. at Ban Chiang were found some plain rings around the ankles of a child (BCES burial 38 from Early Period IV). They were cast bronze with no indications of post-casting working. Bracelets and anklets were by far the most common type of bronze artifact recovered from Ban Chiang. In almost all analyzed cases they were cast tin bronze with no evidence of cold-hammering or annealing. Seeley and Rajpitak (1984, p. 106) note similar results for the bangles from Ban Na Di, a site 20 km from Ban Chiang excavated by Higham and Kijngam (1984). They comment that "decorative objects were fabricated by casting... and other fabrication techniques such as cold working and joining were strenuously avoided." With rare exceptions, similar results have been found for bangles from Non Nok Tha and Ban Chiang (Smith 1973, p. 29; Stech and Maddin, this volume).

Currently bangles followed by socketed implements dominate the inventory of early bronze artifacts recovered from prehistoric northeast Thai sites. It should be noted, however, that the major sites excavated have been cemeteries. Bronze artifacts in good condition generally come from graves, and this of course biases the picture. A few other types of bronze artifacts have been found in levels below the appearance of iron. Small arrowheads and small fish-hooks have been found at Ban Tong, Ban Na Di, and other sites. The edge of one arrowhead from Ban Na Di showed evidence of annealing and working (Seeley and Rajpitak 1984, p. 110). At Ban Na Di were reported comma pendants and so-called wire, which held together portions of a stone bracelet. Maddin and Weng (1984) report that the wire was cast directly into place.

To summarize briefly the current picture of the bronze artifacts from northeast Thailand from the time period before the appearance of iron, most artifacts are either items of personal adornment or implements. The majority of identifiable objects recovered are bangles (bracelets, anklets, and rings) of cast bronze usually with no post-casting modification. Socketed implements, the majority of which are adzes or axes, are common. Spear points seem to be less common. Small tanged implements, including small arrowheads, and small fishhooks are occasionally found, but these may be underrepresented in terms of frequency of recovery because of the bias of the sample toward grave goods. With few exceptions, items appear to be cast bronze alloys with some proportion of tin. The edges of the implements, including axes, spear points, and arrowheads, are likely to show evidence of annealing and working, which suggests that the implements were functional and not just ceremonial replicas.

When wrought iron appeared in the Ban Chiang sequence during the first millennium B.C. in the Middle Period, it is striking that the earliest iron objects were bangles and socketed spear points. Wrought iron bangles were found in burial 26 (BCES) of Middle Period phase VII, and a wrought iron spear point with a cast-on bronze socket was found in burial 24 of the same phase. The earliest iron objects from Ban Na Di have been interpreted as neck rings. Thus the early iron artifacts imply cultural continuity in terms of what the ancient society considered an appropriate use for metal, despite the appearance of a new and in many ways rather different metal technology.

With the appearance of iron, bronze technology did not disappear. Bronze bangles continue in the Middle Period and Late Period. If socketed bronze implements continued, none were recovered at Ban Chiang (except as the sockets on the iron blades). In the Late Period (after c. 300 B.C. until the early to mid-first millennium A.D.) iron implements of various sorts were found, although the typological range has not been addressed. A high-tin bronze (with tin content over 20%), which is found in thin wirelike necklaces, appears during the Ban Chiang Late Period. High-tin bronze has been found in necklaces, bangles, and other fragments at Ban Chiang, Ban Na Di, and Don Klang in northeast Thailand and in bowls at Ban Don Tha Phet in central Thailand, all at about the same general time period. In sum, although metal artifacts show some technological and typological development during the prehistoric time period, metals continue to be used in the region primarily for personal adornments and implements.

Evidence for where and how the metal items were made is beginning to come to light. Melting and casting took place at the village sites on the lowland interior. Small crucibles and clay casting hearths were found at both Ban Chiang and Ban Na Di (Higham,

this volume). Fragments of sandstone bivalve molds came from these latter two sites, and complete sets of bivalve molds were found at Non Nok Tha. The sandstone molds were in general used in the casting of implements. As has also been suggested for Vietnam (Davidson 1979, p. 105), Higham and Kijngam (1984, p. 83) have suggested on the basis of a lead-tin casting sprue that the stone molds may have been used in a lost-lead casting process. The casting of bracelets most likely employed the lost-wax technique (Smith 1973, p. 29; Stech-Wheeler and Maddin 1976, p. 43; Seeley and Rajpitak 1984, p. 109). At Ban Na Di clay mold fragments from bracelets were found, and one bronze bracelet even had remains of insect wax (Higham and Kijngam 1984, pp. 81, 124).

Current evidence does not indicate that ore sources were in close proximity to sites of the Ban Chiang cultural tradition or that smelting took place in sites such as Ban Na Di or Ban Chiang. The question of where the copper ores came from and where the smelting took place is being addressed by the Thailand Archaeometallurgy Project, directed by Vincent Pigott and Surapol Natapintu (Pigott 1985; Pigott and Natapintu, this volume), and by Anna Bennett (1986). Pigott and Natapintu have conducted excavations at potential copper ore sources along the Mekong River in northeast Thailand and near Lopburi in central Thailand. At both sites they found evidence of second millennium human presence at the ore locales. A project from the Institute of Archaeology is investigating potential tin sources in western Thailand (Coote 1986). Although less evidence is available on the ore sources and manufacturing techniques for iron, these investigations are opening a new era of research into the technological side of the prehistoric metal-using period of the region.

Technological investigations are also proceeding in the laboratory. In addition to the presence of tin in the earliest bronzes in northeast Thailand, other elemental constituents have been identified, although the meaning of the elemental variation is not yet fully understood. Arsenic appears in second millennium B.C. metals but usually only at levels consistent with being an impurity. Arsenic may appear at higher levels in what seem to be first millennium slags in central Thailand. Hence, if arsenical copper ores were exploited for their special properties during the prehistoric time period, thus far the evidence does not indicate that this exploitation preceded the use of tin alloys, in contrast to the metallurgical sequence in the Near East.

Lead, which positively affects casting properties but negatively affects mechanical properties of a copper alloy, is another element that may have significant variation. Seeley and Rajpitak (1984, p. 109) note the absence of lead in Ban Na Di arrowheads, despite its presence in some of the decorative objects. They conclude that the choice of the binary tin-copper alloy "was firmly based on a knowledge of its properties, and in critical applications the most appropriate formulation was selected" (Seeley and Rajpitak 1984, p. 109). On the other hand, Seeley and Rajpitak (1984, pp. 119–120) notice an increase in leaded alloys in their sample corresponding to the Late Period, but they claim that this increase does not correspond to greater complexity of design. In contrast, Stech and Maddin (this volume) note an increase in lead in Ban Chiang Middle Period bronzes. This might relate to greater complexity of form in Middle Period bangles (White 1982, p. 40). As for the Non Nok Tha bronzes, Pittioni (1970) suggests that lead was in some cases deliberately added, but Selimkhanov (1979) concludes that in his sample lead is present only at levels indicating impurity. In sum, with respect to lead we can suggest at this time that the variation in content may indicate some degree of experimentation or purposeful technological flexibility. A larger sample of bronzes from more sites may elucidate whether significant variation in lead content can be more consistently related to technological considerations.

Elemental analyses are not the only area where potentially interesting variation seems to be occurring. There is considerable intra- and interregional variation in the bronze artifacts found at individual sites. For example, within northeast Thailand Non Nok Tha is relatively rich in socketed axes and bivalve sandstone molds. Ban Chiang produced only one socketed adze and one socketed bronze spear point and a fragment or two of a sandstone mold for bivalve cast tools. Ban Na Di produced no socketed implements. Some sites seem to lack metals in deposits that are contemporary with other sites that have metals. Thus for a while it was thought that central Thailand had little or no second millennium B.C. bronze on the basis of two sites with little or no bronze—Ban Kao and Khok Charoen. Recent excavations by Natapintu, Pigott, and others will probably change that conclusion.

Various reasons could account for the site to site variability in the presence of metals, including both sampling and cultural factors such as trade networks or social values. Archaeological sampling error could be involved, for it should be remembered that especially in the earliest phases bronze artifacts are rare. Another factor may have to do with the role of the bronze items in the prehistoric society. Throughout much of the prehistoric sequence in Thailand, current archaeological evidence indicates that society was village based with limited ranking. Higham has proposed that in this context the metal artifacts functioned as primitive valuables (Higham 1984, p. 248). Whether or not an individual village placed bronze in graves could in part depend on how an individual village fit into the trade network for prestige items. Bronze is not the only artifact that has an uneven distribution. For example, Ban Na Di graves produced numerous bracelets made from trochus, a shell with marine origins. Not a single example of a trochus bangle was excavated by the Penn/FAD project from a Ban Chiang grave.

On a larger geographical scale, even though early bronzes from elsewhere in Southeast Asia seem generally of the same basic technological tradition as described for northeast Thailand (Murowchick, this volume), interesting differences and variations are emerging. For example, at their central Thai site, Natapintu and Pigott found a new typological range of artifact (judging from the molds) that, although they still seem to be implements, are smaller and thinner than the relatively substantial socketed tools of the northeast. Sandstone is not the only material used for molds in the casting of implements. Clay ax molds have been found at both sites excavated by the Thailand Archaeometallurgy Project in Thailand and in Vietnam. During the first millennium B.C. northern Vietnam shows many developments in its metallurgy that are distinctive from those of northeast Thailand and that culminate in the classic Dongson Period. Perhaps within Southeast Asia we can begin to discuss regional subtraditions.

So what is all this adding up to in terms of the meaning of early metals in Southeast Asia for the study of early metals in general? I have proposed (White 1982, p. 48) that, based on the antiquity and the emerging typological and technological configuration of metallurgy in this region as discussed in general terms, we can talk about an indigenous "Southeast Asian metallurgical province" [following the use of the phrase by Chernykh (1980)]. Although there is site to site and subregion to subregion variation, in terms of typology and technology the configuration of the prehistoric metals in Southeast Asia shows both an internal coherence and, taken as a whole, considerable distinction from other major areas of early metallurgy. The internal variation within the region and over time suggests that metal technology was neither stagnant nor imitative. Instead it was probably adapted to local resources and responsive to temporal, geographic, and cultural conditions within the region.

Scholars specializing in the Near East or China—areas with metals of great typological richness, ornateness, and technological virtuosity—may consider the Southeast Asian metals to be rather prosaic. Alternatively one may view them as an appropriate technology—appropriate to their nonurban, village-based role. This is not the place to document all the differences between the second millennium B.C. societies in China and Southeast Asia. It is sufficient to note that in second millennium Southeast Asia we have nothing to compare with the evidence in China for the degree of social hierarchy, the level of systematic militarization, and the prominence of human sacrifice that is patently evident during the Shang Period. That the second millennium Southeast Asian metals are morphologically simple makes them no less appropriate to their context. Their formal simplicity does not lessen their technological integrity.

This leads to some final points about the significance of the study of early Southeast Asian metals. In my opinion, within the Asian context and the time period of concern, I try not to use the term "independent," which many other anthropologists and I distinguish from the term "indigenous." Cultural phenomena that develop independently of each other have come to imply societies that are cut off, isolated, and have no direct or indirect interaction with other groups. Thus, for example, the development of agriculture and civilization in Mesoamerica is considered independent of those developments in the Old World. In terms of scientific reasoning they can be treated as separate experiments.

There exists little indisputable evidence, such as trade items, to prove that Southeast Asians were receiving cultural contact from China or the Near East during the fourth, third, or early second millennium B.C. However, there are too many gaps in the archaeological record to accept that argument as proof that the region was cut off or "independent." Archaeologists will probably not fill in much of that unknown area in our lifetimes.

When archaeologists are in the position where they cannot prove or disprove something (which is much of the time), they find themselves having to develop the best working assumptions or estimates. What is the best working assumption for the relationships among the cultures of Asia during the third millennium B.C.? There is mounting indirect evidence—linguistic, botanical, zoological—that Asian people were interacting during this time period. We may have a difficult time characterizing this interaction because discussions based on the migration and diffusion are now perceived as at worst wrong and at best simplistic. Nonetheless, although independent invention may be an appropriate concept when discussing the emergence of New World versus Old World agriculture, it has come to the point of naiveté to use it in third millennium Asia. I would argue that the best working assumption for Southeast Asia during the third millennium B.C. is that the region was not totally cut off from the rest of Asia but interacted at some level, perhaps sporadically, minimally, or indirectly, with other societies on the continent. When more archaeological research is conducted in Burma, south China, central Asia, and the coastal regions of Southeast Asia, we may be able to specify the interaction.

In the meantime, in place of independent invention I urge us to substitute the phrase "indigenous innovation" as a more suitable concept for the current discussion. In arguing that the Southeast Asian metallurgical province is an example of indigenous innovation, one can point to numerous differences between the metallurgical traditions found in Southeast Asia and

in other areas of early metallurgy. Only a few differences will be mentioned. In terms of manufacturing techniques, lost wax does not appear in northern China until the sixth century B.C., and hammering and annealing are extremely rare in early Chinese bronze implements. In terms of typology, the use to which the early Southeast Asian and Chinese societies put metals was quite different. Bangles, which are so characteristic of northeast Thailand, are virtually nonexistent in second millennium China. Of course, the bronze vessels and their piece mold method of manufacture are absent in second millennium Southeast Asia. Socketed axes are common in Southeast Asia, whereas tanged implements are common in northern China. Comparisons might be made between Southeast Asia and the Near East, illustrating that, although there are a few points of similarity between the two areas, such as the presence of annealing in both, there are also vast differences in the range of techniques used and the inventory and morphology of objects made.

Some of the differences can be attributed to vastly different social contexts, in that metallurgy developed in both China and the Near East in urban, more militarized societies. Nevertheless the metallurgy of second millennium Southeast Asia cannot be explained simply as a watered-down version of either of these other two traditions. Taken as a typological and technological whole, prehistoric Southeast Asian metallurgy displays a unique configuration of traits that seems to impress the specialists who have looked at the objects with the competence and appropriateness of the technology. The typological range would also seem to be appropriate for a village-based society. It is the appropriate selection and development of techniques and artifact types over time that makes the Southeast Asian metallurgical province an example of indigenous innovation.

If the Southeast Asian metallurgical province is an example of indigenous innovation, as I propose, what is the contribution of this nonurban, competent, but relatively unelaborate technology to the understanding of the beginning of the use of metals and alloys? I would like to return for a moment to Robert Raymond (whose book, although written by a layperson, will be read by more people than the number who read our technical articles). Raymond suggested that Southeast Asian metallurgy might be an example of a "false start" (1984, p. 43). The problem with this viewpoint is that it implies a sort of "manifest destiny" or "technological imperative" in the development of metals technology.

I propose that prehistoric Southeast Asian metallurgy was not a false start but rather an *alternative pathway*. If we are interested not only in the wheres and the whens but also in the hows and the whys, if we are interested in the processes of metallurgical development, we need to be able to compare differing examples in order to separate what is intrinsic to the process from what is specific to the individual example. The Southeast Asian metallurgical province shows among other things that complex social structure involving slave or highly organized coerced labor is not necessary to the systematic exploitation of metals. It may be necessary for *large-scale* exploitation of metals for societies with a high demand for large quantities of objects, such as weapons to outfit a standing army, or for large objects, such as huge ceremonial cauldrons, but it is not necessary for systematic exploitation of metals per se. Nor does the regular exploitation of metals necessarily lead in rapid order to greater social complexity or militarization. Urbanization and militarization eventually come to Southeast Asia but considerably later than the appearance of bronze. Although the metal technology did develop further in conjunction with the social development at least in northern Vietnam, the roots of that development are better sought in social factors. And most likely, Southeast Asia is not the only case where humankind had an impact on the development of metallurgy.

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