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SPAFA Objectives

– To promote awareness and appreciation of the cultural heritage of the Southeast Asia countries through the preservation of archaeological and historical artifacts as well as the traditional arts;

– To help enrich cultural activities in the region;

– To strengthen professional competence in the fields of archaeology and fine arts through sharing of resources and experiences on a regional basis;

– To promote better understanding among the countries of Southeast Asia through joint programmes in archaeology and fine arts.

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The Cover

It shows one of the restored paintings in Wat Hong Rattanaram. Attention to details is apparent in the presence of trees, variation in the elephant s and the expression of the soldiers.

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Problem of Functional Interpretation : The Need for Ethnographic Analogy in Indonesia

by Mundardjito

The discussion in this article is based on problems of functional interpretation often faced by archaeologists. Regarded as an "interpretive science', like all disciplines concerned with the past, archaeology bases its explanations on the data obtained. If archaeological explanation or functional interpretation in particular is not based on reliable data, it certainly will not produce a compelling clarification of knowledge. The fewer the data obtained from an artifact, the greater the problems that arise; the less the explanatory value to the artifact, the lower the quality of interpretation.

Besides a great number of unidentified artifacts mentioned in excavation reports, to this day many museums in various parts of the world still preserve artifacts whose functions are unknown or not entirely established. This is caused by several limitations. Artifacts which are found in fragmentary condition, so that their overall shape cannot be known with certainty, are difficult to identify satisfactorily solely through formal analysis. Artifacts which are donated to museums as objects of unknown provenance and without information about accompanying finds cannot be explained through contextual analysis alone. Moreover, if during an excavation an archaeologist finds an artifact of a sort he has never seen before, we can easily imagine that he will experience even greater difficulty or less certainty when answering questions such as: What is this object? What was it used for? How was it made? Why does it have a particular shape?

Revised paper originally presented at the first Symposium on Archaeology, Cibulan, Bogor, February 21-25, 1977.

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Among scientific finds of this kind are crucibles from the Banten excavations in West Java, Indonesia. These crucibles can be used as an example of the application of ethnographic analogy to solve the problem of functional interpretation. Despite the great number of written documents supporting research in Banten, a historical site of the 17th and 18th centuries, the functional interpretation problems of the artifacts still exist. They have arisen mainly because the metal smelting crucible is a type of artifact rarely mentioned in excavation in this country. In fact not a single excavation in this country ever yielded crucibles previously, hence archaeologists working in this area have never been confronted with this kind of artifact. The great number of these artifacts excavated notwithstanding, it has been impossible to produce acceptable explanations solely by working through formal and contextual analysis. Not until studies are undertaken through ethnographical analogy, which are consequently followed by imitative experimentation, have results valuable enough to use in constructing a hypothesis which could be tested in further field research emerged.

The Problem

Among the 40,000 finds yielded by the Banten excavation carried out by the National Research Centre of Archaeology in 1976 (Mundardjito ***et al,*** 1978), 762 pieces could not be identified; they were only considered to be fragments of clay vessels with shiny red colored glaze. These finds were highly conspicuous among the cracks and clods of earth in the fields for besides their red color and sparkle, several found together had clear green colored particles of copper or bronze and bits of charcoal. After the excavation, several complete vessels were seen in the wall of a well belonging to one of the villagers in rows and upside down. These complete samples were named "vessel X". This name was of a temporary nature, for the sake of taxonomy while excavation was proceeding, until the archaeologists would have become certain of the vessels' function.

The Crucibles

The vessels are cylindrical in form, like a drinking glass, and are made of an originally clay material. They have varying measurements (between 10 and 15 cm height) and very thick walls (about 2 or 3 cm). The outer surface of the wall is not smooth but rather pockmarked and covered by a layer of solidified flow of a dark red colored mineral, shining like glass. An open spout appears on the rim and directly opposite is an angular or a rounded projection. As the base of the vessel is not flat, since almost every base is thickly covered with solidified mineral which has melted and concentrated at the bottom, it cannot stand up on a level surface. The inner wall is paler red in color and not covered with a layer of solidified mineral. It also shows indentations due to the pressures of the fingers during manufacture.

The 762 samples that were collected comprise 744 fragments and 18 whole pieces. The assemblage of finds which contributed the most data relevant to function came from a certain square. It not only provided the greatest concentration of vessel X fragments but also an *in situ* brick floor measuring 2 x 2 meters, a carpet of splashes of copper or bronze over an area of about 1.5 x 1.5 meters, a large number of particles of copper or bronze and iron, metal slag, fragments of iron tools, a variety of foreign (Chinese) and local sherds, metal coins and so forth, all within an excavation square filled with black sandy soil mixed with bits of charred wood and bamboo.

By observing the very concave shape of a vessel, one might presume that it was used to contain a liquid substance. This becomes more evident in the presence of a spout on the rim of the vessel for pouring liquid and a kind of handle to make pouring easier. While classifying the X vessels, it became clear that they came in a variety of sizes and that they were probably used to contain liquids in various quantities. Their function might have been like that of a measuring-glass in a laboratory. The traces of earlier burning of the outer and inner walls of the vessels, often accompanied by charcoal stuck to the surface, indicate that these objects were perhaps used for boiling purposes over a stove or hearth. The shape of this stove or hearth would have to be such that it held vessels with highly covered base upright. The frequent occurence of a hardened liquid substance would make the base even less level. The surface of the outside wall was wrinkled and not as smooth as the surface of ordinary undecorated pottery. Virtually the whole of the body was covered with a hot liquid material which later hardened and formed wrinkles, holes and protrusions causing a rough surface. This layer showed a dark red color, often interspersed with dark green in several places, and glittered in the light.

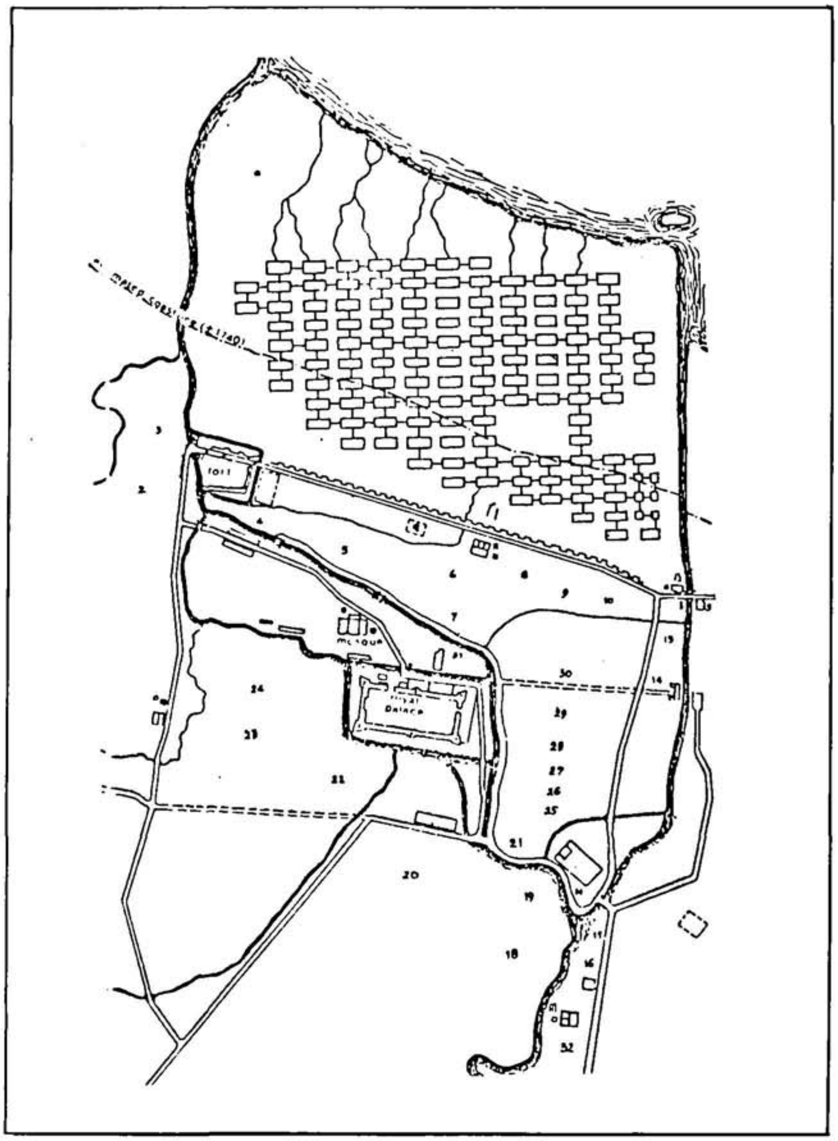
Illustration of an excavated crucible from Banten (Excavation 1976)

Assumption

All of the data mentioned above make us assume that the X vessels were used to heat a red colored liquid and that they were held above a hearth. The red material which melted on the outer wall might have been an overflow of the molten liquid that hardened after the heating process.

Judging from the ancient map without scale of the 19th century (one of the historical documents), the researcher assumes that the site excavated might have been part of an ancient quarter of a weaving area or of a metal working area. If we relate the vessel X finds with the weaving area, we may assume that these artifacts were used to heat certain liquids used for dying the cloth produced there and the red color on the outer wall was caused by spilled liquid. But this notion raises the following question: were all the cloths made colored red?

On the other hand, if the vessel were related to the metal-working area, we may assume that they were used for smelting metal. But, what kind of metal would give a red color to the outer wall without producing the same effect on the inner wall? These questions could only be answered



Legend :

1. Kapakihan : Moslem-scholar's compound
2. Pamarican : Pepper's storage place
3. Pabean : custom's house
4. Kaloran : Pangeran (prince/lord) Lor's compound
5. Kawangsan : Pangeran Wangsa's compound
6. Kapurban : Pangeran Purba's compound
7. Panjaringan : Fish-knapper's settlement
8. Pakojan : foreigner's settlement (Bengalese, Arabian, Turkese)
9. Pratok : handicraft's centre
10. Pasulaman : embroidery's workshop
11. Karangantu : foreigner's settlement (Chinese, Malayan, Portuegese, Dutch)
12. Pamaranggen : keris-making workshop
13. Pawilahan : bamboo's workshop
14. Pakawatan : ?
15. Karoya : ?
16. Kamandalikan : Pangeran Mandalika's compound
17. Camara : ?
18. Tambak : ?
19. Kajoran : ?
20. Kebalen : Balinese compound
21. Kasemen : ?
22. Kawiragunan : Royal official's compound
23. Pajantran : Weaving-mill's workshop
24. Kapandean : metal's workshop
25. Kasatrian : military barracks
26. Karang Kepaten : ?
27. Keraton : Royal official's compound
28. Pasar Anyar : market
29. Pagebangan : ?
30. Kabantenan : Royal official's compound
31. Langgeng Maita : ?
32. Kasunyatan : saint's compound
33. Kagongan : gong-making workshop

A map without scale of old Banten made by Serrurier in 1902.

through special analysis in a laboratory.

However, from the contextual analysis which follows, we are inclined to see the validity of the second explanation.

From the viewpoint of a manufacturing technique, it can be said that the X vessels are hand-made because of the following facts: the inner surface is indented or pitted due to the pressure of the potter's fingers; the inside wall does not show the aligned striations of wheel-turning; and the overall shape of these vessels is not symmetrical or concentric. From the inner surface, we can also observe that a potter's anvil was not used in the manufacturing process. This might be because dense walls were not needed and the working space was limited; in this case a small anvil might have been used which for technical reasons would not have been effective. If we consider the thickness of the vessel wall, which is not proportional to its height and width, we can conclude that there was no compaction with a pounder or paddle. Moreover, the porous body of the vessel also suggests that no process of compacting the walls took place. It is as if this thick paste was intended to give the X vessels a capacity for expansion and contraction, especially needed to withstand high temperatures. But, does cloth dye have to be heated to a temperature far higher than that of the boiling point of water?

Context of finds

The context of associated finds-a number of particles of bronze and bits of charcoal sticking to the walls of X vessels, several fragments of iron tools, fragments of clay moulds for casting metal, some iron and bronze slag, a carpet of bronze splashes 1.5 x 1.5 meters wide, and a deposit of black colored soil due to a thorough mixture with charcoal—indicates that there existed a close relationship between the X vessels and matters related to metal working systems. Thus, if we are forced to make a choice, we would be more inclined to suggest a relationship between the X vessels and a metal working area rather than a weaving area. Through formal and contextual analysis, we can therefore draw a provisional conclusion that this area was a workshop for metal workers who were carrying out casting and forging.

The Importance of Ethnographic Analogy

Having drawn a conclusion does not mean that the problem of interpretation is solved. All data obtained during the course of the excavation still have to be tested and supplemented with ethnographic material. Gathering ethnographic material relevant to the archaeological problem is, we feel, appropriate to our purposes. It is fortunate when researchers can simultaneously carry out an excavation studies within a nearby village to obtain information which is closely relevant to their finds. Indeed this sort of study can only be done in certain places where various social customs and behaviours are considered to be a continuation of ancient traditions. Thus, for example, in order to obtain an idea of the uses of vessels found in excavations, archaeologists usually make an effort to get comparative data from groups of potters whose villages are located within a reasonable distance. Such information can be obtained through direct observation and associated interviews.

But the problem lies in that one cannot be certain that a village which still retains the custom of making or using its own pots (without making ethnographic observations) exists near the site.

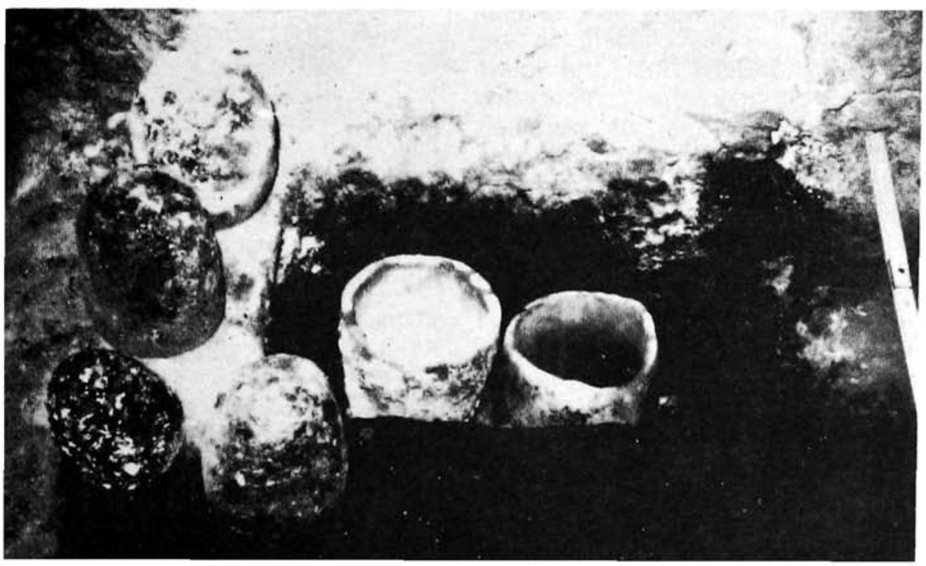
Theoretical comparisons based on the use of ethnographic analogy have attracted the attention of archaeologists and anthropologists for many years. The theoretical basis for this line of thinking is the uniformitarian outlook on natural phenomena and human behaviour. Natural phenomena of the past related to stratification, erosion, tectonic movements and so forth can be interpreted through studies of present similar phenomena. Human behaviour involving the invention and use of tool systems to cope with the natural environment can be understood through ethnographic studies of various contemporary societies which have not yet undergone great alterations. Past experience has proven that it is difficult to make archaeological interpretations before we will have seen and understood similar phenomena which take place in a living society. Stone tools which were once considered to be natural phenomena were only recognized as man-made objects in the 16th century (Fagan 1975: 24), when Michele Mercati observed their function in societies which had not yet been touched by the Industrial Revolution (19th century). It was not until long afterwards, 300 years later, that stone axes which still had handles attached were found at an archaeological site.

Bogor Study

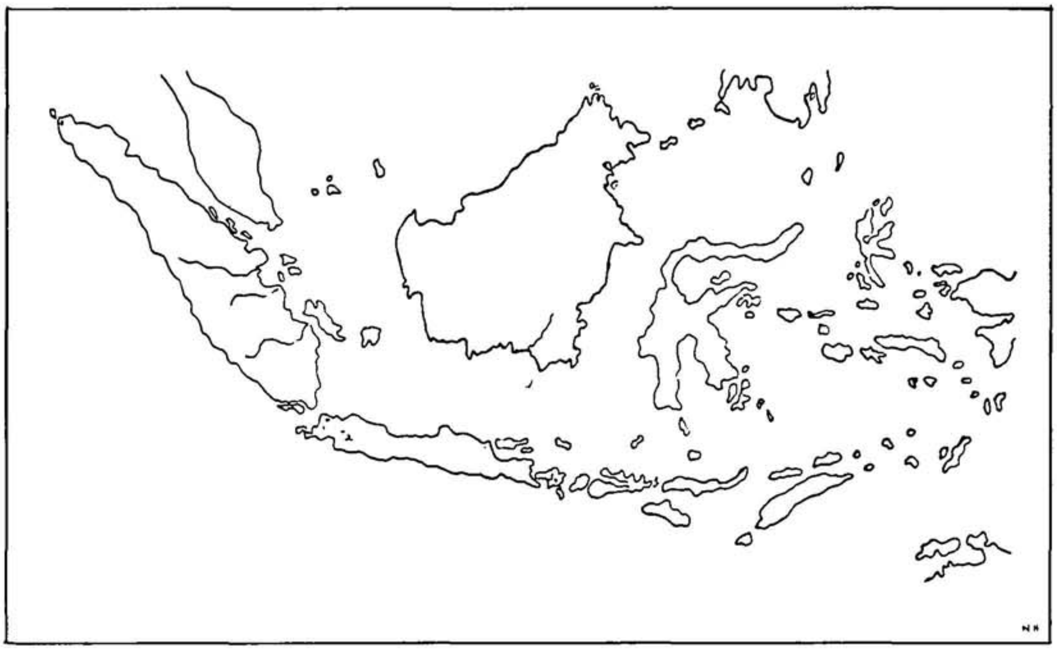
Realizing the importance of the X vessels, the archaeologists carried out further studies in the same year at a village in Bogor, West Java. The workshop there is the only place in West Java which still manufactures gongs and other gamelan instruments (traditional musical percussion instruments made of bronze or copper). The investigators were able to see the process of gong making, starting with the initial melting and mixing of copper and tin in a crucible, through casting in a clay mould and the beating out after heating over burning coals, up to the forming of a gong. The archaeologists were able to see a number of crucibles which could not be used again, jumbled together in a corner of the workshop. Several were still in one piece, but most were already broken.

The entire context was seen with great clarity including the function of these crucibles in the overall manufacturing process. The situation was as follows: a carpet of charcoal covered the whole place such that the earthen floor was black; rounded fireplaces of various sizes full of charcoal and ash; a water tank for cooling the glowing metal while it was forming; a flat stone on the floor for use as an anvil; goat-skin bellows; moulds made of clay in various shapes and sizes; and tools of iron such as hammers, tongs, pliers and lifting tools.

The surfaces of the outer walls of the Bogor crucibles were wrinkled and pitted, colored dark red and shiny enough when put in the light. It was not clear why their outer surfaces were wrinkled whereas their inner surfaces were not. From



Unused crucibles jumbled up near the hearth.



Map of Indonesia
Legend: 1. Banten
2. Bogor
3. Tihingan

interviews, it could only be ascertained that the wrinkling was not *due to overflowing of liquid bronze;* rather it was the result of heating on the hearths. Only one problem remained: was this because minerals in the clay of the crucible itself were liquefying, or because substances within the burning charcoal were adhering to the outer surface, as the informant explained?

Although the function of the X vessels was becoming more comprehensible, there were still several questions which needed to be answered. Besides this, the input data for ethnographic comparisons should, if possible, be obtained from studies of more than one research sample. This is because in the collection of empirical data, one must observe the principle that a single sample is not yet a sample. Thus further studies were carried out at the village of Tihingan, Bali, known as the only village on the whole island of Bali where people still make traditional musical instruments. The problems which especially concerned archaeologists were not matters relating to the social system like those which concerned Clifford Geertz (1964) in his study of the same village but those relating to its technological aspects.

According to the observers, 20 houses out of 180 in this village belong to bronze smiths; 4 of them have large foundries which can manufacture a complete set of gamelan instruments. In the village there are 25 experts, 75 semi-experts and about 100 assistants. Direct observations were made at one large foundry and at one small foundry which was not being used at the time. The observers requested another small foundry to make a crucible and to put it through the stages of melting bronze over a fire and of pouring the liquid into moulds. Furthermore, interviews were held with several people, including craftsmen, semi-skilled men and apprentices. Just as in Bogor, the same setting was seen in Tihingan: a carpet of charcoal, several fire places, tanks for cooling water, angular stone anvils, cylinder bellows, moulds of various sizes and assorted shapes and sizes of tools for hammering, lifting, and pinching. What was most important was the discovery of a number of crucibles, some broken, which had already been used for melting scattered in the corners, piled up beside the hearths and lying on the trash heaps.

Through a detailed formal analysis which had been applied to observe similarities and differences of the crucibles from Tihingan, Bogor and Banten, the archaeologists concluded that almost all the characteristics they possessed were similar. The similarities made the researchers assume that the Banten X vessels had a function which did not differ from that of the crucibles of the other liquid. This assumption is strongly supported by the similarity of contexts mentioned above.

Imitative Experiments

Although the problems of functional interpretation of the Banten X vessels was more or less solved, some problems still remained which led the archaeologists to carry out some imitative experiments. The theoretical justification for using this method of experimentation is the same as that for using ethnographic analogy: that is, uniformitarianism. By attempting to reproduce the activities of people in the past, the researcher can observe certain phenomena. Thus, for example, Iversen performed experiments, using stone axes to fell trees (1956), Outwater (1957) tried to cut and scrape wood with chipped stone tools, Jonnefeld

(1962) excavated with stone implements and Harner(1956) carried out experiments to find out the difference between man-made stone objects and natural stones. Also, Mayes imitated early methods of baking pottery in a kiln (1961) and Johnson (1957) made drawings on the walls of caves to produce lines and colors on their surfaces. The concept of imitative experiment extends even to the famous one performed by Heyardahl (1950) who copied the methods used by the people who sailed from South America to Polynesia in early times.

The researchers saw for themselves how the Tihingan crucibles were made. The raw material comprised clay and burnt rice husks. After these two materials had been thoroughly blended, a chunk of the mixture was shaped by hand into a crucible. Then the crucible was aired beneath the roof of the house so that it would become as dry or hard as leather and later dried in the house-yard exposed to direct sunlight. Afterwards, it was placed beside the hearth a little longer until considered dry and hard enough to be used to melt bronze at a high temperature. Once it had been used for melting, the outer surface became noticeably wrinkled and turned to a glassy red color unlike the inner surface which only darkened and turned slightly red.

All these data were of course most useful for the interpretation of the crucibles. They provided some answers for what the researchers had not been able to understand before: why the surface of the outer wall underwent such alterations even though no foreign material of any kind penetrated the covering layer. Observations throughout the melting process undertaken at Tihingan showed that the overflow of molten bronze, originally supposed to be the cause of the vessels' physical condition, did not occur at all. Therefore, the splashed carpet of bronze seen at the excavated site could have been formed by the broken crucibles, not by the overflow of molten bronze.

Being aware of the need for scientific clarification of this matter, the researchers undertook imitative experiments in the laboratory to observe the changes which might or might not take place in the research sample. These were used to explain the following: why do the crucibles have a surface with amorphous lumps on the outer wall but not in the inner wall? Why do the vessels have very thick porous body walls?

Imitative experiments on the Tihingan samples, supplemented by laboratory examination, were performed in the chemical-archaeology laboratory at Borobudur (Samidi 1976), Central Java. They produced the following results:

(1) In order to reach the melting point of bronze, around 1100 C, the crucible has to be heated to a higher temperature; consequently the heat outside the crucible is hotter than inside.

(2) While the bronze is melting, some of the iron (Fe) and silicon (Si) minerals in the body of the earthenware crucible also liquify, but only outside.

(3) After the heating ceases, due to the sudden temperature change, the molten Fe and Si harden and form numerous amorphous lumps and small cracks on the outer wall.

(4) The dark greenish red color of the outer wall is caused by the oxidation of the iron, while the glassy shine which reflects light is caused by the silicon mineral.

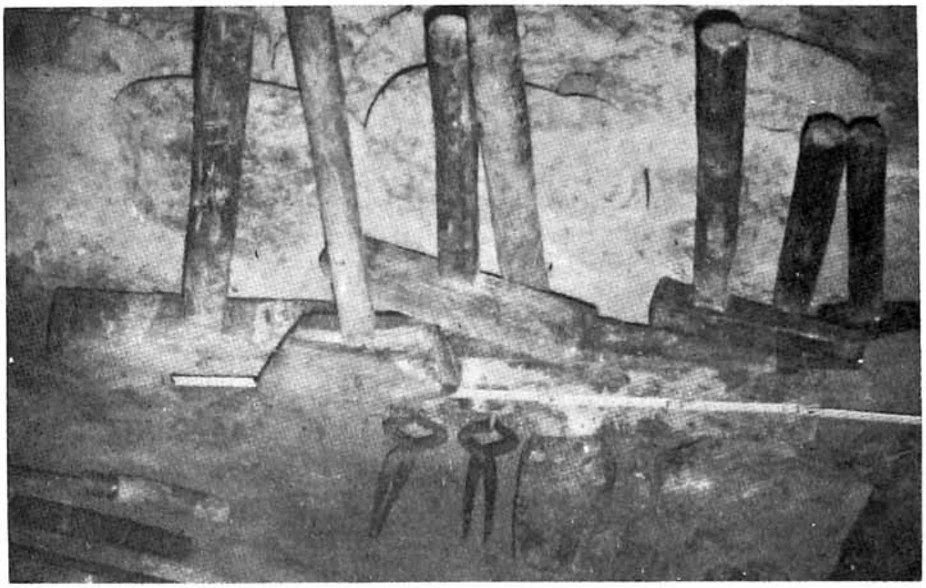
Before use, the surface of the crucible is smooth. It becomes wrinkled and turns glassy red once it is used.

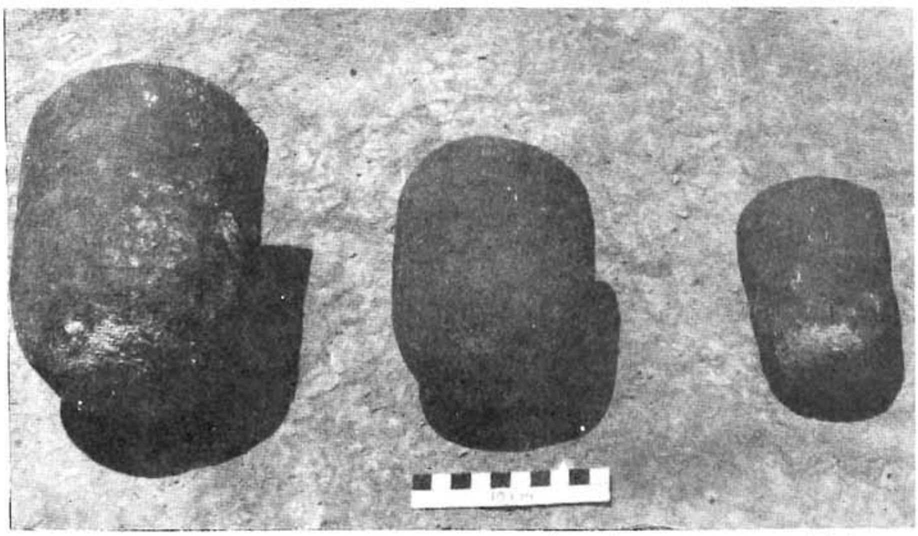
The last stage of crucible making (hand made technique) demonstrated in Tihingan, Bali.

(5) The temperature within the crucible is not as high as on the outside, therefore, the minerals inside the crucible do not liquify.
(6) Aside from unwanted economic factors, the molten bronze cannot boil over because the temperature does not reach its boiling point of 2336 C; otherwise, the crucible will melt first, since iron and silicon minerals liquify under a much lower temperature.
(7) The soft and very porous thick wall lends itself to greater expansion and contraction when the heating takes place.

By attempting to assemble the various data that have already been obtained through analytic methods like those described above, we can now attempt to give a plausible explanation of the X vessels from Banten in the form of a hypothesis which will be tested in later field research. The X vessels are believed to be crucibles, made of porous clay mixed with temper. They are probably used to melt bronze in the course of making traditional musical percussion instruments, since the size and form of the vessels are similar to those of Bogor and Tihigan. The bronze, melted in the crucibles at a high temperature, is poured later into open moulds through spouts on their rims with the help of long tongs to grip the lug on the crucibles' rims. Crucibles of varied sizes are used according to the amount of molten bronze required to form gamelan instruments which are also of varied sizes. Large crucibles are used to make large objects and small crucibles to make small ones. They are shaped by hand without using a potter's wheel. As the workshops are located near the homes of the workers, broken ceramic plates, coins and food remains can also be found.

Part of the gong maker's tool kit at Tihingan workshop.





Modern Tihingan crucible types.

Using this hypothesis, the researchers should do a follow up in the form of an extended excavation to make it possible to collect data which may confirm the assumptions. The knowledge of the layout of the workshops and the kind of implements used can be employed as an expedient guide in future archaeological operations.

Conclusion

With regard to the analytic methods employed in the case of the crucibles, it is obvious that the four methods — analysis of form, analysis of context, ethnographic analogy and imitative experiments — are inter-dependent. Among them, ethnographic analogy plays a very important role and makes a useful contribution to the formation of the research hypothesis.

By emphasizing the use of ethnographic analogy, I do not mean that

I quite agree with just any kind of analogy, such as the application of simple ideas and the incautious manner exercised by some archaeologists of the past. For ethnographic analogy, as demonstrated for example by Hill (1970), is only one phase of the interpretative process in archaeological explanatory activities.

It may be reasonable that, in choosing and making analogies, we have to consider the whole length and width of the dimensions of time and space. Thus, Dozier (1970) states that the shorter the time gap between a prehistoric site and the living site, the more likely it is that the inference will be reliable. And Gorden Childe (1956) suggests that an analogy drawn from the same region or ecological province is likely to give the most reliable hints. The ideas of Chang (1967) and Thompson (1956) limit the use of analogy in archaeology to technological problems. They believe that problems connected with ideas, beliefs, and customs can not be dealt with through analogy.

Use of Analogy

Simply suggesting parallels without taking into account the differences between given areas of culture will trip up any interpretation. It will not be possible to reach results through analogy like those the archaeologists hope for, unless the analogy is tested throughout by compiling as much archaeological data as possible. In the case of Banten, I feel that the real situation can be grasped through the use of analogy because (1) the artifacts being analyzed are technomic (Binford 1962) and of a universal nature; (2) the time-span separating Banten and Bogor-Tihingan is not great; (2) virtually no important technical changes took place during this time; on the contrary, Tihingan evidences are closely similar to those of Banten; and (4) the two localities are within a single Indonesian cultural area.

What has been expounded in this paper constitutes, if nothing else, further proof that archaeologists are constantly confronted by problems which can only be solved through the interdependent methods described above. All these stem from the nature of archaeological data which are greatly limited in matters of quantity and quality.

While some may be of the opinion that analogy is not the best way to archaeological interpretation, I am of the opinion that if archaeologists cannot use analogy at all, they will not be able to carry out the task of "piecing together the past"

If archaeologists cannot use analogy...they will not be able to "piece together the past."

With the Banten example, we can perceive that, although these artifacts were discovered in a historical site which has been only abandoned for 200 years and which is supported by a great number of historical documents, the problem concerning functional interpretation still exists. It is probable that it will be more difficult working in historical sites which can only provide a limited number of written documents, or in prehistoric sites with no records as such (telehistoric, Hawkes 1954). Working in historical sites is not as easy as people might think for the validity of the findings depend on the quality of written documents provided about the sites. For example, the writings of the Dutch and the British writers who came in contact with the Sultans of Banten would not be very helpful in the research on the crucible for they were interested in the international pepper trade, politics, social stratification and religion, rather than in the technology of that area.

Need for Ethnoarchaeology

In addition to the above, ethnographic data or literature do not give archaeologists supporting knowledge about metal technology of this cultural area. Should the ethnologist observe and record these data so that they might some day be of some use to an archaeologists; or should he do so in any event, or should there perhaps be a branch of archaeology (ethnoarchaeology) to take care of such things (Chang 1967:230)? Those are, I believe, questions which are very relevant to archaeological strategies in Indonesia today. Since there is no close relationship between archaeology and anthropology/ethnology (they are two separate departments in the universities in Indonesia), it is difficult for archaeologists to have ethnographic data related to archaeological problems. It is doubly so in Indonesia which consists of 3000 islands, 300 ethnic groups and 250 languages, and has still small societies, relatively isolated, where modern technologies have scarcely touched the people. Hence, Indonesia should conduct ethno-archaeological research which could help solve the various problems in Indonesian archaeology.

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Some Comments on The Importance of Ethnographic Data For Archaeological Interpretations

by Rosa C. P. Tenazas

Analogies to living peoples have been an important methodological resource for archaeologists in the reconstruction and interpretation of past cultures. There are certain aspects of culture which are not directly observable, by the archaeologists but to which the ethnologists, by virtue of their discipline, are in a position to provide insights and understanding to particular phenomena. It may, however, be stated that collaboration between archaeologists and ethnologists has merits only when applied to the recent past. The validity of using ethnographic data becomes suspect in proportion to the remoteness of the culture being investigated as in the case of pleistocene societies. The following discussions are not all fully documented; the comments are especially addressed to ethnologists to make them more aware of the usefulness of their data for specific archaeological interpretations.

In two articles (e.g. Tenazas 1973) that this author has written on the practice of boat-coffin burial in the Philippines and elsewhere in Southeast Asia, the value of ethnographic data was demonstrated in its applicability to the understanding of this widespread practice in prehistoric times. Ethnographic reports among modern marginal societies in Southeast Asia where the concept of a soul boat in connection with burial still survives show that the boat as a mortuary symbol is a substitute for the rainbow as a means of access to the afterworld. On the other hand, the use of ethnographic data on, say, the Negritos of the Philippines to elucidate the Philippine palaeolithic way of life will not hold up scientifically. Here, the interpretations would be including parameters of socio-cultural structure unique only to prehistoric setting going back several hundred thousand years and, as pointed out by one scholar, the problem is compounded when the equation involves comparisons with societies of mankind biologically different from our own.

Based on the article by the same author entitled, "Ethnographic and Archaeological Data as Material for Reciprocal Cultural Interpretation. "**Philippine Quarterly for Culture and Society,** *II (1 – 2), 1974, pp. 55 - 87*

It is an admitted fact that archaeologists owe much to the ethnologists for providing data which are used by the archaeologists as models against which to test their hypotheses. However, this is not to say that it is the sole means by which theories are tested. Sophisticated methods of analyses have been developed involving unique approaches. For example, it has been postulated that the social phenomenon of postmarital residence could be inferred from the archaeological record independent of ethnographic analogies. Studies initiated by the Russian archaeologist P. N. Tretyakov (Binford 1968:269–270) has shown that the form of fingerprints on pottery generally indicated that it was females who manufactured pottery. In societies where matrilocal residence was the rule, the range of variability in pottery types would be much less than would obtain if patrilocality was the rule, since in patrilocal societies the women are brought in from the outside. Subsequent studies along this line by other scholars have resulted in the establishment of post-marital residence patterns of certain prehistoric communities. This model of inquiry had been use by this author in testing theories concerning the distribution of certain Iron Age pottery complexes in the Philippines (Tenazas, 1977). Testing archaeological hypotheses on the bases of ethnographic models was, however, employed in the same research to find out what factors determined settlement and subsistence patterns in at least two widely located prehistoric communities.

Another important role that ethnographic data has played in archaeological investigations is in serving as models for testing hypotheses which seek to reconcile material and behavioral cultural phenomena. This role is exemplified in the new method of investigation which is termed "action archaeology" or ethno-archaeology. In this method a living community is studied from the perspective of an archaeologist. That is studies are made on archaeologically relevant data among living peoples. Aspects of culture such as functional variability in ceramic studies, the relationship between population size and site size, and the relationship between behavior and the spatial structure of artifacts which are observable only in the archaeological record are given attention. For example, a preliminary analysis of an underwater archaeological investigation off the Gulf of Thailand by the SPAFA Thai Sub-Centre was reinforced by ethnographic analogy when two sets of equipment were identified from the point of view of disposition: the more sophisticated assemblage was found concentrated on the stern of the ship while the more utilitarian artifacts were recovered from the opposite end of the ship. The living arrangement on board the ship was thus inferred: the stern or the more protected section of the boat was reserved for the passengers of high rank while the rest of the crew occupied the main deck (Tenazas 1981; Intakosai 1983).

From the foregoing, we have seen some examples of relationships between ethnographic data and archaeological reasoning. It is urged that ethnologists bear this in mind when conducting their investigations so that both groups of scholars could arrive at a common framework of problem solving, for the words of a well-known archaeologist:

".......Prehistory and ethnology are not independent disciplines, but related parts of the single discipline of anthropology. Although the data available for the study of the past and present are quite different, ethnologists and prehistorians are both concerned with human behavior and the interpretations they offer are influenced by their understanding of the universal properties of this behavior." (Bruce C. Trigger 1968:6).

Ethnologists provide data against which archaeologists test their hypothesis.

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Technological and Functional Analyses of Lithic Flake Tools from Rabel Cave, Philippines

by Wilfredo Ronquillo

In 1976-77, archaeological explorations of cave sites were undertaken at the limestone formation area of Penablanca, Cagayan Province, Northern Luzon, Philippines to search for Palaeolithic sites. The explorations resulted in the discovery of 78 caves and rockshelters, 43 of which contained archaeological materials on their floor surfaces. The materials recovered range from Palaeolithic flake and cobble tools to stoneware sherds of Chinese provenance.

Subsequent archaeological excavations were carried out in a number of caves to determine the extent of the Palaeolithic industry (ies) in the area, both spatially and temporally, and to try to explicate the structure of the Palaeolithic industry(ies) there by employing technological and functional analyses on the lithic materials recovered.

The purpose of this paper is to determine the existence or absence, if the data warrant it, of technological and functional variability in the lithic flake tools recovered from the archaeological excavations of Rabel Cave, one of the caves excavated in the Penablanca limestone area. Specifically, it aims to test the hypothesis that the utilized flake tools recovered from Rabel Cave are maintenance tools.

Reprinted from the Anthropological Paper No. 13 of the National Museum, Manila, Philippines, December 1981. W. Ronquillo is the Chief Archaeologist of the Anthropology Division of the National Museum and Chairman of the SPAFA Philippine National Steering Committee.

Description Of The Area

Cagayan Valley, Northern Luzon, Philippines presently forms a large basin which is surrounded, except in the north, by high mountains: the Cordillera Central in the west, the Sierra Madre in the east and the Caraballo in the south. The valley, which is approximately 250 kilometers long by 50 kilometers wide, falls within the provinces of Nueva Vizcaya, Isabela, Kalinga-Apayao and Cagayan.

Cagayan Province, where the limestone cave sites are located, comprises an area of 900,267 hectares (Dagdag 1967). Tuguegarao, its capital, is roughly 500 kilometers north of Manila.

The climate of Cagayan Valley does not have a very pronounced wet season. It has a short dry season which generally lasts from one to three months. The annual precipitation in the northern Cagayan Valley is only 35 inches but the range of the annual rainfall received by most of the valley stations is from 60 to 80 inches (Wernstedt and Spencer 1967:316). The months from December to May are normally quite dry since the precipitation is so distributed while the remaining months of the year are humid and wet.

The Cagayan River is the master stream of the valley and all of the drainage of this region is toward the north. Numerous tributaries make up Cagayan River as it treks northward resulting in a one-sided character of the valley. Since the main stream is entered by tributaries mostly from the Cordillera to the west, the majority "of the alluvial plain lies to the west of the main river channel" (ibid.).

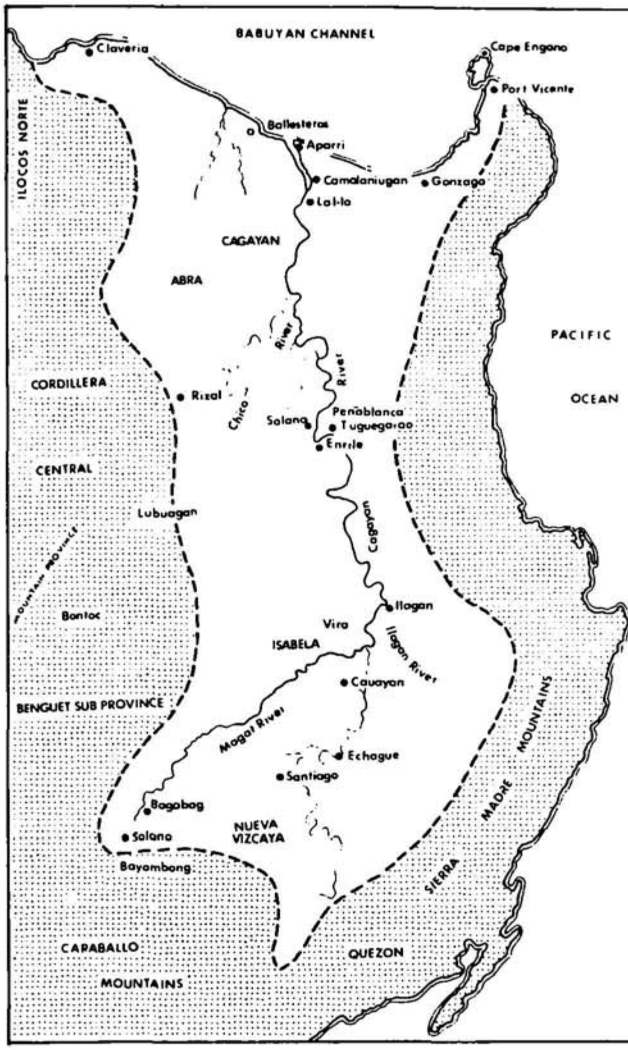
The Geology of Cagayan Valley

The Cagayan basin was formed as a deeply subsiding marine trough during the Oligocene (25 to 35 million years ago) and was subsequently filled by more than 10,000 meters of debris flows deposited on a basement of igneous volcanic and 400 to 2,000 meters of Pliocene transitional marine and fluvial sands of the Ilagan Formation (Corby 1951; Durkey and Pederson 1961).

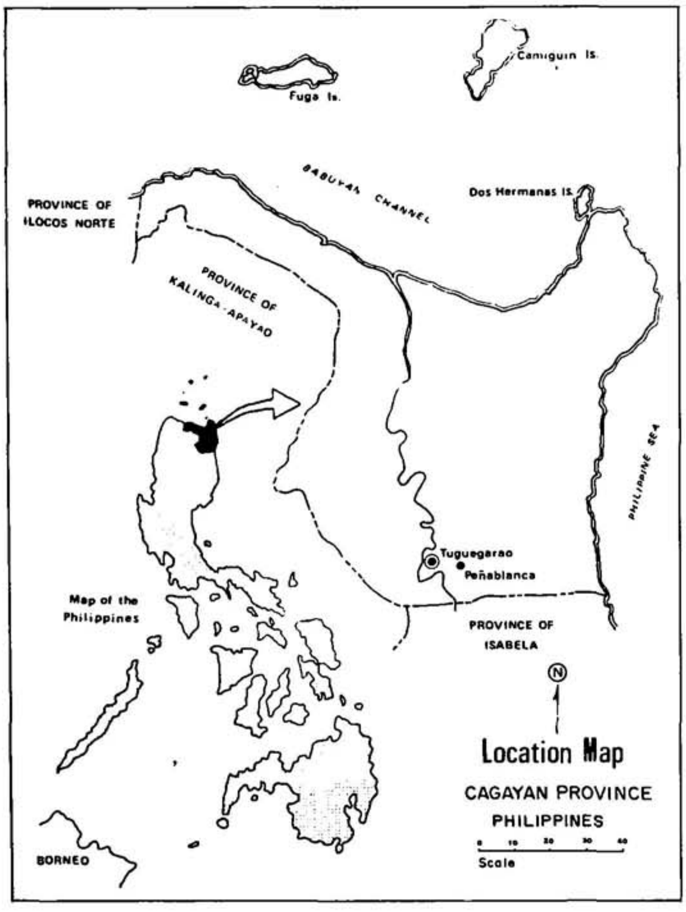
Overlying the Pliocene Ilagan Formation is a 300-meter thick sequence of Pleistocene tuffaceous fluvial sediments assigned to the Awidon Mesa Formation (Durkee and Pederson 1961).

It has been advanced that during the development of the Cagayan basin the Sierra Madre Mountain has been relatively stable and, therefore, a more passive element; the Cordillera in the west, on the other hand, has been considered the dominant tectonic feature of Northern Luzon. During the Palaeocene and persisting into the Pliocene, marine conditions prevailed in the basin. As the Cordillera Central was uplifted during the Upper Cretaceous and the Lower Tertiary, the Cagayan basin was initiated (ibid.).

The basin progressed from deep marine to shallow water during the Upper Miocene. That the final period of uplift in the Cordillera Central lasted from the late Pliocene to the early Plesistocene and that these events resulted sometimes in assymetrical anticlines and intervening synclines were considered by Durkee and Pederson (1961).

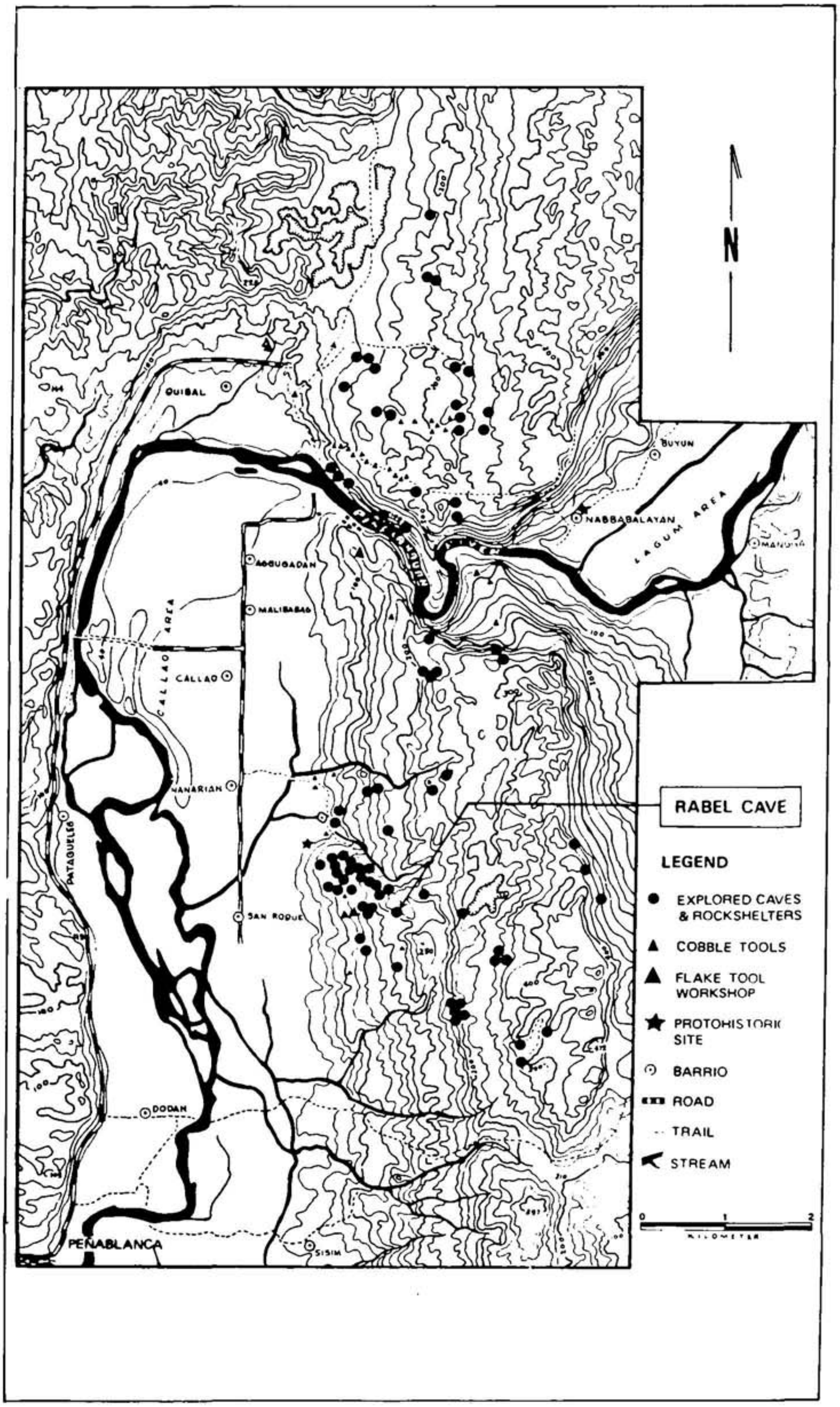


The Cagayan Valley Region, Northern Luzon, Philippines.



Penablanca Municipality

The municipality of Penablanca, the largest municipality in Cagayan Province, is 9 kilometers east of Tuguegarao and has a total land area of 118,060 hectares (PDS 1975). The name of the municipality means "White Rock" or "White Stone" and was derived from the white limestone outcrops that are conspicuously seen from a distance. Penablanca is bounded on the east by the Philippine Sea; on the north



Map of Penablanca Limestone Formation and the distribution of Archaeological sites explored by the National Museum from November 22, 1976 to February 20, 1977.

by the municipality of Baggao; on the south by the municipality of San Pablo, Isabela Province; and on the west by the municipalities of Tuguegarao, Iguig and Amulung. At the time of the excavation, it has a population of 20,644. The main source of livelihood of the residents is farming with corn, rice, tobacco, beans, peanuts and mongoes as the major agricultural products (Yambot 1975).

The limestone formation of Penablanca has an estimated area of 77 square kilometers and an average elevation of 309 meters above the alluvial plain which, in turn, is roughly 40 meters above mean sea level. It is at this limestone formation area where the archaeological explorations and excavations were undertaken.

Rabel Cave

Rabel Cave, one of the larger caves at the limestone formation of Penablanca Municipality, Cagayan Province, is located at the western slope of the limestone outcrop and presently falls within Barrio San Roque. The cave's elevation is 213 meters above mean sea level. The entire limestone area is covered predominantly by abundant vegetation, hence, the caves and rockshelters cannot be seen from the floodplain where a number of the barrios, or political units, of the municipalities are situated.

Rabel Cave, a two-entranced cave, is 167 meters long while the width at the soil floor level varies from as narrow as 2 meters to as wide as 17 meters. The ceiling of the cave is high, approximately 9 meters on the average. The cave is arbitrarily divided into 4 chambers, Chambers A, B, C and D, using natural features such as diverse floor levels, the density of limestone boulders and stalagmites, general characteristics of the surface of the soil floor area, and compass directions of the different chambers as criteria for the division. The soil floor of Rabel Cave slopes gradually downward from both entrances towards the pitch-dark and breezy middle portion of the cave.

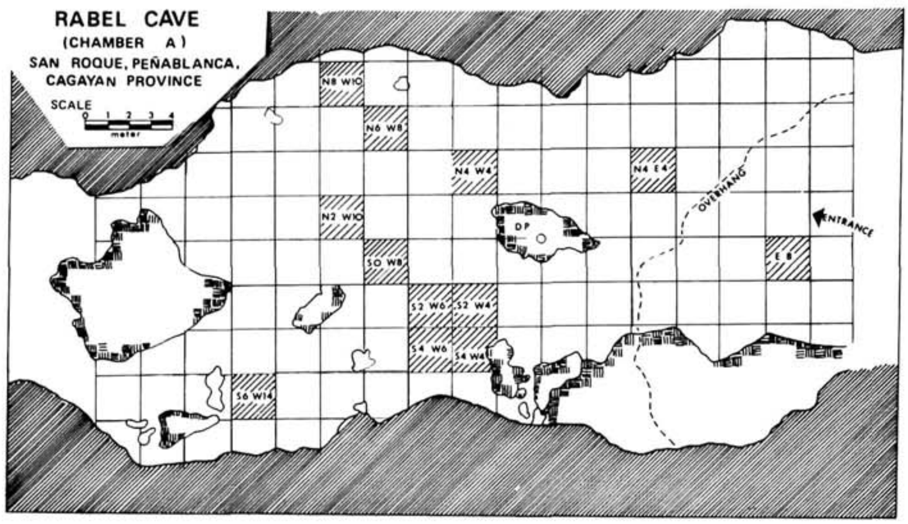
Chamber A, the area by the larger mouth of the cave, is where archaeological activities were undertaken. The mouth of the cave at Chamber A is large being 9 meters and 70 centimeters in height and 18 meters and 20 centimeters in width. With an average width of 18 meters, the ceiling of Chamber A is domeshaped and is characterized by numerous stalactites of varying sizes and shapes. The length of Chamber A is 28 meters and 30 centimeters. Its soil floor area is predominantly clay and rocks; boulders of fallen limestone stalactites and a few stalagmites were present on its surface. Chamber A is well-lighted by sunlight in the morning but becomes dimly-lighted by sunlight in the afternoon. The chamber is cool and breezy the whole day, the latter condition being due to the existence of the second smaller entrance at the other end of this long and winding cave.

Rabel Cave was chosen for archaeological excavations primarily due to the recovery there of extraneous lithic materials, earthenware sherds, small animal bones Rabel Cave, the researcher used various equipment such as a spreading caliper, a goniometer, a weighing

and teeth and river shells. All these materials were found at the surface of the floor of the cave during the exploration period activities.

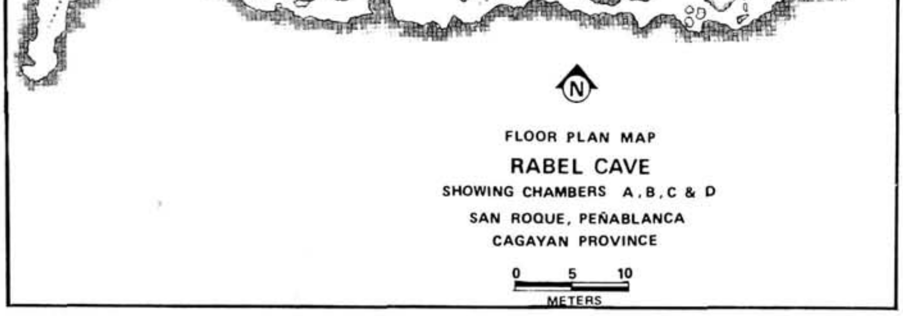
To quantify the technological and functional attributes of the flake tools and waste flakes from

MAP OF EXCAVATED SQUARES



scale and a millimeter tape. The following variables were considered in the analyses: the measurable variables of length, width, thickness, weight; diameter of the flake; angle of the bulb of percussion versus the striking platform, length of the used edge; angle of the used edge and percentage of the used edge; and the non-measurable variables such as edge shape or used edge type, degree of edge wear, and the presence or absence of the bulb of percussion, striking platform, ripples, fissures and a negative bulb.

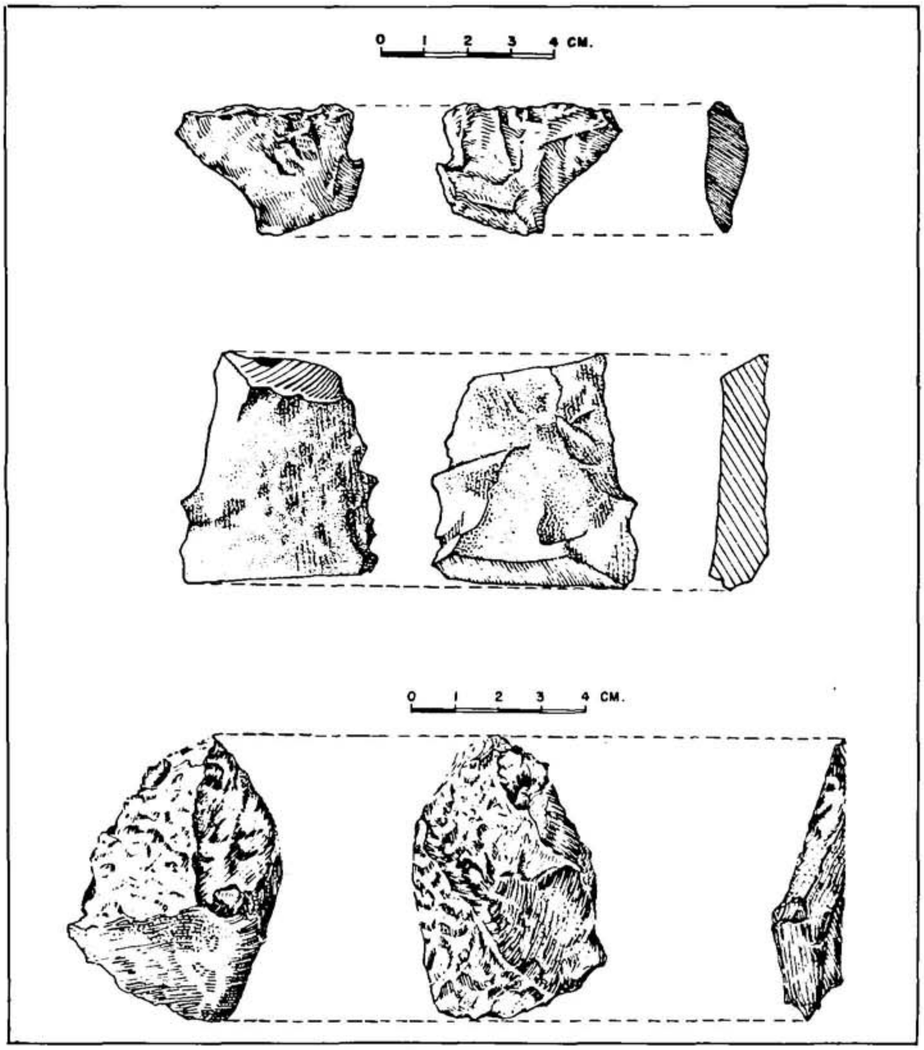
For the measurements of the lithic flakes, Shawcross' method (1964) was followed. This method is based on the recognition of flakes having a common axis which makes the direct comparison of their proportions of length and width possible. The method avoids taking and comparing the maximum and minimum dimensions of flakes which are not necessarily along the defined axes. Shawcross notes that "the axis of the cone, radiating from the point of the impact of the blow, will be perpendicular to the striking platform" and "the existence of this axis means that the length of the flake can only be along that axis, while the breadth must be parallel to the striking platform" (Shawcross 1964:63).



The lithic materials recovered from the archaeological excavations of Rabel Cave include utilized flakes, waste flakes, chips, primary cores, cobble tools and hammerstones. Utilized flakes are pieces which exhibit the presence of several of the non-measurable variables normally exhibited by artificially struck flakes and, more importantly, the presence of sharp and useable working edges. The sizes of the flakes, i.e., large enough to be held between index finger and the thumb with the sharp edge exposed, were also considered.

Waste flakes are lithic materials with some or most of the characteristics of an artificially struck flake except that they do not have sharp and useable working edges. The majority of the waste flakes are likewise generally smaller in size for adequate handling. Chips are very small fragments which normally fly off in the process of percussion flaking. A limited number of primary cores, chunky pieces which are remnants of chipping, were also identified. Likewise, a limited number of cobble tools - river cobbles with one end unifacially flaked to achieve a sharp edge or a point - were encountered. The hammerstones were identified by the battering marks and their ideal sizes for the purpose.

Analyses of the lithic flake tools and waste flakes entailed the identification and recording of variables and attributes which stem from artifact utilization. A total of 22 variables and attributes were used in the analyses of the utilized flake tools and each used edge of a flake was treated separately. Low-powered magnification ranging from 10 x to 40 x was used in the study. All the lithic materials recovered were placed in separate plastic bags to minimize, if not prevent, post-excavation and storage damage specifically to the utilized flake tools.



Andesite Flake Tools, Rabel.Cave..

Results of The Lithic Analyses

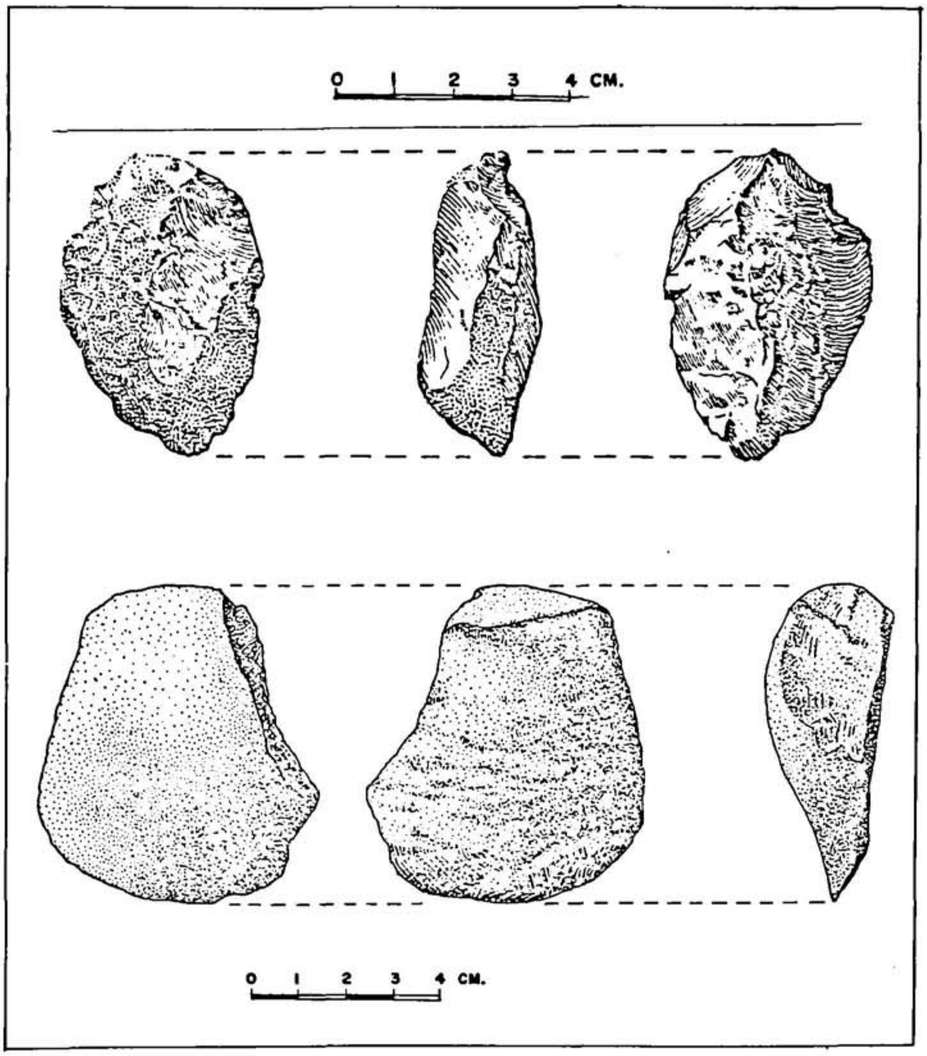
For the purpose of the present study, the lithic materials considered in the analyses and presented in this paper are taken as a whole.

Technological Analysis. Of a total of 3,366 lithic materials recovered 'in situ" from the excavations of Rabel Cave, 1,512 flake tools and waste flakes were individually measured and analyzed.

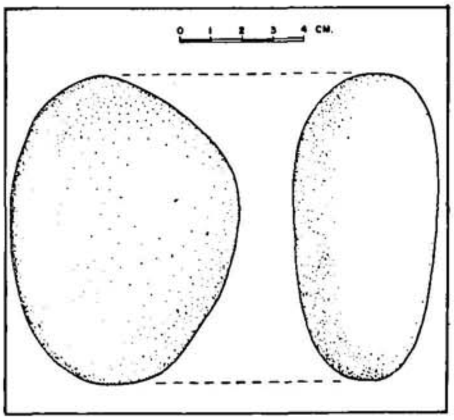
The analysis showed that two kinds of raw materials were used in the manufacture of flake tools at the site, namely, andesite and chert. There are, numerically, more flake tools, waste flakes, and chips of andesite than of chert from the analyzed lithic materials from Rabel Cave. One explanation for this disparity is that andesite, in the form of river pebbles and cobbles, is ubiquitous at the Pinacanauan River floodplain while chert, the distribution and concentration of which is not as prevalent as the andesite, therefore, seem scarce in the immediate area of the limestone formation.

The method of manufacture of the chert and the andesite flake tools, as indicated by the tools themselves and the accompanying manufacturing debitage, is by direct percussion flaking. That there was no core preparation in the manufacture of the flake tools is indicated by the absence of regularly shaped primary cores and flakes. It was also noted that the cortex or original skin of the stone, specifically of the andesite flakes, was used as a striking platform in numerous instances, Limited replicative experiments of direct percussion flaking by the author and some members of the excavation team on andesite and chert nodules indicate that the method employed, without preparation of the core, does not predetermine the overall shape of the flakes knapped. The recovered lithic flake tools from Rabel Cave do not show any regularity in size or shape and it is suspected that what was being sought for by the makers of the flake tools were not the forms but rather appropriate sharp edges. Ethnographic research by J Peter White in New Guinea (White and Thomas 1972) indicates that to meet the requirement of functional tools, flakes need only to fulfill the condition that they have potential working edges. Conformity to standardized overall forms by further modification was noted to be unnecessary.

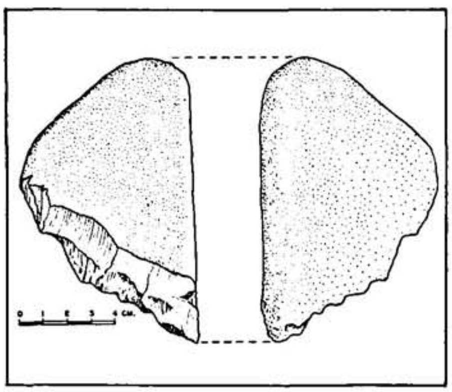
A total of 11 cobble tools were recovered from the excavations of Rabel Cave making 3.3% of the corpus of the lithic materials recovered. All the cobble tools were of andesite. The limited number of cobble tools may indicate that the andesite flake tools were the ones mainly sought for by the artisans. The numerous andesite waste flakes and chips recovered were not only due to the manufacture of the cobble tools but were mostly the by-products in the manufacture of andesite blade tools. It is noteworthy that in the manufacture of andesite cobble tools, as shown by some replicative experiments, there were flakes - possessing potential working edges and are of adequate sizes for handling - that fly off in the process of percussion and may be employed as flake tools. This may well be the case for some of the andesite flake tools recovered at Rabel Cave.



Andesite Flake Tools



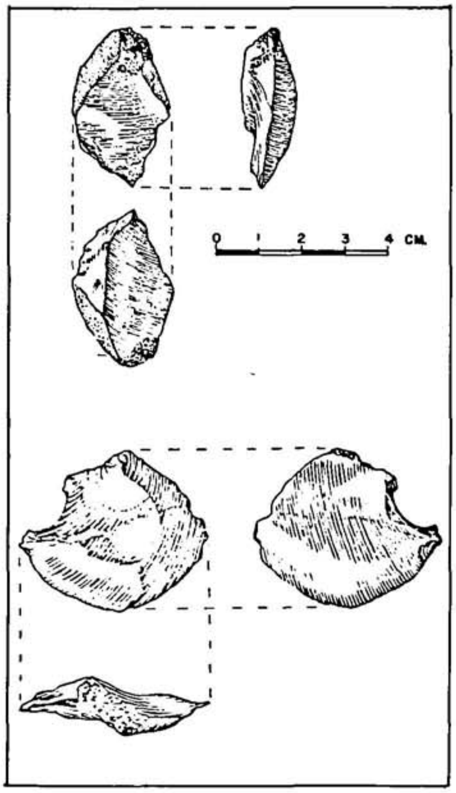
Andesite Hammerstone



Andesite Unifacial Cobble Tool.

The excavations at Rabel Cave resulted in the recovery of only very few un-worked chert nodules of varying sizes. This may be an indication that preliminary modifications of the chert nodules were done outside the cave and that only the final knapping of the chert to make the tools, as shown by the numerous chert flake tools, waste flakes and chips, was done at Rabel Cave.

The andesite materials, however, indicate otherwise. The majority of the andesite flake tools, waste flakes and chips still retain the cortex of the nodule. This suggests that whole andesite nodules were brought to the cave and were subsequently knapped for the manufacture of both flake and cobble tools. The analysis showed that in 45.16% of the andesite flake tools the cortex of the nodule was used



Chert Flake Tools.

as a striking platform while for chert this was observed only in 4.52%

Only 10 chert and 4 andesite primary cores were recovered from the excavations of Rabel Cave. The primary cores show no prepared striking platforms but indicate the randomness of the percussion method applied on the original nodules.

The excavations also resulted in the recovery of 4 andesite hammerstones. These hammerstones, as indicated by the battering marks on them, were the ones most likely used in the manufacture of the andesite flake and cobble tools and also of the chert flake tools. There were no hammerstones of chert recovered at Rabel Cave.

Functional Analysis. For the functional analysis of the utilized flake tools from Rabel Cave, four variables were considered for the purposes of the present study, namely:

Angle of the Used Edge. Edge angle as a functionally specific variable has been indicated by ethnographic studies (Gould, Koster and Sontz 1971:49-169) and its importance has also been noted in use-wear analysis (Semenov 1964: 19-21). Wilmsen (1970:73) has also suggested that different angle sizes of flake tools are related to different functions.

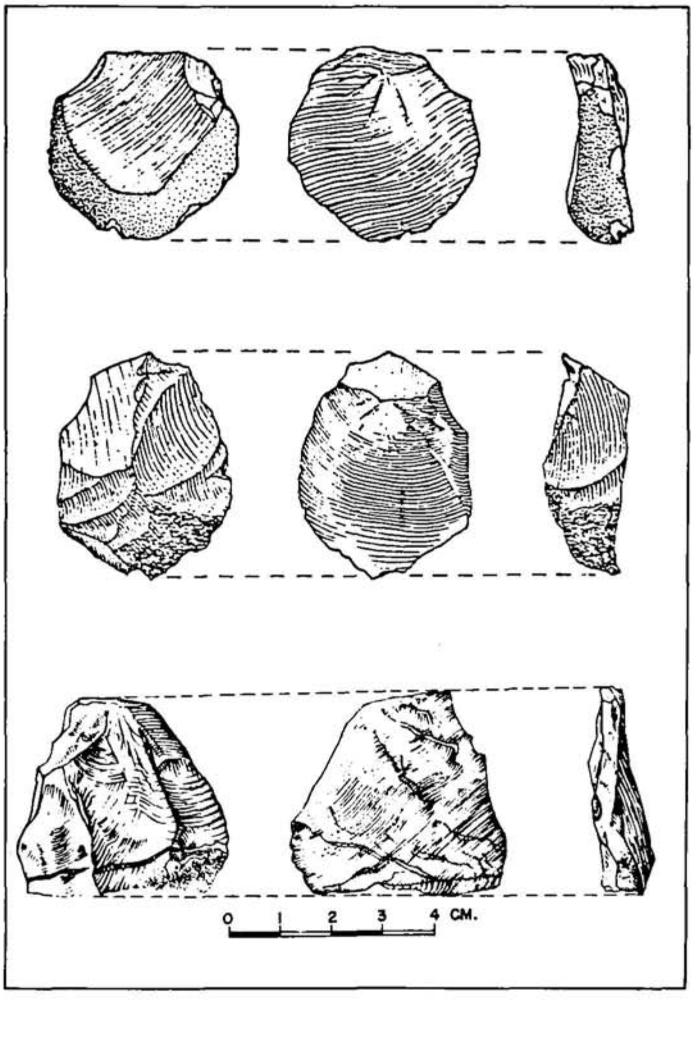
Regarding the edge angles of the utilized flakes from Rabel Cave, it is noted that the highest number of the andesite utilized flake tools (33.90%) had an angle between 30 - 39 while the highest number of the chert utilized flake tools (30.66%) had an angle between 40 - 49.

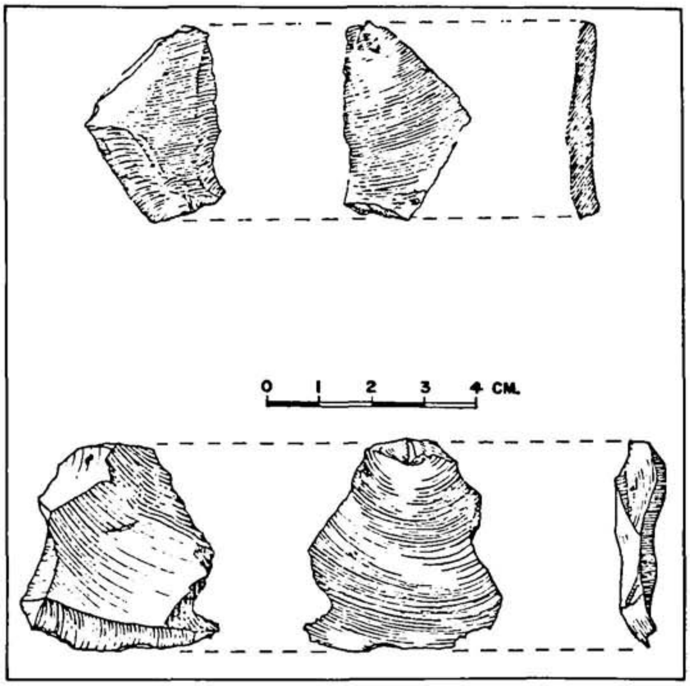
The majority of the utilized flake tools can be seen to fall between the angles of 30 - 59, 73.58% for chert and 81.48% for andesite. Following Wilmsen (1970:70-71), this would make the utilized flake tools, both of chert and of andesite, at Rabel Cave ideal for "cutting, skinning, hide scraping, sinew and plant fiber shredding, heavy cutting of wood, bone or horn and tool back blunting".

Edge Shape or Used Edge Type. It has been noted (Tainter 1979:465) that "certain edge shapes are more suitable for some tasks. In butchering, corners and straight-to-convex edges are preferred". Gould, Koster and Sontz (ibid.) have also observed that concave edges were often the results of woodworking.

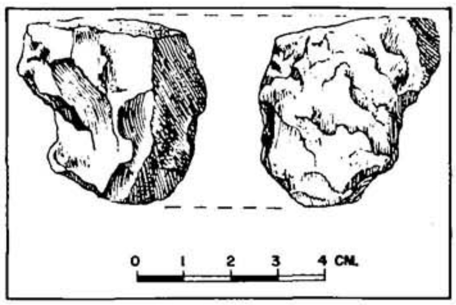
With regards to the used edge type of the utilized flake tools analyzed, the edge shapes of the majority of the tools - 70.76% for chert and 68.66% for andesite - were almost equally divided between straight and convex edges. Following Tainter (ibid.), the data

Chert Flake Tools





Chert Flake Tools



Chert Primary Core

suggest that the utilized flake tools analyzed were ideal for butchering. Only a minimum number of utilized flakes - 12. 74% for chert and 11.68% for andesite - were concave-edged, making them ideal for woodworking.

Degree of Edge Wear. The degree of edge wear was seen as patterns of modification of edges resulting directly from use. It is, thus, more important for utilized flakes than for retouched flake tools since the wear recorded in the former was not altered by subsequent retouching. The raw materials of the utilized flake tools were considered to be important factors during the analysis of this variable.

The majority of the utilized flake tools - 93.40% for chert and 94.58% for andesite - showed slight and moderate degress of edge wear. In over 60% of the chert and andesite flake tools, the degree of edge wear was slight.

It has been noted in recent experimental results regarding stone tools (Walker 1978:710-15) that for most butchering tasks the flakes with unworked edges were more efficient for the job than flakes with retouched edges. Results of experiments by Brose (1975) have also indicated that unretouched flakes do not last longer than four minutes of use in butchering activities suggesting that at sites where butchering activities took place, there will be a high density of stone tools. The high incidence of utilized flake tools of both chert and andesite at Rabel Cave - the majority of which showing slight and moderate degrees of edge wear - and the associated faunal bones and teeth of birds, bats, monkeys and pigs recovered from the excavations suggest the possibility of butchering activities at the site.

Percentage of the Used Edge. The lengths of the used edges and the diameters of the utilized flake tools were noted and recorded, and subsequently, the percentage of the used edges were computed from these two variables. In the majority of the utilized flake tools, 81-60% for chert and 76.64% for andesite, the used edges occur between 10% and 39.9% of the total tool size. Although this variable has not been considered in works on lithic use-wear analyses, it may well be useful, together with ethnographic analogy and replicative experiments, in ascertaining the manner in which flake tools were handled by their users.

Discussion and Interpetation

The results of both the technological and functional analyses employed on the lithic materials recovered from the archaeological excavations of Rabel Cave have shown different aspects important for the understanding of the original inhabitants of Rabel Cave with regards to both their skill in the manufacture of the lithic tools and also the probable uses of the lithic flake tools that they manufactured.

The technological analysis has shown the different methods employed by the knappers in the preliminary modification of the lithic materials. For chert, preliminary modification was done outside the cave while for andesite, this modification was done right at the cave. This was indicated by the difference in the andesite and chert utilized flake tools and waste flakes - with the cortex or portions of it still present on the dorsal surface of the andesite tools - and the density of unworked nodules present at the site. There were very few unworked nodules of chert as contrasted to numerous unworked nodules of andesite. The absence of regularly shaped primary cores and flakes of both chert and andesite indicates no core preparation in the manufacture of the flake tools.

The functional analysis of the lithic flake tools from Rabel Cave shows that, with regards to edge shape, two types - both straight-edge and convex-edged - were sought for by the knappers. The majority of the utilized flake tools are seen to be ideal for butchering and a minimum number, being concave-edged, are ideal for woodworking.

In Southeast Asia, there is a limited amount of work done on edge damage analysis (Gorman 1970; Hutterer 1974; Peterson 1974), the results of which suggest the prevalence of the woodworking functions of lithic flake tools. These give credence to the postulate that the lithic flake tools in Southeast Asia were complemented by a number of non-lithic and, therefore, perishable materials such as bamboo and wood (Solheim 1970; van Heekeren 1972). This maintenance role of lithic flake tools has also been documented ethnographically and archaeologically (White 1969, 1972; White and Thomas 1972; Gorman 1971).

The edge angles of the majority of the utilized flake tools analyzed fall between 30 - 59 for both chert and andesite, thus, making them ideal for a number of tasks. They may, therefore, be considered as generalized maintenance tools.

The slight to moderate degrees of edge wear on the used edges of the utilized flake tools analyzed and also the high incidence of tools at the cave site again suggest, following experimental results by Brose (1975), the possibility of butchering activities at the site. This is reinforced by the faunal bones and teeth of birds, bats, monkeys and pigs directly associated with the lithic materials.

...the lithic flake tools in Southeast Asia were com plemented by non-lithic and perishable materials...

The percentage of the used edge of the utilized flake tools, the majority of which occur between 10% and 39.9% of the total diameter of the tool, may be an indication of the non-hafted characteristic of the tools. This assertion is also supported by the presence of negative bulbs of percussion on the dorsal surfaces of the tools, thus making them adequate for handling, noted in numerous utilized flake tools analyzed. The results of the analyses of the lithic flake tools from Rabel Cave indicate that:

1. In technological terms, the technology of tool manufacture was almost, if not, identical for both chert and andesite; i.e., involving a percussion method and without any core preparation. The main difference shown by the results of the technological analysis was that the preliminary modifications of the andesite nodules were done right at the cave while that of chert nodules were done outside the cave. For both raw materials, the production of flake tools was the main object of the knappers.

2. In functional terms, the analysis has shown the generalized characteristic of the utilized flake tools thus making them ideal for a number of different tasks. The data from the results of the functional analysis give credence to the hypothesis that the utilized flake tools recovered from Rabel Cave are maintenance tools.

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(Continued on page 35)

Conservation of Historical and Archaeological Monument in Indonesia

by Samidi

Restoration of monuments in Indonesia has been carried out for several decades. Many temples have been restored since the Archaeological Service, the "Oudheidkundige Dienst", was formed. At the same time, a store of experience has been obtained. Continuous discussions on the principles and methods of restoration have been conducted among archaeologists, with the result that standard restoration methods have been firmly established.

The recent restoration of Borobudur used not only modern technology but also the previous principles and methods. Of course, some techniques were modified to systematize and to make them more practical, such as developing a registration system and precise sequences of dismantling and rebuilding.

On the other hand, conservation supported by scientific data only began with the restoration of Borobudur. Conservation science was a new branch in the area of preserving Indonesia's historical and archaeological heritage. Hence, prior to its use, conservation science had to seek a proper method that would be both effective and in

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A Buddha head on top of the Borobudur Monument.

accordance with archaeological principles.

Although principles, guidelines and methods of conservation already exist in developed countries, they could not be applied directly in Indonesia due to differences in local conditions. In general, Monumenten Ordinance 238/1931 viz. article 5, paragraph 1 was used as a guide for conservation practice. However it was not sufficient to plan the field application.

Therefore, in this paper, I will describe our limited experience obtained from the conservation of Borobudur stones during the recent restoration.

For convenience, the paper is divided into two parts: 1) Conservation of Borobudur stones during the recent restoration; 2) Discussion.

Conservation of Borobudur Stones

Since Borobudur was rediscovered in the early nineteenth century, attempts toward maintaining and clearing it have been made continuously. A partial restoration was undertaken in 1907-1911 to strengthen the corners, to ensure better drainage of rainwater, and to repair balustrade gates and stupas. From a technical point of view, the restoration can be evaluated as successful, but archaeologically, less so because a great many parts of the structure were not put back to their original places and positions.

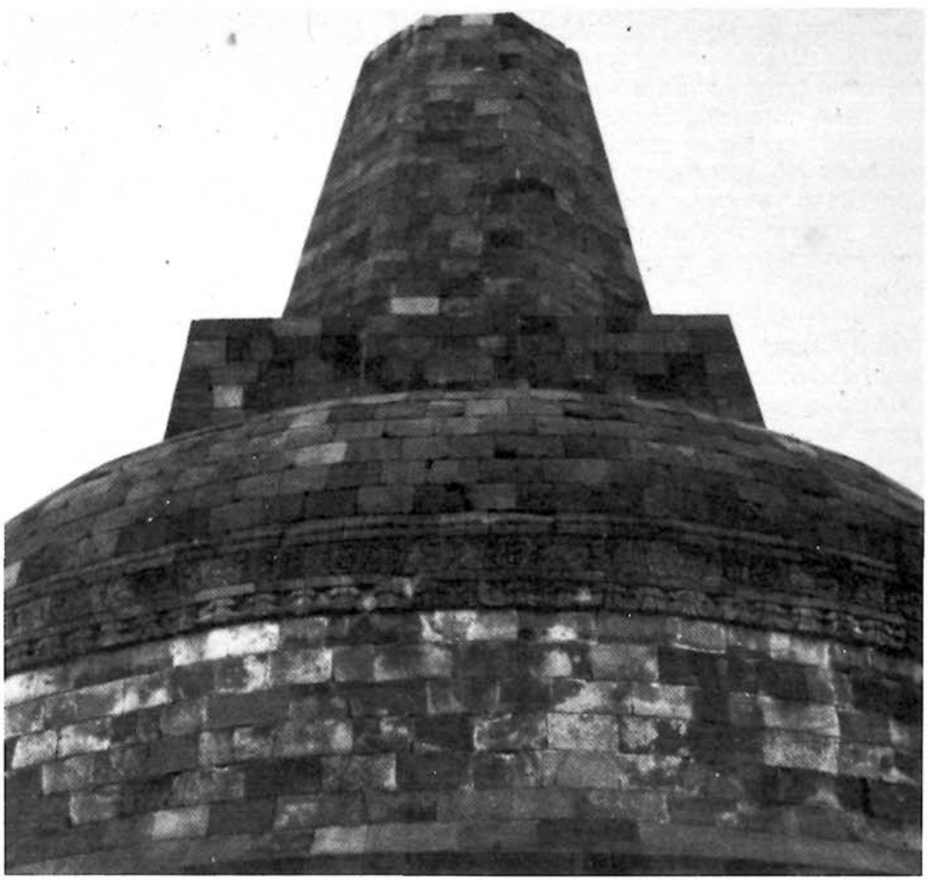
Observation during the next few decades showed that the deterioration of the stones and damage to the edifice continued unabated. A close look revealed new cracks. The coating that had been used to create harmonious color for photographing reliefs caused dilatation of the stone surface. Damage from structural tensions due to rain water that penetrated the subsoil inside the structure was observed mainly in sagging and leaning walls. The cement used in the restoration was soluble in rain water, causing harmful effects on the stones. Microorganisms grew profusely on the stones with high moisture content; and observation revealed that some of them i.e. lichens and mosses had played a dominant role in further stone deterioration.

It became apparent that the 1907 restoration had not sufficiently provided adequate protection to the monument. Another total restoration was judged necessary to achieve the goal of safequarding and preserving the monument for another 1000 years. The second restoration which was only completed this year aimed to halt the deterioration of the stone, to bring the monument as near as possible to its original state, and to take such measures as to make normal maintenance sufficient in the future in preventing a recurrence of the dilapidation.

The restoration was carried out by dismantling the structure. The stones were treated in the workshop, while in the remaining parts of the monument, activities were conducted to decrease humidity by installing reinforced concrete slabs, a drainage system, and a water-tight layer. After all the systems had been put in place and precautions had been taken, the stones of the gallery walls and balustrades were rebuilt on the levels and in the positions which, according to previous computations, represented an accurate reconstruction of the monument. In this paper, however, only the conservation practices will be discussed.

Conservation Principles and Related Research

The term "Conservation" generally refers to the subject of care and treatment of artifacts, with the goal of preventing their further deterioration. As a discipline, Conservation means the control of environmental conditions to minimize the potential decay of artifacts, treating them to arrest existing decay and stabilizing them as far as pos-



The main stupa of the Borobudur Monument.

sible against further deterioration. There are some principles of conservation that should be followed. Three of them are as follows: the procedure should be reversible so that the desired objects can be returned to the pre-treatment condition; as far as possible, the decayed parts should be conserved, not replaced; and the natural patina of objects should not be removed.

General stone conservation processes are classified into three main treatments: cleaning, consolidation, and protection[1]. This division not only arranges the processes in smaller and more manageable classes but also signifies that stone treatment should be seen as an ordered sequence of operations. Each treatment should satisfy different requirements. Conservation processes should be preceded by the identification of the deterioration processes, then cleaning followed by consolidation should be done only when they are required. Finally, protection can be applied to the stone itself as well as to the structure to modify potentially destructive factors in the environment[2].

G. Torraca, an Italian expert on stone conservation, formulated the following principal requirements for the stone cleaning process:

a. It should be possible to regulate the cleaning action at will.
b. The cleaning process must not produce any results which may cause future deterioration.
c. The cleaned surface must be, as far as possible, smooth and free from cracks and other defects that could result in the acceleration of weathering rates.

He also agrees with the principle that the function of consolidation processes must be limited to re-establishing cohesion, where the stone has lost it to such a degree that its physical survival is imperilled. Cracks must be filled and fragments which have become separated must be rejoined by the use of adhesive, so that a basic conservation requirement, i.e. that the stone be homogenous and present a compact surface to the aggressive action of the environment, can be fulfilled[3].

Furthermore, reference may be made to the International Charter for the Conservation and Restoration of Monuments and Sites — ICOMOS — 1966, which was accepted during the last meeting of the SPAFA Workshop on Techniques of Restoration of Monuments. Article no. 10 says that traditional technique for conservation can be used when its efficacy has been shown by scientific data and proved by experience. An understanding is implied here that conservation measures should be effective, on one hand, and done in the simplest way, on the other.

...materials and methods used for conservation must balance effectiveness and retention of authenticity.

Conservation measures in principle should be as effective and long lasting as possible, but must have no side effects on the stones such as changes of property, discoloration, etc. as well as on the environment. This means that materials and methods to be used for conservation must seek the proper balance between effectiveness and retention of authenticity.

The conservation of Borobudur stones is done based on the above principles. It is also in accord with requirements stipulated by archaeologists[4] To fulfil these requirements, a series of intensive studies on conservation has been carried out continuously since 1969 by Indonesian staff in collaboration with foreign experts. The objective of the studies has been to choose a proper method of conserving the Borobudur stone. The studies have also involved identification of the types of stone[5] and deterioration processes and causes plus selection of materials and conservation methods.

Parameters tested to assist in choosing materials include such matters as:

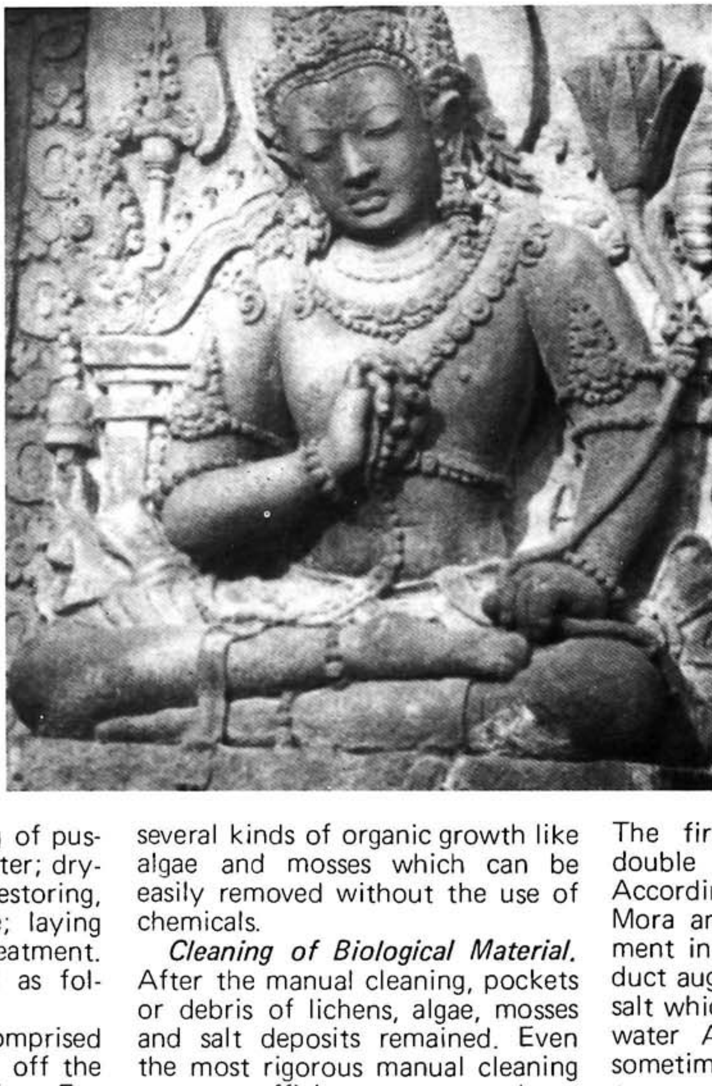
1) Cleaning and preventive treatment: effective at the lowest concentration, innocuous for the stones as well as the environment; long lasting effects in retarding the growth of micro-organisms. 2) Consolidation and repair: reversibility of the process, good adhesion; stability within its environment; possession of physical properties similar to the original stones.

Related Studies

It is necessary to point out that the previous investigations proved that the use of cement produced dangerous effects on the stone of Borobudur. That was why in the recent restoration, it became necessary to change the adhesive used in stone repair from portland cement to synthetic resin.

The studies have been carried out in the laboratory as well as in situ for comparative purposes, since conservation measures have not always been successful. Thus the use of "caution" in their application is appropriate. Chemical products which seem good under laboratory conditions, for instance, may prove ineffective or harmful in practical use owing to environmental factors affecting the condition of the stones. In this connection, data on the environmental conditions to which the monument is exposed such as thermic ranges, relative humidity, rain, direction of the wind and sunshine have also been recorded.

Results of the studies have revealed that cleaning is necessary to eliminate microorganisms as well as other deposits resulting from deterioration processes or from the environs of the monument. Cleaning should be done as far as possible in the simplest way, only by using water. The use of chemicals is acceptable only when water proves to be insufficient. When used, they should be thoroughly washed off later. Consolidation by means of impregnation is considered to be unnecessary, since the stones are still strong enough. The separated fragments only have to be repaired and rejoined. Of course, preventive treatment has to be performed on the cleaned and repaired stones also. This Conservation process used for the Borobudur stones are elucidated in the succeeding paragraphs.



Conservation Practise

The dismantled stones of Borobudur were transported from the monument to the buffer storage for further determination of their order of conservation. When the stones arrived in the workshop, they underwent diagnosis for which purpose a treatment card was prepared. For practical reasons, the diagnosis was not oriented toward the type of deterioration, but directly to the type of treatment which needed to be done. The types of treatment comprised: dry cleaning; wet cleaning-manual cleaning, cleaning of biological material, cleaning of salt deposits, scraping, cleaning of pustules, and washing with water; drying, dowelling, filling, restoring, injection, and camouflage; laying out, and preventive treatment. These steps are described as follows:

Dry Cleaning This comprised several activities: scraping off the cement used by the Van Erp restoration and the clayish deposits on the sides of the stones only, by using compressor driven tools or hand tools. The deposits were carefully removed in order not to damage the stone; removal of organic growth i.e. higher vegetation like spermatophytes, pteridophytes, moss etc. by a wooden spatula or by hand; and removal of paint used in registering the stones during the dismantling with Aceton, or benzene.

Wet Cleaning. The stones were cleaned by washing them with water, brushing, and applying chemical when necessary.

Manual Cleaning. Stones were washed with water and brushed with *ijuk* (palm fiber) brushes to remove dust, remains of clay and several kinds of organic growth like algae and mosses which can be easily removed without the use of chemicals.

Cleaning of Biological Material. After the manual cleaning, pockets or debris of lichens, algae, mosses and salt deposits remained. Even the most rigorous manual cleaning was not sufficient to remove them, especially the debris. To facilitate the disposal of organic remains, a mixture of chemicals (called AC 322[7]) developed by P. Mora and L. Mora was used.

The chemicals were mixed together, and then a quantity of clay was added to form a paste. The paste was applied to the organic remains by means of a brush to a thickness of approximately 0.5 — 1 cm. and was allowed to remain for 24 hours. After that, it was removed by means of spatula, and at the same time, brushed off and rinsed with water.

Cleaning of Salt Deposits. Salt deposits were found on the surface of the reliefs, in the cracks or at the joints of the stone blocks. Sometimes the deposits appeared to have covered Van Erp's coating. Deposits, mainly consisting of salts of silicate and carbonate, were found by chemical or biological processes. In some places, salt deposits formed through concretion, efflorescence, and subflorescence.

Total cleaning of salt deposits was impossible since they were much harder than the stone and highly compact. Moreover, such an endeavor would be technically very difficult and even harmful to the stone itself. Nevertheless the occurrence of salt deposits had to be reduced, especially the salt which totally covered the surface and plugged up the pores, to allow the evaporation of moisture.

To remove soluble salt, several methods were used. The first method, which had a double function, used AC 322. According to the experiments by P. Mora and L. Mora on stone treatment in Europe, this chemical product augments the solubility of the salt which was the washed off with water Another method which was sometimes applied was the use of paper pulp or demineralization through a water bath.

Scraping. Scraping of salt concretions was done in order to have a good and seamless jointing of the stones. The salt concretion was removed by means of a spatula or other tool until a very thin layer of the deposit remained. The cleaning operation had to be stopped at that stage; otherwise the stone itself would be damaged.

Cleaning of Pustules. Pustules which are sometimes called "stone cancer" result from a combination of biochemical deterioration process. Alveoli resulting from disintegration were sometimes penetrated by algae and mosses. At times also, their surfaces were covered with salt concretions due to the dissolution of the calcareous material inside the structure. Once this happened, one saw only the hardened convex surfaces of the stones, called pustules. If the pustules expanded, they could produce further dilation. Hence pustules ought to be cleaned by opening them and eliminating the microorganism inside manually as well as chemically.

Washing with water followed the whole cleaning operation as well as the final washing itself. In order to avoid any environmental pollution, a chemical deposit tank had been installed to collect the wash water. To ensure that no chemical was left on the stone, the restorers examined the P.H. of the wash water. If the p.H. was still 8 or higher, the cleaning was repeated until the p.H. became neutral. The organic growth and other remains had to be thoroughly washed off to prevent recurrence of the biological deterioration of the stone.

Drying. After all cleaning operations had been conducted, the stones were stacked in a drying chamber with a temperature of 40 C for 2-3 weeks to render them dry before being repaired. Drying was necessary because the adhesives used for repair were synthetic resins.

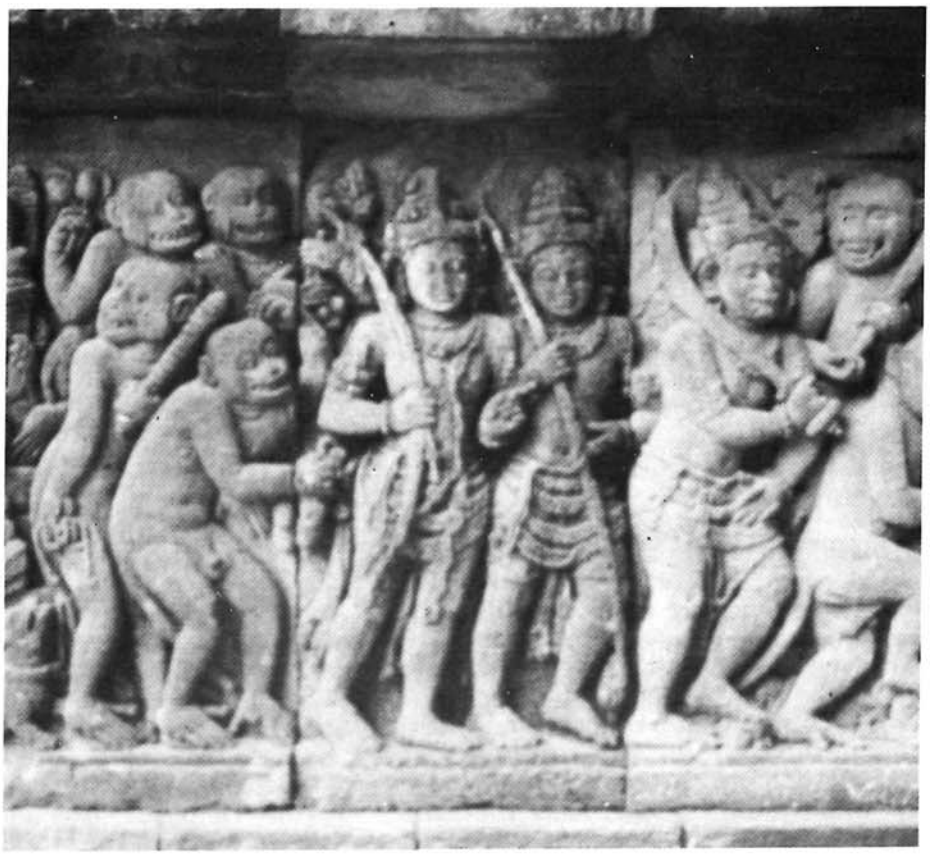
Repair. After the stones became dry, they were transferred to the repair room. Checking was done here to ascertain which stones needed repairing and what kind of repair ought to be made. Stone repairs comprised the following.

Bonding/Fluing: Stone fragments could be bonded to their mother block with the help of thermosetting adhesives. If the broken stones had been temporarily bonded with thermophastic adhesive U-HU during dismantling, they were separated from one another first by means of an Aceton solvent, which also removed the U-HU. The thermosetting adhesives used were:

- *Davis Fuller 614*
  - Composition: Epoxy resin Proportion of the resin and its hardener 4:1 (p.b.v.)
  - Pot life : 1–2 hour (25 C)
  - Drying time : ±4 hours (25 C)
- *Akemi Stein-U Marmorkitt Universal*
  - Composition : Resine: Polyester Hardener: Ben zoyl peroxyde Proportion: 100:3 (p.b.v.)
  - Pot life : 5 minutes (25 C)
  - Drying time : 40 minutes

The kind of adhesive to be used depended on the volume of the broken stone. Small stone fragments were glued with Akemi which set after 40 minutes, since pressing with a carpenter's press could not be done. Large stone fragments had to be bonded with Davis Fuller because the work took a longer time to perform.

The use of Davis Fuller 614 required a setting time of 3–4 hours. Proper measurement of the proportion of each component of the adhesives during the mixing was imperative in order to obtain the proper mixture. The adhesives were spread out thinly on both broken surfaces; afterwards, the fragments were matched and held together by a carpenter's press during the curing time.



A bas-relief along the lower wall of the Monument.

Dowelling: This method is almost identical to bonding. If the broken stone had technically to carry a heavy load in the structure of the monument, a dowel had to be inserted. On both broken surfaces, a hole was drilled and a brass dowel with rough surfaces (with a diameter of 0.5 cm. to 2 cm. and a length of 8-20 cm.) was inserted in the holes simultaneously as the adhesive mortar was poured. The traditional technique had used iron dowels but experience showed that they rapidly oxidized. That was why they were replaced with brass in the Borobudur Project.

Filling: As a result of stone deterioration, alveoles of the pustules or other holes appeared on the surface of the reliefs. It was necessary to fill up these holes to prevent further deterioration of the stone; they were filled with the same resin mixed with stone powder; at the same time, camouflage work was done on the surface.

Restoring: Restoration of some parts by substituting a new stone for a missing one was done only if necessary. In doing this, technical and archaeological factors were taken into consideration. The new stone had to be petrographically similar to the old one. Restoring was done by placing the new stone in the vacancy left by the missing one. The new stone was bonded with adhesive and carved only with the outlines of the reliefs to preserve the geometric image, to retain their aesthetic value and to insure that the archaeological structure was not violated.

Injection: Fine or very fine cracks often appeared in the stone while the affected part was still attached to the stone block. These were remedied by using a very low viscosity resin, injected into the cracks by means of a syringe. Since this method was difficult to carry out, the cracked portion was usually broken up carefully and the pieces, bonded or dowelled. Another method used which did not include breaking the stone was drilling a hole in the stone cross-section-wise and filling the bore-hole with resin and a dowel.

Camouflage: Camouflage was done only when the joint of the repaired fragments was not close. Its purpose was to smoothen the joints, to fill the cracks, and to make their texture, lustre and colour similar, or at least not in contrast with the whole surface of the stone. Camouflaging was done only after the resin of the joints had passed its setting time. The technique of camouflage could be described as follows:

The effect of the preventive treatment lasts approximately one year.

The surface is thinly coated with the resin, followed by the application of a mixture of the same resin and stone powder. Colouring agent could be used if necessary. The granulometry and colour of the stone powder should match those of the stone that is to be repaired. The camouflaged surface is then covered with the same stone powder, when the resin mortar is near setting time. After the setting time of the resin passes, the stone powder which has not adhered to the resin is wiped off.

Laying out. This meant a temporary reconstruction of several contiguous stones to facilitate and increase precision of repair works. It was carried out only if necessary.

Preventive Treatment. After cleaning and repair work had been finished, the stones were checked again. Sometimes, a stone was cleaned or repaired anew. Afterwards the stones were treated with Algicide, Herbicide, or Fungicide[8] to protect them from organic regrowth during the time they were kept in final storage. The method of application varied from spraying and brushing to injection depending on the condition of the stones.

Continuing Conservation Work

Our experience in the conservation of Borobudur stones showed that the materials and methods used were satisfactory. The stones that had been cleaned with the chemical mixture AC 322 were freed from dirt yet preserved their old appearance, since the patina was not disturbed. The effect of this preventive treatment with pesticides can last approximately one year. It is normal since the monument stones, after rebuilding, are again subject to rain water; without preventive treatment, however, regrowth of micro-organism occurs after one month. Since the chemicals are thoroughly dissolved by the rain during the rainy season, several chemical deposit tanks have been installed at the slopes of the hill beneath Borobudur to prevent environmental pollution. To ensure continued protection of the stones, the conservation staff has scheduled routine maintenance measures comprising manual and chemical treatments. Several chemical preservatives rather than a single product will be alternately used to avoid the possibility of micro-organic immunity.

In general, the growth of micro-organisms on stones since their restoration has been limited only to algae and mosses. The optimal humidity of the surroundings promotes fast growth of these micro organisms. The watertight layers seem to be functioning well; on the superficial level, however, the stones are still affected by air humidity as well as run-off of the rain water.

As concluded by Mr. Soediman in his paper[9], continued observations of the results of the conservation will be necessary. The observations will include a study of possible negative effects of the chemicals if used for a long period as stone preservatives. In addition, but much more important, they will also determine alternative patterns for instituting proper long-term preservation maintenance.

The application of Silicone resin as a surface coating to produce water repellency against rain water is still being studied. The high porosity of some stones requires that the study be done. It is necessary to ascertain that silicone resin will not produce any harmful effects, such as detachment, on old stones.

The result of the repair using thermosetting resins is quite good because they possess good adhesion and mechanical properties. In addition, they are also resistant to changes caused by the environment. The thermosetting resins are also viscous enough not to penetrate into the pores of stone. This permits re-breaking of fragments if necessary making the repairing process still reversible.

Note

1 This was introduced by the Working Group of ICOM – ICOMOS – ICCROM during its meeting in Bologna, October 1971. (See G. Torraca, "Treatment of Stone in Monuments: A Review of Principles and Processes", in *The Conservation of Stone I.* Proceeding of the International Symposium, Bologna, June 19-21, 1975, pages 297-316).

2 Protective steps taken to modify destructive factors of the environment on Candi Borobudur include the installation of concrete slabs, filter layers, drainage pipes, and water-tight layers. Since these subjects have been elucidated in the paper of Mr. Soediman, they will not be discussed here. (See *Evaluation of the Recent Restoration of Candi Borobudur,* chapters 2 and 3).

3 G. Torraca, ibid.

4 See also Mr. Soediman, *Evaluation of the Recent Restoration of Candi Borobudur,* page 3.

5 It is necessary to note that Borobudur stones are volcanic rock of andesite type. Their porosity varies from 21 to 51%, and their compressive strength varies from 5-7 according to Mohs scale.

6 A list of materials tested for conservation appears next page.

7 AC 322 was composed of:
Ammonium Bicarbonate 30 gr
Sodium Bicarbonate 50 gr
Carboxymethyl Cellulose 50 gr
Disodium salt of Ethylene Diamine Tetra Aoetic 25 gr
Disinfectant 3 ml
Water necessary to reach the volume required 1 litre

8 The chemicals used for preventive treatment are: algicide : Proven Hyamine
fungicide : Quat Dimanin A
herbicide : Hyvar X
The concentration used varied from 1 to 3%, according to the biological population. Their chemical compositions can be seen below

9 691.421.666.71.
See also Mr. Soediman's paper, chapter 5.

LIST OF CHEMICALS TESTED FOR CLEANING AND PREVENTIVE TREATMENT OF BOROBUDUR STONES

No.	Commercial Name	Type	Basic Composition
1.	Benzalkon	Algicide-fungicide	Ankyl dimethyl benzyl ammonium chloride
2.	Curitan	Fungicide	Dequadin (Iodine lauryl quanidine acetate)
3.	Formaline	Bactericide-fungicide	Formaldehyde
4.	Hyvar XP	Herbicide	5 bromo-3 sec. bulyl -6-methyl urocil (bromacil)
5.	Hyvar XL	Herbicide	Lithium salt of Bromacil
6.	Iosan	Herbicide	Iodophor formulated with phosphoric acid
7.	Karmex	Herbicide	3-(3.4-dichlorophenil)-1.1-dimethyl uracil
8.	Muslick	Herbicide-fungicide	**
9.	Nabasan	Herbicide-fungicide	Disodium ethylene bis dithiocarbonate metalic sulfates
10.	Noranium	Algicide	Alkyl dimethyl benzyl ammonium chloride
11.	Preventol O Extra	Fungicide-bactericide	Orthophenyl phenolate
12.	Preventol O.N.	Fungicide-bactericide	Sodium orthophenyl phenolate
13.	Preventol P.N. *	Fungicide-bactericide	Sodium penthachoro-phenolate
14.	Proven	Algicide	Aryl alkyl trimethyl amonium chloride and sulfur dispheyl halogen
15.	Quat	Fungicide	Alkyl dimethyl benzyl ammonium chloride
16.	S 66		**
17.	Tordon	Herbicide	4-amino-3,5,6-trichloropocolinic acid and 2,4-dichlorophenoxy acetic acid

No.	Commercial Name	Type	Basic Composition	No.	Commercial Name	Type	Basic Composition
18.	Vancide 26	Bactericide-fungicide	Lauryl Pyridium 5 chloro-2 mercapto benzothiazole	22.	Ac 322	Cleaning agent	(See text)
19.	Vancide 26 EC	Bactericide-fungicide	Lauryl Pyridium 5 chloro-2 mercapto benzothiazole	23.	Hyamine	Bactericide-fungicide	Dodecyl tetradecyl hexadecyl dimethyl benzyl ammonium choride
20.	Vancide 51	Bactericide	Sodium dimethyl dithiocarbamate and Sodium 2 mercapto benzothiazole	24.	Dimanin A	Bactericide-algicide	Quartenary compound
				25.	Direx	Herbicide	Diuron
21.	Sodium Hydroxide	Alkaline	Na OH				

**The composition is not known.

LIST OF SYNTHETIC RESINS TESTED FOR REPAIR OF BOROBUDUR STONES

No.	Commercial Name	Type	Ratio of the resin and hardener	No.	Commercial Name	Type	Ratio of th resin and hardener
1.	Akemi Normal	Polyester resin	100 : 3 pbw	7.	Araldit GY 257	Epoxy resin	100 : 18 pbw
2.	Akemi Extra	Polyester resin	100 : 3 pbw	8.	Epasfill PT 521 SL	Epoxy resin	3 : 1 pbv
3.	Akemi Universal	Polyester resin	100 : 3 pbw	9.	Davis Fuller 614	Epoxy resin	4 : 1 pbv
4.	Sinmast P 203	Epoxy resin	3 : 1 pbv	10.	Davis Fuller 609	Epoxy resin	1 : 1 pbv
5.	Araldit AW 106	Epoxy resin	100 : 80 pbw	11.	Instant Resiweld	Epoxy resin	1 : 1 pbv
6.	Araldit XB 2697	Epoxy resin	100 : 33 pbw	12.	Durox 628	Epoxy resin	147 : 53 pbw

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Conservation of The Sukhothai Monuments

by Chiraporn Aranyanak

Most of the ancient monuments in Thailand are in a deteriorated state. Two of the most important factors contributing to this are the environment and climatic conditions. Since Thailand is located in the tropics, high humidity which accelerates the biological activities of various objects is ever present. In addition, moisture also hastens the deterioration processes either physical, chemical or biological.

A survey of the condition of the Sukhothai monuments has indicated that all monuments were mostly damaged by various types of microorganisms and higher vegetation i.e. fungi, bacteria, lichen, algae, ferns, selaginella, grass and other dicots. Their growths not only obscure carving and details of the structure but also affect the stability and durability of the monuments.

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Fungi and bacteria, when present on porous building materials, transform the inner constitution of the materials and also utilize organic matters in some for their nutrients. They not only weaken the materials on which they grow but also produce stains from the metabolic reactions. Some microorganisms produce organic acids of numerous types, for instance, citric acid, oxalic acid, gluxonic acid, etc. which are very harmful to building materials.

Fungi and bacteria may be found in greater or lesser numbers in the soil, water and air over a large part of the earth's surface. Their spores are present in the atmosphere all the time, but generally remain dormant. They become active and start developing as soon as conditions of humidity and temperature favourable to their growth occur. It has been found that the number of microorganisms (cells per gram) is greatest in the rainy season.

Algae are closely related to bacteria and fungi. They possess chlorophyll and are thus able to synthesize their own food. Most of the algae found on the Sukhotai monuments are bluegreen algae. The rest are green algae, diatom, netrium and others. Some algae can convert nitrogen from the atmosphere into nitrogen compounds similar to bacteria. Their dead tissues are the sources of carbon, nitrogen and other growth factors of organisms including higher plants.

Mosses, lichen, hapaticeae, liver-

Details of some parts of the Sukhothai Monuments.

worth, ferns, grasses and other dicots have also been found in every monument. The growth of these plants in building materials severely damage the foundations and walls. Seeds are often deposited in the joints surface through the droppings of birds and bats; their roots penetrate towards the interior and grow slowly inside, separating and detaching structural elements of the wall.

Control of microorganisms

Since biological growth of microorganisms is always associated with moisture retention, the damp-proof course together with mechanical and chemical methods are efficient means of preventing the development of vegetation in the monuments. Mechanical control involves the use of tools such as hoes, spudders, scythes, mowers, etc. for physically lifting or cutting the plants from the surface. However, weeds should be controlled before emergence or when they are small. Biological control can also be done for certain plant species when grown prevent the spread of some weeds.

Many chemicals of varied properties which affect biological growths are available. However, care must be taken to select those which are non-toxic to both man and animals and do not act upon the building materials. At times, these chemicals must be rotated or mixed in order to broaden the spectrum of weeds and microorganisms that they eliminate.

It has been observed that the number of microorganisms and weeds is greatly reduced after the application of biocides. It becomes doubly effective when the monuments or the surface of the building materials have been cleaned prior to the application of the chemicals and when this is done in late summer when the plants and microorganisms have very little stored food.

The type and concentration of the chemicals used depend upon the species of microorganisms and weeds, the properties of the building materials and the location of the monuments.

Thai Paintings of Wat Hong Rattanaram, Bangkok Yai

by Kulpanthada Janposri

Thai paintings in the Wat Hong Rattanaram generally depict the life of Buddha and the Ramakian. They number 57 paintings which are divided into 19 sets, a set comprising three paintings under one frame. Thai famous painters and art historians have concluded that the paintings date back to the beginning of the reign of Rama IV. This is evident in the architectural style used and the presence of modern objects in the art work such as optical lenses, book racks and western flags.

These are tempera paintings. The paints used are a combination of a binding medium, vegetable glue, and pigments. The pigments employed are lead white, red ochre, vermillion, red lead, yellow gambodge, yellow ochre, malachite, verdigris, prussian blue, carbon black, gold leaf and indigo blue. Most of them are mineral pigments with a few, like the yellow gamgodge, organic dyes. The paints are applied in a typical Thai handmade paper, popularly known as *koy*.

The author works as Head of Conservation Section, National Museum, Department of Fine Arts, Thailand.

By their very nature, these materials are all subject to deterioration.The paper being porous absorbs moisture which hastens its disintegration. The same moisture loosens the binding property of the glue which is water soluble for holding the pigments. Moreover, high level humidity causes the growth of microorganism on both the surface and the backing of the painting. The acidity of the paper and the other materials used for mounting like wood and pieces of leather has also a harmful effect on the painting.

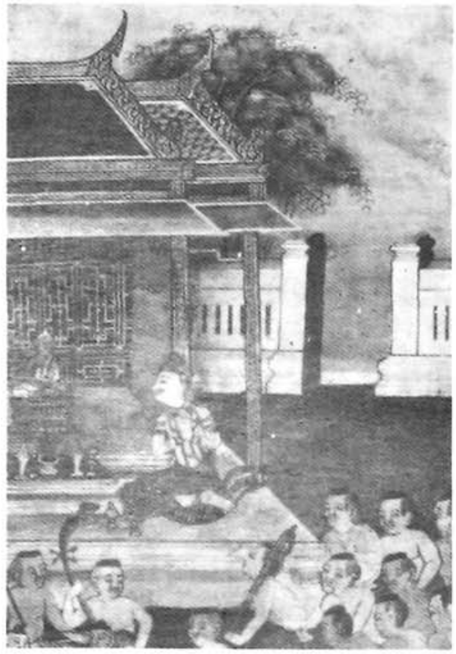
The effects of these factors were apparent in the paintings in Wat Hong Rattanaram. The paintings were brittle and patches of mold and water stains were visible in some parts. A film of dust also covered them. The layers of paint were peeling; in some parts, they became powdery owing to the loss of adhesion force between the layers of paint and the paper and the lack of cohesion among the pigments.

To preserve these paintings, the conservators implemented the following steps: fumigation, cleaning, reinforcement of the paper support and retouching. The fumigation was undertaken using the vapour of formalin. It proved effective in counteracting the effects of the molds. Each painting was cleaned with a soft brush and a rubber blower to clear away the dust. Hydrogen peroxide in ether was applied in each to remove the stains caused by molds and water. Since the paper had become brittle, fragile and torn, the backing was reinforced. A Thai handmade paper called *Sa* was used for this purpose. It was glued with the polyvinyl acetate emulsion, a glue found to be flexible, biologically resistant and non-toxic. It also had enough adhesion and cohesion forces to hold all the elements together. Retouching was done in parts where the layers of paint were damaged or missing with pigments and glue that were carefully chosen to approximate the original.

The restoration work revealed that the pigments used in the paintings were different from those used in the older paintings in other parts of Thailand. Hence, recommendations were made to do further investigations of paintings done at the same time the Wat Hong Rattanaram paintings were executed to determine whether the same finding would be uncovered.

Before conservation, the painting was faded and moldy.

The back shows the disintegrating mounting paper.



After conservation, the details of the painting became more apparent.

The painting before removal of glass.

The back of the painting was also in a sorry state.

The painting after the removal of glass

After conservation

Problem of...

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SAAAA Affairs

Ethnic Music Research Conducted

In connection with the SPAFA Programme on Research and Documentation of Ethnic Music, field researches were planned in the three participating member countries. The Philippine portion of the study was conducted in Sadanga, Mountain Province, last year. In Thailand, research is ongoing among the Phuthai of Northeast Thailand. The field research in Indonesia will be done next year.

The research aims to gather information from the sample areas that will be necessary in preparing an annotated bibliography on ethnic music. To prepare for the eventual recording and analysis of the indigenous music of the sample regions, the researchers also observe and participate in village events, attend musical performances and acquaint themselves with the people and the environment. Documentation is also done on the use and range of musical instruments.

Actual research and documentation work is the second stage in the three-step programme on the SPAFA documentation of ethnic music. The first involved training of personnel who in turn, as in the case of Thailand, conduct the second documentation phase. A consultative workshop on results of the researches and the documentation of ethnic music in the three participating countries will wind up this programme.

Dr. Jose Maceda acts as project leader. In this capacity, he directed the training aspect and is now supervising the research phase.

The Training

The Training Course in Field Music Research was conducted at the College of Music, University of the Philippines and at Sadanga, Mountain Province on 1 April—31 May 1983. It was divided into two parts: an introduction to the theory and method of music research and fieldwork.

Mountain people express their feelings and ask for favors through dance.

Lectures on anthropology, folklore, linguistics and ethnomusicology, made up the first part. Dr. Arsenio Manuel gave a lecture on the prehistoric Southeast Asian traditions – folklore and literature, religion, epic, ballad and song. Dr. Ernesto Constantino described the austro-asiatic languages, particularly the austronesian, and compared the morphology of the Tagalog and Thai languages. He also gave pointers on how to analyze the line structure of songs like the ***ullalim, parang sabil, guman*** and ***gembatetu.***

The various approaches to ethnomusicology were expounded by Dr. Maceda. He discussed the contemporaty music studies and traced the spread of music in different Southeast Asian countries through trade and commerce. He also gave a demonstration on how to transcribe song-texts with special attention on its concomitant problems. His lectures also covered a description of the music instrument in the region and some musical elements like drone, melody and scale formation.

Sadanga Field Study

The field work conducted in Sadanga, Mountain Province, provided the trainees the opportunity to do an ethnological survey and to put into practice the various methods of research that will be used - musical inquiry, text transcription, translation and transformation of recorded voice music into written forms. They worked closely with the community - public elementary school teachers, government employees and students who acted as their guide, translator, informant and transcriber.

The participants were divided into three groups, each group studying a particular aspect of the music culture of Sadanga. Group 1 concentrated on the ***pangis*** (traditional female dormitory), the ***Paanap*** (cure of the sick), and the ***sokkaidan*** (ritual for rain). The second group observed the ***ator*** (traditional male dormitory), the ***padin*** (peace pact) and the ***papatayan*** (sacrificial place) while the third group did work on the ***agamang*** (granary), the ***chono*** (third stage of a marriage celebration) and the ***adog*** (death).

They used the workshop format to discuss their findings and observations. Each group submitted an oral and a written report. At present, the written reports are being refined and edited for presentation at the consultative workshop and eventual publication. The cassette recordings will also be analyzed and edited for production of a long playing record.

The participants to the training course were as follows: Indonesia-Mr. Santosa and Mr. Sunarto; Thailand — Mr Udom Aroonratana, Mrs. Orawan Bangchongsilpa and Mr. Umnuay Banluewong; and the Philippines - Mr. Restituto M. Bangaoil, Mr. Theodore Quiling, Ms. Doris V. Salcedo and Mrs. Helen Tejero.

The research coordinators were Mr. Manuel Gonzales, Jr. and Mrs. Marialita T. Yraola.

Thailand Field Research

The Thai portion of the study started in December with a field work in Phon Sawang, Kutsimkumai, Kow Wong and Phanna Nikhom. The research team gathered research materials needed for the planned bibliography and collected information on the important festivals and rituals in which the researchers could participate in their succeeding field trips to record data related to the music culture of the people. The team also compiled ethnographic studies on the Phuthai. All this information served as basis for the planning of future activities.

The research team is composed of the following: researchers — Mr. Udon Aroonratana, Mrs. Orawan Bangchongsilpa and Mr. Umnuay Banluewong; co-researchers - Mr. Veerachart Premanong and Mrs. Lucia M. Thangsupanich; consultants - Mr. Kovit Kantasiri and Mr. Charoenchai Chonpairoj.

SPAFA, Unesco Implement Pilot Project on Labanotation

The SPAFA Coordinating Unit and the the United Nations Educational, Scientific and Cultural Organization (UNESCO) are collaborating in the implementation of a pilot project on the promotion and preservation of the traditional performing arts in Asia and the Pacific. It involves doing preparatory work for the adoption of the 'Labanotation' system as a means of documenting the traditional dances in the region.

The pilot project aims to consolidate information on basic dance positions, dance terms and dance structures and to prepare a certain number of dance vocabularies and set pieces which will be recorded in videotapes. This is the first phase of a three-pronged project on the use of the Labanotation System to record traditional dances recommended for implementation by the participants to the SPAFA Technical Workshop to Work Out a System of Documentation for the Traditional Dance and Dance Drama held in Jakarta on 18-28 July 1983. The other two phases cover the actual training of would-be dance documentalists on the use of Labanotation and the conduct of an evaluation to determine its effectiveness.

Five countries will participate in the project: the three SPAFA member countries through their SPAFA Sub-Centres — Indonesia, the Philippines and Thailand — which were its proponents and, on the recommendation of UNESCO, India and Japan which will represent South Asia and the Pacific. The implementors of this project in the various countries are encouraged to share experiences and exchange relevant information to facilitate and enrich their work.

Scheduled to last for eight months, the pilot project will be finished in June 1984. Unesco is providing partial funding for the project. SPAFA which prepared the project proposal and organized the activities monitors the project.

Indonesian, Philippine Experts Visit Thailand

As part of a continuing SPAFA programme of exchanging information on selected areas of studies in archaeology and fine arts among experts in the SPAFA member countries, the Thai SPAFA Sub-Centre played host to delegates from the Philippines and Indonesia early this year.

Dr. Virginia F. Agbayani and Assistant Professor Ginny Dandan of the Philippines came on 21-29 January 1984 to discuss and exchange viewpoints on present day needs and curriculum designs of art education. They did work with the following Thai participants: Associate Professor Aree Soothipunt, Mr Thongchai Rakpathum, Associcate Professor Anuvit Charernsupdul and Assistant Professon Sone Srimatrang. The group held small workshops with art education teachers of Thailand's various universities and colleges and visited the different cultural centers in Ayutthaya, Chiang Mai, Ratchburi, Phetchaburi and Sukhothai.

Indonesian dance experts, Dr. Soedarsono and Mr. Ben Suharto, arrived in Bangkok on 12 - 18 February 1984. They were joined by their Thai counterparts, namely: Dr. Surapone Virulrak, Associate Professor Denduang Phumsiri, Mrs. Sathaporn Sonthong, Mr. Chaturong Montrisart, Mrs. Somboon Suksanguan and Miss Saovanut Bhuvanit in conducting dance workshops in selected universities and colleges of Thailand. The visit was aimed at providing an opportunity for the experts in both countries to update each other in the status of their respective traditional performing arts, especially their teaching-learning aspect.

Nicolas, Phothorn Sirichai Receive Scholarship Grants

Three National Museum staffmembers, one from the Philippines and two from Thailand, have been awarded scholarships under the SEAMEO Centre Staff Development Programme.

Mr. Norman Nicolas of the Philippines, a recipient of a French government fellowship award, is enrolled at the Underwater Archaeology Centre in Marseilles, France for a three-month training. It started on 1 May 1984.

A Thai, Mr. Phothorn Bhumadhon, who works at the National Museum in Lopburi, Thailand, is undergoing training in museology at the Musee Guimet in Paris. He has been there since November 1983 on a six-month scholarship grant from the Government of France. Mr. Sirichai Wangcharoentrakul, another Thai, is a grantee of the Government of Australia since 1981. He is currently enrolled in the Master of Applied Science (Chemistry) programme at the Western Australia Institute of Technology in Perth, Australia.

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