KHOK PHANOM DI: THE RESULTS OF THE 1984-5 EXCAVATION

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Many members of IPPA visited Khok Phanom Di in April 1985, and this brief report fulfils a promise then made to keep them informed of progress. It was mid April, shortly after the above visit, when we decided to continue with the excavation until completed rather than to call a halt with the onset of the rains and recommence in November. In the event, we continued until natural was reached, in late July, at a depth of 6.8 m. We were drawn to Khok Phanom Di for many reasons. It is clearly a site capable of illuminating many of the silent pages of Southeast Asian prehistory. Thus, the drowning of the Sunda shelf involved much loss of land and doubtless the destruction of a host of prehistoric sites. The broad facts of the sea level changes are now known, although events will have differed markedly in different parts of Southeast Asia. The late Pleistocene shoreline was 40-60 m lower than at present. A series of fluctuations saw the level rise from -13 m to +4 m between 6000- 4000 BC, and a series of oscillations on a downward trend then saw the sea level fall to +2.5 m by 2000 BC and +0.5 m by AD 200 (Geyh, Kudrass and Streif 1979, Tjia 1980, Tija *et al.* 1983). Khok Phanom Di, which is now located about 22 km from the present coast (Figs 1 and 2), was occupied when the sea level was higher than today and it therefore reflects a marine adaptation with presumably very ancient roots. To judge from the dated changes in sea levels, occupation was, apart from the uppermost occupation horizon which postdates the local decline in sea level, confined to the period between *c* 4000-1000 BC.

We felt it probable at the outset of our research that the site was located near a mangrove-fringed shore, and that there would have been access to fresh-water marshland behind the coast-line. There seemed no reason why we should not expect to find the remains of plants, and naturally anticipated that rice would be among them. Having been disappointed in earlier quests for the original steps towards rice cultivation in the uplands of Mae Hongson and the piedmont margins of the Khorat Plateau, it seemed possible that the margins of the major river valleys of South-east Asia might provide evidence for early plant manipulation. Test excavations undertaken at Khok Phanom Di by Damrongkiadt Noksakul and Pirapon Pisnupong had revealed the presence of human burials and pottery in addition to marine shellfish and crustacea, so the possibility of understanding the nature of the coastal occupation during the period of marine transgressions was presented.

The excavation involved the removal of about 700 m^3 of material, and we were resolved to recover as many biological data as possible, through the use of a flotation chamber under the direction of Gill Thompson. In the event, she identified not only plant remains, but also small gastropods and microfauna. Meanwhile, one of us (Bernard Maloney) was involved in a statistical analysis of the modern flora on and around the mound as well as the extraction of fifteen cores for sedimentological and palynological analyses (see below).

THE EXCAVATIONS (C.F.W.H. and R.B.)

Khok Phanom Di is highest at its margins, because the latest prehistoric inhabitants proceeded to the edge of their village to fire their pots. We chose to excavate near the centre because of its

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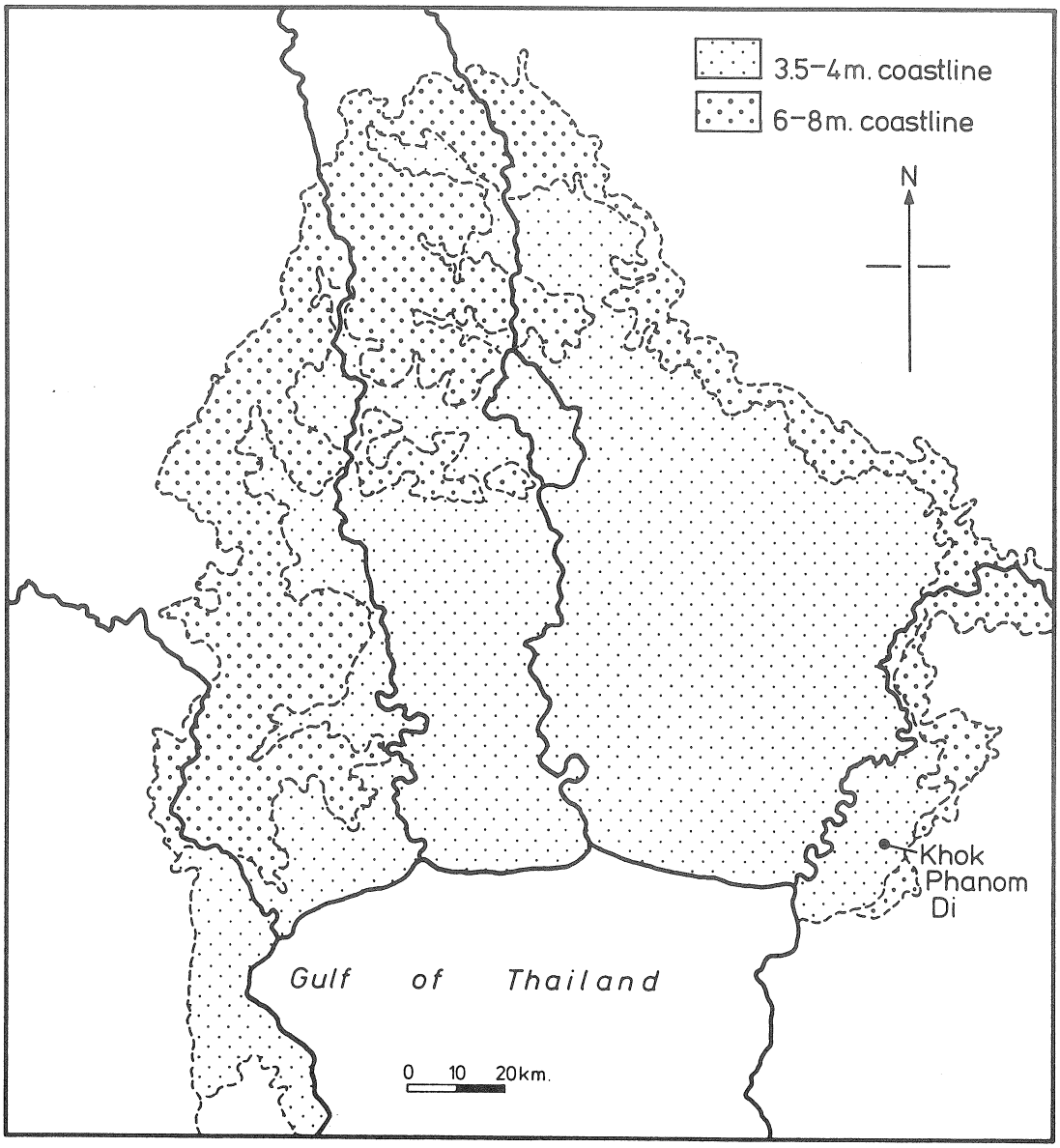

Figure 1: The location of Khok Phanom Di relative to the location of high sea levels proposed by Supajanya and Vanasin (1979)

proximity to an earlier test excavation, and the absence there of trees valued by the landowner. After seven months of excavation we reached natural at a depth of 6.8 m below the present ground surface. For the present purposes, we can recognise three major stratigraphic subdivisions which, starting from the lowest, we will call zones A, B and C. Zone A is made up of a complicated series of lenses. In the main they comprise ash, occupation material including pottery and biological remains, discrete shell middens, charcoal spreads, and lenses of what is probably overwash de-

posit from high or storm tides. There are numerous small hearths filled with ash and charcoal as well as some postholes retaining the wood of prehistoric structures.

Zone A was about 3 m thick, and within it we found 104 inhumation burials. The earliest six were found isolated from one another and, with the exception of one shell bead, were devoid of grave goods. The remaining 98 burials were set out in rows and superimposed, the distribution revealing several clusters separated by areas with no burials. Zone B offers a sharp contrast. The

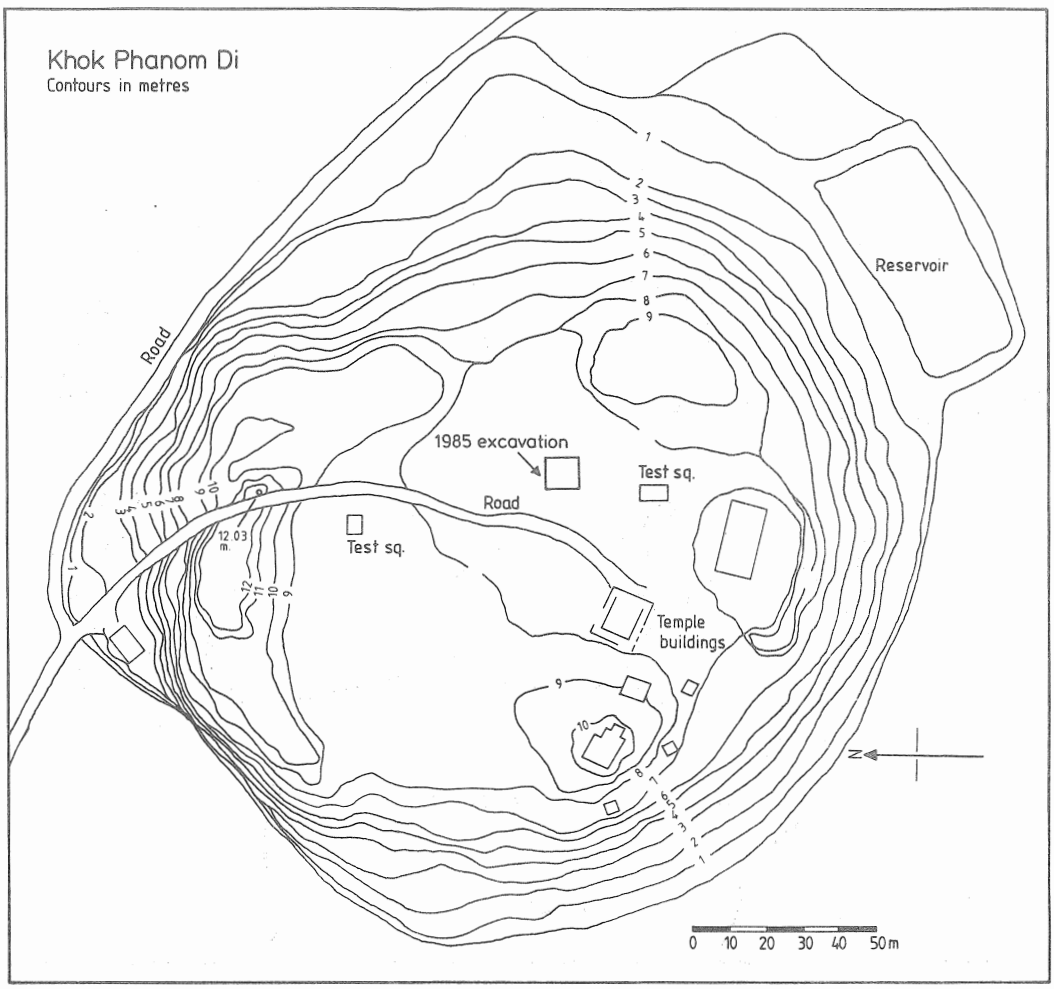

Figure 2: The site of Khok Phanom Di showing the area excavated

northeast quadrant was dominated by a rectangular raised platform surmounted by clay walls. The platform comprised 43 successive floors made of fill covered by smooth plastered surfaces. The posthole configurations indicate several re-building phases. No occupation material was identified on any of the surfaces and the platform was probably part of a larger structure, because the plastered floors proceeded beyond the uppermost clay wall foundation and into the edges of the square. The distribution of burials remained nucleated, one of the latest such groups comprising burials cut through the latest platform floor. In front of the platform and lying on the same orien-

tation as its walls however, we found a row of burials ringed by a set of post holes suggesting a formerly visible mortuary structure. Zone C, which occupies the uppermost metre of deposit, is a much darker soil than Zone B. Where Zone B comprises a sandy matrix interspersed with a few shell middens and ash lenses. Zone C is rich in pottery, animal bone and the implements used in the manufacture of pottery. It contains no burials.

Let us begin with a review of the biological remains. Zones A and B are rich in faunal material. Alan Grant has recently completed the identification of the larger mammalian bones, while the smaller species are being analysed by Barbara West at the British Museum. Alan Grant found a consistent but restricted presence of pig, large and small deer, macaque and langur specimens throughout Zones A and B. With the change to Zone C, the frequencies of these species increased dramatically relative to marine species, which virtually disappeared from the faunal spectrum. Dog remains were very rare throughout, and the water buffalo appeared only in Zone C. The bones of this species were consistent with a wild animal. It is not at present clear whether the pig bones come from a wild and/or a domestic animal, but in either case they were consistently rare until Zone C. The overwhelming majority of remains are aquatic, particularly fish, shellfish, crab and turtle. The main species of shellfish are adapted to a mangrove habitat, though some too are found on sandy tidal flats. A sample of all archaeological layers was processed through a flotation chamber. The residue contains numerous small fish bones. With Zone C, the presence of marine species abruptly halted, giving way to mammalian remains associated with swamp- woodland, including pig, monkey and large, probably wild water buffalo.

The flotation procedure was planned in order to recover the remains of rice and other plants, and this proved successful. Carbonised rice grains were rare, but we found numerous specimens of chaff in all zones. These take three forms: first, there is the recovery of chaff itself in the occupation layers. It was also found represented as chaff impressions on the clay adhering to the exterior surfaces of broken potsherds, and in all zones chaff was found as a clay temper used in pottery manufacture. The first two sources reflect the local availability of material and the last source may reflect local use or the importing of pots from an area where chaff was preferred as a tempering agent. At the moment, we are unsure whether the chaff comes from cultivated rice or wild plants, or perhaps from both. Both in the flotation screens and the square itself, organic remains including nuts, seeds and leaves were found. The botanical remains are currently being analysed by Gill Thompson in Canberra.

On two occasions, human burials were found with the partially digested stomach contents in place. Small fish bones were seen protruding from the exterior surfaces, and we await with great interest the complete analyses. Faecal remains were also relatively common, particularly in Zone B. It is considered likely that these have a human origin because the dog, the principal other candidate, was rarely represented among the animal bones. A glance at these coprolites, even those in the lowest levels, has revealed the presence of fish bone and fragments of rice chaff. During the build up of zones A and B then, subsistence activities were concerned with rice harvesting, fishing, shellfish collecting and obtaining turtle, crab and other marine resources.

Such rich resources, of which only rice was seasonal, must have underwritten either a fully sedentary or at least a logistically mobile subsistence strategy. There are very few similar estuaries with gently shelving beaches round the Gulf of Siam, and it is reasonable to assume that the position of Khok Phanom Di was unusual. Certainly, estuarine conditions would have presented a problem with fresh water, particularly during the dry season. When we turn to material culture, we find that the site was located so as to command two major sources of raw material: clay and marine shell. While the area was deficient in high quality stone, its coastal/estuarine situation was suited to the "gateway" exchange characteristic of interior British Columbia during

later prehistory. From the initial occupation to the final abandonment, the occupants made pottery vessels (see section on ceramics below). The same situation applies to fishing technology. Clay net weights and bone fish hooks were present from the earliest contexts. There are also bone harpoons. Access to marine shell was also important: local manufacture of shell jewellery is attested by the discovery of the parent shell from which tabs have been drilled out in order to shape disc beads. Shell jewellery is also a component of the grave goods in both zones A and B.

Participation in a regional exchange network is evidenced too by the presence of stone axes. These are present from the earliest occupation. A cache of ten was found virtually on natural soil, and axes are present, albeit rarely, in burials. Many axes were sharpened to such an extent that they were worn to a very small size. A variety of different types of stone was employed. The number of postholes found and volume of ash and charcoal in hearths and firing areas hints at a considerable use of such axes in the modification of the local vegetation.

Only the most general statements can be made about the mortuary remains, because the important task of sexing and ageing the skeletons is incomplete. The six lowest skeletons comprise three adults, a child and two infants. They were interred in shallow graves, with heads pointing to the east. The child was buried in a flexed position, all the rest being in an extended position on their backs. One of the adults was accompanied by a solitary shell bead, but all the others were buried without grave goods. Grave 151, that of an infant, was found with the body covered in red ochre and wrapped in white, unwoven fabric resembling bark cloth. This "tapa" covering became common in later Zone A burials.

There is a gap of about 40 cm between these six early burials and the balance from Zone A. The latter set exhibits a marked preponderance of very young infants, there being 52 infant burials, five children and 38 adults. The mortuary ritual involved the excavation of a shallow grave oriented so that the head pointed towards the east. In some case, the remains of wooden biers survived. The corpse was covered above and below with red ochre and, together with any grave goods, was wrapped in binding sheets made of unwoven material.

The presence of grave goods varied between individuals. Twenty one infants were buried in scoops with none of the ritual activity described above. Twelve were associated only with ochre and "tapa". The remaining ten complete infant burials were richer in terms of offerings. All had ochre over the bones, and in addition, two were accompanied by pots, three by pots and shell beads, two by bracelets, two by shell beads and bracelets, and one by pots, beads and bracelets. These richer infant burials tended to be later within Zone A.

The grave goods associated with adults include red ochre, pottery vessels, shell beads, burnishing stones, a polished stone axe and cylinders of prepared clay. In contrast to the infants, no adults were interred with bone bracelets. Ochre was universally applied to adult bodies. Of the 32 complete examples, seven were associated with pebbles bearing facets worn down by the continual burnishing of ceramics. It would be interesting to ascertain the sex of this set. None of the interments stands out, as do the few infants described above, on the basis of grave wealth or ritual of burial though further analysis is necessary, particularly of the pottery fabric, before this can be demonstrated beyond reasonable doubt. The two richest graves from this assemblage are numbers 72 (Fig. 9 and 91 (Fig. 6). The former contains three pots, three burnishing stones and some shell beads placed between the knees. There is a concentration of fish bones over the left shoulder, and the body was covered in red ochre. The latter contained four pots, as well as two burnishing pebbles and a string of shell beads over the chest. Most adults were interred with either one or two pots (n=8) or with pots and shell beads (n=8).

There was a major stratigraphic break between zones A and B, as well as a 40-50 cm hiatus in the presence of burials. Zone B revealed a more homogeneous build-up without the intense

differential lensing found in Zone A. Moreover, the northeast corner of the excavation square contained the platform structure described above. The proportion of infants fell from 55 % in Zone A to 30 % in Zone B. There was a wider range of grave goods in Zone B. In addition to those described for Zone A, we also encounter clay anvils, large shell bracelets, shell discs, shell ear ornaments, a fishhook, and sections of turtle carapace. The shell beads and pots reveal typological changes from preceding forms, but the basic rite remained the same with the head oriented to the east. Again, arrrangement into discrete groups was a feature of burial layout. Two late groups post- dated the last building period of the raised platform structure, but the major concentration of Zone B burials was distributed in front of and parallel with it. This group revealed marked disparity in the grave goods associated with both adults and children. The poorest burials were associated with relatively shallow graves and either an absence of material goods or, at best, one or two pottery vessels and some red ochre. These contrast with two outstandingly rich adult burials and three equally well endowed child burials.

Burial 15 was placed in a grave which stood out on account of its size: it was 3 m in length, 1 m wide and 80 cm deep. It contained the remains of a woman aged *c* 45 years at death. Her body was covered by a pyramid of shaped clay cylinders representing an early stage of pottery working. A pot had been balanced on top of this, reaching almost to the surface of the grave. Four or five further pots of considerable quality (e.g. Fig. 12) were placed over the woman's legs, while a particular feature of the burial was the richness of the shell jewellery. About 250,000 shell-disc beads were encountered, disposed as strands both above and under the chest. She also wore several necklaces made of large "I" shaped beads linked with the smaller disc variety. Two horned shell discs covered each shoulder. She wore a shell bracelet and shell disc ear ornaments. At her feet, we found a clay potter's anvil and two burnishing pebbles which had been placed in a shell container. Her body was covered in red ochre. An adjacent grave of similar date (burial 16) contained an infant buried in an identical manner, accompanied by nearly as rich an array of grave goods. Again, the ochre-covered body lay under a pile of clay cylinders. A bracelet had been placed over the left wrist, and the burnished pots over the legs lay beside a miniature potter's anvil. The upper part of the body was covered in the same types of shell bead as were found with Burial 15. The grave was also far larger than necessary to contain the body.

A second rich infant burial was found to be roughly contemporary with and in the same row as burials 15 and 16 . This one, however, was found within a circular grave. The body was contained within two pots, one of which stood out on account of its superb decoration and almost egg-shell thin finish. Two pots were found beside the feet, and a quantity of shell beads was present over the chest area. The third child burial was rather earlier than the other two. This child was buried with three or four complete pots and a considerable number of "I" and disc shaped beads.

The row of burials found in front of the platform was distinguished from Zone A graves by the presence of postholes set round individual graves and, indeed, possibly round an entire grave cluster as well. This finding suggests the presence of above ground mortuary structures. Indeed, the lack of any intercutting graves surely indicates a planned cemetery in which the identity of earlier burials was known. Within this area, we found several discrete shell middens and spreads of ash and charcoal which lap up to the top of individual graves as if reflecting feasting at or after the burial rite.

We are aware that the analysis of mortuary behaviour has hardly begun, but do feel able to make one or two tentative conclusions. The earliest six graves were not in any way part of a group, as occurred later. They were not endowed with a range of grave goods. Like those found in the rest of Zone A, they were set within an occupation-industrial area. Some were cut through or set within shell midden or occupation layers. There is variation in the number of grave goods

for Zone A as a whole, but no individual or group of graves stands out as being unusually rich. This situation contrasts with the establishment of a specific cemetery in Zone B. Much attention was given to the construction and maintenance of a platform structure, and graves show a sharp dichotomy between considerable wealth associated with few adults and children, and the relative lack of wealth with the balance. The essential burial ritual, however, was similar throughout the zones in that the same orientation to the east was employed, ochre was used to cover the corpse, pots and shell beads were commonly placed with the dead and graves were located in clusters. When rendered graphically (Fig. 3), it is apparent that clusters in zone A underlay clusters in the same part of the site in the succeeding zone B.

The last Zone B burial was cut from just below the distinct stratigraphic change involving a transition from virtually sterile sand to a dark occupation layer rich in material culture and organic remains (ZOne C). No further marine shells or crabs were found, and mammalian species became common. Stone bracelets were favoured, and pottery was made *in situ* as evidenced by numerous clay cylinders and anvils. There were many stone axes, but no evidence for prehistoric metallurgy. This change is correlated with a lowered sea level and a considerable consequential adjustment in subsistence and exchange activities. Analysis of the pottery should inform us on the issue of continuity in terms of people occupying Khok Phanom Di in late Zone B and in Zone C.

At this juncture, it would be most desirable to be able to consider the radiocarbon chronology of Khok Phanom Di. To date, we have received six results from the radiocarbon dating laboratory of the D.S.I.R., Wellington, and a further set is pending at the radiocarbon dating laboratory of the Australian National University. All have been corrected for the secular effect. The dates obtained are as follows:-

Level 8 sp.2 lens 6. A lens of ash and charcoal at 3.25 m below datum, which antedates burial 26. 2270±150 BC.

Level 8 sp. 3 lens 5. A small lens rich in charcoal and ash at the eastern end of the grave cut for burial 16 at 3.15 m below datum. Antedates burial 16. 40±345 AD.

Level 8 surface of sp. 7 lens 10. A hearth rich in charcoal, at a depth of 3.55 m below datum. It is cut through by burials 31-2. 1660±200 BC.

Level 9 surface of sp. 1 lens 2. A clear, white ash lens with much charcoal, antedating burials 28, 30-2. 1640±150 BC.

Level 9 sp. 6, a charcoal rich deposit mainly comprising ash. 2150±310 BC.

Level 9 sp. 7, hearth. A very concentrated ash-charcoal hearth at 4.12 m below datum. 2950±820 BC.

It is evident that a definitive statement on the chronology of the site must await the further determinations. The set above come from zone B. With the one exception of the date of 40±345 AD, which is archaeologically unacceptable, the dates are not inconsistent with a dating of zone B within the period 3000-1250 BC *sensu lato*. The samples now in Canberra are large and well provenanced, several coming from basal deposits. We must await the results of these before being able to offer realistic estimates for the date of zone A. There are, however, two further points. In 1979, Damrongkiadt Noksakul excavated a test square at the site and obtained a set of radiocarbon dates determined on the basis of human bone from burials. Two burials located about two metres above natural were dated to *c* 4000 BC (uncorrected). The remaining dates from higher burials were so mutually contradictory as to be of little use. If these two dates are supported by our own determinations, then initial occupation may well lie within the millennium 5000 to 4000 BC.

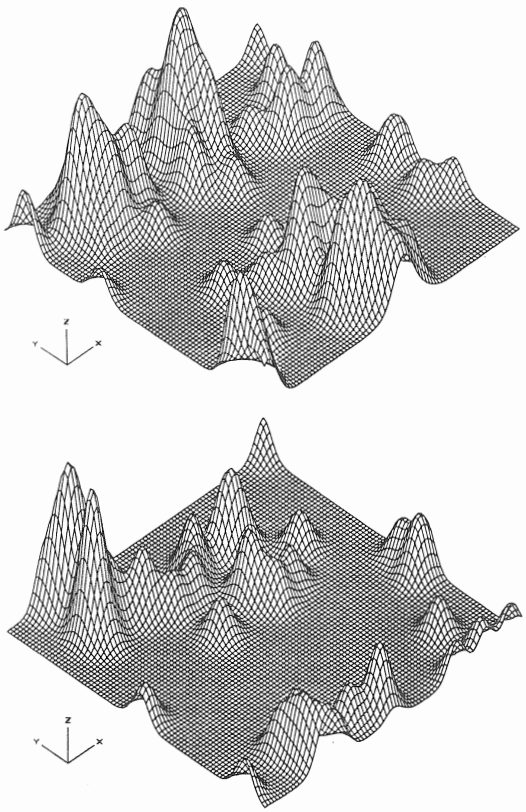

Figure 3: The clustering of burials for Zone A (above) and Zone B. It is noted that they indicate the use of the same parts of the excavated area through a considerable time span (figure courtesy of Glen Standring)

Secondly, Van der Kevie (1971) has published a set of radiocarbon dates. These suggest that the deposition of acid sulphate soils on top of the green marine clays of the Bangkok Plain commenced *c* 4000 BC, and ceased about 1500 BC. The former event probably corresponds with the initial occupation of Khok Phanom Di. A tentative prediction, therefore, is a date of *c* 4000-3000 BC for Zone A, 3000-1250 BC for Zone B and from 1250 BC for Zone C. Given the problems which have resulted from extravagant and unfounded claims for early bronze and iron in Southeast Asian contexts, it is hoped that the highly tentative nature of the above brackets will be appreciated.

THE PALAEOENVIRONMENT (B.K.M.)

Work on the palaeoenvironment surrounding Khok Phanom Di concentrated upon stratigraphic recording and collection of core and monolith samples for various forms of microscopic analysis (pollen, phytoliths, diatoms, desmids, charcoal, ostracoda, etc.). This was carried out from mid January to early April 1985. It is important to know what vegetation, soil, climate and sea level changes took place around the site, and also its geomorphic nature. There are some clues to these questions in samples from the environs of the site and substantial blocks of natural deposits underlying the basal cultural layer were collected for further analysis at the end of the excavation. Preliminary examination of sediment from the top of natural, and some lenses within the cultural build-up has suggested that we are dealing with either a spit or barrier which was occasionally overtopped by storm waves and possibly received loessic material from an estuarine or coastal mud flat from time to time. There is geomorphic evidence for the occurrence of major barriers in the Gulf of Siam during prehistory (cf Takaya 1972); indeed Bangkok is said to be built on the remnant of one, and no doubt others are to be found beneath the sea. It is not possible to establish the extent of the original Khok Phanom Di barrier without very detailed topographic maps (which do not exist) or air photographs (which may exist). If the barrier was never closed, brackish water lagoonal conditions may have existed behind it for much of the occupation period. If it was closed there may well have been an abundant source of potable water near at hand in the form of a freshwater lagoon. One might then expect to find remains of freshwater as well as salt water aquatic fauna in archaeological zones A and B. The fact that these do not occur may argue for estuarine or semi-estuarine conditions. It is vitally important for the proper interpretations of the lower layers of the site to establish where the source of potable freshwater was. If it was not nearby, it is difficult to envisage any sort of long term occupation by man.

The sedimentary stratigraphy of two cores from north of the site suggests that a freshwater stream may have been close at hand. However, both of these were extracted from existing irrigation canals and, although they are several metres deep, the alluvium could represent recent fill. This problem can only be resolved by radiocarbon dating of sediments from immediately above and below the change in sedimentation, but there are stratigraphic reasons, which will be mentioned in fuller discussions, which suggest that the initial interpretation is correct.

The stratigraphy of cores and monoliths from the environs of Khok Phanom Di in general reveals more evidence which can be interpreted in terms of natural environmental change than man's impact on the landscape. Disturbance of vegetation at a piedmont edge location might reveal itself in the form of inwashed products of soil erosion in sedimentary sequences from the plain or alluvial fans abutting on the plain, but Khok Phanom Di is an area of low relief far distant from uplands. Some possible inwash of charcoal does occur in the upper levels of one core (KPD DG) from the northwest edge of the site though and other thin organic bands presently interpreted as normal river deposits may contain material washed out from the site but this will not be easy to prove.

During the course of the fieldwork, two deep fishponds were dug about 100 m north of the site. We were thus able to remove a large monolith from one side wall. The main exposures uncovered were *c* 2.5 m deep but *c* 50 m long, it was initially thought that they might cover the complete Holocene. Coring elsewhere later suggested otherwise. The changes apparent from the base upwards were: dark grey clay of unknown depth and likely brackish water origin below 2.47 m; a thin pebble bed of uncertain origin; 0.2 m plus of black woody clay containing no rooted material; a thin grey organic clay; a thicker (0.12 m) series of laminated light and dark grey sands with inwashed wood and shells (? a tidal flat); almost 0.9 m of green, mainly clayey, marine

deposits representing a transgression; over 0.4 m of dark grey brackish water alluvium; a light grey clay with orange iron mottles indirectly representing a change to freshwater conditions (acid sulphate soil formation); and finally, half a metre of dark brown freshwater alluvium probably laid down by Bang Pakong River floods.

Coastal deposition is often extremely variable over even very short distances and that of the Khok Phanom Di area is no exception. The thickness of the layers varied considerably along the *c* 50 m long exposures and woody bands were not always present. It was not surprising to find that this sequence was not matched in detail elsewhere and that there was much variation from core to core. The most complete sequences were fortunately derived from quite near the site: KPD DG at its southeast end and BMR2 from *c* 200 m north. Both of these cores terminated in

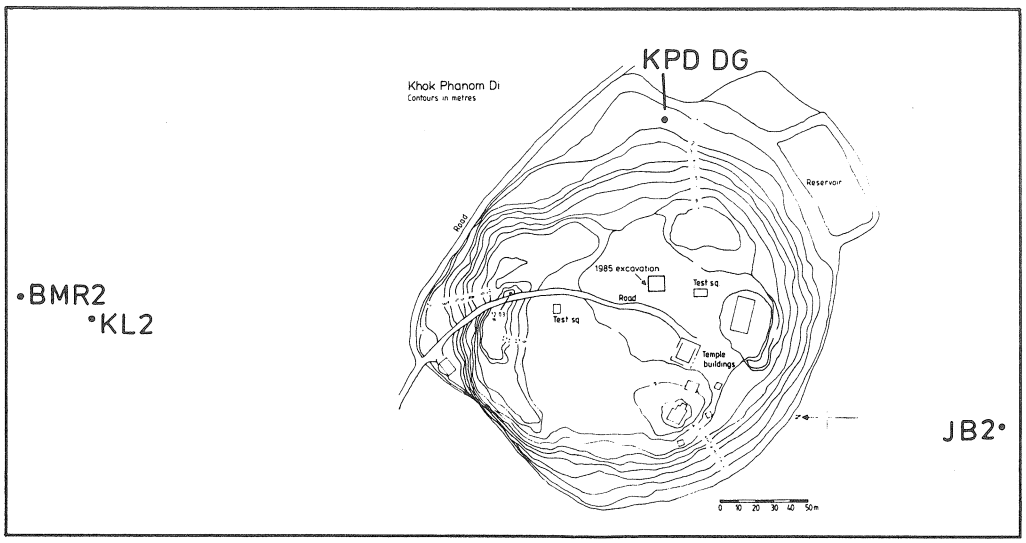

Figure 4: The location of pollen cores referred to in the text from the vicinity of the site of Khok Phanom Di

a very stiff white clay containing some darker organic bands. Outcrops of white clay occur at several places within a few kilometres' radius of Khok Phanom Di and Takaya (1972) attributed

some to an origin in the last interglacial. The organic banding suggests that we are dealing with river deposits which may date to any period between the last interglacial and the early Holocene. These clays were overlain by green silty to sandy clays representing the main post-glacial rise in sea level. Most cores terminated in similar deposits and some, such as that from Ban Bang Hak 7 km west-southwest of the site, where they exceeded 8.3 m in thickness, contained shelly bands. The green sediments ranged from 3.5-4.5 m in thickness near Khok Phanom Di but did not correlate with the thinner marine clay in the fishpond section, which apparently represents a second marine transgression. Paradoxically, where a second green layer was represented in cores it was very much thinner than that of the fishpond and one has some doubts if this may not in fact represent erosion and redeposition of sediment from elsewhere.

The main marine deposit is overlain in most cores by dark grey brackish water clay and light grey silty clays, which indicate the occurrence of acid sulphate soil formation and a change to an environment where fresh water was abundant. Acid sulphate soils develop in young brackish water sediments which are characteristically covered by mangrove swamp. Rapid lowering of the watertable during the dry season can oxidise the upper sediments converting iron and aluminium sulphides into sulphates, a process which releases sulphuric acid and decreases the pH (Ismangun and Dreissen 1974). Dehydration naturally also reduces volume, decreases pore space and leads to soil compaction. Where the watertable is lowered slowly such changes, which are damaging to most crop plants, (rice is often an exception), can be avoided. Several profiles from near Khok Phanom Di have horizons dominated by jarosite (as evident from the buff colouration) which can form through slow oxidation (by the reaction of ferric hydroxide and sulphuric acid), although it can also be formed in other ways. The irregularity in distribution suggests that the jarosite cannot be taken as evidence for climatic change, but it might reflect efficient land management of some areas during the period of irrigated agriculture, which we are anxious to date.

The thin layer of marine clay thought to belong to a second transgression is sandwiched between acid sulphate soils at different stages of development. So, judging by Van der Kevie's (1971) C14 dates from the Bangkok Plain, acid sulphate soil formation may pre-date the time of Christ in the area and it is safe to conclude that climate has not altered radically locally since then. The minor rise in sea-level probably did bring relatively short-lived moister conditions near the coast, but as the main transgression encroached during the time of occupation of the site the local soil climate must have become moister either due to a direct change in precipitation or the accompanying rise in the watertable. Of course, this is difficult to prove palaeobotanically. The same problem is encountered in the British Holocene: was the advance of alder due to direct precipitation change or a rising watertable as the transgression advanced? At the time of writing the sedimentological interpretation of events in the environs of Khok Phanom Di is still sketchy as the cores have not been examined by a geomorphologist.

Work by Maloney has commenced on pollen, phytolith and microfossil charcoal analysis especially, and John McAlister is undertaking inorganic chemical analyses of samples from core KL2. This core is from north of the site, between BMR2 and the fish pond section. Analysis of core BMR2 is almost complete and Judith Brown has examined some surface samples from a core from *c* 150 m south of the site. Interpretation based on a summary pollen diagram from BMR2 (Fig. 5) and the field stratigraphic log indicates that the depositional site was probably a tidal creek during the time period when the 2-6.5 m levels were deposited. The 1.2-2 m levels were characterised by a high *Rhizophora* representation, but not high enough to suggest incontrovertably that *Rhizophora* was growing locally on this side of the mound. Also, very large peaks in the charcoal curve were mirrored by slight increases in grass pollen representation, and Chloridoid and Panicoid phytoliths occurred. Unfortunately, Rhizophoraceae do not produce many

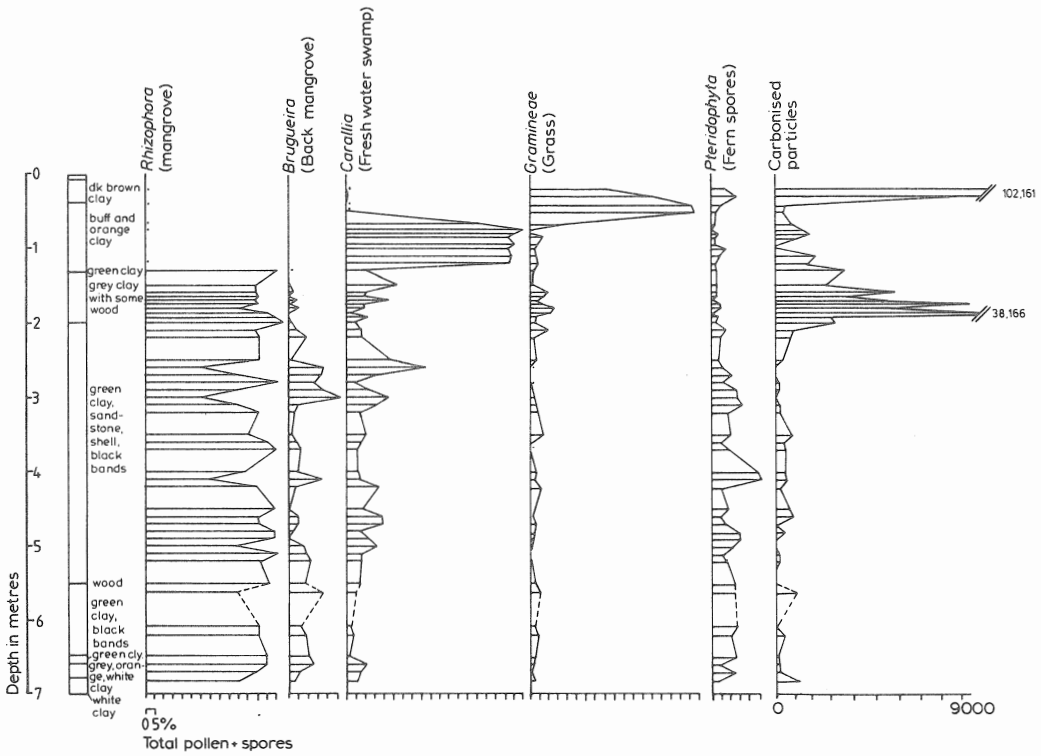

Figure 5: The pollen core from BMR2. Its location is seen in fig 4.

silica bodies (Piperno 1985). This upper section of the diagram probably dates to just beyond the time of the post-glacial sea level maximum and it is tempting to assume that the vegetation was attacked by man as local conditions became drier. In view of the considerable debate about the indicativeness of charcoal, it is better not to pursue this argument too strongly until comparative results are available from several more cores. Burning may have led to the premature decline of *Rhizophora*, however. It was replaced by an abundance of pollen which I have labelled as *Carallia* sim. (similar to *Carallia*). *Carallia* is another bush/small tree in the family Rhizophoraceae, and much of this group of pollen is closer to *Gynotroches* , which does not have a central Thai distribution, than to *Carallia*. There is also an overlap with Aizoaceae, possible colonisers of

mud flats, and *Elaeocarpus* (another swamp forest/lowland swamp forest tree) is a possibility. Some *Elaeocarpus* pollen does occur but it is smaller and has a smooth surface. Nor does it have a scabrate-reticulate patterning as found in *Carallia* sim.

The stratigraphy suggests that the deposition site of BMR2 consisted of an acid sulphate soil. This was overlain by dark brown clay (a probable Chao Phraya flood deposit or another acid sulphate soil horizon) below *c* 30 cm. However, grass pollen, including possible rice, *Paspalum* and *Coix*, began to rise below the stratigraphic break, while *Carallia* sim. declined rapidly and charcoal became more abundant again (Figure 5).

Work on core KL2 is nearing completion and promises to yield even more exciting results, while at least two other cores are also deserving of quite thorough analysis. KL2 comprises a mixture of apparent freshwater deposits and acid sulphate clays over the main marine transgression deposits. The samples from 1-1.5 m below the rice field datum (*c* 3 m a.s.l.) were analysed early on. One contained little pollen, but was not necessarily oxidised as diatoms and phytoliths were equally sparse. The other seven, although having quite a large pollen and spore flora (over 100 types), were dominated by grass pollen and contained an abundance of grass phytoliths and small charcoal particles, a few of which definitely derive from monocotyledon leaf epidermis. Some 15 % or more of the grass pollen in each sample was in the size range of rice (see Maloney 1986 for a detailed discussion of rice pollen). A small proportion also had a surface pattern which resembled rice viewed under light microscopy, but confirmation using S.E.M. is necessary, and wild and cultivated rice pollens are unlikely to be separable even with the S.E.M. A few chloridoid type grass phytoliths (which might actually be from oryzae) occurred too, but further study of all phytoliths in relation to modern reference material is needed. Several weeds contributed to the microfossil record, e.g. two species of *Ludwigia* (a cosmopolitan weed) and the fern *Ceratopteris thalictroides*. Despite this, it is not possible to claim conclusively that anything more than a herbaceous swamp was present, but enough has been said to indicate that there are grounds for guarded optimism.

The phytolith samples from BMR 2 were not nearly as interesting, but they contained important palaeoenvironmental data, partly because other siliceous microfossils also occurred. Two sections of the core have been examined: 5.5-6.0 m and 1.5-2.0 m. The former was poor in microfossils except for sponge spicules and radiolarians, and seemed to represent deposition some distance from the shore, but not necessarily in especially deep water. However, possible rice phytoliths were present as far down as 5.62 m. Chloridoid and Panicoid grass phytoliths occurred sparsely in some samples from the 1.5-2.0 m segment and grasses may have formed a component of a strand-line vegetation or, more likely, of herbaceous swamp behind the mangrove. Alternatively, they may have grown on the mound of Khok Phanom Di.

The process of building a phytolith reference collection is underway. Some 124 samples covering around 100 plant families have already been processed. Many families briefly documented by Piperno (1985) have been left aside for the time being but a check on her findings must eventually be made by reference to Southeast Asian material. Despite the likely pH due to the abundance of molluscs and leachates from these, all four samples from the excavation square examined so far contained phytoliths. These were most abundant in the material from Burial 149. Non- descript elongated rod-shaped phytoliths were caught up in fibres of the 'tapa'; the grass phytolith component was dominated by the Festucoidae type (which might prove to be from *Lophatherum gracile*, a forest grass still present on the mound today); some Panicoid and Chloridoid phytoliths occurred; and there were an additional 14 morphological types, capable of subdivision, including other probable herb phytoliths.

As phytoliths are abundant in the pollen cores, the pollen and phytolith records can be com-

pared once satisfactory determinations can be made, and it may be possible to use this combination of data to make more detailed inferences about vegetation on the mound where pollen is unlikely to be preserved (except hopefully, in the coprolites). Phytoliths may also be of use in identifying the chaff and other difficult macrofossil remains, such as leaves, but extraction of phytoliths is a destructive process. Piperno (1985) claimed that maize phytoliths could be recognised. We must look for those of rice, sugar cane and bamboo, the three most useful local grasses. Bamboo flowers irregularly and its pollen does not differ markedly in size, shape or surface patterning from that of several local weed grasses. There are better prospects for detection of sugar cane (wild or cultivated) pollen: indeed this may be achievable using light microscopy. Some of the pollen exceeding the usual size of rice in KL 2 might prove to be from either *Paspalum*, *Saccharum* or *Coix*. If gingers were growing in the area they are likely to have been on the shade of the mound during the time of local dominance by grassland vegetation, and Bernard Maloney is rather hopeful that they produce phytoliths, especially as the pollen is fragile and unlikely to preserve.

Thankfully, pollen and spore determination is not a major problem, but determination of the phytoliths and diatoms is going to be more time consuming, so the initial aim must be to fill in the general background of vegetation change using palynology, thereafter paying more attention to other useful microfossils. A long monolith has been collected from a sidewall of the excavation square and Bernard Maloney would welcome applications from prospective PhD students to come and work on this at Queen's. The results should be most exciting.

To date, diatom analysis has only yielded one feature of major interest: some samples from KL 2 seem to exhibit a *Eunotia formica* 'bloom'. As far as ascertained at present this is a freshwater species. Desmids occurred very rarely in the samples, which is somewhat surprising but may be explained by the alkalinity of drainage waters deriving from the site. Desmids prefer rather acidic conditions. Other algae, possibly *Spirogyra*, were found sparsely in KL 2 and some samples from BMR2, but these have not been properly identified yet and almost every sample examined had some microfossil charcoal.

Judith Brown has analysed the pollen content of some surface samples taken along a north-south transect from the mound and these yield results comparable to those from KL 2. Almost all samples from the core she is studying are dominated by Rhizophoraceae but she is making large counts to try and establish what other vegetation existed in the area. Comparison of her results with mine suggest that mangrove, a short-lived plant community, was present in the area at more than one time period and the continuity must relate to the pattern of sea-level change although we require much more pollen counting to determine exactly what happened. So, the theory that the site was formerly located near mangrove is sustained by our evidence. What is surprising is that *Rhizophora* should dominate a core from north of the site. We still need more data on what lay behind it. The BMR2 samples show an abrupt change to tree-dominated freshwater swamp late on, but there could have been freshwater forest nearby throughout the period covered by the record. It would seem, paradoxically, that more information on this should come from samples obtained north of the site rather than south of it.

There is some evidence that the mound had a forest cover throughout the time periods covered by our samples but the evidence from grass phytoliths is equivocal. These may be from wild plants growing on the site, or our chaff may indeed be from wild or cultivated rice. If the traditional view, which can be doubted, that the pig is a forest animal is accepted, the mammalian evidence from the site confirms the suppositions derived from pollen. Hopefully we will be able to detect disturbance of the vegetation on the mound by man using either phytolith or core evidence. The eventual aim of pollen work is to build up a three-dimensional picture of vegetation change, but

also to place results from individual samples in sequence to form a composite diagram using computer methods. It is unlikely that we will be able to put further gloss on the course of climatic change but it would be surprising if we did not find evidence for minor oscillations of sea-level during the main transgression. Thankfully, conclusions reached so far reinforce and in some cases expand upon the findings of archaeology rather than contradict it, and the combined efforts of the team should yield palaeoenvironmental information unsurpassed from any other area of lowland Southeast Asia.

THE CERAMIC MATERIAL (B.A.V.)

A full and detailed analysis of the ceramic assemblage is being carried out by the author of this section. Sorting, sampling and the reconstruction of complete vessels has now been completed and more detailed analyses are now underway.

As with all archaeological assemblages, it is necessary to establish whether the ceramics, even if present in considerable quantity, were produced at the site or were imports. Even without the assistance of petrographic analysis compelling *prima facie* evidence of an intensive indigenous industry was indicated at Khok Phanom Di. This took the form of the accoutrements, raw materials and firing areas associated with pottery manufacture.

The approach adopted for the ceramic material represents a departure from previous analytical techniques employed in Southeast Asia. It addresses a different set of problems to those illuminated in earlier studies and involves a full ceramic analysis. In addition to style, morphological or functional questions, an examination of the material the pottery is composed of will also be undertaken. The use of geochemical techniques such as scanning electron microscopy (for firing temperature assessments), X-ray diffraction (clay structures), electron microprobe and standard petrographic microscopy will be used to characterise the various ceramic fabrics involved. Particular attention will be paid to technological aspects including methods of clay preparation, vessel construction, and firing.

Characterisation of the technical parameters of prehistoric pottery production should provide physical evidence directly related to what may reasonably be assumed were traditional craft methods. While forming and decoration processes are often influenced by tradition, other less immediate factors may render these aspects unreliable when viewed in isolation. Thus, while potters may often copy trade articles or take up fashionable contemporary designs in response to transient influences, they require more drastic reasons to change their basic technological framework. Experimentation in clay preparation or firing methods is much more risky than form or decorative innovations. As a result, potters tend to be conservative in technological matters. Changes in ceramic fabrics therefore often indicate major culture changes not necessarily related to pottery production *sensu stricto*.

Ceramic fabrics as well as forms are here given equal weight because together they comprise the essential components of the ceramic "type". Of course, many reports on pottery fabric can be found in the Southeast Asian archaeological literature. In comparison to the many comprehensive typological descriptions based on form, however, the fabric is usually given little attention. Even when included such fabric descriptions are of little value and often quite misleading.

Inclusions are often misidentified (e.g. natural inclusions such as detrital pisolitic limonite or oolitic hematite have been recorded as a purposefully added laterite temper). The terminology is usually vague and imprecise. Variations in fabric density have been incorrectly categorised as "hard sand" or "soft sand", or as temper, in the absence of accurate petrographic evidence. Terms such as "crumbly sand", "mica and grit", "clay", "mineral", "vegetable", and "fibre", used

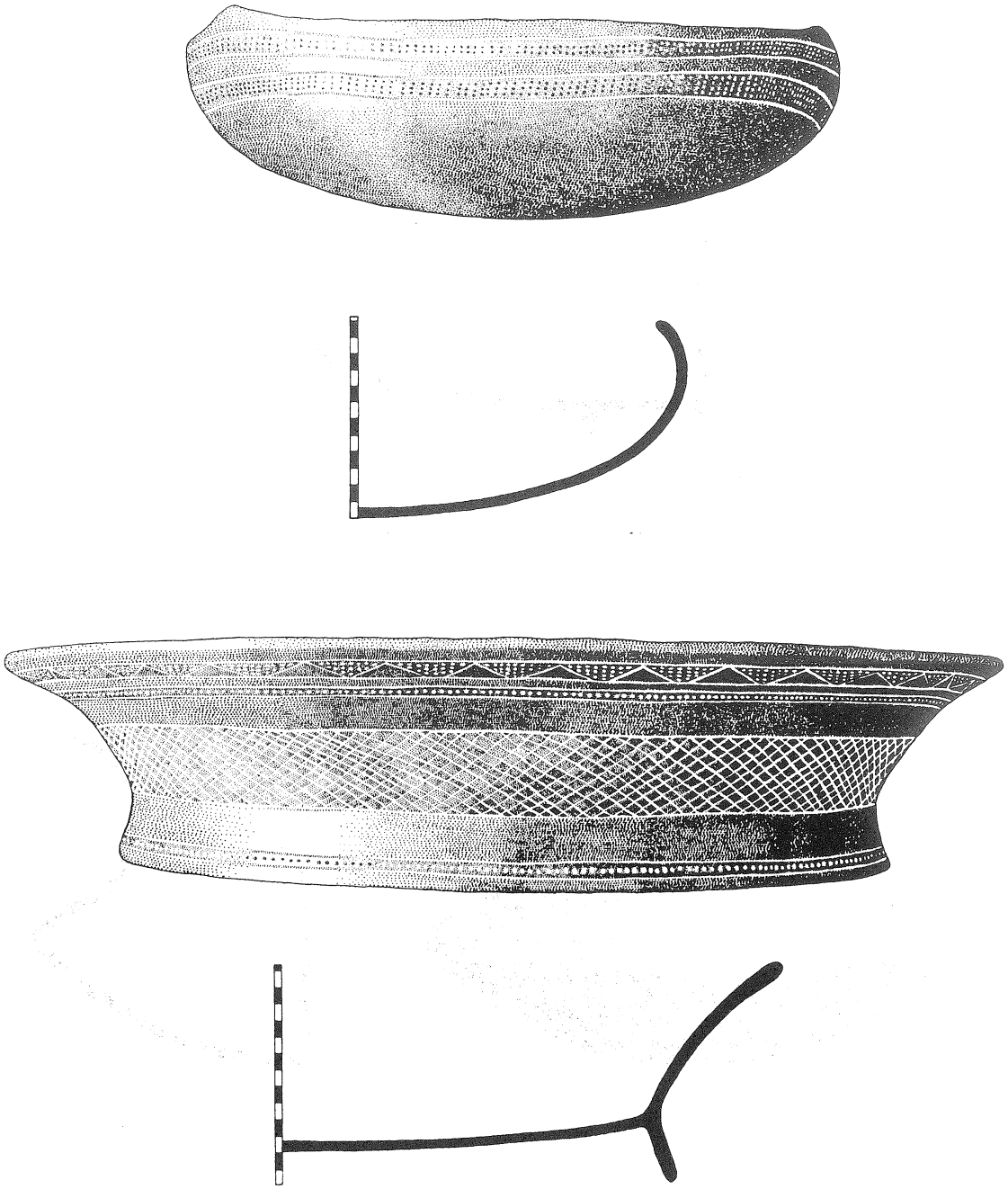

Figure 6: Above, Burial 91, Pot A (Zone A). Oxidised and lightly burnished with punctate fields bounded by incised lines. The rim features three apiculate peaks. Below, Burial 90, Pot A (Zone A). Reduced and highly burnished with incised and punctate fields.

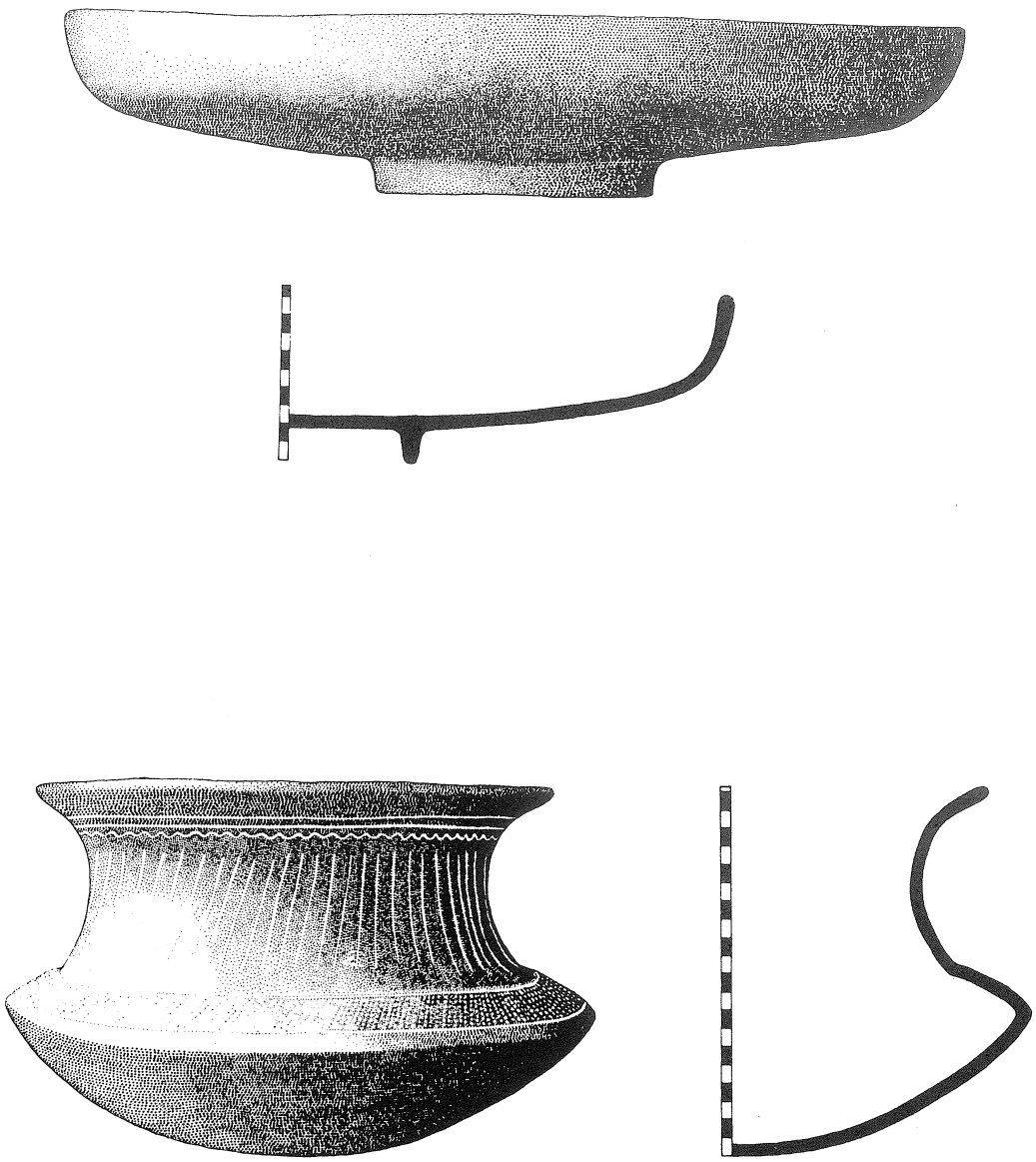

Figure 7: Above, Burial 58, Pot B (Zone A). Oxidised and smooth surfaces. Below, Burial 72, Pot C (Zone A). Highly burnished. Oxidised exterior with fire clouds. Interior extensively reduced.

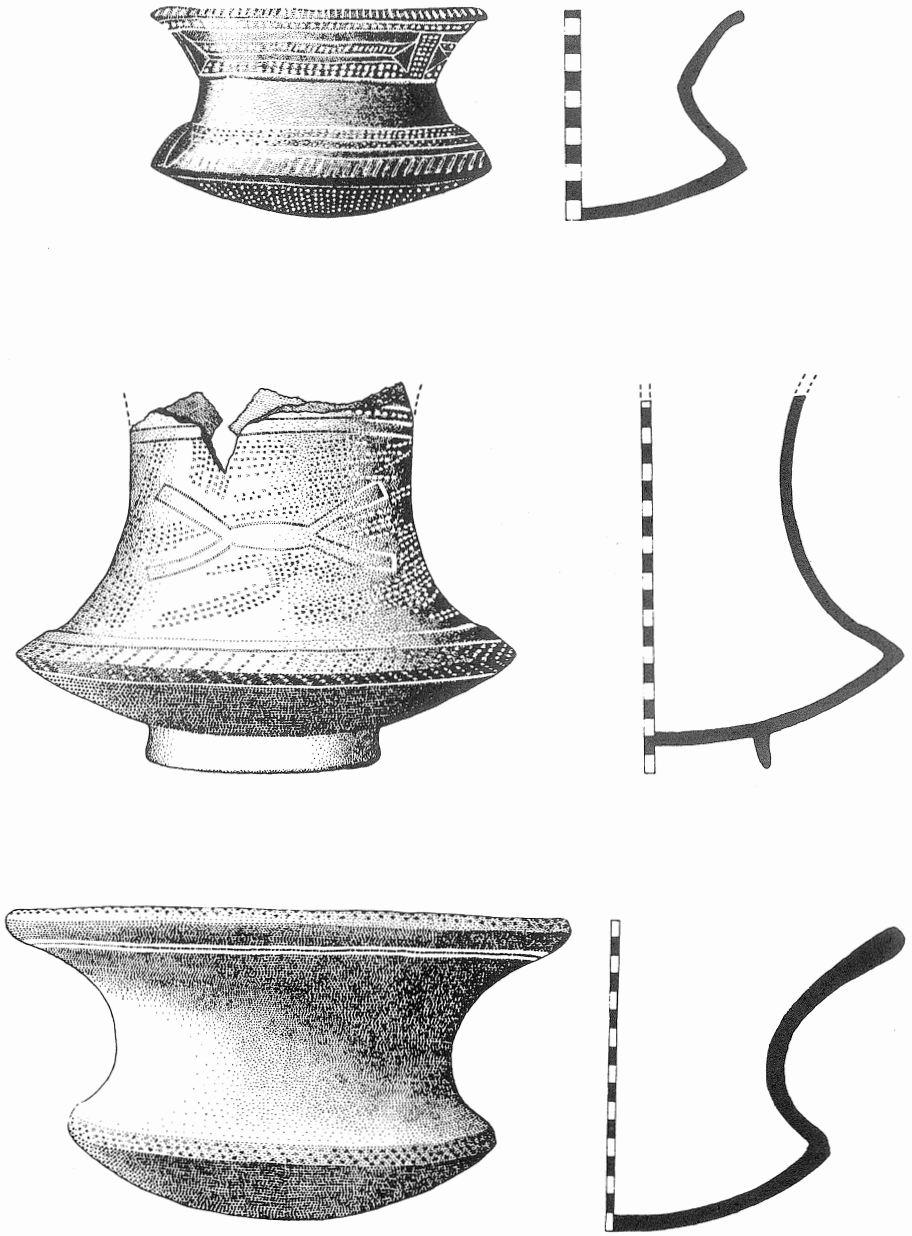

Figure 8: Above, Burial 88, Pot B (Zone A). Lightly burnished. punctate fields bounded by incised lines. Middle, Burial 120, Pot A (Zone A). Oxidised and punctate fields above and plain below lower incised line. Plain figure outlined by incised lines. Below, Burial 44, Pot B (Zone B). Highly burnished, oxidised interior. Exterior slightly reduced particularly towards the base.

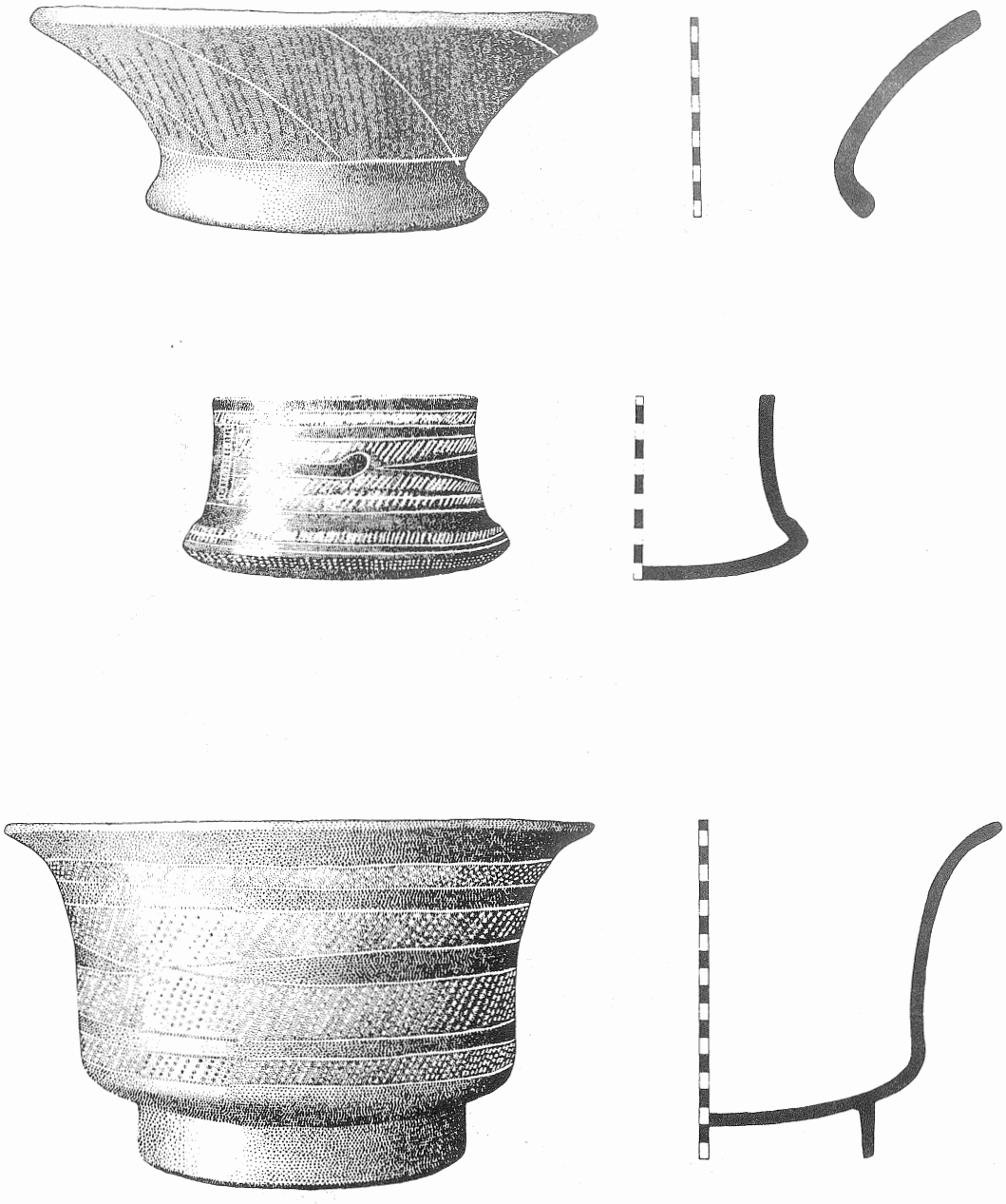

Figure 9: Above, Burial 13, Pot B (Zone B). Oxidised with small fireclouds. Middle, Burial 103, Pot A (Zone A). Highly burnished and reduced. Punctate fields bounded by incised lines. Below, Burial 72, Pot A (Zone A). Highly burnished and reduced. Punctate fields bounded by incised lines.

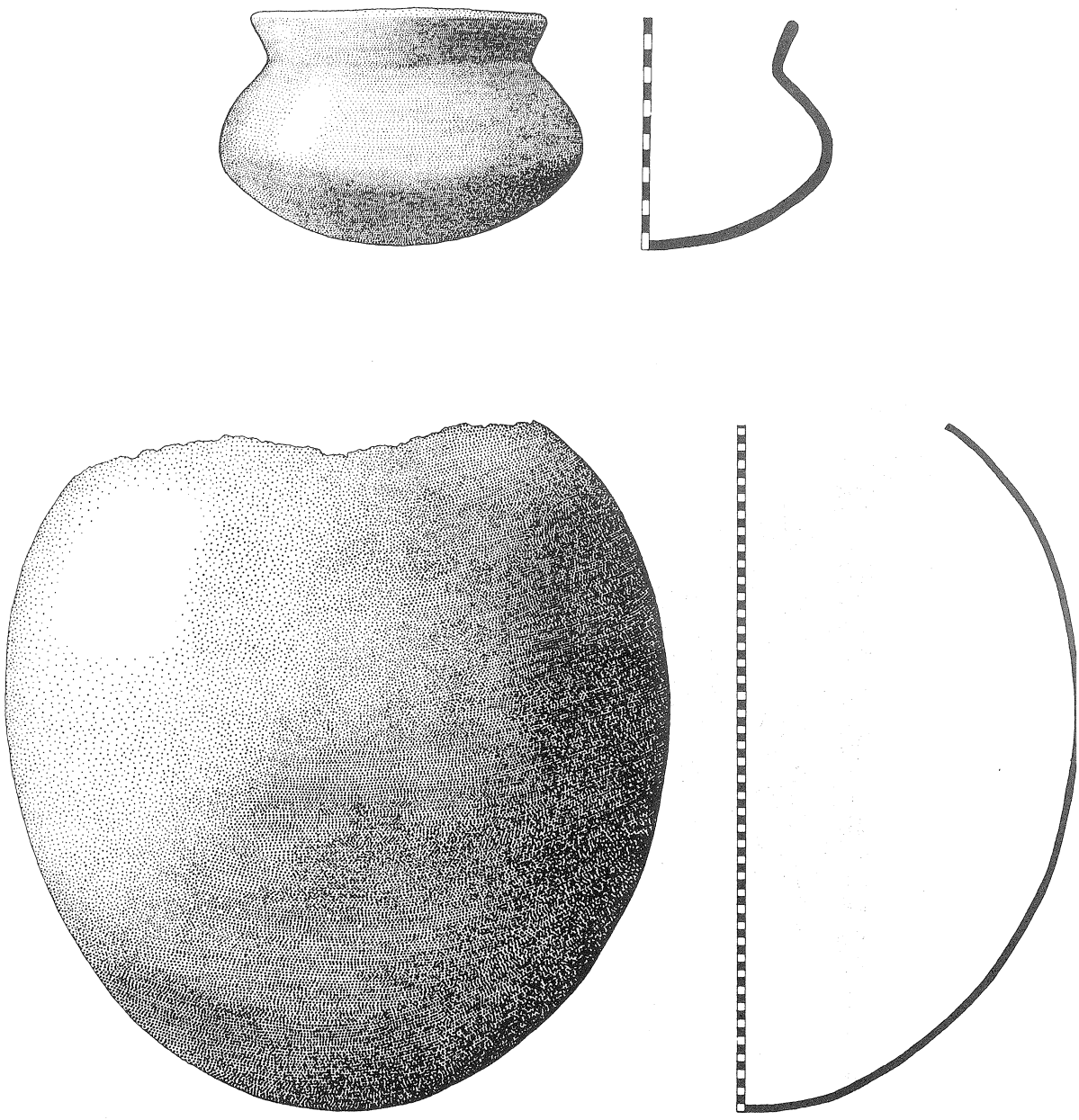

Figure 10: Above, Burial 16, Pot A (Zone B). Oxidised and small fireclouds. Lower, Burial 14 Pot A (Zone B). Oxidised and small fireclouds.

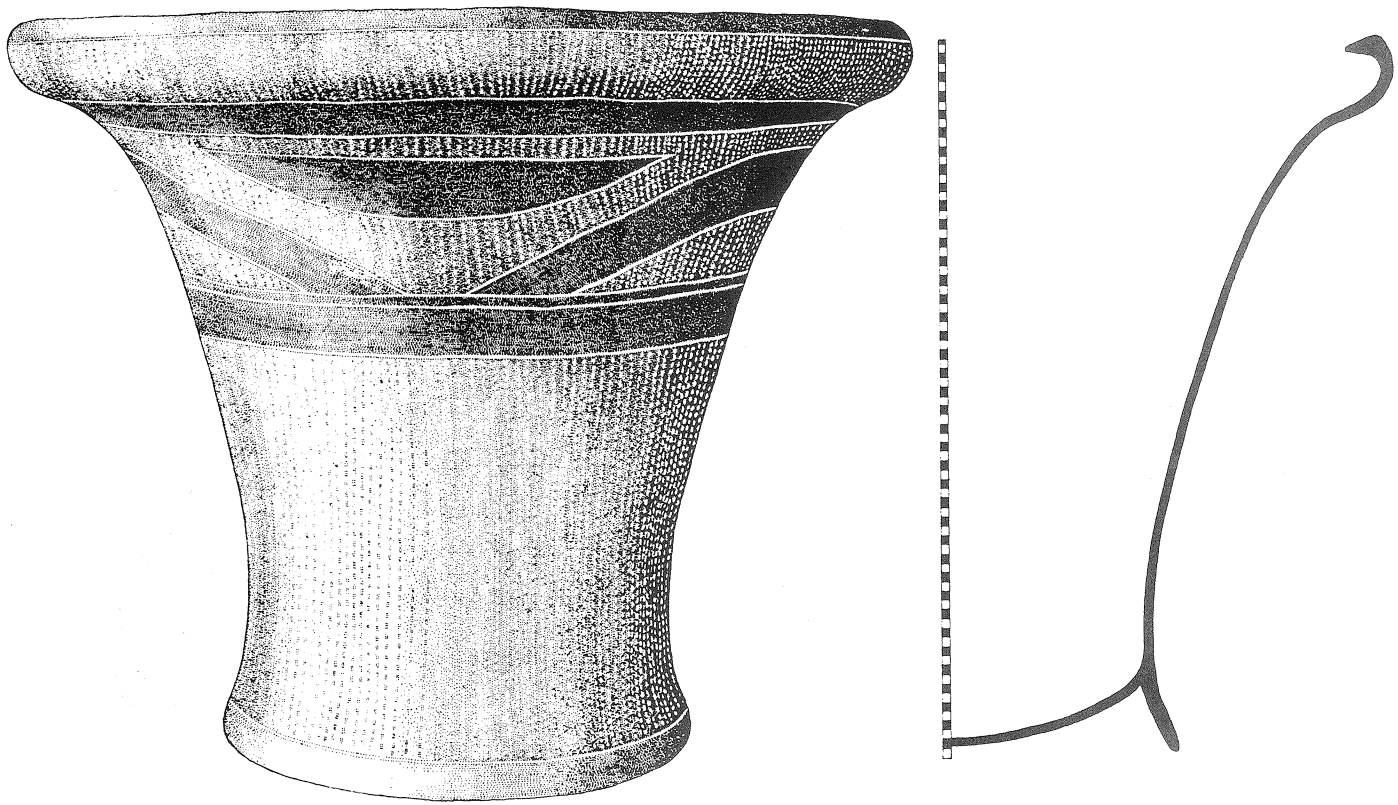

Figure 11: Burial 14 Pot B (Zone B). Oxidised and small fireclouds, highly burnished with plain fields surrounded by incised lines.

Figure 12: Burial 15, Pot C (Zone B). Highly burnished interior and exterior with incised fields. Reduced apart from exterior below the carination.

to describe tempers, are of little value except as generalized descriptions. The urgent need for a standardized terminology that is both precise and appropriate is clear.

Two principal sources of data are available for Khok Phanom Di. During the course of the excavations, clay samples were collected from various locations for comparison with the prehistoric ceramic evidence. The prehistoric material includes over 200 ceramic anvils, shaped cylinders of prepared potting clay, and a small mound of either raw or partially processed clay. Numerous ash lenses often containing pottery "wasters" and ceramic anvil-like objects were uncovered. The latter were probably used as firing platform supports.

A comprehensive assemblage of over 145 intact or reconstructable vessels was recovered. Burnishing stones, net weights, clay (or ceramic) pellets, and several tonnes of potsherds were also excavated. Nearly all the vessels, and many of the anvils, burnishing stones and clay cylinders were associated with burials.

Such a wealth of data will require a great deal of time to analyse. At this stage petrographic examination of the ceramic artefacts and the modern clay samples is proceeding in tandem with form classifications. This latter portion of the work includes the reconstruction of funerary vessels, and their classification in conjunction with rimforms, surface treatments and various other vessel components present in the overall assemblage. In view of the propensity of potters to imitate novel designs or styles, it is crucial that both the fabrics as well as their forms are subjected to detailed study. Rimforms are receiving close attention because they are potentially very important as diagnostic components of whole vessels.

While it is too early for any definitive statements to be made regarding the inception and overall development of what appears to be an intensive local ceramic industry, several preliminary observations appear warranted. The ceramic anvils cover a broad range of shapes, sizes, and surface decoration. They were often associated with cylinders of prepared potting clay. The cylinders measure approximately 8 to 9 cm in diameter by 30 to 40 cm in length.

The vessel forms include shallow dishes varying in shape from convex-based to flat (Fig 6 upper and lower), sometimes with an applied ring-footed base (Fig 7 upper). Surface decoration ranges from cord-marked with or without incised decoration, to plain. The latter are either matt finished or highly burnished with or without geometric or curvilinear incised designs. Some have carinated walls (Fig 7 lower and 8 upper). They vary in colour from fully oxidised bright reds (Munsell 10/R4) to deeply reduced blacks (5Y/3/1). This decorative set occurs throughout the assemblage. The designs are occasionally intricate and detailed. Many appear symbolic (Fig 8 middle).

Common vessel forms include round-based bowls with concave walls and a direct everted rim with a round terminus. In mortuary contexts, a sharply carinated version features these rims as a counterpoise to the carination from which they rise (Fig 8 lower). Burial 86 contained a vessel with small (*c* 20 x 20 mm high) tripod feet. These were circular in section with flat bases. In addition several detached conical pot feet, round to ovoid in cross-section, were recovered from Zone A. They measure up to 10 cm high and taper from approximately 6cm in diameter to a point. All of the tripod legs are solid (see Peacock 1980:65-72 for a discussion of tripod wares).

Burial 13 includes a small circular "pot stand". It has simple concave walls which taper to form an irregular cylinder with open ends (Fig 9 upper). Both flat and round-based pots are present, with the latter predominating (Figs 9 upper and 10 upper). These were often found together as in burial 14 which contained two large funerary urns, one egg shaped while the other featured a concealed flat base (Figs 10 lower and 11). Both vessels were expertly made.

The remaining forms are too comprehensive in range to be detailed here. However, the notably rich burial 15 included some very high quality vessels (Fig 12), in association with numerous fragmented cylinders of prepared clay, an anvil, and pebbles suitable for burnishing pottery. Overall, the non-funerary assemblage is clearly dominated by cord-marked wares. The majority of these were probably utilitarian. This contrasts sharply with the mortuary ceramics where plain (i.e. smoothed) surfaced pots dominate. These plain surfaces were often highly burnished and/or incised in a clearly expert manner. This preference for plain surfaces in pottery intended as grave goods is predictable when the relative amounts of energy involved in creating the different surface finishes is taken into account. Given the same raw materials, a paddle and anvil cord-marked finish represents minimal energy input, whereas a plain finish requires additional effort and time. Burnished and/or incised plain wares demand even higher energy. Thus, it seems logical to assume that the highest values were attached to such wares because they required the greatest time and skill in manufacture. It may be noted that, while on one the hand we are dealing with a funerary assemblage reflecting considerable vigour and expertise, their quantity is not great when measured against the number of burials (approximately 145 to 155 burials, $\bar{X}$=<0.9). This compares with Ban Na Di (Vincent, 1984:666), $\bar{X}$=2.3, and Non Nok Tha, $\bar{X}$=>3.0 and possibly higher (Bayard pers. comm.).

Donnan and Mackey (1978) documented from Peruvian archaeological contexts individual grave assemblages that are invariably characterised by the lack of duplication of any discrete pottery type within any single grave assemblage. This phenomenon was again noted by Vincent (*op.cit.* :665) for Ban Na Di in the Sakon Nakhon Basin. Although more refined analysis is needed the same phenomenon also appears to be present at Khok Phanom Di. The important task of correlating vessel fabrics with their forms, which is now underway, will clarify this point.

On the basis of on-site impressions convincing evidence of pottery manufacture *in situ* abounds. The scale and persistence of the industry however, has yet to be established. Several clues to these crucial questions can be discussed even at this early stage in the research.

The shape of the most common rimforms gradually changes with time. Technologically how-

ever the early rimforms appear ancestral to the later examples. In each case the rim terminal consists of a simple internal or external fold. For each rimform the construction method remains the same. Only the shape gradually changes. We thus may be witnessing an example of rimform evolution, a phenomenom not only relatively rare archaeologically but possibly diagnostic of an enduring regional ceramic tradition. Before this can be confirmed close attention will need to be paid to any changes in the local fabrics and their relationship to this apparent evolution in form.

Calculations aimed at providing an assessment of the proportion of utilitarian as opposed to ornamental wares will hopefully assist in determining whether much of the production was intended for exchange. Initial impressions are that the utilitarian wares were, in the main, intended for such a trade.

There are 62 anvils in Zone A, 23 in Zone B and 121 in Zone C contexts. The poor representation in Zone B reflects the intensive burial nucleation and resultant lack of industrial activities in this part of the site during the period it represents. Initial examination of anvil thin-sections suggests that for the upper zones locally available clays were used. However, the fabric of anvils from the lowest level is petrographically different from the succeeding anvils. This change in anvil fabric parallels changes in the fabrics of postulated local wares from both burial and occupation areas. Petrographic examination of anvils, level sherds and what appear to be the fragmented portions of a prepared clay cylinder, all derived from the basal levels, reveals that they are all composed of a fabric containing angular sand of up to granule size which is dominated by both mono- and polycrystalline quartz. Tourmaline and mica (possibly biotite) are present as accessory minerals. Argillaceous particles, of sand to very fine pebble size, are also occasionally present in varying amounts. These include iron- rich pisolites, in addition to what may be purposefully added grog temper. As Whitbread (1985) has pointed out, however, it is often difficult to discriminate between argillaceous rock fragments and grog in thin section. Resolution of this should follow further detailed examination of the fabric. The resultant fabric gives the appearance of being sand-tempered in hand specimen. Several caches of coarse sand to medium pebble-sized grains, containing mono- and polycrystalline quartz, pisolitic limonite rock fragments, and further as yet unidentified minerals, were recovered from lower Zone A contexts. This material may well have been used to temper the earliest pottery. The nonplastic inclusions mentioned above, however, may be natural components of the raw clay. Without either a sample of the raw untreated clay for comparative purposes or alternatively a detailed statistical treatment of the size/texture distribution of the nonplastics it is not possible to state at this stage more than that these fabrics differ from those representing the later ceramics.

In Zones B and C the postulated local wares comprise fabrics mineralogically consistent with the local regional and geologically recent, sedimentary geology. Clay samples collected from five quarries currently utilized for brick making and situated within a 20 km radius of Khok Phanom Di have been examined petrographically. They display considerable variability in nonplastics, but this is principally in degree of sorting and size. Two of these clays are compatible, if not identical mineralogically, with two of the major fabric groups postulated as local wares. In addition, clay collected from sections adjacent to the site is mineralogically consistent with a further "local-ware" fabric. Thus it appears that during the period of occupation represented by Zones B and C, and possibly much of Zone A as well, locally available clays from at least three separate sources

were utilised. This is not to suggest that these sampled clay sources coincide precisely with the prehistoric sources, but that the local geology includes clay deposits that are mineralogically consistent with those used in prehistory and such clays are probably quite widespread although locally restricted in extent.

The immediate regional geology consists of expanses of rapidly deposited marine clays, combined with and influenced by alluvial and colluvial sedimentation. Depositional processes of this type produce a mosaic of often highly localised potting clay deposits. As a consequence of such geological conditions considerable local fabric variability is predictable. The mineralogical compositions of the various modern samples clearly demonstrate this variability.

To date, 65 burial pots have been examined petrographically, and while detailed work on these thin sections has yet to be undertaken, the majority are comprised of fabrics mineralogically consistent with the regional sedimentary terrain. They are either local wares, or display the same degree of variability as nearby modern clay quarries. Two different groups contain exotic fabrics. One contains fabrics petrographically consistent with sedimentary clays but which are different from and probably unrelated to the known modern clay sources. Another group contains igneous minerals suggestive of a granitic or granodiorite source. Outcrops of granitic rocks occur about 25 km south of the site.

Several burial vessels contain "incidental" rice fragments (Yen 1982). Local wares are either untempered or tempered throughout Zone B and much of A,with a grog species perhaps best described as "orthodox". It consists of rounded to angular prefired potting clay usually of sand size. This tempering method was probably widespread in prehistory. It occurs extensively at many prehistoric sites throughout the Khorat Plateau from the earliest levels. In the northern portion of the plateau it was replaced by a highly distinctive grog species described as "blebs" (Vincent 1984).

Bleb temper, which is invariably associated with rice husks, occurs throughout the sequence in occupational contexts and in Zone B burial vessel fabrics. It is associated with a range of parent ceramic bodies, including an early Zone C anvil, that are all consistent with the sorts of clays found within the large tract of sedimentary terrain which surrounds the site. But in each case they are almost certainly exotic to Khok Phanom Di itself. The marked fabric variability of bleb tempered wares suggests that this technologically related method of tempering was regionally widespread. Some bleb tempered wares probably derive from production centers located substantial distances from Khok Phanom Di, but still within the vast sedimentary structure of the Central Plain.In the occupational levels at least, bleb tempered pottery may be positively correlated with a paddle-impressed surface finish.

A rim from basal levels is tempered with blebs in association with abundant rice husk. The fabric incorporates a micaceous clay body containing very fine nonplastics including a few sponge spicules. Such clays are consistent with the local sedimentary geological region. This fabric however, is not clearly related to the postulated local ware nor is the rimform common. Thus, on both counts the rim can be reasonably considered exotic.

The use of large amounts of rice husk as a tempering agent should not be viewed as a whimsical aberration in a ceramic manufacturing strategy or tradition, because any temper selected must be reliable in two ways. It must be dependable in terms of its function as a component of the ceramic fabric and crucially, because temper plays a central critical role in the overall pottery manufacturing process, it must be readily available. A key factor in the choice of a temper is the existence of a consistently reliable supply.

The use of rice husks for temper indicates a close and intensive relationship between subsistence and technology. It further suggests that this valuable source of food was exploited on a

permanent basis. Whether rice was available as a cultigen or an abundant and readily harvested wild plant has yet to be established. In either event an intimate knowledge of the plant on a regional basis seems obvious.

At this stage the local use of rice temper appears to be restricted to Zone C utilitarian wares, as represented by the most common rimform. However, rice appears consistently throughout the sequence as "incidental" inclusions in the local fabrics, and this alone indicates its local ubiquity. Local evidence for the advent of deliberate land clearance, coupled with a subsequent rise in grass species, is suggested by the pollen spectrum reported by Maloney (this paper).

Arnold (1985:71-79) reports that in climates subjected to substantial rainy seasons, and consequent high relative humidity, (e.g. monsoon conditions such as currently experienced in Southeast Asia), ceramic industries are seriously affected. Because of excess atmospheric moisture, and/or long periods of heavy rainfall, plastic pottery fabrics often cannot be dried enough to ensure they will hold their shape. These conditions may also cause unfired pottery to crack. Firing under these conditions is hazardous, and in addition moving unfired pottery because of them risks damage. In such conditions manufacture is not warranted and production ceases in the wet season. This regulatory effect has important implications. First it precipitates a process of negative feedback.For potters wholly or partially reliant on production for subsistence, these enforced seasonal constraints mean that other forms of subsistence activity are needed to minimize the regulatory effect of weather and climate. Such conditions favour deviation amplifying processes, where two subsystems interact to their mutual enhancement (Flannery 1968, Hammond 1977). Thus, because volume pottery production is climate-dependent, and accentuated seasonality may places restrictions on it, the subsistence base annual regime may need to be modified in order to accommodate the excess labour available when potting is not possible.

Volume ceramic production is labour intensive. Once committed to a strategy of intensive, seasonally constrained industry, subsistence base options are automatically restricted. Two likely options are either those involving division of labour or those capable of producing seasonal surpluses. The question of whether the above cultural processes were active at Khok Phanom Di may be illuminated by the clarification of two crucial points. Firstly whether the ceramic production parameters, including any diachronic changes in production levels and/or technology, were related to dynamic environmental factors, perhaps involving the modification of the local floral environment. Such environmental changes could have invoked constraints related to seasonality by reducing the locally available flora and fauna. And secondly the possible integration and interdependence of pottery manufacture, which is a technologically and labour intensive craft industry, with the subsistence base.

In contrast with the relatively minor number of exotic fabrics identified to date in funerary vessels, the occupation level sherds include a wide variety of different fabrics, many of which are exotic. These differences, which are apparent in either fabric mineralogy or temper, or both, are evident to varying degrees throughout the sequence. An example of this variety is a Zone B fabric which contains limestone. Limestone outcrops in two locations 50 to 60 km to the southeast. A third outcrop is located 72 km to the east. The igneous mineralogy observed in the burial pottery is also present in occupational wares from the earliest levels. Thus evidence of links both to the south and east of the site are indicated. A range of fabrics contain argillaceous granule-sized inclusions some of which probably indicate clays derived from metamorphic terrain. A further fabric contains large (2-7 mm) crystal-shaped geometric voids representing inclusions that have probably decomposed during firing. Thus pottery from many different geological source regions is present.

The dominant Zone C local rimsherds are rice tempered. Other exotic fabrics, some differ-

ently tempered, are also represented in these rimforms. Such variation in temper species within a form group strongly suggests a regional rimform design. Because potters exhibit extreme conservatism in their use of temper (Shepard 1956), the separate use of different temper species within a single ceramic tradition is highly unlikely. Rice also occurs as incidental inclusions in both occupational sherds and burial vessels. These include a burial 88 vessel fabric which is probably exotic, and several level sherds from the earliest levels that are probably local fabrics. One of these sherds displays what appear to be rice husk impressions on its surface.

The earliest levels contained numerous ash deposits sometimes in association with sherds interpreted as pottery "wasters". Some have ash, charcoal and fossilised wood adhering to their surfaces. The ash has been interpreted as firing residue. Several unusual ceramic artefacts recovered from within or near these ash deposits may have been employed as supports under a wooden framework used in the firing process. One of these stands is approximately 14 cm high, with a deeply concave circular base 9 cm in diameter. A lenticular ridge with a convex head forms the upper terminus. It measures about 70 by 60 mm in plan along the axes.

The fabric of these "stands" is very fine and dense with few nonplastics but has the general appearance of the modern local clay sample in thin section. This suggests that the nonplastics may have been purposely removed in order to prevent "dunting", or cracking due to thermal shock as the silica inversion temperature (573 C^0) is crossed. Normally in controlled firings dunting is not a problem. However, when silica rich ceramics are repeatedly allowed to cool and reheated to temperatures in excess of the silica inversion, the likelihood of catastophic fracture is increased considerably.

Many of the anvils and clay cylinders were incised with distinctive marks which may denote individual ownership. Some of the cylinders, for example, display spiral incisions extending along their walls. At least one anvil is also marked in this manner. Other anvils have concentric incised circles or a series of punctate circular holes impressed into their handle bases. To date, only the incised spiral markings can be positively related to both cylinders and anvils. However, as far as the author of this section is aware this is the first instance of possible potters marks to be recorded in Southeast Asian contexts, and it contrasts with the 22 anvils uncovered at Ban Na Di in Northeast Thailand which were all unmarked. In contrast to Khok Phanom Di none of the Ban Na Di anvils was firmly associated with a grave offering (Kijngam 1984).

Nor are the burial vessels in any sense "ordinary". From both a technical and artistic perspective they are clearly the work of practitioners who were not only familiar with their craft, but excelled in it. Many easily satisfy Leach's (1975) criteria for "masterpieces". Their range of shapes, surface decoration and size is both comprehensive and detailed. Many are apparently unique in Southeast Asia. Although some of these vessels may give cause for diffusionists to reach for their comparative literature, at this stage no realistic parallels, in terms of overall forms, apart perhaps for the tripod ware touched on above, seem tenable.

In conclusion the following points are noteworthy. Pottery was locally produced throughout the sequence. It was produced in quantity often featuring standardized, but evolving, forms. These forms may, in some cases, represent a regional style. Some vessels may have been intended for exchange. For at least some of the sequence potters incised or impressed a variety of marks into their anvils. This suggests that several were manufacturing pottery contemporaneously. Further, the quantity and density of potsherds in the occupation levels may reflect a full time mode of production for at least part of the year.

Changes in postulated local ceramic fabrics occurred soon after initial occupation of the site. A second change coincides with the abandonment, in this portion of the site at least, of the burial ground. The final occupation phase saw the local use of rice as a temper. It is likely that a variety

of local clay sources were exploited throughout the sequence.

Given that Khok Phanom Di was, in terms of its ceramic industry, a production centre, and thus for a significant portion of its annual production cycle given over to large scale or volume pottery production; and given that the prevailing climatic conditions were similar to those currently experienced, then it seems likely that ceramic production was seasonally constrained. An environmental limitation of this kind would be impossible to cope with in the absence of a sophisticated technological apparatus. The effect would be more or less total, with the annual production cycle divided into periods when volume production was possible and those when it was not. This constraint may have had considerable implications for the overall cultural system. It may have stimulated changes in other subsystems, particularly the subsistence base and engendered a process of "deviation amplification" (Flannery, *op. cit.*).

Ceramic artefacts were also entering Khok Phanom Di from a wide range of geological source regions. The comprehensive variety of these exotic fabrics indicates that exchange networks of considerable complexity may have been involved.

The quality of many mortuary vessels was very high indeed. Most of those examined to date appear to have been locally produced. By contrast with the clear evidence of what looks like a major manufacturing centre probably involving many potters, relatively few vessels were dedicated as funerary furniture. It is possible that due to the close association with an intensive pottery industry ceramic artefacts did not attract a high value unless they were of exceptional quality.

The important question of whether Khok Phanom Di was a manufacturing centre, and as such a net exporter of ceramics, awaits a much fuller analysis and remains one of the central aims of the ceramic portion of the study. However the brief outline set out above suggests several compelling factors in support of a major indigenous industry of considerable duration. If so, questions concerning related cultural processes may well prove profitable to pursue.

CURRENT IMPRESSIONS ON THE STATUS OF KHOK PHANOM DI (C.F.W.H. and R.B.)

The excavation ended in July 1985, and the laboratory analyses have only been underway for about seven months. Clearly we have no conclusions, only a series of impressions. The macro food remains are dominated by marine-mangrove species during the buildup of Zones A and B, and by aquatic and woodland species in Zone C. Maloney's views on the palaeoenvironment based on pollen, sediments and diatoms are in favour of a coastal location, perhaps on a marine barrier which protected its immediate hinterland from the sea and thus favoured the development of fresh water swamps. Certainly, the recovery of some potsherds from lower levels encrusted with barnacles, and the presence of lenses reflecting marine overwash hint very strongly that the site was close to the sea, at least during Zone A.

We have many data on the prehistoric diet. Apart from fish and shellfish, we found the remains of crabs and squid, and much plant material which includes leaves and nuts. Zones A and B yielded very little mammalian fauna. We found the remains of deer, pig, macaque, langur and dog. We also encountered much rice chaff. This was found scattered through the prehistoric layers, and adhering in large clumps to the exterior surfaces of potsherds. Some too, was used as a tempering agent in the manufacture of pottery. This material is identical with the substance which has been described as rice chaff since it was recognised in Dvaravati period bricks and the pottery from Non Nok Tha and Ban Chiang. Yen (1982) has, of course, described the remains from Ban Chiang as being derived from rice. This chaff, which we feel comes from rice, was present from the basal layers. Detailed analysis will, it is hoped, provide some insight as to the wild or domestic status of the remains from the different contexts at the site. Evidence for the diet

came from two unusual if not unique sources. We found the remains of partially digested food in the stomach areas of two burials. They contained at least small fish bone and fish scales. There were also many faecal remains which, given the rarity of dog remains, are more likely to come from man. Again, on site examination of the exterior surfaces of these specimens revealed fish bone fragments and "rice" chaff.

The burials will furnish much interesting information. There is a clear thread of continuity in terms of the mortuary rite from the earliest through to the latest grave. The orientation is almost without exception with the head towards the east, and bodies were laid out on their backs, with hands by the sides in association with a variable range of goods. These comprised pottery vessels, shell beads, shell bracelets, stone axes, burnishing stones used in pottery manufacture, potters' anvils, and food remains, in particular turtle carapaces. Bodies were covered in red ochre and wrapped in a shroud made of unwoven material which looks like bark cloth. There is a change from Zones A to B in terms of age structure, the former having many more infant burials. Again, whereas the Zone A burials were placed in occupation deposits, the later ones were laid out in rows in a soil matrix free of occupation debris, and aligned with a raised platform structure. Some of the Zone B burials, both of adults and children, are outstandingly rich. We feel, at present, that we have a long and continuous mortuary tradition which underwent modifications towards increased ceremonial and polarisation into rich and poor burials with time. Use of the excavated area as a cemetery terminated with Zone C.

The material culture from zones A and B shows elements of continuity and change. Vincent has already commented on the pottery. There is a large sample of stone axes, which were both shouldered with a square tang, and oval in cross section. The absence of high quality stone from the area around the site encourages the idea that the axes were obtained through exchange. There was abundant evidence for fishing in the form of netweights, fishhooks and harpoons. There is much evidence too, for local manufacture. Some of the ash lenses are currently interpreted as the remains of firing of pottery vessels. The clay anvils used for pottery making are found from the top to the bottom of the site, and there are also many burnishing pebbles from both occupation and mortuary contexts. Shell beads and bracelets were also made at the site. It is worth mentioning that small shell disc beads and other items of shell jewellery similar to those found at Khok Phanom Di are among the items found in early inland contexts, such as Khok Charoen, Ban Kao, Ban Tha Kae (Hanwong 1985) and Samrong Sen (Mansuy 1923). It is not unreasonable to suppose that Khok Phanom Di was a manufacturing centre involved in wide ranging exchange networks.

Such maritime exchange networks with inland connections were, of course, very widespread during the period of early anthropological interest in Melanesia. To those uncovering the remains from Khok Phanom Di, the clear evidence for a very considerable time depth to such exchange systems was one of the most exciting aspects of the field research. Much laboratory research must be undertaken before we can replace impressions with properly documented models for the maritime adaptation of the people of Khok Phanom Di. At this juncture, it would be unwise to go further than to suggest that we have a reasonable chance that the data to hand will illuminate an early stage in the exploitation of rice within the economic system.

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