Chapter 7

The ceramic traditions of Ban Na Di

7.1 Archaeological summary

Ban Na Di is located less than 20 km from Ban Chiang (Gorman and Charoenwongsa 1976, White 1986). It is situated near low terrace soils (Moorman *et al.* 1964), at the confluence of two small streams. This is a typical environmental relationship shared with many other prehistoric sites recently surveyed in the Kumpawaphi area (Kijngam *et al.* 1980). For some of its prehistory, the site was occupied contemporaneously with Ban Chiang (White 1982, 1984, 1986). Radiocarbon determinations, derived from secure and stratigraphically unambiguous contexts, imply an occupation sequence spanning the period from *c.* 1500 B.C. to after *c.* 200 A.D., according to the excavators (Higham and Kijngam 1984:29-32).

Eight stratigraphic levels have been identified at Ban Na Di (Higham and Kijngam 1984). The earliest three, (levels 8 to 6), contained superimposed inhumation burials with numerous thin sand lenses interspersed between them. These lenses are apparently derived from over-bank floodwaters. The excavators have subdivided this early mortuary phase (MP1) into three successive subphases 1a-c. A second mortuary phase (MP2) is ascribed to level 4. MP2 is less well represented, comprising only five child jar burials. Evidence for bronze casting spans levels 8 to 4. Bronze casting clearly becomes intensive, however, with the creation of level 5. Iron initially appears in level 7. This is fugitive, however, and can readily be explained by post-deposition disturbance. Higham (1987:145), considers 500-400 B.C. as a reasonable date for the origins of early iron-working in Southeast Asia. The first clear indications of iron-working at Ban Na Di derive from level 5 (Kijngam 1984:91). The excavators' proposed chronology is set out in Table 7.1 below.

Ceramic materials occur throughout the entire sequence. They include what seem to be utilitarian and ornamental wares. One hundred and thirty four vessels were associated with mortuary ritual. Animal figurines modelled from clay were also interred as funerary furniture. Accoutrements used in pottery manufacture and bronze-working were uncovered. This equipment includes ceramic anvils and metallurgical apparatus, the latter including moulds, crucibles and furnace remains. A total of 263 rimforms and 147 vessels have been examined, along with ceramic rings, bow pellets and several perforated sherds. Fabric associations are summarized in appendices one to three. Ceramic artefacts from levels one and two have not been analysed, except in rare instances, as this portion of the stratigraphy is considered by the excavators to post-date 1550 A.D.

TABLE 7.1: Ban Na Di: Excavators Proposed Chronology

Level	Mortuary Phase	Chronology	Cultural Activity
8		c.1500 to 900 B.C.	occupation
7	1	c.900 to 500 B.C.	Mortuary Subphases:
		c.900 to 700 B.C.	1a (lower level 7)
		c.700 to 500 B.C.	1b (upper/mid l.7)
6	1	c.500 to 100 B.C.	
		c.500 to 400 B.C.	1c (lower level 6
5		c.100 B.C.to 200 A.D.	industry (bronze casting)
4	2	post-dates 200 A.D.	mortuary/industry (bronze casting)
3	3	post-dates 500 A.D.	occupation/mortuary
2			occupation
1		recent	occupation

Note: Three separate areas were excavated. A 2 x 2m test square, and two main excavation areas of 3m x 15m (squares A1 to A4), and 4 x 4m (square F6) respectively.

7.2 Ban Na Di Ceramic Traditions

The Ban Na Di pottery can be separated into three groups, funerary and occupation context wares, and industrial ceramics. Non-ceramic clay figurines and furnace remains are also present. Each of these aspects will be considered. We will examine burial, occupation and industrial fabrics and consider the relationships between these fabrics and artefact forms. Interments during the earliest mortuary subphases derive from stratigraphic contexts of exceptional clarity. Therefore we commence with an examination of burial fabrics.

(a) “Whole” vessels

Eleven burial context fabrics have previously been partially described (Vincent 1984b). Some of these have been modified in the light of subsequent, more detailed, evidence. Along with a further four fabrics, they are described in Appendix one. Whole vessel fabrics, including those stratigraphically equivalent with the burial phases, are also summarized in Appendix one. No vessels were recovered from phase 3 burials, thus burial fabric groups relate to mortuary phases 1 and 2 only. Mortuary phases 1a to 1c will be considered first. Figures 7.1 to 7.6 illustrate the stratigraphy of Ban Na Di, the site layout, and selected burials respectively.

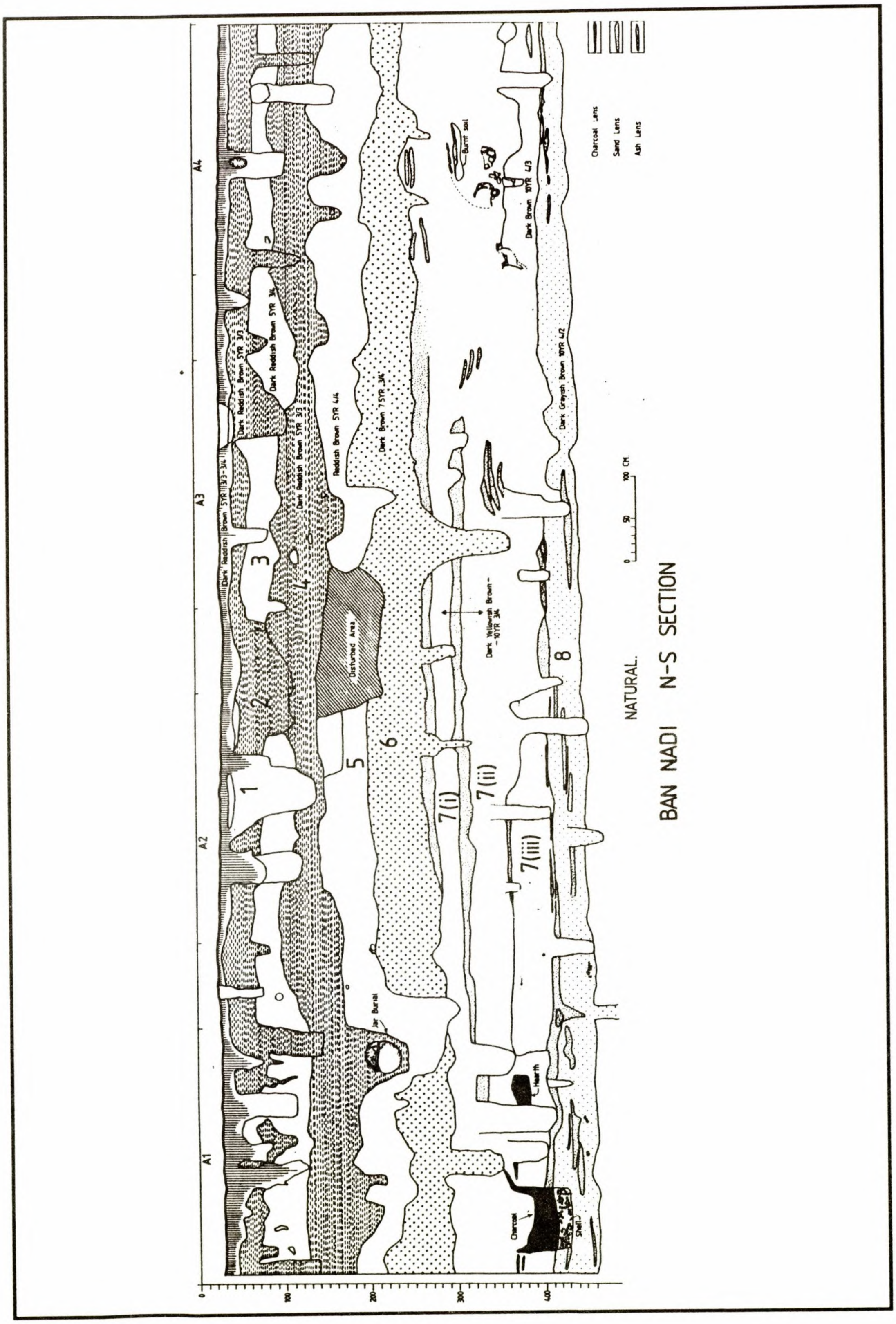

FIGURE 7.1: STRATIGRAPHIC CROSS-SECTION OF BAN NA DI.

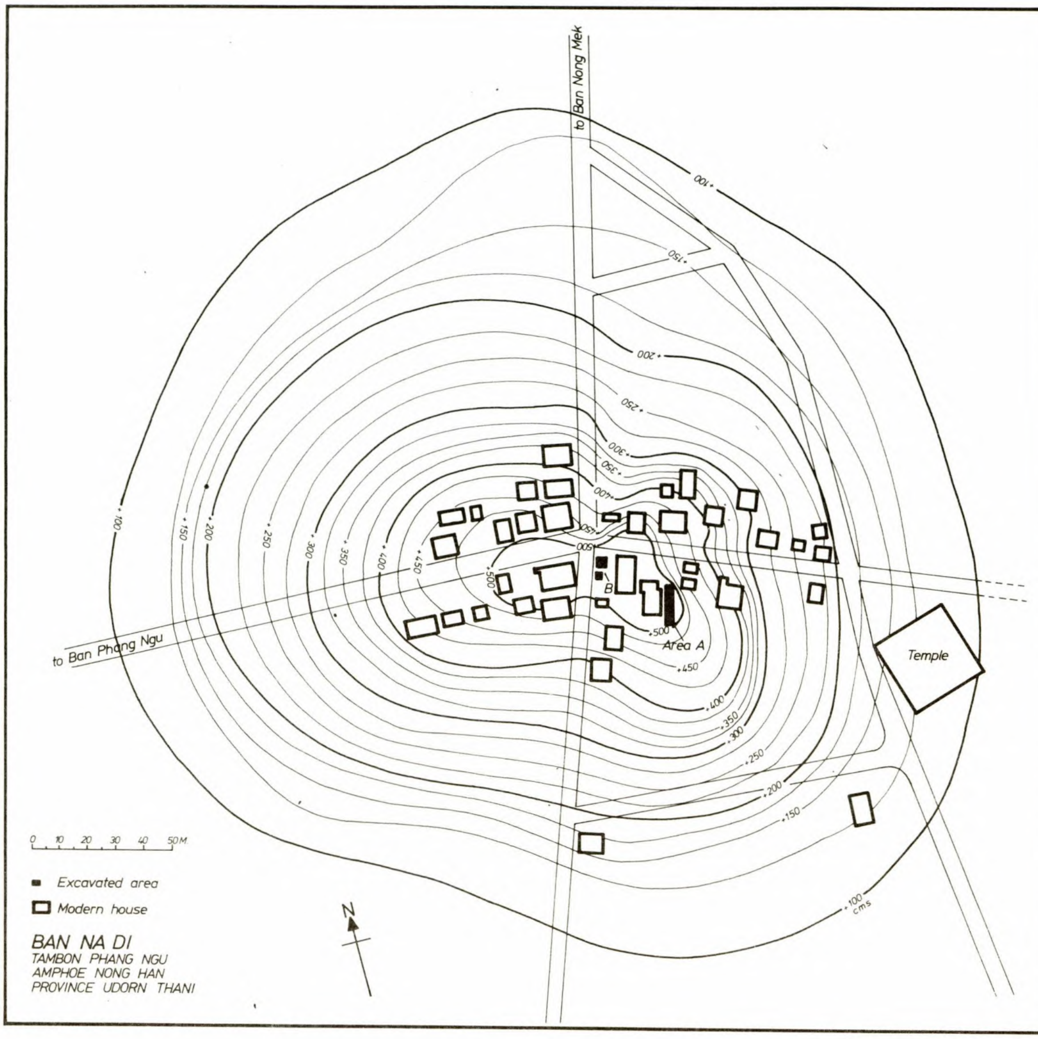

FIGURE 7.2: SITE PLAN OF BAN NA DI.

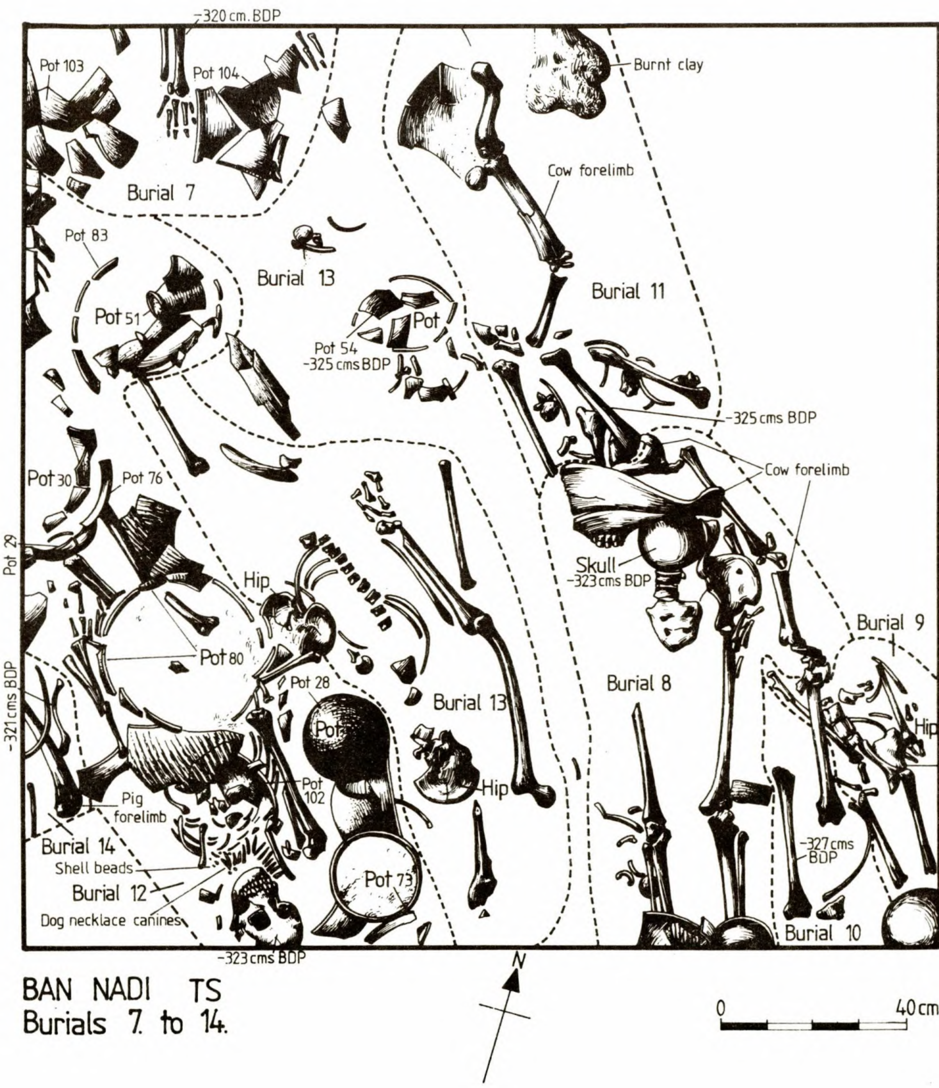

FIGURE 7.3: (a)SELECTED BAN NA DI BURIALS.(burials 7 to 14).

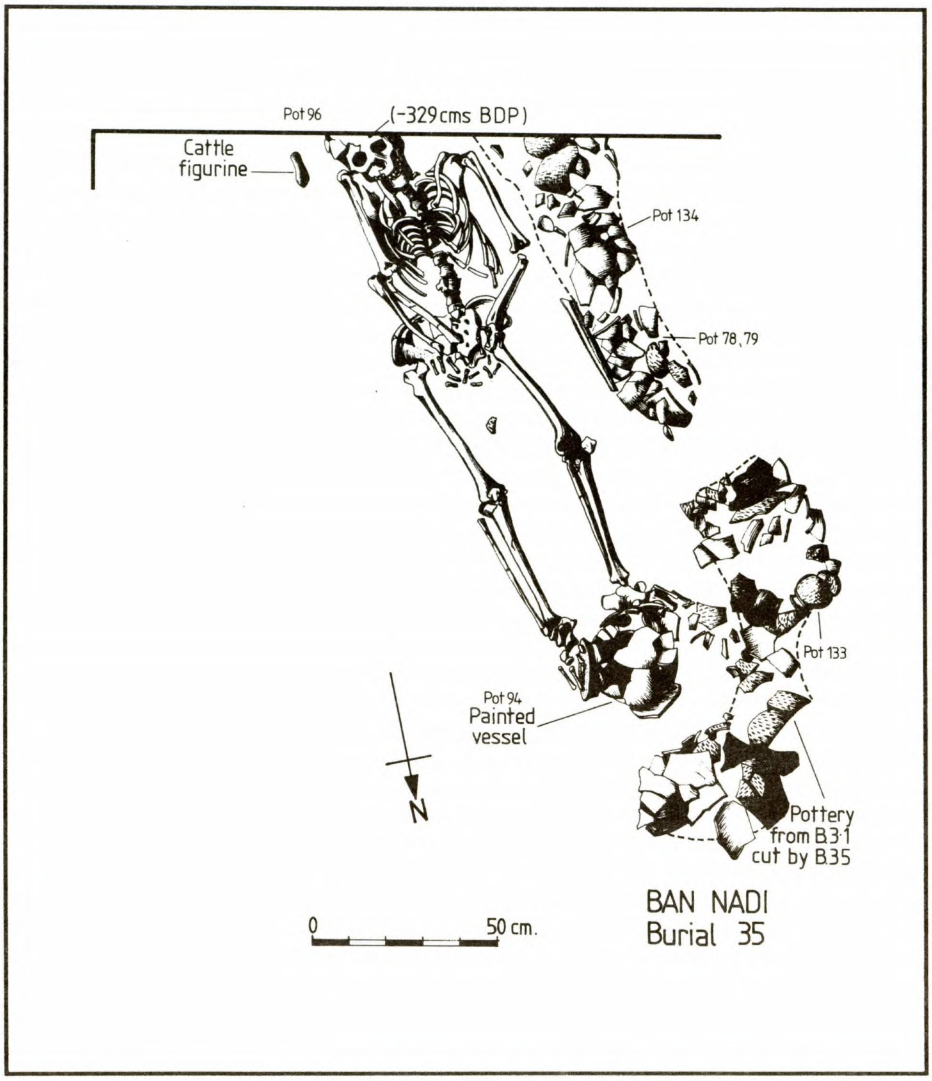

FIGURE 7.4: (b)SELECTED BAN NA DI BURIALS.(burial 35).

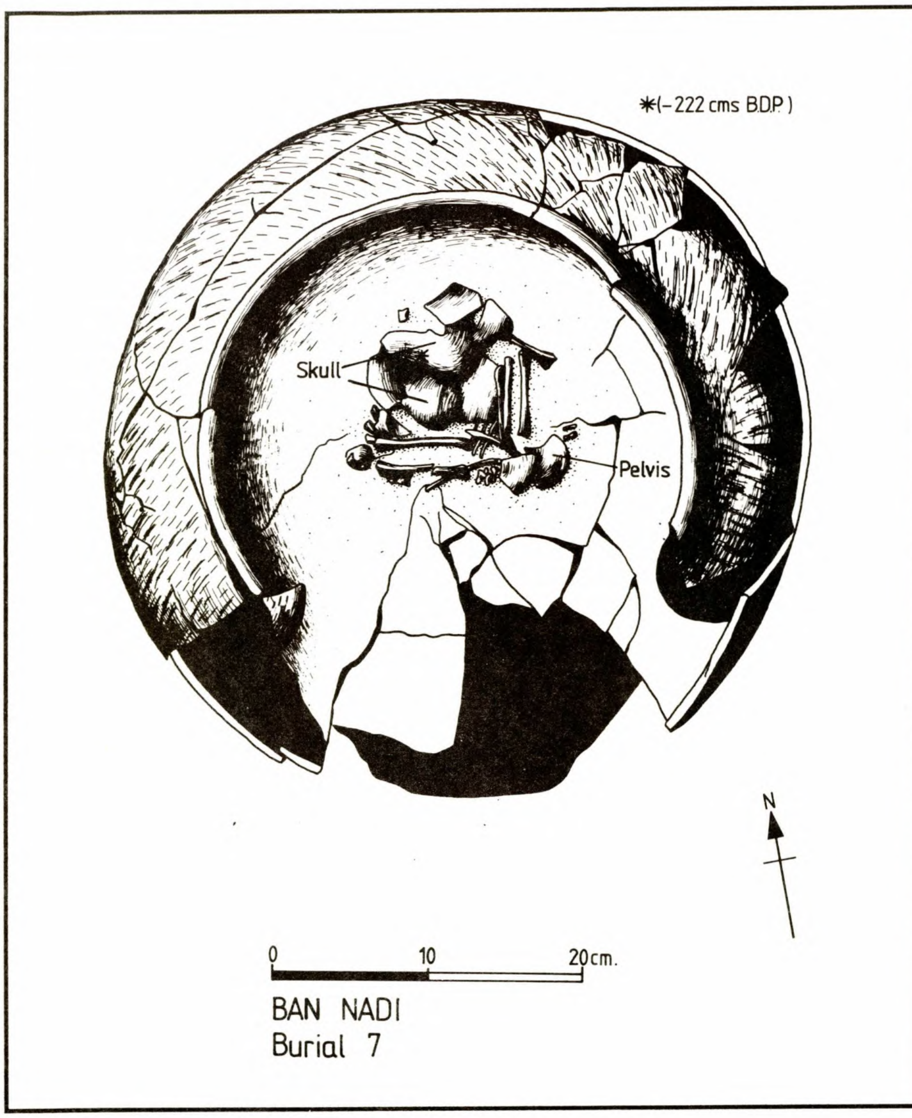

FIGURE 7.5: (c)SELECTED BAN NA DI BURIALS.(burial 7).

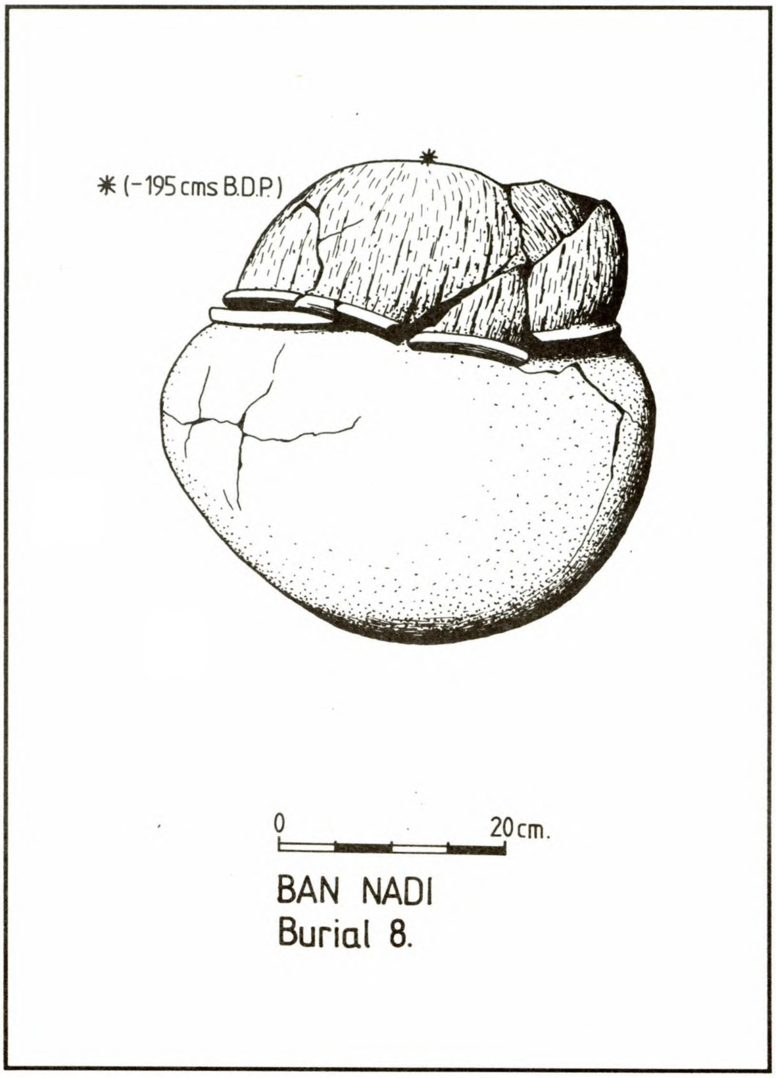

FIGURE 7.6: (d)SELECTED BAN NA DI BURIALS.(burial 8).

7.3 Mortuary phase one

Fabrics during mortuary phase 1 can be conveniently divided into three groups:

(i) grog tempered

(ii) rice tempered

(iii) sandy fabrics occasionally containing relatively minor amounts of grog or grog-like argillaceous material

We have noted that grog can be subdivided, according to the criteria given in chapter six, into orthodox and bleb subspecies. Fabric groups 1, 2, 3, and 4 all contain orthodox grog morphologically similar to that shown in figures A.1 and 6.1. Each is considered a product of the earliest ceramic tradition (Appendix one). They are grouped according to technological characteristics which are reflected in the quantity of grog, plant material, quartzose sand and spicules in each fabric. Table A.1 (Appendix one) sets out the vessel fabrics, forms, mortuary phases and likely source. Form categories are derived from Higham and Kijngam's (1984:306-309) factor analysis. Therefore they need to be considered in conjunction with fabrics. The validity of these form categories, for comparative purposes, is here considered to be restricted to MP1 Ban Na Di pottery, the ceramic tradition the majority of them represent. An example of each form category is illustrated below (figs. 7.7 to 7.21). In each of the illustrations a is at the top.

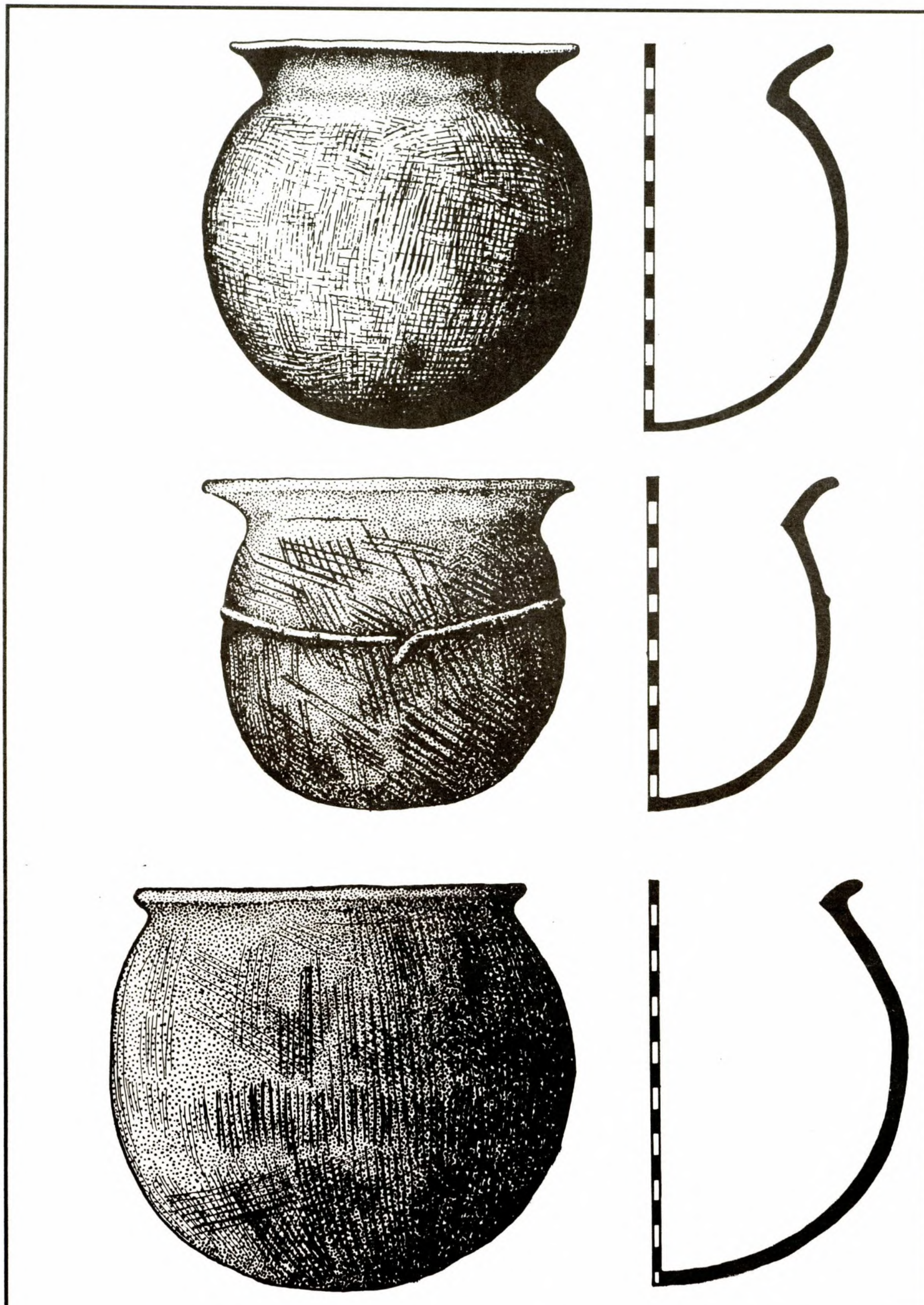

FIGURE 7.7: BAN NA DI "WHOLE" VESSELS (a: pot 5, form 1a. b: pot 9, form 1b. c: pot 6, form 1c.).

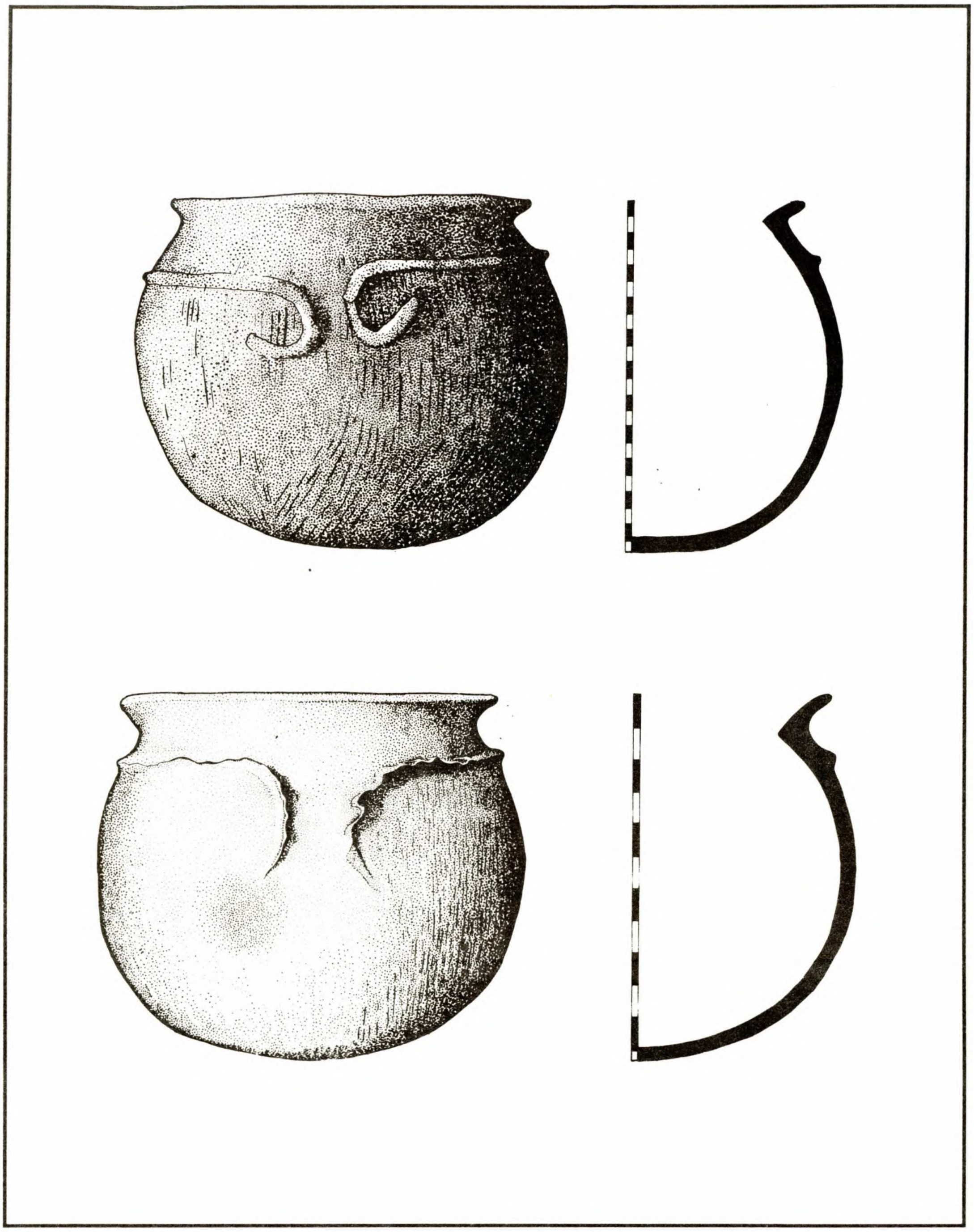

FIGURE 7.8: BAN NA DI "WHOLE" VESSELS (a: pot 30, form 2. b: pot 34, form 2.).

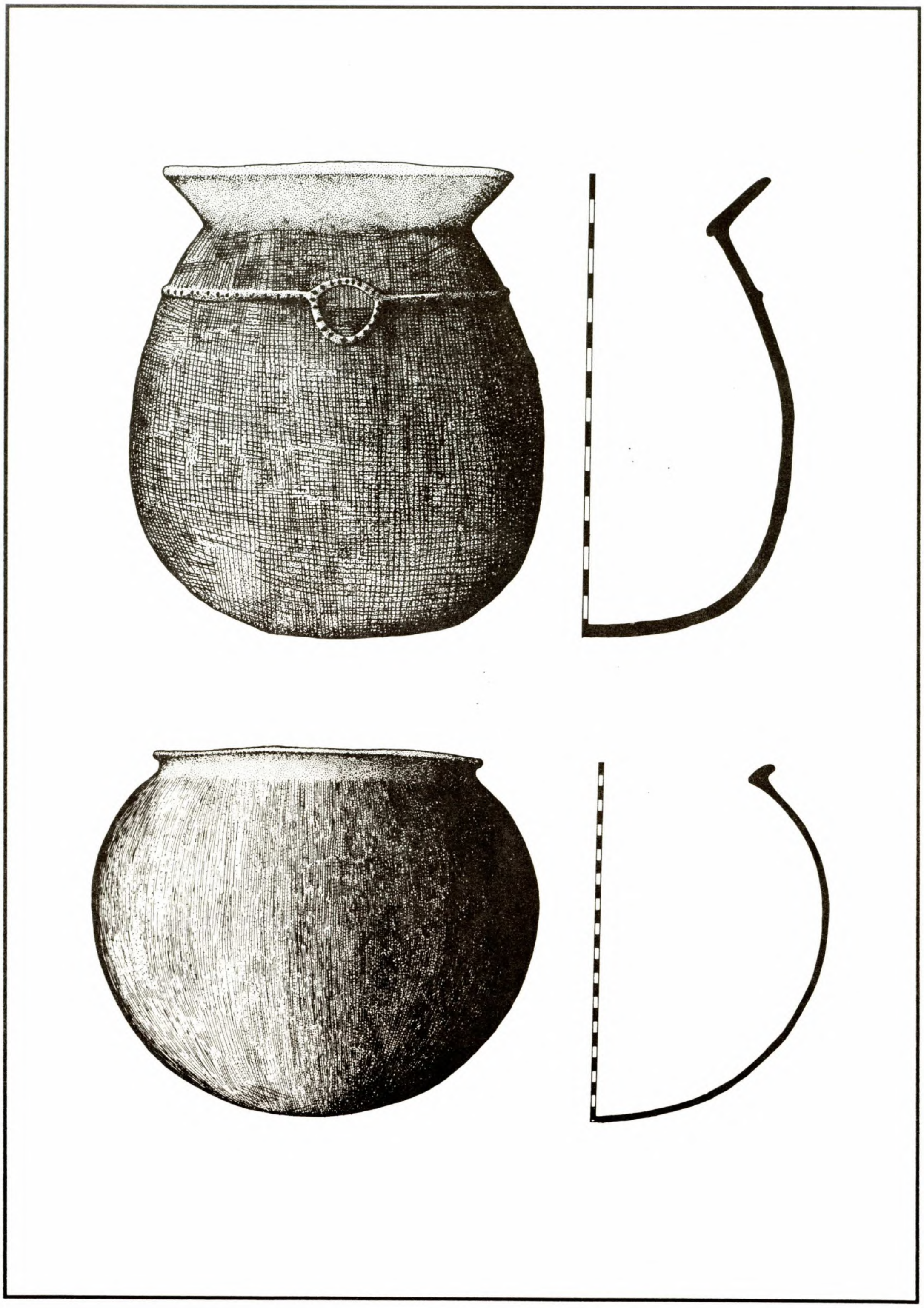

FIGURE 7.9: BAN NA DI "WHOLE" VESSELS (a: pot 108, form 3. b: pot 135, form 4.).

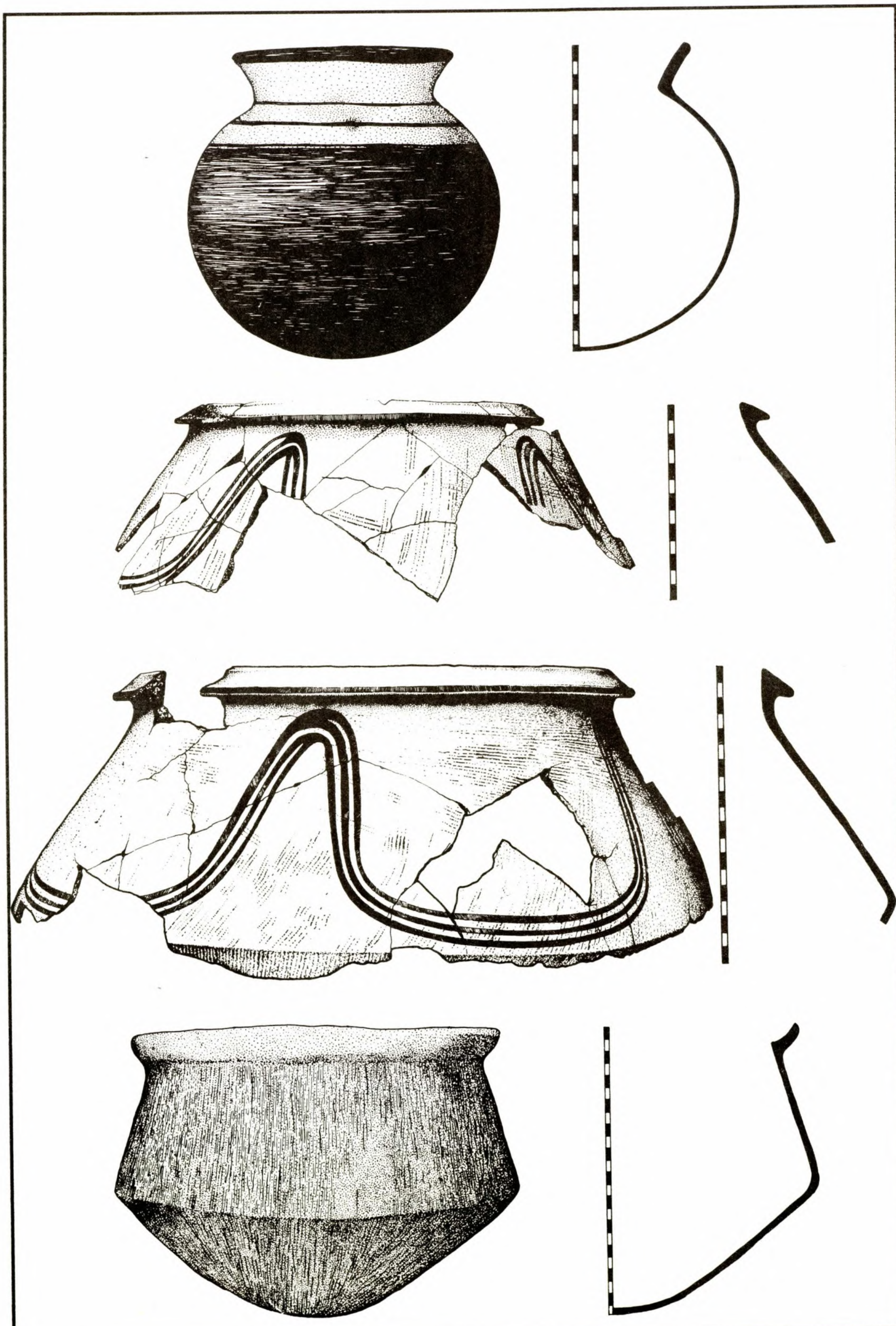

FIGURE 7.10: BAN NA DI "WHOLE" VESSELS (a: pot 95, form 5. b: pot 97, form 6. c: pot 109, form 6. d: pot 96, form 7.).

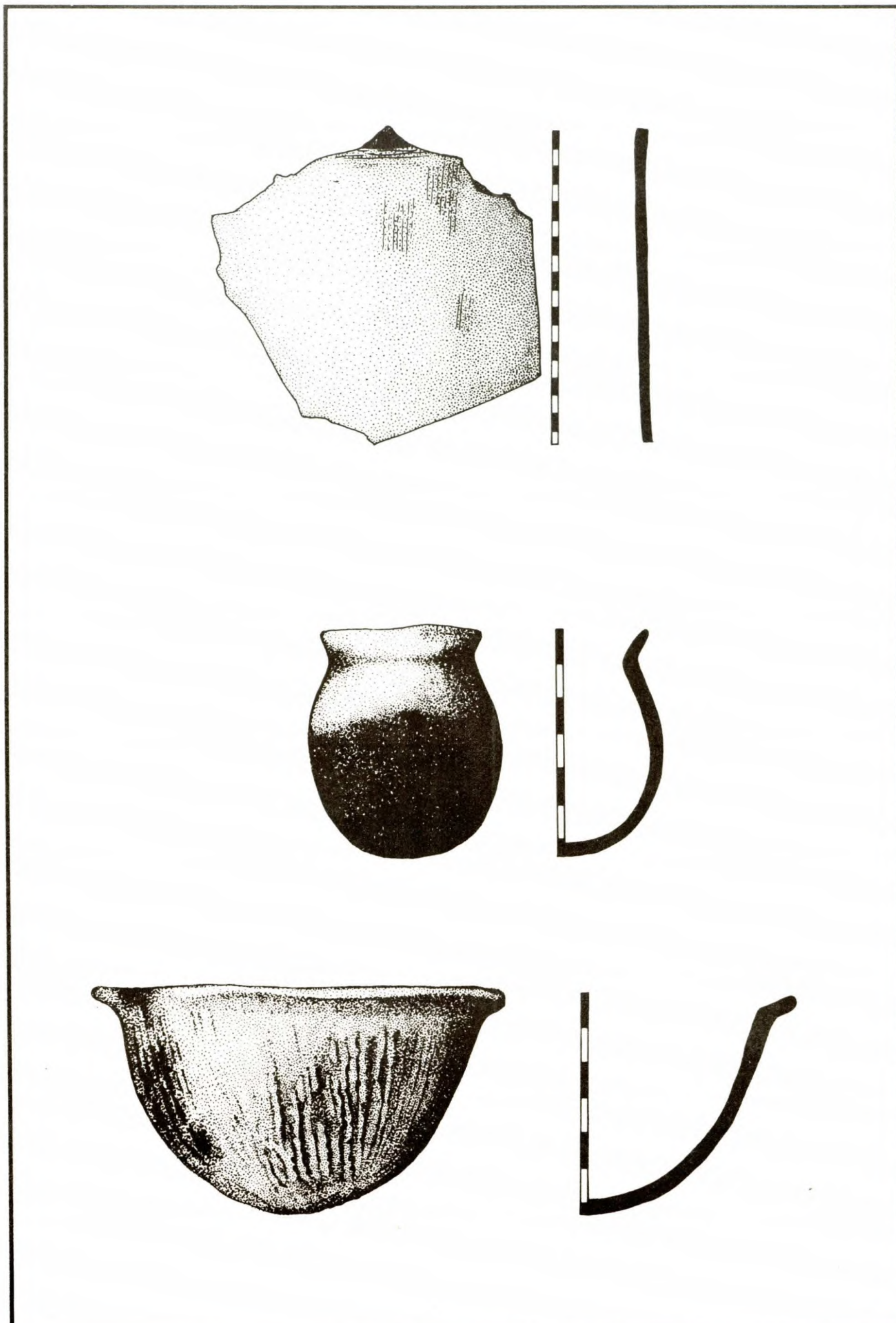

FIGURE 7.11: BAN NA DI "WHOLE" VESSELS (a: pot 131, form 8. b: pot 88, form 9. c: pot 99, form 10.).

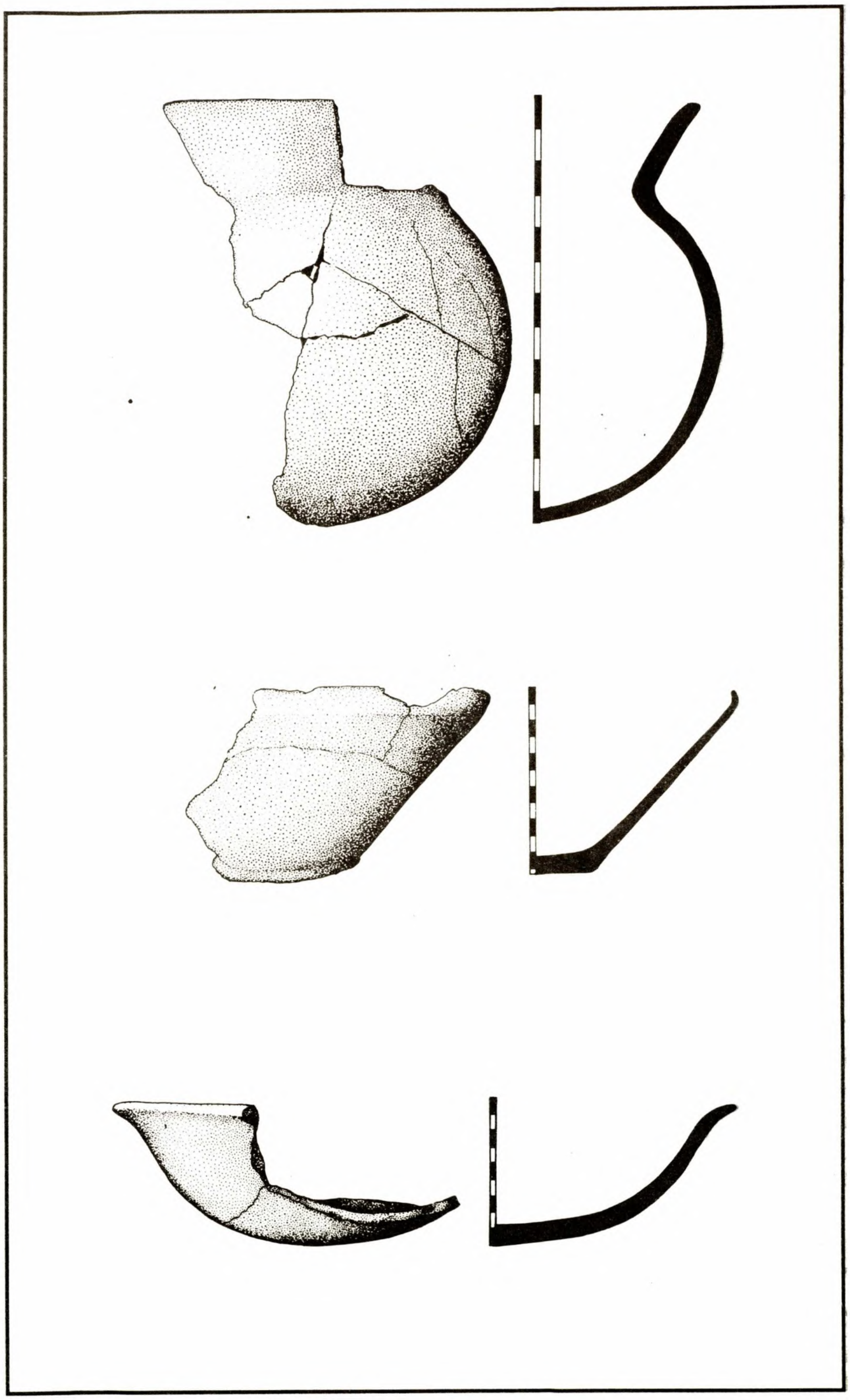

FIGURE 7.12: BAN NA DI "WHOLE" VESSELS (a: pot 125, form 11. b: pot 122, form 12. c: pot 127, form 13.).

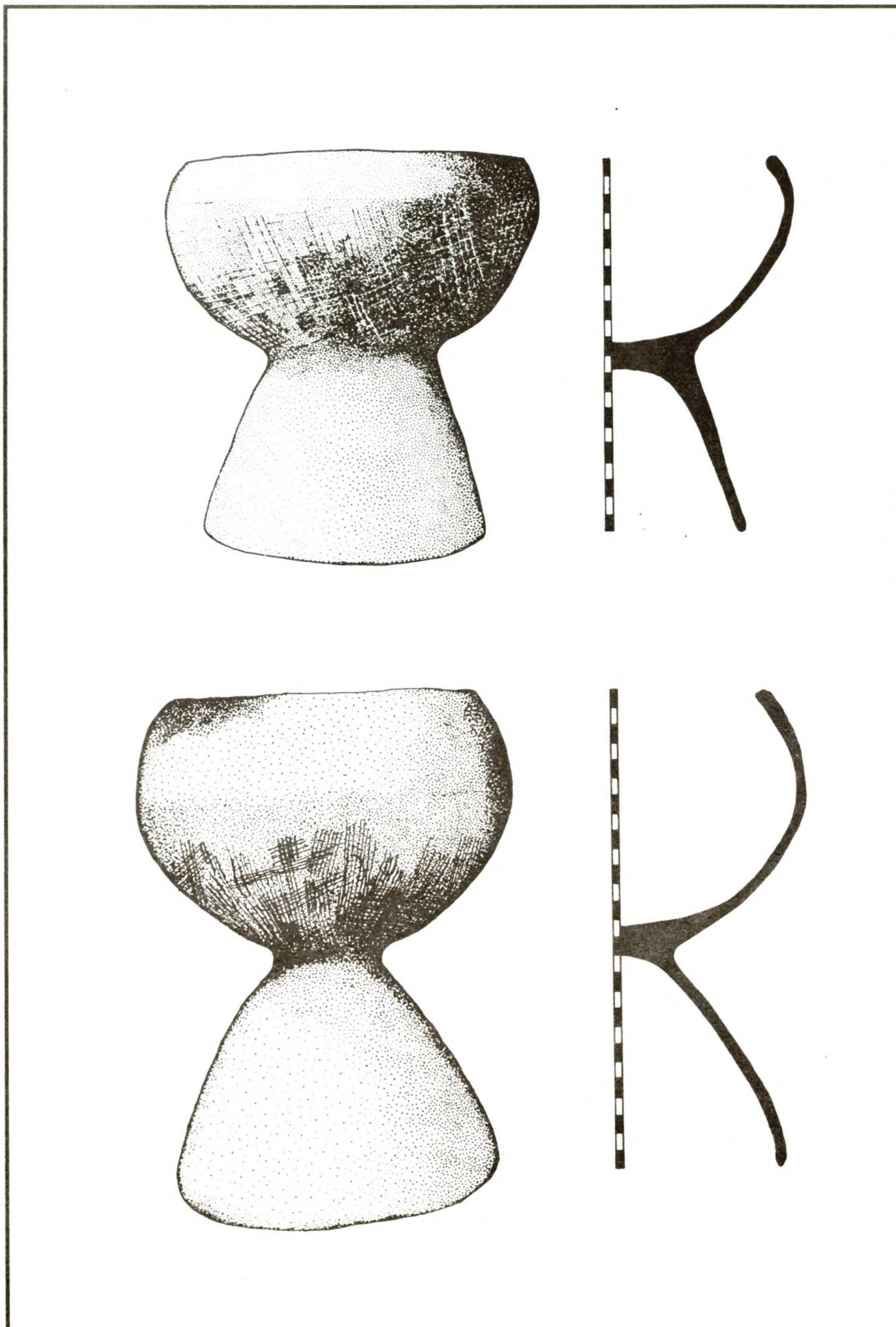

FIGURE 7.13: BAN NA DI "WHOLE" VESSELS (a: pot 39, form 14a. b: pot 37, form 14b.).

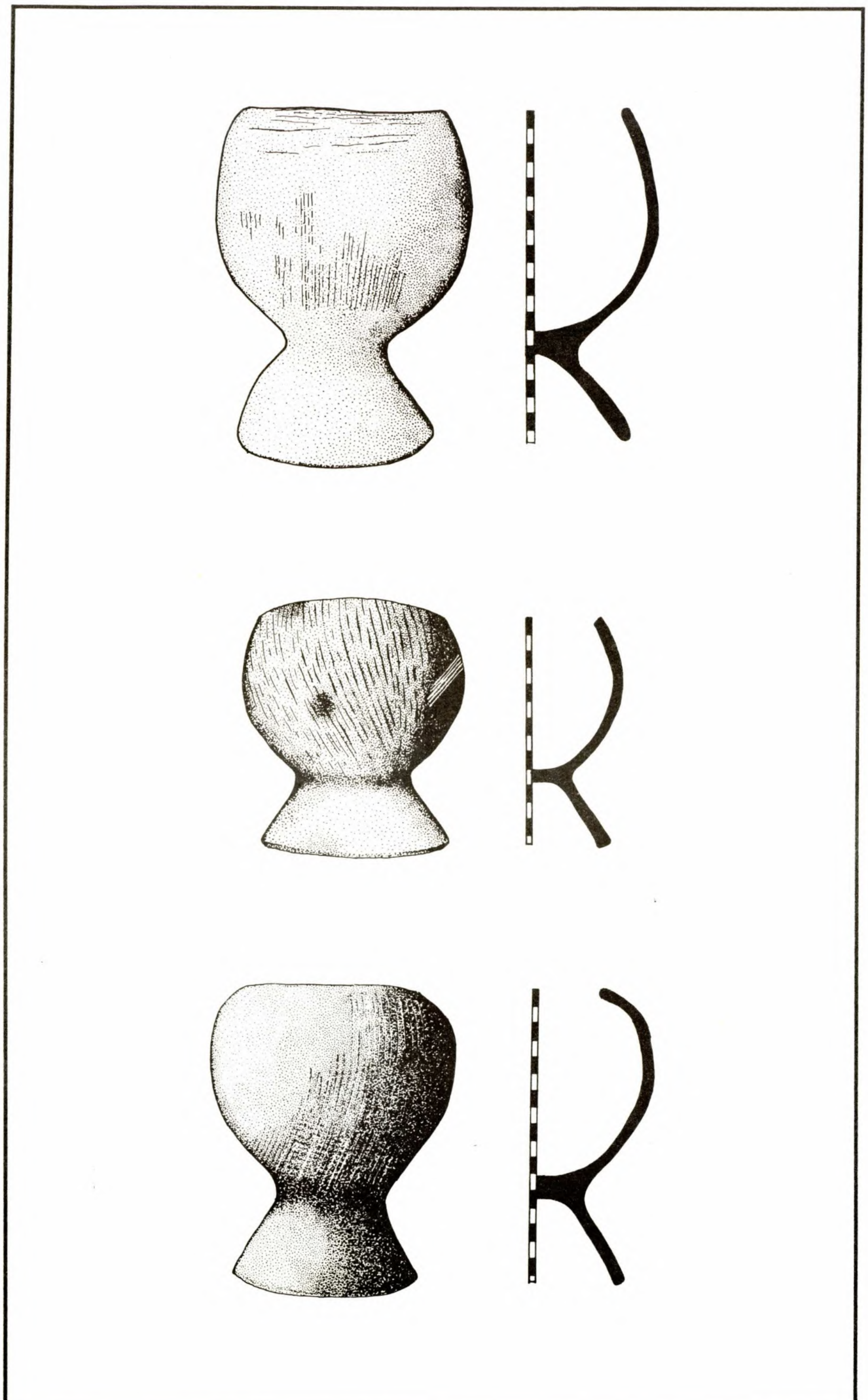

FIGURE 7.14: BAN NA DI "WHOLE" VESSELS (a: pot 44, form 14c. b: pot 47, form 14c. c: pot 48, form 14c.).

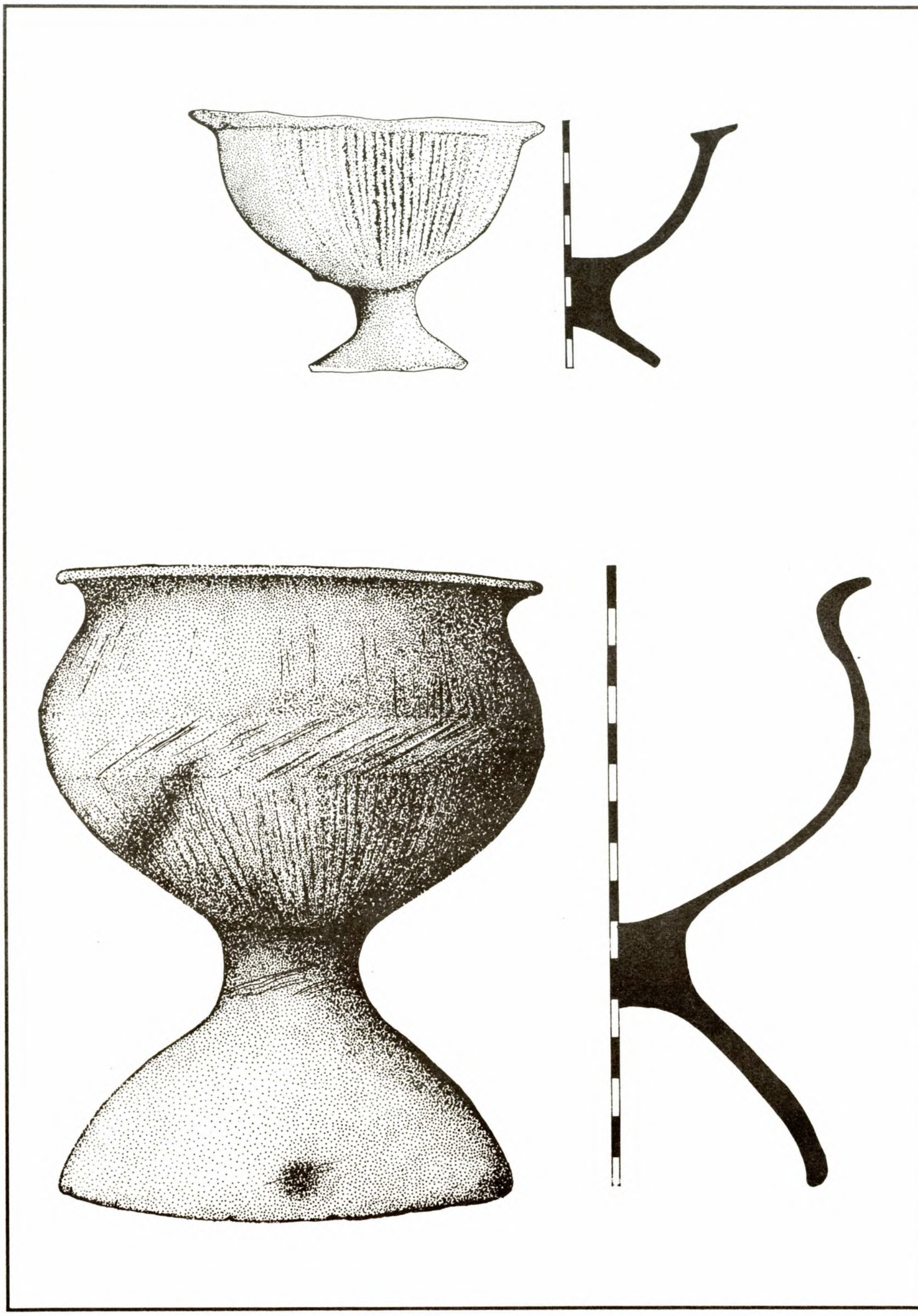

FIGURE 7.15: BAN NA DI "WHOLE" VESSELS (a: pot 86, form 15. b: pot 128, form 16.).

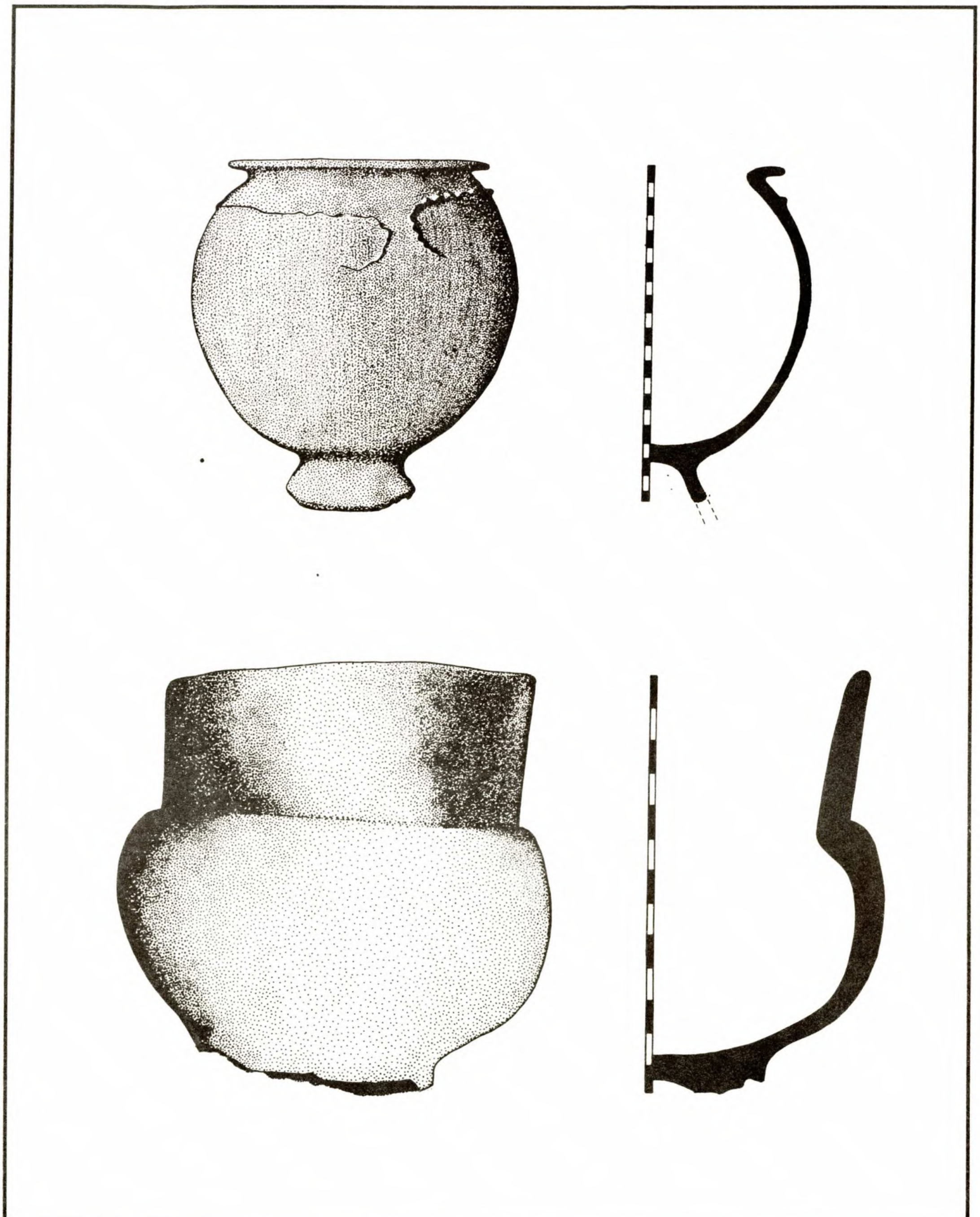

FIGURE 7.16: BAN NA DI "WHOLE" VESSELS (a: pot 92, form 17. b: pot 123, form 18.).

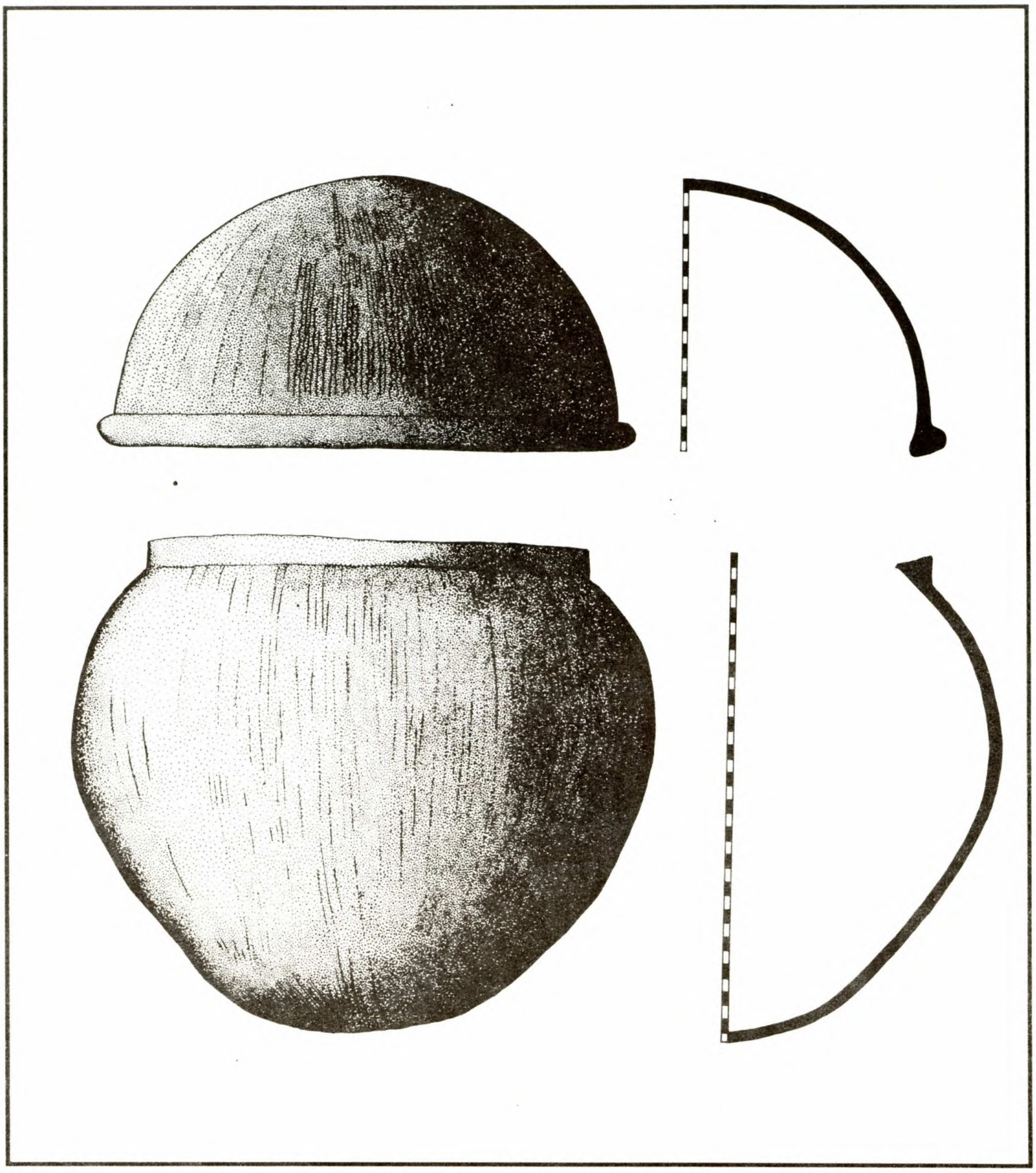

FIGURE 7.17: BAN NA DI "WHOLE" VESSELS (a: pot 113 and lid, form 19.).

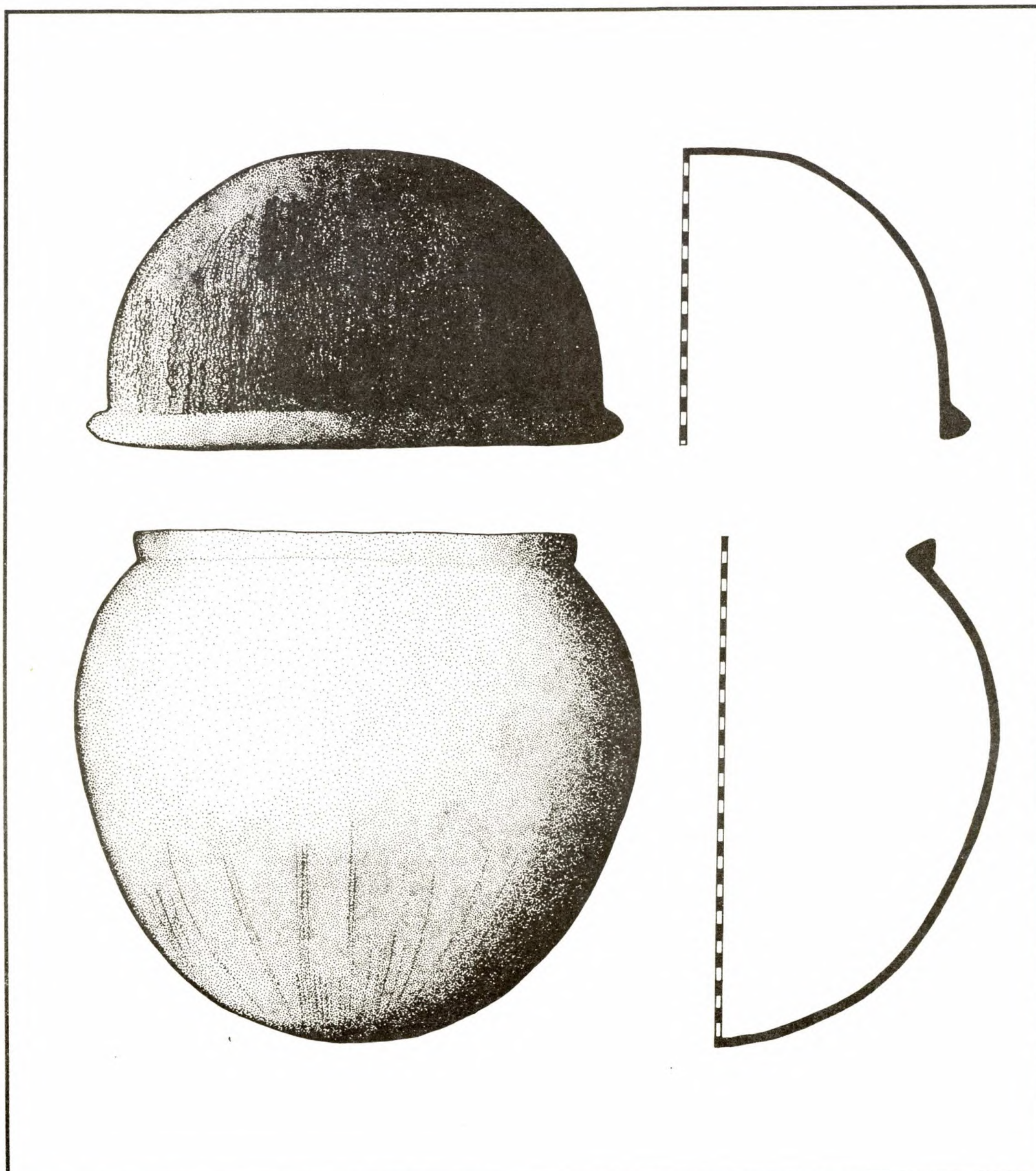

FIGURE 7.18: BAN NA DI "WHOLE" VESSELS (a: pot 114 and lid, form 19.).

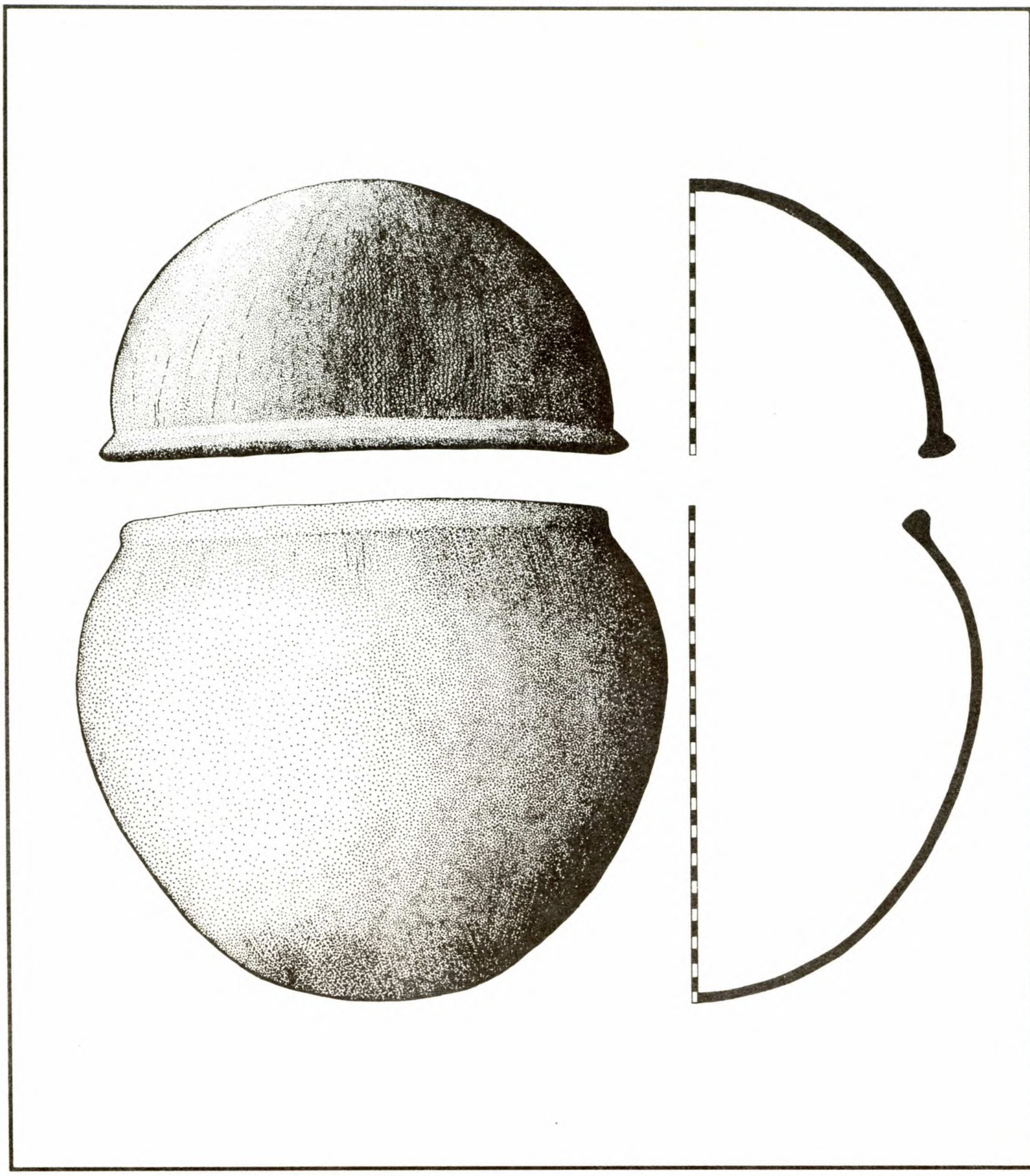

FIGURE 7.19: BAN NA DI "WHOLE" VESSELS (a: pot 115 and lid, form 19.).

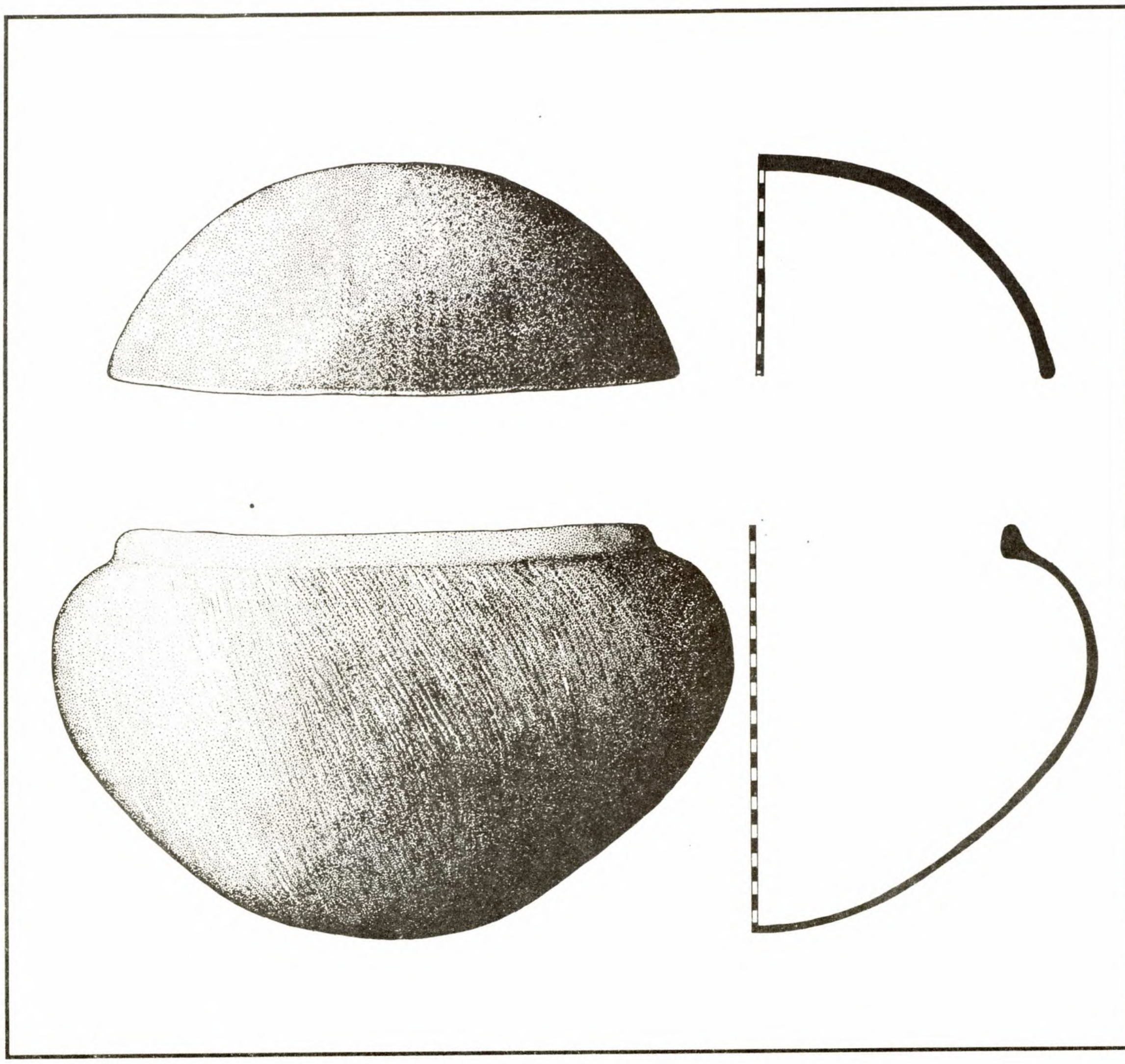

FIGURE 7.20: BAN NA DI "WHOLE" VESSELS (a: pot 116 and lid, form 20.).

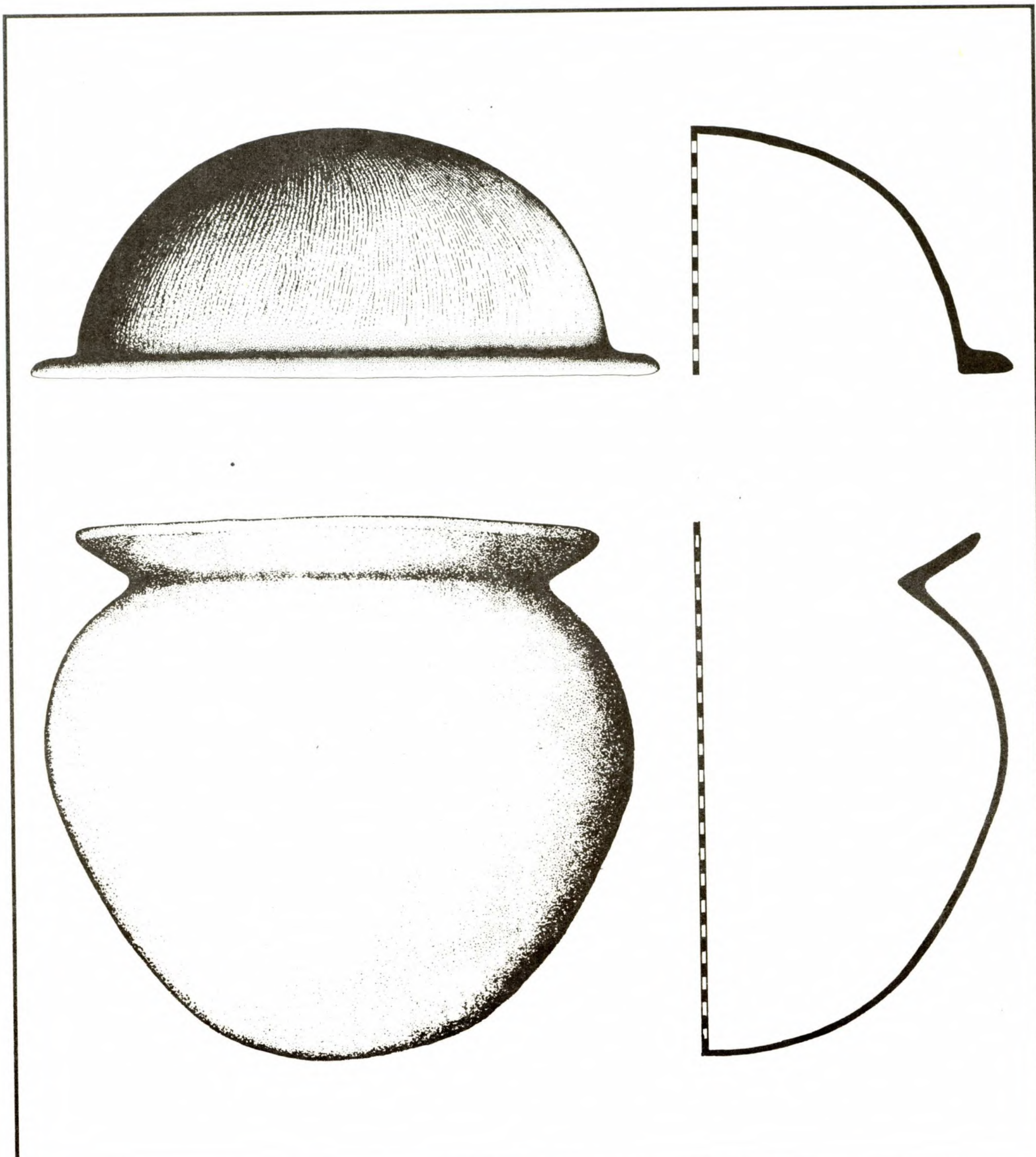

FIGURE 7.21: BAN NA DI "WHOLE" VESSELS (a: pot 117 and lid, form 21.).

"Whole" vessels are those with sufficient surviving portions to form a substantial cross-sectional outline of the intact pot. Once whole vessels have been thus defined, rimforms are valuable as diagnostic representatives of whole vessel forms. Of the total 147 whole vessels, 146 have been assigned fabrics. The fabric of Pot 47 displays close similarities to fabric group 7, although it cannot readily be associated with this group without further more detailed analysis. The "whole" vessels include 133 from burials and 13 from occupation levels. Table A.2 (Appendix one), sets out mortuary and occupation level vessel fabrics in chronological order. Tables A.3 and A.4 (Appendix one) show the distribution of MP1 local ware fabric groups and exotic fabric groups respectively.

Evidence set out below shows that two ceramic traditions are mutually exclusive to MP1 and MP2. Therefore pottery derived from either occupation levels or burial contexts, during each mortuary phase, are here considered together in terms of their respective stratigraphic associations. The combined number of whole vessels comprised of fabric groups 1, 2, 3, or 4 amounts to 85.22% of the total MP1 assemblage. In thin-section all are compatible with the Nong Kham Din clay (site 10), except for fabric 3 which differs in nonplastic proportions. The overall appearance is similar, but quartz increases at the expense of the spicule count in fabric 3. Direct comparisons of pottery with clay are not entirely valid because they involve raw versus processed materials. Fabrication techniques, for example, may redistribute nonplastics in pottery unevenly. Forming operations can cause a loss of finer particles, and disproportionately reduce the original clay matrix component. Thus direct comparisons can only be regarded as approximations.

Point counting of six fabric group 3 vessels give the following values: matrix component X = 70.26% (S.D: 7.59, V:48); quartz X = 23.10% (S.D:7.59, V:47.02); spicules X = 1.8% (S.D: 0.63, V:0.33). Values for a fabric group 1 vessel are set out in Table 7.3 below. They are: matrix component 66.6%, quartz 4.8%, spicules 8.8%. The fabric group 1 constituents match closely those of Nong Kham Din clay (clay 10, Table 5.1 chapter five, and appendix one). Fabric group 3 is clearly different. Nonplastic and clay matrix components for the Sakon Nakhon Basin potting clays are set out below (fig. 7.22). A 50/50 blend of each Ban Na Di clay with clay 10 is included for comparison. Clays 10 and 13, when blended, give nonplastic ratios of: matrix 76.8%, quartz 14.5%, spicules 4%. For clays 10 and 14 the values are: matrix 71.8%, quartz 19.4%, spicules 3.9%. Fabric group 3, in terms of nonplastic proportions, closely matches a blend of local with Nong Kham Din clay. Nong Sung clay is the only other likely source. This clay, however, lacks sufficient spicules and can thus be excluded from consideration.

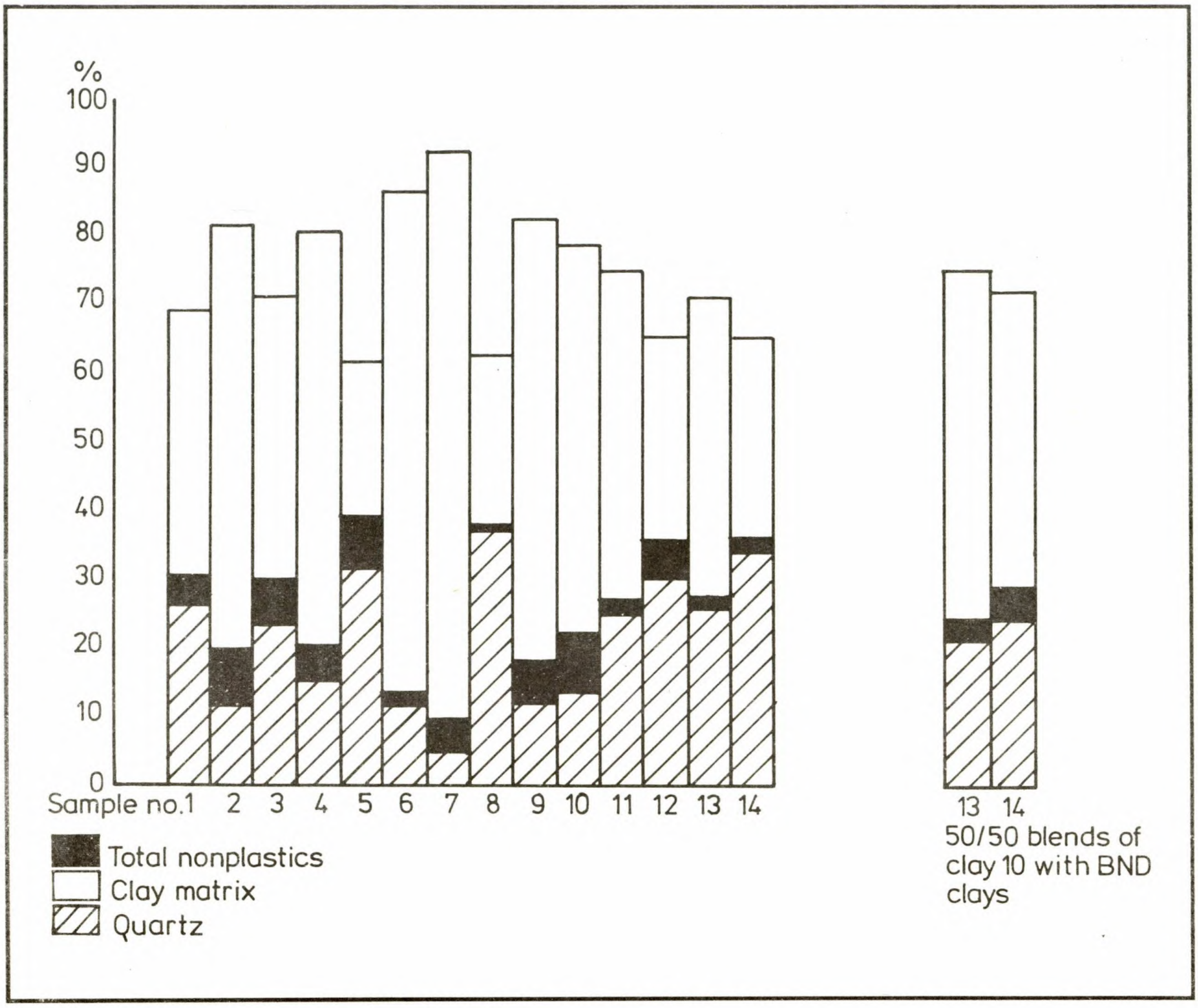

FIGURE 7.22: THE NONPLASTIC COMPONENT OF SAKON NAKHON BASIN POTTING CLAYS.

One vessel, (pot 35, fig. 7.23), displays characteristics which are informative. This data relates to the composition of fabric group 3 and fabrication details which apply to most MP1 whole vessels. As a guide to fabrication methods, Table A.5 (Appendix one) gives a summary of cordmarking on whole vessels. Pot 35 was interred with burial 36 along with pots 15, 16, 39 and 40. The former two pots contain fabric group 1 material. Pots 39 and 40 are "goblets". They contain fabric 2 and 1 respectively. It is important to note that pot 35 does not seem to have been used prior to interment. Apart from post-deposition adhesions of calcium and iron, it is in pristine condition. Note also the vertical shrinkage crack. An equatorial join between the moulded lower section and upper paddle and anvil construction is clearly evident in the wall opposite the crack. This construction method dominates local wares. It is discussed further below. Note that the crack extends from the rim to just beyond the equatorial join, thus it traverses the major join between the upper and lower fabrication stages. Such vertical cracks are symptomatic of the addition of excessive amounts of nonplastic material, either as temper or the incorrect blending of short and plastic clays (Hamer 1975:78). In form and method of construction, pot 35 is clearly associated with vessels containing fabric group 1 or 2 material.

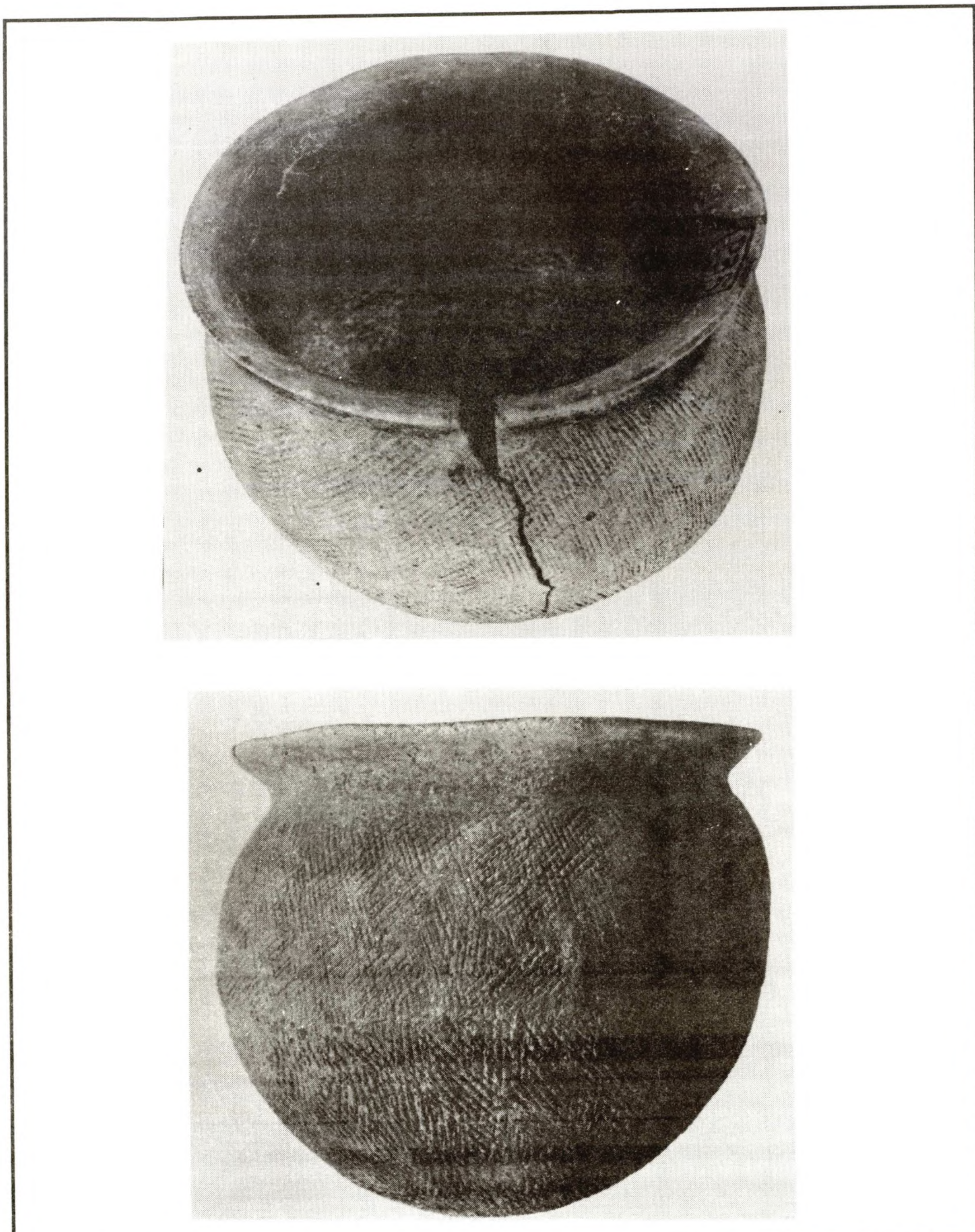

FIGURE 7.23: POT NUMBER 35.

The data set out above suggest that pot 35 represents the result of a local blending failure. In addition, evidence for deliberate conservation of imported Nong Kham Din clay is set out below. This information, when considered together, strongly supports the notion that local and imported clays were blended to produce fabric group 3. The blending strategy would conserve a valuable exotic resource. Notably, this fabric is confined to forms 1a, 1b, 3, and 4 vessels, all of which are probably utilitarian wares. Petrographic and construction evidence both support a local origin for fabric groups 1 to 4.

Fabric group 1 dominates local wares. Fabric groups 2, 3 and 4 are essentially modifications of fabric group 1. We have seen that fabric group 3 is a technological variation probably related to the conservation of imported clay. Fabric groups 2 and 4 form a continuum. They closely correlate with forms 14a, b, and c "goblets" (Higham and Kijngam 1984). This form corresponds with Sørensen's fruit stands (*"tou"*, Sørensen 1967:75), Watson's pedestal bowls (1968:304), and Bayard's "type 4b footed bowls" (1977:67). Of the 29 examples, 27 (93.1%), contain local fabrics. The exotic vessels are restricted to form category 14c. The single local ware 14c goblet (pot 44), differs in detail to the two exotic forms (pots 47 and 48). Pot 44 has an "S" twist cordmark and a rounded base edge termination, pots 47 and 48 cordmarks are "Z" twist, and their base edges terminate in a square edge (fig. 7.14). Fabric groups 2 and 4 increase with time (Table A.1 Appendix one). They form 30% of MP1a local wares, 30.23% of MP1b, and 40.38% of MP1c. Two local ware goblets occur in MP1a, 10 in MP1b, and 13 in MP1c mortuary contexts. Goblet fabrics are set out in Table 7.2 below.

TABLE 7.2: Ban Na Di "goblet" fabrics.

Fabric	Form 14a	14b	14c
1	1	2	-
2	3	18	1
4	-	2	-
10	-	-	1
note	-	-	1
n vessels	4	22	3

Note: pot 47 (see Table A.1 appendix one).

As with fabric group 3, fabric groups 2 and 4 are tempered with orthodox grog. They can be distinguished from fabric group 1, however, by the presence of rice remains. It is important to note that these two inclusions were separate additives. Rice remains or impressions are essentially absent from the grog. This contrasts sharply with bleb temper where rice impressions are common. Thus the rice was not involved in the grog manufacture. The only difference between fabric group 1 and the goblet fabrics is the addition of rice. There is thus no obvious technical requirement for its presence. Goblets, therefore, both in terms of fabric and form, represent a special type of ware. Accurate quantification of the proportion of rice remains in fabric groups 2 and 4 is difficult because of problems with thin-section sampling. Further, it is difficult to assess whether rice was included accidentally in some cases during manufacture. We can anticipate that, in communities where rice was exploited for subsistence, it would be difficult to exclude it from pottery even if desired. Thus apart from goblets, forms 1b, 1c, 2, 3, 4 and 10 also contain fabric group 2 material.

The following fabric group 2 and 4 form correlations are evident: form 1b:7.14% (n = 13), form 1c:33.33% (n = 12), form 2:14.28% (n = 7), form 3:40% (n = 5), form 4:25% (n = 28), form 10:100% (n = 1). Form 10 is represented by Pot 99. This vessel was placed over the abdomen of burial 18. The fabric groups 2 and 4 correlations for all goblets, however, is 88.88% (n = 27). Clearly, goblets are closely correlated with fabrics containing rice remains.

Vessels of similar form have been postulated as ritual (Weinberg 1965:195), or ceremonial wares (Rawson 1980). When both fabric and form are associated in this manner we can be confident that this is *prima facie* evidence of importance. The use of forms and/or colours as a symbolic means of communication is described by Harris (1986:126) as "graphic isomorphism". These systems, he argues, convey pictorial messages independently to script at a basic level of communication. Thus graphic forms can act as a mode of communication *sui generis*. Visually independent communication systems are ideally suited to ritual symbolism. In the case of specially prepared and designed mortuary vessels, it is possible that we may be encountering a powerful system of visual communication. In the absence of evidence to the contrary, however, "goblets" are here inferred to represent a mortuary ware of ritual significance.

Prior to considering fabrication and firing details, we need briefly to discuss the optical properties of fabric groups 1 to 4 because these relate to the method of construction and clay origin. In polarized light, the matrices of MP1 local ware fabrics display a moderately birefringent sheen. Shepard associated this with the abundant presence of mica in low-fired pottery, and described it as a "golden or silvery cast" (1956:30). In Ban Na Di fabrics the birefringence is seen to best effect when the microscope stage is rotated between crossed polars. It is probably due to the effects of both clay mineral orientation and matrix texture. Clay mineral flakes tend to lie nearly parallel to the plane of pot surfaces. This results from clay preparation processes, and the mechanical effects of shaping (Hamer 1975:63). The effect is most prominent in oxidised surface "herringbone" zones where closely packed, fine lath-like micaceous particles are randomly orientated. It tends to be masked by reduction.

Similarly, in shales, a principal cause of fissility is the tendency of clay mineral flakes to lie almost parallel to bedding planes. Thin-sections cut normal to stratification present these flakes on edge. As both extinction position and slow vibration direction parallel the apparent flake elongation, the whole thin- section tends to show aggregate positive elongation. When rotated between cross polarizers, an entire thin-section may extinguish in two principal directions. If the clay particles are more randomly oriented "the appearance of a thin-section does not vary appreciably when rotated between cross polarizers, and it does not tend to extinguish preferentially in any two directions." (Williams *et al.* 1982:321).

Most prehistoric Khorat Plateau wares were probably shaped by the paddle and anvil method. Potters used mainly cord-wrapped or carved paddles. Observation of thousands of sherds suggests that, even when a smooth finish was required, these paddles were probably used as the main shaping instrument. Plain paddles were probably reserved for the final smoothing process. Paddles with a rough surface distribute wet clay more efficiently during forming, because they impart more surficial force given the same mass. This is because serrated versus plane surfaced paddles concentrate the impact force within a smaller area given the same mass and effective area of impact.

Thin-sections cut perpendicular to pot walls often reveal some aggregate sorting. Larger nonplastics tend to concentrate in the centre. In modern vessels, paddle and anvil shaping results in differential sorting and finer constituents are concentrated towards wall surfaces. This is due to mechanical forces, and the water-born transportation of very fine particles through pores in the plastic fabric. Much of this finer fraction often sticks to the potters hands and tools. Thus pots may retain proportionately more nonplastics than the parent raw clay.

Depending on the amount of carbonaceous material present in unfired pottery, and firing atmosphere conditions, pottery fired in the open is often not fully oxidised (Shepard 1956:75-94). In thin-section, most MP1 local ware fabrics have a reduced central core. Only the surface 1mm or so of vessel walls are oxidised and the majority have reduced interior surfaces. Exterior surfaces are generally oxidised, often with "fire-clouds" (Shepard 1956). Many rims are almost entirely reduced. This is often interrupted by oxidised "flares". Internal reduction and rim flares strongly suggest these pots have been fired upside down. Where oxidisation is complete the micaceous sheen is apparent. Oxidised zones near surfaces often display a "herringbone" effect, due to a random orientation of closely packed, fine lath-like particles of mica.

Nong Kham Din clay is consistent with fabrics groups 1, 2 and 4. It is postulated that it also formed a component of blended fabric group 3 along with local clay. Nong Kham Din clay is moderately micaceous and also contains numerous spicules. Thus it is unique among the clays studied. Table 5.2 (chapter five), sets out the relative quantities of spicules for each Sakon Nakhon Basin clay. The proximity of sources is also of prime importance in the acquisition of raw materials. Nong Kham Din and Nong Sung (clay 6), each lie about 6 km from Ban Na Di (fig. 4.7). Arnold (1985:38- 51), reports that for geodesic walking distances, out of 111 cases tabulated from ethnographic sources, 84% of quarries were located within 7 km of the point of production, and this "probably represents the upper limit of the maximum range of exploitation", but the preferred exploitation territory probably occurs at 1km.

In addition to the mineralogical evidence discussed above, we can exclude Nong Sung as the MP1 clay source for several other reasons. Firstly, ceramic anvils composed of clay mineralogically compatible with Nong Kham Din are exclusive to MP1. MP2 anvils, however, contain Nong Sung clay. In each case the anvils are associated with the contemporary local ceramic tradition. Thus fabric group 1, which dominates MP1 wares, is also the major MP1 anvil fabric. Similarly, fabric group 12 dominates both MP2 wares and anvils (Tables A.1 and A.13 Appendix one). Secondly, MP2 is associated with a different ceramic tradition. A simultaneous change in technology and clay source is associated with this transition. Nong Kham Din clay is replaced by material mineralogically compatible with the Nong Sung clay. This clay was used for both anvils and vessels (Tables A.13 and A.1 Appendix one). Thirdly, differential use of each clay is evident during both mortuary phases. Thus MP1 crucibles are composed of Nong Sung clay (Table A.14 Appendix one). MP1 figurine fabrics (Table A.6 Appendix one), however, contain untempered and unfired Ban Na Di clay. During MP2, crucibles contain the latter clay (Table A.14 Appendix one). Thus local clays were employed where ceramic quality was unimportant during MP1, and for crucibles opposed to pottery during MP2. The poor quality of the local, versus imported clays, (chapters four and five), suggests this was a purposeful act of conservation. It reinforces and helps corroborate the geological evidence which demonstrates that the better quality clays were exotic. Non Sung clay is important because it not only spans both traditions, but is also associated with imported wares. We will return to it later.

In both fabric and form, vessels containing fabric groups 1 to 4 inclusive are compatible with a single ceramic tradition. This homogeneity is further strengthened by a distinctive fabrication method. During MP1 a practice of forming the lower hemisphere of medium to large bowls on a mould dominates. Excluding miniatures, 84 local fabric vessels are sufficiently complete for analysis. Of these, 76 (90.48%), are unequivocally mould-made. The method is revealed by a prominent, usually straight, equatorial join and positive cord impressions to the interior lower hemisphere. Upper interior hemispheres, in contrast, are smooth with a generally undulating surface. The undulations are consistent with a series of jointed coils (Glanzman and Fleming 1985:115). They appear to have been added to the preformed moulded base. Although erosion prevents an accurate assessment, most of the remaining vessels were also probably moulded. Very few appear to have been made from either slabs and/or coils.

Ethnographic data are available for a moulding technique which would satisfy the Ban Na Di evidence, of which pot 35 (fig. 7.23) is a typical example. Foster (1960:205-214), describes a technique employed by potters at Alcatlan, Mexico. The moulds, over which several forms are shaped, are vessels constructed robustly enough to withstand the strains generated during the manufacturing process. These moulds are essentially vessels thicker and heavier than normal, and feature striated exterior surfaces. One mould may serve as the base for several different final products. This parallels the Ban Na Di tradition where small spherical bowls (such as forms 1 and 2), and goblet bowls (forms 14a, b and c, figs. 7.7, 7.8, 7.13 and 7.14), are all mould-made, and of similar size and shape.

The method involves kneading a previously mixed quantity of clay into a flat pancake on a mat. This is then placed over the bottom of an upturned mould. The sheet of clay is patted with a paddle until uniform, trimmed and removed, thus forming the lower half of a pot. The upper portion is completed when the moulded section is sufficiently dry to support further material. As Foster pointed out, fragments of broken moulds in archaeological contexts would probably be overlooked due to their similarity with actual vessels. Thickness and density are characteristic however, and at Ban Na Di several dense sherds 10-12 mm thick were recovered from MP1 levels, although not actually associated with interments. Mortuary phase 2 vessels are not mould-made.

7.4 Firing temperatures

Ethnographic studies (Shepard 1956, Solheim 1964, Bayard 1977a) allow insights into the firing parameters in ceramic technology as practiced by household or individual workshops employing relatively simple production methods. In assessing firing temperatures, information regarding the type and likely duration of firing is important. Ethnographic and technological analyses are here combined with the intention of bringing into focus the fundamental variables involved in prehistoric firing methods.

We commence with the need to qualify and quantify a range of variables that affect ceramic firing procedures and their final product. These include the nature of vessel fabrics prior to firing, the atmosphere throughout the firing sequence, and the length of firing. The manner in which vessels are fired (singly or in multiples), and the method of stacking also have some influence on the final results (Shepard 1956:74-75).

At Ban Kham O, (Vincent 1984b), pots are fired on a bamboo raft packed with rice straw. The pots are placed upside down, without straw in between them, and then covered with straw for firing. Fired pots display generally oxidised exterior surfaces and slightly reduced interiors. Fire clouds cover up to 10% of the exterior surfaces of most pots. Raft firing is common in many modern Northeast Thai manufacturies, but firing durations vary from approximately two to five hours (Solheim and Bayard *op. cit.*), and possibly longer, with generally oxidising atmospheres.

It is possible to infer with reasonable confidence that the early mortuary phase local wares were mostly fired upside down in a generally oxidising atmosphere for the following reasons. Of the 85 pots suitable for assessment (miniatures and form 14 bases are excluded), only 8.24% are substantially oxidised internally and externally. The outstanding firing-related features of the remaining 91.76% are their oxidised exterior surfaces (if fire clouds occur they are minor), and their substantially blackened interior surfaces. A marked tendency towards increased blackening is noticeable towards upper portions and rim interiors. This could derive from colloidal carbons, contained in sooty smoke trapped within the upturned pot during firing, penetrating the fabric pores and creating permanent "smudging" (Shepard 1956:88). This is unlikely, however, given a generalised oxidising atmosphere. Alternatively the atmosphere within the vessel could be reducing.

Stacking round-based pots upside down on a firing raft reduces the risk of catastrophic toppling and breakage when the inflammable supports are consumed. During firing the irregular surfaces created by burnt fuel would probably admit some oxygen into the insides of vessels. It is likely, however, that the pot's internal atmosphere would be extensively reducing. Significantly, in kiln firings where vessels are not placed directly onto the fuel, the danger of toppling is minimised, particularly where loading allows adequate support. Thus kiln firings of vessels stacked upright in an oxidising atmosphere could be expected to produce oxidised interior and exterior surfaces.

Recorded temperatures for the type of raft firings outlined above are not presently available. Shepard (1956:78) records open firing temperatures up to 940° C for dung fuels and notes 1000° C is rarely attained in direct open-air firings. Lauer (1971:73) records a maximum of 920° C for dry wood and coconut leaf fronds. A firing duration of about one hour applies in both cases. May and Tuckson (1982:47) tested the firing ranges of 32 Papua New Guinea clays. The lowest vitrification temperature was 1100° C, but most were 1200° – 1250° C. They note that "the top temperatures reached in open firings are between 900° C and 1000° C". Irwin (1977) recorded a maximum temperature of 1018° C on Mailu Island, but most ranged from between 900° to 950° C. From prehistoric contexts, Meacham and Solheim (1980) report temperatures of up to 975° C for Non Nok Tha layer 7 sherds, and up to 1200° C (but as low as 800° C) for Phimai sherds. Their results were based on thermal expansion measurements (Tite 1969).

In considering firing temperatures achieved by MP1 Ban Na Di potters, we commence by assuming that valid assessments of the firing behaviour of clays used in prehistory are possible provided that the same clay used in prehistory can be obtained and fired to known temperatures under known conditions, and that the firing conditions used in prehistory can be established and replicated.

It follows that if the same material and methods are used, the same or similar results can reasonably be expected. Of course it is not practically possible to replicate precisely either the ceramic fabric or the firing conditions used in prehistory, but it is possible to approximate them.

Nong Kham Din clay (clay 10), has been fired in an electric muffle kiln to sequentially higher temperatures in an oxidising atmosphere. Bisques, measuring 15 x 2.5 x 0.8 cm, were fired at the increasing rate of 100° C/hour. The kiln was preheated to 150° C and the bisques air-dried for seven days prior to being fired at 50° C increments to temperatures ranging from 700° C to 1150° C. Although an unlikely procedure in prehistory, slow firing is considered appropriate in test conditions to minimise cracking and deformation. To prevent thermal shock the bisques were allowed to cool in the kiln (Howard 1982:147).

Chips with clean fracture surfaces were removed from each bisque, suitably coated, examined and photographed in a scanning electron microscope at X1000. This followed Maniatis and Tite (1978, 1981) who used a combination of chemical and physical techniques to assess original firing temperatures of prehistoric sherds. They noted that a reducing, opposed to an oxidising, atmosphere lowered the temperature at which various vitrification structures formed by *c.* 50° C for non-calcareous clay. Calcareous clays (those normally containing >6% calcium oxide), developed glassy phases associated with vitrification later than non- calcareous clays dependent on the clay texture and temperature intensity. Between 1050°-1150° C the amount of glass in calcareous clays rapidly increased and continuous vitrification similar to that displayed by pottery made from non-calcareous clay occurred. The firing atmosphere effects noted above were less pronounced for calcareous clay pottery. Maniatis and Tite's method involved identifying the type of clay used, fineness of its texture, and then estimating from observed vitrification structures displayed by prehistoric sherds in-the-received-state and after re-firing at known temperatures. They identified four temperature related stages: no vitrification (NV), initial (IV), extensive (EV), and continuous vitrification (CV). Each stage developed dependent on firing atmosphere and calcium oxide content. Initial vitrification structures (smooth isolated areas or filaments of glass) were similar for both non-calcareous and calcareous clays and typically developed at 800° – 850° C in an oxidising atmosphere. At higher temperatures the quantities of glass increased and the structures developed were critically dependent on both clay type and firing atmosphere. A variety of bloating pores were produced, each characteristic of, and dependent on, the clay type, firing atmosphere, temperature achieved and rate of firing.

In view of the comprehensive assessments of open firings undertaken by Shepard and others noted above, temperatures in the upper range 800°–950° C were anticipated. Thus in terms of Maniatis and Tite's findings, neither clay type nor firing atmosphere were considered critical. Petrographic examination revealed authigenic calcite deposits, at times very extensive, both as surface adhesions or networks of interstitial veins within the pottery fabrics, apparently resulting from post-depositional ground water effects. It is important to note that these chemical changes are probably accelerated by tropical conditions. Silica and calcite- cemented sand is also present as surface deposits on some sherds. In potting clays calcium has a "potent tendency to reduce the vitrification range" (Grim 1962:124). When pottery is fired in reducing conditions this converts $Fe^{3+} \longrightarrow Fe^{2+}$ and this increases the fluxing potential of the iron particularly when calcium is present (Edwards and Segnit 1984:73). Both of these minerals are present in the Sakon Nakhon Basin potting clays analysed in chapters four and five.

Grim (1962), notes that fluxes cause the development of amorphous glassy material at relatively low temperatures. Fluxes are much more effective either as part of the clay mineral or as adsorbed ions (Grim 1962:124). Smectites and vermiculites have a high cation exchange capacity (1962:30). Initial high temperature phases depend largely on the structural character of the clay minerals present, later high temperature phases depend more on the total composition "these generalities apply, of course, to clay minerals which do not contain considerable extraneous fluxes" (Grim 1962:96). Thus refiring highly calcinated sherds in an oxidising atmosphere risks misleading results. Hence Nong Kham Din clay fired at known temperatures was compared with sherds as received.

Figures 7.24 a to d illustrate the following vitrification stages and related firing temperatures. Pot 112 is oxidised to exterior (5YR/6/4) and interior (5YR/7/4), but has post deposition stains probably derived from calcium, and manganese, which is also a highly migratory element (Shepard 1966:871). In an earlier work (Vincent 1984b), it was stressed that this figure represented the maximum degree of vitrification observed in fabric group 1. Furthermore, as both the grog and parent matrix of fabric group 1 are mineralogically compatible with clay 10, it is reasonable to expect a similar firing response for both materials. Comparison of modern clay and fabric group 1 SEM photomicrographs suggested temperatures in the range of 1000° C to 1100° C were possible as *maxima*. These postulates are further clarified below.

Several points need emphasising. First, given the kind of industry under consideration, it seems unlikely that temperatures in excess of 1000° C could have been regularly exceeded. Second, in making assessments of ancient sherd thermal responses, a lack of precise understanding of the clay mineral composition is a major difficulty. Grim (1962:96, 108-111) reported that different clay mineral species respond variously. Mixed-layer clays further complicate these responses. Third, the effects of post-depositional calcium, as a fluxing agent, are also unclear (Grim 1962:96). Fourth, potsherds may have a slightly increased calcium content due to the effects of processing discussed above. Thus direct comparisons of raw and fully processed clays may also be slightly misleading.

As a check on the modern with ancient comparisons, fabric group 1 sherds were refired to 1050° C and soaked at that temperature for 20 minutes. Their colour changed from 5YR/5/2 to 5YR/6/8. Figures 7.24 a and b illustrate as-received and fired states. The as-received photomicrograph displays some glassy phases, but not extensive, and is thus considered as in the initial vitrification stage. An extensive amount of bloating pores consistent with continuous vitrification is evident in much of the refired sherd, although fig. 7.24 c, another view of the same refired sherd, shows less bloating and vitrification structures. These compare with those observed in other as-received sherds (fig. 7.24 d). This is pot 112 as received previously published in Vincent (1984b:fig 15-6, D).

In an attempt to resolve the fluxing question, additional pieces of the same potsherd were left in simmering hydrochloric acid for 90 minutes. These sherds were thin-sectioned and checked for any residual authigenic interstitial calcite. As substantial amounts remained, the sherds were left for 2 hours in boiling HCl, and the sherds were again thin-sectioned. Although less prominent, calcite was still well represented. The calcium is clearly very difficult to remove and this problem remains unresolved.

McGovern *et al.* (1985:106) used the SEM method in assessing the ancient firing temperatures reflected in Ban Chiang "ware types". They concluded that "uniformly low temperatures (*c.* 500° C-700° C)" were represented. Given that at least some of their fabrics are composed of local potting clay, and this seems highly likely, comparison of photomicrographs from both sites suggests the Ban Na Di wares were fired to higher temperatures. These data, combined with the evidence set out above for Ban Na Di fabric group 1 wares, indicates that temperatures somewhere between the two were probably the norm for Ban Na Di potters.

Conservatism is called for when direct evidence, such as experimental or field firing temperature data, are lacking. Based on the information provided above, we may reasonably assume that at Ban Na Di firing atmospheres would have been reducing for much of their duration. The influence of calcium is uncertain. Given its ubiquity in Sakon Nakhon Basin clays, however, it may also have been a factor. Thus it is prudent to allow for the effect of both calcium and reduction. If we allow 50° C for each, a *maximum* temperature of 950° C seems probable. This is reinforced by some local ware sherds (fig. 7.25 e, (pot 127) and f, (pot 104)), which display fewer vitrification structures. Figures 7.25 g and h illustrate clay 10 fired to 1050° and 1100° respectively. Keeping the firing atmosphere and calcium allowances in mind, these sherds suggest even lower temperatures. At 950° C, the postulated maximum firing temperatures compare with those ethnographically recorded for open firings discussed above.

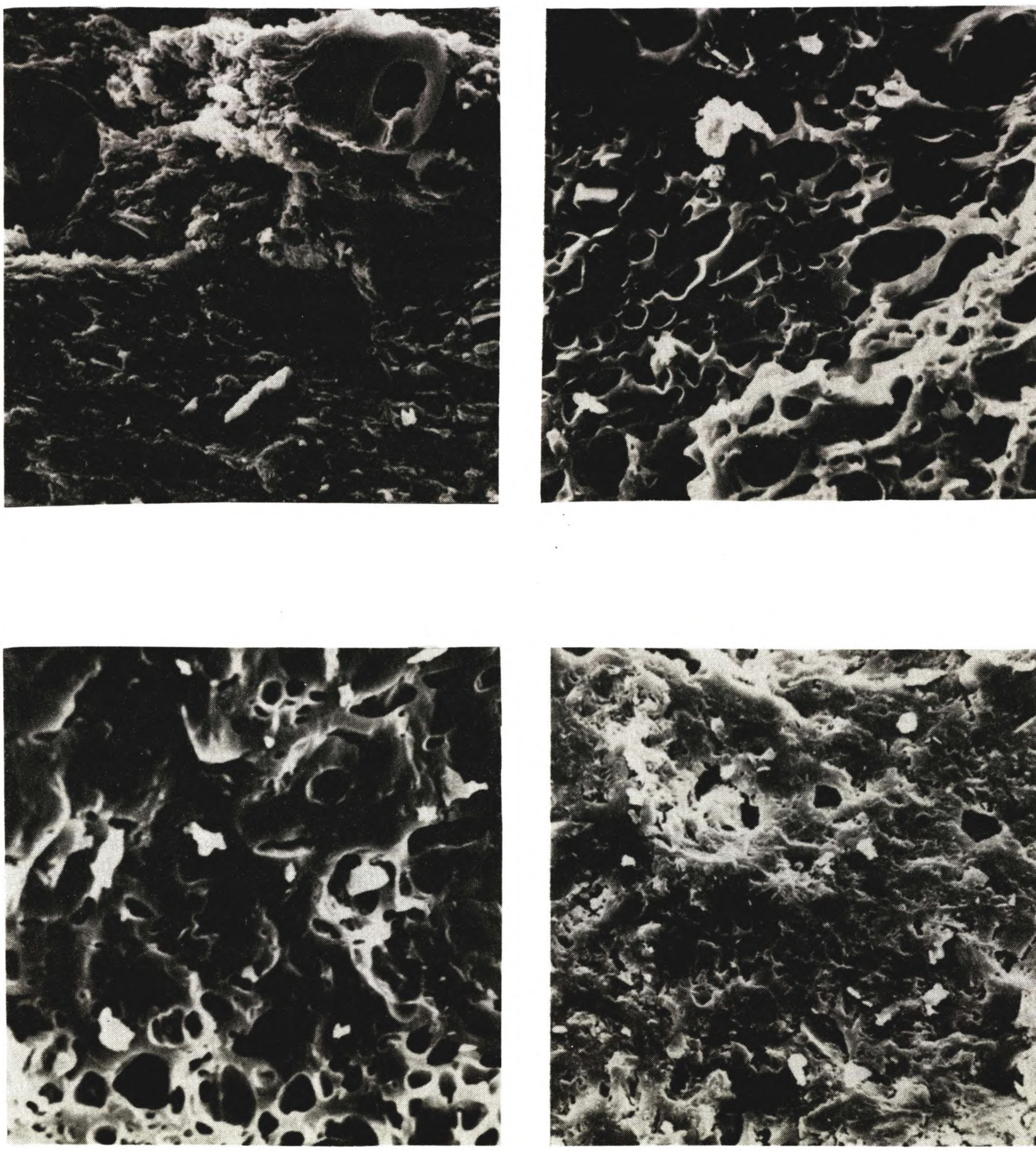

FIGURE 7.24: VITRIFICATION STRUCTURES IN BAN NA DI MP1 LOCAL WARES.(from left to right, top: a, b, lower: c, d. x1000 magnifications)

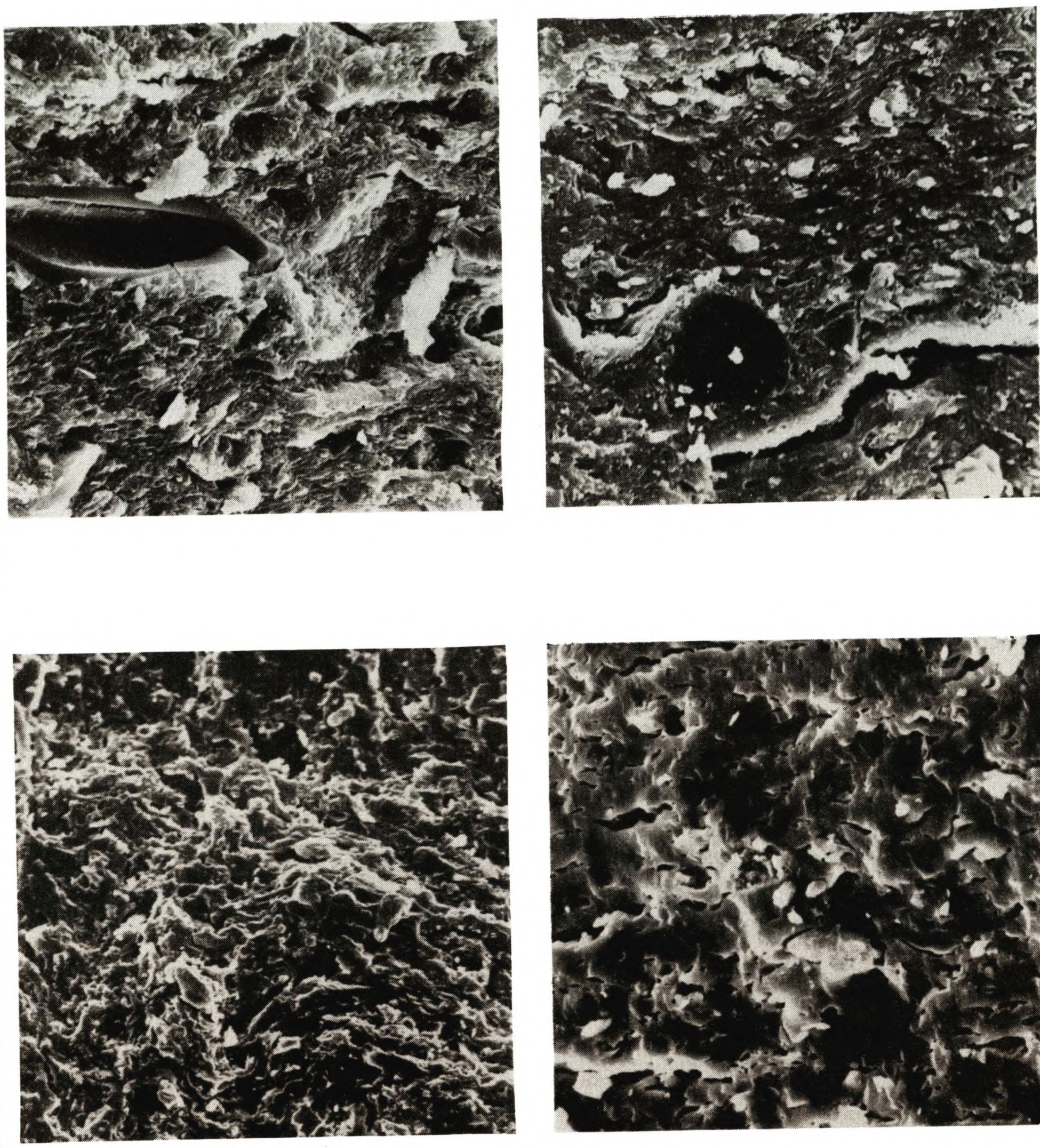

FIGURE 7.25: VITRIFICATION STRUCTURES IN CLAY 10 AND BAN NA DI MP1 LOCAL WARES.(from left to right, top: e, f. lower: g, h. x1000 magnifications)

7.5 Mortuary Phase Two vessels

Five stratigraphically contemporaneous infant burial urns, each with an enclosing lid, make up the MP2 sample (figs. 7.19 and 7.20 and 7.21). One urn and its lid (pot 116, fig. 7.20), contains a fabric previously ascribed to fabric group 1 (Vincent 1984b). The remainder (figs. 7.17, 7.18, 7.19 and 7.21 are composed of bleb-tempered fabric 12, a fabric group not represented in the earlier burial phases (Table A.1 Appendix one). The presence of an orthodox grog fabric, which characterizes MP1, in MP2 contexts has rightly been questioned by White (1986:311-312). A more precise interpretation of fabric associations is now possible, following the quantification of non-plastic inclusions, and a detailed analysis of Sakon Nakhon Basin clays. Two bleb-tempered burial urn lids have been compared in thin-section with a MP1 pot of fabric group 1 and pot 116. Point counted values for the major constituents are set out in Table 7.3 below.

TABLE 7.3: Point counting analysis of Ban Na Di burial vessels.

Pot No.	matrix	Quartz	Kspar	spic	grog	Fe.	voids	pm*	ph+
117 lid	59.4	6.0	0.2	0.8	14.4	0.0	9.2	8.0	2.0
115 lid	60.8	6.0	0.4	1.0	16.6	0.0	9.4	4.0	1.8
116	80.2	5.8	0.2	2.8	8.0	0.0	1.6	0.0	1.4
4	66.6	4.8	0.0	8.8	9.6	5.4	4.4	0.0	0.4

Notes: * plant material (mainly rice husk).
+ phytoliths.
Values are expressed as percentages of total.

The non-plastic constituents of the two bleb-tempered pots, (115 and 117), are compatible with vessel 116. The fabric group 1 specimen (pot 4), however, contains orthodox grog, the same temper species as pot 116. Pot 116 has no plant material or ferruginous minerals and few spicules. Nong Kham Din clay is consistent with pot 4, but not the bleb-tempered vessel fabrics or pot 116. These latter fabrics are constituently compatible with clay 6 from Nong Sung (chapter five).

Because pot 116 is tempered with the same grog species as fabric group 1 vessels, the dominant tempering technique of early ceramic traditions in the Sakon Nakhon Basin, and detailed analysis of clay samples had not been completed, it was initially not recognised as being different. Pot 116 and its lid contain fabric group 16 material. This fabric provides an important link between early orthodox grog-temper and later bleb-temper traditions. It occurs in anvil fabrics during both mortuary phases at Ban Na Di. The parent matrix is clay 6, the parent material for MP2 bleb wares, and the bleb-tempered anvils discussed below. Thus although Ban Na Di, and as the data set out below demonstrates, much of the Sakon Nakhon Basin as well, witnessed a major change in traditional ceramic production techniques, fabric group 16 endured unaltered.

Firing temperature assessments have not been undertaken for MP2 wares as this lies outside the scope of the present work.

(b) Figurines

Nineteen clay animal figurines from MP1 burial and level 7 occupational contexts have been examined, (fig. 7.26, and Table A.6 Appendix one), ten in thin-section. The latter figurines were modelled from clay petrographically compatible with material local to Ban Na Di (clay 13). In hand specimen each figurine has similar clay characteristics. It seems reasonable, therefore, to extend the petrographic data to them all. The figurines are soft, fragile, (< 3 on Moh's scale), and crumble easily. Notably none survived intact. Replicas were modelled by the writer from clay 13, and air-dried. They are the same colour, (10YR.5.5/2), with a similar texture and cohesiveness to the prehistoric figurines. These properties contrast with those of the fired local wares, which are durable.

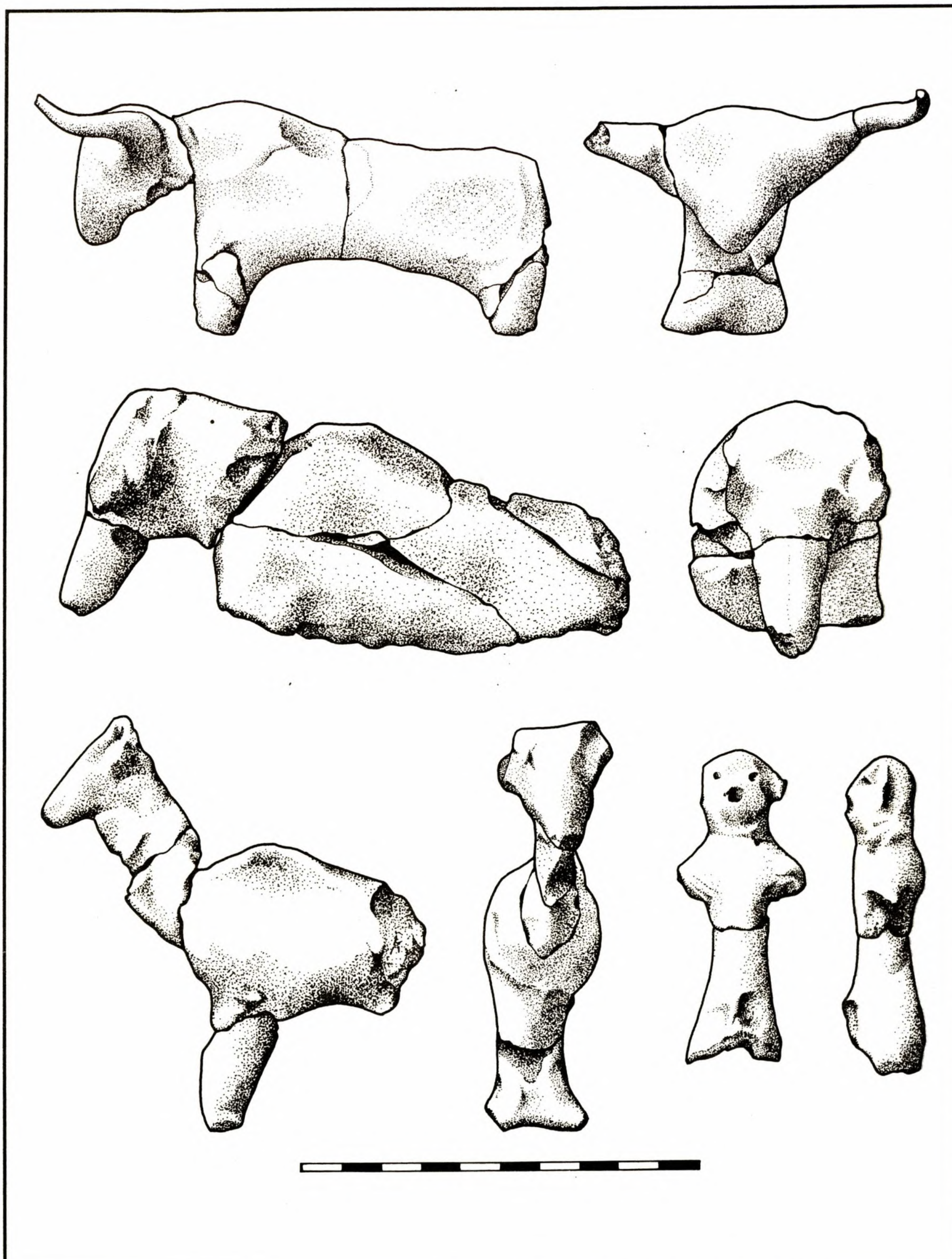

FIGURE 7.26: THE BAN NA DI BURIAL FIGURINES.

The prehistoric figurines were not tempered or fired. If they were designed specifically for mortuary ritual, such a composition would be appropriate. This is because, as funerary furniture, they would only require sufficient strength to survive the duration of the interment rituals. Such a highly specialized use of local clay, which had a limited ceramic usefulness due to its poorly crystalline clay mineral component, (chapter four), helps corroborate the notion of conservation associated with imported quality clay. This motive is also suggested by the blending of local and imported clays in fabric group 3 discussed above. Thus it seems that any opportunity to conserve this exotic resource was readily taken.

Eight figurines were painted with a red iron oxide solution, probably derived from hematite, (Birkeland 1974:67, 86). Another figurine had received a sealant coat of what appears to be a resinous material. Fingerprints and pinched surfaces are often clearly visible which suggests they were hand-modelled. A sharp instrument has been used to model eyes, nostrils and the nose of the human figurines (fig. 7.26).

7.6 Occupation Fabrics

Post deposition disturbances, such as postholes and midden pits, can mean that secure stratigraphic contexts for non-burial pottery are rare. The clarity of flood lenses at Ban Na Di has afforded a secure provenance for grave goods, and allowed precise chronological divisions. These circumstances are not accorded the non-burial pottery. A sampling strategy is required, therefore, which provides a degree of contextual rigour to material of less certain provenance.

Peacock (1982:172), warns that probabilistic sampling risks inadvertent selection of deposits dominated by residual material, and the exclusion of potentially primate samples derived from excavated contexts. Such situations favour judgemental sampling. They may also lie behind the widespread practice of selecting rimsherds as representing the broadest, and most readily recognisable, range of pottery "types". This strategy has proved successful in previous studies, (Kidder *op. cit.*, Shepard *op.cit.*, Rutnin *op. cit.*), however it includes one serious shortcoming.

Rimform classification studies are heavily biased in favour of selection for exotic wares. Thus rare and/or novel individual members of the sample are emphasized at the quantitative expense of more common varieties. This bias can be briefly demonstrated by comparing the proportions of Ban Na Di MP1 local ware pots to exotic vessels in two ways (Tables 7.4 and 7.5). First, the different proportions with respect to form categories are compared, and second, with respect to the total sample. Mortuary phase 2 and non-burial vessels are excluded.

TABLE 7.4: Proportions of exotic MP1 burial pot forms.

Phase	n pots	n forms	n exotic forms	% of exotic forms
1a	11	3	1	33.00
1b	49	14	3	21.42
1c	63	13	9	69.23

TABLE 7.5: Proportions of exotic MP1 burial pots.

Phase	n pots	n exotic pots	% of exotic pots
1a	11	1	9.09
1b	49	5	10.20
1c	63	11	17.46

The implication of selecting for form variants rather than for form-plus-fabric types is that it clearly biases the sample in favour of form or stylistic variety. Thus exotic wares will be disproportionately represented. This is predictable because in a sense exotic is synonymous with novel, and *variation* orientated studies are, therefore, biased towards the exotic. Of course a range of factors influence the presence or absence of exotic items in any given archaeological context. What is promoted here is that if exotic items are present as individuals in a class of artefacts that includes substantial numbers of locally produced artefacts of the same class, then the bias discussed will prevail.

(a) Rimsherds

Definition of discrete forms allows primary differentiation but risks the bias mentioned above. Unfortunately this bias is exacerbated by the propensity of potters to copy novel forms. In contrast to fabric types, which can be expected to reflect the potter's inherent technological conservatism, forms are often copied. Such pottery may spread across fabric boundaries. Thus, a single form may exhibit both local and exotic fabrics. With whole vessels, nuances in surface finish and construction methods usually allow copies to be recognized. The situation with rims, however, is less clear. Often only a small portion is available, and plainware rims commonly exhibit little variation in shape. Therefore, correlations between complexity and a single fabric group, or simplicity and more than one fabric group, is selected with increasing sample size.

Table A.7 (Appendix one) sets out the rim fabrics following Wichakana's (1984:223-290) form categories and nomenclature for levels 8 to 3 inclusive. Representative examples of each form are set out in figures 7.27 to 7.44. White (1986:311) argues that the "US" (for "Upper Songkhram") designation which precedes Wichakana's rim categories is geographically incorrect in the case of Ban Na Di, and presumably other sites within the Pao and hence Chi river drainage system. Any attempt to alter Wichakana's system along these lines would lead to a less descriptive term, however, because we are dealing with *cultural* entities. We particularly need to discriminate between Chi Valley sites and those within the Sakon Nakhon Basin. This northern basin is usually conceived by geomorphologists as being bounded by the Phu Phan Range. Thus it includes the Kumphawapi zone (Cruijs 1978:8-9, Thiramongkol 1983:14). Ban Na Di is located in this latter zone.

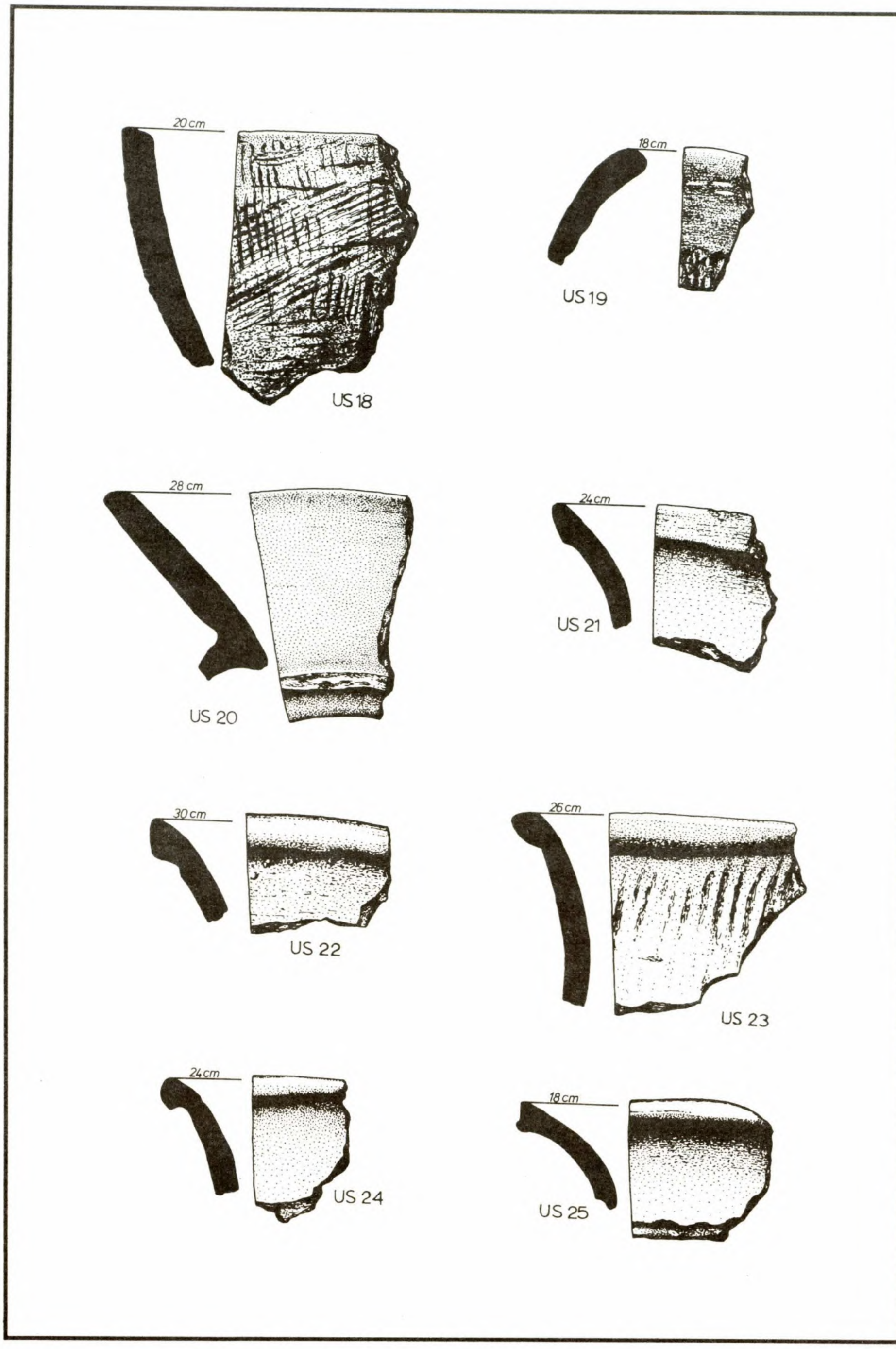

FIGURE 7.27: THE BAN NA DI RIMFORMS FROM LEVEL 8. Scale 1:2

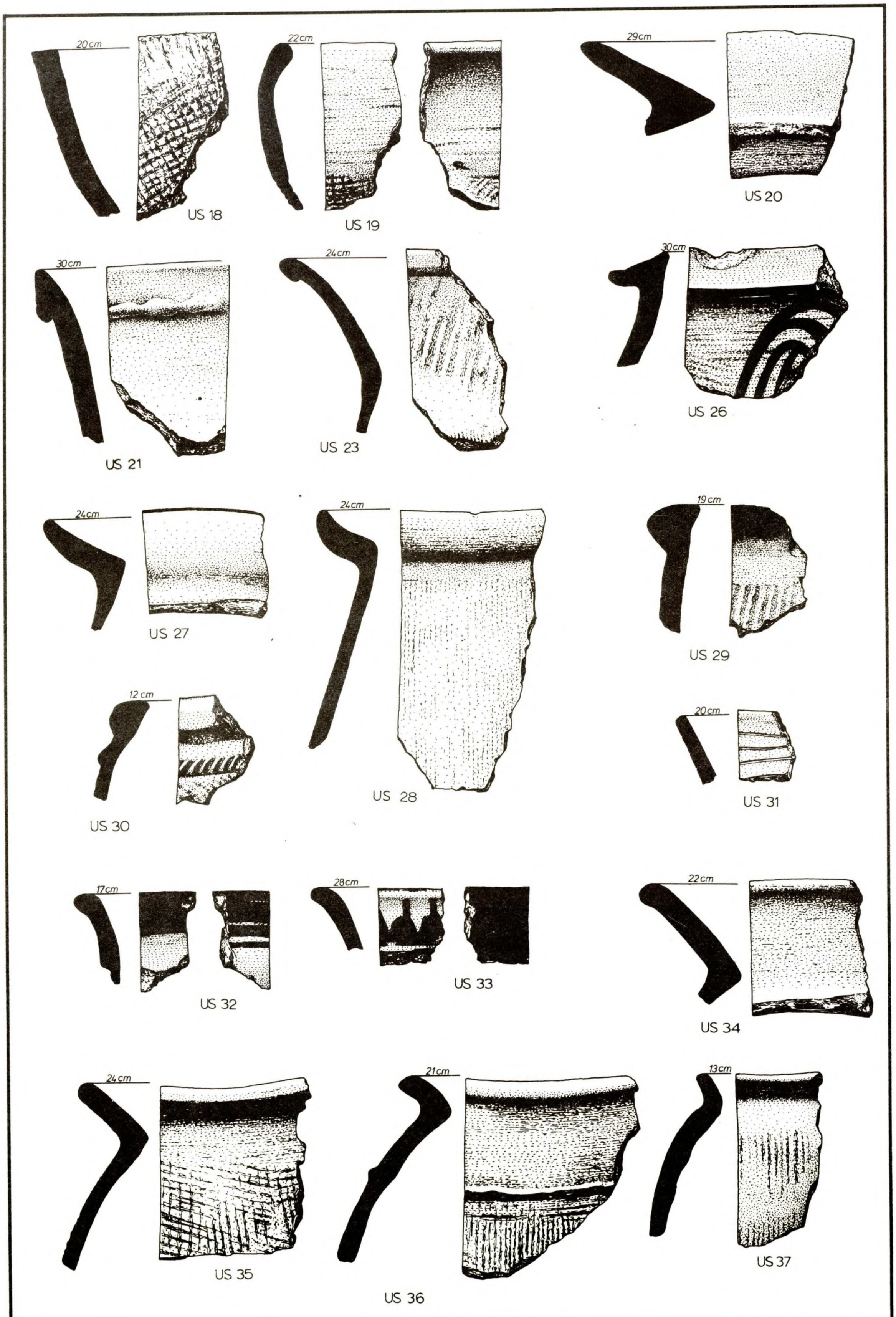

FIGURE 7.28. THE BAN NA DI RIMFORMS FROM LEVEL 7. Scale 1:2

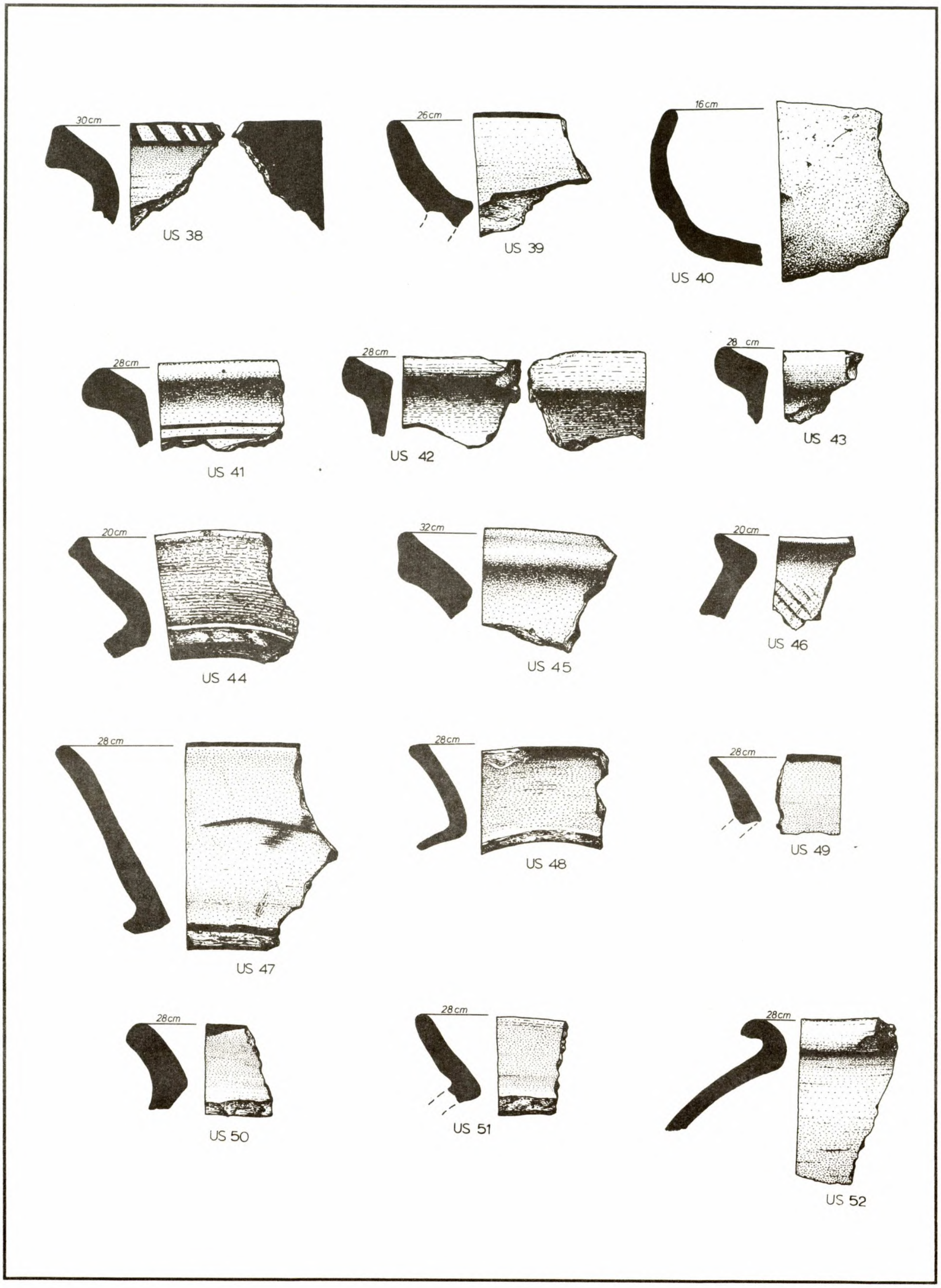

FIGURE 7.29: THE BAN NA DI RIMFORMS FROM LEVEL 7. Scale 1:2

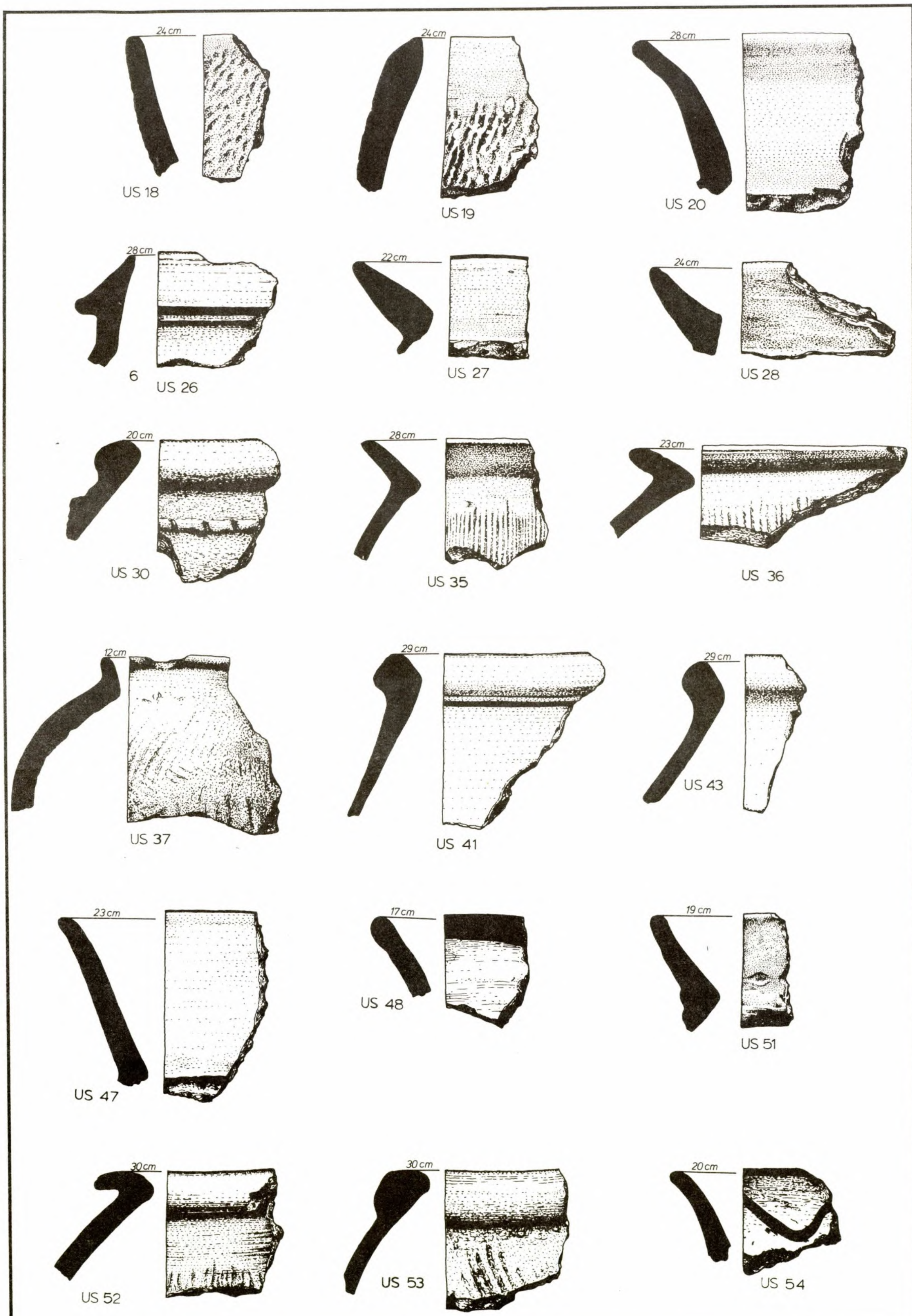

FIGURE 7.30: THE BAN NA DI RIMFORMS FROM LEVEL 6. Scale 1:2

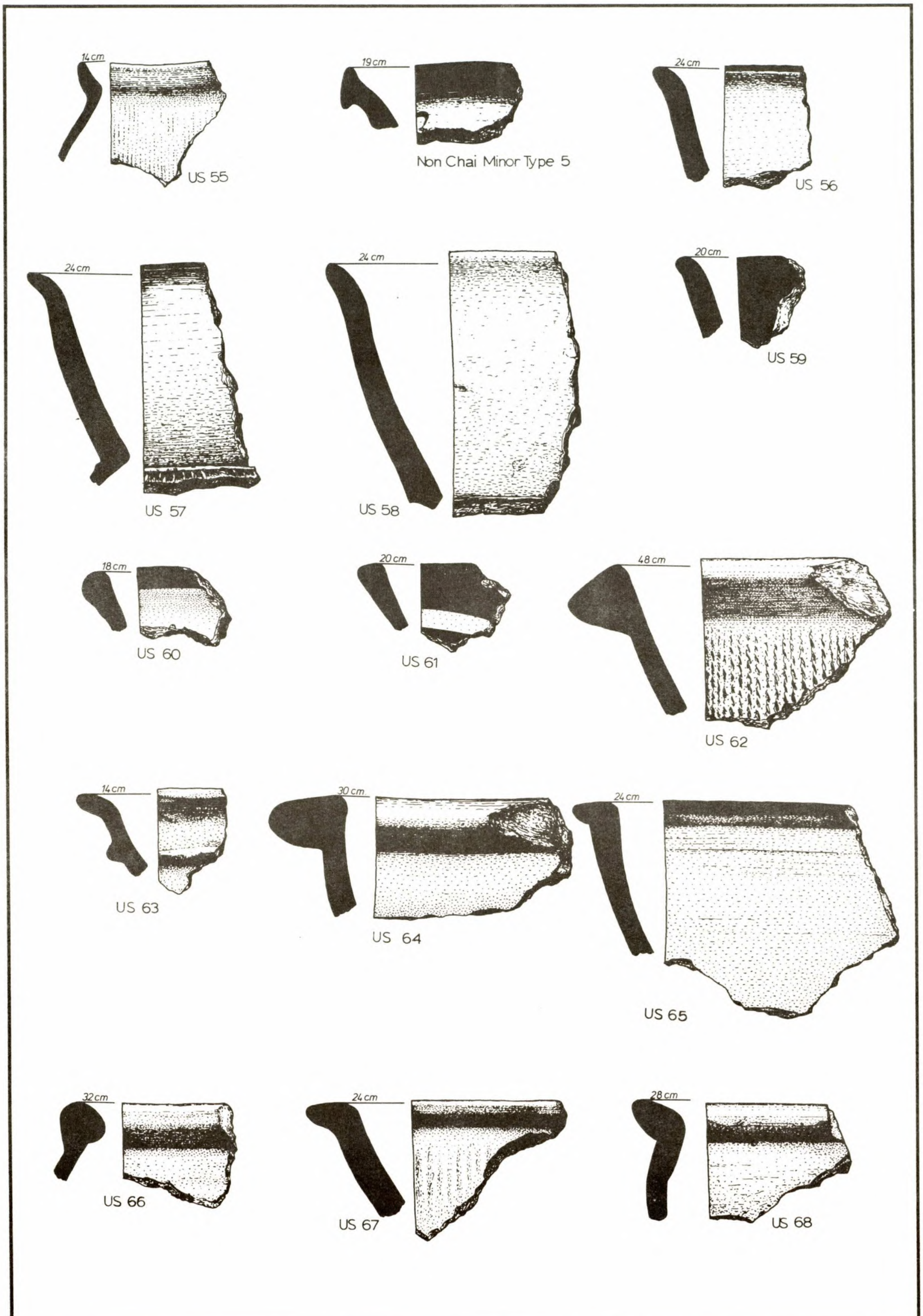

FIGURE 7.31: THE BAN NA DI RIMFORMS FROM LEVEL 6. Scale 1:2

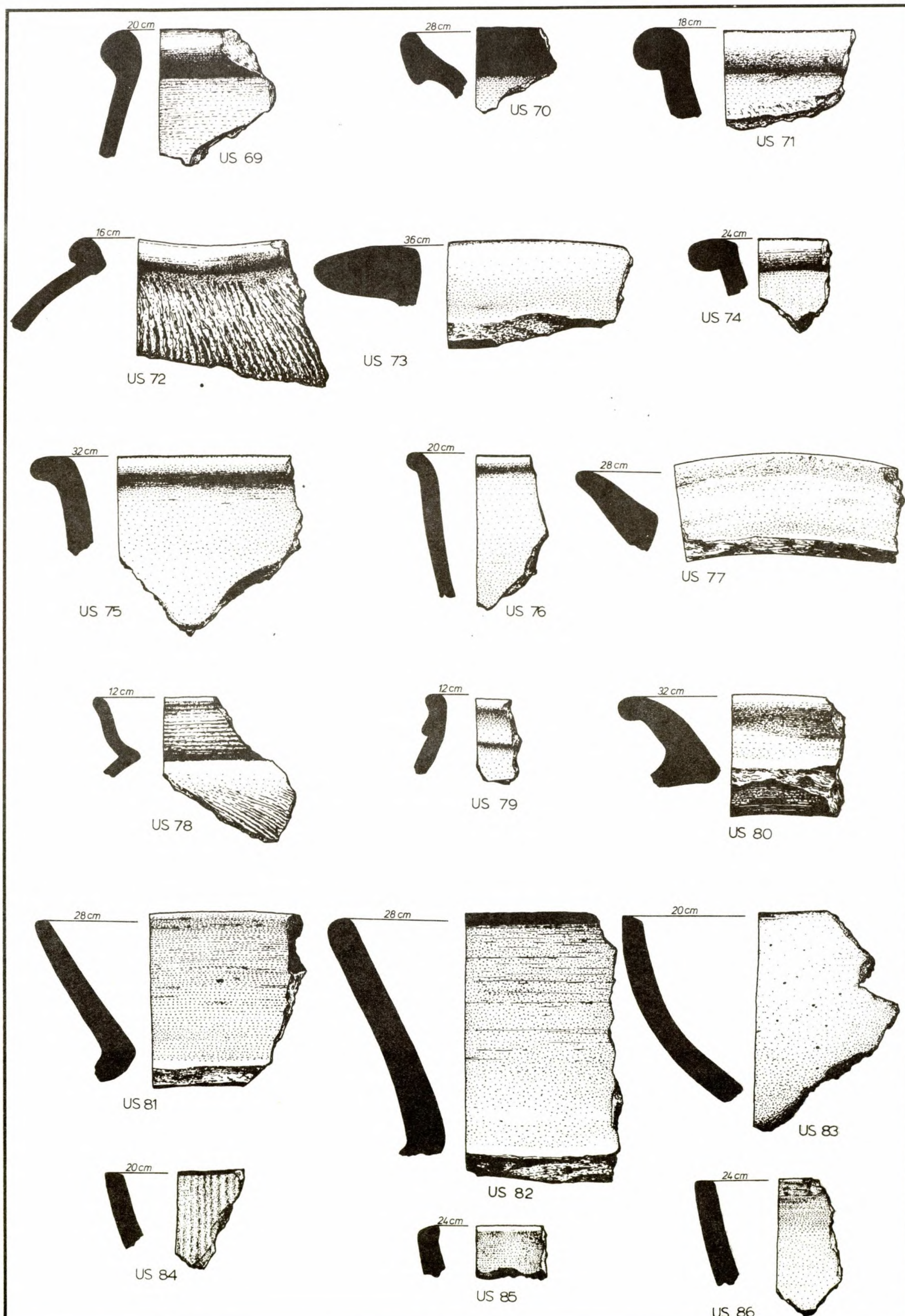

FIGURE 7.32: THE BAN NA DI RIMFORMS FROM LEVEL 6. Scale 1:2

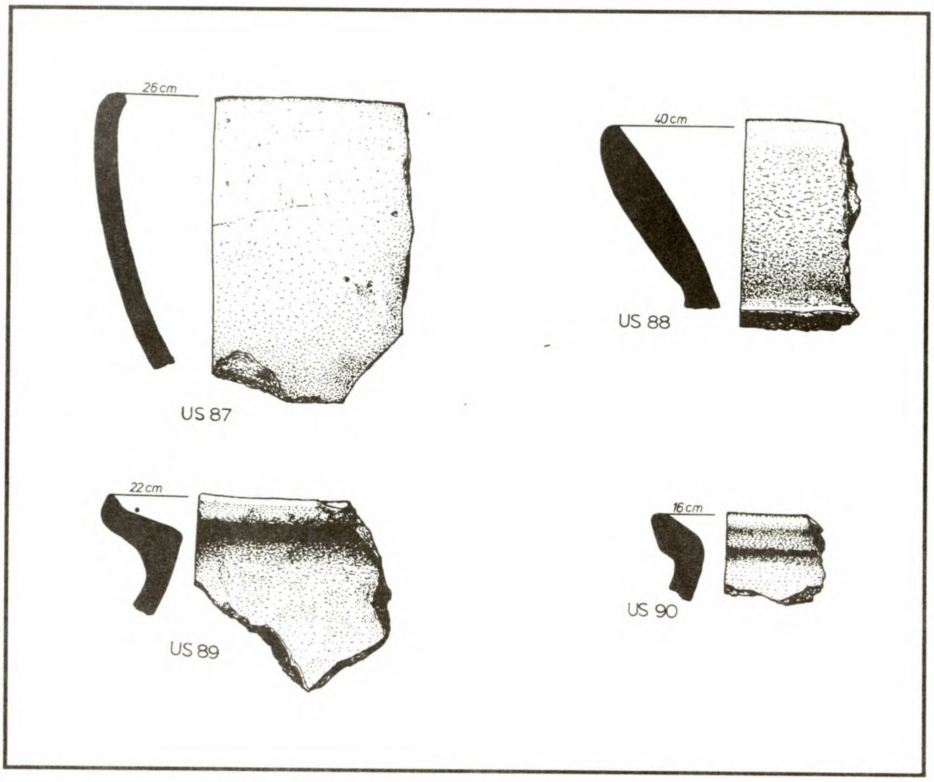

FIGURE 7.33: THE BAN NA DI RIMFORMS FROM LEVEL 6. Scale 1:2

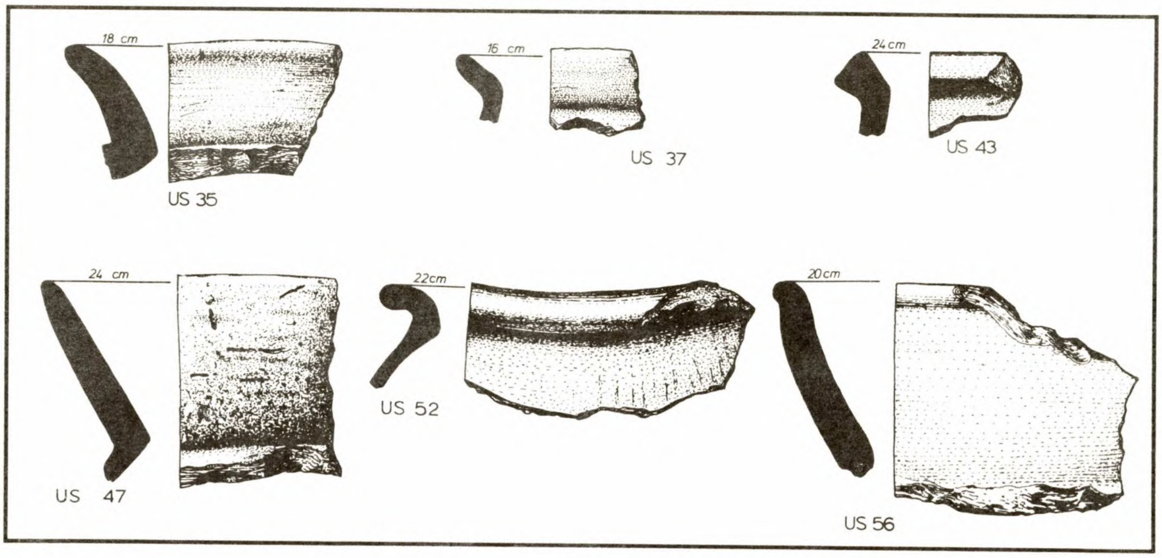

FIGURE 7.34: THE BAN NA DI RIMFORMS FROM LEVEL 5. Scale 1:2

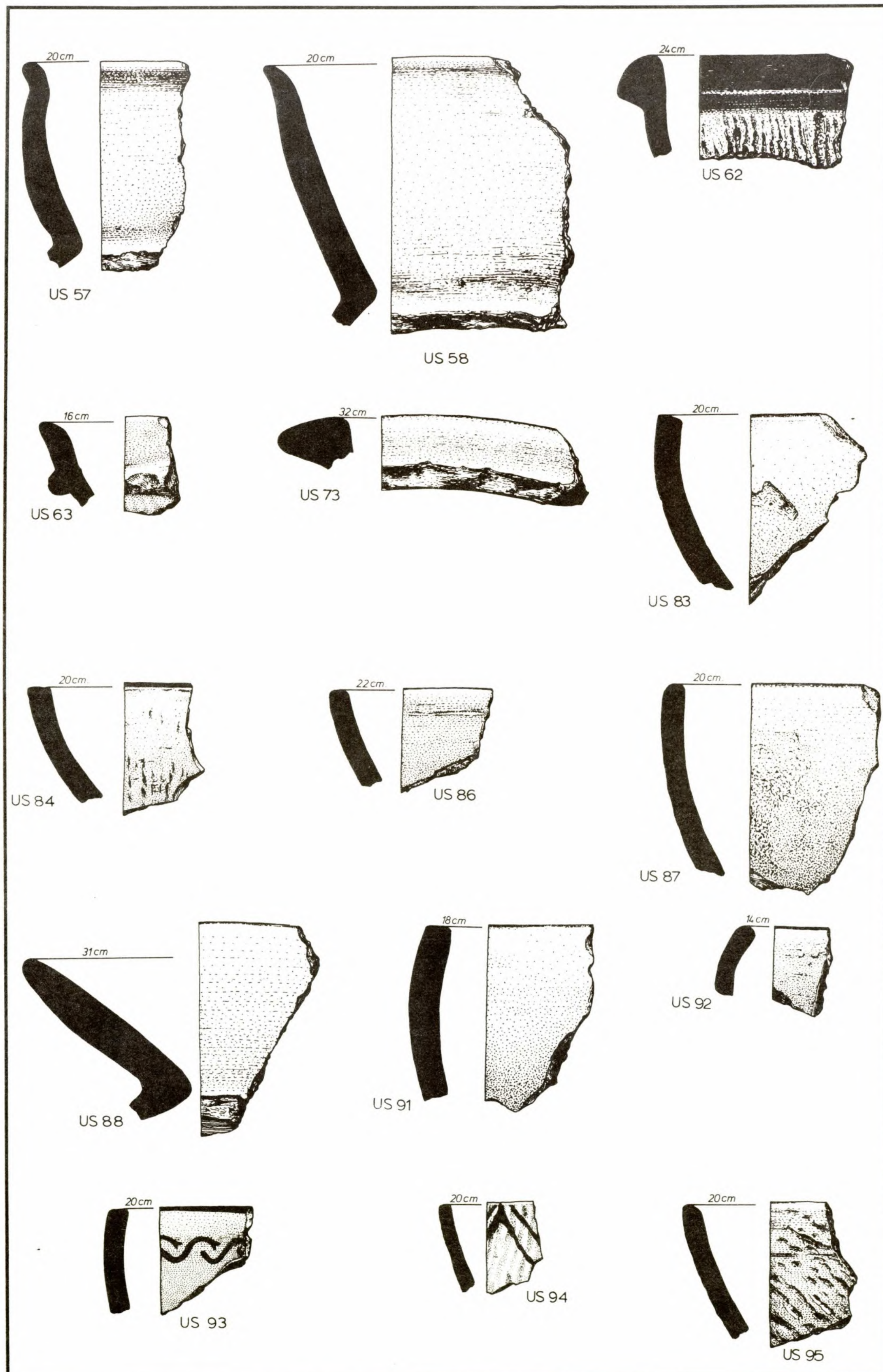

FIGURE 7.35: THE BAN NA DI RIMFORMS FROM LEVEL 5. Scale 1:2

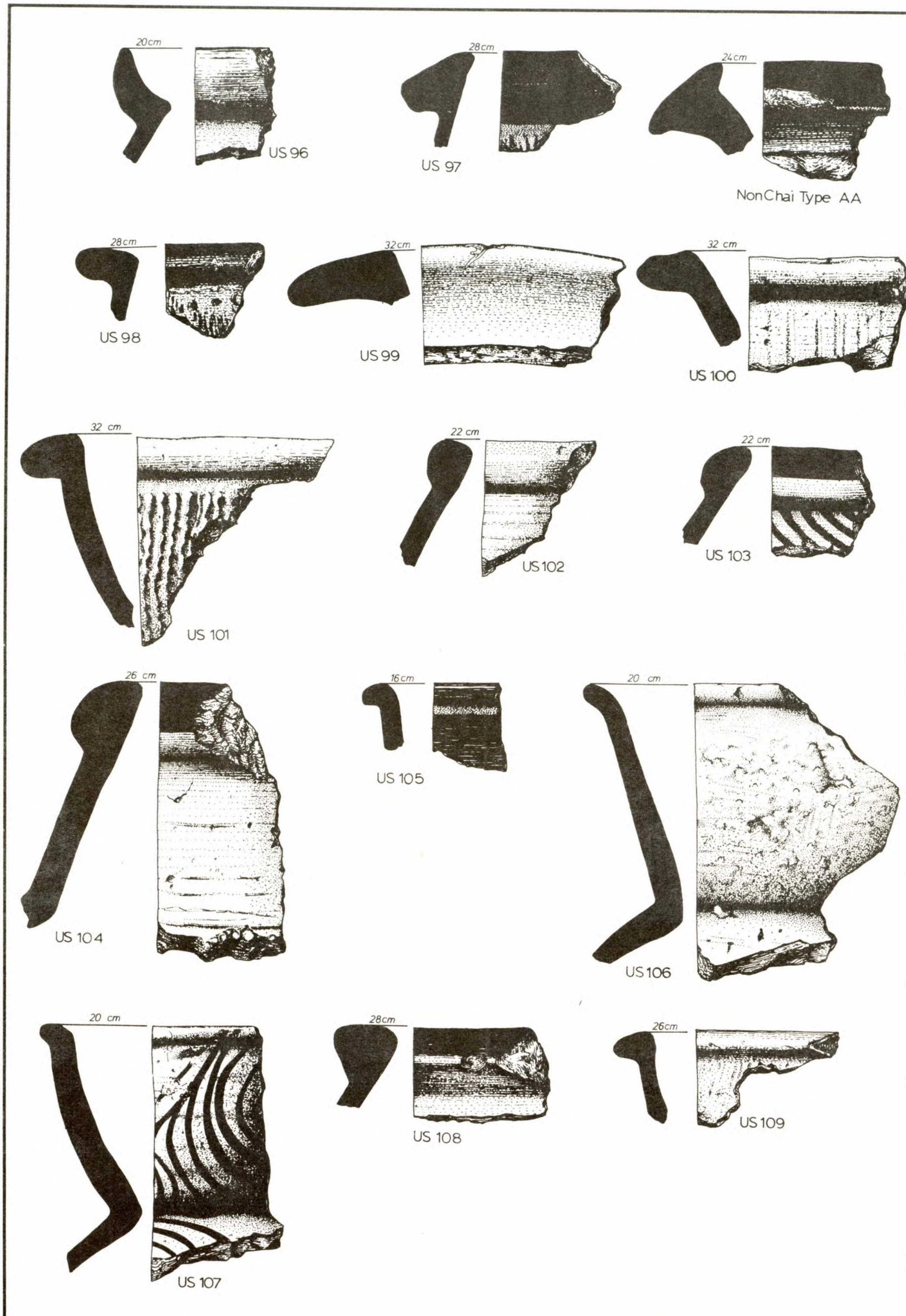

FIGURE 7.36: THE BAN NA DI RIMFORMS FROM LEVEL 5. Scale 1:2

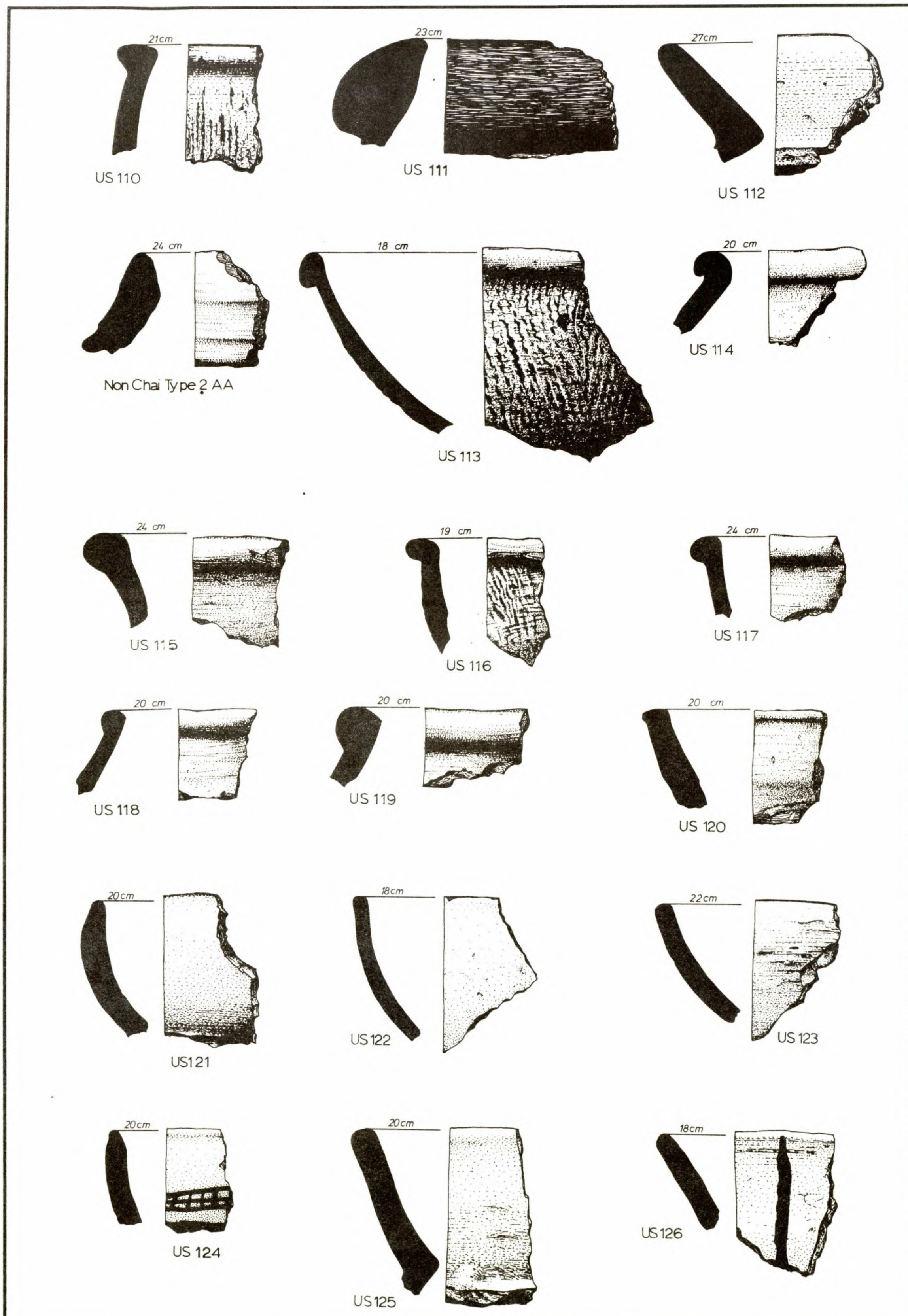

FIGURE 7.37: THE BAN NA DI RIMFORMS FROM LEVEL 5. Scale 1:2

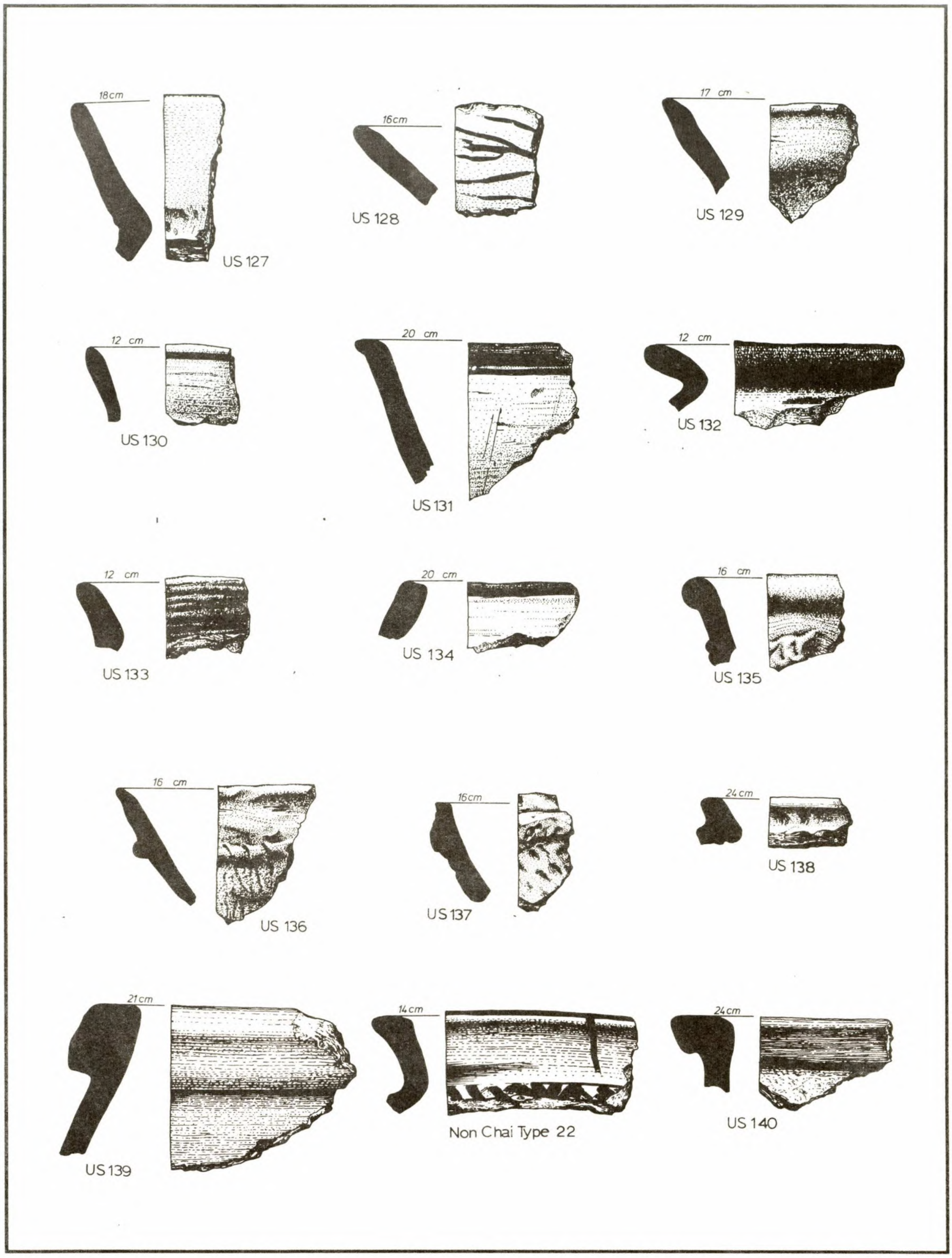

FIGURE 7.38: THE BAN NA DI RIMFORMS FROM LEVEL 5. Scale 1:2

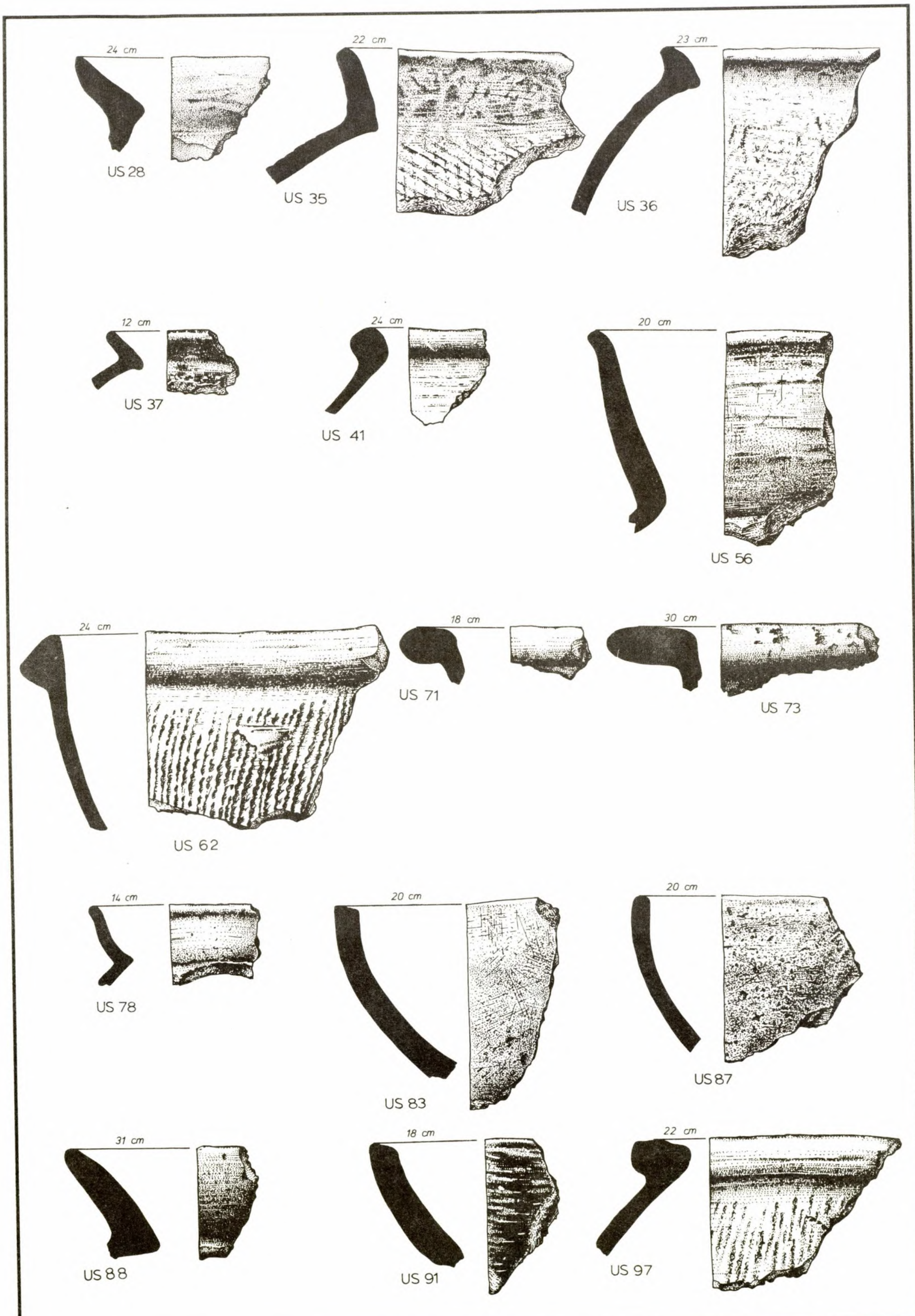

FIGURE 7.39: THE BAN NA DI RIMFORMS FROM LEVEL 4. Scale 1:2

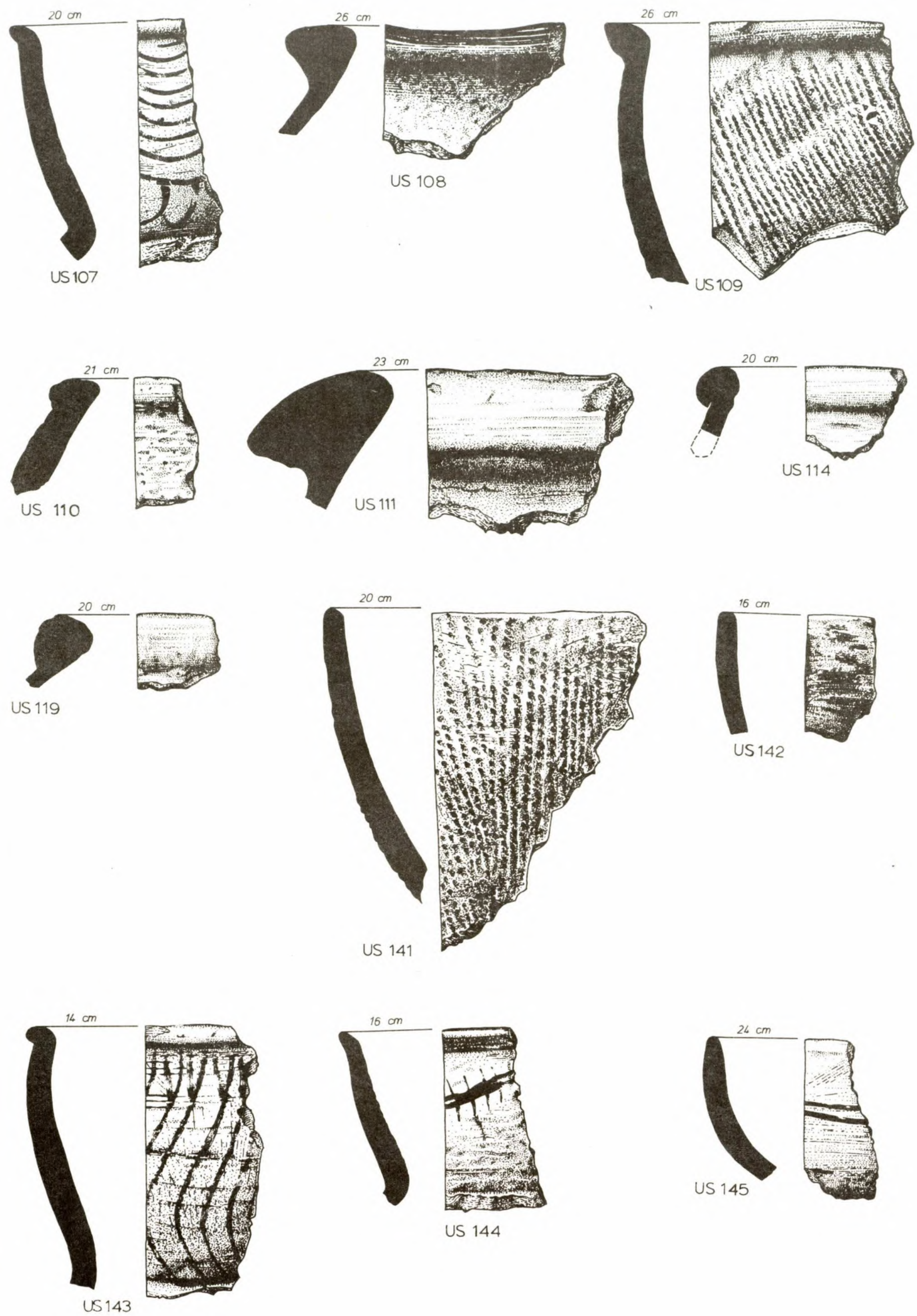

FIGURE 7.40: THE BAN NA DI RIMFORMS FROM LEVEL 4. Scale 1:2

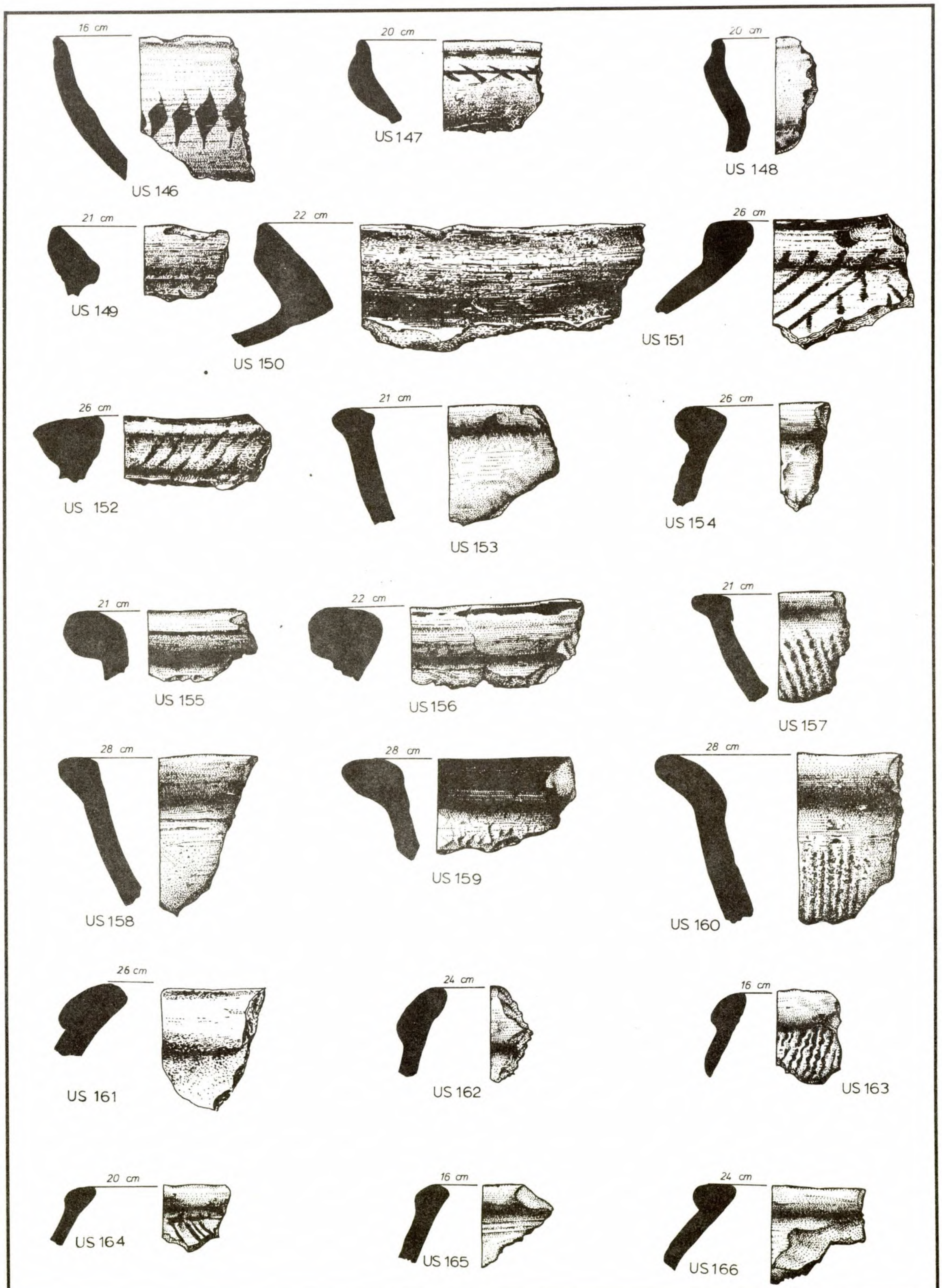

FIGURE 7.41: THE BAN NA DI RIMFORMS FROM LEVEL 4. Scale 1:2

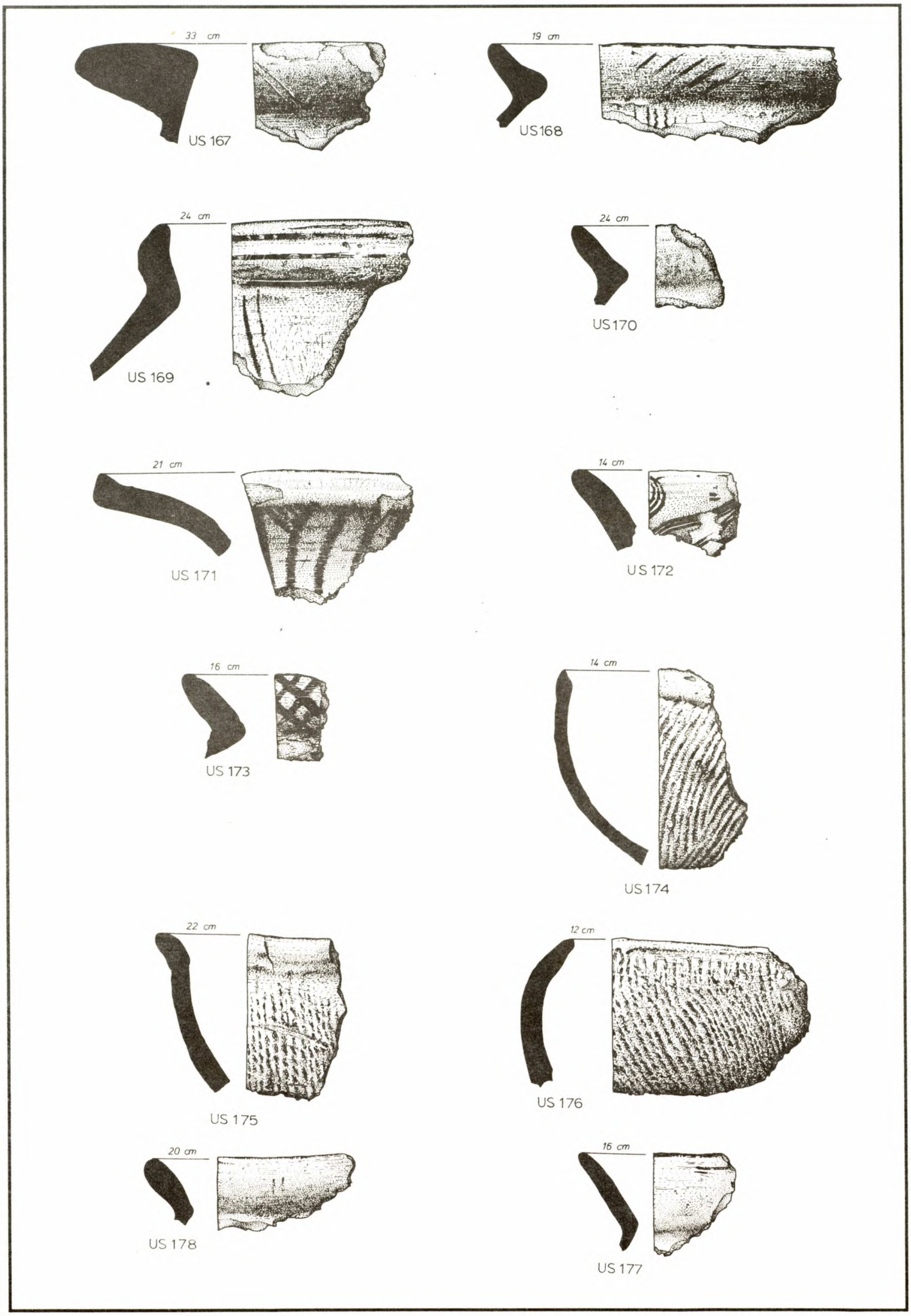

FIGURE 7.42: THE BAN NA DI RIMFORMS FROM LEVEL 4. Scale 1:2

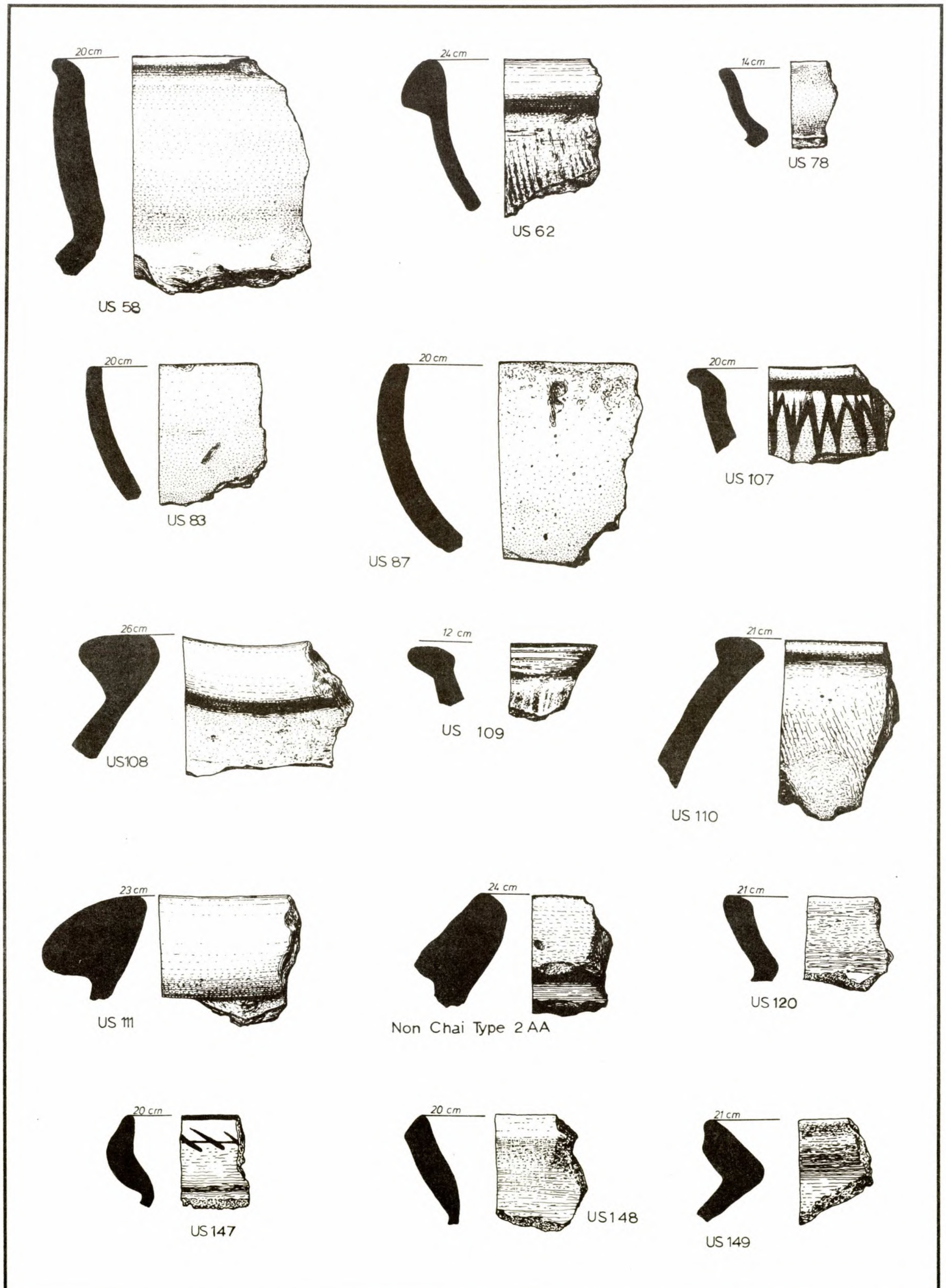

FIGURE 7.43: THE BAN NA DI RIMFORMS FROM LEVEL 3. Scale 1:2

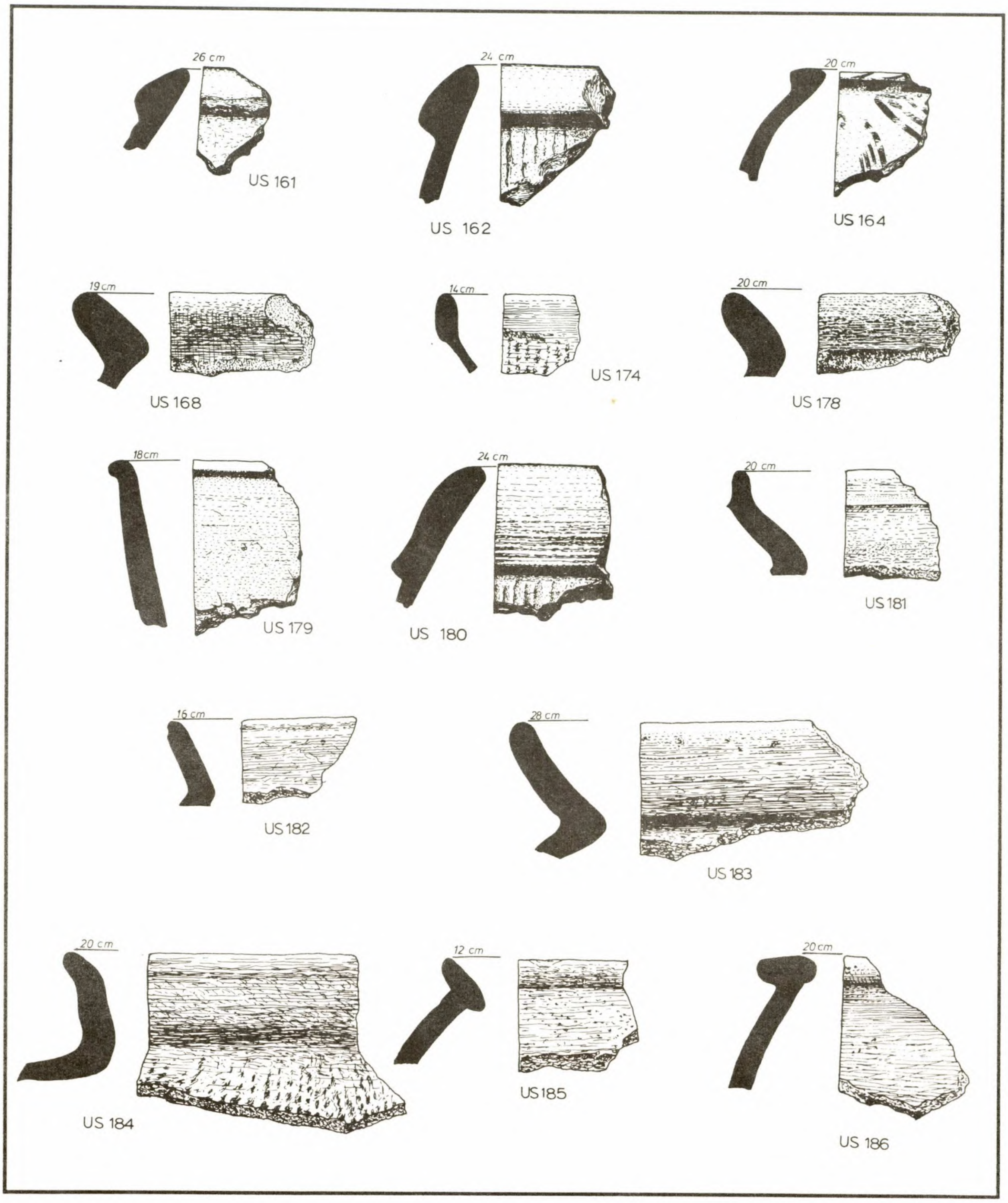

FIGURE 7.44: THE BAN NA DI RIMFORMS FROM LEVEL 3. Scale 1:2

Some exotic rimsherd fabrics are not fully described as such detail lies outside the scope of the present work. This applies particularly to fabrics considered to originate from sedimentary terrain, and which are not readily associated with Sakon Nakhon Basin potting clays. Many, however, are readily understood in terms of these clays. They have been allocated probable sources with varing degrees of confidence. Thus, these latter fabrics are readily related to general areas. Those of less unequivocal association are followed by a question mark. It is stressed that Tables A.1 to A.11 (Appendix one), can be regarded as approximations only. Further, the stratigraphic contexts of occupation level rimforms should be treated with caution due to the post-depositional disturbances discussed above. Therefore, *in situ* funerary wares are given stratigraphic primacy over occupation level rimforms.

We can be confident, however, that the rim fabric plus form associations are meaningful because they reflect pottery types *sensu stricto*. Thus the associations set out in Appendix one can be considered acceptably secure. The histograms set out below (fig. 7.45 to 7.46), summarize distributions of exotic vessels and rimform fabrics detailed in Tables A.1 and A.7 (Appendix one), and the temporal distribution of orthodox grog and bleb-tempered rims considered local to Ban Na Di. It is important to note that the distribution of exotic fabrics originating outside the Sakon Nakhon Basin closely follows that of local Ban Na Di bleb wares. Exotic "whole" vessel distributions correlate with the exotic rim tendency up to level 5. In combination, these data corroborate the overall rim type distributions. They are mutually supportive, and point to a major change at the level 5/6 interface. A concurrent major stratigraphic discontinuity in mortuary vessels underscores the rim type changes. At the same time, funerary furniture and mortuary ritual also undergo a comprehensive range of changes (Higham and Kijngam 1984). Several other ceramic artefacts have been examined. Comments regarding the origins of exotic rims apply equally to these artefacts as well.

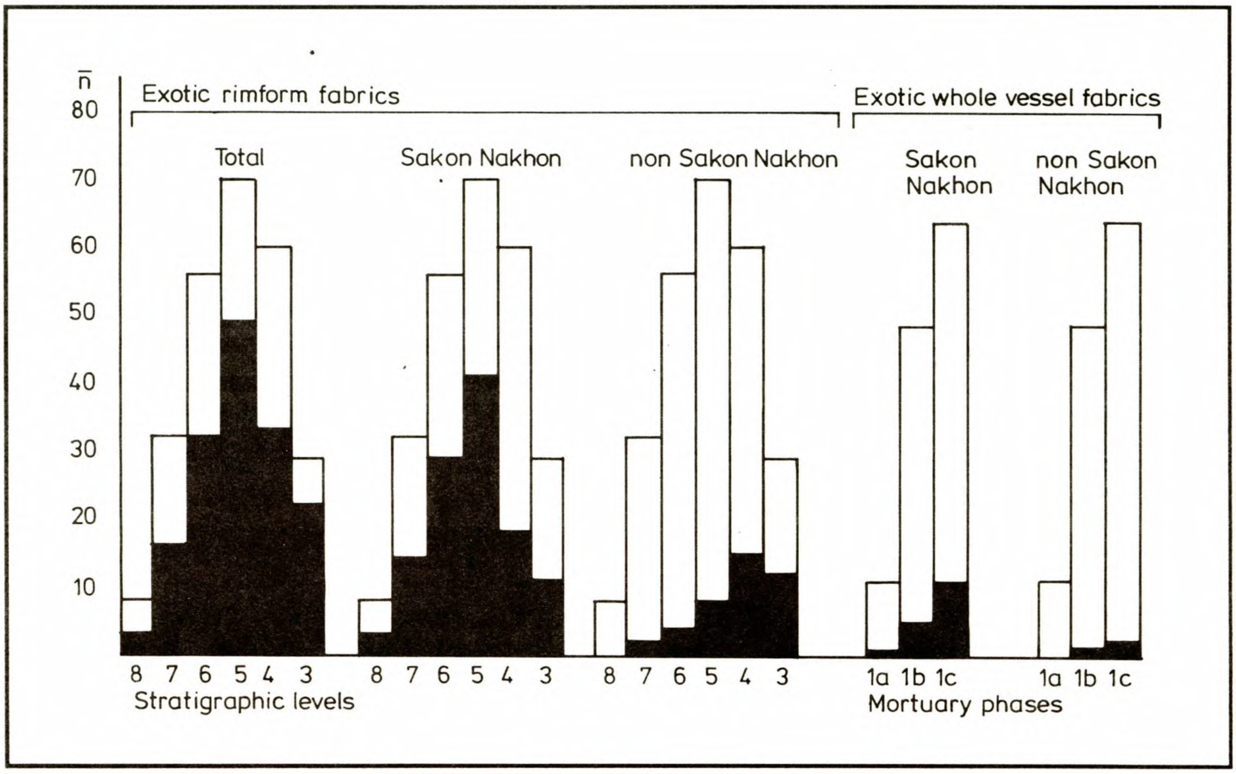

FIGURE 7.45: THE DISTRIBUTION OF EXOTIC FABRICS AT BAN NA DI.
(Shaded area represents exotic wares, totals are outlined.)

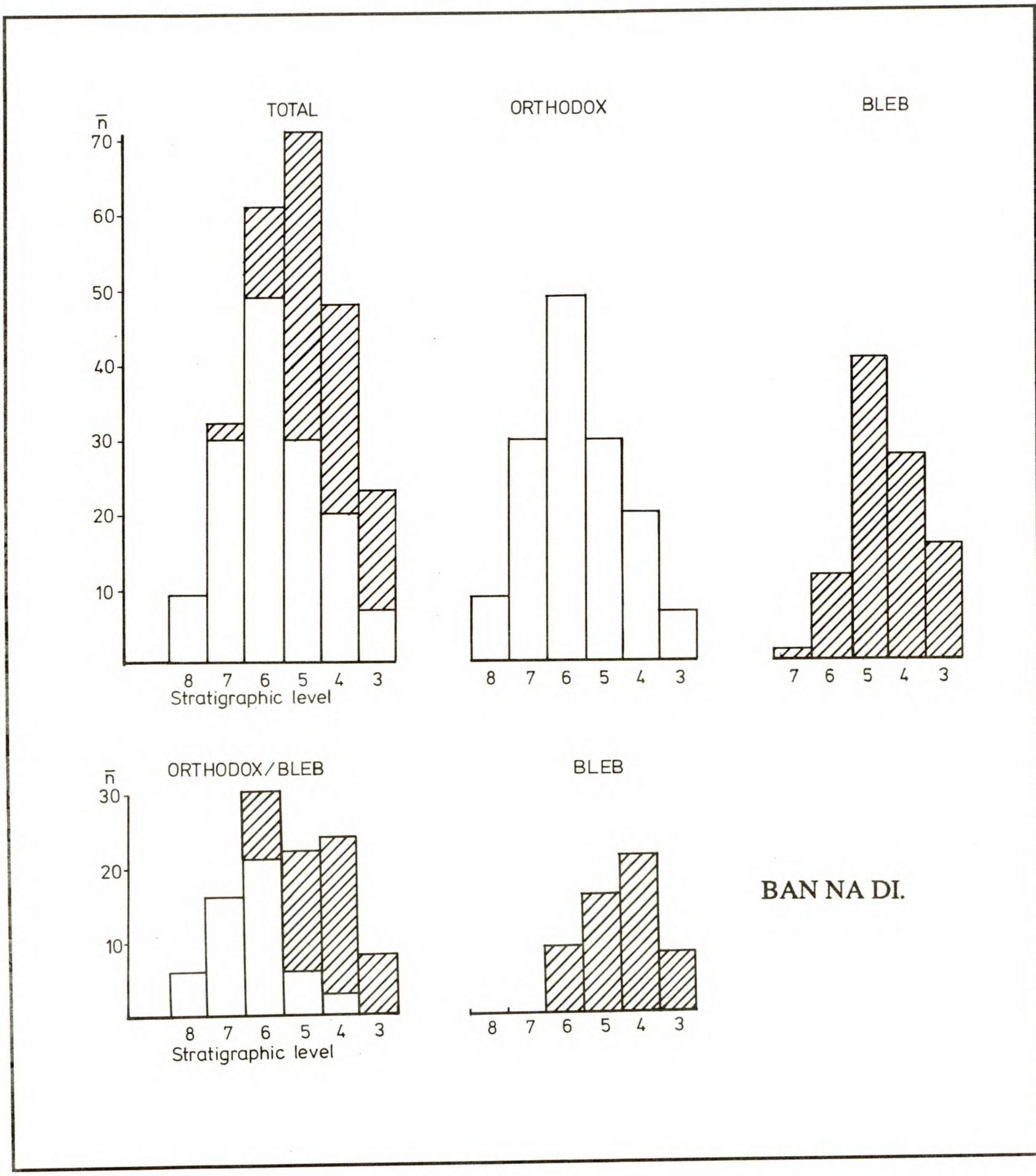

FIGURE 7.46: THE DISTRIBUTION OF ORTHODOX AND BLEB GROG AT BAN NA DI. (Upper: totals for site. Lower: Ban Na Di local wares.)

(b) Ceramic "rings"

Several fragmentary artefacts, apparently fashioned as rings or bracelets with round or oval cross sections, were recovered. A small representative sample has been thin-sectioned.

TABLE 7.6: Ban Na Di ceramic "ring" fabrics.

level	fabric	catalogue No.	provenance
7	3	860	A2 43
7	13	777	A1 32
4	12	197	A2 16
4	+	1513	A3 13

Note: + untempered Ban Na Di clay 13.

(c) Ceramic "ladles"

Only one ladle fragment (cat. 1357 L8 A3/A4 30) has been examined. It is composed of a fabric tempered with orthodox grog. Its origin is uncertain. The parent matrix is consistent with a Sakon Nakhon Basin source.

(d) "Bow" pellets

Abundant small ceramic pellets, probably used with a pellet bow as missiles, occur throughout the sequence. They range in size from about 12 mm to 23 mm in diameter. Those composed of local clay have a high proportion of nonplastics and their hardness (>5 on Moh's scale) and cohesiveness suggests they were fired. None of the pellets rendered in Ban Na Di clays was tempered. Level 4 revealed an orthodox grog tempered non-local pellet. A fabric group 12 pellet was recovered from level 2. The fabrics are summarized in Appendix one, Table A.12.

7.7 Industrial Fabrics

(a) Ceramic anvils

The paddle and anvil technique remains a principal means of vessel forming in modern north-eastern Thai pottery production and ceramic anvils are still common. Of the 23 anvils recovered at Ban Na Di none was firmly associated with burials. Twenty-one have been thin-sectioned. Their fabric associations and suggested provenance are summarized in Table A.13 (Appendix one).

Eight, (61.53%) of the 13 MP1 anvils examined are composed of fabric group 1. Three (23.07%), contain clay 3. Thus they have eastern Sakon Nakhon Basin affinities. One anvil (7.69%) has a fabric which probably relates to the western Sakon Nakhon Basin margins. The other is composed of fabric group 16 material, which contains clay from nearby Nong Sung. The MP1 anvil forms, (Higham and Kijngam 1984:154-157), can be subdivided into two groups. These correlate with local against exotic fabrics. A typical fabric group 1 anvil is illustrated below, (fig. 7.47) along with cats. 1850 and 858, which contain fabric groups 10 and 16 materials respectively. These latter anvils differ in shape to the majority of fabric group 1 forms. A single fabric group 1 anvil, (cat. 1851), however, is similar to the fabric group 16 example.

(b) Crucibles

Twenty six fragments of ceramic crucibles have been thin- sectioned. Their petrographic characteristics are summarized in Table A.14 (Appendix one). Several crucibles have bronze slag and/or metal adhering to inner surfaces. In some crucibles, this has also penetrated into the ceramic fabric. Cross sections reveal two clearly different mineralogical portions within such modified crucibles. Peripheral areas tend to be consistent with "normal" pottery ceramics. Areas adjacent to the metal, however, in many cases have been modified, presumably by heat during use. Mullite is present in these latter areas, and this indicates that they were subjected to relatively high temperatures (Rigby 1948, Grim 1962:99-100). A sample Ban Na Di crucible is illustrated in figure 7.48 below.

Fabrics presumed to have partially changed during bronze casting operations, (Seeley and Rajpitak 1984:109), were compared with more extensively affected samples. This provided background data useful in assessing their unmodified ceramic properties. Detailed studies of industrially modified crucibles are of course properly the province of metallurgists, and clearly lie beyond the scope of the present work. Fabric identifications, however, may provide insights into important cultural factors outside metallurgical questions *sensu stricto*. Thus we may note that, with one possible exception, prior to level 5, crucibles were not fabricated from local clays 13 or 14. Most (17 (80.95%), of the 21 examined), were tempered with orthodox grog. Three were rice tempered. Six crucibles are composed of fabrics consistent with MP1 fabric groups 1 or 2. Two of the earliest crucibles parallel a very early occupation level 8 rim fabric, which may derive from within the plagioclase feldspar zone relatively close to Ban Na Di. One crucible has clear mineralogical associations with clays located east of Ban Na Di, close to the Phu Phan Range. This crucible contains sand of a quartzose composition. Numerous chert, many potassium and several plagioclase feldspar grains are present in the sand.

Three level 5 crucibles have been examined in thin-section. Two contain untempered Ban Na Di clay. The other is composed of fabric group 13 material, a fabric group considered to originate in the eastern Sakon Nakhon Basin.

(c) Jewellery moulds

Eleven "clay" moulds were recovered, one from level 6, nine from level 5, and one from level 4 (Higham and Kijngam 1984:82). These have been examined in hand specimen only. Of particular interest are moulds presumed to have been involved with the manufacture of bronze bracelets. In cross-section, two distinct materials are visible. An inner, very fine, portion, which often bears fine negative impressions of positive engravings, and an outer encasing coarse shell. The inner component is 1-2 mm and the outer 4-10 mm thick. Some fragments are intact in section, thus it is probable that the *cire perdue* method, employing either wax or a low melting metal, was used. Ball (pers comm.), describes a method which may explain the process used at Ban Na Di. First, a completed template is dipped into a fine slurry of levigated clay, and then carefully allowed to dry. Second, when leather hard, the initial coat is manually covered with a thicker covering of a coarser clay preparation such as commonly used in pottery manufacture. After a further appropriate period of air drying the mould is ready for casting.

(d) Furnace fragments

Four furnace fragments have been examined in thin-section. One (cat. 472), incorporated a sherd tempered with orthodox grog. The fabric of this sherd is consistent with a Sakon Nakhon Basin source. The largest furnace fragment (cat.955, fig. 7.49), measures 130 mm x 92 mm x 56 mm. It has woven mat impressions on one surface. Two further fragments (cats.916 and 1472), were examined. The former has a partial hand imprint. All of the furnaces were constructed from local clay. Compared to figurine and modern clay samples, however, the furnace fragments are dense with a high proportion of nonplastics. Their composition suggests they were either derived from a slightly different local source than the one the figurines and modern clays were quarried from, or that a preparation technique was used which selectively reduced the clay matrix component. During MP1, only one furnace was uncovered in level 7.

(e) Miscellaneous artefacts

Perforated sherds are present from level 6 at Ban Na Di, and in layers 4, 6 and 7 at Ban Chiang Hian. Such sherds have often been associated with rice steaming. Calder (1972:14) describes similar looking vessels from Ban Koeng as alkali filter pots. Until more complete vessels are available, the precise role of perforated vessels is conjectural. Their provenance and suggested sources are set out in Table 7.7 below.

TABLE 7.7: Perforated sherd fabrics.

level	fabric	catalogue No.	suggested source.
4	12	1503	Ban Na Di
4	blebs	307	Non Chai?
4	blebs	1508	Non Chai?

Five rod-like ceramic artefacts, measuring 30 to 40 cm long, by 12 to 18 mm in diameter, were recovered. Each has one pointed end, and is rounded in cross section. A level 7 sample, (cat. 719), has been examined in thin-section. It is composed of dense, but otherwise untempered, fired local clay.

7.8 Final comments and summary

Clearly, the ceramic evidence from Ban Na Di is complex. Only the more salient aspects require discussion at this point. First, two different indigenous ceramic traditions are reflected in the MP1 and MP2 funerary wares. During MP1 manufacture was apparently conducted under the stress of a lack of quality local clay. This led to blending, and the use of local clay in artefacts which did not require a quality ceramic composition. Although affected by this shortcoming, MP1 potters retained their basic tempering method. Modifications were restricted to supplementing imported clay with local material, and to the addition of rice to their basic potting mixture. This was apparently added for ritual purposes. Unfortunately we are unable to examine in detail the MP2 mortuary ritual, except to note that infant burial urns make their first appearance. These contain a technologically different temper from that of the earliest tradition. The MP1 method of vessel fabrication featured the use of moulds. This technique was not used in constructing the MP2 burial urns. They were built up from slabs or slabs and coils.

Surface decoration also differs between MP1 and MP2 wares. A majority of MP1 vessels were cordmarked. Miniatures aside, of the 100 vessels sufficiently intact for analysis, 99 were finished in this way. We have noted that this finish, when a paddle and anvil are used for forming, is less demanding than a smooth surface. In contrast to MP1, however, from level 5 onwards smoothed, and red painted or slipped, surfaces dominate (Table B.8 Appendix two). The MP2 burial urns reveal that a plain instrument was used to smooth over underlying cordmarks. This two-stage process preceded a wide variety of painted decoration. In comparison with MP2 rimforms, the MP1 repertoire is very limited. The later production appears to be more developed. Therefore it was probably conducted under different socio-economic conditions. These were apparently more intensive. External relationships, in terms of exotic rim types, involved a much expanded exchange network.

Funerary, occupation and industrial ceramics all demonstrate that a major discontinuity was associated with the replacement of the MP1 tradition by a new one which involved the manufacture of bleb tempered pots. A different clay source was exploited for pottery. This same source, however, probably provided the clay for MP1 crucibles. It is present in anvils during both periods. We have also noted that the changes in pottery manufacture was accompanied by changes in clays and fabrics used in metallurgy. The transition from the MP1 to the new ceramic and metallurgical traditions is marked by technical discontinuity. Several external relationships, however, continued as before. This is reflected in imported materials and a maintenance of technological connections with the eastern Sakon Nakhon Basin region. Such continuity suggests that some existing socio-economic links were maintained and other, perhaps new, relationships are strengthened.

Wares tempered with orthodox grog are present throughout the sequence. During MP1 they were locally manufactured and varied in composition only through the addition of rice. Rice is positively correlated with what are probably ritual vessels. When ceramic strength was not important an inferior local clay was substituted for a quality imported clay normally used for pottery. Figurines, some small artefacts and furnaces contain local clays. "Bow" pellets and crucibles suggest that this practice probably spans both traditions.

Ceramic anvils relate directly to pottery manufacture. They are, therefore, essential items in a potter's equipment. It seems likely that potters would make their own anvils and identify with them. If so, anvils possess potential as sensitive indicators of cultural changes. At Khok Phanom Di several individual anvils and cylinders of prepared clay were incised with distinctive marks. If such "potters' marks" denote individual ownership, this concept is reasonably extended to the Ban Na Di anvils. The movements of individual potters, perhaps by way of marriage exchange, are potentially traced through the mobility of anvils. We can also anticipate that changes in ceramic traditions should also be accompanied by a change in potters' equipment. These are sensitive *prima facie* indicators of culturally significant processes.

Although the Ban Na Di sample is small, several pertinent points are obvious. First, a clear dichotomy is evident between the distribution of anvil fabrics on each side of the level 4/5 interface. Second, although a variety of exotic fabrics are represented, only one anvil is consistent with a source external to the Sakon Nakhon Basin. An isolated Chi Valley anvil might reasonably be equated with marriage exchange. In this instance, however, we are also presented with a comprehensive range of related developments. And in each instance they correlate with each other. Thus the changes from orthodox to bleb grog at Ban Na Di closely matches changes in the spectrum of imported pottery. Similarly, increases in exotic wares, which during MP1 emphasize the Sakon Nakhon Basin, are by level 5 strongly influenced by Chi Valley imports. And by level 4 both regions are virtually equally represented in the exotic ware spectrum.

Mortuary vessels are conclusive both in terms of fabric and provenance. Again they are mutually exclusive to MP1 and MP2. Unfortunately, however, they are absent from level 5. In order to resolve this omission, we have been able to focus on rimsherds, crucibles, anvils and several other ceramic artefacts. The first, rim fabrics, clearly support a change at the level 5/6 boundary. Although bleb-tempered rims occur in level 6 and 7, the quantity is small and readily explained by *in situ* artefact mobility, a familiar phenomenom in Southeast Asian prehistoric sites, where human and animal disturbances, such as posthole digging and bioturbation, are common.

Crucible fabrics are equally important in illuminating the transition at level 5. During MP1 bronze workers avoid using local clay for crucibles. Conversely, however, they use local clay in the construction of their furnaces. There is no evidence to suggest that this strategy was altered during a period of over a millenium. The situation changed dramatically in level 5 with the appearance of the first crucibles made from untempered local Ban Na Di clay. It coincides with the disappearance of the principal MP1 crucible fabric. Admittedly this is a small sample. It is stressed, however, that these accoutrements are key components of a vital industry. The following chapter will outline a model designed to account for temporal changes at Ban Na Di and related sites.

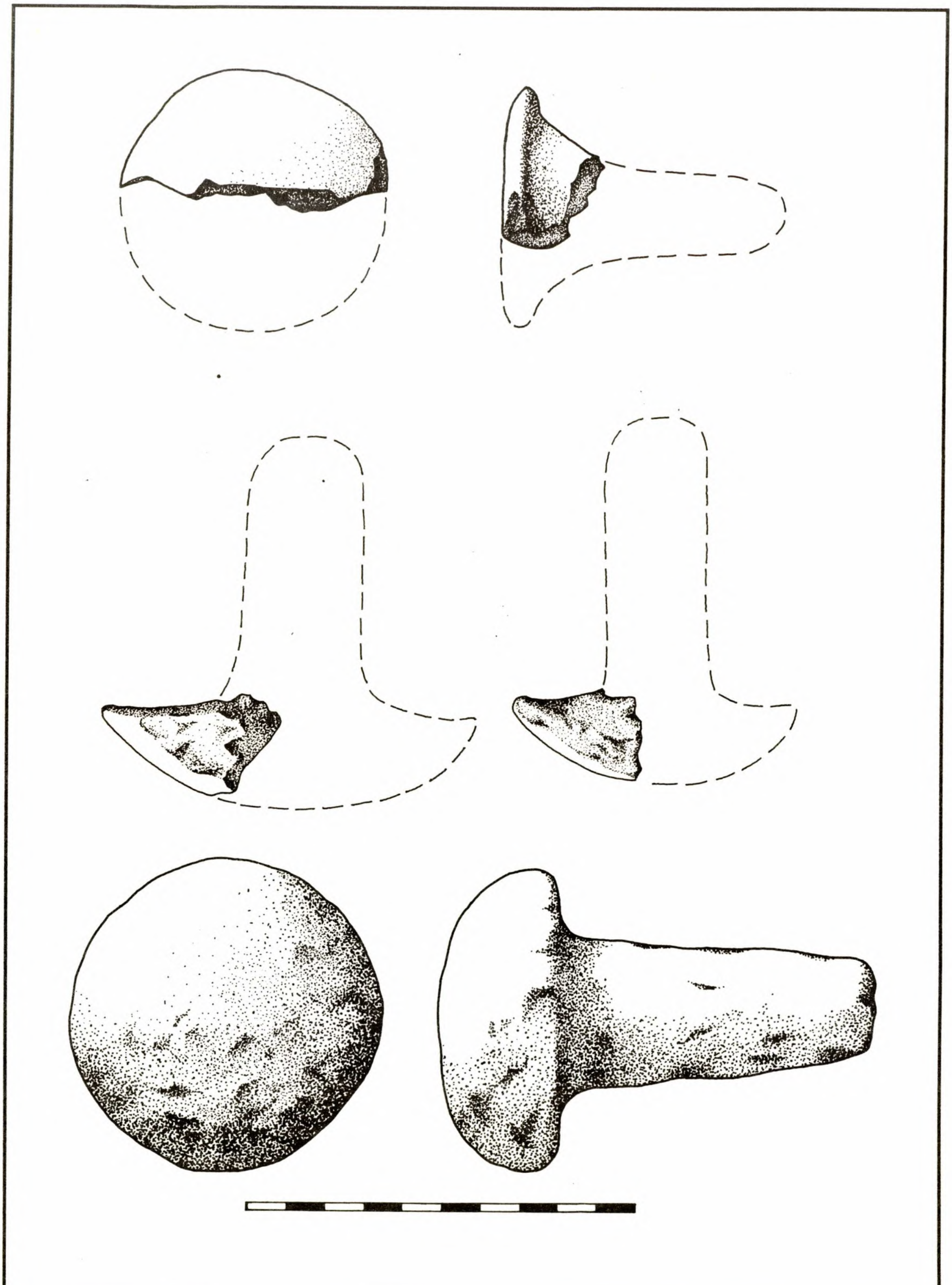

FIGURE 7.47: CERAMIC ANVILS FROM BAN NA DI.(upper: cat. no 858; middle left: cat. no 1851; middle right: cat. no 1850; lower: a typical local anvil form).

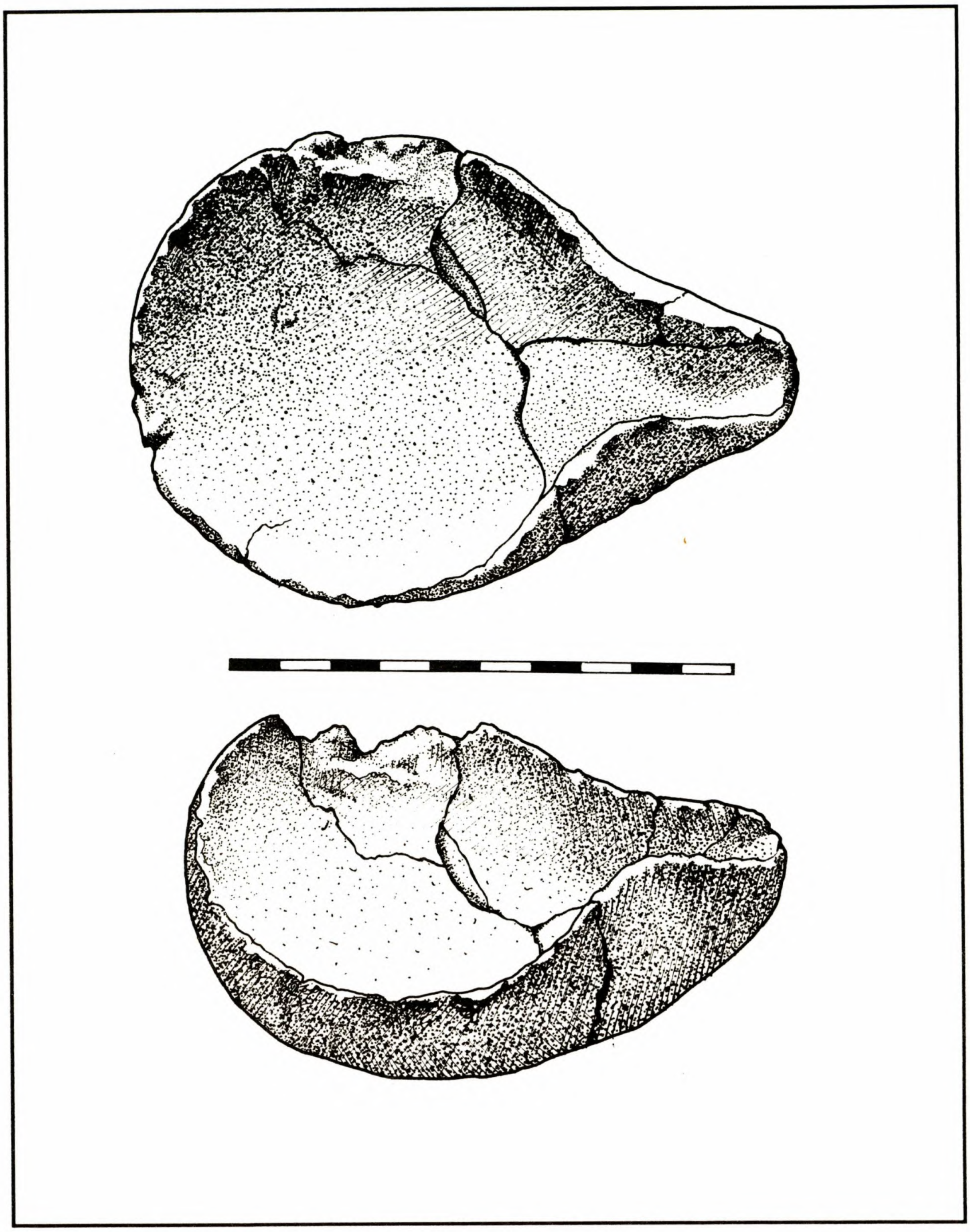

FIGURE 7.48: A BAN NA DI CRUCIBLE.

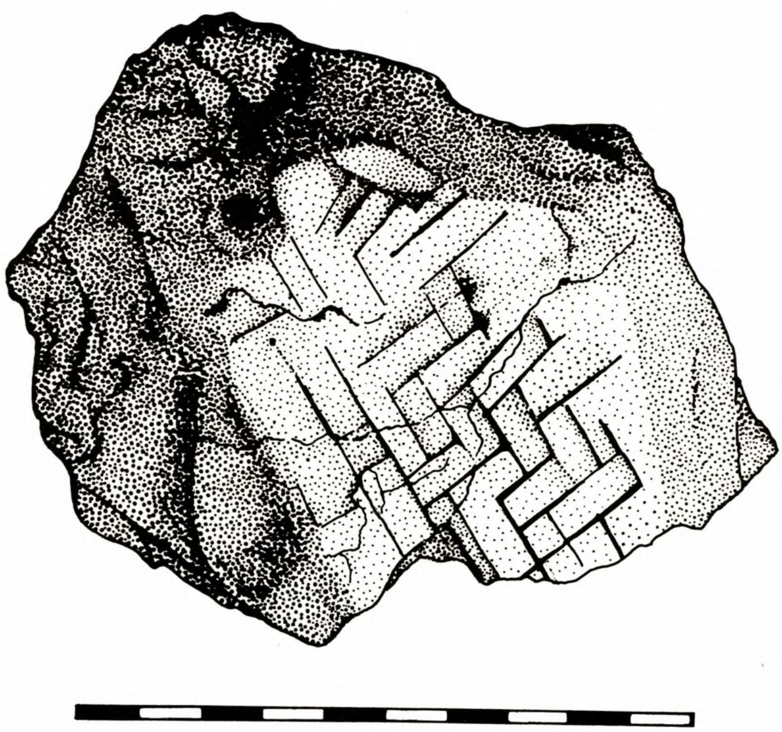

FIGURE 7.49: A FRAGMENT OF FURNACE FROM BAN NA DI.

Chapter 8

A model to account for temporal change

It is now necessary to consider sites with a wide geographic distribution in order to bring into focus evidence for cultural change at Ban Na Di. Sakon Nakhon Basin sites will be considered first, followed by the Khorat Basin, and finally data available from areas external to the plateau. Although many fabrics have been examined in thin-section, a detailed consideration of each is beyond the scope of the present work. Fabric descriptions will, therefore, be confined to general statements. Particular attention will given to temper varieties. Further details will be provided only when essential to demonstrate specific points of interest. Intra- and inter-regional comparisons are necessary if temporal changes in technology are to be identified, because they may involve broadscale processes. As many sites as possible have been examined with the aim of constructing a basic temporal and areal framework. Site names are listed in Table B.1 (Appendix two). The prehistoric ceramics derive from 16 excavations and 32 surveyed sites which were surface collected. All of the excavated pottery has been analysed in thin-section. In 15 cases, surface collected pottery has been considered in hand specimen, the remainder were studied in thin-section. Thin-sections of pottery from 5 modern manufacturies have also been examined for comparison.

8.1 Surface collected Sakon Nakhon Basin pottery

Sherds collected from 29 intensively surveyed Sakon Nakhon Basin sites, (Kijngam *et al.* 1980), have been analysed (fig. 8.1). A summary of fabrics and temper types is set out in Table B.3 (Appendix two).

The distribution of surface collected fabrics is summarized in Table 8.1 below. The data is based on an analysis of 78 sherds, 26 in thin-section.

TABLE 8.1: Sakon Nakhon Basin surface collected fabrics.

fabrics	sand ?	orth. grog	blebs	rice	vitrified
sherds	1	20	26	25	5
sites	1	18	24	25	5

The sampling strategy employed (Kijngam *et al.* 1980:81) involved collecting "at least 40 sherds" and "rims, bases and decorated body sherds were preferred to badly worn or plain