6. Excavations at Kobatuwa, central Flores, Indonesia

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Abstract

This paper describes excavations at Kobatuwa, which is the most northwestern site so far recorded in the Soa Basin. Excavations yielded *Stegodon florensis florensis* fossils and stone artefacts. The deposits accumulated in and near a fluvial channel between ~800,000 and 750,000 BP. Because of its marginal position within the Soa Basin, the stratigraphic sequence at Kobatuwa is condensed, lacking the basal tuff member of the Ola Bula Formation. Channelized conglomerate ribbons with large boulders are developed in this marginal basin sequence. The sandstone layers bearing fossils and artefacts are approximately the same age as the fossil-bearing layers at Mata Menge and Boa Lesa, but these sites are closer to the basin centre and are dominated by more fine-grained lacustrine and fluviatile deposits. Significantly, stone artefacts from Kobatuwa include large (> 5 cm) cores and flakes that are rare or not represented at Mata Menge and Boa Lesa. Differences in the size range of stone artefacts correlate with differences in environmental context - specifically the size of readily available stone for knapping and fluvial transport capacities.

6.1. Introduction

Kobatuwa is situated near the base of the Ola Bula Formation in the northwestern part of the Soa Basin (Coordinates: 008.68851° S, 121.08790° E), approximately 1.5 km northwest of Mata Menge. The site was discovered in 1998 by the joint Indonesian-Australian team during the mapping survey of the Soa Basin. *Stegodon* fossils and stone artefacts were found exposed on a sandstone platform along a dry creek. White, tuffaceous siltstones from below and above the fossil-bearing sandstones, on the west side of the creek, yielded fission-track ages of 800,000 ± 90,000 BP and 700,000 ± 70,000 BP, respectively (O'Sullivan, *et al.*, 2001), thereby constraining the age of the fossils and stone artefacts. Another white, tuffaceous silt, higher up the grassed slope to the west, yielded a fission track age of 750,000 ± 60,000 BP (O'Sullivan *et al.*, 2001).

A 3 m high scarp near the head of Kobatuwa Creek bed forms a natural enclosure on three sides that is used as a cattle yard, with the north side fenced off by a wall of stones. The base of the cattle yard consists of volcanic breccias of the Ola Kile Formation, while the scarp surrounding the cattle yard to the east, south and west, consists of a horizontal bedded resistant layer of tuffaceous mudstone that forms the base of the Ola Bula Formation. This mudstone is overlaid by a very hard tuffaceous sandstone layer, which forms a platform 120 metres long and maximum 10 metres wide on both sides of the creek (Fig. 6.1).

At the northern end of the site, the top of the Ola Kile Fm drops down at least 100 cm and a layer of pink tuffaceous siltstone has partly filled in the depression. This siltstone is relatively soft and has weathered out to undercut the overlying sandstone. Stone artefacts are exposed in the coarse sandstone scarp and in the roof of the undercut (near excavation T3, Fig. 6.1). A scatter of artefacts

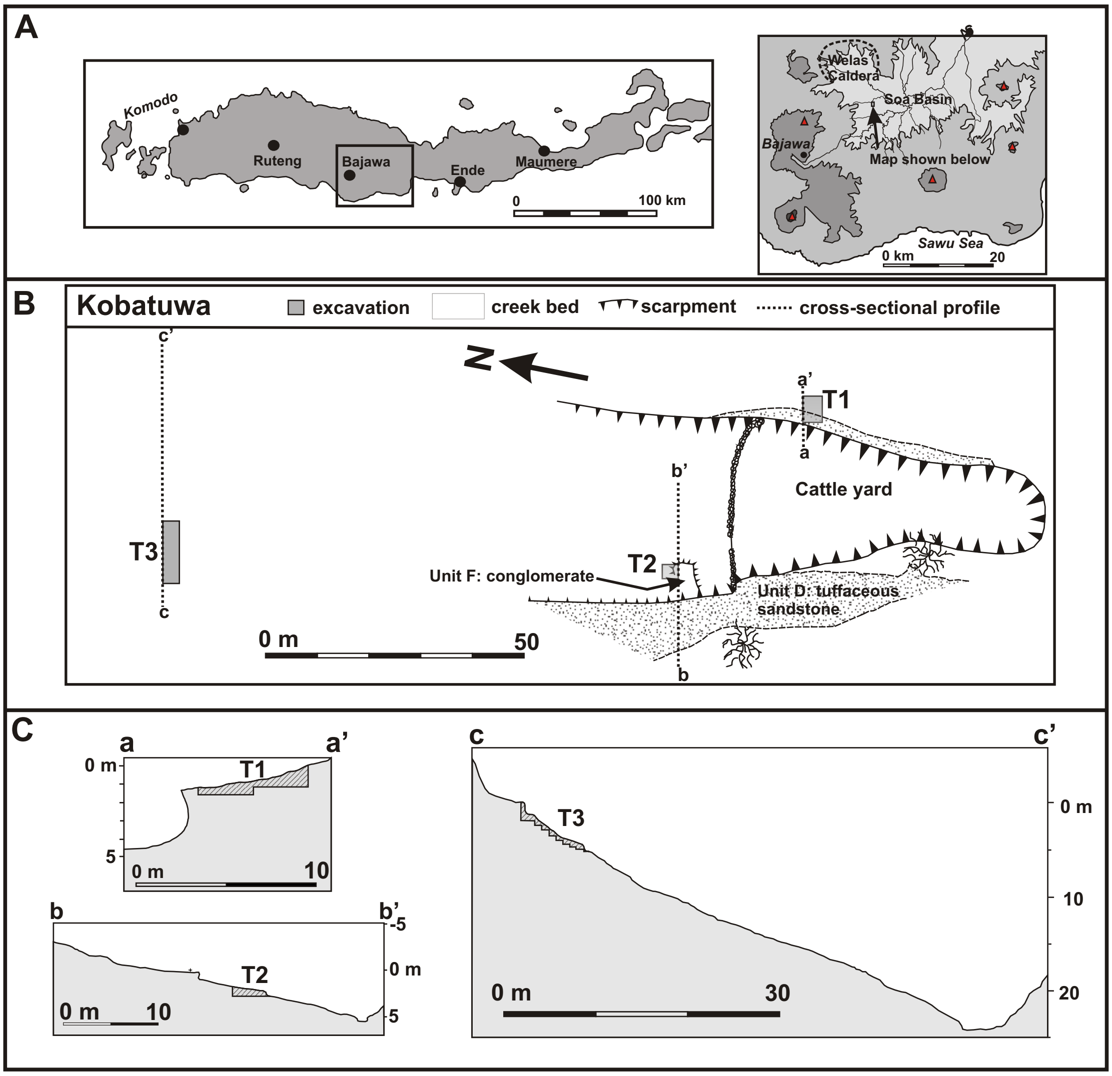

Fig. 6.1. A: Map of Flores and the Soa Basin, showing the position of the site Kobatuwa within the basin. B: Map of the Kobatuwa site. The 3 excavations are indicated (T1-T3). Also indicated are the crossection profiles shown in panel C (indicated with a-a', b-b' and c-c'). C: cross-sections at the three excavation sites.

also occurs beneath the scarp on the slope down to the creek bed.

Situated on the northwestern margin of the Soa Basin, the Ola Kile Formation at the site shows localised topographic variation (e.g. water channels). The characteristic white basal tuff member of Ola Bula Fm (see Chapter 2) is not developed and the sandstone member of the Ola Bula Fm is only 25 metres thick, capped by the lacustrine limestone member of the Ola Bula Formation. As a site on the margin of the Soa Basin, Kobatuwa offers opportunity to compare patterns of stone tool manufacturing, usage, discard and taphonomy in high-energy non-depositional and/or erosional bed-load fluvial conditions, with those at sites in the low-energy lacustrine/fluvial conditions of the central basin (e.g Mata Menge and Boa Lesa)

6.2. Procedure

Three excavations were undertaken in three successive field seasons from 2005 to 2007 in order to obtain information on the spatial differences in stratigraphy and sedimentology and the context of deposition, and to recover a representative sample of *in situ* fossils and stone artefacts (Fig. 6.1).

At each excavation a baseline was established running parallel to the valley slope. Rock was removed in 10 cm thick spits with the help of local labourers, but at the boundaries of successive layers the stratigraphy was followed. The extremely hard rock was removed with picks, geological hammers and chisels, then smashed up and closely examined. It was not possible to sieve the excavated deposits.

6.3. General stratigraphy

The general stratigraphy throughout the Kobatuwa site area comprises eight distinct main stratigraphic units, with local variations. Stratigraphically, in order of age, these comprise:

Unit H: Volcanic breccias and dark grey sandstones of the Ola Kile Formation

Unit G: Light brown, massive tuffaceous sandy mud

Unit F: Conglomerate (channel fill)

Unit E: White/pink tuffaceous silt

Unit D: Massive, grey coarse-grained pebbly tuffaceous sandstone

Unit C: Fine-grained, tuffaceous sandstones and siltstones

Unit B: Pebbly sandstone with angular clasts

Unit A: Topsoil

The Ola Kile Formation (Unit H) is a massive, over 75 m thick, sequence of well-consolidated and hard andesitic volcanic breccias (see Chapter 2). In the upper part the breccia layers become thinner (from > 10 m to ~ 1-5 m thick) and alternate with resistant dark-coloured sandstones and mudstones. The top may have been eroded, and has locally given rise to a low-angle unconformity with the overlying strata of the Ola Bula Formation.

The breccias of the Ola Kile Fm are derived from the now dormant Welas Caldera volcanic centre, some 6 km northwest of Kobatuwa. Deposition was dominated by volcanic mudflows or lahars, and Kobatuwa is actually located on the remnant footslope of this volcanic centre. Standing at Kobatuwa looking to the north, the eastern rim of this caldera can be seen as a prominent dipslope of Ola Kile Fm. breccias, cut to the west by the caldera rim (Fig. 6.2). The Ola Kile Fm. might have been slightly folded prior to deposition of the Ola Bula Fm., because it shows a regional dip of 5º to the south (O' Sullivan *et al*., 2001). However, it is also possible that this southward dip (partly) reflects the original deposition on the distal footslope of the volcano.

Throughout the Soa Basin a depositional and sometimes angular unconformity separates the Ola Kile Fm from the overlying Ola Bula Fm. Near Mata Menge to the southeast, the base of the Ola Bula Fm was dated at 0.94 ± 0.06 Ma (sample taken at several metres above the top of the Ola Kile breccias), whereas at Kobatuwa a date of 0.80 ± 0.09 Ma was obtained for a sample retrieved 2 m above the Ola Kile Fm. At Kobatuwa the top of the Ola Kile displays vertical erosional steps, indicating that erosion took place prior to the onset of accumulation of the Ola Bula Fm; and in the upper part of the Ola Kile Fm erosional channels up to 170 cm deep are filled with homogeneous grey sandstone. At the northern end of the site, the Ola Kile Formation drops down at least 100 cm and a layer of pink tuffaceous siltstone (of the Ola Bula Fm) has filled the resulting depression. This

Fig. 6.2. View from Kobatuwa towards the north showing the east dipping slope of the Welas Caldera rim in the background. In front the sandstone platform developed in the hard tuffaceous sandstone of Unit D.

siltstone is relatively soft and has weathered out to undercut the overlying sandstone. The tuff is laterally equivalent to the 0.80 Ma old white, tuffaceous silt located 3.4 metres above the Ola Kile breccias at the southern end of the site.

These observations indicate that deposition of the Ola Bula Fm. started later than in the central part of the Soa Basin. In the southern section of Kobatuwa, the Ola Kile breccias are overlaid by an up to 3.4 metres thick massive layer of yellowish to pinkish brown sandy mud (Unit G). The layer has no internal structures, and coarser grained particles are "floating" in a muddy matrix, indicating that the layer represents a massive mudflow deposit.

Just outside the cattle yard entrance and on the western side of the creek bed, the mudflow deposit is incised by an erosional conglomerate ribbon (Unit F) that cuts down at least 80 cm (Fig. 6.3). The resistant conglomerate forms a tongue protruding from the escarpment along the western side of the valley floor, extending over an area of 8 x 12 m (Fig. 6.1). It lies stratigraphically between the top of the Ola Kile Fm and the resistant fossil-bearing sandstone layer flanking the cattle yard. The conglomerate has a hard sandy matrix and, unlike the angular coarse clastics of the Ola Kile Fm, contains subrounded to rounded boulders up to 30 cm in diameter, as well as stone artefacts and fossil fragments.

Locally, up to 25 cm thick lenses of white tuffaceous silt (Unit E) overlie this conglomerate. The tuffaceous lenses seem to have filled in gullies and depressions associated with the conglomerate channel. In 1998 a fission track age was obtained from this tuff layer, 25 cm below the overlying sandstone sheet of Unit D (Fig. 6.3).

Unit D constitutes a sheet like body of very hard, coarse-grained, tuffaceous sandstone, locally with small pebbles. It is 50 to 230 cm thick, and forms the escarpment surrounding the cattle yard and the adjacent platform. This unit does not contain fossils or artefacts, but both occur at the interface with the overlying unit, consisting of a series of thin, well-sorted and fine-grained tuffaceous sandstone and siltstone layers (Unit C). At the contact between Unit D and Unit C a thin (1-2 cm thick) concretionary layer with rusty brown colorations marks the boundary, and it is here that a concentration of fossils and stone artefacts occurred. The amalgamated thin layers of Unit C have a total thickness of 20-40 cm. On the east side of the creek bed, a 15 cm thick matrix-supported conglomerate lens with angular clasts constitutes the top of the exposed sequence (Unit B). At most places an up to 50 cm thick layer of topsoil (Unit A) covers the underlying strata.

6.4. Profiles

6.4.1. Excavation T1

The first excavation, T1, was undertaken at the original finding site of *Stegodon* fossils on the sandstone platform along the east side of the cattle yard (Figs. 6.1) It measured 3 x 6 m in area, with the longest side of the trench oriented east-west, perpendicular to the valley axis. The profile of the north baulk of the excavation is shown in Figure 6.4. The excavation reached a maximum depth of 145 cm in the eastern half of the trench, and 70 cm in the western half (or 153 cm depth from the datum level). The stratigraphic sequence from young to old consists of –

1) A 0-70 cm thick layer of topsoil;

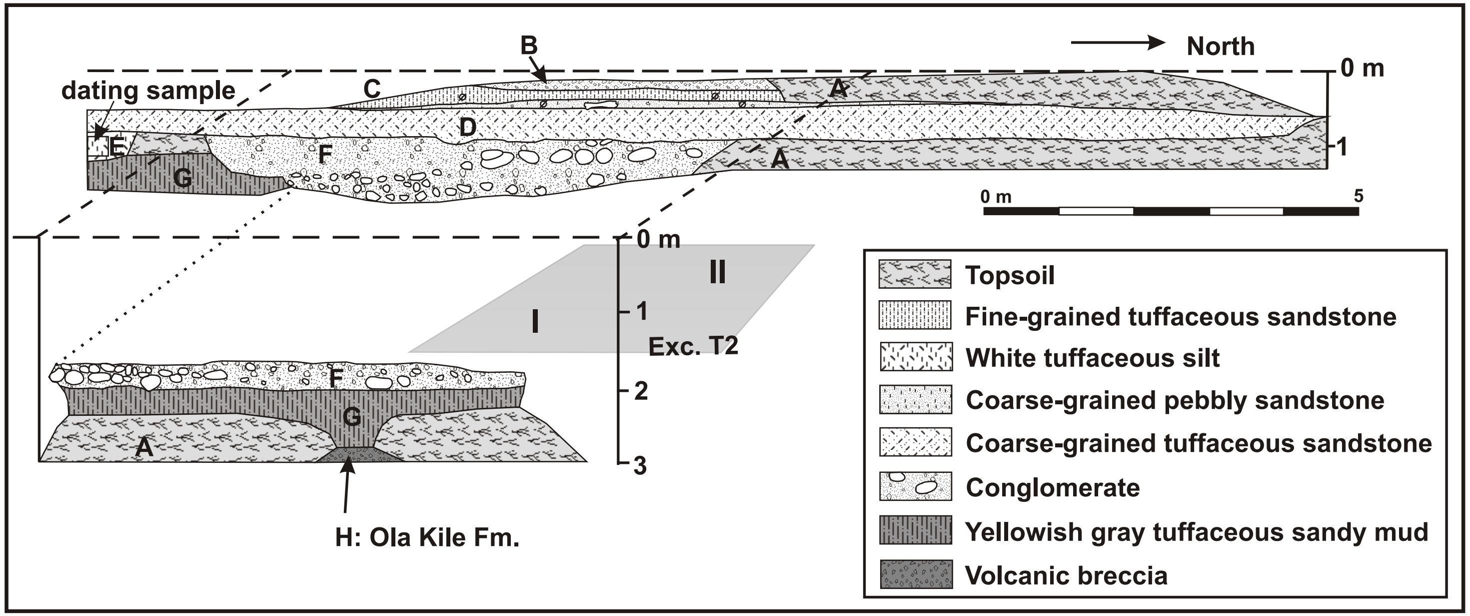

Fig. 6.3. Stratigraphic relations between the various lithological units halfway along Kobatuwa on the west bank of the creek, near excavation T2. A resistant conglomerate lens (Unit F) has cut into the massive mudflow (Unit G). Excavation T2 was undertaken in to this conglomerate and is schematically indicated as a grey plane.

2) A 20-30 cm thick layer of white tuffaceous silt (C1), at the base oxidized rust-brown carbonate concretions has developed locally (C2). It is precisely in this concretionary layer that fossils and stone artefacts are concentrated.

3) A 200-230 cm thick massive layer of coarse-grained tuffaceous sandstone (D), dark-grey in colour and heavily cemented with calcite. The excavation did not reach the base of Unit D, but its thickness can be derived from the adjacent profile of the scarp directly west of the excavation. It can also be observed in the same scarp that Unit D overlies the massive mudflow deposit of Unit G.

Excavating was severely hampered by the very hard nature of Unit D. Because no artefacts or fossils were found in the top interval of this unit, the excavation was not continued to deeper levels. The *in situ* findings at the Unit C/D boundary in Excavation 1 comprise two *Stegodon* molar fragments, nine stone flakes and three cores.

6.4.2. Excavation T2

Excavation T2 is located 38 metres northwest of T1, and was started in 2005 after an *in situ* core was observed in the horizontal conglomerate lens (Unit F) exposed on the west side of the creek bed (Fig. 6.1). In addition, it is overlain by a white, tuffaceous silt that yielded a fission-track age of 0.8 Ma.

The excavation measured 3.6 x 3.4 metres, along the northern margin of the conglomerate tongue

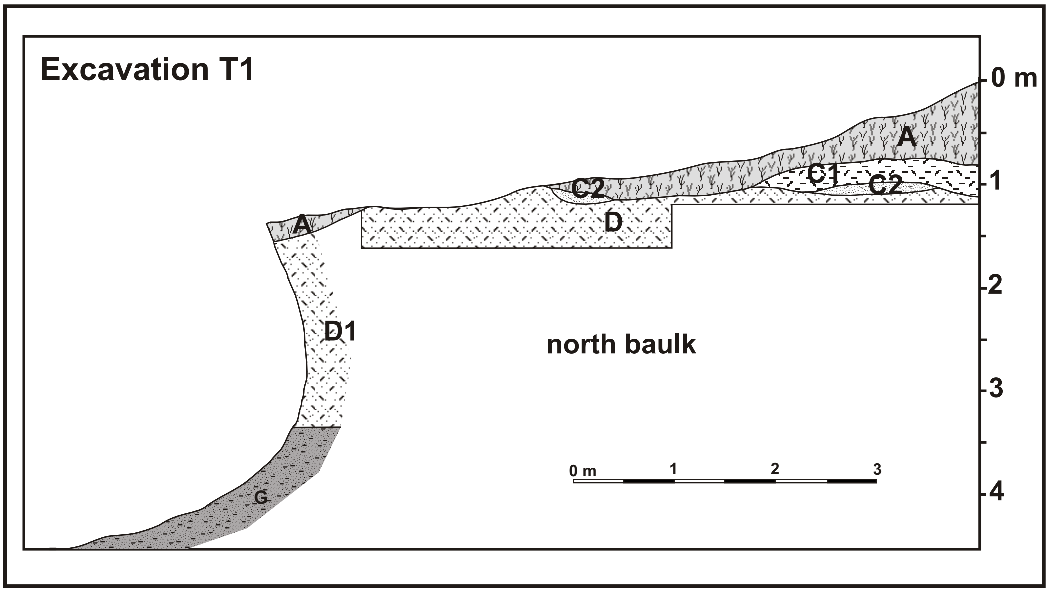

Fig. 6.4. Profile of the north baulk of excavation T1. Massive layer D did not yield any fossils or artefacts, but a concentration of both was found at the boundary with the overlying unit C, in particular in the fine-grained rusty-brown concretionary sandstone lenses (C2).

Fig. 6.5. South baulk of excavation T2. Excavating was performed down to the base of conglomerate Unit F when the underlying mudstone (Unit G) was reached. The prominent sandstone layer visible in the background is the widespread Unit D overlying the conglomerate

and had its long axis oriented east-west (Fig. 6.5). The conglomerate was excavated from the surface (at 80 cm below the datum level) to a maximum depth of 269 cm below datum level. Excavation proceeded very slowly, again due to the very hard nature of the deposit.

In the south baulk of excavation T2 (Fig. 6.6) the erosive base of the channel-fill conglomerate (Unit F2) slopes down from west to east, suggesting that the palaeo-channel axis ran roughly north-south and parallel to the present-day valley. Near the top of Unit F a smaller channel fill lens consisting of coarse sand (Unit F1) is developed on the western side of the south baulk. Patches of white tuffaceous silt (Unit E) of at least 21 cm thickness can be distinguished on top of the conglomerate where soil formation has not yet fully altered its texture. A dating sample was obtained from Unit E in the main escarpment south of the protruding conglomerate tongue (see Fig. 6.3).

In total 77 lithic artefacts, one bone fragment and two molar fragments were recovered from the conglomerate.

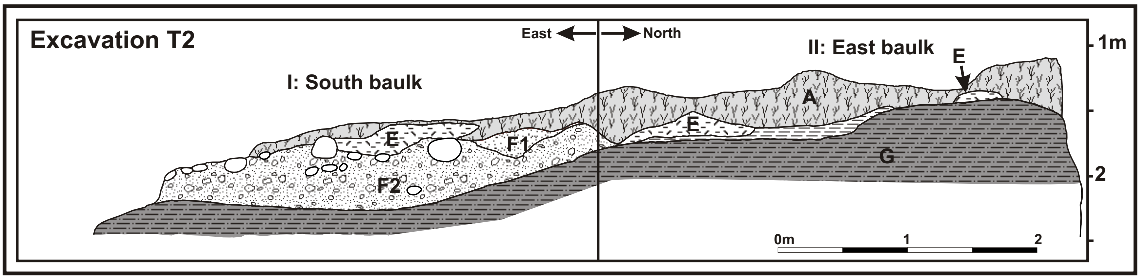

Fig. 6.6. Profile of the south and west baulks of excavation T2. The conglomerate channel fill (Unit F) contains lithic artefacts and rare fossils. The base of this unit is erosive and cuts down deeper from west to east, suggesting that the channel axis ran approximately parallel to the present-day creek valley (north-south). Locally, patches of white tuffaceous silt (Unit E) can be distinguished on top of the conglomerate, but this fine-grained material has mostly converted to topsoil (Unit A).

6.4.3. Excavation T3

To the north Kobatuwa Creek rapidly cuts down and the valley becomes narrower and its walls steeper (Fig. 6.1). The third excavation, T3 was positioned on the western valley slope in 2007 some 95 metres north of excavation T2. It measured 1.5 x 7.5 m, but due to the steep slope was undertaken in stepwise 1.5 x 1.5 metre squares, with the long axis of the trench oriented west-east (Fig. 6.7).

Around T3 the top surface of the Ola Kile Fm drops down at least 100 cm and a layer of pink tuffaceous siltstone fills in the resulting depression. This tuff (Unit E) is relatively soft and has weathered out to undercut the overlying massive sandstone that forms an escarpment. Stone artefacts are exposed in the coarse sandstone scarp and in the roof of the undercut. This sandstone represents Unit D that forms the sandstone platform further south.

No fossils or artefacts were recovered from excavation T3, which predominantly cuts through the upper part of the Ola Kile Formation.

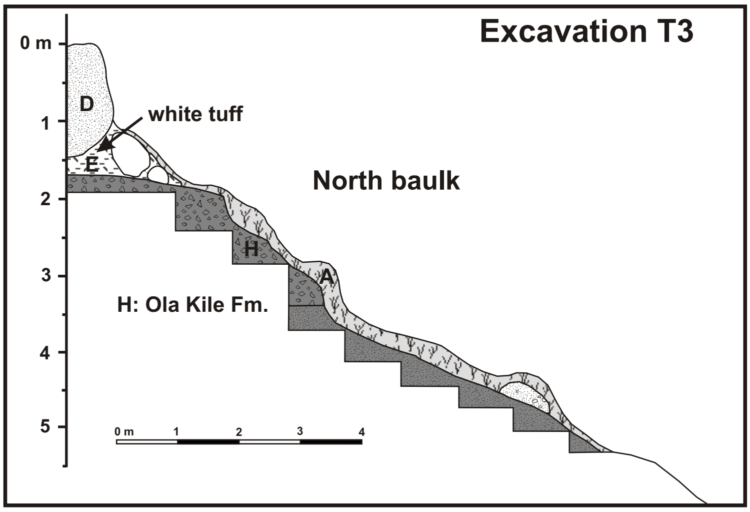

Fig. 6.7. North baulk of excavation T3. The white tuff layer (Layer E) is laterally equivalent to the white tuff shown in Figure 6.3.

6.5. Finds

6.5.1. Stegodon

Two small *Stegodon* molar fragments (both referred to as specimen KBT/T2/05-43) were unearthed in T2 from the conglomerate of Unit F. Both fragments are broken near their base, and they do not fit together, but they are of comparable size and may belong to the same molar. One fragment has a basal width of 65.6 mm, and an unworn height of 49.6 mm, giving a hypsodonty index of 75.6. The fragmentary nature of this isolated ridge does not allow identifying the rank of the molar. However, its width is above the maximum width observed in the last three upper molars of *Stegodon sondaari* (W of M^1 to M^3 ranges between 40 and 47.7 mm) from the locality Tangi Talo. The width corresponds with that of the maximum width of the Upper M3 of *Stegodon florensis florensis*, varying between 63.3 and 86.8 mm (van den Bergh *et al*., 2008). The Kobatuwa specimen may also represent a M^2 of *S. florensis* of which only a single specimen with a maximum width of 61.6 mm is recorded.

Excavation T1 yielded a posterior *Stegodon* M^3 fragment (specimen KBT/05-12; x = 220 cm; y = 110 cm; z = 108 cm). It originates from the boundary between Units C and D. The fragment bears -8x ridges but the anterior 4 ridges are broken halfway in the middle. The base of the posterior four ridges is quite damaged so that no basal width could be measured. The enamel is quite weathered and shows signs of partial dissolution. The fourth ridge from behind has a basal width of more than 41 mm, the third ridge from behind measures approximately 38 mm in latero-medial direction. In upper M3 the posterior portion of the molar tapers backwards, so the maximum width of this molar may have been more than 50 mm, and it can be safely attributed to *Stegodon* cf. *florensis*.

6.5.2. Stone artefacts

The small sample of stone artefacts from excavation T1 clustered around the transition between Unit C and Unit D, all artefacts occurring between 108 and 127 cm below datum. In total 12 artefacts were recovered, of which 9 are flakes (six with retouch) and the remaining three are cores (25%). Most artefacts (75%) are of andesite and basalt; both volcanic materials that are readily available near the site as pebbles and boulders. One core and one flake are made of silicified tuff, and one chert flake is also present. The size of the Excavation T1 artefacts varies between 28 and 116 mm. The biggest specimen is an andesite flake or “chopper” (Fig. 6.8). Average flake length is 66 mm, core size 87 mm, the and overall artefact size 71 mm.

Excavation T2 yielded the most artefacts, which were evenly distributed throughout the conglomerate lens. In total 77 artefacts were retrieved *in situ*, of which 37.7 % were flakes, 24.7% retouched flakes and 35.1% cores. Two larger artefacts can also be classified as “choppers”. Some three cubic metres of conglomerate were excavated in total, resulting in an average density of 25 artefacts per cubic metre. Their maximum length ranges between 30 and 139 mm, with the average of 65 mm, while the average length of flakes and cores is 63 mm and 66 mm, respectively. Raw material used comprised volcanic (92.2%), chert (5.2%), and small amounts of jasper and quartz.

Though few artefacts were recovered from Excavation T1, they are very similar in typology, size and in raw material representation to the larger assemblage from Excavation T2 (Figs. 6.9 and

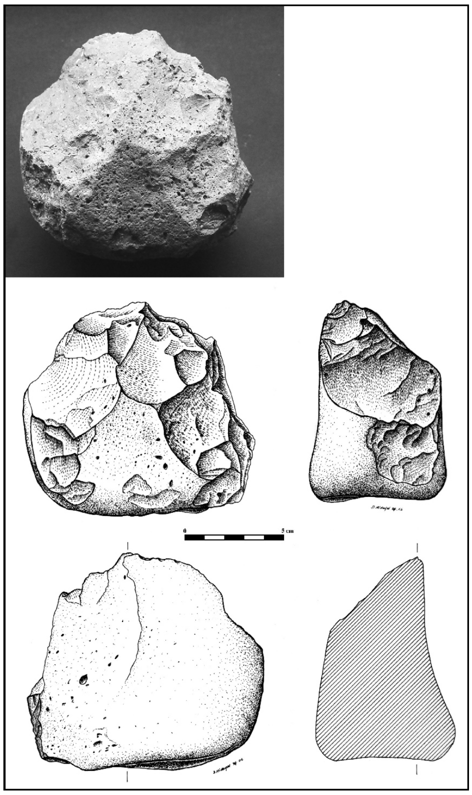

Fig. 6.8. Massive andesite pebble tool or "chopper" (Coll. Nr. 1/KBT/T1/04) excavated in situ at Kobatuwa Excavation T1.

6.10).

Overall, however, the Kobatuwa stone artefact assemblage differs significantly from the Mata Menge assemblage. Large stone artefacts, such as chopper/chopping tools and large cores with a diameter in excess of 80 mm, were found in both the T1 and T2 excavations T1, but are lacking at Mata Menge, despite the fact that over 500 artefacts were recovered there. At Mata Menge flakes are on average 32.4 mm (range 5–70.7; Brumm *et al*., 2006), whereas at Kobatuwa T2 flakes are significantly larger, with an average maximum length of 63 mm (range 30-115 mm). This is not surprising, at least for excavation T2, because the artefacts are associated with a high-energy fluvial conglomerate with boulders of up to 30 cm in diameter. Most T2 artefacts are heavily worn by water transport, indicating that the bias towards larger artefacts was probably due to more energetic fluvial transport, whereas at Mata Menge hydrodynamic conditions near a lake margin were calmer. Another difference is that at Mata Menge only 13.8% of the stone artefacts consisted of cores, while at Kobatuwa cores comprised 35.1% of the assemblage.

6.6. Discussion

The stone artefacts and associated *Stegodon* remains at Kobatuwa are broadly contemporaneous with those Mata Menge (~ 800 kyr), but were deposited in a very different environmental setting. At

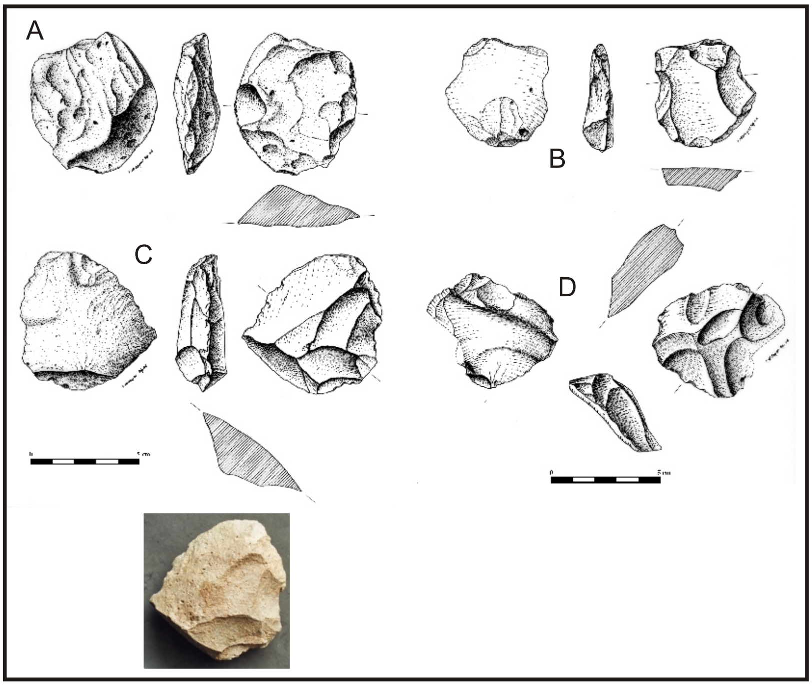

Fig. 6.9. Large retouched flakes excavated in situ at Kobatuwa in 2005 and 2006. A: Excavation T1 (Coll. Nr 10/KBT/T1/05); B: Excavation T2 (Coll. Nr. 15/KBT/T2/05); C: Excavation T2 (Coll. Nr. 48/KBT/T2/05); D: Excavation T2 (Coll. Nr. 26/KBT/T2/06).

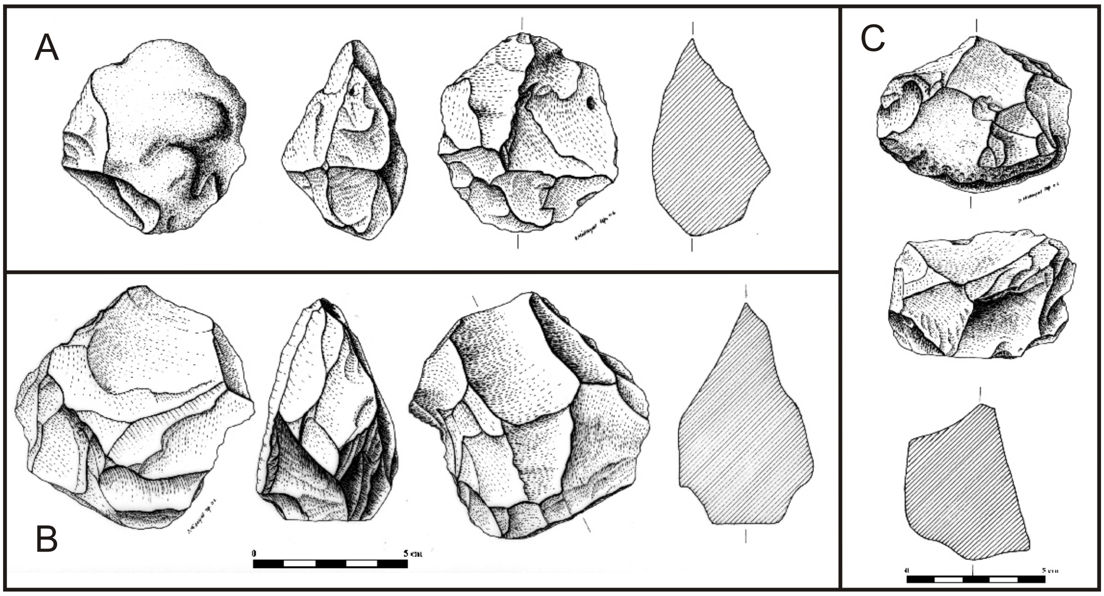

Fig. 6.10. Cores excavated in situ at Kobatuwa Excavations in 2005 and 2006. A: Excavation T1 (Coll. Nr 7/KBT/T1/05); B: Excavation T2 (Coll. Nr 38/KBT/T2/05); C: Excavation T2 (Coll. Nr 27/KBT/T2/06).

Kobatuwa, remains of *Stegodon florensis* occur in the basal layers of the Ola Bula Fm. The lower tuff member of the Ola Bula Fm, which yielded the dwarfed *Stegodon sondaari* at Tangi Talo (see Chapter 3), is not developed at Kobatuwa. The pumice tuffs characteristic for the basal member of the Ola Bula Fm were either not deposited at Kobatuwa, or they were eroded before the middle sandstone member accumulated.

Kobatuwa is located near the margin of the basin dominated by erosion and high-energetic fluviatile conditions where deposition started much later than at Mata Menge, where low-energy lacustrine conditions prevailed at the time artefacts were produced (see Chapter 4). At Mata Menge raw material in the form of large volcanic boulders was not readily available nearby, whereas at Kobatuwa high-energy fluvial channels provided a readily available source. Many of the artefacts from excavation T2 were probably transported by the river from higher ground, where raw material may have been easily accessible in the form of exposures of volcanic rock, though at least part of the assemblage consists of modified pebbles obtained from the river.

The findings at Kobatuwa and Mata Menge suggest that massive tools, traditionally classified as the chopper/chopping tool complex (Bellwood, 1997), form part of the same technology as the pebble and flake technocomplex recognized at many places in Southeast Asia (Moore & Brumm, 2007). The predominance of heavier tools and waste products at sites seems to largely reflect the size of available source material and strong water action. In contrast, low energy sites with limited access to conglomerates or rock outcrops generally have smaller flakes and cores (Brumm *et al*., this volume).

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