NEW ZEALAND JOURNAL OF ARCHAEOLOGY

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Excavations at Vunavaung (SDI), Rakival Village, Watom Island, Papua New Guinea

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ABSTRACT

At Vunavaung (SDI) in the coastal settlement of Rakival, two of a series of four test pits just in front of the raised coral cliff at the rear of the present-day village revealed an undisturbed 1.4-m-deep cultural deposit, sealed by about 1.8 to 2.2 m of redeposited and primary volcanic ash. The excavations, although of limited extent, provided four securely dated pottery assemblages spaced over 1000 years from 800 BC to after AD 200. These document the stratigraphic relationship between highly decorated Lapita pottery at the beginning of the sequence and ceramics minimally decorated with applied-relief and nail incision at the end.

Keywords: PAPUA NEW GUINEA, WATOM, LAPITA, VUNAVAUNG, EXCAVATIONS, POTTERY.

INTRODUCTION

As excavations progressed at the SAC locality in the Reber-Rakival Lapita site on Watom Island in 1985, it became increasingly desirable to compare the results emerging there with material from another locality where the underlying cultural strata were also intact. Limited excavation of such a location might show whether or not the ceramic and other changes apparent at SAC were a more general phenomenon. It was also hoped that it would provide suitable samples for some independent radiocarbon dating of the cultural deposits underlying the Rabaul ashfall. Finally, cultural indicators at such a location might provide further examples of internal differentiation within a large Lapita site.

A likely location became known to us when the late Gregor Turadavai, store owner and big man at Rakival village, presented us with a number of Lapita pottery sherds and some stone artefacts. These had been discovered 85 m NNE of SAC (Green and Anson 2000a: Fig. 1) during the digging of rubbish pits on his property at Vunavaung, close behind his house and store and inland of the path running north/south through Rakival village. The land here rose steeply to the foot of a high coral cliff far above present sea-level, leading us to hope we might find undisturbed strata there.

Excavations and recording at SDI were carried out over a 12 day period. The first two trenches, in the immediate vicinity of the rubbish pits, revealed either disturbed or secondary deposits. Trench I (Fig. 1) proved to be disturbed down to the beach sand by both human and land crab activities. In trench II on the other side of the rubbish pits, the stratigraphy consisted of about a metre of alternating and discontinuous lenses of redeposited volcanic

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ash and organic deposits with pottery. One represented deposits washed in from above, the other cultural deposits from below thrown up by recent human activity long after the initial Lapita occupation and the volcanic ashfall.

Clearly defined stratigraphy was not encountered until the excavation of trench III. Initially a 1 x 2 m E–W rectangle, trench III was progressively extended upslope by 1.5 m (trench IIIA) to provide sufficient room for excavation of the undisturbed cultural deposits. To increase the sample size from these intact deposits, an additional square metre (trench IIIB) was opened to the south (Fig. 1). This resulted in an L-shaped trench with excellent stratigraphy.

The deposit was at its deepest at the western end of trench IIIA. Here a 1.4 m occupational deposit (zone C) was found buried under 1.8 m of a sparse top soil (zone A) and thick layers of redeposited and primary ash (zone B) (Fig. 2).

In trench IV at the foot of the coral cliff, the occupation deposits were buried by 2.4 m or more of primary and secondary volcanic ash. Only two 10 cm spits in the underlying occupational deposit could be dug here before large coral rocks fallen from above were encountered. The rocks could not be removed and the 1 x 1.5 m trench, which had by then become dangerously deep, was abandoned. Nevertheless, there is every indication that further excavation in this area would expose the same deep zone C deposits revealed by trench III and that they might extend back under the shelter of the cliff undercut by wave action. As it was, the two spits which could be excavated in this area produced examples of worked shell and a complete shell adze.

Excavation and recovery procedures at SDI were the same as those adopted at SAC, which the workers were already trained in. The ashfall deposits were quickly removed by bucket and hand shovel. Trowelling, followed by screening with 5 mm sieves, was used throughout the excavation of the cultural-bearing layers, each of which was taken down by 10 cm spits until the next stratigraphic layer was encountered in the last partial spit. As at SAC, screening proved to be extremely difficult because of the wet nature of the deposits (reinforced by a number of rainy days when work had to stop entirely). For this reason, every screenful was continuously sorted through by hand as well as by periodic shaking of the sieve.

SITE INTERPRETATION

Drawing on specific information recovered at SDI (trenches I, II, III and IV, and the rubbish pits), some of which is described in more detail below, and general information from elsewhere about the overall environmental setting of the Reber-Rakival Lapita site, a schematic section through the locality, more or less to scale, can be constructed (Fig. 3). As at SAC, the beach line approximately 2800 years ago, when SDI was initially being used by people, lay some 40 to 50 m inland of its present position. In this northern portion of what was then a recently emerged sandy sea beach, only a fairly narrow coastal strip (no more than 25 to 30 m wide) was available for occupation between the sea and the high raised coral limestone cliffs. At the base of these cliffs was a wave-cut notch, attesting to a former higher sea stand of 1.5 to 2.5 m between 6000 and 3000 years ago (see Green and Anson 2000a and Fig. 6 in that report for further discussion). To the south of SDI toward SAC and SAD, the narrow strip steadily expanded and then gave way to a stream-based opening in the coral limestone cliffs at the rear of the beach flat (Green and Anson 2000a: Fig. 1).

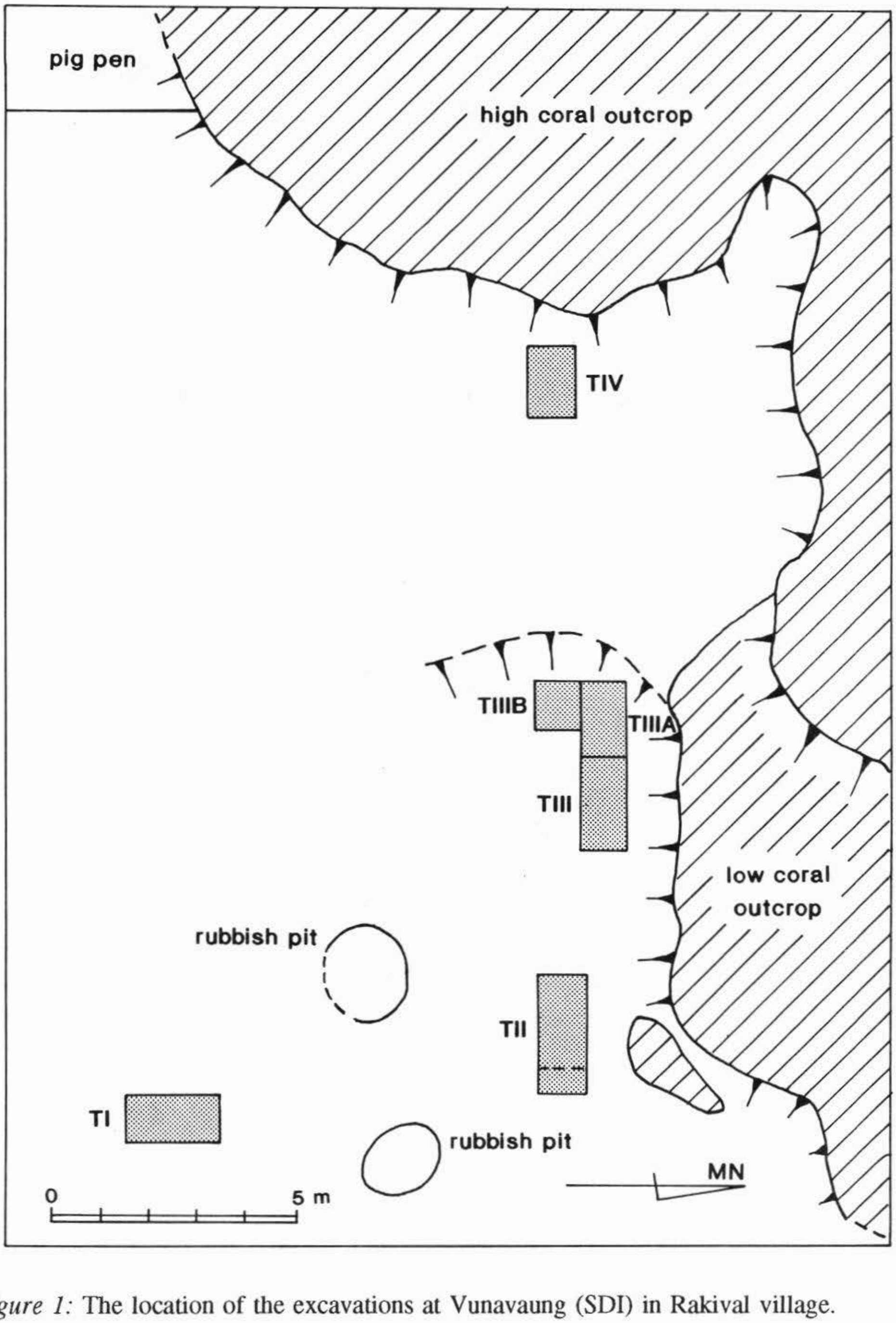

Figure 1: The location of the excavations at Vunavaung (SDI) in Rakival village.

On this newly minted strip of beach sand, dark charcoal-stained cultural deposits containing quantities of broken pottery (although little in the way of other cultural debris) accumulated over nearly a millennium (see below) in a series of near horizontal layers.

Figure 2: Local workman, Bernard Kunai, standing in trench III at SDI. The ranging pole indicates thick secondary ash deposits overlying cultural deposits beginning at shoulder height.

Coral limestone blocks of various sizes periodically fell from the adjacent cliff face and became incorporated in the deposits. The lowest of these cultural deposits is, as expected, mixed with the underlying beach sand, but the three layers above are largely loamy soils

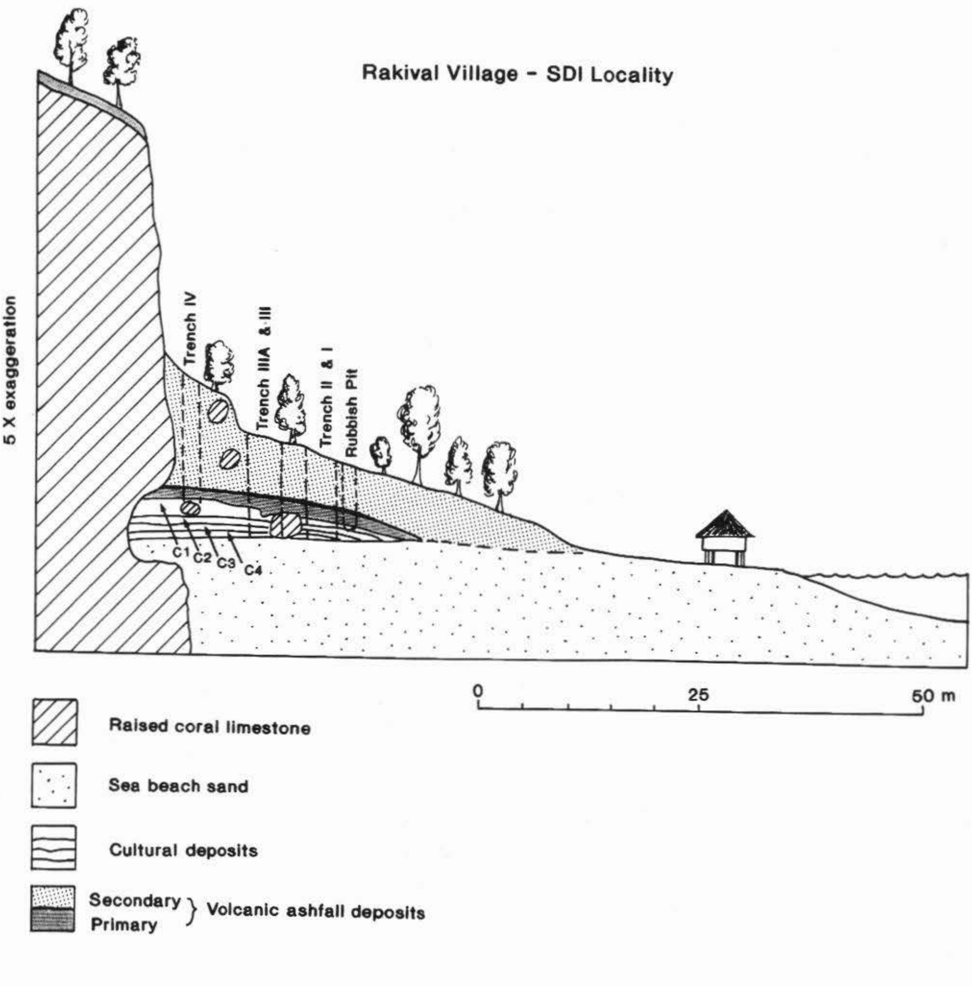

Figure 3: Schematic cross-section of the SDI locality at Vunavaüng in Rakival village.

from deposits which slowly washed down the cliff face and out on to the flat from the gradual slope above the cliff. There is no indication that the pottery sherds or other items in the cultural layers constitute rubbish dumped from above, and the zone at the top of the cliff was not really suitable for habitation. The cultural material seems to have been discarded on the narrow flat at the base of the cliff.

About 1300 to 1100 years ago (see below), 30 to 40 cm of primary volcanic ashfall covered Watom Island, including this locality, and sealed the pottery-bearing cultural deposits. During the next 1200 years, nearly twice the depth of reworked secondary ashfall deposits accumulated, as these new sediments washed in from above at a much higher rate than during the pottery occupation period. This increased supply of sediment from above also contributed to the continuing progradation of the shore to its present position. With this general picture and the schematic section in mind, details of the stratigraphy and dating at SDI and the pre-ashfall occupation sequence can be described more fully.

STRATIGRAPHY AND DATING

This section deals only with trench III and its extensions, because strata in trenches I and II were disturbed and trench IV had proved impossible to complete (see above).

The stratigraphy (Fig. 4) at SDI is similar in most respects to that at SAC and can therefore be described using the same terminology.

Zone A is a 10-cm-deep topsoil which is not as well developed as at SAC, because SDI is situated on a continuously accumulating tree-covered slope.

Zone B consists of redeposited and *in situ* volcanic ash layers. Zone B1 is made up of two redeposited layers, thickest at the top of the slope from which they have clearly slipped down. The first, immediately below the top soil, is a layer of ash and pumice pebbles. Below this is a layer of fine yellow ash. Zone B2, which marks the Rabaul volcanic eruption, is made up of three almost horizontal layers. The uppermost is a layer of volcanic ash and thin pumice pellets. Below this is a yellowish layer representing the main air fall volcanic ash. The third layer, B3, consists of intermittent charcoal lenses containing charred plant specimens. Samples from these lenses were used for radiocarbon dating and plant identification.

Zone C consists of cultural deposits distributed through four dark brown and black to grey layers. These contain numerous pottery sherds, a little obsidian and a few other stone artefacts, but very limited amounts of marine shell and animal bone. Layer C1, immediately under the ash and charcoal, is a blackish loam containing much coral stone. The next layer, C2, is a compacted sandy brown earth containing whole shell and coral stone fragments. The third layer, C3, is similar in colour to layer C2 but contains smaller quantities of coral stone and smaller fragments of shell. The fourth layer, C4, which sits on the natural beach sand, is an organically-stained dirty grey sand deposit containing coral.

Zone D is the natural white beach sand with shell and coral fragments.

The age of the sequence of deposits at SDI was determined by dating four radiocarbon samples, one of charcoal from the base of layer B2, and three of shell from successive occupation layers in zone C.

A *Tridacna maxima* shell from the organically-stained occupation layer C4, resting on the white beach sand, was used to assess the age of initial occupation in this locality. The sample, Beta 16836, provided a date of 2570±80 BP with a $\delta^{13}C$ value of +2.28. It yields a conventional radiocarbon age of 3020±90 BP. Based on a ΔR ocean reservoir correction set at 0, the age range with intercept at one standard deviation is 914 (817) 770 BC. This is an acceptable result in the light of the much higher percentage of sherds decorated in the Lapita style in layer C4 at SDI than in any Lapita deposit with a younger date at the Reber-Rakival site.

A *Trochus niloticus* shell sample, ANU 6475, from layer C3, the compacted occupation deposit of dark brown loam overlying C4, gave a conventional radiocarbon age of 2630±80 BP using a $\delta^{13}C$ value of 0±2.0. With the ΔR ocean reservoir correction again set at 0, the age range and intercept values are 405 (365) 264 BC at one standard deviation. This dates further occupation in this locality a number of centuries after that of layer C4, at a time when the amount of decoration on the pottery had been greatly reduced. It probably overlaps in time with the initial occupation (layer C2) at SAC.

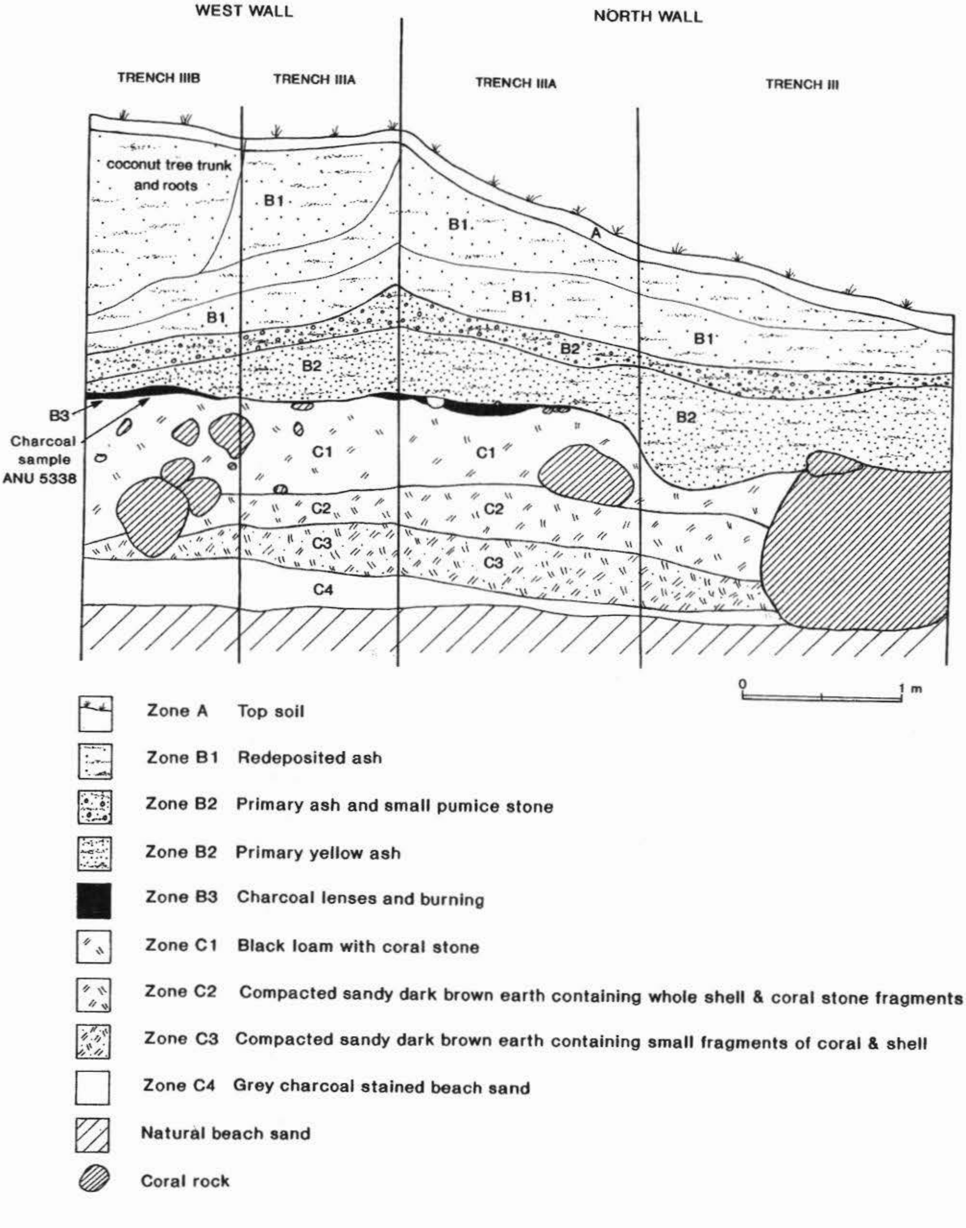

Figure 4: Stratigraphic sections, SDI.

ANU 5329 consisted of a *Hippopus hippopus* shell from the sandy brown loam occupation deposit, layer C2. As expected from its later stratigraphic position, it gave a conventional radiocarbon age of 2190±80 BP using a $\delta^{13}C$ value of 0±2.0. With the ΔR ocean reservoir correction set at 0, the age range and intercept are AD 84 (163) 261 at one standard deviation. This dates layer C2 and the layer C1 deposits that follow to the first few centuries AD, at a time when very few of the sherds were decorated and only one (perhaps from an heirloom pot) still exhibited the use of dentate-stamping. These two layers, therefore, are some of the latest occupation deposits in the Reber-Rakival site, just as layer C4 is one of the earliest.

Resting on the undulating surface of layer C1 were lenses of charred vegetation lying directly under layer B2—the primary volcanic ashfall deposits from the Rabaul eruption (Fig. 4). Burned remains identified in samples from the lenses suggest that the surface of layer C1 supported coconut palms and various kinds of *Canarium* trees at the time of the eruption (see details below). A charcoal sample, ANU 5338, provided a conventional radiocarbon age of 1290±80 BP for the eruption with a $\delta^{13}C$ value of -24.0±2.0. Using the secular corrections of Stuiver and Becker (1986), and Stuiver and Reimer (1986), this result gives an age range at one standard deviation for the primary ashfall on Watom of AD 650 to 850 with three intercepts between AD 686 and 767. Such an estimate is consistent with, but slightly later than, the 1400 year age assigned to the latest large-magnitude eruption of the Rabaul volcano (Walker *et al.* 1981: 181; Nairn *et al.* 1995: 269). It suggests that after the deposition of layer C1, representing the last plain ware ceramic occupation at SDI during the first several centuries AD, useful nut-bearing trees were grown in the vicinity by the inhabitants until the Rabaul eruption and ashfall destroyed them.

The four radiocarbon determinations are not only stratigraphically consistent, but imply that the deposition of the four layers of zone C covered a period of about 1000 years. Cultural discard was probably not continuous but intermittent, recurring at various intervals of several hundred years, so that a series of separate layers can be distinguished, each with a different pottery content.

Occupation began on a previously low-lying and level white sand beach. This was followed by disturbance of the vegetation above and inland of the coral cliffs so that subsequent sedimentation came mainly from that area, rather than from the sea. However, in layers C2 and C3 sufficient sand from the sea was mixed into the dark brown loam deposits to distinguish them from the blacker loam of layer C1 above and the grey sandy deposits of layer C4 below.

OCCUPATION SEQUENCE

In contrast to SAC, little obsidian was encountered in any of the cultural layers at SDI, and it was especially rare in the lowest two (Table 1). It was much less frequent than potsherds, which was the exact opposite of the situation at SAC. In layers C1 and C2, obsidian pieces occurred in a similar frequency per m^2 (1 to 10) as in layer C2 at SAC (where it varied between and 1 and 24 flakes per m^2: Green and Anson 2000a: Table 7). In layers C3 and C4, there were no more than one or two flakes per m^2 and in some squares there were none in layer C4. Potsherds, on the other hand, were generally abundant, exhibiting far higher densities in layers C2 and C3 than in any layer at SAC (Table 3). The density of sherds in SDI layer C1 and C4 (83 per m^3) is similar to that of layer C1 at SAC (75 sherds per m^3).

The amounts of economic debris were also different from SAC. Very little bone, especially fishbone, was recovered (see below) and remains of shellfish were uncommon, as in layer C1 at SAC. At SDI, however, the sparsity of food shell was not the result of a taphonomic process, but a case of genuine absence due to infrequent discard. Because of the nonconcentrated nature of the shellfish remains and the small size of the excavation, no attempt was made to collect representative samples for quantitative analysis. However, bone was retained. Most of the identifiable pieces proved to be from pig (see below).

No structural features such as pits, hearths, ovens or postholes were identified in the cultural layers either during excavation or in the sections. The exception was a much later pit identified in trench II, probably another recent rubbish pit. Whatever activities were carried out in this locality, they seem to have differed from pre-ashfall activities at SAC and SAD, and did not result in the usual kind of debris from habitation, such as was encountered at SAC, for example. Rather, the discard of often larger than usual amounts of broken pottery but limited numbers of other portable artefacts, the minimal food waste and lack of evidence of any cooking or storage features, all suggest that this locality functioned in quite a different way during the pre-ashfall period. It may not have been a suitable place for structures, because of the continual dislodging of rocks, some of large size, from the coral limestone cliff. It seems to have functioned periodically over the first 1000 years as a dry-land pottery rubbish dump among the rocks at one end of the settlement, similar to SAD in a much wetter environment at the other end.[2]

ECONOMIC ASPECTS

As noted above, the small size of the area opened at SDI precluded the collection of useful shell and bone samples for quantitative analysis. The identifiable bone, although very limited in amount, proved informative. Twelve fragments of bone and two teeth were recovered from layers C1 (6 fragments), C2 (2 teeth, 3 fragments) and C3 (3 fragments). Pig was securely identified from a left astragalus in layer C1, an incisor in layer C2 and a left radius in layer C3. Several other bone fragments are also likely to be pig. These remains and those from SAC confirm the presence of pigs in the Reber-Rakival site from 400 BC to about AD 200.

Marine food shell, both complete specimens and fragments, occurred only intermittently in the four layers of zone C, along with pieces of coral. This contrasts with zone C at SAC, where marine food shells, coral fragments and bone occurred in the bottom grey sand midden layer, whereas for taphonomic reasons only bone was found in the upper black loam palaeosol. Occasional exploitation of shellfish throughout the cultural sequence at SDI is indicated. The range of shell did not seem any different from that at SAC, but without adequate samples this cannot be assessed empirically. Although slightly more complete shells were present in layer C2, the amount in any layer was never great. The kind of discard activity that occurred at SDI did not result in concentrations of either shell or bone remains.

One item not encountered at SAC was a large (13 x 16 cm) piece of turtle shell, found in layer C4 at the very base of trench IIIB. It is unusual for such material to be preserved in Pacific archaeological deposits. Slate pencil sea urchin spines are another item not noted previously in the Reber-Rakival site.

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[2]Specht recovered some 3633 sherds from 100m^2 of excavations at SAD (Anson 1983: 284).

Additional economic information relates to the period following the Lapita occupation at this locality, when the vegetation growing on the site was charred and burned during the initial stage of the volcanic eruption and ashfall from Rabaul. This information came from charcoal pieces in two samples taken from the lenses at the base of layer B2 in trench IIIB. These were submitted to Douglas E. Yen, then ethnobotanist at the Australian National University, for identification of plant remains, before the remaining fragments in one sample were radiocarbon dated.

In the sample used for radiocarbon dating (see above), shell cases of three or four *Canarium* nut species were found, along with shell fragments of *Cocos nucifera*, the coconut palm. The common species *C. indicum* dominates the *Canarium* sample and is confidently identified, as is a wild variety of *Canarium*, not assigned to species, whose kernels are too small and cases too hard to crack for it ever to have been eaten. A less confident identification, based on three fragments, is of *Canarium salomonese*, and a questionable but possible identification, based on one fragment, is of *Canarium harveyi*. Yen (1991: Fig. 6) states that the specimens similar to *C. salomonese* and *C. harveyi* "signify less certain identification of material remains in the sites". He goes on to show that while *C. salomonese* occurs in Papua New Guinea to the south of Watom, "the incidence of *C. harveyi*-like specimens from New Britain ... might indicate the transfer east of mixed genotypes that allowed for progressive selection and domestication in the Santa Cruz group" (Yen 1991: 84 and Fig. 5). Identifiable plant remains in the other sample supported the dominance of *Canarium indicum* and suggested the probable presence of some pieces of coconut. The inference is that at about AD 700, when it was burned and blanketed by the Rabaul ashfall, this locality supported a grove of largely economic nut-bearing trees.

PORTABLE ARTEFACTS

Although pottery is the dominant and most indicative portable artefact from this locality, other items of importance were also recovered. Foremost among these are adzes, two stone examples of which were found by Gregor Turadavai while digging rubbish pits. A shell adze was found in layer C1 of trench IV during excavation.

ADZES

Although a burnt shell adze of post-ashfall age was found at SAC (Specht 1969: Fig. XII–14l), dorsal region Tridacna shell adzes from Near Oceanic Lapita contexts are seldom reported. The recovery of a typical dorsal region Tridacna adze with a broken but once pointed poll (Fig. 5a) from the uppermost cultural deposit in trench IV (equivalent to layer C1 in trench III) is a useful addition to the evidence that this type of shell adze formed part of the Lapita to just post-Lapita adze kit (Green 1991).

The other excavated adze is the butt portion of a very battered and broken stone specimen of flattened oval cross-section (Fig. 5b). The rock is a slightly altered fine-grained basic basalt with augite crystals, which probably came from the nearby northwest portion of the Gazelle Peninsula area of New Britain (Dickinson 2000: Fig. 1). The adze was found in trench IIIA at the base of layer C1 and is thus of comparable age to the shell specimen. It still exhibits signs of polish on front and back as well as along the sides, indicating that it was once polished all over.

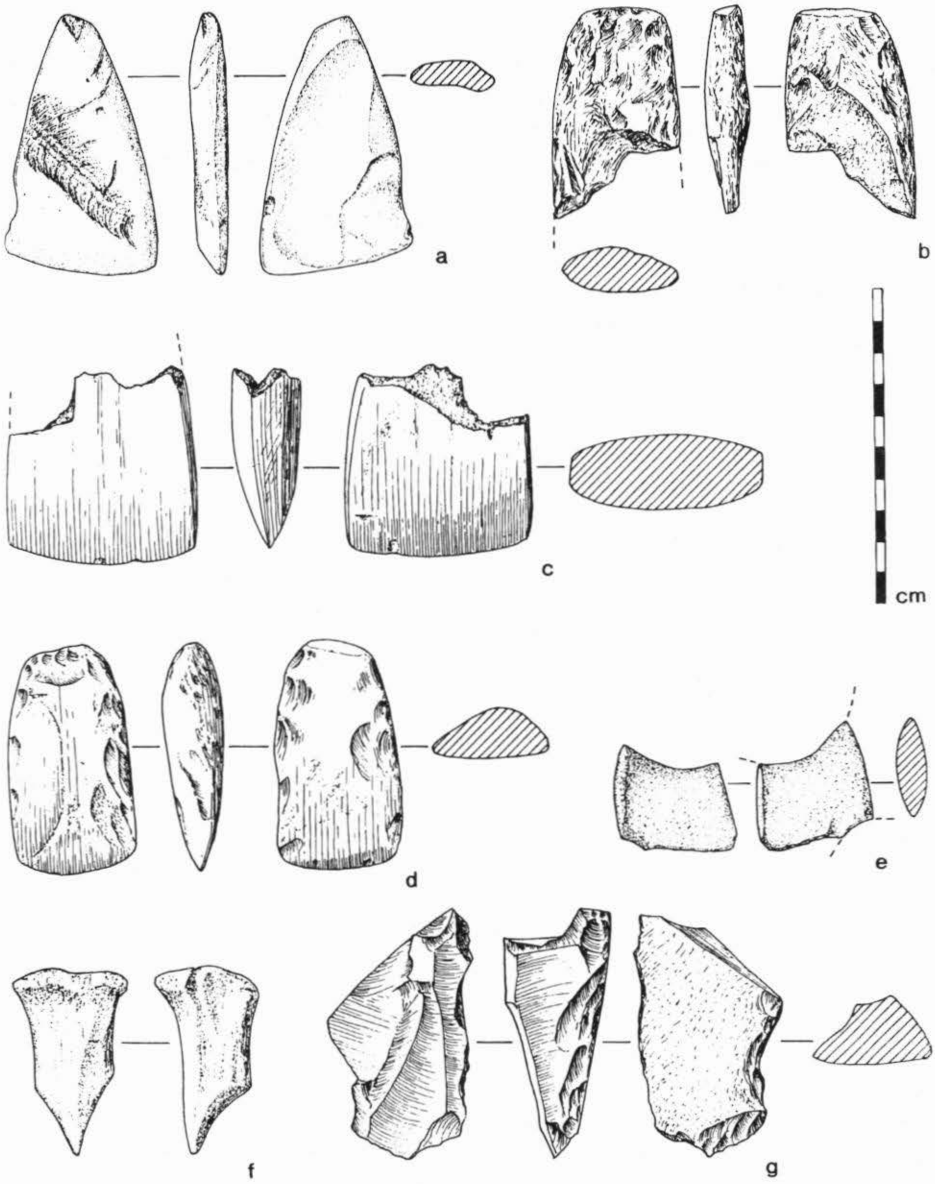

Figure 5: Artefacts from SDI. a. Tridacna shell adze. b. Butt end of oval-sectioned stone adze. c. Bevel end of plano-lateral-sectioned stone adze. d. Plano-convex-sectioned stone adze. e. Worked stone. f. Bone awl. g. Stone core.

One might be inclined to exclude from this discussion the two adzes found during the excavation of the rubbish pits, because of their uncertain provenance and the possibility of more recent origin. They are, however, typologically distinct from late Melanesian oval-sectioned adzes and more closely resemble adze forms known from Lapita contexts. It is therefore likely that they came from the pottery-bearing deposits under the ash, as their finder claimed. The probability of any of these adzes or other exotic rocks coming from the overlying volcanic ash deposits is fairly low, whereas it would not be surprising if the land owner had encountered them when digging into the underlying cultural deposits.

The medium-sized adze bevel fragment (Fig. 5c) is of a familiar planilateral Lapita adze type, a small example of which was also found at SAC (Green and Anson 2000a: Fig. 11c). The stone from which it is made is a slightly altered fine-grained basalt and like most of the adzes, this piece is an import from adjacent New Britain where such rocks occur. The smaller complete adze (Fig. 5d) is not as well finished and is less easily placed typologically. It is roughly plano-convex in cross-section and thus resembles a principal early adze form of the Fiji–West Polynesia region. The "exotic to Watom" stone from which it is made is again probably a slightly altered fine-grained basic basalt.

OTHER STONE AND BONE ITEMS

Besides the two adzes, the land owner had also saved four pieces of stone he thought exotic to Watom, which also exhibited human modification. Two of these, of similar stone to the adzes, are less certainly formal artefacts, both having naturally smoothed and polished basaltic surfaces. They are presumed to have come from zone C (see above). One is an 8 cm elongated slender pebble, the narrower end of which has been battered and modified by pecking, while the broader end has lost flakes through percussion. The other is a 6.5 cm elongated but fatter pebble with both blunt ends showing loss of flakes through percussion.

Another item found by the landowner is a small (2.5 x 3 cm) piece of flattened stone, one side of which has been abraded. It seems to be from some kind of file; the exotic rock from which it is made is a silicified tuff. The final stone fragment recovered from a rubbish pit, probably also from zone C, is a puzzle. It seems to have two artificially modified arcs belonging to some much larger object (Fig. 5e). The surface has a largely natural polish and is reddish in colour; the material is probably a kind of basalt, though it is uncertain whether or not it is from Watom.

An unusual bone awl, made from the shaft of what is probably a pig femur (Fig. 5f), was found among the disturbed deposits of trench II. Although it could be of more recent origin, it is more likely that, like the pottery in that trench, it derives from once intact cultural deposits below the ash.

Trench IV produced a few other pieces of worked shell in addition to the shell adze from layer C1. Further excavations there might well increase the sample of this poorly represented but typical component of the Lapita portable artefact inventory.

Other excavated stone artefacts consisted of a core, 4 flakes of either silicified tuff, siliceous rock or other basaltic materials, a broken igneous pebble (hammer stone?) and 47 obsidian flakes (Table 1). The obsidian, like the pottery, was distributed throughout zone C but reached densities which, while low, are comparable to other localities of the site, only in layers C1 and C2.

A stone flake with cortex on one surface is not further modified. Two adze flakes were recovered from layer C2. One from trench IIIA has one smooth surface but is not polished. It is of the same material as the greenish-hued adze core described below. One from trench IIIB is a chip with a polished surface from an adze in the same material as that in Figure

5b above. One other basaltic flake, without cortex, has been used on a formerly sharp straight edge about 38 mm long. This has produced a blunted, polished edge of 10 cm at one end; the remainder is abraded and minutely step-flake fractured as if had been used to cut a fairly hard, resistant material. This item was found in layer C4 of trench IIIB. A much larger piece is a core remnant, probably from a former adze, and retains one small patch of polished surface (Fig. 5g). It is from trench IIIA, layer C3. The surfaces exhibit a slightly greenish cast, typical of rocks belonging to an altered basic basalt exhibiting some augite crystals, which are thought to be of non-Watom origin.

OBSIDIAN

Because of the limited size of the obsidian sample, the 47 pieces from the four layers of zone C were not subjected to detailed technological analysis but were included with the SAC material sent to Hanslip (1999) for study. As can be seen from Table 1, the majority of the obsidian was recovered from late (mostly post-SAC) contexts dating to the first few centuries AD, where it occurred in small amounts (between 1 and 10 pieces) in all metre squares.

TABLE 1

Distribution of obsidian in trenches III, IIIa and IIIb at SDI

	III	**IIIA**	**IIIB**	**Layer total**
Layer C1	2	9	10	21
Layer C2	3	10	6	19
Layer C3	1	3	1	5
Layer C4	-	-	2	2
Total	**6**	**22**	**19**	**47**

Like the much larger SAC obsidian assemblages, discussed in more detail elsewhere (Green and Anson 2000a), Hanslip (1999) found these SDI obsidian specimens to fit a pattern consistent with an expedient technology with haphazard and opportunistic reduction sequences. Efficient control of end shapes or attempts to produce formal tool types or edge forms are not evident.

Preliminary sourcing used the same relative density methods that were employed with the SAC assemblages (Green and Anson 2000a). Forty-six flakes were classed as lighter than 2.3566, between that figure and 2.3870, or heavier than 2.3870. One flake was overlooked at this stage of the study and its density not measured. Five flakes were heavier than 2.3870. Two were from layer C2 and one from each of the other three layers. These five were thought to be from the Lou Island, Umrei source in the Admiralty Islands. One flake fell in the intermediate category. The 40 flakes less than 2.3566 in density were assumed to be from either the Talasea Kutau/Bao subsource (most likely) or the Mopir source (less likely).

These 46 flakes and the one without a density measurement were all sent for elemental analysis. This was carried out by Peter Sheppard of the University of Auckland as part of an AINSE grant using the PIXE-PIGME ANSTO facilities of the Australian Institute of Nuclear Science and Engineering at Lucas Heights. The sourcing allocations determined by him employed discriminate analysis using data on 7 element ratios for 11 standard sets of subsource determinations (Total n=212) held by ANSTO to which unknown samples were then assigned.

Three flakes sent for elemental analysis could not be analysed. One was too small and irregular to run, and although the other two were run, the spectra proved too broad to analyse because of high counts of light elements, possibly the result of some residual surface contamination not removed by cleaning. All three of these specimens had densities of less than 2.3566, and on that basis they are assumed to have probably had a Kutau/Bao subsource, because of the results of elemental analysis of the rest of this density class (see below).

The results are set out according to layer in Table 2. The five flakes with densities greater than 2.3870 all proved to be from the Lou Island Umrei source in the Admiralty Islands, as predicted. The flake without a density measurement was also from this source. The one flake in the intermediate class was from the Pam Lin source, also in the Admiralty Islands. Of the 37 analysed flakes with densities below 2.3566, 26 (70.3%) were from the Talasea Kutau/Bao subsource, 10 (27%) were from Mopir, and 1 (2.7%) from the Talasea, Gulu subsource.

TABLE 2
Sources of obsidian at SDI according to PIXE-PIGME analysis

Source	UM	P L	Mo	K/B	G	N.D.	Total
Layer C1	1	0	3	15	0	2	21
Layer C2	3	0	4	11	1	0	19
Layer C3	1	1	2	0	0	1	5
Layer C4	1	0	1	0	0	0	2

Admiralty Island sources: Um = Umrei; P L = Pam Lin; New Britain sources: Mo = Mopir; K/B = Kutau/Bao; G = Gulu; N.D. = not determined

The following conclusions can be drawn from these results. As at SAC and SAD, three main source regions are involved: the Lou and Pam Lin Islands in the Admiralties, Mopir on Cape Hoskins, New Britain, and the Willaumez Peninsula area of New Britain around Talasea based on the subsources of Kutau/Bao and Gulu. Both the Admiralty Island and Mopir regional sources are represented in all four layers of the millennium-long SDI sequence, despite the very low numbers of flakes from layers C3 and C4. Any chronological changes were not in the regional sources in use, but in the proportions in which obsidian was imported from these three regions. Where the numbers are probably sufficient to judge (in layers C1 and C2 dating to the first few centuries AD), the Talasea sources, usually the Kutau/Bao subsource favoured in most Lapita sites, are dominant at 63% (layer C2) and 80.9% (layer C1). This supports the results from SAC, which suggested there was an ever increasing dominance of Talasea obsidians in later contexts in the Reber-Rakival Lapita site (Green and Anson 1991: 178).

POTTERY

Secure pottery-bearing strata that could be fully excavated were found only in trenches III, IIIA and IIIB. The pottery was distributed throughout layers C1 to C4. Although the sample was from an area of only 4.5 square metres, the 6.75 m^3 of deposit excavated produced 958 sherds, exceeding by several hundred the number found at SAC, where a far greater area was excavated in 1985. The overall concentration index is 142 sherds per m^3, much higher than for any layer at SAC or SAD (Green and Anson 1991: 175). However, as can be seen in Table 3, the number of sherds recovered from the various cultural layers varies considerably, as does the average thickness of the layers. Except for layer C4, the total numbers of sherds are quite high for a 4.5 m^2 area, compared to any other locality in the site. However, the volumetric densities of sherds in layers C1 and C4 are very like the sherd density in the 28 m^2 of general habitation deposit of layer C1 at SAC (Green and Anson 2000a: Table 11), which was about 75 sherds per m^3. This is four times the density of sherds in layer C2 at SAC, where initial habitation was followed by a burial ground. The sherd densities of layers C2 and C3 at SDI are much greater than those of more definite habitation layers in the Reber-Rakival Lapita site, and even the sherd densities of layers C1 and C4 at SDI are quite a lot higher than those of layer C2 at SAC.

TABLE 3

Distribution of pottery from trenches III, IIIa and IIIb at SDI

Layer	Av. Th.	No.	Density	No. Dec.	% Dec.
C1	0.5m	182	72	2	1.09
C2	0.25m	459	408	3	0.65
C3	0.25m	259	230	8	3.08
C4	0.15m	56	83	9	16.07

Av. Th. = average thickness of layer over 4.5 square meter area; Density = number of sherds per cubic metre; No. Dec. = number decorated excluding brushed sherds; % Dec. = percentage of decorated sherds when brushed sherds are counted as plain

In view of the length of time represented by the four layers of zone C at SDI, analysis of this pottery sample from them is important in the interpretation of ceramic change in the Reber-Rakival Lapita site. Although the sherd sample from layer C4 is small, it exhibits a far higher level of decoration (nearly all of it dentate-stamped) than has been encountered in any other context in either SDI or SAC, where decoration is typically 5% or less and only some of the sherds are dentate-stamped. In layers C1 and C2 at SDI, in contrast, the pottery is almost entirely plain, with only occasional sherds exhibiting nail-impressed or applied-relief decoration. Therefore, it may not be warranted to designate these first millennium AD assemblages as Lapita (for further discussion of this point see Green and Anson 2000b).

As at SAC and SAD, the great majority of the pottery found at SDI was plain. The decorated pottery consisted of sherds with brushing or striations, dentate-stamped and incised Lapita sherds, and sherds with nail-impressions and applied-relief (Specht 1968: 128–30) (Table 4).

Plain sherds (Figs 6A–G and 8a–g) were not only found in greater numbers than any other kind of pottery style, but the proportion of plain to brushed or decorated pottery increased from 76.8% in layer C4 to over 98% in layer C1 (Table 4).

The plain sherds included 29 rims. As noted by Specht (1968: 128), the majority of rim sherds at Watom are modified at the lip (Fig. 6D–G). The SDI sample makes it possible to quantify the proportion of modified to plain rim sherds (Fig. 6A–C). Only five of the 29 rim sherds were plain. It is possible that the proportion of modified to plain rims may have

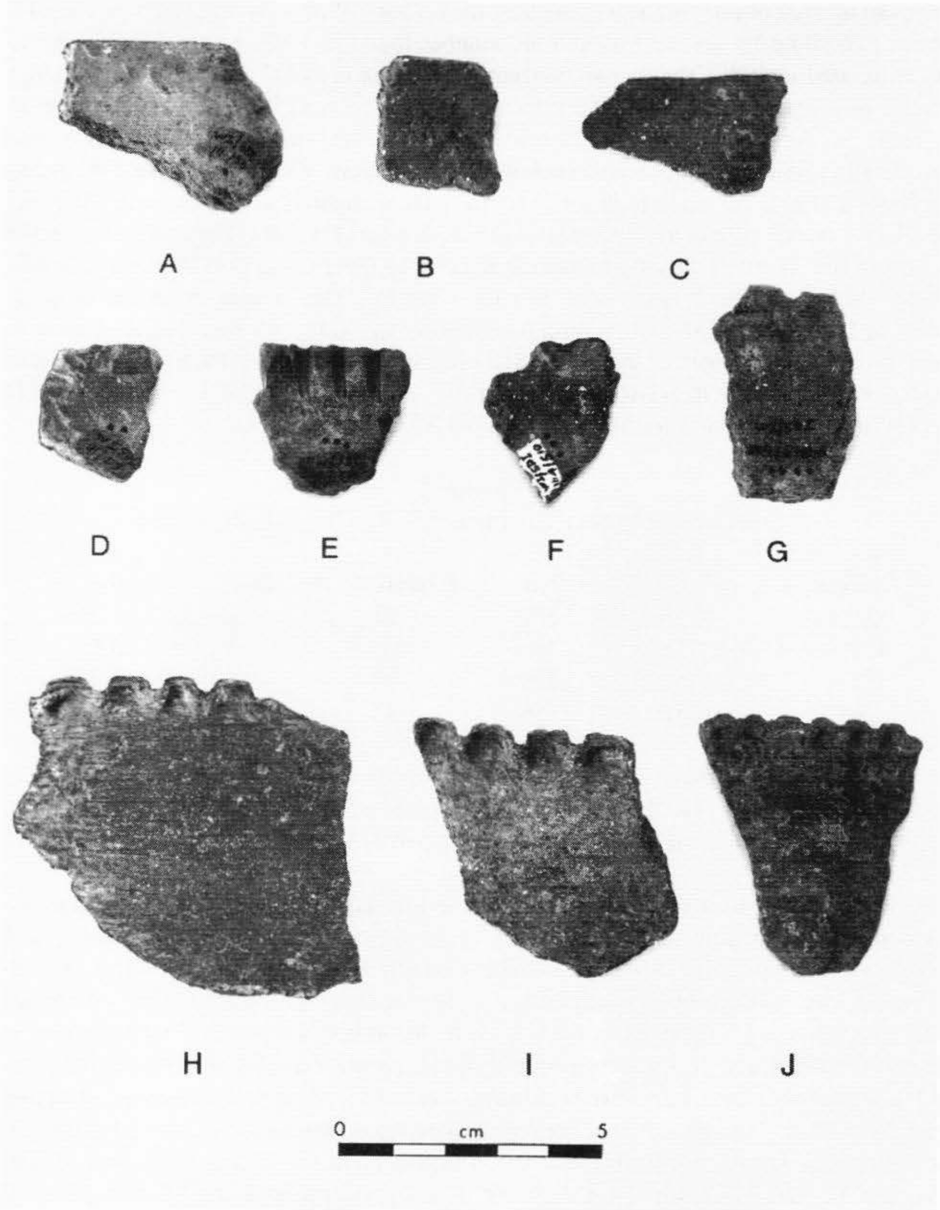

Figure 6: Selected plain and brushed pottery sherds from SDI. A–G. Plain sherds, D–G with rim notching. H–J. Brushed sherds, all with rim notching.

decreased through time, although the sample is too small to be sure. The one rim sherd found in layer C1 was unmodified. Six of nine rim sherds from layer C2 were notched or crenellated. In layer C3, 10 of the 12 rim sherds were modified by notching or crenellation. Seven rim sherds were found in layer C4, of which six were notched or crenellated.

TABLE 4
Distribution of pottery types at SDI

Layer	Plain	Brushed	Dentate	Incised	Nail imp.	Relief
C1	179 (98.2%)	1 (0.6%)	1 (0.6%)	-	-	1 (0.6%)
C2	453 (98.5%)	3 (0.7%)	-	-	1 (0.2%)	2 (0.4%)
C3	245 (94.6%)	6 (2.3%)	3 (1.2%)	1 (0.4%)	1 (0.4%)	3 (1.2%)
C4	43 (76.8%)	4 (7.1%)	8 (14.3%)	1 (1.8%)	-	-

Dentate = dentate-stamped; Nail imp. = nail impressed; Relief = applied-relief

None of the rims were everted although some of the neck sherds suggest the presence of globular shapes restricted at the neck. The small size of the plain sherds makes it difficult to add anything more to earlier descriptions (Specht 1968: 127–28; Green and Anson 1991).

Brushed pottery (Figs 6H–J and 8h–j) exhibits striations below the rim. These may have been formed by brushing the unfired pot with the broken end of a fibrous stick. A number of these sherds have been found amongst the pottery collected by Meyer in Watom (Anson 1983: Fig. VIII/16–21). Specht (1968: 128) also reported finding two such sherds and considered that the effect may be due to the use of a carved paddle. Interestingly, the striations on this pottery sometimes stand out in relief similar to that of the "ribbed relief" or paddle-impressed pottery of New Caledonia, Fiji and Vanuatu (Golson 1971: 70). In the Bismarck Archipelago, brushed sherds have also been reported at Eloaua (Egloff 1975: 23) and Ambitle (White and Specht 1971: 90; Anson 1983: Fig. IX/8–10). More recent analyses have not treated this kind of surface modification as true decoration, and it is not often described.

Fourteen brushed sherds were found (Table 4). Eight of the nine rim sherds are typically modified by notching or what may best be described as crenellations or a scallop-shaped undulation (Anson 1983: Fig. VII/16–21). This also seems to be the case with the ninth, but its small size makes it difficult to be certain.

Brushed pottery appears to consist of bowls or in some cases beakers or other shapes of small diameter (Anson 1983: 42–45). Where original pot dimensions at SDI can be estimated from sherds, three vessels had a diameter of about 50 cm while another was nearer to 40 cm. The three brushed sherds from layers C1 and C2 are much thinner walled than the others. Thin walled brushed sherds were also found amongst the brushed potsherds at SAC (Green and Anson 2000a).

Brushed or striated pottery from Watom is best viewed as part of the plain Lapita pottery suite and is so treated in Table 3. Like dentate-stamped and incised Lapita pottery, it is most strongly represented in layer C4 and is found in much reduced proportions in the succeeding layers (Table 4). The rim modification which serves to distinguish it is similar to that on plain and rare examples of incised (Anson 1983: Fig. V/5 and Plate 1) and dentate-stamped Lapita pottery (Specht 1968: 128, Plate 1/d).

Twelve dentate-stamped Lapita sherds were found; four are illustrated (Figs 7A–D and 8k). The largest percentage was found in layer C4 (Table 4). The representation of this decoration technique drops off dramatically in the overlying layers. The one sherd from layer C1 may represent an heirloom or curated pot, or be a piece out of context (Green and Anson 1991: 175). It should not be taken as evidence that dentate-stamping lasted into the first millennium AD.

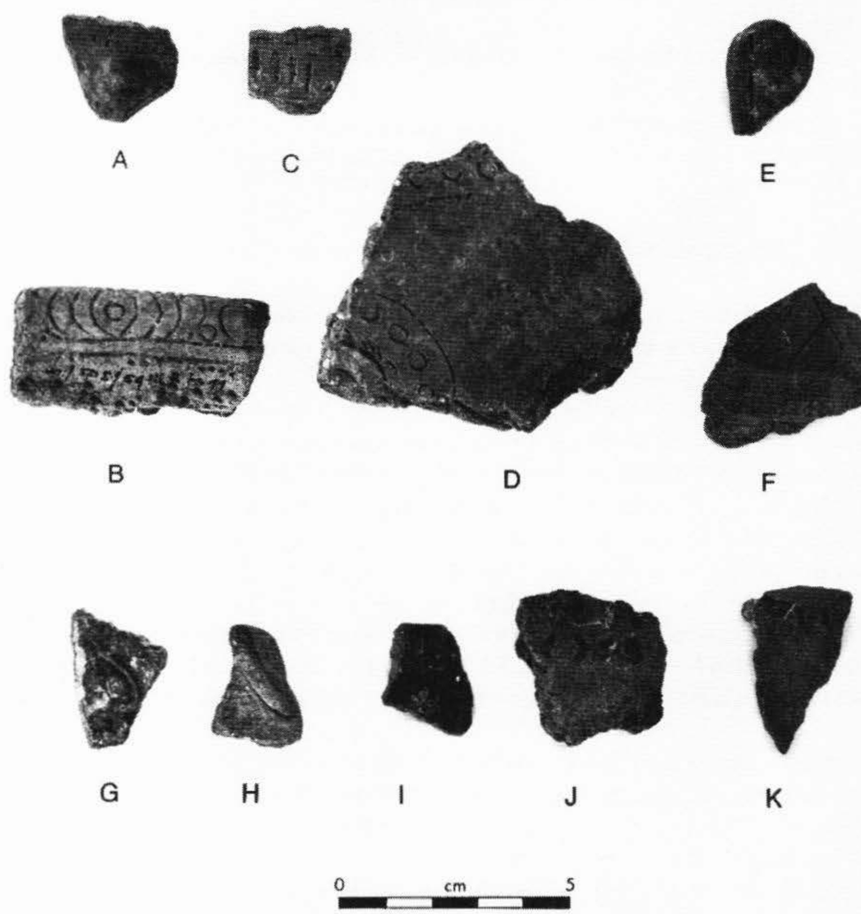

Figure 7: Selected decorated pottery sherds from SDI. A–D. Dentate-stamped sherds, A and B rims and A also with nubbins. E–F. Incised sherds, F with carinated shoulder. G–K. Applied relief and nail-impressed sherds.

The dentate-stamped sherds are very fragmented and/or worn and only three motif types can be recognised (Anson 1986: 159–61; Anson 1990: 53–58; Anson 2000b: Table 1). Other decoration not previously found on Watom Lapita consists of applied knobs or nubbins, as on a sherd from layer C3 which is also decorated with dentate-stamping (Fig. 7A). Sherds decorated with nubbins are found with Lapita pottery in the Reef-Santa Cruz sites (Donovan 1973: 18) and nubbins also occur on Lapita pottery at Ambitle (Anson 1983: Fig.X/4–7).

Only one dentate-stamped Lapita rim-top sherd was found at SDI. This sherd from layer C4 (Fig. 7B) appears to have been part of an everted rim approximately 50 cm in diameter with a very thick cross-section (Fig. 8k).

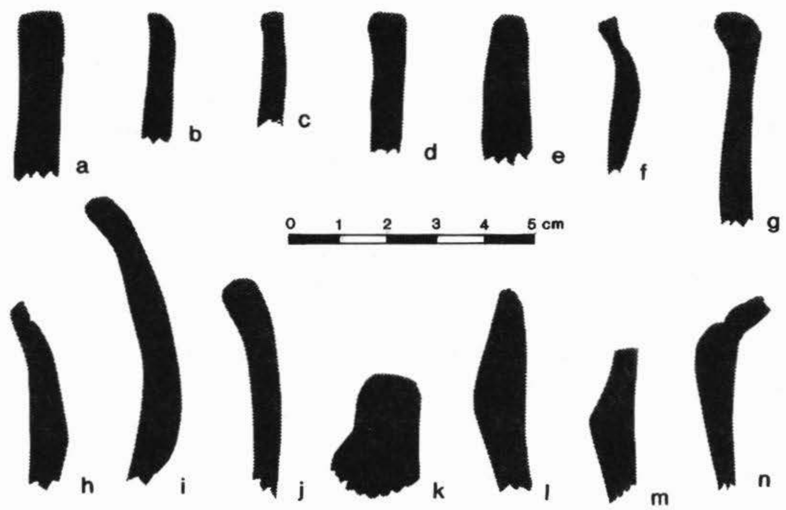

Figure 8: Profiles of selected sherds. a–j Rim sherds in Figure 6A–J. k. Rim sherd in Figure 7B. l. Carinated sherd in Figure 7F. m–n. Carinated sherds in Figure 7J–K.

Two incised sherds were discovered (Table 4; Figs 7E–F and 8l). The pattern on the sherd from layer C3 could not be made out. The sherd from layer C4 (Fig. 7F) displays an interlocking hatched triangle motif found commonly in Watom (Anson 1983: Fig. V/3–4; Green and Anson 2000a). This is a carinated shoulder sherd indicative of a pot form restricted at the neck (Fig. 8l). It fits comfortably amongst incised sherds in the Lapita style.

The few sherds with nail-impressed and applied-relief decoration (Table 4; Figs 7G–K, 8m–n) are of a type also known from Meyer's (Anson 2000a: Fig. 11) and Specht's (1968) excavations. The decorative technique of nail-impressing consists of short, opposed impressions consistent with pinching. The relief decoration consists of applied bands or large, irregular circles (Specht 1968: 28). This pottery is slipped in greyish-reds and browns which are unlike the bright red-browns common amongst plain and other decorated pottery from Watom.

These decorative techniques evidently occur on bowls restricted at the neck (Anson 1983: 48, 51, Fig. XI/1–11, Plate IX/8–21; see also Specht 1969: Plate XI–47/m–z). The only known rim sherd (Anson 1983: Fig. XI/4) has modification which goes beyond the usual notching. The incisions are broader and deeper. At the bottom of each incision there is a flattening of the ceramic paste, which then protrudes both outwards and inwards from the body section.

None of the nail-impressed and applied-relief sherds from SDI are rims. However, three exhibit carinated or shoulder angles (Fig. 8m–n), confirming the existence of restricted body shapes in nail-impressed and applied-relief pottery. With two exceptions, the sherds are grey to brown in colour.

Specht (1968: 128) classified nail-impressed pottery separately from pottery decorated with applied-relief. It now seems, however, that they are variants of the same group, as nail-impression and applied-relief may occur together on the same sherd (Anson 1983: Plate IX/14 and 15). Moreover, in an analysis of the composition of sherds from SAD, the two types proved to form a discrete cluster different from that of dentate-stamped pottery (Anson 1983: 48, 142; Anson 1999).

O'Reilly called this pottery "Melanesian", in contrast to the dentate-stamped Lapita pottery, which did not resemble any Melanesian types then known (Anson 2000a). More recently, some Watom pottery has again been likened to pottery from Melanesia, namely the incised and applied-relief Mangaasi pottery (Garanger 1971: 65). Mangaasi-type decoration became widespread in Melanesia after the disappearance of Lapita and it has been argued that it may have developed from and succeeded Lapita (Spriggs 1984: 215–18; Spriggs 1997: 140, 161).

As discussed in Green and Anson (1991: 179–80) the relationship between dentate-stamped Lapita pottery and nail-impressed and applied-relief pottery on Watom remained unclear because none of the latter had been found in secure contexts until the 1985 excavations. Specht (1967: 31) speculated that Watom's "Melanesian" and "non-Melanesian" pottery might represent different kinds of pottery used and made by the same people to serve different uses. Anson (1983: 263, 278–79) was able to show that the paste of dentate-stamped pottery and pottery with nail-incised and applied-relief decoration was technologically and compositionally similar and probably local.

The discovery of four sherds with either nail-impressed or applied-relief decoration stratified with three dentate-stamped Lapita sherds in layer C3 at SDI (Table 4) now demonstrates the coexistence of these two wares, at least during the first few centuries BC. The table also suggests that dentate-stamping and incising in the Lapita style may have given away to largely plain pottery with occasional nail-impression or applied-relief over the period in which SDI was occupied.

A sequence of change in ceramic decoration can be proposed on the basis of the distribution of pottery types in SDI. The absence of nail-impressed pottery in layer C4 suggests that this decorative technique may have appeared after dentate-stamping and that it was contemporary only with a late stage of Lapita decoration as found in layer C3 at SDI (and layer C1 at SAC—Green and Anson 2000a: Table 11) when dentate-stamping was rare (Table 4). The same may be true of pottery with applied-relief decoration. Sherds with relief decoration appear only in layers C3 and C1 at SDI, and are apparently absent at SAC.

The absence of sherds with nail-impression and applied-relief from the earliest layers at both SDI and SAC adds strength to the argument that nail-impression and applied-relief in the Reber-Rakival Lapita site began some time after dentate-stamping and incising in the Lapita style were already well established. However, this will need to be confirmed by additional excavations at SDI. At present it has been demonstrated that the three types coexisted when layer C3 was deposited at SDI, but probably not after that period, at least in that locality.

No temporal change in the temper of the pottery is apparent at SDI. At SAC, variations in the density of white inclusions alerted us to a possible change from a predominantly carbonaceous modal temper in layer C2 to one dominated by a plagioclase feldspathic modal temper in layer C1 (Green and Anson 2000a; see also Green and Anson 1991). The counting of the white grain inclusions in sherds from SDI showed that sherds with a high density of these inclusions were strongly represented in all layers. Taphonomic soil processes do not seem to have affected the sherd tempers in this locality, in contrast to layer C1 at SAC (Green and Anson 2000a).

Petrographic analysis and point counting of ten dentate-stamped sherds from SDI large enough to sample confirmed the presence of both modal tempers in this site; five were of the coastal carbonaceous mode and five of the inland dominantly feldspathic one. Most of the carbonaceous sherds were from layer C4, but the size and nature of the decorated sherds from the other layers prevents comment about the proportions there.

CONCLUSION

The excavations at the SDI locality in the Reber-Rakival site, though of limited extent, provided a set of securely dated pottery assemblages spaced over 1000 years from 800 cal BC to after cal AD 200. These indicated ceramic change from an early assemblage in which the sherds were predominantly dentate-stamped with some incised and brushed, to later ones in which dentate-stamped sherds were few and were associated with a small number of sherds carrying nail-impressions and applied-relief. Some of the deposits at SDI had a significantly higher density of pottery sherds by volume than any others excavated in the Reber-Rakival site.

The cultural layers also contained small amounts of marine shellfish, occasional pig bone from after 400 cal BC and, at the end of the sequence, a dorsal region Tridacna shell adze and a stone adze with a rounded cross-section.

SDI had more stratigraphically distinct depositional layers than other localities in the Reber-Rakival site. The last three reflect slope-wash run-off of loam on to the sandy beach from the area above and behind the coral cliffs. The four layers of zone C represent a series of intervals in the overall occupation of the site. The first, layer C4, represents the earliest recorded use of the site. The next, layer 3, is approximately contemporary with the initial occupation at SAC, while the last, layer C1, seems to be later than any layers at SAC. Layer C2, with its nail-impressed pottery and first century AD or later age, fits with or just after the final occupation at SAC. The limited area excavated at SDI exhibited no evidence of the residential or burial activities present at SAC (Green and Anson 2000a) or of the deposition of cultural materials in water-logged or water-laid deposits as at SAD (Specht 1968). SDI seems to reflect different activities and events from those that took place at SAC and SAD within the overall Reber-Rakival site.

After the series of Lapita occupations, the next use of SDI was also different from the post-Lapita developments at SAC and SAD. Mature, nut-bearing trees grew at SDI, whereas SAC was used for gardening (Green and Anson 2000a) and SAD became covered in mangroves (Specht 1968). The three localities shared the same fate when they were destroyed, covered and sealed by ashfall deposits from the large magnitude Rabaul eruption, dated at SDI to the 8th century AD.

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Received 22 May 1998
Accepted 10 September 1998