NEW ZEALAND JOURNAL OF ARCHAEOLOGY

Excavations at Kainapirina (SAC), Watom Island, Papua New Guinea

R.C. Green[1]

Dimitri Anson[2]

ABSTRACT

This paper is the final report on excavations in 1985 at the locality of Kainapirina (site SAC), situated on the Reber mission station adjacent to Rakival village on Watom Island. It backgrounds previous investigations there, the objectives of the 1985 endeavours, and the excavation strategies undertaken to achieve them. The occupation sequence based on stratigraphy, dating, and associated structural features is described and illustrated. Aspects of the human skeletal remains recovered are briefly reviewed; the economic evidence is discussed in detail. Analyses are provided of the various portable artefacts from these Lapita contexts, particularly stone adzes, obsidian, and pottery. These document an 'exotic to Watom' exchange component among the local manufactures. It is concluded that these 1985 excavations at SAC currently best enable an understanding of the significance of the entire Reber-Rakival Lapita site.

Keywords: OCEANIA, WATOM, LAPITA, ARCHAEOLOGY, KAINAPIRINA.

INTRODUCTION

ISSUES AND OBJECTIVES

In 1985, further excavations were undertaken in the Kainapirina (SAC) locality in order to address various issues which had arisen from previous work in the Reber[3]-Rakival area. The aims were to develop a better understanding of the stratigraphy, obtain more adequate dates for the cultural layers, determine the changes in and associations among the various types of pottery, increase the portable artefact assemblage, expand information on what appeared to be a burial complex, and open an area large enough to reveal structural features in order to improve understanding of activities at the locality.

Dating of the Watom Lapita assemblages had proved difficult because of the lack of suitable radiocarbon samples from secure stratigraphic contexts. Only the date of 2420±100 BP (ANU 37b) on a sample of human bones from the zone C2 burials recovered by Specht (1968: 124) appeared to be satisfactory, but even this was suspect because of the difficulty of determining and interpreting bone dates (Spriggs 1989: 598, 1990: 6).

---

[1] Department of Anthropology, University of Auckland, Private Bag 92019, Auckland, New Zealand

[2] Otago Museum, P.O. Box 6202, Dunedin, New Zealand

[3] The 'b' represents a prenasalised phoneme 'mb', so on some maps this is spelled Rember.

New Zealand Journal of Archaeology, 2000, Vol. 20 (1998), pp. 29–94.

Specht's limited excavations at Kainapirina established the existence of two undisturbed cultural layers, zones C1 and C2, lying on top of a coralline sand beach deposit and sealed by primary and secondary ashfall deposits (Specht 1968: 122–123). This was in line with Meyer's earlier observations (Anson 2000a), and with the results of a systematic set of soil auger samples taken by Key over a wider area at the time of Specht's investigations. The coring results allowed us to be fairly confident of the integrity of the deposits in this locality. Thus there was every expectation of being able through excavation to develop a better stratigraphic sequence and to address further questions pertaining to the interrelationship of structural features, pottery types and other items known from earlier work at Watom.

The relationship between the various Watom pottery types had never been satisfactorily demonstrated. Dividing them into Melanesian and non-Melanesian types as O'Reilly did (Anson 2000a) was not helpful beyond raising the question of whether or not applied relief and pottery with designs occurred together. Specht's (1968: 127) sample of 155 sherds from zone C at SAC was too small to throw light on the problem, while the larger assemblage from Maravot (SAD) was derived from somewhat disturbed contexts. As a result, observations by various workers provided nothing more than hints of the kinds of relationships that might be involved. Thus Meyer (Anson 2000a) commented that sherds from the black layer at Kainapirina (SAC) had more applied motifs than those from Maravot (SAD). Specht (1968: 129) noted that sherds with nail impressions, common at SAD, were absent at SAC. Anson (1983: 146–48 and Figs LIV–LVI) found that it was possible to discriminate between two sets of dentate-stamped sherds, one from SAC and one from SAD, on the basis of their elemental composition, with SAC sherds having higher potassium values. To obtain the larger sample needed to define more clearly the interrelationship of these ceramics, more extensive excavations in layers C1 and C2 at Kainapirina seemed an obvious approach.

The opening of a much larger area at SAC was also expected to advance two further important aims. One was to expand the sample of human remains beyond the three, or perhaps four, individuals encountered by Specht (1968: 126). An enlarged sample would provide vital biological data on the people associated with Lapita pottery, a topic on which there was (and still is) little information. The other objective was to open up a sufficient area of each of the layers to reveal structural features (including burial pits), so as to gain a better understanding of the activities that had taken place in this locality.

Meyer had also found burials at Kainapirina in 1909. In his only trench at this location he found a late crouched adult burial in the secondary ash at 60 cm depth (Meyer 1909: 1093) and a child in an uncertain context (1910: 1160–61). Pottery was found in the black cultural layer.

Specht (1968: 120–21) excavated 16 m^2 of deposits in two trenches. The seaward one (II) of 6 m^2 contained no human remains and apparently had few features at its base. The inland trench (I) of 10 m^2 produced three articulated burials and a few additional bones suggesting that it could be part of a burial ground. When he ended the 1965–1966 excavations at the onset of the wet season, he had completed excavations to the basal beach sands in Trench II, but had not completed the lowermost spits in zone C2 in Trench I. At that point he laid down a plastic sheet on the unexcavated surface, intending to return in the following season. Our first task, then, was to relocate Specht's Trench II, remove the backfill and complete the excavation. On the basis of the results of this work and Key's unpublished map we would then decide in which directions to expand our excavations in the five weeks available.

PRESENT AND FORMER SETTING

Whereas Specht (1968, 1985) was able to demonstrate that cultural-bearing layers under the volcanic ash at Maravot (SAD) were deposited in a muddy, disturbed stream- and sea-inundated environment, the Kainapirina environment was known to have been quite different. This was indicated not only by Specht's excavations in Trenches I and II, but also by the auguring programme carried out by Key, which made it possible to map the surfaces of the former yellow coralline beach sand and the zone C black 'loam' cultural-bearing layers, which were covered by a metre or more of primary and secondary ashfall deposits. Specht's trenches had been placed between the former church and present cemetery in what is today a flat grassy area bisected by the World War II Japanese trench (Fig. 1). Though largely infilled, this historic feature could still be seen as a hollow extending across the area. The position of the old church was indicated by its concrete foundation and floor. Before our arrival in 1985, a modern church had recently been constructed just west of the old one, and the flooring of the latter used as pavement at the front of it. The whole area, from inland of the present church, including the SAC excavation zone and the cemetery, sloped gently to the beach 50 m or more to the east (Fig. 1).

The placement of the 1985 SAC excavation units was in part predicated on the assumption that the former beach had prograded seaward with a buildup of deposits, especially eroding ashfall, in the shallow tidal zone lying behind the fringing reef along this part of the bay. Given the current level of high tide at about 225 cm depth in the SAC locality (based on the level of the water table in the base of excavated features), we estimated that a former juncture between the high tide on a sandy beach and dry land would have lain some 40 to 50 m inland from the present-day beach. Thus from all the information available to us it appeared that occupation in this locality in the mid part of the first millennium BC had been on a projection of a well drained sandy coralline beach flat with a few low-lying beach dunes to the rear (Green and Anson 1991: 170). It also appeared that to the south and north, as well as to the east, beach sand and cultural deposits dipped down to below today's high tide mark.

Specht's excavations (1968, 1985) at SAD to the south demonstrated that this area, through which the stream at different times cut numerous channels, was more or less continuously waterlogged. Only after the period of Lapita occupation was it covered by fairly extensive swamp vegetation (Specht 1968: 125) and then by volcanic ash. Although the northern edge of the last stream channel there today is reasonably well defined, it may not always have been, perhaps shifting from time to time. In contrast, the southern edge is currently controlled by its present course next to the coral limestone outcrop, which would always have been a defining feature. It is possible that in the past, the seaward part of the area now occupied by the stream may have been a small tidal embayment (Specht 1968: 123) into which a slightly shorter stream emptied.

The former (and more irregular) northern edge of the SAC locality is more difficult to establish, partly through lack of excavation and partly because of the presence of the modern cemetery. There is no reason to infer the existence of a former stream here, although a muddy swale that rapidly filled with cultural deposits, raising it above the high tide level, is a plausible reconstruction on the sketchy available evidence.

In sum, at the time of the Lapita occupation in the locality of SAC, the environmental setting was different from that of today. Our reconstruction of this former setting was a major factor in our decision to return to this particular locality, rather than SAD or somewhere else in the village, to achieve the objectives set out above. It was clear that the

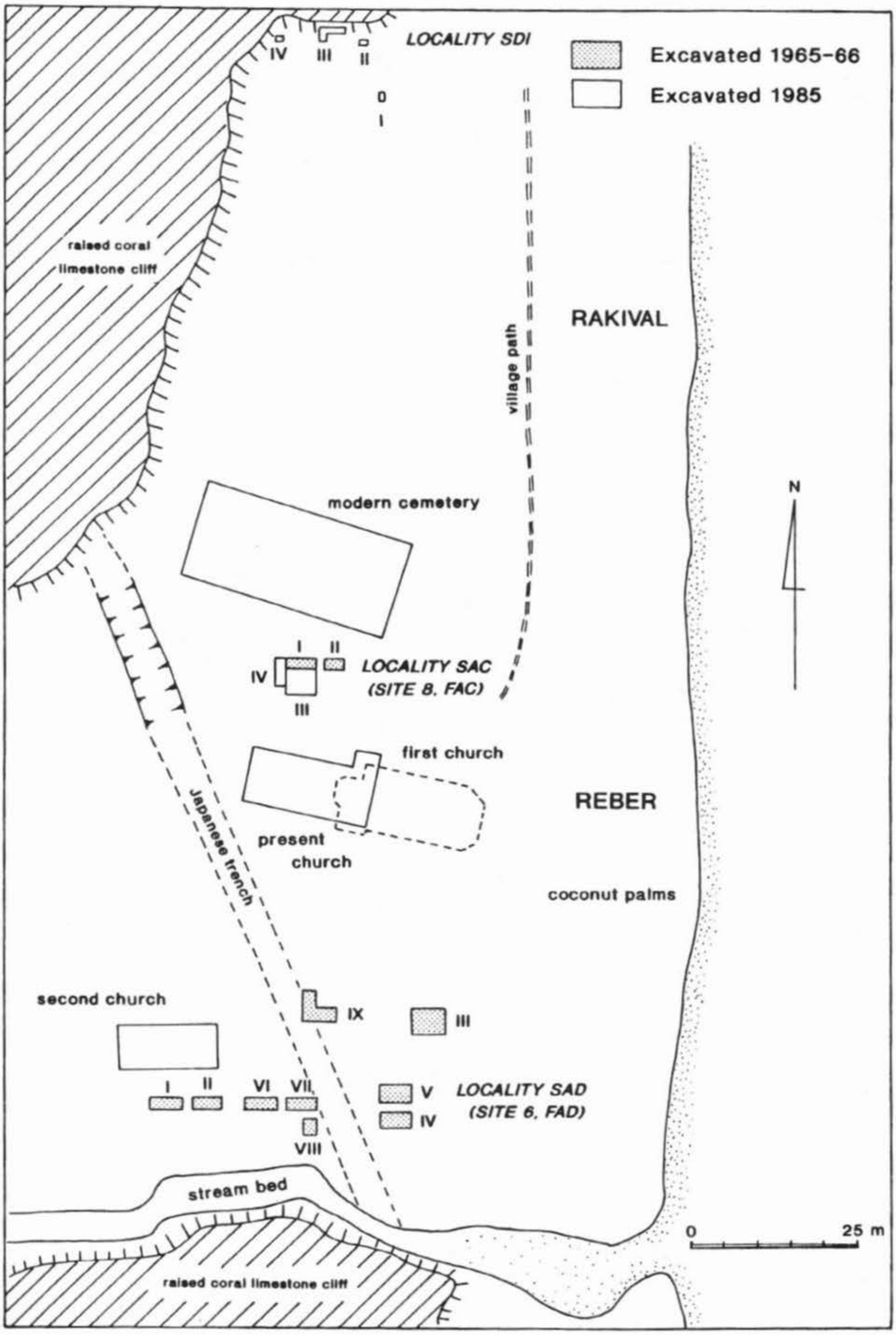

Figure 1: The Reber-Rakival Lapita site showing localities SAD, SAC and SDI and modern structures.

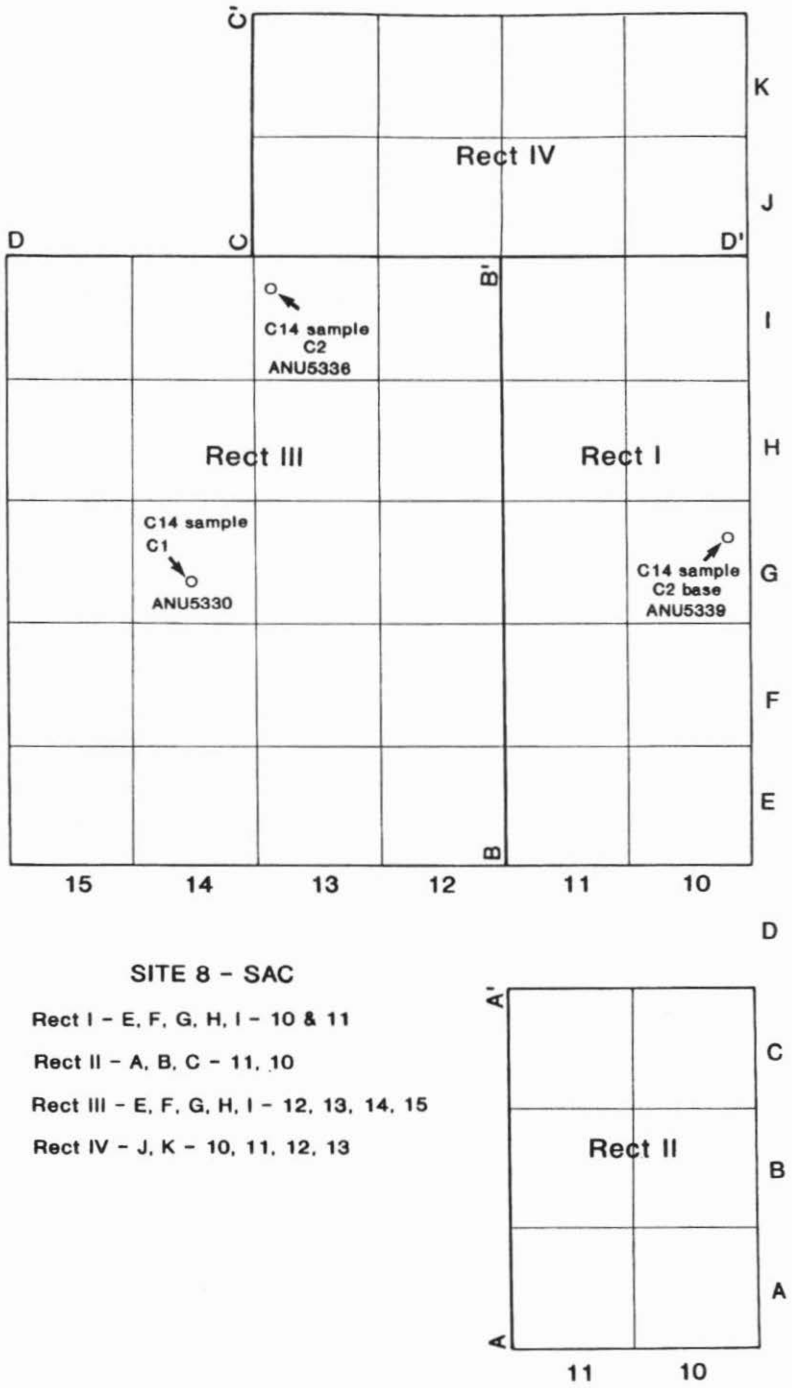

Figure 2: Layout of SAC rectangles and one metre squares, showing positions of E–W and N–S stratigraphic sections. Grid designations are different from those of Specht (1968).

SAC locality, protected by its deep and uniform cover of primary and secondary ashfall, was the most likely place to find intact stratigraphy, secure assemblages of portable artefacts, additional burials, and associated features.

EXCAVATION STRATEGY

We were fortunate in having Specht with us when we returned to the Reber-Rakival Lapita site some 19 years after his excavations. Using an updated version of his map (Specht 1968: Fig. 3), the now obscured location of his Trench I was soon identified (Fig. 1) by a shallow excavation strip and renamed rectangle I. Other rectangle designations and an overall set of grid square designations were then developed for use as the excavation area expanded (Fig. 2). Rectangle I was re-opened, so that its excavation could be completed. The removal of the backfill down to the rotting plastic covering the end of Specht's excavation was soon accomplished, and the definition and excavation of the remaining features and burials cut into the underlying beach sand was begun. As well as defining parts of two more burial pits, confirming the pit of a third burial, and exposing a possible fourth such pit, the excavations demonstrated that various rocks plotted by Specht aligned with others uncovered by ourselves to form a possible boundary wall across the eastern end of the rectangle (see below and Fig. 7).

The above results and the extension of parts of burials 2 and 5 into the southern face of the rectangle suggested that it would be most profitable to expand the excavations in that direction. Key's unpublished contour map of the black loam (zone C1) surface showed the area as flat. Specht's results from his Trench II to the east suggested that extensions in that direction were unlikely to be as productive, as it lay close to the postulated former shoreline. A 4 x 5 m rectangle, III, was therefore laid out to the south of rectangle I (Fig. 2).

Like Specht, we removed the cultural deposits in 10 cm spits or, towards the base of layers, in thinner spits to conform to the stratigraphy. Sieves of 5 mm mesh were used throughout the excavation. Because of the intractable nature of the deposits it was necessary to combine sieving with hand stirring, feeling and sorting of the deposits in the sieves and dipping any lumpy objects in a bucket of sea water. We and the workmen soon became very adept at retrieving minute bits of bone, pottery and obsidian despite the slowness of the process and the difficulties involved. The limitations of our equipment and the logistics of the situation precluded any attempt at wet sieving with sea water and the only fresh water in the vicinity, from the church roof, could not be spared.

By the time the excavation in rectangle III neared completion, the stone wall alignment had been traced completely across its eastern end, and burials 2, 5 and a new one, 6, had been fully defined. However, at least two burials extended into the west (inland) face of the excavation, one in rectangle III and either one or two in rectangle I. The subsurface contour maps and sections suggested it was feasible to expand in that direction. Yet time was running short, particularly as we had decided to undertake a second small test excavation (SDI) further north in Rakival village in the hope of obtaining material for comparison with our results from SAC. Thus any additional work at SAC had to be of limited extent. A 2 x 6 m rectangle, IV, was laid out, but only 8 m^2 were excavated. This enabled the two remaining burial pits (4 and 7) and their skeletal remains to be defined, and resolved the matter of the uncertain one (burial 8) (see Fig. 8 below) while enlarging the portable artefact samples. However, the 44 m^2 excavated in the SAC locality, 38 m^2 of which are contiguous, largely achieved our purpose of conducting an areal excavation in a Lapita site rather than engaging in a series of limited test excavations which would not realise the principal objectives.

THE OCCUPATION SEQUENCE

STRATIGRAPHY

Specht's (1968: 122–123) excavations in rectangles I and II had defined the stratigraphic sequence at SAC. He confirmed Meyer's recognition of three zones resting on a coral debris sand surface (Anson 2000a), designating them as zones A, B and C. He added to Meyer's initial description by dividing the pottery-bearing 'black earth' zone into two units: zones C1 and C2. We adopted Specht's stratigraphic description in our investigations, but designated the yellowish white beach sand at the base as zone D. Units within two of the zones, B and C, could also be distinguished. These units are referred to as layers. Hence in zone B, the pumiceous zone, the deposits composed of secondary ash, B1, are usually distinguished from those of primary ashfall, B2. In zone C, two cultural occupation layers, C1 and C2, are recognised.

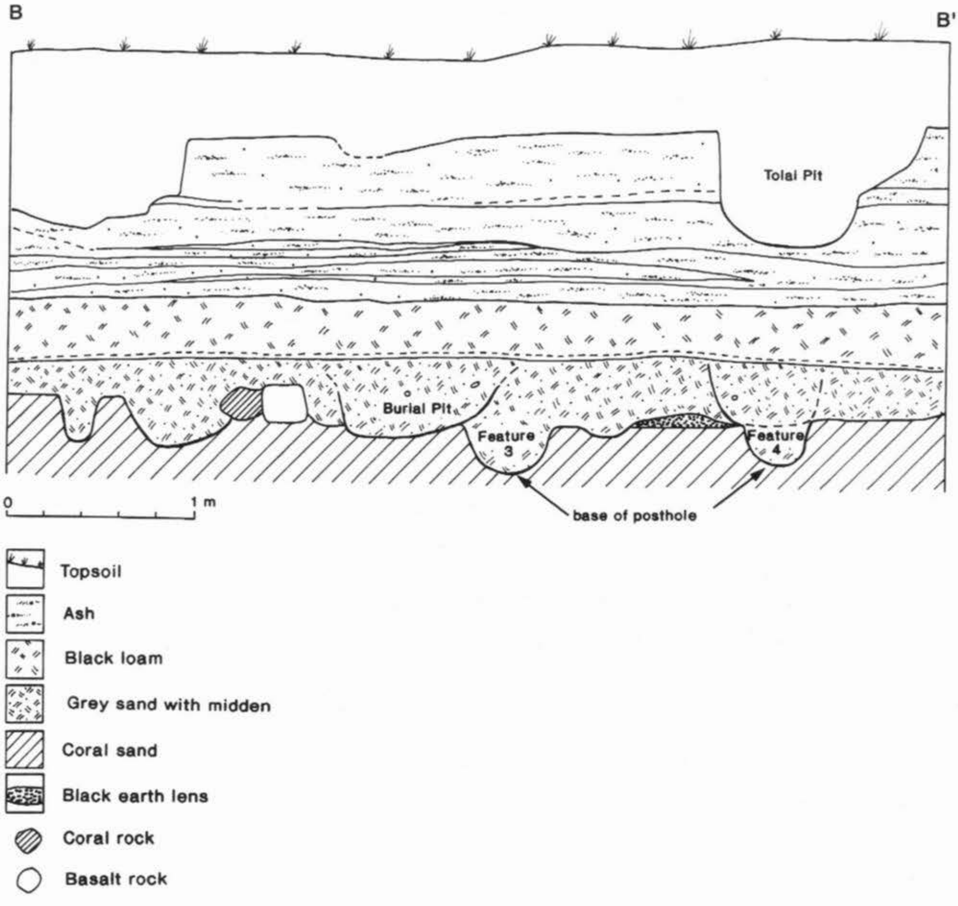

Figure 3: East–west stratigraphic section, SAC. South face, squares E11 to I11.

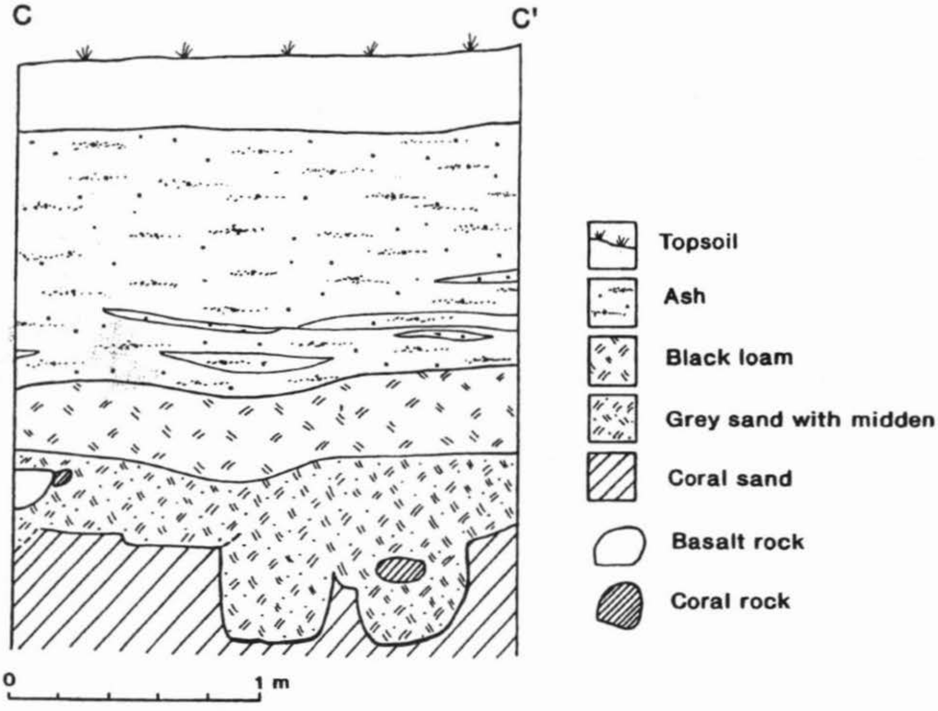

Figure 4: East–west stratigraphic section, SAC. South face, squares J13, K13.

Two of the most informative stratigraphic sections are presented here. One is an east–west discontinuous section from grid units E to K, consisting of two parts. The first is the south face of rectangle I as originally drawn by Specht and verified by us; we have completed its base (Fig. 3). The second is the south face of rectangle IV (Fig. 4). These two portions of the east–west section are linked by a continuous north–south section which includes the west face of rectangle I (originally drawn by Specht and verified by us with its basal portion added by ourselves) (Fig. 5). The following stratigraphic units may be distinguished in these sections.

Zone A: A black to brown recent soil horizon formed on secondary ash deposits, with modern pits dug from it into the underlying ash.

Zone B: Naturally deposited volcanic ash deposits from the Rabaul eruption. These may be subdivided into:

B1: soft, yellowish, reasonably uniformly sorted, redeposited volcanic ashfall deposits;

B2: primary ashfall deposits from the last major eruption of the Rabaul volcano (Walker *et al.* 1981), consisting of a fine grey ash with pellets, and coarser deposits with lenses and lines of pumice pellets above.

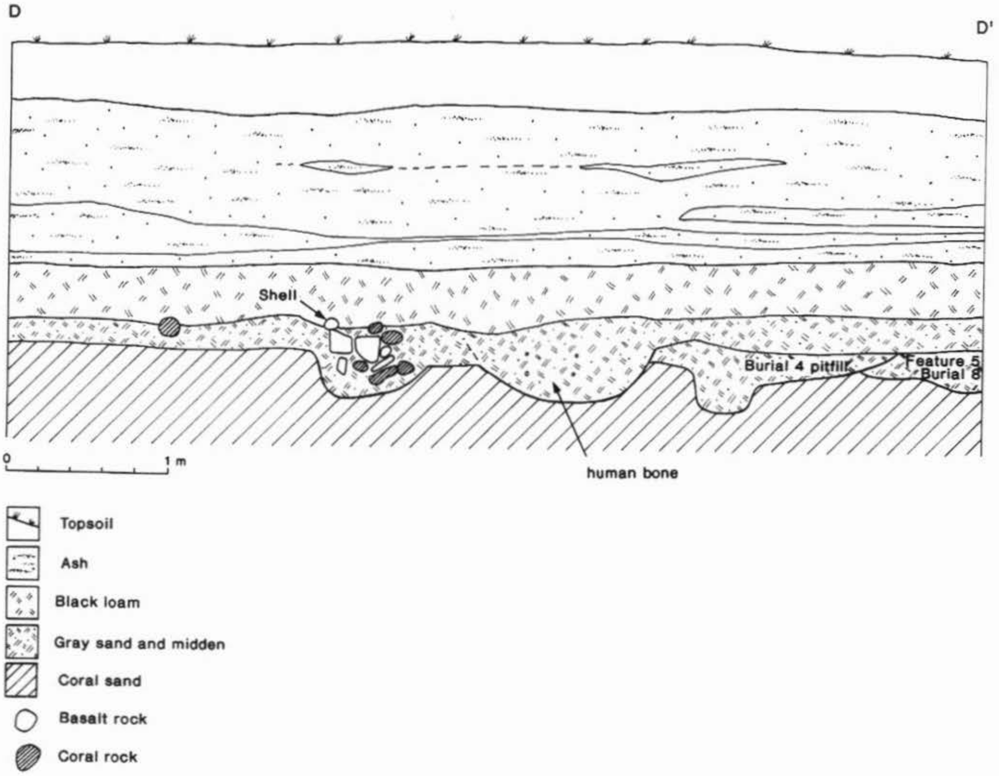

Figure 5: North–south stratigraphic section, SAC. West face, squares I10 to I15.

Zone C: Black to grey sandy loam to coral sand cultural deposits containing pottery sherds, obsidian and other stone artefacts, marine shells, human, animal and fish bones, and oven stones. The zone consists of two units as follows:

C1: a black to brown sandy loam, representing a palaeosol horizon, rarely including marine shells or coral bits;

C2: a grey coralline sand with marine shells and coral fragments as regular inclusions.

Zone D: A culturally sterile yellowish-white coralline beach sand of unknown depth.

As will be observed from the sections, very few cultural or natural disturbances penetrated through zone B. This natural deposit, which blanketed the whole locality, effectively sealed the underlying cultural deposits. Moreover, as might be expected of a primary ashfall, the contact between the base of layer B2 and the surface of layer C1 was everywhere sharply defined and exceedingly uniform. This was in marked contrast to the surface of layer B1, into which numerous modern pits and depressions intruded. The top of zone D was also an irregular surface, difficult to define. This was due to its sandy nature, into which even more pits and postholes had been cut. In contrast to this rather diffuse C2–D contact, the interface between layers C1 and C2 was defined with relative ease, and exhibited only occasional traces of truncated features in the top of layer C2.

Drawing on the published sections, Key's auguring programme, and Meyer's observations, it is reasonable to apply the above stratigraphic description to the entire Kainapirina locality. However, it is worth noting that it differs in a number of respects from both Maravot (SAD) (Specht 1968) and Vunavaung (SDI) (Anson 2000b), while sharing some overall similarities. This is a nice illustration of the now widely recognised fact that events recorded in one locality of a large Lapita site may differ significantly from those in another (Gosden *et al.* 1989: 573), and that small tests pits in one or two locations are an insufficient basis from which to draw more general conclusions.

DATING

Dates for the ashfall on Watom provide an indication of the probable age and duration of the most recent occupation at SAC. The presence of up to 40 cm of mostly fine airfall ash above the basal Plinian pumice covering on Watom has been demonstrated by Walker *et al.* (1981: 186) and assigned a general age of about 1400 years ago from samples collected on New Britain (Walker *et al.* 1981: 181). At SDI, Anson 2000b) was able to date the ashfall on Watom itself at between CAL AD 650 and 850. Thus the age of layer B2, the primary ash fall deposit, is reasonably securely fixed. Layer B1 presumably spans the next several centuries, until the landscape had again stabilised and was revegetated.

This estimate of some centuries of ash redeposition is consistent with Specht's (1968: 122) finding at SAD of three hearths and a burial on a surface of intermittent occupation at 120 to 130 cm depth underlying a zone of redeposited volcanic ash and then one of modern topsoil. A date for one of those hearths of 720±57 BP (ANU 72) indicates that by then sufficient stability and vegetation growth had developed on Watom for the island to be re-occupied (Specht 1968: 124). Thus at SAC, the succession of pits and other features at the base of zone A dug into layer B1 (see below), the late crouched burial described by Meyer, a burned shell adze found by Specht (1969: Fig. XII-141), and the recent portable European artefacts found by ourselves, probably all date to the last 800 years, and most of them to the last few centuries. The period covered by zone A can be estimated as AD 1100 to the present.

The SAC deposits sealed in by the ashfall are dated by four new radiocarbon determinations on marine shell samples and Specht's previous date on human bones.

Shells suitable for dating were extremely rare in layer C1. The most appropriate was one of several partially dissolved *Tridacna maxima* shells recovered from the base of the layer, in this case from square G-14. It was found at the interface between layers C1 and C2. The sample gave a radiocarbon determination of 2390±80 BP (ANU 5330). When calibrated with a marine ΔR value of 0, this yields a one sigma age range and intercept value of 160 BC (96 BC) AD 38. This accords well with both its stratigraphic position and the dates discussed below for layer C2. The only charcoal sample we collected from layer C1 proved to contain a cigarette filter and yielded a modern result, suggesting it derived from the backfilling of Specht's excavation.

The two dates for layer C2 are on samples from another *Tridacna maxima* shell. This shell was the lowermost in a stack resting on top of the yellow-white sand beach layer. The shells proved to be partly contained in a pit feature centred on grid squares I–J/13–14, which cut down into zone D (Figs 4 and 5). The shell itself was from spit 2 in layer C2. The whole pile formed part of the infill of the pit, consisting of numbers of volcanic and coral rocks as well as the shells, which first became apparent at the base of layer C1 (Fig. 7) and which spilled eastwards down, across and outside the pit (Fig. 8). One would therefore judge it *not* to date the first occupation features of layer C2, but the subsequent burials and stone alignment which followed those initial activities. Two laboratories ran radiocarbon determinations on pieces from the shell. Beta 16835 provided a ^{14}C date in years BP of 2015±70 with a $^{12}C/^{13}C$ ratio of +2.42, yielding a ^{13}C adjusted ^{14}C age of 2470±75 BP. ANU 533 gave a $\delta^{14}C$ result of -231.9±7.5 per mil adjusted by standard $\delta^{13}C$ of 0.0±2.0 per mil. They reported this result as a conventional age of 2530±90 BP. When these two statistically very similar results are combined by the appropriate Case I formula (Polach 1969; Ward and Wilson 1978), the result is 2495± 58 BP. A ΔR ocean reservoir correction of 0 implies an age range and intercept within one sigma of 291 (184) 113 BC.

This result is statistically compatible with a previous radiometric determination on a selection of human bones from the three layer C2 burials recovered by Specht (1968: 124). The result of 2420±110 BP (ANU 37b) is difficult to calibrate because of a variety of factors, including the uncertain effect of $^{12}C/^{13}C$ ratios of human diet on such calculations. Therefore, the date only provides general support for a time estimate of between 350 and 50 BC (the two sigma age range for the shell date) for the later activities associated with layer C2.

Together these results from layer C2 and that from layer C1 suggest that Lapita occupation in the SAC locality covered a time span from earlier than about 400 BC to about AD 100.

There is no securely associated date for zone D, the basal yellowish-white sand beach. However, we did submit a *Trochus niloticus* shell sample (ANU 5339) from the base of Square G-10 at a depth of 1.85 m below the surface. This was 15 cm below the spit 5 surface on which Specht's excavations had stopped and thus hard down into zone D. It produced a radiocarbon result of 3490± 80 BP. We think this is too old to date layer C2, in the light of the other dating results and the associated pottery assemblages. The date probably relates to the age of the coralline beach sand deposit, although it is just possible that it is an odd food shell from an initial occupation of this beach, not associated with the cultural materials in layer C2 above it. When calibrated for marine correction with ΔR set at 0, the one sigma age range with intercept is 1509 (1415) 1350 BC, about 500 years earlier than any other date for the Reber-Rakival site.[4]

Our current interpretation of the zone D beach deposits is that they represent another case of what Allen and Gosden (1996) deduce is the initial creation of modern-day beach environments in the Bismarck Islands of Near Oceania following the waning of a former mid-Holocene (*ca.* 6000–3000 years ago) high stand (*ca.* 1.5.–2.5 m) from a hydro-isostatically controlled change in sea level (Dickinson and Green 1998). This event and the emergence of those beaches explain the abrupt appearance of Lapita sites on them during the latter part of the second millennium B.C. On Watom this appears to correlate with a wave-cut notch in the coastal coral limestone cliffs lying somewhat above the current sea stand level (Fig. 6; Green, personal observation).

---

[4] Appendix 1 provides a comparison of the shell dates for SAC and SDI given in the text, which have been calibrated using ΔR set at 0, with a recently published alternative set calibrated by a different method. The overall results are compatible except that the alternative makes these shell dates slightly younger at the top end of the range (Specht and Gosden 1997: 188).

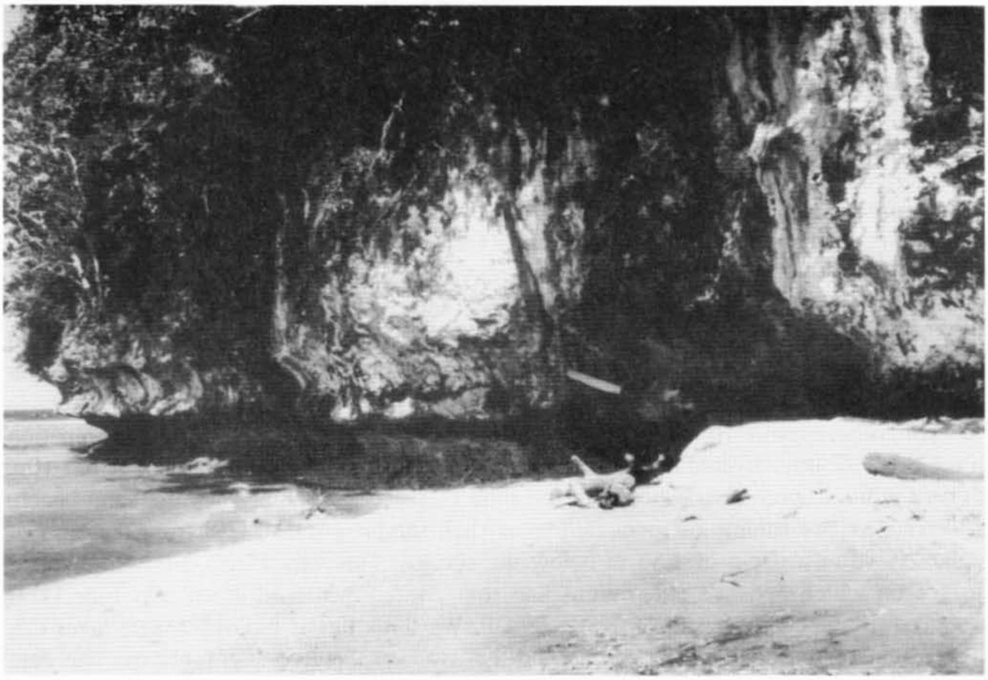

Figure 6: The east coast of Watom Island near Rakival village showing the present day wave-cut notch and, just above it, that of the former mid-Holocene high sea stand. Photograph by Dimitri Anson.

STRUCTURAL FEATURES AND OCCUPATION SURFACES

Zone A

We mapped 22 features in rectangle III which occurred at the base of zone A and cut into layer B1. These consisted of one small oven, four slot like depressions, ten postholes of varying depths, and seven pits, five small and shallow, and two much larger and deeper. They indicate activity, most of it recent, in this part of this locality during the later part of the last millennium. They were not associated with any portable artefacts other than those of European origin, and they contained no pottery.

Zone C1

Features associated with layer C1 could only be identified as intrusions into the surface of layer C2. They consisted of postholes, slotholes, and depressions (Fig. 7). Also resting on the surface of layer C2 were rocks of coral and volcanic origin, and the shaft portion of one human limb bone. The features were shallow and lacked sharp edges (in contrast to those at the base of layer C2), suggesting that subsequent activities associated with layer C1 may have obliterated their tops and blurred their definition. This could in turn account for the smaller and more fragmented condition of bone and pottery sherds from layer C1 (in comparison to those of layer C2). We interpret all of this as evidence that after occupation represented by the layer C1 assemblage of portable artefacts (see below) and the associated

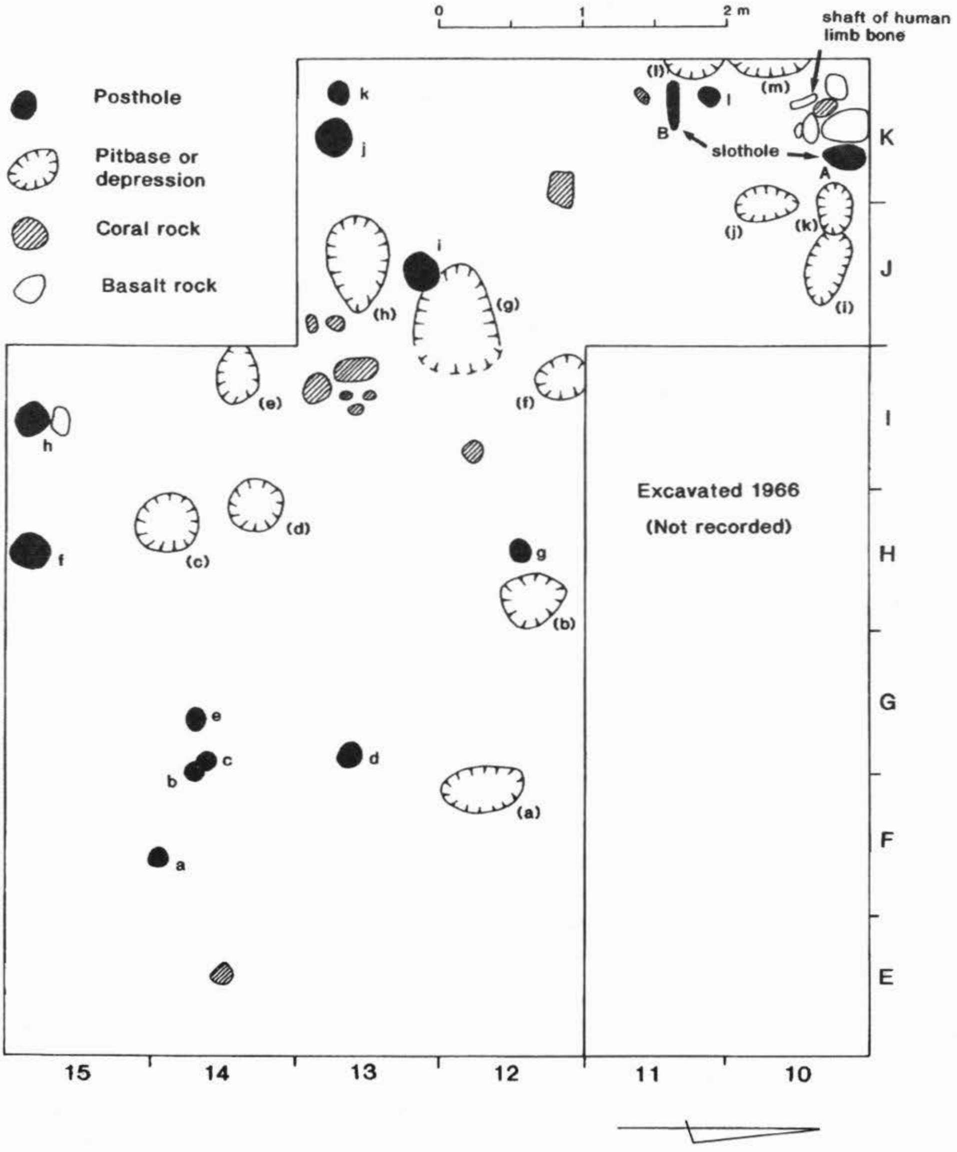

Figure 7: Muted features at SAC cut into the upper surface of layer C2, associated with activities of Layer C1. See Appendix 2 for details.

features reviewed here, the C1 deposits in this locality were repeatedly turned over by gardening activity to a depth of about 30 cm. This garden soil horizon became a palaeosol when sealed in by the primary ashfall.

There is no pattern in the distribution of the post and slotholes at the base of layer C1 to indicate the type of structures involved. Most were of small diameter; only one (Fig. 7, posthole f) was of any size (20 cm deep and 28 cm diameter). Rather modest buildings are therefore suggested, and as neither ovens nor hearths were found, they may not have been residences or cook houses. It may also be significant that the depressions representing bases of pits are concentrated inland of grid row H with one exception. All except one (Fig. 7, pit (g)) are very small, and even that one is not as large as many of the more modern pits encountered at the base of zone A. This and a lack of surviving debris in their fill preclude their further interpretation at this time. The postholes and pits when taken together with fish, pig and other bone, a low frequency of potsherds, a large quantity of obsidian and an occasional adze (see below) would seem to indicate some kind of generalised domestic occupation disturbed as a result of subsequent use of the locality for gardening.

Our interpretation of overall disturbance to a depth of 30 cm or occasionally even more is consistent with our finding of a few fragments of human bone in the lower spits of layer C1. An example is the shaft of a limb bone in square K 10 (Fig. 7). It is also consistent with the evidence from the burials of layer C2 that most of them had been disturbed in antiquity and a variety of skeletal parts perhaps lost or removed through this process (Green *et al.* 1989: 219). Finally, it conforms with the findings of Smith (2000) on bone size and ourselves on sherd size (see below) that these items had been broken into smaller pieces by such activity.

A few rocks, many of coral, appeared on the surface of layer C2 when layer C1 was completely removed. Although they were mapped as part of layer C1, it is apparent that they more properly belong to underlying features in layer C2. This certainly applies to the isolated coral rock in square E-14, and the group in the western part of square I-13 and the eastern part of J-13 (Fig. 7). The first group is part of the layer C2 rock alignment along the eastern sides of rectangles III and I; the latter is part of the rock and shell pile centred in I-13, I-14, and J-13 (Fig. 8, see also Fig. 5). When these last are taken together with the layer C1 volcanic rock in I-15, and those in the same square but from layer C2, plus the coral and volcanic rocks of layer C2 in square I-14 (Fig. 8) and perhaps that of layer C1 in K-13 and those of layer C1 in K-10 (Fig. 7), another possible alignment (now greatly disturbed) can be suggested. It runs parallel to the other more convincing seaward example and forms a border just inland of the various burial pits of layer C2. We raise the possibility of this interpretation, while not insisting on more than seeing these rocks as stratigraphically in the same position as the layer C2 rock alignment to the east, i.e., overlying an earlier feature and situated in either the upper part of layer C2 or at the base of layer C1.

Zone C2

The features associated with layer C2 are more numerous and represent a changing set of activities over time (Figs 8 and 9). Also, whereas those recorded for layer C1 are restricted to a 28 m^2 surface, those for C2 cover the full 44 m^2 of excavation area. Lastly, in layer C2 it is possible to demonstrate sequences of superimposed features, something not evident at all in layer C1. Thus, this layer may well represent a longer and certainly a more complex occupation, even though the sherds and pieces of obsidian recovered are much fewer in number (see below).

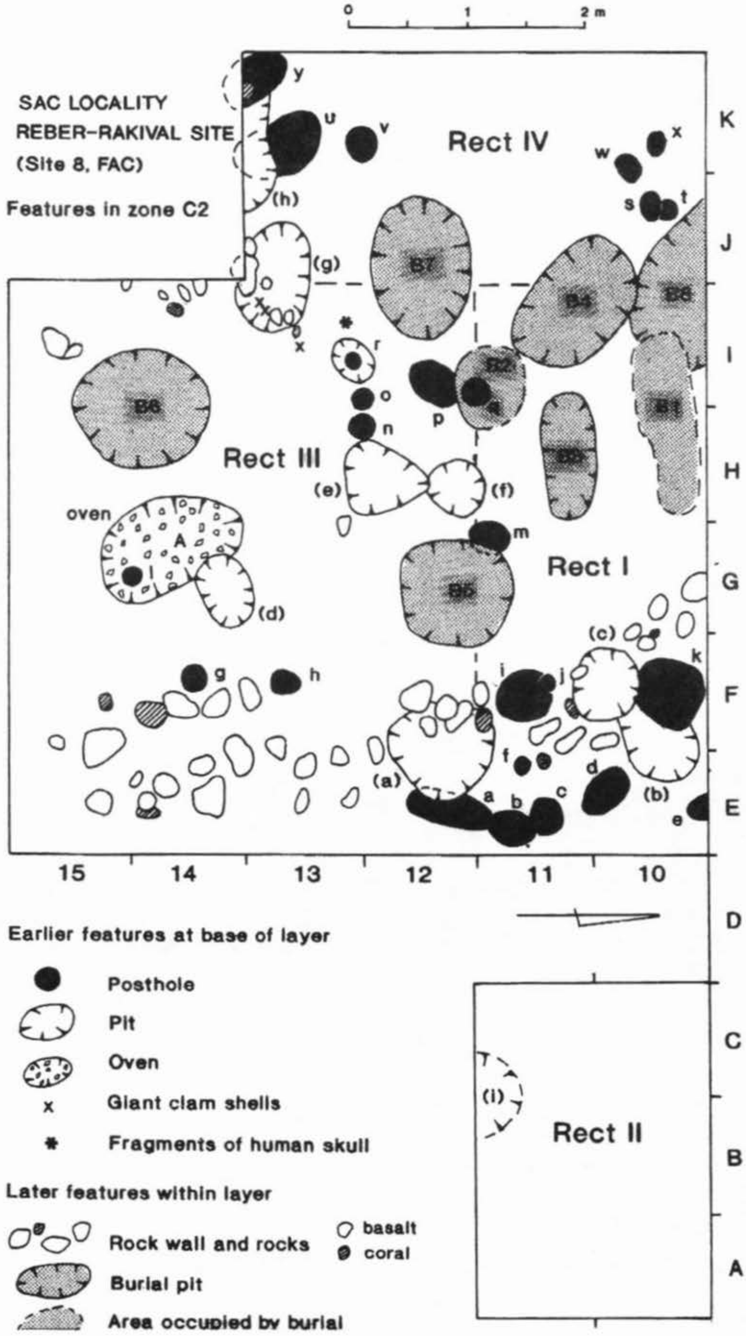

Figure 8: Features within and cut into the yellow white sand beach of zone D at SAC and associated with activities of layer C2. See Appendix 2 for details.

It is our understanding that only one feature, part of a shallow pit indicated in a section, may have been recorded in rectangle II. According to our environmental reconstruction (see above), this rectangle lies only a few metres inland from the former high tide zone, so that the general absence of features right next to high tide on the beach is understandable. Indeed, from our evidence, a real concentration of features begins about 6 to 8 m back from the proposed old shoreline and extends inland. Moreover, the N–S alignment of rock walling where this concentration begins displays a slight north-northwest slant, an orientation parallel to the projected slant of the earlier shoreline in that vicinity.

Several building periods can be distinguished during the layer C2 occupation on the basis of features superimposed on or intercutting one another (Fig. 8). There are eight examples of one feature being displaced by another: postholes u and y by pit (h), pit (f) by (e), posthole r by pit (r), posthole i by j, posthole t by s, postholes a and c by posthole b, and posthole a by pit (a), oven A by pit (d). In one case the sequence is longer: pit (c) cuts into posthole k which in turn cut pit (b) which is also cut into by pit (c). These would be sufficient to infer two and perhaps three building periods. Three and perhaps even four such periods are strongly indicated by two of the examples above, where stone from the rock alignment lies above intercutting features: i.e., rocks superimposed on pit (a) which cuts posthole a, and rocks of the alignment superimposed on pit (c) which cuts into posthole k

Figure 9: View of rectangle III at SAC from the north, after excavation of layer C2, showing basal features and remnants of stone alignments. Photograph by Dimitri Anson.

that in turn cuts into pit (b), also cut by pit (c). The inference to be drawn from this is that there is reasonably satisfactory evidence for at least two building periods before the construction of the rock alignment. The rock pile in I–13–14 (and possible parallel alignment [see above]) that lies above and infills pit (g) is in a similar stratigraphic position and the two sets of arranged stones are probably contemporary. Both are thought to be contemporary with the burial pits. Here it is significant that (a) none of these burial pits are cut by other features, (b) two burial pits overlie earlier features: burial 5 above posthole m and burial 2 above posthole q and cutting into posthole p, and (c) the sides of burial pits in some cases could be traced in section well up into layer C2, showing that some depth of deposit had accumulated by the time they were dug. This was not true of most of the other features. As a result, the rock pile, rock alignment, and burial pits are inferred to be the final set of features associated with layer C2 but sealed in by layer C1. They are believed to be part of the first burial ground to be identified in a Lapita site (Green *et al.* 1989).

Seven of the burials were in pits; the eighth (No. 1) had no pit. One burial, No. 8, is earlier than the others, as its pit is cut into by burial 4 and another part of its edge was destroyed when burial 1 was laid out.

Although SAC was a burial ground during the final stage of the layer C2 occupation, there was at least one and quite probably two earlier building periods of a different sort in the same vicinity. On the evidence available, the activities seem to relate to a domestic or residential function. In contrast to the postholes of layer C1, some quite sizeable examples occur in layer C2, suggesting more substantial structures. In the southern two thirds of rectangle III only three small postholes and one small pit were present. The main feature of that area was an early oven depression filled with ash and cooking stones. On the other hand, 21 postholes and 7 pits appear in the remainder of the excavation area. One might infer the presence of one side of some large building (Fig. 8) on the basis of postholes y, u, p, m, i and k, with depths of 50, 50, 23, 26, 36, and 32 cm. It could be correlated with another alignment based on postholes a, c, d and e at the eastern end of rectangle I. However, the area opened by excavation is really not large enough to have exposed any entire structure, and we can only speculate on its possible existence, in association with the oven to the south, during the initial occupation of this locality.

Distribution evidence indicates that neither the pottery nor obsidian pieces from layer C2 were in any way closely associated with the burials. What was notable was the much higher frequency of these items in layer C1, i.e., 4 times as much pottery and 7.5 times as much obsidian in layer C1 as in layer C2. One reason for this may be that these items were discarded only during the initial domestic activity period of layer C2, but not during the subsequent burial phase. They would be associated with the midden shell and fish, pig and other bone thrown away at this time, but not with the use of the locality for burial.

A final issue relates to relative sea level (see above). It seems unlikely that the sandy spit was ever under water when it was occupied. The burial pits and ovens as well as the other pits certainly militate against this interpretation. Rather, the sea had recently retreated, leaving the sand beach available for occupation. In fact, because the pit bases usually filled with water at high tide, it is more likely that relative sea level about 3000 years ago was slightly lower than today. In summary, the Kainapirina occupation appears to have been on a low lying but dry sandy spit just above and closely adjacent to the sea. If residential occupation on stilts extended out into the sea, it is more likely to have been in the Maravot locality, although we think that dumping and erosion were the source of most of the subtidal cultural deposit encountered there.

Sequence Summary

Kainapirina appears to have been a recently exposed but unoccupied beach flat between 1300 and 1500 BC. The structural features and associated materials of layer C2 suggest that the initial occupation of this locality related to domestic habitation. This short period may have encompassed several stages of building construction, after which residential activities ceased for a time, while the locality was used as a burial ground. This is dated to between about 300 and 100 BC, with initial occupation inferred to have begun about 400 BC or even earlier. As Smith (2000) observes, the weathering on the bones from the surface of this layer indicates a short period when there was little or no activity in this locality.

The few small muted and truncated features of layer C1 and a greater amount of cultural debris indicate that the next major occupation was of a domestic type, but of uncertain form. It is dated to between about 150 BC and AD 50. In the next few centuries the locality was used for gardening, and a mature soil horizon developed on layer C1. Again, this is indicated by the weathered bone at the surface of this layer (Smith 2000) and the leaching of calcareous material from the temper in many of the sherds (Dickinson 2000, see also below). This surface was sealed by the last major Rabaul eruption of AD 650 or after (layer B2). Erosion over the next few centuries restored the landscape to stability, in the process washing much secondary ash on to the coastal flats and extending them seawards (layer B1). By 800 or 900 years ago people were again able to return to Watom and reoccupy this locality and SAD. These people were no longer making or using pottery. It is not known what their relationship to the previous Lapita occupants was, but their origin could well trace back to incoming Tolai ancestors of the current Reber village occupants (Green and Anson 2000).

HUMAN AND ECONOMIC EVIDENCE

HUMAN REMAINS

Eight adult skeletons were recovered, seven (2–8) from individual burial pits and another (1) not lying in a pit. All were mature adults, two female and six male (Table 1). Where stature could be determined, the people tended to be at the taller end of the Oceanic height range. The bones were in generally poor condition because they were within or just above the high tide water table. During excavation, some were repeatedly under water and could not be satisfactorily dried until removed. They were therefore soft, fragile and difficult to excavate intact or, when excavated, difficult to dry and harden. Skeletons 1, 3, and 6 were largely complete and in position of articulation, yielding a reasonable collection of bones, but the skull of burial 1 was missing, and that of burial 6 had been disturbed by the excavation of pit (c) (Fig. 7) during the layer C1 occupation. The other five skeletons showed greater degrees of disturbance in antiquity; skeleton 5 was the most affected. Fragments of human bone extended into the upper part of layer C2 and occasionally into the lower spit of layer C1. Pieces of human bone, including parts of two mandibles and portions of a cranium, were scattered in the squares to the west of the burials in rectangle IV. Most skeletons had bones missing. However, the random nature of this loss suggests that it was not a result of secondary burial of selected bones, or of deliberate later disturbance of primary burials to recover particular bones. It is more likely to have been caused by the occupational activities of layer C1 and the later gardening of that horizon. A listing of skeletal material from SAC can be found in Pietrusewsky (1989: Appendix C), and descriptions of these remains as a biological population appear in papers by Houghton (1989) and Pietrusewsky (1989). The dental characteristics of two of the most intact mandibles are also described by Turner (1989).

TABLE 1
Details of skeletal remains from SAC

Burial	**Age**	**Sex**	**Height**	**Skull/Jaw**
1	30	F	164 cm	no skull
2	18–20	F	155 cm	no skull
3	30–40	M	176 cm	rocker jaw
4	35 (23–39)	M	170 cm	rocker (?) jaw
5	30	M	174 cm	no skull
6	30–35	M	180 cm	not rocker jaw
7	mature adult	M	173 cm	skull fragments
8	*c.* 35 (25+)	M	172 cm	no skull

Source: Pietrusewsky 1989: Appendix B, Table 1, see also Houghton 1989: Appendix A.

Various statements (none of them well supported because of small sample size) have appeared about the relationships of the few known examples of Lapita skeletal material to various populations in the Pacific. Houghton (1980: 71) assessed the Lakeba skeleton from the Lau Group in Fiji as very Polynesian in physical form, as did Spennemann (1987: 301) the individual from To.1 in Tonga. Pietrusewsky (1985: 394) found a 'loose' association between the mandible from Natunuku, Fiji and that from Lakeba, but concluded that it tended to resemble various samples of Island Melanesian origin more than any from Polynesia (Pietrusewsky 1985: 398, 401). Finally, a small and miscellaneous collection of skeletal fragments and often isolated dental remains from Lapita sites in the Mussau Islands was tentatively judged to show these people had slightly closer affinities with Indonesian than Melanesian populations (Kirch *et al.* 1989).

In this context, the sample of eight individuals from SAC is important as more representative of a single population. It provides fuller data on skeletal and dental characteristics than anything previously available. However, its chronological position toward the end of the Lapita sequence, some 40 generations (or 1000 years) after the Lapita cultural complex first appeared in the Bismarck Archipelago 3500 years ago, must also be taken into account in any assessment of biological relationships to other populations. In this light, Houghton's conclusion (1989: 229) that the Watom population may represent a type of palaeopopulation in the Melanesia region from which the Polynesian population may be derived through the effects of small sample size and selection is an important contribution. Visser (1994) found the Watom population to be very like both the Sigatoka burial mound population of similar age and the Fijian Natunuku skeleton (now also dated to this time period, Davidson and Leach 1993). Also, they are equally like variously dated Polynesian skeletal collections and the single Lapita skeletons from Lakeba and Tonga.

Pietrusewsky (1989: 244) was more cautious, stating that:

> Limited univariate comparisons indicate morphological similarities (e.g. rocker jaw, tall stature, costo-clavicular sulci etc.) between Watom and Lapita people and other inhabitants of the Pacific and Polynesia but further reveal a number of biological

> differences such as small teeth, slender lower long limb bones and short broad mandibles which are generally not found in Pacific Islanders. Multivariate analyses, using mandibular measurements, generally separate the Watom and Lapita mandibles from other Pacific and Asian groups but hint of a possible biological connection with eastern Melanesian (and possibly Polynesian) populations.

Lastly, Turner (1989: 296)) found that the teeth of the SAC mandibles were not very different from those of some present day New Britain populations.

Burial Practices

The layout of the SAC burial ground has been discussed above and by Green *et al.* (1989). Besides the stone alignment forming a boundary wall along the eastern side of rectangles I and III, we have provisionally identified what may be another wall parallel to it just inland of burials 6, 7, and 8. It seems likely that the intact alignment, the rock pile, and other odd

Figure 10: Close-up view of burial 6 at SAC, which consisted of a nearly complete skeleton, lying in a seated flexed position on its back, shoulders to the south. The skull, however, had dropped forward to the north. Photograph by Dimitri Anson.

stones at this stratigraphic level were all once part of a small enclosure, with its seaward and inland borders parallel to the former beachline.

As is evident in Figure 8, inhumation in a shallow round-to-oval pit was the normal practice, the exception being burial 1, which was without a pit. This may be significant as it was the one skeleton laid out in a fully extended supine position. A slab of igneous rock was placed where the skull should have been. All the other inhumations were in pit features of a size suited to placement of the body either in a flexed position or as a bundle. Three burials, 3, 4, and 6, were definitely flexed. This could also have been the case with 7, 8, and perhaps 2 (Green *et al.* 1989), where the degree of articulation of at least some of the bones seems to exclude bundle burial. The greatly disturbed burial 5 may have been a bundle burial, but this does not seem likely in the light of other evidence. A preferred placement of the body with the head to the west (even where missing) is indicated by burials 1, 3, 4, and probably 7. In the case of burial 6, it would appear the torso lay to the south and the head had tipped forward (Fig. 10).

The burial ground at SAC is the first to be found in a Lapita site. Previously, only three individual Lapita burials were known from Fiji/West Polynesia (Green *et al.* 1989). Taken together, these and the Watom data make it possible to affirm that one of the common inhumation practices in a Lapita site was burial within a pit, often with the head toward the west. This was the practice at SAC between 300 and 100 BC, where a distinct burial ground marked by low boundary walls was situated for a time in part of a large Lapita settlement. The grave pits contained no obvious burial goods. Three, however, contained seemingly associated volcanic stones. The shank of a shell fishhook in burial 4 could be an exception. Pots were not funerary items.

Dietary Results

An unresolved question about the Lapita economy has been the degree to which horticultural and other land-based resources (meat) were important compared with those of marine origin. The difficulty has been in estimating the proportion of the various components, particularly the vegetable component, for which there has been at best only indirect evidence, in contrast to meat (pig, chicken, a few birds) and the marine portion (fish and shellfish), for all of which there is direct evidence (Horwood 1988: 8–38, and especially pp. 79–82 for Watom). Trace element and isotope analysis of the human bones from Watom may provide a better quantitative assessment of the different food components (meat/vegetable and terrestrial/marine) than is possible from the excavated evidence (see below) alone (Horwood 1988: 82). Although this approach is fraught with difficulties, especially of diagenesis and in the interpretation of raw results (Horwood 1988: 41–49; Sillen *et al.* 1989), some tentative conclusions have been reached which are useful in evaluating the economic data presented below.

Neither Evans (1987, 1989) nor Turner (1989) found any evidence of dental caries, though the number of teeth examined was so small that interpretation must be limited to the suggestion that diet was probably healthy. Trace element analysis of bones from eight Watom skeletons by Horwood (1988: 91, and Tables 13 and 27), using ribs from each individual and a femur from burial 8, with two bird bones as controls, proved to be a better indicator. Horwood's (1988: 81, 102) legitimate concern about the effects of diagenesis at Watom may be overdrawn; she is wrong in asserting that the bones were subject to continual stream flooding as at SAD, and therefore suffered from the known consequences of exposure to groundwater. However, her concern over the elevation of strontium through contamination by sea water may be quite valid. On the other hand, the bones derive from an environment that would probably have reduced the effects of diagenesis. As she says of the Namu burial ground, where the soil environment is coral gravel in which alkaline conditions prevail, "Diagenetic change is therefore unlikely to be a problem for this group" (Horwood 1988: 100). This would be also true of layer C2 and zone D at SAC. An alkaline situation is also supported by the fact that seawater at 25°C has a pH value in the range of 7.2 to 8.3 (MacKenzie 1979 (13): 479).

After assessing all the variables and normalising the data, Horwood (1988: 138) concluded that the relatively low zinc value combined with the high normalised strontium value of the Watom samples can be interpreted as indicating that this population ate more vegetable foods than meat. Moreover, in combination, the three trace elements, zinc, strontium, and especially the low magnesium values, suggest that foods from the marine environment were not as important as those from terrestrial sources. It seems that the diet of the Watom people, like that of people from the Namu burial ground in the Duff Islands, Temotu Province, Solomon Islands, was predominantly terrestrial.

More detailed support for this viewpoint was furnished by ^{15}N, ^{13}C and ^{34}S stable isotope analysis. In this case, Quinn (1988) sampled rib bones of six burials from SAC: 1, 3, 4, 5, 6, and 7. Her results were combined with those of a number of colleagues (Leach *et al.* 2000) in order to model more closely the dietary conclusions based on trace element analysis. This provided estimates that about 64% of the diet was land-based and 36% came from the sea. The sea portion was divided into three parts: shellfish (8.7%), coral reef fish (6%) and non reef fish (21.3%). Plants contributed 53.3% of the land portion (2.7% of which followed C4 and 50.6% C3 pathways). Land herbivores provided the remaining 10.7% of the diet.

ECONOMIC ASPECTS

As noted above, there is a long standing debate about the Lapita economy (Groube 1971; Green 1979, 1982; Best 1984; Kirch 1997). Most have favoured a generalised mixed economy rather than a specialised 'strandlooper' one. One recent summary (Gosden *et al.* 1989: 573) notes that the evidence for marine exploitation is now impressive, reflecting mainly inshore fishing, but also the taking of benthic and pelagic fish. The evidence for arboriculture, too, has recently been greatly improved (Gosden *et al.* 1989: 573, 574; Kirch 1997: 203–10). Additional evidence has been forthcoming about the terrestrial meat portion of the diet, especially in the form of domesticated animals such as the pig, plus a range of other animals and a few birds. Thus the current view is "that subsistence during the Lapita period was based around horticulture, together with marine exploitation"... so "that these long lasting settlements had secure supplies of food" (Gosden *et al.* 1989: 573).

The SAC data provide further supporting evidence for both terrestrial meat and marine components in the diet. Evidence for the terrestrial plant portion, whether arboricultural or vegetable, is indirect. Pig bones, which are usually interpreted as one basis for inferring the latter, are present. Stone or shell tools assumed to have been used for vegetable processing are lacking, although the adzes could have been used in garden clearance.

The data on terrestrial and other marine fauna presented in detail by Smith (2000) may be briefly summarised here. Pig husbandry rather than the hunting of feral animals constituted the most demonstrably important food source. This implies the availability of largely domesticated plant foods in sufficient abundance to feed both pigs and people. On the other hand, only a few wild animals (bandicoot), a few unidentified birds and a reptile are represented. Although these data provide no means of quantifying the plant, domesticated and wild meat components of the diet, they do lend support to the reconstruction by Leach *et al.*, summarised above, of a significant plant food component. Some of this was converted to domesticated and wild meat supplies by raising pigs and perhaps chickens and killing various wild land herbivores.

In addition to the few examples of marine turtle identified by Smith, there are also some crab fragments, which may be either a land or marine type. Land crabs are not active in this locality today, in contrast to SAD (Specht 1985). If these fragments are land crab remains, it is likely they are ancient but they could have been intrusive from a time of higher sea levels. The principle items of marine fauna in layers C1 and C2 are fishbone and marine shells. The latter are restricted to layer C2 except for a few examples of large, partially dissolved Tridacna shells at the base of layer C1 and rare examples of Nerita, topshell and Conus.

Fishbone

The fishbone was analysed by Michiko Intoh at the University of Otago archaeological laboratories. Bones were identified using five paired cranial elements and several 'special' bones which are diagnostic of certain species or families of fish. The methodology employed was that of Leach (1986).

TABLE 2
Identified fishbones by element from SAC
See Table 3 for abbreviations

Element	**Sc**	**Bo**	**Mo**	**Ep**	**Lu**	**La**	**Pl**	**Ne**	**Ch**	**Ra**	**Total**
LD	2	4	3	-	-	-	-	-	-	-	9
RD	3	1	2	1	-	-	1	-	-	-	8
LP	-	-	1	1	-	-	-	-	-	-	2
RP	3	1	1	-	-	-	-	-	-	-	5
LQ	-	-	-	1	1	-	-	-	-	-	2
RQ	-	-	-	-	1	-	-	-	-	-	1
SPC	4	-	-	-	-	-	-	-	-	-	4
IPC	9	-	-	-	-	2	-	-	-	-	11
VER	-	-	-	-	-	-	-	-	3	-	3
DCL	-	-	-	-	-	-	-	-	-	[1]	1
SPI	-	-	-	-	-	-	-	[1]	-	-	1
NISP	**21**	**6**	**7**	**3**	**2**	**2**	**1**	**[1]**	**3**	**[1]**	**47**
NIE	**5**	**3**	**4**	**3**	**2**	**1**	**1**	**[1]**	**1**	**[1]**	**22**

LD = Left dentary, RD = Right dentary, LP = Left Premaxilla, RP = Right Premaxilla, LQ = Left Quadrate, RQ = Right Quadrate, SPC = Superior Pharyngeal Cluster, IPC = Inferior Pharyngeal Cluster, VER = Vertebra, DCL = Denticle, SPI = Spine, NISP = Number of Identified Specimens, NIE = Number of Identified Elements, [] Identification not certain

TABLE 3

Minimum Numbers and Percentages of Identified Fish from SAC

Family or species and common name	**Layer C1**		**Layer C2**	
Scaridae, parrotfishes	**11**	**57.9%**	**2**	**22.3%**
general (Sc), parrotfishes	8 (IPC)	42.1%	1(IPC)	11.1%
cf. *Bolbometapon* spp. (Bo) Two colour, double headed parrotfish	3 (LD)	15.8%	1 (LD)	11.1%
Nemipteridae (Sparidae, now Lethrinidae) porgies, sea bream	**3**	**15.8%**	**2**	22.3%
general (Ne), sea bream	1 (SPI)	5.3%	-	-
cf. *Monotaxis grandoculis* (Mo) large eyed sea bream (tropical porgie)	2 (LD)	10.5%	2 (RD)	22.3%
Serranidae, sea basses and gropers	**1**	**5.3%**	**2**	**22.3%**
cf. *Epinephelus/Cephalopholis* spp. (Ep) sea bass and groper	1 (LQ)	5.3%	1 (RD)	11.1%
cf. *Plectropomus* spp. (Pl), coral trout	-	-	1 (RD)	11.1%
Labridae (La), wrasses, rainbowfish	**1 (IPC)**	**5.3%**	**1 (IPC)**	**11.1%**
Lutjanidae (Lu), snappers, sea perch	**1 (LQ)**	**5.3%**	**1 (RQ)**	**11.1%**
Chondrichthyes, cartilaginous fish (Ch)	**2**	**10.5%**	**1**	**11.1%**
general cartilaginous fish	1 (VER)	5.3%	1 (VER)	11.1%
cf. Rajidae (Ra), skates	1 (DCL)	5.3%	-	-
Total	**19**	**100%**	**9**	**100%**

Note: for element abbreviations see Table 2

Although the taxonomy used by Intoh followed that of Munro (1967), we have used the more recent nomenclature and arrangement of Migdalski and Fichter (1976: 13–16), as in Green (1986: Table 8.2). The results are given in Tables 2 and 3. The number of identified specimens (NISP) from rectangles III and IV is 47, too small for anything beyond a few general observations. Specht (1968) recorded but has not provided further identifications of fishbone from rectangles I and II.

Intoh used the distribution of bone by spit to calculate minimum numbers of 32 and 14 fish for layers C1 and C2 respectively, whereas we have chosen to ignore spits, squares or groups of squares and bone size, using only the more certain division between layer C1 and C2. This has reduced the minimum numbers to 19 and 9, based on the most frequent element for any one category in that layer (Table 3). The distribution of fishbones in rectangles III and IV exhibited no patterning; they were widely scattered.

As Table 2 shows, the identifications of scarids (including Bolbometapon), *Monotaxis grandoculis* and epinephelids are well based, the remainder are less securely based and the identification of rajids is uncertain. Using NISP values, 93% of the total collection is made up of scarids (59.6%), nemipterids (17.0%), serranids (8.5%) and chondrichthyes (8.5%). This accords well with the MNI values for layer C1 where 90% of the individuals are also scarids (57.9%), nemipterids (15.8%), serranids (5.3%) and chrondrichthyes (10.5%). Layer C2, with its very small numbers, differs in having fewer scarids (22.3%) and more serranids (22.3%).

The low ratio of cod-groper to parrotfish indicates that more time was spent in shallow water and coral reef fishing than in benthic fishing. More than 85.1% (by NISP) of the assemblage is from moderate depth species such as scarids, nemipterids, labrids and lutjanids. No pelagic species are present.

These limited data tend to support the earlier findings of Green (1986: 129–32), Kirch (1988a: 336) and Gosden *et al.* (1989: 573) that Lapita fishing was predominantly inshore on and about coral reefs and, in this case as in others, favoured families such as scarids, nemipterids and serranids (cf. Green 1986: Table 8.2), with the occasional shark or skate. Here fishing for scarids and labrids would have been primarily by netting. Non reef fishing, with some use of baited hooks (only one example of which was found), is supported by the sea bream, sea basses, snappers and a shark. In this respect, the fishbone favours a concentration on reef and inshore fish which the human bone stable isotope dietary reconstruction suggests was biased towards the inshore non reef fish.

Shellfish

As reported above, because marine shells appeared only rarely in layer C1, it did not seem feasible to collect a sample for analysis. This was a good decision. As we now know from the loss of shell temper in the layer C1 sherds (see below and Dickinson 2000), shells have probably also been largely leached from this soil horizon by later taphonomic processes. This was clearly not the case in layer C2, where a different problem occurred, namely that the sand beach deposit which formed the layer already contained pieces of marine shell. Distinguishing food shell debris from shell of natural origin is an old and familiar problem.

Our solution, given that bagging and transport of large samples also presented problems, was to collect all shell items which appeared to represent food debris (plus inevitably some that did not) from layer C2 in grid row G in rectangle III as a representative set of sub-samples. This provided two shell samples from each of squares 12 to 15, one from spit 1 (0–10 cm) and one from spit 2 (10–20 cm) and an additional sample from the fill of a pit feature. In the analysis, we looked for differences between the upper and lower spits (because, for example, more natural beach shell may have been included in the lower spit samples) as well as between the squares.

The process of separating food shells from those of natural origin was carried out in the field using buckets of sea water. We retained all the intact or mostly intact shells which the workmen considered edible, and discarded all the smaller broken bits and those which were so badly worn that they could be interpreted as dead when deposited. Thus shells which broke more easily or were of a size or kind that workmen regarded as inedible may be under represented. But we feel that we have identified the major food shells and gained an idea of the habitats that were being exploited. The sample is inadequate for detailed calculations of predation or food value, although it probably reflects the less than 9% contribution shellfish made to the occupants' economy according to the stable isotope analysis of human bone.

The shellfish were cleaned, identified, counted and compiled into Table 4 by Elizabeth Pascal, using the Oceanic archaeologically-based reference collection in the Department of

Anthropology at the University of Auckland. The model of ordering the data followed that established by Swadling (1986) for shellfish from the Reef/Santa Cruz Lapita sites. In cleaning the shell it seemed to Pascal "that shells from spit 1 of layer C2, apart from the occasional badly worn individual that could be interpreted as dead when collected, were in better condition and less worm eaten than those in spit 2. But a spot comparison between the spits of similar sized individuals of the same species from the same squares, did not confirm the impression". In general, processing in the field seemed to have been fairly successful in removing the water worn and broken beach shells and retaining those of obvious food value. Moreover, the range is not restricted to the 12 genera listed by Meyer (Anson 2000a), of which all except *Chama* spp. are present, but is far wider and not greatly different from that provided by Swadling (1986: Table 9.2) for the three Reef/Santa Cruz Lapita sites.

TABLE 4
Shellfish identified in the sample from SAC
p = present but quantity unknown

I. Filter feeding and algal symbiotic bivalves

	Spit 1				Spit 2				
Taxon	G12	G13	G14	G15	Feat.	G12	G13	G14	G15
ARCIDAE									
Anadara antiquata	4	3	-	3	1	1	4	1	-
Arca sp.	-	1	-	-	-	-	1	-	-
CARDIIDAE									
Laevicardium elongatum	-	1	-	-	-	-	-	-	-
Cardium sp.	-	-	-	-	-	-	1	-	-
PSAMMOBIIDAE									
Asaphis violascens	1	-	p	-	-	-	2	-	-
SPONDYLIDAE									
Spondylus ducalis	1	3	1+	1	-	-	1	-	3
TRIDACNIDAE									
Hippopus hippopus	-	-	-	1	1	-	-	-	-
Tridacna maxima	-	p	-	-	1	-	-	-	1
Tridacna sp.	-	-	-	1	-	-	-	-	-
VENERIDAE									
Atachtodea striata	-	1	1	-	-	-	3	-	-
Atachtodea sp.	2	-	-	-	-	-	-	-	-
Gafrarium sp.	-	1	1	-	-	-	-	-	-
Notocallista sp.	-	-	-	-	-	-	-	1	-
MINIMUM TOTAL	8	11	5	6	3	1	13	1	4
No. SPECIES	4	7	4	4	3	1	7	1	2

TABLE 4 Continued

II. Browsing molluscs (Gastropods)

	Spit 1				Spit 2				
Taxon	G12	G13	G14	G15	Feat.	G12	G13	G14	G15
BULLIDAE									
Bulla sp.	-	-	-	1	-	-	-	-	-
BULIMULIDAE									
Placostylus sp.	-	-	-	1	-	-	-	-	-
CERITHIIDAE									
Cerithium nodulosum	-	1+	2	1	-	-	1	-	1+
Cerithium sp.	2	-	-	-	-	-	-	-	-
Terebralia sp.	1	-	-	-	-	-	-	-	-
CYPRAEIDAE									
Cypraea argus	1	-	-	-	-	-	-	-	-
Cypraea tigris	-	1	-	-	-	-	-	-	p
Cypraea sp.	-	-	1	-	-	-	-	-	p
ELLOBIIDAE									
Pythia scarabaeus	-	1	-	1	-	-	-	-	-
NERITIDAE									
Nerita albicilla	2	-	-	-	-	-	-	-	1
Nerita polita	-	-	-	1	-	1	-	-	1
Nerita undata	-	-	1	-	-	-	-	-	-
Nerita sp.	-	-	2	-	-	-	1	-	-
PATELLIDAE									
Patella flexuosa	1	-	-	-	-	-	-	-	-
STROMBIDAE									
Lambis lambis	-	1+	-	-	-	-	1	-	1
Lambis truncata	-	-	-	1+	-	-	-	-	-
Lambis sp.	1	-	p	-	-	-	-	-	-
Strombus canarium	-	-	-	1	-	-	-	-	-
Strombus lentiginosus	1	-	1	p	-	-	-	-	-
Strombus luhuanus	-	1	1	1	-	-	1	-	-
Strombus sp.	1	1+	1+	-	-	-	-	-	p
TROCHIDAE									
Angaria delphinus	-	2	-	1	1	-	-	-	-
Tectus pyramis	-	-	1	p	1	-	-	-	1
Trochus histrio	p	-	-	1	-	1	-	-	-
Trochus maculatus	p	1	p	-	-	-	1	1	-
Trochus niloticus	2+	5+	p	p	2	-	2	1	1+
TURBINIDAE									
Turbo argyrostomus	2+	2+	3+	1+	1	1	1	3	2+
Turbo chrysostomus	5	8+	4+	4+	1	2	5	3	5
Turbo crassum	-	-	-	1	-	-	-	-	-
Turbo setosus	-	-	-	-	1	-	-	-	-
Turbo sp.	2	-	2	2+	-	1	-	-	1
MINIMUM TOTAL	25	30	24	24	7	6	13	8	20+
No. SPECIES	14	11	13	16	6	5	8	4	12

TABLE 4 Continued

III. Predatory and scavenging molluscs (Gastropods)

	Spit 1				Spit 2				
Taxon	G12	G13	G14	G15	Feat.	G12	G13	G14	G15
CONACEAE									
Duplicaria sp.	-	1	-	-	-	-	-	-	-
CONIDAE									
Conus bullatus	-	1	-	-	-	-	-	-	-
Conus leopardis	-	1	-	-	-	-	-	-	-
Conus marchionatus	-	-	-	-	-	1	-	-	-
Conus marmoreus	1+	-	-	1	-	2	-	-	-
Conus rattis	-	-	-	-	-	1	-	-	-
Conus sp.	-	p	1	-	-	-	-	-	p
Gastridium geographis	-	-	-	-	-	-	1	-	-
FASCIOLARIIDAE									
Fasciolaria sp.	-	-	1	-	-	-	-	-	-
Latiris smaragdulus	-	1+	-	-	-	-	-	-	-
MURICIDAE									
Thais tuberosa	-	-	1	-	-	-	-	-	-
Thais sp.	-	1+	-	-	-	-	-	1	-
TURBINELLIDAE									
Vasum ceramicum	p	1+	-	1	-	-	-	-	p
Vasum turbinellus	-	-	-	-	-	-	-	1	-
MINIMUM TOTAL	3	10	3	2	0	4	1	2	2+
No. SPECIES	2	7	3	2	0	3	1	2	2
IV. Total All Categories Combined									
MNI	33	51	32	32	10	11	27	11	28
No. SPECIES	20	23	18	22	9	8	16	7	14

In Table 4, the number of individuals has been given where possible. Where there were both whole individuals and broken shell the number has been given as 3+, i.e., more than three whole individuals. Where there was only broken shell and it was impossible to tell the number, the species has just been checked as present. In totalling up numbers of individuals, checks as present have been counted as 1, and 1+ as 2 individuals, etc. Swadling's (1986) three principal habitat categories have been used. A species identified to genus is only counted as a species if no other species in that particular genus has been identified.

At least eleven filter feeding and symbiotic bivalves are represented, 25 browsing molluscs, and 12 predatory and scavenging molluscs (Table 5B). The proportions of species by number in the three habitat categories, 22.9%, 52.1%, and 25.0%, are virtually the same for bivalves (21.6%), higher for browsing molluscs (66.4%), and lower for predatory and scavenging molluscs (12.0%) when based on individual specimens. This reflects a generally diverse and opportunistic strategy of collection with only a mild concentration on two Turbo species. The same lack of concentration on the cropping of particular shellfish is reflected in the amount of shellfish recovered from this so called 'midden' layer. The 226 individuals in the 2.0 m^3 sample yield an average concentration index of 113 shellfish per cubic metre for layer C2. Even by doubling this to allow for fragmented individuals not sampled, it remains an exceptionally low figure. In fact square G-13, which had the highest shell concentration of any square, only reached a figure of 156 individuals per cubic metre. As Pascal remarked, the collection does not give the impression of "an organised, consistent, and methodical exploitation of a vital resource..., but of a sporadic and inefficient harvesting by individuals".

TABLE 5

Shellfish from SAC according to Principal Habitat Categories

A. Numbers of individuals and percentages by square

Spit 1

Cat.	G12	G13	G14	G15	Total
I	8 (22.2)	11 (21.6)	5 (15.6)	6 (18.8)	30 (19.9)
II	25 (69.4)	30 (58.8)	24 (75.0)	24 (75.5)	103 (68.2)
III	3 (8.3)	10 (19.6)	3 (9.4)	2 (6.3)	18 (11.9)
total	36 (23.8)	51 (33.8)	32 (21.2)	32 (21.2)	151 (100)

Spit 2

Cat.	G12	G13	G14	G15	Total
I	1 (9.1)	13 (48.1)	1 (9.1)	4 (15.4)	19 (25.3)
II	6 (54.5)	13 (48.1)	8 (72.7)	20 (76.9)	47 (62.7)
III	4 (36.4)	1 (3.8)	2 (18.2)	2 (7.7)	9 (12.0)
Total	11 (14.7)	27 (36.0)	11 (14.7)	26 (34.6)	75 (100)

B. Totals in categories by individuals and species

Category	No. of individuals	Percentage	No. of species	Percentage
I	49	21.6	11	22.9
II	150	66.4	25	52.1
III	27	12.0	12	25.0
Total	226	100.0	48	100.0

I = filter-feeding and symbiotic bivalves
II = Browsing molluscs
III = Predatory and scavenging molluscs

This exploitation of shellfish focused in the main on browsing gastropods, with less than a quarter of the sample reflecting the taking of filter feeding and algal symbiotic bivalves, and half of that again the use of predatory and scavenging molluscs. Twice as much of the sample came from spit 1 as spit 2, but the two spits in general are, as expected, very similar in their composition. In spit 1, variation between squares from the averages for any category was small and quite within the expectation of sample variation; figures for individual squares in spit 2 show wider deviations from the averages in several cases, but all but one are in the low frequency bivalve, predatory, and scavenging categories, and when averaged together conform to the general norms (Table 5A). Hence no significant patterning is exhibited along the G row, which as far as we could judge was typical of layer C2 throughout the area opened at SAC. Rather, the change was from few remains of food shellfish at the base of layer C2 to more at the top of it, falling away to very little in layer C1. It seems likely that most of the shells once present in layer C1 were highly fragmented by gardening activity and then dissolved away during the formation of a mature soil horizon. Thus only occasional pieces of various species noted above and a few large Tridacna shells remained.

TABLE 6

Habitat preferences of shellfish from layer C2, SAC,
based on species which form 2% or more of sample derived from
counts of individuals (as per data in Table 4).

Spit	1	2
Intertidal areas of seaweeds or weedcovered rocks on coral reefs	%	%
Nerita spp.	4.0	2.0
Angaria delphinus	2.0	x
Trochus niloticus	7.3	9.3
Tectus pyramis	x	2.7
Trochus maculatus	2.0	2.7
Turbo argyrostomus	8.0	12.0
Turbo chrysostomus	15.2	21.3
Cerithium nodulosum	3.3	4.0
Cypraea spp.	2.0	2.7
Intertidal sand and coral rubble area of coral reef		
Conus marmoreus	2.0	2.7
Vasum ceramicum	2.0	–
Intertidal sandy areas on coral reef		
Anadara antiquata	6.6	9.3
Intertidal areas of rock, dead coral, or mangrove trunks		
Spondylus ducalis	4.6	5.3
Sand patches on coral reefs		
Strombus luhuanus	2.0	x
Strombus lentiginosus	2.0	–
Sand or mud flats or in sand patches on rocky or coral reefs		
Lambis lambis	x	2.7
Muddy sand on reef platform		
Asaphis violascens	x	2.7
Portion of total sample	63	79.4

x present at less than 2%, i.e. <3 specimens in spit 1 or <2 specimens in spit 2
– not present

The environment from which the shellfish were collected is fairly strongly indicated by the species which form 2% or more of the sample on the basis of individual numbers (Table 6). These form 63% and 79.4% of the total, and are not in any important way contradicted by the remaining identified individuals, which are either present in numbers comprising one or two shells of related species or in shell fragments which could not be assigned to particular species. The majority of the collection is from the intertidal zone and focuses on seaward-covered parts of a coral reef with occasional patches of sand. This reflects the fringing reefs still present today in the Reber-Rakival area. It also ties in well with the emphasis on inshore fishing.

SUMMARY

It is apparent from the direct economic evidence that exploitation of marine resources, such as turtle, fish and shellfish, was an important but not primary component of the subsistence strategy. They do not support, as Swadling (1986: 145–46) also demonstrated with the Reef/Santa Cruz Lapita sites, a strandlooper hypothesis for the Lapita economy. In contrast, as Smith (2000) shows, pigs constituted an important protein (and fat) meat component. What is missing entirely, of course, is any direct evidence for the major terrestrial plant portion of the diet, both from arboriculture and domesticated vegetables. The pig allows us to infer the existence of the latter and assign major importance to it, but it is at present only through the study of the chemistry of associated human bone from the SAC burial ground that we can say more positively to what degree this was the case.

PORTABLE ARTEFACTS

ARTEFACTS OTHER THAN OBSIDIAN AND POTTERY

Obsidian pieces and pottery sherds dominated the portable artefacts in zone C and are reviewed in detail below. Less numerous items reflective of the Lapita cultural complex included stone adzes, flakes from their use, abrading rocks, hammerstones, red ochre nodules, chert flakes, and a range of shell objects including a fishhook and various arm band pieces. These are described first.

Stone adzes

Four adzes were found, two in layer C1 and two in layer C2 (Fig. 11). A small chisel-ended adze from layer C1 has a planilateral cross-section and is somewhat different in shape from most Lapita adzes (Fig. 11a). The planilateral cross-section, however, is typical of one Lapita adze type, and is exhibited by two other adzes from SAC. The other specimen from layer C1 is the poll end of a small adze, again of planilateral section (Fig. 11b). One of the two adzes from layer C2 is a tiny example of a typical planilateral Lapita adze type (Fig. 11c). Usually such adzes, often in green coloured rock, are 18–20 cm long (Green 1979: Fig. 2.4; Green *et al.* 1988: Figs 1 and 2). This example, which is also greenish in colour, is only 4 cm long. The other adze from layer C2 is made on a blade-like flake with the bulb of percussion and striking platform at the poll end. The back is formed by the flake surface without further modification beyond a very narrow bevel surface ground to form the cutting edge (Fig. 11d). The front is formed by two older flake scars, further modified by secondary flaking from two directions around the thickened poll end. The result is a most unusual form of adze with an irregular triangular cross-section.

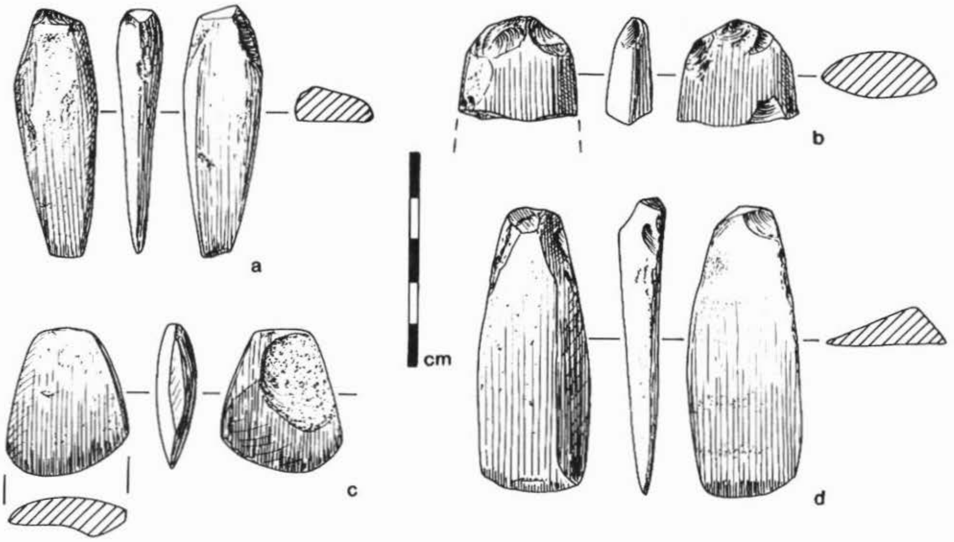

Figure 11: Stone adzes from zone C Lapita contexts at SAC. a, square F15, layer C1; b, square G13, layer C1; c, square E15, layer C2; d, square K12, layer C2.

These four adzes, together with a selection of flakes from stone adzes and similar tools described in the next section and artefacts of the same kind from SDI (Anson 2000b), were examined in hand specimen by Professor Philippa M. Black of the University of Auckland Geology Department. Two principal kinds of rock type can be identified and account for all of the adzes from both SAC and SDI, nearly all of the stone flakes and all but a few of the other items. One rock type is a slightly altered fine-grained basic basalt, often exhibiting augite crystals; the other is a silicified tuff, usually displaying little or no texture, where chloritisation frequently tends to produce a greenish tinge to the surface colour. The chisel-ended adze of Fig.11a, the plano-convex sectioned adze of Fig. 11c and the flake adze of Fig. 11d are all silicified tuffs, as is an adze previously described by Specht. The planilateral-sectioned adze butt of Fig. 11b is one of the basic basalts exhibiting augite crystals. Four of the SAC adze flakes were also identified as clearly silicified tuffs, and one such flake from SDI even had veins of quartz with pyrite shooting through it. A number of the other SAC flakes are derived from rocks assigned to the altered basic basalt category. Some flakes, however, can only be described as having an igneous origin.

Because the flakes occur in such limited numbers, often bear a surface polish on one face showing they come from a finished artefact, and closely match the composition of the adzes, it is evident that only use and perhaps resharpening took place in the localities excavated. This suggests that the adzes were imported in a more or less finished state to the SAC and SDI localities. The bedrock of Watom is (as noted by Dickinson 2000) entirely basalt and basaltic andesite of the Quaternary Rabaul Volcanic series, often exposed as interbedded lavas and scoriaceous breccias. The dense black basic basalts used in some of the adzes, however, do not appear to be examples of such a Quarternary origin, but have been slightly modified hydrothermally and thus lack crisp unaltered minerals, while the silicified tuffs are even more clearly a product of low grade metamorphism and have at times been pervasively altered. The nearest source of such rock types is, as Dickinson (2000: Fig. 1) describes, the Oligocene to mid-Miocene North Baining Intrusive complex on the nearby prong of New Britain's Gazelle Peninsula west of Ataliklikin Bay. Not surprisingly, this also proved to be the likely source of most of the 'exotic to Watom' pottery. The difference is that whereas almost all the adzes were probably imported from this region, only a small number of the pots were.

Two other adzes recovered from Lapita pottery contexts on Watom Island were illustrated by Specht (1973: 448). His initial statement (Specht 1968: 127) that the rare examples of adzes found at the Reber-Rakival site have flattened lenticular cross-sections (what we have here called planilateral) has subsequently been corrected (Specht 1969: 284). One adze, from SAC rectangle I, layer C1, is a seemingly unfinished form in flaked and pecked basalt. It is of a roughly rectangular plan, but exhibits a slight asymmetry to its cutting edge. However, the lateral margin along one side has been fully ground, resulting in a strongly quadrangular cross-section, which Specht (1969: 284 and Fig. XII, 14a) believes was the intended final form. A polished adze fragment, found on the beach surface in front of SAC, was made in a fine-grained green rock. Its colour and generally rectangular section are traits which tentatively associate it with the Lapita pottery horizon. The other polished adze, excavated from SAD, zone 4a, is also rectangular in plan and is made from a mottled green tuff. Its cross-section is ovoid to lenticular, though the back is rather flatter than the front.

Specht (1969: 284–85) observed that these adzes were quite different from those of the later Buka adze tradition; certainly nothing like them had then been found in that region. Instead, he found it useful to compare them with the Lapita adzes found by the Birks at Sigatoka in Fiji, which are typical of the range of adze types found with the Eastern Lapita pottery of the Fiji, Tonga, Samoa region (Green 1971). Nor are they easily related to the later adze forms with oval to lenticular sections, often called the typical 'Melanesian' type, one of which Specht (1969: 285 and Fig. XII, 14d) found on the surface of a site elsewhere on Watom. He did not think his adzes from the pottery contexts at the Reber-Rakival site belonged to this later adze tradition, and neither do we. All of them (both those we found at SAC, and those Specht found at SAC and SAD) fit nicely with those recovered from the pottery levels at SDI (Anson 2000b) and more generally with the range of forms assigned to the Lapita adze kit as set out by Green (1991).

Flakes from adzes and similar tools

Thirteen flakes of exotic origin, four with polished surfaces, were recovered from rectangles III and IV. Eleven of these, three of them polished, are from layer C1, and two, one of them polished, from layer C2. They range from 7 to 40 mm in length, and several carry flake scars or bulbs of percussion. However, none exhibits signs of deliberate secondary usage, giving the impression that they are simply flakes dislodged from stone tools during use. Certainly the polished piece from layer C2 is a chip broken from the cutting edge of the blade of an adze.

Abraders and hammerstones

Specht (1969: Fig XII, 14g) found a quadrangular-sectioned piece of a stone abrader in layer C1 of rectangle I at SAC and may also have found some hammerstones. We found (and retained) a hammerstone pebble, 50 x 36 mm, in layer C1 of rectangle III. Five other probable hammerstone pebbles are recorded in our fieldnotes, two from layer C1 and three from layer C2. A worked piece of pumice from layer C1 was also recorded. In addition, we found two small nodules of a haematite or red ochre rock with an abraded surface in rectangle III, one in layer C1 and one in layer C2.

Siliceous flakes

The siliceous flakes and cores recovered from rectangles III and IV are mostly cherts. They range in colour from red through brown and tan to grey, although a few exhibit an opaque milky white or translucent white surface hue. All but one are from layer C1. The piece from layer C2 and two of those from layer C1 have signs of use-wear fractures on a few of their flake edges. Two of the pieces are small exhausted cores, 40 and 27 mm long. The flakes range from 12 to 37 mm. Although these materials are clearly exotic to Watom Island, their source, probably in New Britain, is at present unknown. These silicates had relatively little importance compared with obsidian, which was imported in bulk, although cherts are often a common component of Lapita sites as well as sites of earlier and later ages (Sheppard 1996).

Shell artefacts

Shell artefacts, if present, did not survive in layer C1. The shank leg of a Trochus shell one-piece fishhook from burial pit 4 of square I-J-11, layer C2, rectangle I, could possibly have been associated with the person placed in that grave, perhaps as a personal ornament or offering. The main line attachment of this fishhook is a little knob at the top of the shank (Fig. 12a) but the snooding itself may have extended down to the notch incised in the shank. Specht also recovered the head of a simple Trochus shell hook from an undisturbed pottery level in trench I of locality SAB (site 7) (Specht 1969: 291–92 and Fig XII, 14m). This specimen has a long backward-projecting lashing device with a knob and two lashing grooves. The whole device has been joined at a right angle to the top of the outwardly curved shank leg (Specht 1969: 292). Simple one-piece fishhooks, usually in Trochus shell, are now a well established artefact form in Lapita assemblages, though seldom present in any quantity.

A small diameter Tridacna shell arm band was recovered from layer C2 in square F14 (Fig. 12b). An even smaller diameter Conus shell ring was found in the base of oven feature A, layer C2, square G14–15 (Fig. 12c). Finally, another Conus shell ring of similar diameter was found in layer C2 of square H15. It is one of the rather rare examples from Lapita contexts decorated with a series of grooves on the outside surface (Fig. 12d). Specht (1969: 297 and Fig XII, 14i, 1968: 126) found a Tridacna ring with a groove on its exterior surface in zone 4b at SAD. He noted that a contrast with his later Buka sites was "the presence of incomplete Trochus rings and worked Trochus bases in levels undoubtedly associated with the pottery" of sites SAD, SAC, and SAB (Specht 1969: 297–98). He (1968: 126) specifically reports Trochus shell ring fragments of sub-circular cross-section from SAD, zone 4b.

Although the collection of shell artefacts from the pottery-bearing levels of the various localities in the Reber-Rakival site is small, it includes an adze from SDI (Anson 2000b), two simple fish hooks, and Conus, Trochus and Tridacna shell rings of small diameter, with some of the latter decorated on the exterior. None of these items is out of place in a Lapita

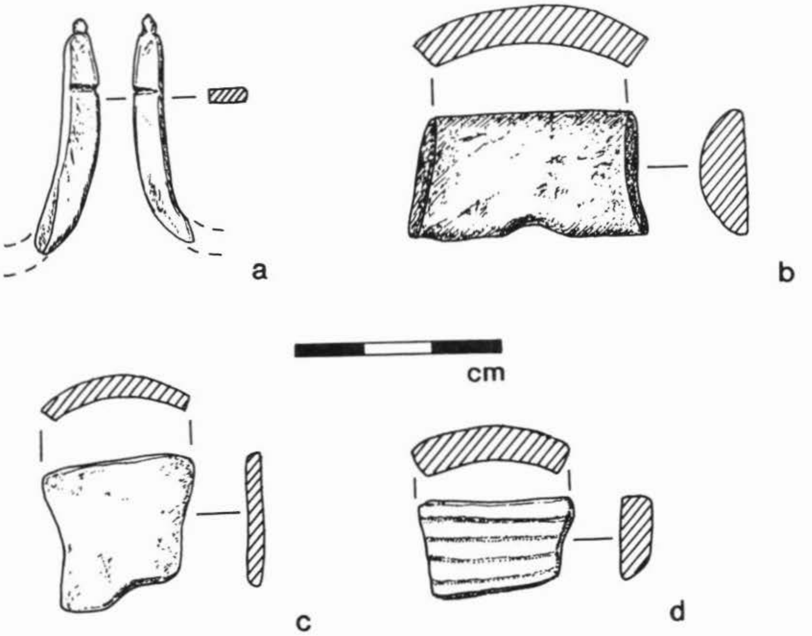

Figure 12: Shell artefacts from layer C2 Lapita contexts at SAC. a, broken Trochus shell fishhook, burial pit 4, square I–J11; b, fragment of Tridacna shell ring, square F14; c, fragment of Conus shell ring, base of oven A Feature, square G14–15; d, fragment of decorated Conus shell ring, square H15.

context; all have been repeatedly found in such sites and are an important aspect of the whole complex. However, unlike some other Lapita sites, this was not one where people engaged in the manufacture of shell items for exchange (Kirch 1988b).

OBSIDIAN ARTEFACTS

Distribution and Technology

Flakes of obsidian (along with some cores) were the most frequent portable artefacts recovered (2478 pieces, Table 7). They were more than four times as numerous as sherds in layer C1 and more than twice as numerous as sherds in layer C2. Their distribution by grid square revealed no concentration in any area, either in layer C1 or layer C2. This suggests there was no specialised activity, involving the use and discard of obsidian, in that part of the SAC locality. The overall pattern may be described as one of fairly uniform disposal of a material which, at that point in its life cycle, was assigned very little value, despite the distances from which some of it had come.

TABLE 7

Distribution of excavated obsidian pieces
from layers C1 and C2 at SAC by density class.

	Layer C1				Layer C2			
Square	**>2.387**	**Int*.**	**<2.3566**	**Tot.**	**>2.387**	**Int.**	**<2.3566**	**Tot.**
E12	20	3	63	86	3	3	3	9
E13	17	3	53	73	2	0	5	7
E14	14	5	64	83	0	0	1	1
E15	13	3	85	101	2	0	3	5
F12	15	5	46	66	9	2	12	23
F13	7	4	43	54	5	0	1	6
F14	9	2	57	68	0	0	0	0
F15	16	2	48	66	1	0	6	7
G12	15	2	54	71	3	1	6	10
G13	18	3	60	81	0	1	1	2
G14	7	3	64	74	3	1	5	9
G15	12	8	47	67	1	1	5	7
H12	16	2	59	77	10	3	7	20
H13	18	2	46	66	3	6	11	20
H14	17	3	43	63	2	3	4	9
H15	15	1	66	82	7	1	7	15
I12	6	0	68	74	1	5	7	13
I13	14	1	82	97	4	3	6	13
I14	12	1	48	61	2	2	3	7
I15	21	0	44	65	1	0	3	4
J10	14	1	68	83	1	2	6	9
J11	17	0	63	80	8	8	8	24
J12	18	2	72	92	7	5	6	18
J13	20	3	67	90	2	0	3	5
K10	12	1	71	84	2	2	3	7
K11	10	3	87	100	5	2	5	12
K12	20	1	91	112	5	1	5	11
K13	19	0	53	72	7	1	9	17
Total	**412**	**64**	**1712**	**2188**	**96**	**53**	**141**	**290**

* Int. (between) is the intermediate category, between the two major density groups of less than 2.3566 and greater than 2.387.

In view of the wholly expedient technology also exhibited by this industry (discussed below), we think the distribution evidence strongly supports a low value utilitarian role at this point in what was probably a more complex commodity value history, with quite different exchange costs during transportation (see below). Sheppard (1993: 135) argued this to be the case for the obsidian in the Reef/Santa Cruz Lapita sites, which was widely distributed in proportion to the general level of activity throughout the excavated portion (154m^2) of a site with several more specific activity focuses (Sheppard and Green 1991: 100). This also seems analogous to its role in the Massim region kula exchange system of ethnographic times. There obsidian (and later glass) was one of numerous raw materials moved by barter, and was a subsidiary 'decorative' item accompanying the formal exchanges of shell valuables and high-ranked axe blades (Green and Bird 1989: 88). Our interpretation is that obsidian was not itself a valuable at SAC, but did have more value as a block or lump of raw material accompanying an exchange event than it did once it was reduced to flakes. It was then used and discarded as an item without further value.

The one significant difference in obsidian distribution at SAC is its greater abundance (some 7.5 times more) in layer C1 (Table 7). This certainly cannot be explained by a greater volume of deposit. It does not seem to be the result of a higher degree of reduction in end flake size, or of subsequent taphonomic processes and breakage that affected some artefacts and ecofacts in layer C1. Those might well be contributing factors, but the difference is probably largely a reflection of the kinds of activities represented by the two layers. Thus we associate the 290 flakes of layer C2 largely with the initial short period of habitation, and not with the later stage when the location served mainly as a burial ground. The larger accumulation of obsidian in layer C1 would represent a much longer period of more sustained generalised activity and continual occupation discard. Subsequent gardening and mixing of the deposit prevents a more precise interpretation of those activities.

Hanslip (1999) examined the SAC obsidian industry as part of a wider ranging study of many western Oceanic obsidian assemblages belonging to this general time horizon. He concluded that the whole collection reflects an extremely expedient technology, i.e., haphazard and opportunistic reduction sequences with little attention to efficient use of materials or controlled end shapes. Most of the pieces proved to be so weathered that informative outcomes from use-wear studies proved to be impossible. This is consistent with the consequences of the taphonomic processes and weathering in layer C1 noted elsewhere in this paper and by Smith (2000). It meant that there were few diagnostic residues, and Hanslip believes most of those present are in fact post-depositional in nature.

Sheppard also examined a sample of 1377 pieces from layers C1 and C2, looking especially for retouched and utilised items. He reported as follows (pers. comm.):

> I was only able to identify two possible gravers (numbers 5686 and 5645) and a small number of utilised flakes. It is very likely that the gravers are fortuitous pieces given the size of the sample. This assemblage is very different from those I have examined from the Reefs/Santa Cruz where retouched and utilised pieces are comparatively numerous. The reduction technology appears to be similar. However, it is my impression that the overall size of the Watom pieces is smaller. I suspect that larger flakes and chunks have been removed from this assemblage and deposited elsewhere. Given the quality of the obsidian and the relative proximity to source I would expect a much higher proportion of large complete flakes. Such size sorting may account for the absence of retouched pieces. Confirmation of the pattern would require quantitative analysis.

Other studies of obsidian technologies associated with Lapita pottery have reached rather similar conclusions. For example, Torrence (1992: 120) characterises the Bitokara Mission (FRL) obsidian assemblages as exhibiting "expedient flake technologies typical of Lapita assemblages at Talasea and elsewhere"; 'elsewhere' here refers to the Reef/Santa Cruz region in particular (Sheppard 1992, 1993). The Phase 3 or Lapita horizon assemblages of the Talasea/Willaumez region exhibit "almost no planning in the stone technology. Flakes are hit from unprepared cores, used on the spot, and then discarded at the same location" (Torrence *et al.* n.d.). Halsey (n.d.), using the same kind of technological analysis and model as Sheppard (1993), found the Makekur obsidian assemblages from a Lapita site on Adwe Island in the Arawe group of West New Britain were "remarkably similar" to those Sheppard had studied from the Reef/Santa Cruz region, despite the much shorter raw material transport distances involved. Finally, Allen (n.d.a) reaches similar conclusions about Lapita obsidian assemblages in the Mussau group.

In summary, the SAC obsidian industry fits at the simplest end of the expedient range in those Lapita assemblages studied to date in sufficient detail to allow controlled comparisons. The SAC raw material may have been imported from a distance as a consistently sought-after item, but it was reduced, used and discarded in a most utilitarian way.

Sourcing

The objective of our sourcing study was to make a reasonable quantitative assessment of the various distant geographic source regions from which the 2478 obsidian artefacts found at SAC had come. We did this using a combination of over-all density-based stratification of the total assemblage and PIXE-PIGME elemental analysis on a set of small samples carefully drawn from it.

The three source regions in question are the Admiralty Islands about 540 km distant by sea, the Talasea group of sources 265 km distant by sea, and the Mopir source group on Cape Hoskins at a distance of 240 km by sea and 30 km inland up-river. A source of volcanic glass close to Rabaul is known (Key 1968; our field notes and samples collected for us) but seems not to have been used. This may be because it was not available 2500 years ago.[5] More recent studies of the geological-eruptive sequence of the Rabaul caldera demonstrate multiple tephra events, some of considerable age (Nairn *et al.* 1995) and it appears likely that chemically, these glassy materials in fact belong to an event of post-Lapita age and the dacites of the 1400-year-old eruption (Nairn, pers. comm. 1998), or were judged technologically inferior to the higher quality rhyolitic glasses actually used, or were not considered a socially approved raw material for exchange. The first is most likely.

This section expands on and refines preliminary interpretations of the SAC obsidian data previously reported (Green and Anson 1991: 177–78). Our approach is based on the premise that "even if sophisticated elemental analysis seems theoretically and procedurally possible, stratified sampling techniques, and a range of methods from the visual, to density, to abbreviated forms of elemental analysis, are going to have to be developed by archaeologists if they wish to achieve a sufficient understanding of the range and frequency of source subgroups within the large cultural assemblages they often recover" (Green 1998: 229). The Lapita Homeland Project provided for PIXE-PIGME elemental analysis of only 158 samples from SAC (Bird and Ambrose 1992; Bird ms), whereas separation by relative density into three categories was feasible for all 2478 obsidian artefacts (Table 7).

The first stage of density analysis showed that while most of the obsidian could be assigned to a category with a value of less than 2.3566, a second category with a value greater than 2.3870 was also well represented in both layers (Table 7). As anticipated, a much smaller part of the collection fell between these two values. At this point, all 290 specimens from layer C2 had been relative density tested, along with a slightly larger

---

[5] Key (1968: 360) says this porphyritic glass "occurs as cobble size lumps in the lower tephra of the last major eruption of the Blanche Bay volcanic complex at Rabaul."

number from layer C1. In the next stage, a carefully selected sample of 128 artefacts was run through the PIXE-PIGME system. The samples represented 26.9% (78 specimens) of the obsidian artefacts from Layer C2 and 30 specimens from layer C1, spit 2. As expected on the basis of previous experience with PIXE-PIGME studies, the greater than 2.3870 category proved to be wholly from the Admiralty regional sources and the less than 2.3566 category contained flakes deriving from both the Talasea and Mopir regional sources. Also as expected, the smaller intermediate category displayed more variable regional source and subsource outcomes.

TABLE 8

Sourcing data on 290 obsidian specimens from layer C2 at SAC

A. Source allocations for a density-stratified sample of 78 specimens determined by PIXE-PIGME analysis (Bird and Ambrose 1992).

	Density		
Source	**>2.3870**	**Between**	**<2.3566**
Admiralty Source Region			
Lou Island — Umrei	23	1	0
Lou Island — Wekwok	3	7	0
Pam Lin Island	0	1	0
Unallocated (but Admiralty)	2	0	0
New Britain Source Region			
Talasea Group — Kutau/Bao	0	9	20
ZZ (Talasea provenance not proven)	0	3	1
Mopir (Hoskins)	0	1	7
Total	**28**	**22**	**28**

B. Probable specimen numbers by source based on elemental results from Section A[*] when applied to densities of all 290 pieces (estimates assume ZZ is from a Talasea subsource).

Source:	**1**	**2**	**3**	**4**	**5**	**6[**]**	**Total**
<2.3870	106	35	0	0	0	0	141
Between	29	2+	2+	17	2+	0	53
>2.3870	0	0	79	10	0	7	96
Total	**135**	**37+**	**81+**	**27**	**2+**	**7**	**290**
Percent	**46.6**	**12.9**	**28**	**9.3**	**0.8**	**2.4**	

Sources: 1=Talasea, 2=Mopir, 3=Umrei, 4=Wekwok, 5=Pam Lin, 6=Unallocated

[*] For density category <2.3566 the estimation is based on a 19.9% sample, for the intermediate category is 41.5% and for >2.3870 it is 29.2%. Thus sampling is greatest where source estimation numbers are most equivocal.

[**] Unallocated to a particular Admiralties subsource but very likely to be from the Admiralties region.

TABLE 9

Sourcing data on 2188 obsidian specimens from layer C1 AT SAC

A. Source allocations for two density-stratified samples. One consisted of 30 specimens from all three density categories, and the second of 50 specimens from the <2.3566 density category, all from spit 2. Determined by PIXE-PIGME analysis (Bird and Ambrose 1992)

		Density	
Source	**>2.3870**	**Between**	**<2.3566**
Admiralty Source Region			
Lou Island — Umrei	4	0	0
Lou Island — Wekwok	1	0	0
Unallocated (but Admir.)	1	0	0
New Britain Source Region			
Talasea Group — Kutau/Bao	0	7	49
Talasea Group — Gulu	0	-	3
ZZ (Talasea provenance not proven)	0	1	3
Mopir	0	1	10
Total	**6**	**9**	**65**

B. Probable specimen numbers by source based on elemental results from Section A* when applied to densities of all 2188 pieces (estimate assumes ZZ is from a Talasea subsource).

Source:	**1**	**2**	**3**	**4**	**5****	**Total**
<2.3566	1449	263	0	0	0	1712
Between	58	6	0	0	0	64
>2.3870	0	0	275	68+	68+	412
Total	**1507**	**269**	**275**	**68+**	**68+**	**2188**
Percent	**68.9%**	**12.3%**	**12.6%**	**3.1%**	**3.1%**	

Sources: 1=Talasea, 2=Mopir, 3=Umrei, 4=Wekwok, 5=Unallocated

* The sample of 80 specimens out of 2188 is tiny (3.7%), but predicted outcomes are more robust than this figure might seem to indicate because (a) the >2.3870 density category has nearly always proved to be an indicator of an Admiralty region subsource, though proportions between Umrei, Wekwok and Pam Lin are indicative only; (b) the 9 specimens from the between density category in fact represent a 14.1% sample as that category is only 3.0% of the overall total; and (c) the 65 pieces in the <2.3566 density category (3.8% sample of the total in the layer) include a random sample of 50 drawn from spit 2, which contained approximately a third of the specimens from layer C1.

** Unallocated to a particular Admiralties subsource but very likely to be from the Admiralties region.

We then concentrated on completing the density analysis for all spits of layer C1. This showed that the less than 2.3566 category (1712 items) constituted 78.2% of the assemblage from that layer, and the greater than 2.3870 category (412 items) constituted just 18.8%. Only 64 specimens (2.9%) fell in the intermediate category. Clearly, further analysis of this last category would have little effect on overall source proportions, whereas a larger PIXE-PIGME sample of the less than 2.3566 density category from layer C1, spit 2 would allow a much better estimation of the regional sources and subsources in that category. A random sample of a further 50 obsidian artefacts in this category from Layer C1, spit 2 was therefore submitted for analysis.

Stratification of the entire obsidian assemblage from SAC into three relative density categories (Table 7), in combination with a PIXE-PIGME analysis of samples drawn from each category (Tables 8 and 9), provides a basis for discussion of three geographic source regions. Moreover, it permits some evaluation of the particular subsources within each region. Finally, it allows us to specify which regional sources and subsources provided much of the content of the obsidian collection.

The first major source region is the off-shore islands of the Admiralty group. Of the various subsource localities, those on Lou Island clearly stand out. The subsources of Umrei and to a lesser degree Wekwok seem to be definitely represented, but estimations of specific proportions from these two subsources are indicative only (Tables 8 and 9). No great weight should be placed on the relative subsource quantities. The indication that tiny Pam Lin Island, 6 km from Lou, was also very occasionally a subsource of SAC obsidian is supported by its identification once among the 44 obsidian artefacts recently analysed from SDI, using improved conditions and better established elemental values for subsources (Anson 2000b). It has also been identified in a Lapita context in the Mussau group (Allen n.d.b).

We can be reasonably confident that most if not all the SAC obsidian in the greater than 2.3870 relative density category is from the Admiralty Island sources. This is the result for all 39 specimens from the SAC and SDI locations analysed by PIXME-PIGME, and it has been the general experience of all those using the relative density method within the Near Oceanic area (Torrence and Victor 1995; White and Harris 1997; Allen n.d.b). There is little reason to think that significant quantities from other sources are hidden among the 474 SAC pieces with this density not submitted for PIXE-PIGME treatment.

As our analysis shows, however (Table 8), the intermediate density category can contain a few pieces from a lesser used Admiralty region subsource. Moreover, the known density range of the Pam Lin source (2.337 to 2.4055) means that it too may occur in the intermediate category employed in this analysis (as it does at both SAC and SDI) and at the upper end of the less than 2.3566 density range (as it does in the Mussau case, Allen n.d.b). Thus it is not possible at present to make any more precise statement than that obsidian from this particular Admiralty Island subsource is present in the Reber-Rakival site. We still think that our predictions about the proportions of obsidian from the Admiralty source region, based on density results for the entire assemblage (Table 10), are reasonably robust, despite the small number of samples in the relevant density categories able to be analysed by PIXE-PIGME. This is because of the high predictability that the over 2.3870 density class is almost entirely derived from Admiralty region sources and is supported by the PIXE-PIGME finding of only low numbers of Admiralty subsources among the small number of specimens in the intermediate density category.

Similarly plausible sets of predictions can be made for the less than 2.3566 density class, and about the quantitative abundance of the Mopir sources in the SAC assemblages. All of the 130 Reber-Rakival Lapita obsidian artefacts in this density class analysed by PIXE-PIGME (93 from SAC, Tables 8 and 9; 37 from SDI, Anson 2000b) were assigned to either the Talasea or Mopir source regions. The sample of 28 items from layer C2 (Table 8) indicated that 25% are from Mopir and the rest from Talasea. The sample of 65 items from layer C1, spit 2 predicts that about 15.4% or 3 in every 20 from that context derive from the Mopir sources (Table 9). It is recognised that there will be a few items from Mopir sources in the small intermediate density category as well. Still it would appear that the estimated proportion of obsidian artefacts from the Mopir sources in the overall collection (Table 10) is probably not too wide of the mark. Only in one case (ANU 3266) has an initial Mopir source assignment been changed to Talasea (Bird ms). The attribution of obsidian to Mopir has been highly consistent in these analyses, in contrast to the 'non-recognition' of Mopir in many of the earlier PIXE-PIGME analyses.

TABLE 10

Comparisons between obsidian assemblages from SAC and SDI*, indicating changing trends in exchange by source region.

				Source Region	
Site	**Layer**		**Admiralties**	**Talasea Group**	**Mopir**
SDI	C1	Number	1	15	3
		Percent	5.3	78.9	16.8
SDI	C2	Number	3	12	4
		Percent	15.8	63.1	21.1
SAC	C1	Number	412	1507	269
		Percent	18.8	68.9	12.3
SAC	C2	Number	117++	135	37+
		Percent	40.6	46.6	12.8

* 50 flakes from SAD basal layers have also been run (Summerhayes *et al.* 1998: 149 and Table 6.3) and the results are known, but are not currently available for discussion. When they are, it will be interesting to see, in light of the table above, and motifs comparisons of Anson (1998c) that equate SAD decorated sherds most closely with those of SAC layer C2, if the SAD results are also interpreted as being most similar to those of SAC, layer C2.

Finally, it should be noted that the relatively late dating proposed above for the Reber-Rakival Lapita assemblages is in good agreement with the presence in those assemblages of obsidian from Mopir sources. The massive explosion of Mt Witori close to these sources about 3600 years ago (Torrence *et al.* n.d.: Table 1) meant that they were not available for exploitation for a period during the earlier part of the Lapita horizon (what is frequently called Far Western Lapita), though they were again being used in the later part of that horizon, as the Watom and other evidence attests (Summerhayes *et al.* 1998: 150–51).

Elemental analysis of the Talasea group of subsources has been considerably upgraded technologically and in degree of subsource sampling since the PIXE-PIGME results reported here were produced (Bird *et al.* 1997; Torrence *et al.* 1992; Summerhayes *et al.* 1993, 1998). These improvements now make it possible to discriminate with some degree of accuracy between four distinct geochemical groupings in the Talasea region: (1) Mount Kutau/Mount Bao and (2) Mount Gulu, both on the Willaumez peninsula itself, (3) Mount Hamilton on Garua Island and (4) Mount Baki on both Garua and Garala Islands. However, those distinctions cannot be made with confidence in the analyses presented here. The subsource attributions might be better summarised as a large group very likely to be from Kutau/Bao, a lesser group probably also from Kutau/Bao, and a small number of artefacts designated ZZ. The element concentrations of this last group are mostly similar to the Kutao/Bao results, but they exhibit low and somewhat variable Rb as well as high and variable Ca, an unusual combination. Bird (ms: 28) thinks these differences in the ZZ artefacts are likely to have arisen from later surface modifications. Certainly Kutau/Bao stands out as the most likely subsource for obsidian artefacts of this period nearly everywhere (Bird *et al.* 1997: 66). This conclusion is supported by more recent PIXE-PIGME results under improved conditions on samples from the West New Britain region dating to the period 3,500 to 1,500 B.P. In this case, 347 pieces from 18 sites were sourced to Kutau/Bao. Only five from three sites derived from the Gulu subsource, five from one site on Garua Island were from its Baki subsource, and only one from one site was from the Hamilton subsource (Summerhayes *et al.* 1998: Table 6.5). It would therefore appear that at this time Kutau/Bao was to an overwhelming degree the principal subsource for obsidian in the West New Britain area, as it was in the Reef/Santa Cruz Lapita sites of Remote Oceania (Summerhayes *et al.* 1998: Table 6.3 and our sample data based on their information). The same now appears true of PIXE-PIGME sourced obsidian artefacts from SAC and the more recently analysed sample from SDI (Anson 2000b). Under these circumstances, the three SAC flakes attributed to the Gulu subsource (Table 9) and the one variously listed as Kutau/Bao/Garala, or Garua, or Baki must be considered quite sceptically (see Allen n.d.b for a similar comment on Gulu obsidian in the Mussau sites). These four specimens from SAC should be reanalysed if it becomes important to discriminate between Talasea subsources.

It is now possible to return to the main regional source groups—Talasea, Mopir and Admiralties—and construct a temporally ordered comparative listing for the two layers at SAC and the upper two layers at SDI (Table 10). PIXE-PIGME results have also been obtained for SAD but are not yet available for discussion. In our view the data are quite sufficient, as we indicated in our preliminary report, to support a picture of change in the use of two of the three regional source groups over time at the Reber-Rakival Lapita site. The sequence begins with similar quantities of Admiralties and Talasea obsidian (40% plus) at 2400 years BP in SAC layer C2. By about 2200 BP and thereafter, the proportion of Admiralty obsidian (in SAC layer C1, SDI layers C2 and C1) has more than halved, while the amount of Talasea obsidian has risen considerably. A similar trend has been identified in the nearby Lapita sites of the Duke of York Islands, although White and Harris (1997: 104) date it as beginning somewhat earlier there (after 2800 cal. BP). In contrast, no change of any significance is evident in Mopir obsidian throughout the sequence. It is always a lesser regional source of raw material, though its transport cost is not much greater than that of Talasea. The ever increasing focus on one particular subsource at Talasea and the continuing lack of change in importation of obsidian from the Mopir sources may have a social rather than a purely economic basis.

Taking this observation further, we note that the probably post-Lapita and certainly useable source of porphyritic volcanic glass close to hand in the nearby Rabaul crater region was apparently never exploited, and to date has not appeared among artefacts in any of the collections examined from Near Oceania. Once it became available, technological quality and social considerations could have played a role in its rejection. However, once the Mopir source became available again during the Lapita phase, one might expect it to be represented in similar amounts to Talasea and certainly to occur in greater quantity than material imported from the more distant Admiralty sources. Yet this was not the case except perhaps at the end of the Reber-Rakival Lapita sequence where small sample size makes it particularly difficult to judge (Table 10). As observed now on a number of occasions, social rather than strictly economic factors seem to have been at work during the transport of whole blocks of obsidian as a raw material constituting a highly appropriate and seemingly much sought-after good, though not a status-enhancing valuable (Torrence and Summerhayes 1997; Allen n.d.b). In the words of Summerhayes *et al.* (1998: 153) "local communities chose to obtain ordinary commodities from somewhere else in order to maintain social links with other groups". Distance to source at that stage in the commodity cycle was not a determining factor in the import process.

CERAMIC ARTEFACTS

Pottery was first recovered from SAC by Meyer (Anson 2000a). Specht (1968: 127) found 155 sherds in zone C in rectangles I and II. It is our impression that rectangle II contained fewer sherds per cubic metre than the more inland rectangle I. Certainly the density of sherds increased further inland in rectangles III and IV, excavated in 1985. A total of 656 sherds was found, 525 in layer C1 and 131 in layer C2, raising the number of sherds per cubic metre to 47 (in comparison to about 20 in rectangles I and II). Like Specht's material from SAC and SAD (Specht 1968: 127), most of this (614 sherds) was plain (Table 11). The small size of this first stratified sample of Watom pottery makes it difficult to add much to previous descriptions.

TABLE 11

Numbers and percentages of pottery types recovered from excavations in zone C at SAC

(Dentate = Dentate-stamped; Nail = Nail-impressed; Rel. = Applied-relief).

	Plain	**Brushed**	**Dentate**	**Incised**	**Nail**	**Rel.**
Layer C1	495	4 (0.8%)	17 (3.2%)	6 (1.1%)	3 (0.6%)	0
Layer C2	119	2 (1.5%)	9 (6.9%)	1 (0.8%)	0 (0.0%)	0

The decorated pottery consists of sherds with brushing or striations and dentate-stamped and incised Lapita sherds. Also found in rectangles III and IV were nail-impressed and applied- relief pottery. These types were described by Specht (1968: 128–30) from the Musée de l'Homme and Melbourne Museum collections and from his own findings at SAD, but had not previously been recorded at SAC.

Pottery types

Plain pottery (Figs 13A–G, 16A–G): Specht (1968: 127–28) and Anson (1983: 41–44) have previously described Watom plain pottery. Including pottery discovered earlier by Specht, SAC produced 20 plain rim sherds—18 from layer C1 and 2 from layer C2. Three of the C1 rims were everted (e.g., Fig. 13A) and 15 were straight (e.g., Fig. 13B). Eight of the 20 were also notched or otherwise modified (e.g., Fig. 13E). Both thin- and thick-walled pots are represented (Fig. 16A–G). One of the two rim sherds from layer C2 was notched or crenellated and the other was everted. A very few carinated (Fig. 13F) and neck sherds (Fig. 13G) suggest the presence of globular shapes restricted at the neck.

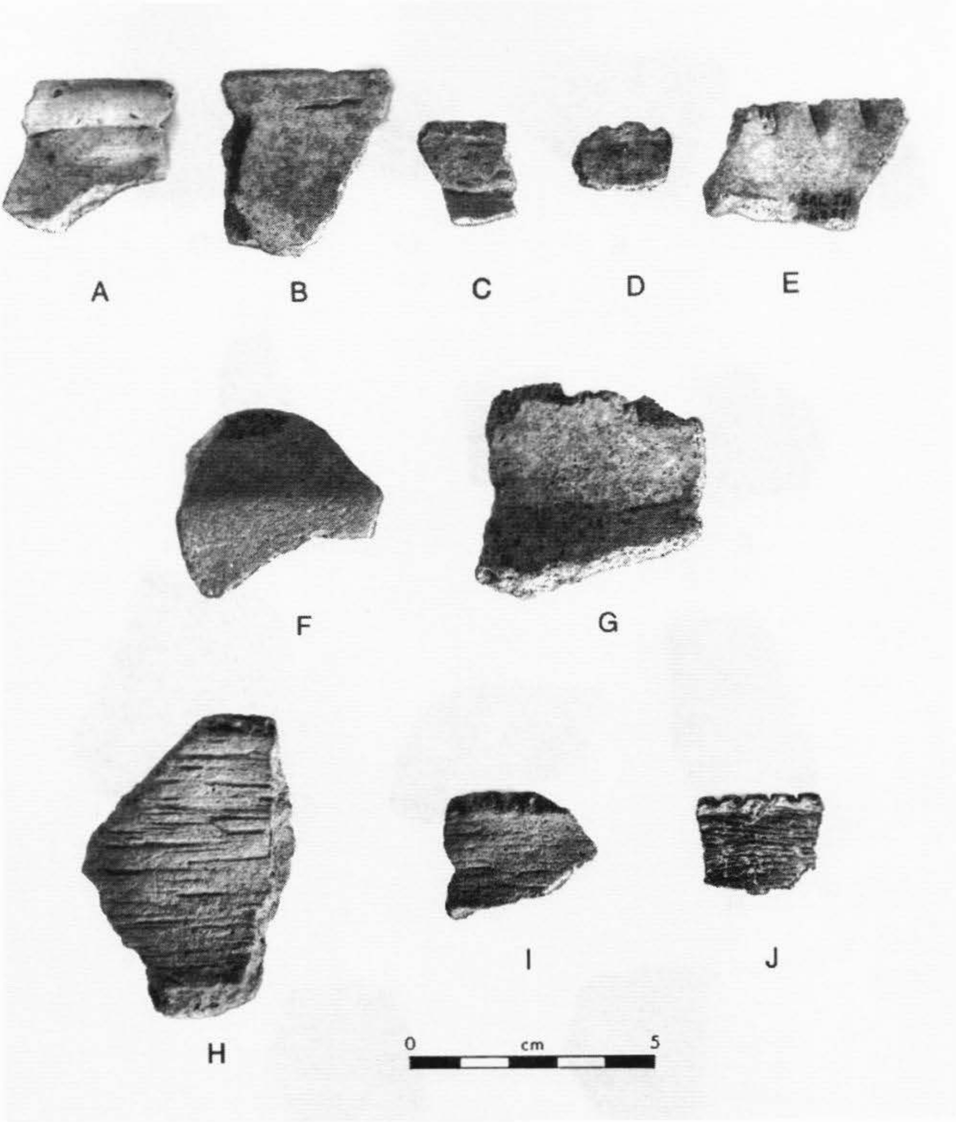

Figure 13: Pottery sherds from zone C, SAC. A–G plain; H–J brushed. A, everted rim; B, straight rim; C–F, notched or modified rims; F, carinated sherd; G, neck sherd; H, plain rim; I–J, notched rims.

Brushed pottery (Figs 13H–J, 16H–J): Anson (1983: 42–45, Fig. VII/16-21) has previously described brushed pottery from Watom. Six brushed sherds were found in rectangles III and IV; four in layer C1 and two in layer C2. It seems likely that this style is part of the plain Lapita component (Anson 2000b). Two of the sherds (Fig. 13I, J) are of the thin-walled variety and two of the three rims were modified by notching to form a crenellated or a scallop-shaped undulation (e.g., Fig. 13I, J).

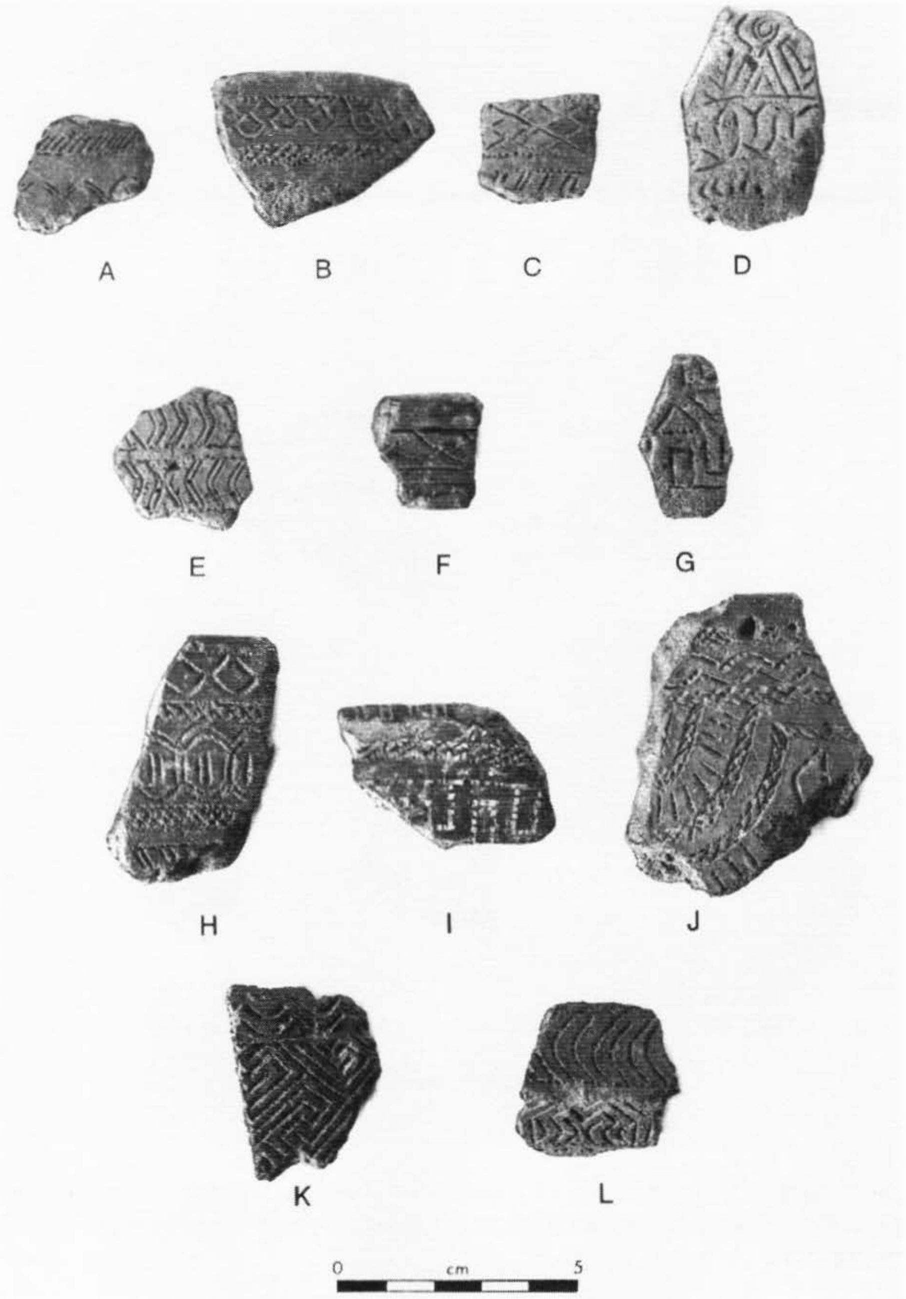

Figure 14: Dentate-stamped Lapita pottery sherds from SAC. A–G, from layer C1; H–L from layer C2. A, C, D, E, G, body sherds; B, undecorated flat lipped rim sherd; F, undecorated everted rim sherd with undecorated lip but decorated on inner everted rim surface and on inside surface of probable bowl form; H, decorated lip on rim sherd; I, decorated everted rim sherd with decorated flat lip, also decorated on inner everted rim surface and on inside surface of probable bowl form; J, pierced rim sherd with decorated lip; K, body sherd with fracture near a shoulder carination; L, body sherd exhibiting carinated shoulder of bowl with restricted neck.

Dentate-stamped pottery (Figs 14A–L, 16K–P): Dentate-stamped decoration from Watom has been described by Specht (1968: 129–30) and Anson (1983: 30–32), who drew up a table of decorative motifs of all Watom sherds then available (Anson 1983: Table XII). Twenty-six new dentate-stamped sherds were found in rectangles III and IV at SAC in 1985. A number of these bore sufficient decoration to enable the codification of all their motifs or design elements (Anson 2000c: Table 1, also drawing on Anson 1983: 53–75, 176–77; Anson 1986: 159–61; Anson 1990: 53–58). The dentate stamping of a thin-walled rim sherd from zone C2 (Fig. 14I) stands out, as it is impressed by larger than usual square indentations with calcareous white in-filling.

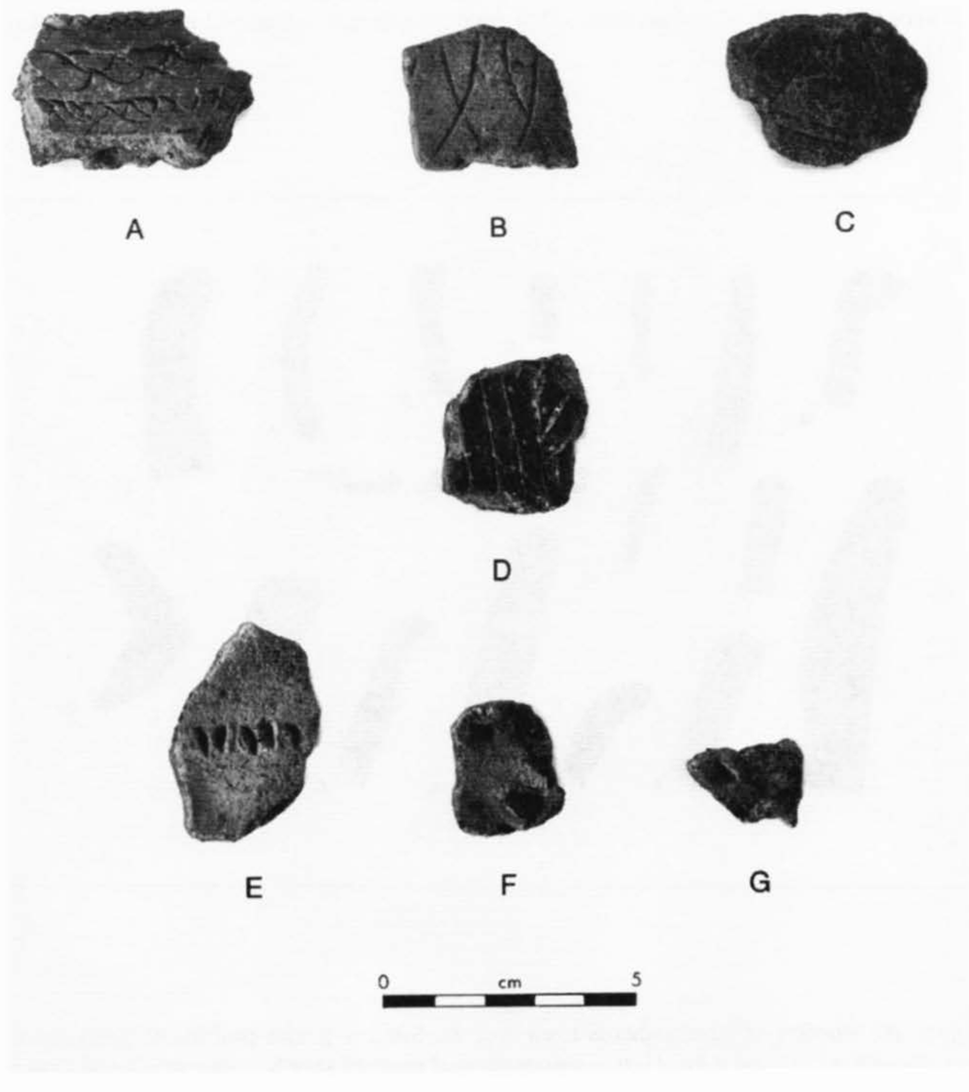

Figure 15: Pottery from SAC. A–D, incised Lapita sherds from zone C; E–G, nail-impressed sherds from layer C1.

The shapes of Watom's dentate-stamped pottery have been described by Specht (1968: 127–28) and Anson (1983: 31, 35–36, Fig. II). The sherds discovered at SAC in 1985 are small and fragmentary. Straight and everted rim sherds were found in both layer C1 and layer C2 (Fig. 16K–O). Two particularly thick-walled rim sherds were found in layer C2. One is unusual in that it was pierced through the lip after firing, perhaps to be worn as an ornament (Fig. 14J). A carinated body sherd indicates the presence of bowls with a restricted neck (Fig. 14L).

Incised pottery (Fig. 15A–D): Specht (1969: Plate XI-47/i-j) reported two incised sherds from SAC, one from rectangle I, layer C1 and the other from rectangle II, layer C2. These sherds were decorated with parallel and radiating incised lines. A third incised sherd from rectangle II, layer C2 (Specht 1969: Plate 12-9/r) was unusual in being decorated with zone markers and a motif of a type more often found on dentate-stamped Lapita pottery (Fig. 15A).

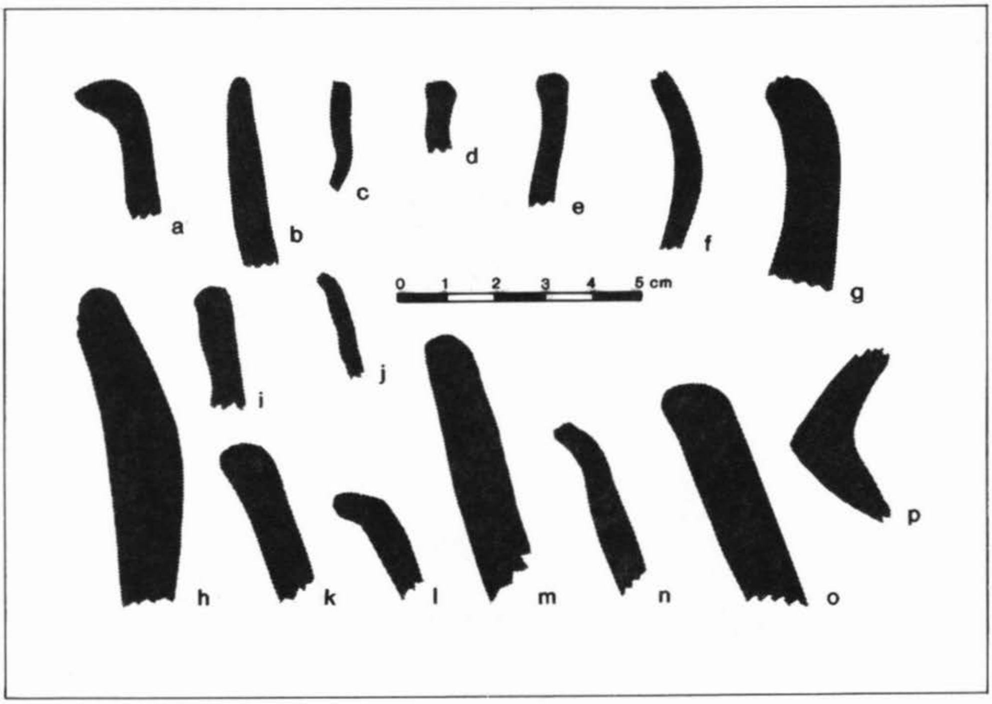

Figure 16: Profiles of Lapita sherds from zone C, SAC. a–g, rim profiles of plain sherds corresponding to Figure 13A–G; h–j, rim profiles of brushed sherds corresponding to Figure 13H–J; k–o, straight and everted rim profiles of dentate-stamped sherds; k, l, from layer C1, corresponding to Figure 14B, F; m–o from layer C2, corresponding to Figure 14H–J; p, profile of dentate-stamped carinated shoulder in Figure 14L.

Only the three largest incised sherds from rectangles III and IV retain enough of their original decoration to be recognisable. One of these, from layer C1 (Fig. 15B), is decorated with a leaf-like pattern made up of curved lines. This motif has not previously been found in Watom but is known from Ambitle Island (Anson 1983: Fig. VI/10 and 13). The decoration of an incised sherd from layer C1 (Fig. 15C) is made up of a hatched interlocking triangle motif common to both Watom and Ambitle (Anson 1983: Fig. V/3-4 and Fig. VI/6).

Nail-impressed pottery (Fig. 15E–G): The stratigraphic relationship of Watom's nail-impressed and dentate-stamped Lapita pottery could not be demonstrated until the present excavations revealed nail-impressed sherds stratified with Lapita in layer C1 (Table 11). The 'pinched' decoration of these three body sherds conforms closely with extant descriptions of the type (Specht 1968: 128) as does their greyish-brown slip colour (Anson 2000b). None of the three small sherds found is diagnostic in shape.

No nail-impressed sherds were found among the 129 sherds from layer C2. It is unclear whether their absence means that they were not present in the earlier layer or whether it is a result of the small sample size. Evidence from SDI supports the former explanation (Anson 2000b). However, the results of optical mineralogy and fabric analyses of nail-impressed and applied-relief sherds, showing them to have a calcareous temper type, suggest they could have been present as early as the earliest Lapita pottery in this site. What is certain at present is that the two types co-exist in layer C1 at SAC and also at SDI (Anson 2000b).

Temporal Change

In the course of excavation it became apparent that there was a gradual change in the pottery. Firstly, sherd size in layer C1 appeared to be smaller than in layer C2. This was confirmed by multiplying the length and width of each sherd to obtain an approximate estimate of sherd area. There were 10.3% more sherds of less than 5 cm size in layer C1 than in layer C2. On the other hand, layer C2 contained 5.4% more sherds in the 6 to 10 cm range than layer C1. Furthermore, only 6.7% of sherds were larger than 11 cm in layer C1 compared with 11.9% in layer C2 (Table 12).

TABLE 12

Numbers and percentage of sherds from SAC according to sherd areas

Sherd Area	**1-5**	**6-10**	**11-15**	**16-20**	**21-25**	**26-30**	**30+**	**40+**
Layer C1								
No.of sherds	385	105	21	10	2	2	0	0
percent	73.3	20.0	4.0	1.9	.4	.4	0	0
Layer C2								
No.of sherds	84	34	7	3	3	0	1	2
percent	63	25.4	5.2	2.2	2.2	0	.75	1.5

TABLE 13

BMDP7M Stepwise Discriminant Function Analysis classification matrix of SAC pottery colour data

Group	**% Correct**	**No. Cases Classified into Group**	
		C1	C2
C1	80.4	377	92
C2	69.7	36	83
Total	**75.1**	**413**	**175**

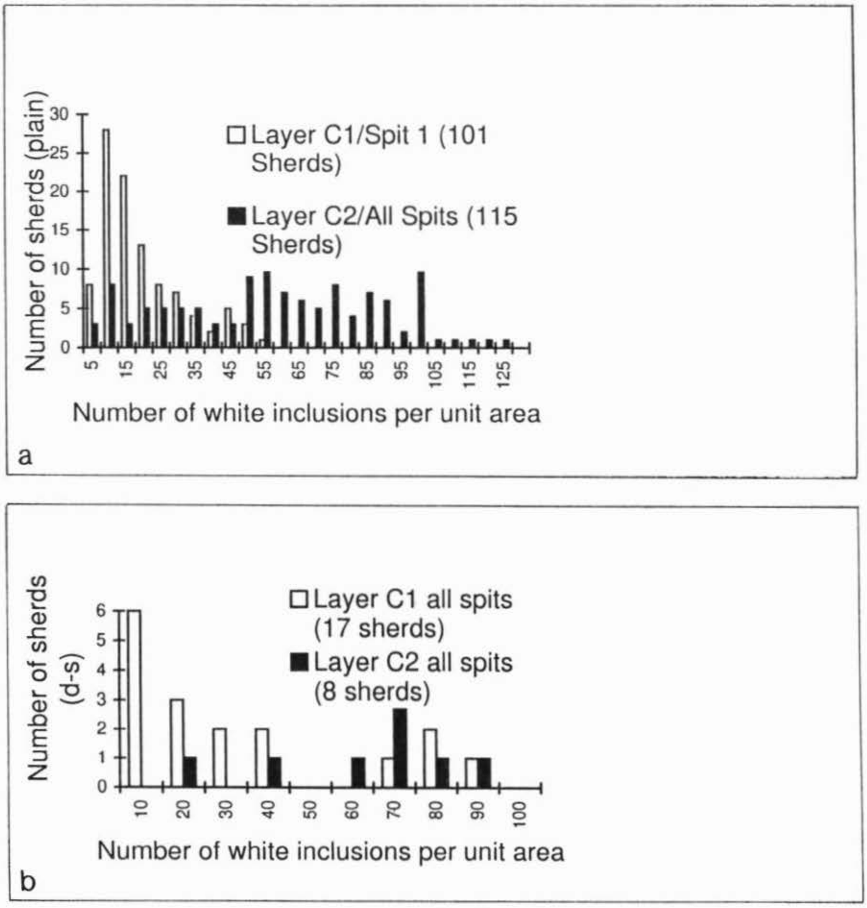

Figure 17: The number of white inclusions on a 3 x 5 mm area counted on the fracture part of sherds from SAC. a, 101 plain sherds from layer C1 contrasted with 115 from layer C2, showing the dominance of white inclusions due mainly to the incorporation of calcareous shell fragments in the temper. b, 17 dentate-stamped sherds from layer C1 contrasted with 7 from layer C2. The dominance of white inclusions in layer C2 is not quite so marked as in the plain sherds.

Secondly, most of the sherds from layer C1 appeared to be bright reddish and to contain fewer white inclusions than the majority of pottery from layer C2, which was rather darker and more brown. This impression of colour difference was confirmed when the hue, value and chroma of the outer and inner surfaces and fracture of 588 of the larger and more robust plain and decorated sherds were examined using a Munsell soil colour chart. A computer classification of these data using BMDP7M Stepwise Discriminant Function Analysis (Das Gupta 1973) showed that the chroma value of the external surface and the hue value of the fracture enabled 80.4% of layer C1 sherds and 69.7% of layer C2 sherds to be correctly classified (Table 13).

To define the observed change in the white inclusion content of pottery, a systematic count of these inclusions was carried out at a 3 x 5 mm unit area on the fracture of each plain sherd. This revealed that while no sherd from layer C1, spit 1, had more than 55 white inclusions, 52.8% of sherds from layer C2 exceeded this number (Fig. 17a). A similar change in the proportion of white inclusions was shown to occur amongst the dentate-stamped pottery from layers C1 and C2 (Fig. 17b).

There appears to be a correlation between the change of colour and the white inclusion content. Figure 18a, which plots the fracture colour data of sherds from layer C1 (spit 1) and layer C2 (all spits) with a per unit inclusion content of 9–29 grains, shows mostly layer

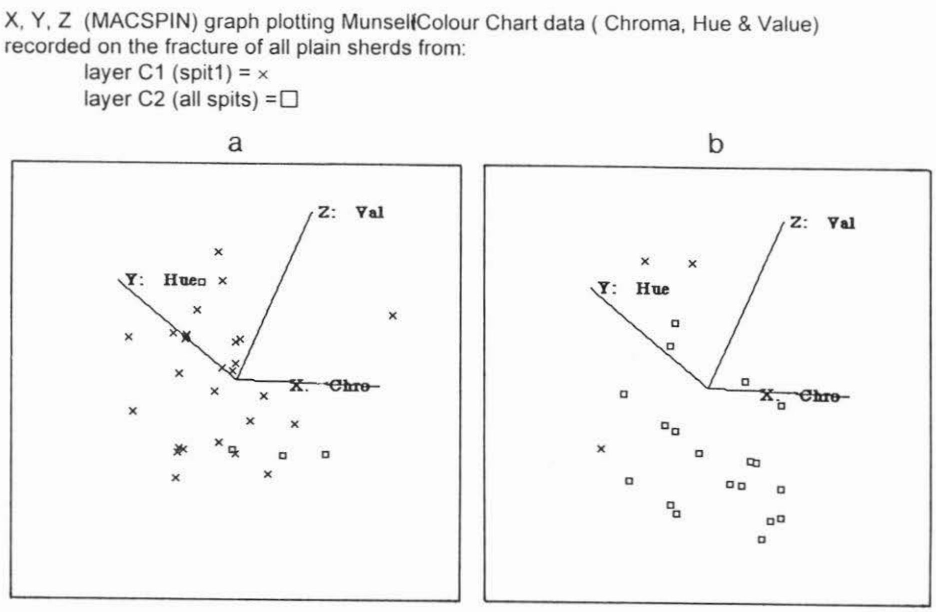

Figure 18: Fabric colour change in the fracture zone of plain Lapita sherds between layers C1 and C2 at SAC exhibited by the MACSPIN colour chart graphs. a, when sherds with white inclusion counts of 9–19 grains per 3 x 5 mm unit area are selected, most come from layer C1; b, when sherds with white inclusion counts of 67–87 grains per unit area are selected, most sherds come from layer C2, implying that aspects of differences in sherd fabric colour are correlated with white inclusion content.

C1 sherds. When the colour data of sherds with a per unit white inclusion content of 67–87 grains are plotted (Fig. 18b), all but four of the sherds shown come from layer C2. In comparing the two plots we find that the more sparsely-grained layer C1 sherds in Figure 18a also display some differences in hue and chroma values from the more heavily-grained layer C2 sherds plotted in Figure 18b.

The correlation of white grain inclusion content with changes in colour is confirmed by the results of a second Discriminant Function Classification of both plain and decorated sherds (Table 14). Here the addition of the white inclusion data (with the continued contribution of the chroma and hue values) proved to be the most significant factor in improving the classification (cf. Table 13). This classification shows that while the more brown and white-grained sherds continue to be found in equal numbers in both layers C1 and C2, the number of reddish sherds, with a lesser density of white inclusions, increases dramatically in layer C1.

TABLE 14

BMDP7M Stepwise Discriminant Function Analysis Matrix
of SAC colour and white grain count data

Group	**% Correct**	**No. of Cases Classified into Group**	
		C1	C2
C1	81.0	380	89
C2	73.9	31	88
Total	**77.45**	**418**	**179**

Compositional analyses of pottery

In order to examine more closely the change in white inclusion content from layer C1 to layer C2, 53 sherds were selected for further analysis. The analytical technique consisted of mineralogical point counting of these sherds in thin section. To take account of the density of inclusions in the clay fabric, points at which no mineral grains were found were also counted. The sample from layer C1 consisted of 14 plain sherds and all 17 dentate-stamped sherds. Fifteen plain sherds and seven dentate-stamped sherds which were sufficiently robust for thin sectioning were selected from layer C2. The sherds were chosen from those shown to be typical of layers C1 and C2 by the Discriminant Function Analysis (Table 14) on the basis of white grain content and colour.

The results of the mineralogical analysis (Table 15) indicate that the white grain inclusions in the fabric of the SAC pottery consist of a calcareous carbonate modal temper type and another modal type of plagioclase feldspar. However, while the feldspathic modal temper type is dominant in layer C1 and present in layer C2 samples, the carbonaceous modal temper type is present only in the layer C2 sample. Point counting of the areas at which no inclusions were found also showed that the carbonaceous tempered sherds were characterised by a higher inclusion-to-clay ratio than the feldspathic sherds (cf. Table 15 normalising procedure). Thus the carbonaceous tempered sherds have a significantly lower matrix or clay volume than those with feldspathic modal tempers.

A similar result was obtained from the point counting of a small sample of sherds from spits 1, 3, 4, 5, and 6 at Specht's (1968) excavations in rectangle I of SAC, earlier studied by Anson (1983). The sherds with carbonates appear only in spits 4 to 6 (i.e., layer C2). These sherds had previously been examined by Anson (1983) using optical emission spectroscopy (Table 16). The results of this analysis confirm the results of the point counts. They show a complete lack of strontium in all but one of the sherds from the upper spits compared with its presence in all the sherds of the lower two spits (Table 17).

When the change in sherd colour and composition was initially observed at SAC (but not SDI—Anson 2000b), we attributed it to a possible shift in cultural practice of pottery manufacture or use.

> One is therefore left with the view that either the sequence went from a dominance of the Watom calcareous temper type, to the feldspathic type and then back to the calcareous type over the course of 800 plus years, or more likely, that the gradual change observed in temper dominance in the sherd assemblage at SAC is something that is again locality specific and based on where the pottery was produced and or its function. Temper changes need not be some general phenomenon applying in an overall fashion to the Reber-Rakival area. (Green and Anson 1991: 177)

TABLE 15

Means and standard deviations of mineralogical point count data
for 53 plain and dentate-stamped pottery sherds from layers C1 and C2 at SAC

1=plagioclase feldspar; 2=calcium carbonate; 3=clinopyroxene; 4=volcanic glass and rock fragments; 5=olivine, iddingsite, ferrugenous clays and ferromagnesian alterations; 6=potassic feldspar; 7=quartz; 8=opaque oxides; 9=sedimentary*.

Pottery	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Layer C1 plain	15.4,4.2	0,0	2.6,2.4	3.2,2.1	2.0,1.6	0.7,1.7	0.3,1.2	3.5,3.6	1.0,1.2
Layer C2 plain	12.5,4.7	21.5,10.5	1.8,1.8	2.8,2.1	2.0,2.7	2.5,2.9	0.9,1.3	1.9,1.9	.08,1.4
Layer C1 d-s	15.3,3.7	0,0.1	4.5,3.6	4.5,3.6	1.3,2.1	4.4,3.5	0.2,0.8	3.1,1.7	0.2,0.7
Layer C2 d-s	12.0,4.4	16.6,7.2	2.7,2.1	2.7,2.1	1.6,1.6	2.4,2.1	1.4,1.8	3.8,3.5	0,0

* Normalizing procedure:
Step 1: Identify major group in raw data. The two modal parameters—carbonates and plagioclase feldspars—effectively separate the data into two broad groups.
Step 2: Calculate average matrix volume for each broad group.
Carbonaceous = 51.9% of total count
Feldspathic = 71% of total count.
Step 3: let
c = normalised count of mineral grain
c' = raw count of mineral grain without adjusting to average matrix
x = adjusted average matrix for individual sample
y = counted matrix (raw count) for individual sample
then c - c' (100 - x/100 - y)

The more recent work of Dickinson (2000) has alerted us to several confusions in the above interpretation and suggested another possibility. Many (though not all) sherds of the feldspathic temper types, when examined microscopically, exhibit voids that once probably contained calcareous particles. This explanation is entirely in line with all other observations by ourselves about layer C1 at SAC as a weathered and thus highly leached palaeosol horizon (in contrast to layer C2) and by Smith (2000) about the comminuted and weathered nature of its bone fragments. The observed change in temper and colour is therefore probably in large part a result of a locality-specific taphonomic process, and not to be attributed to some culturally-based practice of pottery production or function. Indeed, what all localities (SAC, SAD, and SDI) now indicate to us is that local terrigenous coastal sand, incorporating sea-derived shell fragments, was the dominant temper type added in pottery production throughout the Reber-Rakival pre-ashfall sequence.

There was in addition a consistent but lesser component of indigenous sherds whose temper was without shell fragments but otherwise of the same terrigenous sands recovered from more inland sources on Watom Island. At present we cannot estimate their exact proportion in the SAC sherd assemblage, but their occurrence is not unexpected.

TABLE 16

Optical emission spectographic analysis results of 16 plain and decorated Lapita sherds from spits 1,3,4,5 & 6 of Specht's excavations at Rectangle 1 at SAC (after Anson 1983)

Sherd*	**Spit**	**B**	**Co**	**Ga**	**Sc**	**Mn**	**Mo**	**Ni**	**Pb**	**Sr**	**V**	**Zr**
WI 8/26	1	10	0	35	1	100	20	15	2	300	100	60
WI 8/2	1	10	15	50	2	400	500	15	3	0	100	60
WI 8/77	3	20	0	40	1	200	2	10	3	0	150	80
WI 8/55	3	10	0	30	1	300	2	20	2	0	150	100
WI 8/32	3	15	0	35	1	100	2	10	3	0	100	60
WI 8/34	3	20	0	35	1	250	500	10	3	0	100	60
WI 8/66	3	10	0	36	1	300	2	15	3	0	100	40
WI 8/42	4	15	0	40	1	100	25	15	3	0	100	60
WI 8/19	5	10	0	35	1	100	2	10	2	1000	150	60
WI 8/47	5	15	0	40	1	250	2	15	4	800	100	100
WI 8/63	5	15	0	35	1	250	0	15	3	300	100	40
WI 8/106	5	10	0	35	1	300	2	15	2	800	100	100
WI 8/45	5	10	0	35	1	150	2	10	4	600	60	80
WI 8/46	5	25	0	35	1	250	2	15	3	300	150	60
WI 8/109	6	20	0	35	1	150	2	15	2	400	100	40
WI 8/110	6	15	20	40	1	150	250	15	4	400	100	60

* Sherd number prefix WI 8 refers to Watom Island site 8 (Specht's [1967] nomenclature for the SAC location)

Exotic sherds

We have always believed the bulk of the Reber-Rakival pottery to be of local origin (Green and Anson 1991: 176). This view is based on temper analysis, mostly of sherds from SAD (Dickinson and Shutler 1979: 1647), and on microprobe analysis of a local Watom clay compared to Watom sherds (Anson 1983: 166). Moreover, the dominant modal temper types in SAC, the carbonaceous and feldspathic, are mineralogically fully compatible with an origin on Watom (Dickinson 2000). This contrasts with Lapita sites like those in the Mussau group, where much of the pottery has proved to be of exotic origin from a number of different sources (Anson 1983: 116; Kirch *et al.* 1991: 158). Few exotic sherds have been identified in the collections from the various Reber-Rakival localities. One with a rich hornblende temper was identified by Dickinson and three with unusual elemental composition by Anson (1983: 148), all from SAD. The rest are from SAC and are identified as exotic with slightly less confidence.

TABLE 17

Distribution of 21 plain and decorated Lapita sherds from rectangle I at SAC by spit and strontium content (derived from Anson 1983)

	Strontium in parts per million						
Spit	**0**	**300**	**400**	**600**	**800**	**1000**	**Total**
Spit 1	2	1	-	-	-	-	3
Spit 2	-	-	-	-	-	-	-
Spit 3	5	-	-	-	-	-	5
Spit 4	1	-	-	-	-	-	1
Spit 5	-	2	-	1	2	1	6
Spit 6	-	-	6	-	-	-	6
Total	**8**	**3**	**6**	**1**	**2**	**1**	**21**

Four sherds among the carbonaceous modal type and nine among the feldspathic modal type have both potassium feldspars and quartz grains as part of their composition. In contrast, some 32 feldspathic modal type sherds lack K-feldspars and only on occasion exhibit a little associated quartz, while 19 of the 33 sherds of the carbonaceous modal type completely lack these two minerals and 5 others are without quartz, though they have the K-feldspars. One reasonable interpretation is that they originate from a different source. We take those sherds with the quartz and potassium feldspars (perhaps 20% based on our point counted sample) as a possible signal of an exotic source among the island arc-plutonic intrusive rock complexes of nearby New Britain, as for example that of the North Baining region (Whalen 1985: 604; Dickinson 2000).

CONCLUSION

Of the localities examined in the Reber-Rakival site, Kainapirina (SAC), has yielded the widest range of data. We understand more about the two periods of occupation, represented by layers C1 and C2, at this location than about any layers at SDI or the rather disturbed deposits at the base of SAD and at SAB. Also, we have a wider range of economic, structural, and artefactual information securely associated with pottery from SAC than from the other excavated localities. Finally, only the SAC excavations produced skeletal material of Lapita age.

For these reasons, the SAC excavations are central to the interpretation of the Reber-Rakival site, even though they yielded a smaller assemblage of pottery sherds (656) than either SDI (964 sherds) or SAD (3873 sherds) (Green and Anson 1991: Table 1). Moreover, if we are to gain a better understanding of Lapita sites and consequently of the full cultural complex, it is necessary to shift from a focus on the pottery to a more balanced view that includes all the evidence. It is in this light that the results from the excavations at SAC are summarised.

Most Lapita sites have undergone a long and continuing series of physical and/or cultural transformations since they were occupied (cf. Green 1979: 31–32). The basal cultural deposits at SAC have been preserved from later cultural disturbance by a primary ashfall followed by substantial secondary deposition of reworked ash. Although this has transformed the present landscape in which the site now exists, it means that cultural disturbance of the Lapita zone at this locality took place either at the time of the Lapita occupation itself or in the 600 to 700 years that followed before the Rabaul eruption. However, it also means that the environmental setting of the site at the time of its occupation has had to be reconstructed as part of the interpretation. Finally, it shows that a commonly held view that most of the Watom Lapita site is badly disturbed was mistaken. Localities exist at the Reber-Rakival site with intact and well-stratified occupation deposits under the ashfall, as demonstrated by excavations at SAC and also at SDI.

Results from the excavations and the coring programme around SAC reveal that the layer C1 and C2 occupations took place on a recently emerged, small dry sandy spit projecting out from a well drained, sandy coralline beach flat with a few low-lying beach dunes to the rear. To the south by SAD was a small freshwater stream that discharged into a little tidal embayment while to the north, low-lying hollows may have contained muddy swales. Moreover, at the time of occupation, the excavated deposits were within a few metres of the beach, not some 50 metres away as they are today.

Specht excavated the two stratigraphic units he identified in his zone C under the ash in a series of up to six spits. We also used spits, but we excavated the two layers separately as layer C1 and layer C2. This procedure revealed a complex occupation sequence as follows: (a) initial domestic habitation with postholes, pits, ovens, obsidian, potsherds, shellfish, and fishbone as principal associated items, and with several stages of building construction possible; (b) a short interval without activity; (c) a burial ground with stone enclosing wall on one or more sides and most inhumations in shallow, round to oval pits; (d) a less specific kind of domestic occupation, again with a few postholes and pits, but also with more associated potsherds and obsidian pieces; and (e) gardening of the locality and the disturbance of some of the previous features. The cultural sequence was terminated by the Rabaul ashfall, followed by the deposition of secondary ash, which in this locality effectively sealed off these remains from further cultural interference.

One of the problems in the Reber-Rakival investigations up to 1985 had been a lack of secure dates. At SAC we were able to rectify this with a series of radiocarbon dates on shell which are consistent with the one previously obtained on human bone from SAC and with other shell dates from SDI. The results suggest the following ages for various events outlined above:

- Establishment of the recently emerged sandy spit and beach flat by 1500–1300 BC.
- Initial domestic occupation by about 400 BC, if not earlier.
- Use as a burial ground between 300 and 100 BC.
- Later less specific domestic occupation between 150 BC and AD 50.
- Gardening activities in the interval between AD 100 and 650.

On Specht's limited data of three, perhaps four individuals, the possible function of SAC as a burial ground could have been canvassed. But it was the recovery of eight individuals associated with burial pits and coral stone alignments which turned this possibility into a securely supported interpretation. This is the first Lapita burial ground to be documented from about 30 excavated Lapita sites. It allowed us to outline for the first time several kinds of burial practice, some possible genetic relationships with other Pacific populations, and aspects of a probable diet attributable to these people on the basis of their bone chemistry.

Meyer reported some associated faunal items (Anson 2000a). Specht (1968: 125–26) was able to add only a few items to Meyer's list, partly because the stratigraphic context of the plant remains, especially, was uncertain. Layer C2 has contributed a useful assemblage of shellfish, fishbone, and pig remains, supported to a limited extent by pig bones and teeth from layer C1. Two aspects of the marine assemblage stand out. The marine resources largely reflect exploitation of an inshore beach and reef not greatly different from those of today; secondly, they were only a small component of the subsistence base. It was the terrestrial resources that were important; this is best reflected in the strong evidence for pig husbandry (Smith 2000). That evidence dispels any doubts that archaeologists such as Groube (1971) have had about the association of pig with Lapita remains, an association reported long ago by Meyer (1910) and more recently by Specht (1968). The general evidence does suggest, however, that pig keeping may have intensified over time in the Lapita sites of Near Oceania.

Meyer (Anson 2000a) reported that the pottery of the Reber-Rakival site was contemporary with various stone and shell artefacts. He listed obsidian, a stone axe, a whetstone, stone knives and other objects, along with Trochus shell bracelet pieces and preforms and a Trochus shell fishhook. Specht (1968, 1969) was not able to add much to this list from his excavations at SAD and SAB, but from the items he recovered at SAC and those we found there, a small but useful group of associated objects can be described. They help to define the types of portable artefacts that may be assigned to the Lapita cultural complex. Most useful are the adzes of several types, also found in Lapita pottery assemblages elsewhere, one-piece Trochus shell fishhooks, and various kinds of shell arm rings. When the adze types from SAC are combined with those from SAD and SDI, they comprise an adze kit which is otherwise poorly documented from Lapita sites in Near Oceania. Most of them are imports, probably from adjacent New Britain, which is in keeping with the presence of some exotic pottery.

Technological, usewear, and residue studies of the obsidian document simple, expedient in-place tool production, of a very utilitarian nature, followed by random discard. However, the sourcing data suggest a different attitude to the long distance transport of obsidian blocks to Watom as raw material. At that stage, social rather than strictly economic considerations seem to have dominated. These results, along with many similar studies from other sites, are important in understanding the social aspects of the exchange process in Lapita times. They document the import of resources to SAC from a distance, in this case from the Talasea and Hoskins peninsulas on the West New Britain coast and Lou and Pam Lin Islands in the Admiralties. The Talasea regional sources, especially the Kutau/Bao subsource, became dominant over time, but contact with all three regions continued.

The two assemblages of Lapita pottery from layers C1 and C2, although smaller than might be expected from the area excavated, are sufficient to define Reber-Rakival Lapita ceramics of the period 400 BC to AD 50, and to demonstrate some changes in decorative techniques and in aspects of the temper and fabric composition due to post-depositional taphonomic effects. The most important change in decorative techniques is the presence of nail-impressed pottery in layer C1. The motifs from the two layers exhibit a high degree of similarity and imply reasonable continuity in the series of occupation events (Anson 2000c). They also suggest that the strongest relationship is between the layer C2 assemblage and those from SAD (from which most of the Meyer collections probably also came). Thus the SAC excavations have provided the most useful stratigraphically controlled and dated pottery assemblages from the Reber-Rakival site. Most of the pottery is locally manufactured, but perhaps one fifth of it comes from nearby New Britain, and a few pieces from farther afield.

The Reber-Rakival site on Watom was the first Lapita site reported in the literature. Largely through the excavations at SAC, it now contributes significantly to the understanding of a very late to transitional phase of the Lapita cultural complex in Near Oceania.

ACKNOWLEDGEMENTS

We would like to thank Jim Specht for his aid and assistance throughout all phases of the work, from planning of the excavations to initial assistance in the field and in subsequent analyses. We would also like to acknowledge the interest and support given by Father Winfried Holz of the Volavolo Catholic Mission Station and Gregor Turadavai, the local headman and store keeper in Rakival village. Equally, without the direct involvement of many friends and workers from Rakival village, little of what was accomplished would have been possible. They deserve our heartfelt gratitude.

We would also like to recognise here the support of our respective institutions, the Otago Museum and the University of Auckland. This took the form of overseas leave on salary for both of us and, in addition, a research grant (Anthropology 141) from the University of Auckland to undertake the fieldwork. Both institutions have given extensive backing for laboratory analysis, and provided time and resources during the extended period over which parts of this research have been written up. The work of Dorothy Brown in word processing and editing is gratefully acknowledged, as is that of Beverley Lang.

For additional help and advice at various points in the analysis and interpretation process, the authors wish to thank not only Jim Allen and Patrick Kirch as referees, but also the following colleagues: Melinda Allen, Wal Ambrose, Philippa Black, Bill Dickinson, Michael Hanslip, Michiko Intoh, Geoff Irwin, Foss Leach, Helen Leach, Ian Nairn, Elizabeth Pascal, Peter Sheppard, Ian Smith, Robin Torrence and Peter White.

Finally we wish especially to recognise the role played by Jim Allen, Chris Gosden, and the Department of Prehistory, Research School of Pacific Studies, Australian National University in fostering and underwriting our research as part of the Lapita Homeland Project.

APPENDIX 1. ALTERNATIVE CALIBRATIONS OF SHELL DATES FROM WATOM RELEVANT TO THE AGE OF LAPITA POTTERY

	Calibrated Age BP		Calibrated Age		
Site	**No.**	**Layer**	**Lab. No.**	**Using ΔR***	**ORE correction**0**
Vunavung	SDI	C2***	ANU5329	1866–1689	1880–1530
	SDI	C3	ANU6475	2355–2214	2360–2000
	SDI	C4	Beta16836	2864–2720	2870–2380
Kainapirina	SAC	C1	ANU5330	2110–1912	2130–1730
	SAC	C2	ANU5336	2300–2000****	2340–1880
	SAC	C2	Beta16835	2300–2000****	2300–1840
	SAC	D	ANU5339	3459–3300	3470–3070

* Dates used in the text of this paper and in Anson (2000b), calibrated to a one sigma range with a ΔR value set at 0.

** Dates as provided by Specht and Gosden (1997: Appendix 3) when calibrated to a two sigma range by deducting 400 years for the Oceania Reservoir Effect and then applying the atmospheric curve.

*** Error in Specht and Gosden (1997: Appendix 3) in recording layer.

**** A combined (Case I) result for the same shell specimen run by two different laboratories then calibrated at a two sigma ΔR range.

APPENDIX 2. DEPTHS OF FEATURES EXCAVATED AT SAC (in cm).

A. Layer C1 features cut into the upper surface of layer C2 (Fig. 7)

Postholes: a-6, b-3 to 4, c-12, d-12, e-14, f-20, g-10, h-14, i-10, j-10, k-11, 1-5.

Pitbases or depressions: (a)-9, (b)-8, (c)-15*, (d)-12, (e)-16, (f)-3 to 4, (g)-12, (h)-10, (I)-8, (j)-11, (k)-6, (l)-12, (m)-10

Slotholes: A-13, B-4 to 5

* The base of this feature cut into the skull of burial 6 in layer C2 below

B. Features within and cut into zone D and associated with activities of layer C2 (Fig. 8)

Postholes: a-29, b-26, c-25, d-25, e-6, f-14, g-13, h-23, I-36, j-9, k-32, l-15, m-26, n-11, o-18, p-19, q-23, r-32 (pit with posthole in base), s-21, t-8, u-50, v-20, w-16, y-50

Pits: a-34, b-11, c-12(?), d-26, e-27, f-21, g-22, h-10, I-20(?)

Burial Pits: 1-no pit, 2-30, 3-20, 4-25, 40, 5-26, 6-30, 7-23, 35, 8-12, 25

Oven: A-30

REFERENCES

Allen, J. and Gosden, C. 1996. Spheres of interaction and integration: Modelling the culture history of the Bismarck Archipelago. *In* J.M. Davidson, G. Irwin, B.F. Leach, A. Pawley, and D. Brown (eds), *Oceanic Culture History: Essays in Honour of Roger Green*, pp. 183–97. New Zealand Journal of Archaeology Special Publication, Dunedin.

Allen, M.S. n.d.a. Under a spreading malai tree: obsidian tool production and use at the ECA site, Mussau Islands. *In* P.V. Kirch (ed.), *The Lapita Culture in Oceania: Archaeological Investigations in the Mussau Islands, Western Melanesia*. Contributions of the University of California Archaeological Research Facility, Berkeley (in press).

Allen, M.S. n.d.b. Three millennia of obsidian importation in the Mussau Islands. *In* P.V. Kirch (ed.), *The Lapita Culture in Oceania: Archaeological Investigations in the Mussau Islands, Western Melanesia*. Contributions of the University of California Archaeological Research Facility, Berkeley (in press).

Anson, D. 1983. Lapita Pottery of the Bismarck Archipelago and its Affinities. Unpublished PhD thesis, University of Sydney.

Anson, D. 1986. Lapita pottery of the Bismarck Archipelago and its affinities. *Archaeology in Oceania* 21: 157–65.

Anson, D. 1990. Aspiring to Paradise. *In* M. Spriggs (ed.), *Lapita Design, Form and Composition. Proceedings of the Lapita Design Workshop, Canberra, Australia, December 1988*, pp. 53–58. Occasional Papers in Prehistory 19. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Anson, D. 2000a. Appendix 1. The archaeological excavations of Father Otto Meyer on Watom Island. *In* R.C. Green, An introduction to investigations on Watom Island, Papua New Guinea. *New Zealand Journal of Archaeology* 20.

Anson, D. 2000b. Excavations at Vunavaung (SDI), Rakival Village, Watom Island, Papua New Guinea. *New Zealand Journal of Archaeology* 20.

Anson, D. 2000c. Reber-Rakival dentate-stamped motifs: documentation and comparative implications. *New Zealand Journal of Archaeology* 20.

Best, S.B. 1984. Lakeba: The Prehistory of a Fijian island. Unpublished PhD thesis, University of Auckland.

Bird, J.R. ms. Pacific Obsidian Studies. Manuscript in preparation, Research School of Pacific and Asian Studies, Australian National University.

Bird, J.R. and Ambrose, W.R. 1992. Lapita Homeland Project: Obsidian Analysis. Final Report to R. Green (incorporating Interim reports Watom 36, 37, 44 for artefact specimens ANU 3186–3215, 3216–3293 and 3347–3396). Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Bird, J.R., Torrence, R., Summerhayes, G.R. and Bailey, G. 1997. New Britain obsidian sources. *Archaeology in Oceania* 32 (1): 61–67.

Das Gupta, S. 1973. Theories and methods in classification. A review. *In* T. Cacoullos (ed.), *Discriminate Analysis and Applications*, pp. 77–137. Academic Press, New York.

Davidson, J.M. and Leach, F. 1993. The chronology of the Natunuku site, Fiji. *New Zealand Journal of Archaeology* 15: 99–105.

Dickinson, W.R. 2000. Petrography of sand tempers in prehistoric sherds from Watom Island and comparison with other temper suites of the Bismarck Archipelago. *New Zealand Journal of Archaeology* 20.

Dickinson, W.R. and Green, R.C. 1998. Geoarchaeological context of Holocene subsidence at the Ferry Berth Lapita Site, Mulifanua, Upolu, Samoa. *Geoarchaeology*, 13 (3): 239–63.

Dickinson, W.R. and Shutler Jr, R. 1979. Petrography of sand tempers in Pacific Islands potsherds: summary. *Geological Society of America Bulletin* 90, Part I: 993–95, document No. 591101, and 90, Part II: 1644–1701, document No. 1791101.

Evans. J.A. 1987. Comparative Dental Conditions in Several Prehistoric Oceanic groups. Unpublished MA thesis, Department of Anthropology, University of Otago.

Evans, J.A. 1989. The incidence of dental caries in some prehistoric Pacific groups. *In* D.G. Sutton (ed.), *Saying So Doesn't Make It So: Papers in Honour of B. Foss Leach*, pp. 286–94. New Zealand Archaeological Association Monograph 17. Dunedin.

Gosden, C., Allen, J., Ambrose, W., Anson, D., Golson, J., Green, R., Kirch, P., Lilley, I., Specht, J. and Spriggs, M. 1989. Lapita sites of the Bismarck Archipelago. *Antiquity* 63: 561–86.

Gosden, C. 1991. Learning about Lapita in the Bismarck Archipelago. *In* J. Allen and C. Gosden (eds), *Report of the Lapita Homeland Project*, pp. 260–68. Occasional Papers in Prehistory 20. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Green, R.C. 1971. Evidence for the development of the early Polynesian adze kit. *New Zealand Archaeological Association Newsletter* 14: 12–44, 46.

Green, R.C. 1979. Lapita. *In* J.D. Jennings (ed.), *The Prehistory of Polynesia*, pp. 25–60. Harvard University Press, Cambridge.

Green, R.C. 1982. Models for the Lapita cultural complex: an evaluation of some current proposals. *New Zealand Journal of Archaeology* 4: 7–19.

Green, R.C. 1986. Lapita fishing: the evidence of site SE-RF-2 from the Main Reef Islands, Santa Cruz Group, Solomons. *In* A. Anderson (ed.), *Traditional Fishing in the Pacific:*

Ethnological and Archaeological Papers from the 15th Pacific Science Congress, pp. 119–35. Pacific Anthropological Records 37. Bernice P. Bishop Museum, Honolulu.

Green, R.C. 1991. The Lapita cultural complex: current evidence and proposed models. *In* P. Bellwood (ed.), *Indo-Pacific Prehistory 1990, Volume 2*, pp. 295–305. Bulletin of the Indo-Pacific Prehistory Association 11. Canberra and Jakarta.

Green, R.C. 1992. Definitions of the Lapita cultural complex and its non-ceramic component. *In* J.-C. Galipaud (ed.), *Poterie Lapita et Peuplement: Actes du Colloque Lapita, Nouméa, Nouvelle Calédonie, Janvier 1992*, pp. 7–20. ORSTOM, Nouméa.

Green, R.C. 1998. A 1990s perspective on method and theory in archaeological volcanic glass studies. *In* M.S. Shackley (ed.), *Archaeological Obsidian Studies: Method and Theory*, pp. 223–35. Plenum Press, New York.

Green, R.C. and Anson, D. 1991. The Reber-Rakival Lapita site on Watom: implications of the 1985 excavations at the SAC and SDI localities. *In* J. Allen and C. Gosden (eds), *Report of the Lapita Homeland Project*, pp. 170–81. Occasional Papers in Prehistory 20. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Green, R.C. and Anson, D. 2000. Archaeological investigations on Watom Island, Papua New Guinea: early work, outcomes of recent investigations and future prospects. *New Zealand Journal of Archaeology* 20.

Green, R.C and Bird, J.R. 1989. Fergusson Island obsidian from the D'Entrecasteaux Group in a Lapita site of the Reef Santa Cruz Group. *New Zealand Journal of Archaeology* 11: 87–99.

Green, R.C., Anson, D. and Specht, J. 1989. The SAC burial ground, Watom Island, Papua New Guinea. *Records of the Australian Museum* 41 (3): 215–21.

Green, R.C., Best, S.B. and Richards, R. 1988. Exotic type adzes from Tonga and Western Samoa. *Archaeology in New Zealand* 31: 215–21.

Groube, L. 1971. Tonga, Lapita pottery and Polynesian origins. *Journal of Polynesian Society* 80: 278–316.

Halsey, A. n.d. Characterising flaked obsidian technology during the Lapita period: implications for models of resource maximisation and exchange. Paper presented at the Third Lapita Archaeology Conference—The Western Pacific 5000 to 2000 BP—Port Vila, Vanuatu, August 1996.

Hanslip, M. 1999. Expedient Technologies? Obsidian Artefacts in Island Melanesia. Unpublished PhD Thesis, Australian National University.

Horwood, M. 1988. Trace Elements and Prehistoric Diet in the Pacific: a study of six human groups from bone strontium, zinc and magnesium concentrations. Unpublished MA thesis, Department of Anthropology, University of Otago.

Houghton, P. 1980. *The First New Zealanders*. Hodder and Stoughton, Auckland.

Houghton, P. 1989. Watom: the people. *Records of the Australian Museum* 41 (3): 223–33.

Key, C.A. 1968. Trace element identification of the source of obsidian in an archaeological site in New Guinea. *Nature* 219 (No. 5152): 360.

Kirch, P.V. 1988a. The Talepakemalai Lapita site and Oceanic prehistory. *National Geographic Research* 4: 328–42.

Kirch, P.V. 1988b. Long-distance exchange and island colonisation: the Lapita case. *Norwegian Archaeological Review* 21: 103–17.

Kirch, P.V. 1997. *The Lapita Peoples: Ancestors of the Oceanic World*. Blackwell, Oxford.

Kirch, P.V., Swindler, D.R. and Turner, C.G. II. 1989. Human skeletal and dental remains from Lapita sites (1600–500 B.C.) in the Mussau Islands Melanesia. *American Journal of Physical Anthropology* 79: 104–15.

Kirch, P.V., Hunt, T.L., Weisler, M., Butler, V. and Allen, M.S. 1991. Mussau Islands prehistory: results of the 1985–86 excavations. *In* J. Allen and C. Gosden (eds), *Report of the Lapita Homeland Project*, pp. 144–65. Occasional Papers in Prehistory 20. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Leach, B.F. 1986. A method for analysis of Pacific island fishbone assemblages and an associated data base management system. *Journal of Archaeological Science* 13 (2): 147–59.

Leach, B.F., Quinn, C.J., Lyon, G.L., Haystead, A. and Myers, D.B. 2000. Evidence of prehistoric Lapita diet at Watom, Island, Papua New Guinea, using stable isotopes. *New Zealand Journal of Archaeology* 20.

MacKenzie, F.T. 1979. Development of oceans. *New Encyclopaedia Britannica: Macropaedia*, pp. 476–82. 15th edition. Chicago.

Meyer, O. 1909. Funde prähistorischer Töpferei und Steinmesser auf Vatom, Bismarck-Archipel. *Anthropos* 4: 1093–95.

Meyer, O. 1910. Funde von Menschen- und Tierknochen, von prähistorischer Töpferei und Steinwerkzeugen auf Vatom, Bismarck-Archipel. *Anthropos* 5: 1160–61.

Migdalski, E.C. and Fichter, G.S. 1976. *The Fresh and Salt Water Fishes of the World*. Alfred A. Knopf, New York.

Munro, I.S.R. 1967. *The Fishes of New Guinea*. Department of Agriculture, Stock and Fisheries, Port Moresby.

Nairn, I.A., McKee, C.O., Talai, B. and Wood, C.P. 1995. Geological and eruptive history of the Rabaul Caldera area, Papua New Guinea. *Journal of Volcanology and Geo-thermal Research* 69: 255–84.

Pietrusewsky, M. 1985. The earliest Lapita skeleton from the Pacific: a multivariate analysis of a mandible fragment from Natunuku, Fiji. *Journal of the Polynesian Society* 94: 389–414.

Pietrusewsky, M. 1989. A study of skeletal and dental remains from Watom Island and comparisons with other Lapita people. *Records of the Australian Museum* 41 (3): 235–92.

Quinn, C. 1988. A preliminary discussion of five populations based on initial results from nitrogen, carbon, and sulphur isotope analysis. *In* M. Horwood, Trace Elements and Prehistoric Diet in the Pacific: a study of six human groups from bone strontium, zinc and magnesium concentrations, Appendix 4, p. 176. Unpublished MA thesis, Department of Anthropology, University of Otago.

Sheppard, P.J. 1992. A report on the flaked lithic assemblages from three Southeast Solomons Lapita sites (SE-SZ-8, SE-RF-2, SE RF-6). *In* J.-C. Galipaud (ed.), *Poterie Lapita et Peuplement: Actes du Colloque Lapita, Nouméa, Nouvelle Calédonie, Janvier 1992*, pp. 145–53. ORSTOM, Nouméa.

Sheppard, P.J. 1993. Lapita lithics: trade/exchange and technology. A view from the Reefs/Santa Cruz. *Archaeology in Oceania* 28: 121–37.

Sheppard, P.J. 1996. Hard rock: archaeological implications of chert sourcing in Near and Remote Oceania. *In* J.M. Davidson, G. Irwin, B.F. Leach, A. Pawley, and D. Brown (eds), *Oceanic Culture History: Essays in Honour of Roger Green*, pp. 99–115. New Zealand Journal of Archaeology Special Publication, Dunedin.

Sheppard, P.J. and Green, R.C. 1991. Spatial analysis of the Nenumbo (SE-RF-2) Lapita site, Solomon Islands. *Archaeology in Oceania* 26: 89–101.

Sillen, A., Sealy, J.C. and van der Merwe, N.J. 1989. Chemistry and paleodietary research: no more easy answers. *American Antiquity* 54: 504–12.

Smith, I.W.G. 2000. Terrestrial fauna from excavations at Kainapirina (SAC), Watom Island, Papua New Guinea. *New Zealand Journal of Archaeology* 20.

Specht, J.R. 1968. Preliminary report on excavations on Watom Island. *Journal of the Polynesian Society* 77: 117–34.

Specht, J.R. 1969. Prehistoric and Modern Pottery Industries of Buka Island. Unpublished PhD thesis, Australian National University.

Specht, J.R. 1973. Prehistory poses many problems. *Australian Natural History* 17 (2): 445–51.

Specht, J.R. 1985. Crabs as disturbance factors in tropical archaeological sites. *Australian Archaeology* 21: 11–18.

Specht, J.R. and Gosden, C. 1997. Dating Lapita pottery in the Bismarck Archipelago, Papua New Guinea. *Asian Perspectives* 36: 175–99.

Spennemann, D.H.R. 1987. Reanalysis of the human remains at To.1. *In* J. Poulsen, *Early Tongan Prehistory*, Volume 1, pp. 289–303. Terra Australis 12. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Spriggs, M.J.T. 1989. The dating of the Island Southeast Asian Neolithic: an attempt at chronometric hygiene and linguistic correlation. *Antiquity* 63: 587–613.

Spriggs, M.J.T. 1990. Dating Lapita: another view. *In* M. Spriggs (ed.), *Lapita Design, Form and Composition. Proceedings of the Lapita Design Workshop, Canberra, Australia, December 1988*, pp. 6–27. Occasional Papers in Prehistory 19. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Summerhayes, G.R., Bird, J.R., Katsaros, A., Shagholi, N., Gosden, C., Fullagar, R., Specht, J. and Torrence, R. 1993. West New Britain obsidian: production and consumption patterns. *In* B. Fankhauser and J.R. Bird (eds), *Archaeometry: Current Australasian Research*, pp. 57–68. Department of Prehistory, Research School of Pacific Studies, Australian National University, Canberra.

Summerhayes, G.R., Bird, J.R., Fullagar, R., Gosden, C., Specht, J. and Torrence, R. 1998. Application of PIXE-PIGME to archaeological analysis of changing patterns of obsidian use in West New Britain, Papua New Guinea. *In* M.S. Shackley (ed.), *Archaeological Obsidian Studies: Method and Theory*, pp. 129–58. Plenum Press, New York.

Swadling, P. 1986. Lapita shellfishing: evidence from sites in the Reef/Santa Cruz Group, Southeast Solomons. *In* A. Anderson (ed.), *Traditional Fishing in the Pacific: Ethnological and Archaeological Papers from the 15th Pacific Science Congress*, pp. 137–48. Pacific Anthropological Records 37. Bernice P. Bishop Museum, Honolulu.

Torrence, R. 1992. What is Lapita about obsidian? A view from the Talasea sources. *In* J.-C. Galipaud (ed.), *Poterie Lapita et Peuplement: Actes du Coloque Lapita, Nouméa, Nouvelle Calédonie, Janvier 1992*. ORSTOM, Nouméa.

Torrence, R., Specht, J., Fullagar, R. and Bird, J.R. 1992. From Pleistocene to present: obsidian sources in West New Britain, Papua New Guinea. *Records of the Australian Museum*, Supplement, 15: 83–98.

Torrence, R. and Victor, K.L. 1995. The relativity of density. *Archaeology in Oceania* 30: 121–31.

Torrence, R. and Summerhayes, G.R. 1997. Sociality and the short distance trader: inter-regional obsidian exchange in the Willaumez region, Papua New Guinea. *Archaeology in Oceania* 32: 74–84.

Torrence, R., Pavlides, C., Jackson, P. and Webb, J. n.d. Volcanic disasters and cultural discontinuities in the Holocene of West New Britain, Papua New Guinea. *Geological Society of London, Special Publication* (in press).

Turner II, C.G. 1989. Dentition of Watom Island, Bismarck Archipelago, Melanesia. *Records of the Australian Museum* 41 (3): 293–96.

Visser, E.P. 1994. The Prehistoric People from Sigatoka: an analysis of skeletal and dental traits as evidence of adaptation. Unpublished PhD thesis, University of Otago.

Whalen, J.B. 1985. Geochemistry of an island-arc plutonic suite: the Uasilau-Yau Yau intrusive complex. *Journal of Petrology* 26 (3): 603–32.

Walker, G.P.L., Heming, R.F., Sprod, T.J. and Walker, R.F. 1981. Latest major eruptions of Rabaul volcano. *In* R.W. Johnson (ed.), *Cooke-Ravian Volume of Volcanological Papers*, pp. 181–93. Geological Survey of Papua New Guinea Memoir 10. Port Moresby.

White, J.P. and Harris, M.-N. 1997. Changing sources: early Lapita obsidian in the Bismarck Archipelago. *Archaeology in Oceania* 32: 97–107.

Received 23 May 1998
Accepted 28 September 1998