ARCHAEOLOGICAL FIELDWORK IN WEST NEW BRITAIN, PNG
June-July 2001

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Prepared for PNG Museum and Art Gallery, West New Britain Provincial Government, New Britain Palm Oil, Ltd, Mahonia Na Dari

NOTE: This report summarizes PRELIMINARY results compiled immediately following fieldwork. For confirmed and accurate data, please consult publications.

SUMMARY

Fieldwork undertaken in West New Britain during five weeks in June/July 2001 provided important new information about the prehistory of the Willaumez Peninsula. Excavations at the Pleistocene site FABM on Numundo Plantation demonstrates the existence of a well stratified sequence of volcanic ashes and buried soils preserving substantial evidence of human activities in the form of stone artifacts and burned stones. Excavation has confirmed that FAAH has very well stratified and substantial deposits containing Lapita pottery as well as stone artifacts from earlier periods. A detailed study of Boduna Island and its lagoon concluded that undisturbed archaeological deposits are unlikely to be preserved there. Brief surveys identified 11 new archaeological sites at Lotomgan, Numundo and Kulu-Dagi. Rescue excavations were carried out at 4 localities where significant archaeological material had been disturbed through road building and trenching activities.

Samples for luminescence dating were taken from levels containing Pleistocene and Holocene volcanic ashes at several sites and samples of pottery and burned stone were also collected for this purpose. Monitoring cells to help calibrate obsidian hydration dating were collected.

The background geological and environmental work again focused on understanding the volcanic history of the region and on the coastal history at Numundo, but the team also clarified the peat sequence on Garu plantation, which is critical for dating of the marker volcanic ashes used throughout the region. New evidence for the dramatic impact of earthquakes on relative sea levels was detected at Kulu-Dagi and on Boduna Island.

In Port Moresby the team shared our findings with the prehistory staff at the National Museum and Art Gallery and the University of Papua New Guinea. In West New Britain meetings were held with the Provincial Administrator, head of Cultural and Tourism, staff at the Provincial Cultural Centre, head of European Union Nature Centre, staff at Dami Oil Palm Research station and the PNG Oil Palm Research Association, New Britain Palm Oil Ltd managing director, NBPOL plantation managers, and field managers at Numundo Plantation to inform them about the results of our research and to increase awareness about the significance of the archaeological resources in this region.

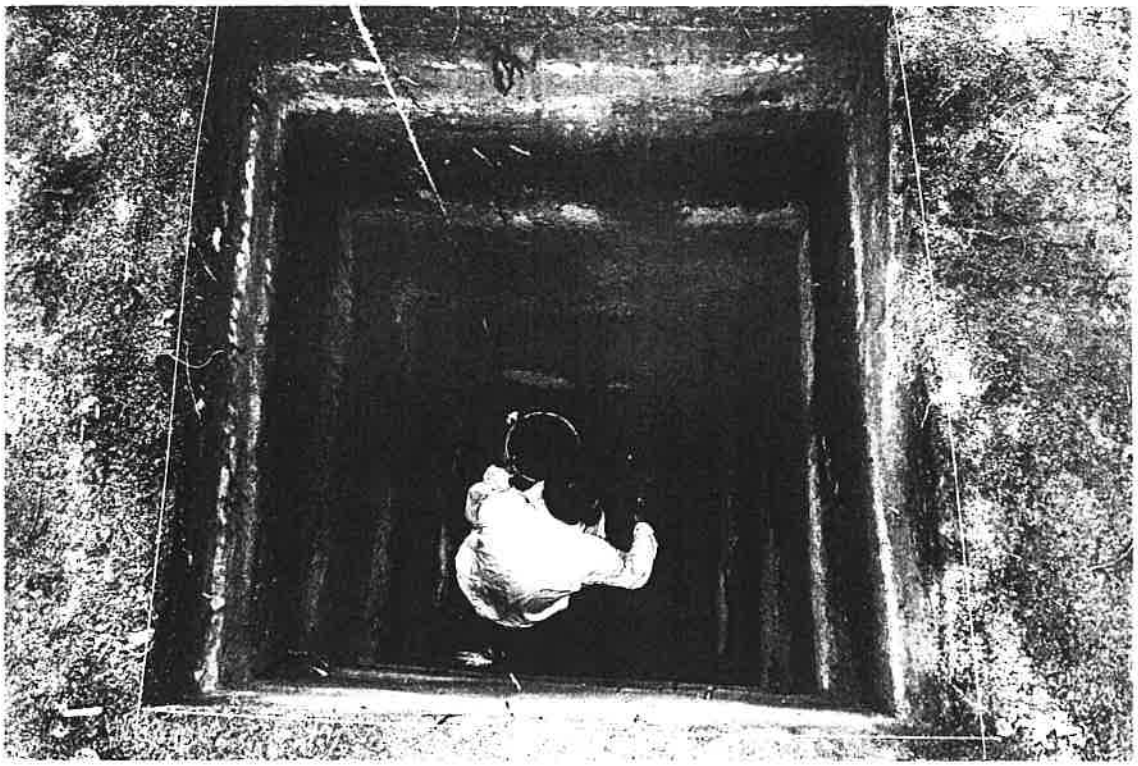


FIGURE 1 The 2.65 metre deep sample pit XIX, which is located at site FACC on Haella plantation, illustrates the excellent preservation of ancient landscapes (dark layers) which are sealed between volcanic ashes (light layers). This unusual stratigraphy makes the Willaumez Peninsula an important region for archaeological research. The obsidian artifacts recovered from the base of this pit date to more than 6,000 years ago.

RECOMMENDATIONS

The 2001 fieldwork reinforces the recommendations given in previous reports in 1999 and 2000 and we urge that these be reviewed annually. We note that NBPOL has made efforts to protect the important archaeological sites previously reported, particularly the Pleistocene remnant at FABM and the important Lapita site of FABN (Boku Hill). Once again we restate the basic principles to guide further development activities.

1. All areas should be assessed through survey and test excavation before development activities such as road making, terracing and construction are commenced.

2. A watching brief should be carried out during development activities. If significant archaeological material is uncovered, activities should cease temporarily until rescue through surface collections and, where required, test excavation can take place.

3. An attempt should be made to conserve some areas on hill and ridge tops because this is the most likely place for the preservation of significant archaeological remains.

With regard to recommendation 3, it is clear from our surveys this year and in previous work that many very deeply stratified and important archaeological sites occur on hills and ridge tops. These appear to sustain the worst damage during road building, especially in cases, such as Locality 01/17 at Kulu-Dagi when the entire top of the hill was removed, although this was well in excess of the area needed for the road. In this case a very rare and important site has been completely destroyed. NBPOL need to keep a closer watch on contract bulldozer operators to ensure that these very archaeologically sensitive areas do not sustain more damage than is absolutely necessary.

As stated in our 2001 report, it is necessary for NBPOL to establish and maintain links with the impact archaeologists in the Prehistory section of the National Museum. They will be able to assist with monitoring during development and with

rescue excavations. Our research project is not designed to achieve these tasks and is too small a scale to cover the entire area impacted by NBPOL.

4. NBPOL staff should visit the known traditional villages at Lotomgan in the company of the traditional owner, Ben Valuka, and record their names and their locations by GPS or plot them on plantation maps. Attempts should be made to preserve sections of these sites with the recent, surface deposits intact.

Finally we realise that successful monitoring of archaeological resources requires much better knowledge and awareness on the part of the people working on the ground in the area. Several sites were brought to the attention of the team by NBPOL employees who had observed stone tools. The cooperation and assistance of people who have detailed on the ground knowledge of the region is a key to the success of the archaeological research. Bob Wilson initiated a very productive meeting with field managers at Numundo Plantation this year to inform them about our work and to ask for their assistance in locating archaeological materials. It is hoped that this type of informal discussions with field staff can be repeated in other plantations during the next field trip in 2002.

5. We therefore recommend that senior staff at NBPOL provide the archaeological team with opportunities to address field staff at each plantation in order to explain the nature of the archaeological resources in the region, to discuss what can be done to care for them, and to ask for their assistance in locating new sites.

6. We also recommend that staff from the WNB Provincial Cultural Centre continue to assist archaeologists with raising awareness about heritage among all the people in the province.

FIELDWORK IN 2001

This year's archaeological fieldwork in the Willaumez Peninsula has again highlighted the importance of this region for Pacific history (e.g. Torrence in press a; in press b). The excellent preservation of ancient landscapes which has resulted from the high frequency of volcanic activity and associated falls of tephra (volcanic ash), as shown in Figure 1, has established the basis for a detailed reconstruction of prehistoric settlement, subsistence and trading patterns from the late Pleistocene period (roughly 35,000 years ago) up to the present (e.g. Summerhayes *et al.* 1998; Torrence 2000;Torrence *et al.* 1999a; 2000; Torrence and Stevenson 2000). The abundance of well stratified, open-air sites is currently unprecedented elsewhere in the Pacific region. A summary of the chronology represented in the region is presented in Table 1 and the locations of the studies undertaken in 2001 are presented in Figures 2 and 3. The support of the West New Britain Provincial government and its residents together with the cooperation and collaboration of New Britain Palm Oil Ltd has contributed to another very successful archaeological fieldtrip. Once again the team has identified and rescued important archaeological data gathered from a broad range of locations within the Numundo Group plantations and the new developments at Tili, Kulu-Dagi, and Lotomgan.

The major aims of this years' fieldwork were as follows: (1) to assess the nature and quantity of archaeological material and the environmental history of FABM, FAAH, and FEA; (2) to collect samples for luminescence dating of both the Pleistocene and Holocene volcanic tephras which comprise the basis for relative chronology in the project area; (3) to continue geological and geomorphological studies directed toward environmental reconstruction of the region during the time of human presence, (4) to explore archaeological sites revealed through recent development activities at Kulu-Dagi and Lotomgan and (5) where possible to maintain a 'watching brief' over archaeological sites at Numundo Plantation. The region is far too large for our small team to adequately assess and rescue the large number of archaeological sites that are continually becoming exposed as a consequence of the development of new oil palm plantations. In last year's report we noted that it would be impossible in the context of our ARC funded research to adequately monitor the new developments in the northern part of the Willaumez Peninsula and our brief trip to

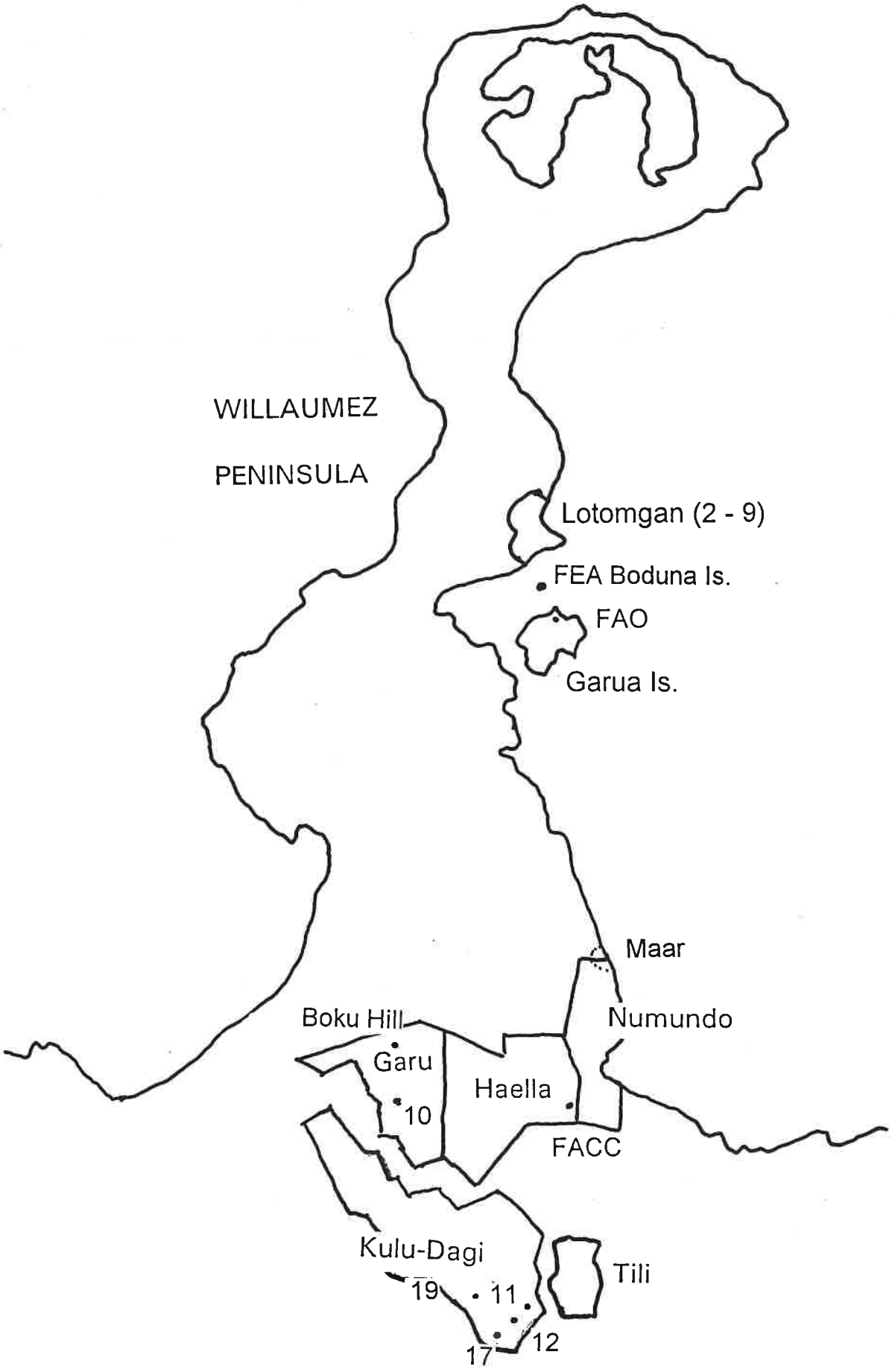


FIGURE 2 Location of the areas studied during the 2001 fieldwork. A detailed map of Numundo Plantation is shown in Figure 3.

Lotamgan this year has reinforced this conclusion. Although it was useful to visit the area to obtain an impression of the archaeological resources, in order to compare with previous work on Garua Island and our focus area to the south, the current research project is not capable of adequately monitoring and assessing this region.

It is clear that we need to put more emphasis on local awareness of archaeological resources so that managers and workers employed by NBPOL will take a more active role in preserving the very rich and important archaeological heritage of this region. The team has met with field staff at Numundo Plantation and we attempt to explain our work to staff we encounter during our work, but a more comprehensive education program needs to be put in practice.

Archaeological Results in 2001

The aims of the 2001 field trip were achieved successfully. The addition of two new experts to the team, Vince Neall and Ed Rhodes, has considerably broadened the scope of the research and should help solve the problem of dating at the important Pleistocene site of FABM. The initial sampling program for luminescent dating of volcanic tephras was highly successful and also included samples of pottery and burnt stone. Additional sediment samples were collected at FABM for assessment of a number of new dating techniques by Neall's colleagues at Massey University. All these initiatives hold great promise for this very significant site. Detailed studies of sites FABM, FAAH and FEA were undertaken; study test pits were excavated on Numundo, Haella and Kulu-Dagi plantations as part of the long-term study of landscapes; and survey forays by truck were made at Lotamgan and Kulu-Dagi. We begin by summarising the results of the special site studies, then discuss the test pit programme, and finally turn to the general surveys.

FABM Pleistocene site

The site consists of a small remnant hill probably formed in the Pleistocene and now about 10 metres above sea level (Torrence 1999 *et al.*; 1999a). Originally it may have been connected to the larger ridges and hills to the west (e.g. FAAY). Many of the same tephra layers than make up FABM are also observed in the hill just to the west. It appears that Holocene fan aggradation and tephra accumulation has largely

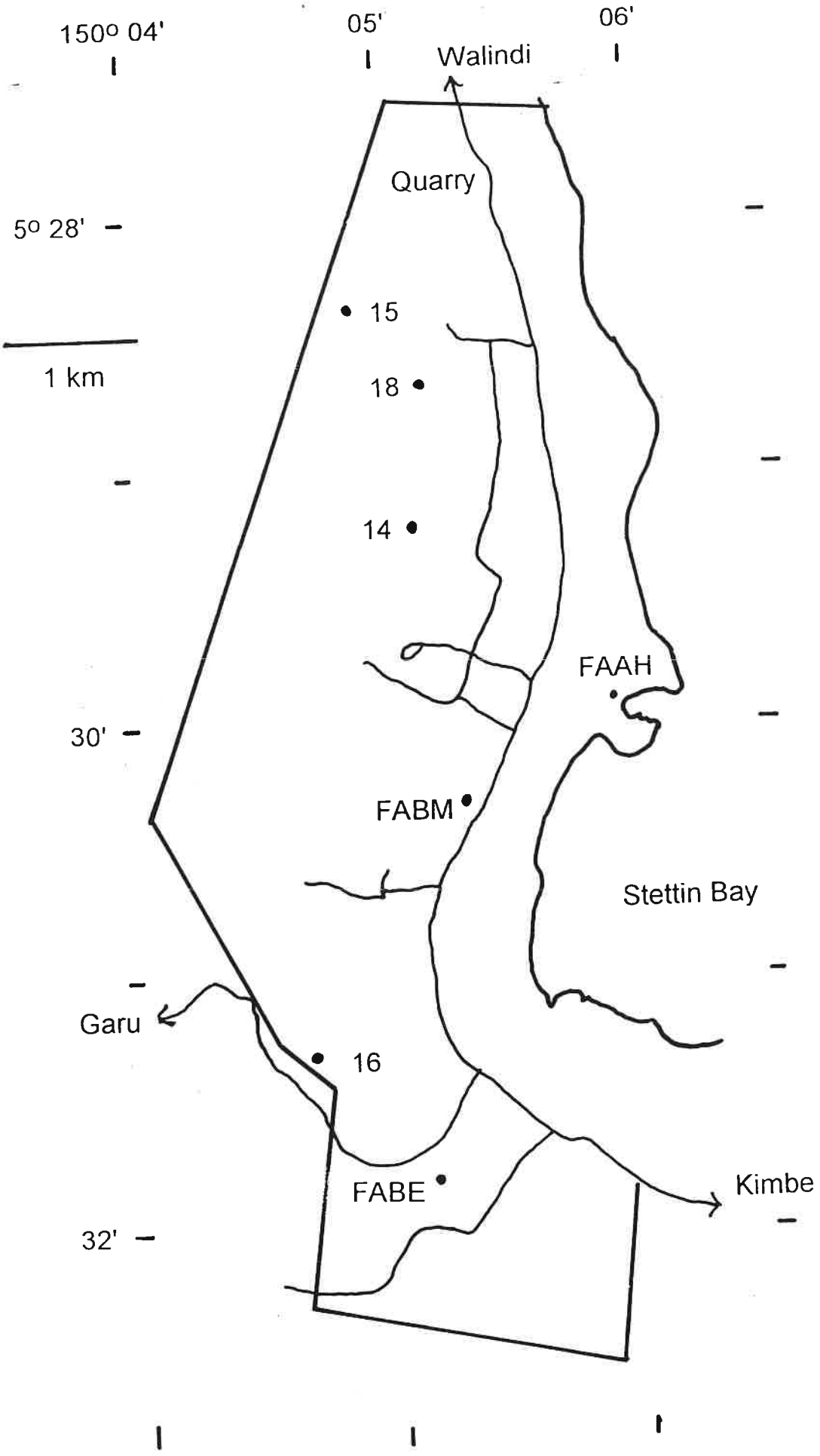


FIGURE 3 Localities studied at Numundo Plantation in 2001.

buried the former dissected landscape isolating this small hill on all sides. The consistent mantle bedding of the heavily weathered Pleistocene tephras and the conformable nature of the Pleistocene sequence suggests that a hill may have been a persistent feature at this location since at least the time the lowest tephras we observed, some 4 m below the top, were laid down, as shown in Figures 4 and 7). At some point in the late Pleistocene or Early Holocene, the hill was eroded to form steep sides. Currently there is an unconformity between the top of the Pleistocene tephras and the base of the Holocene tephras (W-K1 through W-K4). Clearly, the early Witori tephras, W-K1 and W-K2, eroded off the top of the hill soon after they fell and then piled up around the base of the hill thereby creating a more gentle steep slope than the underlying the eroded Pleistocene surface. Subsequent tephras W-K3, W-K4, and the W-H series are draped over the top and sides of the hill. There may have been additional periods of erosion during the Pleistocene period because excavation in squares B and C identified a marked unconformity on the north side of the hill between units E and H (cf. Figures 4, 6, 8).

Just over half of the western side of the hill has been removed by quarrying, but this stopped in 1999 after the discovery of artifacts in the Pleistocene layers (Torrence *et al.* 1999). Shortly before we arrived this year, NBPOL removed a pile of coconut trees cut down in 1998 and also scraped off the topsoil down to the top of the Pleistocene layers over much of the remaining hill (i.e. on the eastern side). Piles of coconut trunks still remain at the northern and southern ends of the hill (cf. Figure 5). We began our investigation of FABM by cleaning off the quarry face on the western side of the hill using earth removal equipment. The machine carved out four sections along the original quarry face through talus created by collapse of the top of the hill and slump of the quarry wall. The sections range from 2-6 metres in height. Excavation proceeded beneath the level of the current ground surface for about 1.5 metres into several layers of very hard tephra and below what appeared to be artifact-bearing units. The sections have been labelled from north to south as cuttings II-V, with section IV located in the tallest central part of the hill. In addition, cutting I is a step cut by the excavator into the northern side of the hill at right angles to the quarry face and intersecting with the top of cutting III. Later cutting VI was made by hand. The steps of cuttings I and VI provided safe access for excavation of the entire profile of the hill. The locations of the cuttings is illustrated in Figure 5 and Figure 6 shows

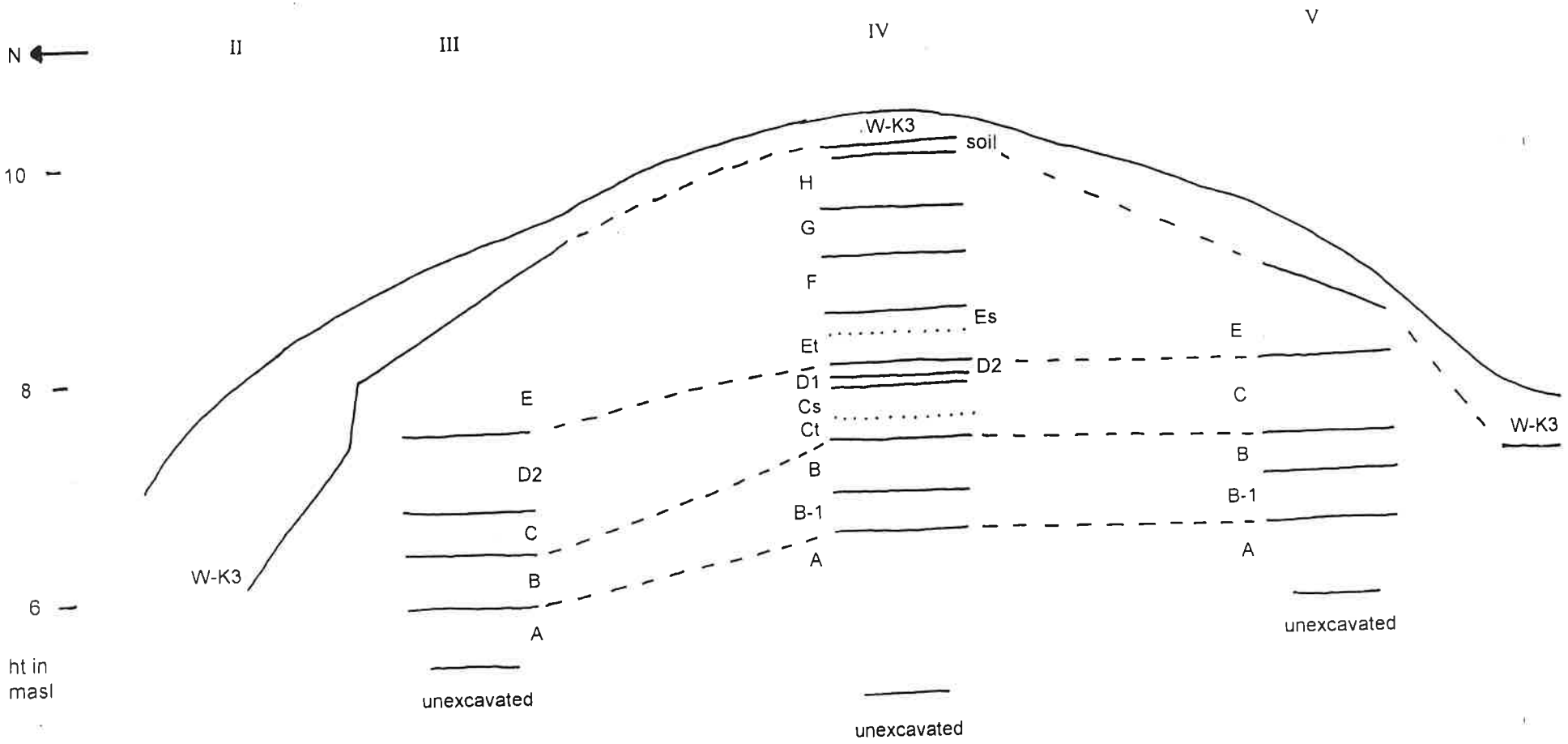


FIGURE 4 Cross section of the FABM hill showing the position of the stratigraphic units in the profiles created by the cuttings. The units were identified by McKee.

cutting IV (with sample holes and flags) on the right and cutting I with the excavation trenches to the left.

Stratigraphic studies were made by McKee and Neall of cutting IV and by Neall of sections in the excavated squares running east-west through cutting I. Summary diagrams showing their results are presented in Figures 4 and 7. McKee concentrated on the description of the tephras, while Neall recorded a range of pedogenic attributes on the sediments and noted anthropogenic features such as stone lines. The orange flags in Figure 6 indicate the boundaries between McKee's units. Various samples of pumice and sediments were collected for geochemical and pedological analyses by both specialists. Rhodes took dose readings and then collected samples for luminescence dating from all the identified Pleistocene units identified by McKee (cf. Figure 13). The location of the samples is indicated by the holes shown in Figure 6.

An archaeological sounding of the hill was made using a combination of 3 one metre squares placed in cuttings I and VI, which are located just above the section at the eastern end of cutting III (Figure 5). Contiguous squares A and B were arranged in a roughly east-west direction using the section at the eastern edge of cutting III as the western end. Square C was placed about 20cm further to the east of square B within cutting VI. C was excavated to a depth of 2 metres below present ground surface and preserved the upper beds of F and H, with G very poorly represented or missing in this locality on the side of the hill. As shown in the section diagram in Figure 8, the lower layers of the site were sampled in squares A and B. Square A (excavated to a depth of 1.9 m below the base of cutting I) began with unit E, was taken well down into unit B, and reached patches of unit A in many places (as represented by the area marked with a tape measure in Figure 9), whereas square B (excavated to a depth of 1.4 m below the base of section I) also began within unit E but was terminated about 10 cm below unit C in the soil on B. No finds were made in unit B, although several stones indicated human presence and 2 artifacts were found in this unit when studying the quarry face in 1999 and 2000. We are confident that the cultural layers have been reasonably well sampled at the site, although due to an unconformity at this side of the hill, units E and G were poorly represented or missing altogether.

All the units at the site are composed of very heavily weathered clays which are very difficult to discriminate, especially in the upper units H-E. For this reason, excavation was carried out mainly by arbitrary 10 cm spits, except where clear

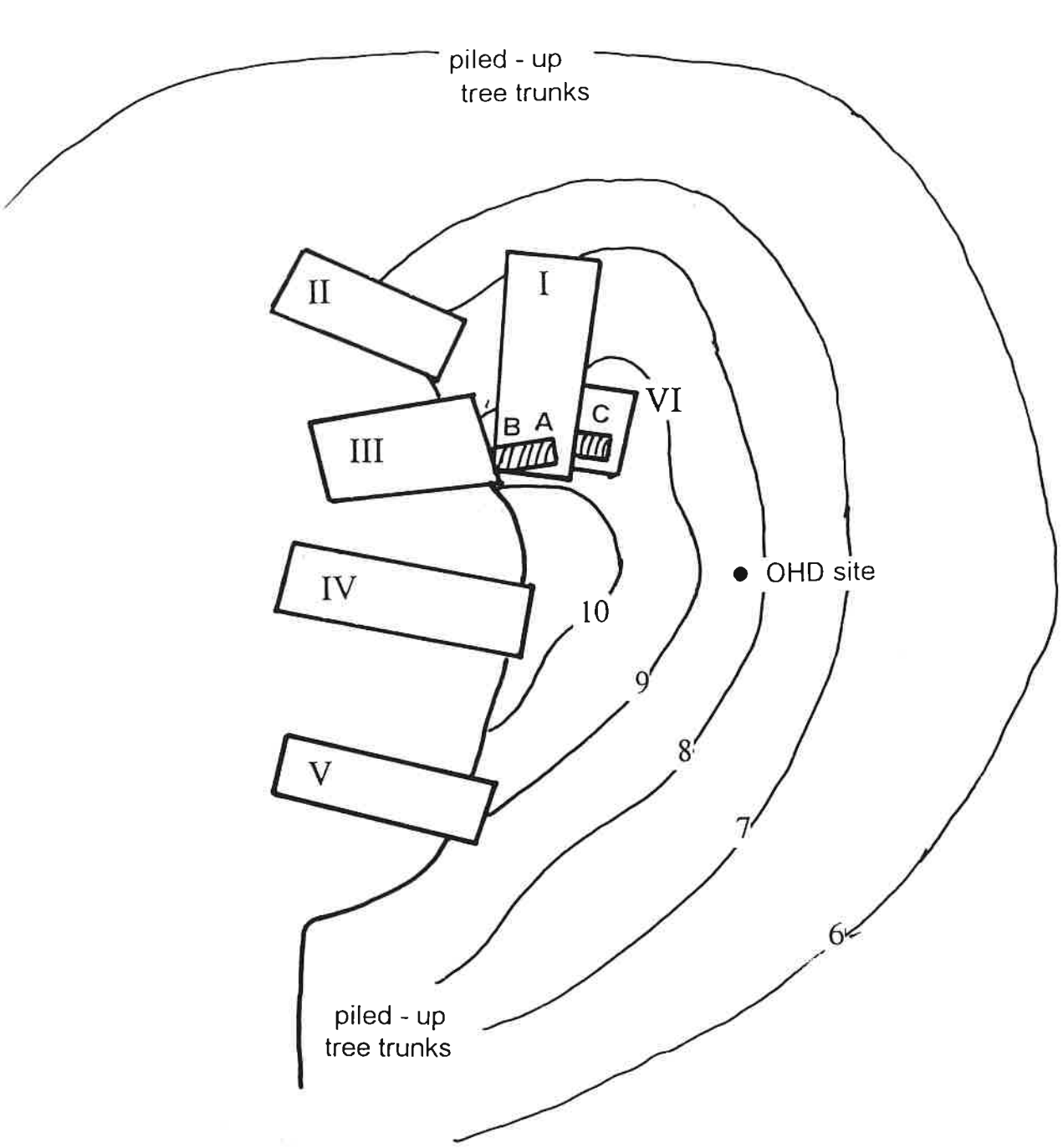


FIGURE 5 Contour map of FABM showing the locations of the cuttings, the excavated squares, and where the obsidian hydration dating (OHD) cells were left in situ for a year.

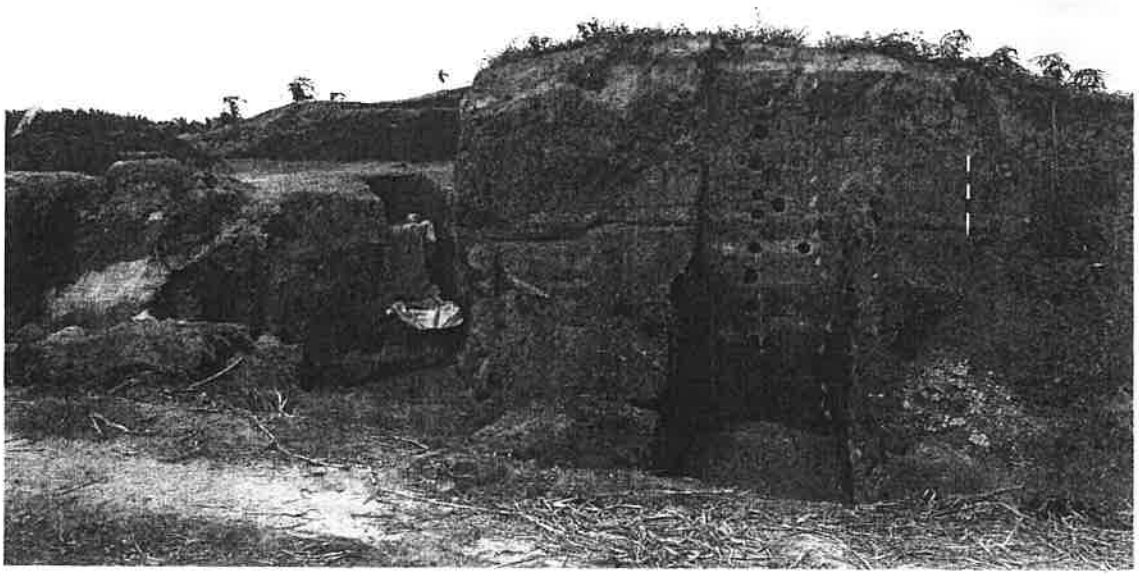


FIGURE 6 The northern end of the quarry at FABM showing the location of the excavated squares A, B in cutting I (covered with orange plastic), square C in cutting VI (just to the right and behind A, B), and the main profile in cutting IV. The orange flags mark the stratigraphic units identified by McKee (cf. Figure 7) and the holes indicate where the luminescence samples were taken by Rhodes.

stratigraphic distinctions could be made using correlations between the sections of the quarry face represented in cuttings III and IV. Subsequently, more accurate correlations were made following Neall's analysis of the excavated sections.

Table 2 shows the number of obsidian chipped stone artifacts recovered from each of the stratigraphic units in the excavated squares and those removed from the quarry face or section IV during sediment sampling and luminescence dating in 1999-2001 (cf. Torrence 2000; Torrence *et al.* 1999a; 1999b). In total 190 artifacts have been found at FABM. All except for 2 chert artifacts (one each in units F and H) are obsidian. The majority of the artifacts are very small, noncortical flakes and many were derived when larger tools were retouched. So far only 2 retouched artifacts have been noted (one each in H and C), but a full study has not yet been made. The surfaces are extremely eroded and pitted when viewed under high powered microscopy and so wear traces have not been preserved.

Artifacts are present in all the identified units, although there are higher densities in units H, F and especially C. Within C the obsidian artifacts were scattered in and among a relatively high density of fractured volcanic rocks which we hypothesize were used as oven stones. As illustrated in Figures 8 and 9, a very dense cluster of stone identified in squares A and B is very similar to the one observed in 1999 in the quarry face at the opposite, southern end of the hill (Torrence *et al.* 1999b).

Since the hill is formed by airfall volcanic ashes, all the stone must have been brought to the site from somewhere else. The majority of the stones are andesite which could easily have been obtained from nearby hills or alluvial fans. Significant stone lines, a further indication of human presence, were also identified in the excavations and in section IV at the top of unit E, in lower unit E, and at the top of units D and B. Unit G, which is well represented in section IV, but is not preserved in the excavated squares, is composed of stones, artifacts, and derived sediments and is anthropogenic in origin. Its apparent restriction to the top of the hill may be related to the localised nature of the human activities (?gardening, levelling, post hole digging) which created this particular unit. Further investigation of this unusual unit is certainly merited but will require excavation at or very near the top of the hill.

Neall conducted a preliminary analysis of weathering on the putative oven stones from FABM and a number of Holocene contexts excavated at Numundo, Haella and Kulu-Dagi. His study of the maximum depth of weathering rinds and exfoliation showed that at FABM these are correlated to depth (and by implication age) and that

assemblages from FABM are significantly different to the Holocene contexts. These tentative results confirm that there are major differences in age between the Pleistocene units at FABM and the Holocene contexts from nearby sites dating back to 6,000 years ago. A more comprehensive study of weathering may help produce a relative chronology and will be pursued in future work.

Even at this early stage of analysis, we can conclude that the FABM hill has been occupied intermittently by humans for a very long time. The number of Pleistocene tephras overlying the high density of artifacts in unit C along with the advanced stage of weathering of the sediments, artifacts, and manuports all indicate a significant age. The occurrence of obsidian (some sourced to the Willaumez sources) suggest a date of less than 40,000 years, which is the oldest fission track date for these obsidians (Bonetti *et al.* 1998). Kutau obsidian, which is known from contexts dated to around 20,000 years ago in New Ireland (Summerhayes and Allen 1993), is absent in the FABM assemblages tested so far. Since Kutau is dated by fission track to 26,707 ± 7688 (Bonetti *et al.* 1998), the site may pre-date the formation of those flows. A comprehensive characterisation study using PIXE-PIGME has been proposed and awaits funding.

The FABM hill was first used at the time of unit B. The presence of a fire cracked stones suggests cooking. In unit C the intensity of use increased greatly. The large number of small obsidian artifacts may largely represent waste by-products of repairing and retouching obsidian tools, but were possibly also used in processing the food from the ovens and/or in other maintenance tasks. Only one small retouched artifact, with two small notches creating a tiny point, has been recovered from this level.

From unit F there is a possible increase in the intensity of use up through unit H. The highly retouched tip of a stemmed tool was found in unit H. However, since the early Holocene tephras were quickly eroded off the hill, unit H may represent a very long period of human use. We cannot accurately assess human occupation during the Holocene period because the upper layers have been seriously disturbed in recent years through land clearing. The Holocene layers have been totally removed from most of the hill.

Although we do not know the source volcano, the thickness of the Pleistocene tephras are similar to those in the early phases of the Witori sequence (Machida et al. 1996). This indicates that the local area experienced serious devastation as a

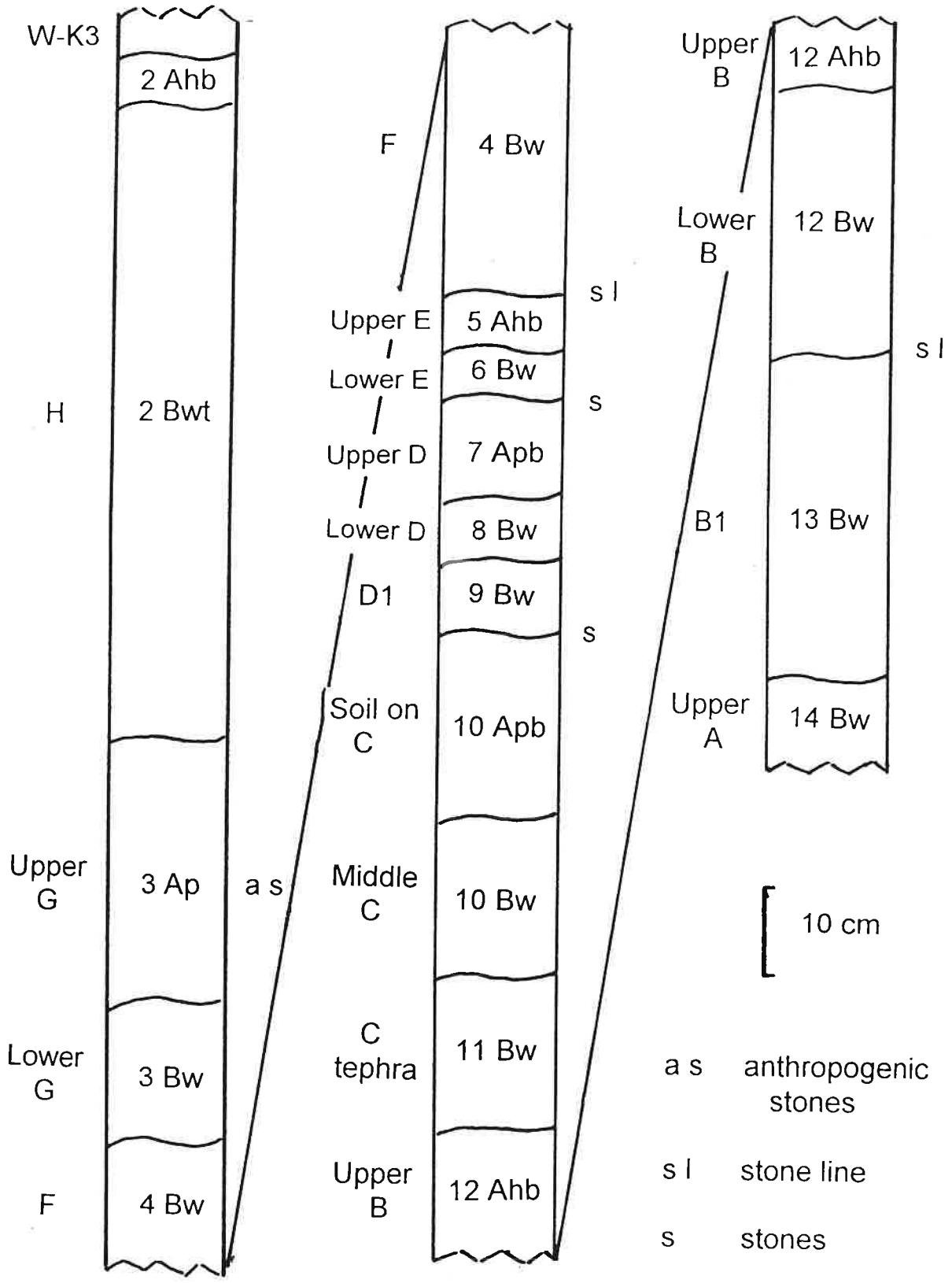


FIGURE 7 Summary section of the stratigraphic units identified at FABM by Neall.

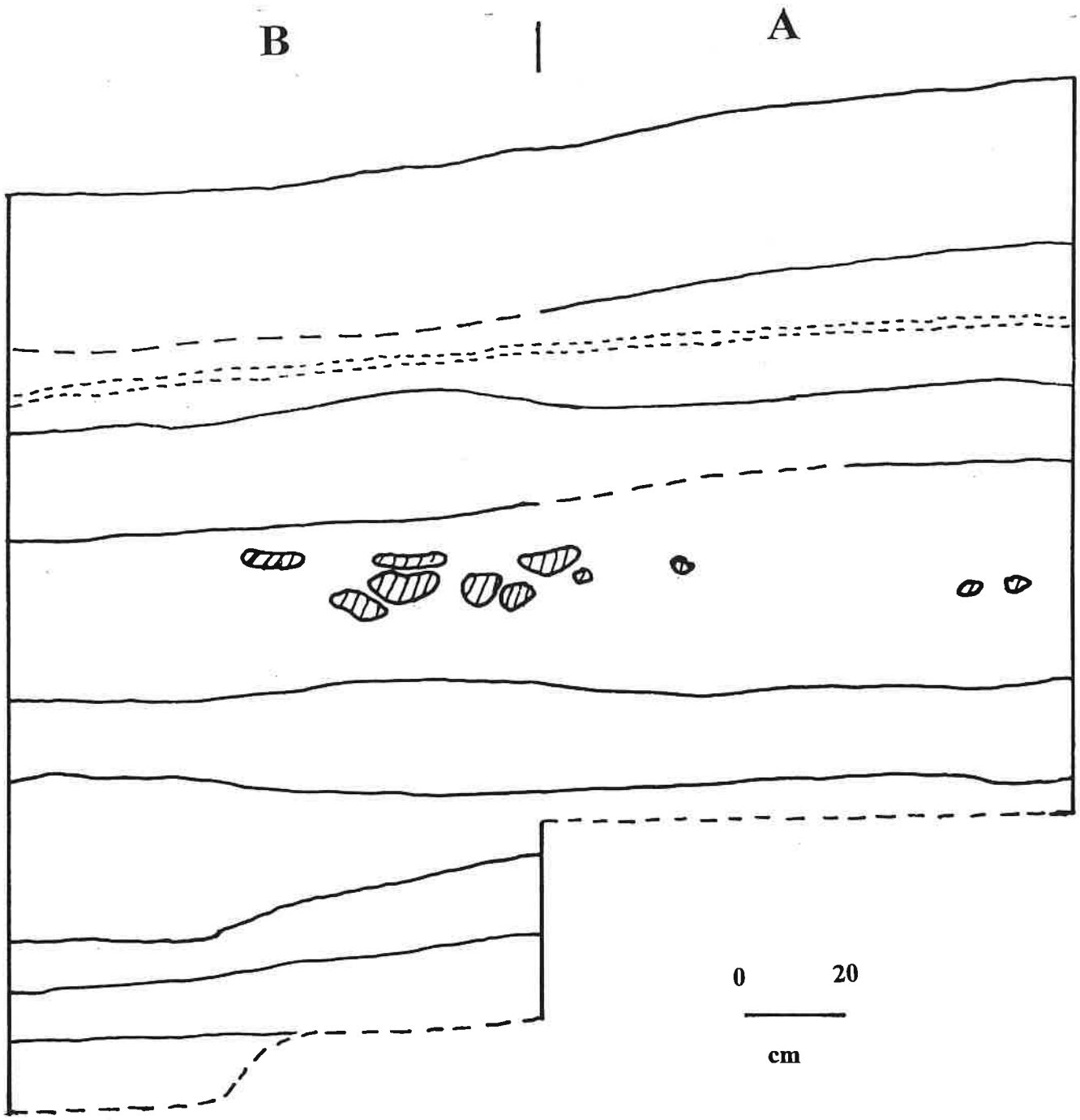


FIGURE 8 Section drawing of the south wall of squares A and B. The stone feature within the C soil is clearly distinguished. A stone line was also detected at the top of unit E.

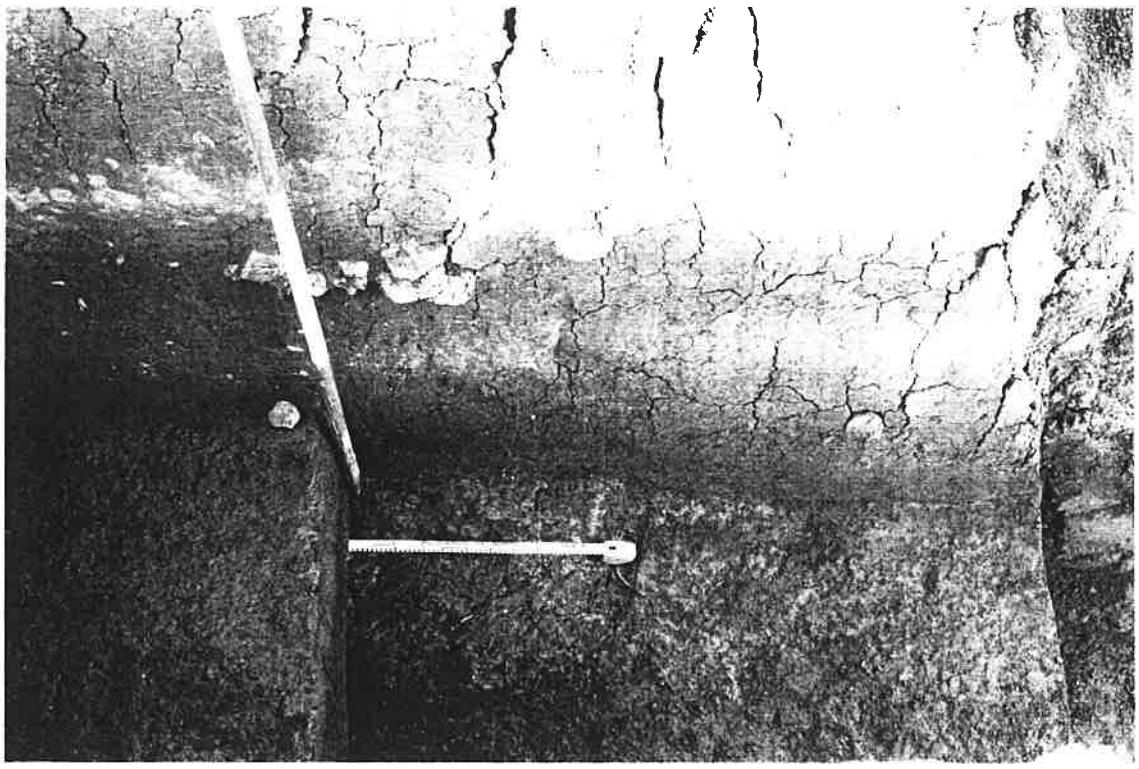


FIGURE 9 View of the southern section in squares A, B (cf. Figure 8) showing alternating layers of tephras (light colours) and soils (dark colours) and the stone feature within the C soil. The horizontal tape lies on unit A.

consequence of each of these events. After some unknown length of time, people returned to the region following each volcanic eruption, much as they did later during the Holocene. Hopefully, one day it will be possible to compare the impact of the Pleistocene volcanic events on human settlement with those of the Holocene (Torrence in press b; Torrence *et al.* 2000).

Finally, the following analyses of sediments and artifacts from FABM have now been initiated: (1) geochemistry of pumices to identify source volcanoes; (2) mineralogy of the sediments to determine environmental conditions under which they were formed and to identify residual minerals that can be used for dating; (3) luminescence dating; (4) microwear and residue analysis of artifacts; (5) characterisation of obsidian to determine sources; (6) technological analyses of the artifacts; (7) phytolith analyses to reconstruct ancient vegetation.

In conclusion, the fieldwork has shown that an excellent record of human land use is preserved within the Pleistocene tephras at FABM. When compared to other sites of roughly this date (?40,000-10,000 years ago), the quantity of artifacts is relatively high, particularly for an open context (cf. Pavlides & Gosden 1994; Pavlides 1999), indicating a high intensity of use, possibly a long-term settlement. Due to the lack of organic material in the highly weathered sediments, we are dependent on luminescence dating or other experimental techniques to place these activities more accurately in time. If our attempts are successful, then an extended programme of excavation at this location may be justified.

FEA Boduna Island (5° 16' 30.3"S 150° 04' 4.6"E)

Although Boduna Island is strictly outside the region of our intensive study, recent finds by John Ray, a local collector from Kimbe, indicated that the site may contain important intact material that was therefore under threat from unsystematic digging. In 1989, during the Lapita Homeland Project, Wal Ambrose and Chris Gosden identified Boduna Island as a rich Lapita site. The data obtained from several test excavations, however, showed that the dry land component of the site was no longer in original stratigraphic context and had been seriously re-worked (Ambrose and Gosden 1991). However, Gosden (pers. comm. to J. Specht) later suggested that the extensive, shallow and well protected sandy lagoon on the western side of the island might preserve the remains of a stilt village like that found at ECA Eloaua. In

2000, further interest in Boduna was stimulated by the discovery in the lagoon of three unusual sculptured pottery faces, clearly of Lapita origin, by local collector John Ray of Kimbe (Torrence and White in press).

The overall objective of this year's investigation on Boduna Island was to decide whether more detailed archaeological research was justified by the presence of undisturbed contexts. The fieldwork therefore tried to determine whether there were any intact deposits remaining with the lagoon. A secondary aim was to try to clarify the nature of the natural and cultural processes which had formed the archaeological deposits currently found on the island.

These questions were tackled by Peter White, Cosmos Coroneos and Ken Mulvaney between 11-13 July, and by Bill Boyd and Vince Neall on 27 July. Permission to study, excavate and collect samples on the island was given by Bernard Mundaro and three other clan elders of Pangalu village, who also nominated our three assistants (Alphonse, Anton and Andre). On first landing, we surveyed around the island, noting that cemented, shelly beachrock containing sherds outcropped on the cleared western side of the island, but that occasional sherds were also found on the north and south beaches. All sherds were well rolled.

A line of 8 small shovel pits (c. 20cm on a side) was then dug from the beach on the western side to a point 50 m inland. These showed that the beach rock was cemented up to 20 m inland from high water mark, but beyond this point the shelly sand was not consolidated though it continued to contain rolled pottery and occasional shells. Away from the beach area, it was overlain by a fine yellow-brown tephra which resembles that derived from Dakataua volcano dated elsewhere to about 1000 years ago. The spatial distribution of this tephra was sharply truncated 18 m from the sea where a deposit of cobbles of coral and large Tridacna clamshells banked up against it to a height of about 90 cm above the current sea level. This deposit is likely to be the result of a tsunami. Neall and Boyd observed a similar deposit within a spade pit excavated roughly 10 metres above the high water mark on the western end of the island. There beneath topsoil and loamy tephra, they found a 30cm deposit of cemented coarse sandy limestone boulders surrounded by pockets of light grey sand. The boulders could only have been emplaced by a sudden calamitous event such as a tsunami.

Neall and Boyd noted three stratigraphic units overlying dead coral heads which relate to the stratigraphy recorded by the archaeology team. Cutting through the

FIGURE 10 Beachrock on the west side of the island of Boduna Island. The large cracks, which contain pieces of Lapita pottery, were probably formed during an earthquake.

lowest level, a weakly cemented coralline limestone, are subparallel fractures up to 20 cm wide which are oriented in a south westerly direction and extend offshore (Figure 10). The fractures in the underlying limestone are too large to be caused by dessication and are similar to tensional faulting created by earthquakes. The orientation of the fractures suggest the tensional stresses were in a NW/SE direction. This could be interpreted as either a NE/SW graben structure between Boduna Island and the nearest shore to the north or a curved boundary fault to a caldera to the west and north. The natural hot springs on the reef around Boduna suggest it is part of an active geothermal field and that this area might demarcate a partially submerged caldera. The cracks contain cemented beach rock with sherds and obsidian artifacts. This second unit had accumulated in a coarse sandy marine, possibly intertidal, environment, but its relationship to the environment at the time the Lapita pottery was deposited is still in question. A radiocarbon date on the shell within this deposit may help resolve this question. The shelly sand was still loose when the earthquake occurred and has become cemented since, implying that the date of the earthquake was later than the time of Lapita pottery and some time before the deposition of the Dakataua tephra which forms the upper third layer.

All these observations suggest that an earthquake and a small tsunami had a profound affect on the archaeological deposits. It seems likely that these catastrophes may be related to sinking of the western side of the island, perhaps a metre of more, and consequently the drowning of some of the archaeological deposit in the lagoon. We found a few pieces of the cemented deposit in the lagoon up to 6 m from the beach (about 1m underwater at high tide) and suggest this is the source of the pottery now found there.

A notable finding in cemented beachrock located right at the beach edge was the existence of several fossil megapode shells. These must have been laid when this part of the island was forested and before the beachrock was cemented, at a time presumably after the island ceased to be regularly occupied by the people who made the Lapita pottery. Two shells were collected and one has been submitted for dating.

Coroneos and Mulvaney systematically surveyed three transects across the lagoon and they also searched along the outer edge of the reef. They noted very few, occasional sherds on the surface of the transects. There were no surface sherds in the half of the lagoon nearer the reef, none on the surface of the reef and none on the outer edge of it. Sherds were collected from small holes (roughly 20 cm deep and up to

30cm diameter at the top decreasing to 10 cm at the base) dug by hand into the lagoon sand. They found that the sand was everywhere quite shallow and was underlain by coral rubble and reef. Sherds, mostly small in size, were found in these holes up to 40 m from the shore, but beyond 20 m out from the island they were very rare. John Ray reported that all the pottery he collected from within the lagoon came from the top few centimetres of sand.

There has been some suggestion that sherds from the lagoon were either larger and/or less rolled than those recovered from the surface collections and excavations on land. We did not carry out extensive measurements, but inspected a) about 250 sherds on the beach and in the lagoon, b) a dump of some 200 sherds which J. Ray had collected in the lagoon but returned to the island and c) some further 200 sherds in Ray's collection in Kimbe. Nearly all sherds from the lagoon are heavily rolled, with rounded edges and thin cross sections. Some sherds are less rolled, a very few even appearing almost fresh. With decorated sherds, the design is sometimes clear but often faint as if lightly abraded. On average, sherds from the lagoon seem to be larger than were found on land, an impression confirmed by measurements of Specht's study of the excavated collection. Thus we consider that the history of the sherds in the lagoon is essentially the same as that of those on land, though whether they were originally dumped as larger sherds or have simply been less broken as a result of taphonomic processes through time is hard to determine.

To conclude, the history of Boduna Island since the time of Lapita occupation has clearly been complex, almost certainly involving tectonic movement, an earthquake and a tsunami (perhaps associated). This has resulted in some of the archaeological deposit being drowned and some cemented within the cracks created by the earthquake. Continued human use of the island, along with the activity of megapodes (one is said to be still resident on the island) has meant that the occupation layer has been continually disturbed and consqeuently most of the pottery has been rolled or abraded. The decoration on the pottery demonstrates that there was Early (Far Western) Lapita occupation of Boduna and probably both later Lapita and subsequent occupation and/or use, but there seems now no chance that any well preserved deposits remain. Chance discovery might produce further unusual sherds, as with the moulded faces, but our following up of Ambrose and Gosden's (1991: 187) statement that "the island definitely merits further investigation" demonstrates that detailed, systematic archaeological research is no longer a useful aim.

FIGURE 11 Test pits were excavated at 4 localities to rescue material that had been disturbed during development activities.

A. Excavation in process at test pit XVI within site area FABE. A large number of trenches such as these have been excavated at Numundo Plantation to bury diseased coconut trunks. The team rescued a sample of artifacts from rich deposits which were exposed in the wall of this trench. They date to periods 5 and 6.

B. Team selecting an area for excavation at Locality 01/12 at Kulu-Dagi. A new road cutting exposed earth ovens dating from periods 3, 4, and ?8. Pieces of pottery as well as ground stone and obsidian artifacts were discovered in the bulldozer push on the side of the road.

C. Lapita pottery, a ground stone pestle, chert and obsidian artifacts were discovered scattered over the top of a small ridge in a road cutting at Locality 01/17. Very few artifacts, however, were recovered within test pit XXII, seen under the tarp in the background.

D. On Avenue 5 at Kulu-Dagi looking east toward test pit XVIII (Locality 01/11) on the hill. Here broken stones and obsidian artifacts were exposed in the road surface.

A

B

C

D

The geological history of Boduna is also important because it preserves evidence of an earthquake and possibly a tsunami sometime between c. 3,000-1,500 (after the time of Lapita pottery and long enough before Dakataua eruption for cementation of deposits to occur). These dramatic events have important implications for human settlement in the region and therefore it would be useful to search for further indications of these events in the exposures along the shoreline of Garua Harbour.

Test pits

Six one metre square test pits were excavated at Numundo (FABE,XVI; FAAH, XVII), Haella (FACC, XIX), and Kulu-Dagi (Locality 01/11, XVIII; Locality 01/12, XXI; Locality 01/17, XXII). GPS locational data and a summary of the periods represented in each pit are presented in Table 3 (cf. Figure). A further test pit, XX at Locality 01/12 Kulu-Dagi, was abandoned at an early stage because the deposits had been highly disturbed as a result of road building activities. Although all the pits will contribute to the overall objective of the current research project, i.e. to gain an understanding of variation in human land use over the region, the samples made at Kulu-Dagi and at FABE were especially selected to rescue sites which had been disturbed by road building and trenching respectively (Figure 1). We were fortunate to acquire samples of material stratified under the W-K1 tephra (i.e. pre-6,000 BP) in pits XVII, XIX, and XVIII. A retouched obsidian stemmed tool was found between the W-K1 and W-K2 tephra at XIX. A very dense deposit of Lapita pottery was recovered from XVII, confirming the importance of site FAAH for this period.

Although dentate stamped Lapita pottery was collected on the surface at Locality 01/17 and plain pottery (?recent) was found at Locality 01/12, ceramics were not recovered from within the stratified contexts in the test pits. In addition, a number of flaked chert pieces were found at Locality 01/17, along with a broken ground stone pestle. These very unusual finds indicate that this site was utilised over a very long period and may have held special significance within the region. Unfortunately, further exploration at both these localities is probably not possible since both represent ridge tops where there is very little, if any, remaining area that has not been bulldozed. Since they have not yet been planted, a watching brief should be maintained to recover additional diagnostic material.

Several preliminary observations resulting from the excavations may lead to testable hypotheses in the next stage of the research. Firstly, the frequency of dense deposits of burned, presumed 'oven' stones at Kulu-Dagi is quite notable. Clusters of these dating to Periods 2, 3, 4 and 7 were observed on road surfaces. The stones had presumably been carried from the Kulu River since similar cobbles do not occur in the current small streams nearby. Whether the presumed high density of earth ovens in the hills in the Kulu-Dagi region is related to the abundance of raw material because of its proximity to the river or to the existence of specialised economic activities is an interesting question that should be pursued in future research.

Along these same lines it was notable that nutshell was virtually absent in the Kulu samples, although it is quite common at Numundo. We presume that this is likely to be an environmental difference because there are likely to be fewer nut producing trees present in the swampy regions. Unfortunately, the lack of nutshell has the additional effect of causing a serious lack of dating material for the swamp environs. Finally, it is notable that the densest deposits of material recovered from Kulu belong to the earliest Periods 2-4 with almost nothing recovered later. Part of this problem may be due to greater disturbance of the upper levels through oil palm activities, but it is notable nevertheless that the large amounts of material typically found on the soil developed on the W-K4 tephra, dating to Period 6, were absent at Kulu, although this period is well represented at Tili. Detailed survey of Kulu needs to be undertaken. Our work this year was dominated by rescue activities.

General Surveys

A special trip was made to Lotomgan primarily to study geological sections containing the Dakataua tephra and to search for evidence of the so-called 3.5 tephra which has been found at Numundo. Numerous archaeological sites were encountered while driving around the region. In addition, several sites were pointed out to us at Kulu-Dagi by Jamie Graham and Ruari MacWilliam and another was located during a foot survey.

Lotomgan Plantation

After paying our respects to the local big man, Bernard Mundaro, at his residence on the beach nearby, the rest of the one day trip was spent at Lotomgan

Plantation. We were fortunate to be guided by Ben Valuka, a traditional owner of much of the area who is extremely knowledgeable about the location of traditional villages. We were unable to visit all the old villages that he knows about and recommend that NBPOL record GPS readings of these places while the knowledge is still accessible.

Our brief truck survey along a few major roads confirmed the impression gained in 2000 that this region contains a great number of archaeological sites. We recorded a wide range of site types: a mortar near the current SDA church; cupmarks of various sizes on boulders both a few metres inland on a small hill and at sea level on the shore at Rovu (01/02); surface scatters of obsidian (01/03-4); a traditional village, Malokutanga, at 01/07 where there are dense scatters of obsidian, burned stone from earth ovens (some of which are still relatively intact), and sea shells and where Valuka has also collected polished stone axes; scatters of Lapita pottery on a small hill (01/06); as well as deeply buried obsidian artifacts including stemmed tools pre-dating the W-K2 tephra of 3,600 years ago (01/05, 01/08, 01/09). Surface collections were limited to Lapita pottery (01/06), stemmed tools (01/05), and a few shells for dating and a large collection of obsidian for characterisations studies from Malokutanga (01/07). Clearly, archaeological material dating from at least 6,000 years ago up to the recent past is fairly abundant in the Lotomgan region and there appear to be a number of places with intact stratigraphy. Further detailed surveys and excavations are clearly merited.

Garu Plantation

Only parts of two days were spent on Garu Plantation during this field trip. In the first instance the peat section exposed in a ditch at Locality 01/10, which is situated very close to the deep samples of tephras and peat collected at Location 1 in 1999, was investigated for the possibility of luminescence dating of the tephras. The very low dose readings taken by Rhodes differed markedly from those at other localities and indicate that the peat and/or submersion in water had probably interacted to contaminate the tephras. These samples will therefore not be used for luminescence dating.

Study of the section itself, however, was extremely useful for interpreting the 1999 section. On closer inspection one could determine that what had previously been assumed to be a tephra (designated as tephra 4) was in fact a fine silt comprising

predominantly 15-20 μm sized volcanic glass shards and interbedded plant material including sago leaves. It probably represents an overbank flood deposit which was the result of a single large flood that occurred over the whole swamp. A similar bed was also observed in the Kulu swamp. Further stratigraphic studies over the region could determine the spatial extent of this major event. The closer study of the section at 01/10 has markedly improved our interpretation of the radiocarbon dates from the 1999 section because we can now easily link the stratigraphic sequences recovered from excavations at Haella and Numundo to the Garu swamp peat and tephra samples which will form the cornerstone for dating the various volcanic eruptions. Furthermore, the two unidentified thin tephras within Peat 4 are stratigraphically equivalent to the Witori-Galilo (lower) and "3.5" (upper) tephras and so this section provides an opportunity for obtaining further dates for these events, if their composition can be matched with known occurrences elsewhere.

The team also visited the staff compound of Boku Hill which provides an excellent viewpoint of the surrounding region. Slightly raised ground was identified in several areas and will be targeted for test pit sampling in 2001. Finally, we also revisited site FACG at a local hot springs in the company of Kefu Boromana, Garu Plantation manager.

Kulu-Dagi

Recent road building activities at Kulu-Dagi have revealed a number of very important sites (Figures 11, 12). The team was much assisted by Jamie Graham and Ruari MacWilliam who provided an excellent orientation of the region, provided maps, gave us a tour of newly cleared areas and peat swamp, and pointed out where obsidian artifacts and oven stones were found in a road surface eroding from under the W-K1 tephra (i.e. older than 6,000 years) (01/11). They also introduced us to 01/12 where additional clusters of oven stone disturbed by road building were identified (Figure 11). In this case a dense scatter of angular stones and obsidian flakes at Area 1 is stratified under the W-K2 tephra (i.e. older than 3600 years); at Area 2 a compact feature comprising fire cracked stone was found eroding from under W-K3 tephra and lying on the W-K2 tephra (3600-1800 years old); and in Area 3 a cluster of fire-cracked stones belonging to the most recent 500 years were recorded and sampled. Test pits were excavated at both these localities.

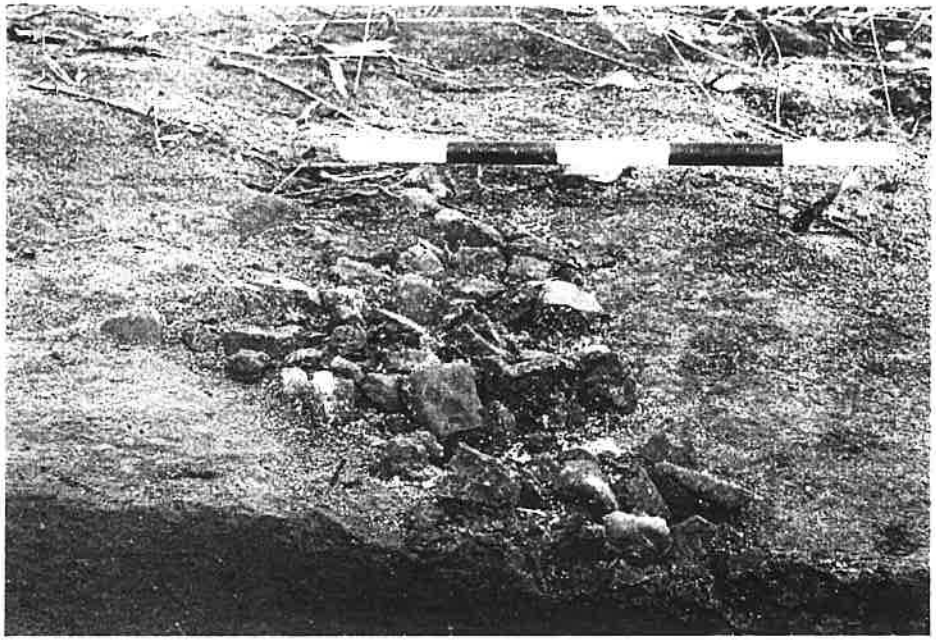
FIGURE 12 Clusters of broken river cobbles and obsidian artifacts that may be part of ancient hearths or earth ovens were common finds at Kulu-Dagi in 2001.

A. A small cluster of angular cobbles was found in a bulldozer cut along a new road at Area 3, Locality 01/12. The stones lie within a shallow pit containing charcoal and ash that might be the remains of a hearth or earth oven. The feature probably dates to within the past 500 years.

B. A tightly packed cluster of stones, possibly the remains of an earth oven, was found eroding from under the W-K3 tephra (i.e. older than 1800 years) in a road cutting at Area 2, Locality 01/12. The feature is relatively shallow but has left a dark stain in the underlying W-K2 tephra.

C. At Locality 01/11 a dense scatter of broken stones and obsidian artifacts was eroding from under the W-K1 tephra (i.e. older than 6000 years) in the middle of Avenue 5. The feature is at least 2 metres in diameter since it was found in the nearby test pit XVIII.

D. Area 1, Locality 01/12 where a dense cluster of broken river cobbles and obsidian artifacts was discovered eroding from under the W-K2 tephra (i.e. older than 3600 years). The feature has a restricted distribution since it was not recovered in test pit XXI, located near the blue tarp seen in the background.



A

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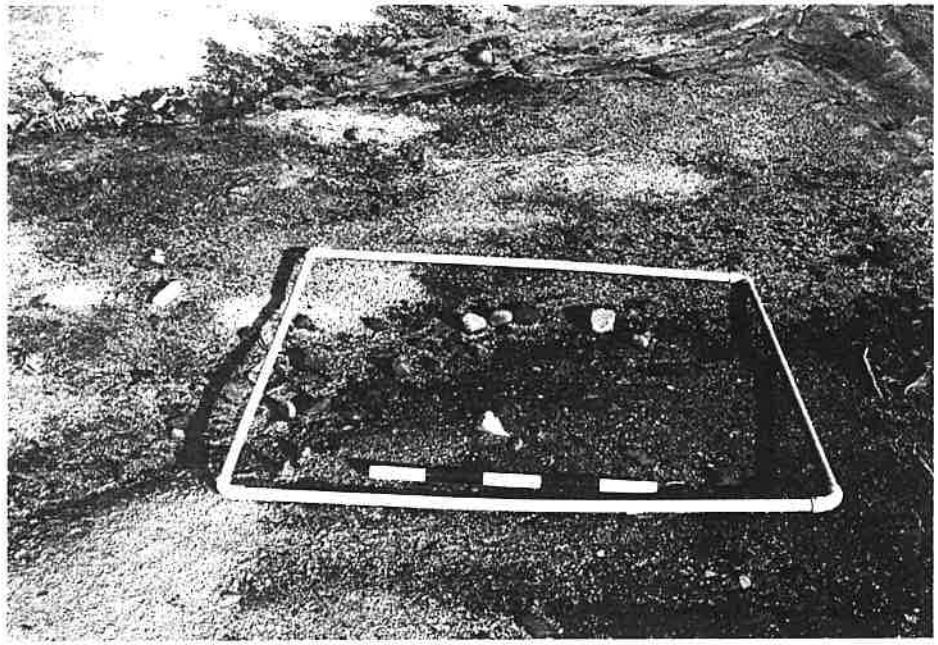

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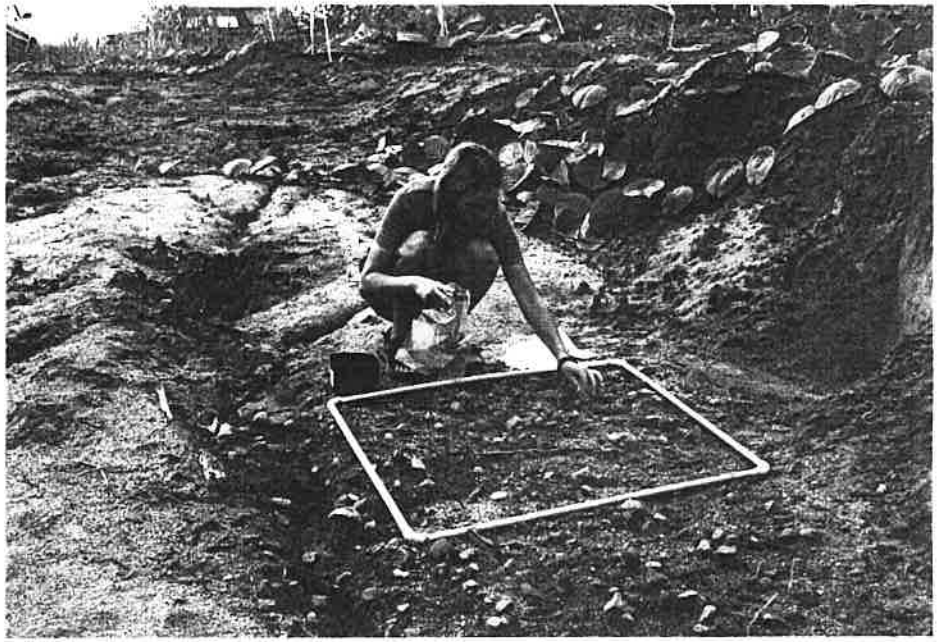

D

In addition the team made a very brief foot survey from the logging camp headquarters down Road 6 to Avenue 2. Scattered obsidian artifacts were observed on Road 6 but their original provenience is unknown. During this survey Locality 01/17 was identified on a small hill on Avenue 2 and later a test pit was excavated (Figure 11).

Boyd and Neall spent one day checking sections in the test pits and in ditches close to 01/17 and then in the region near 01/19 (between Avenues 6 and 7 and Roads 6 and 7). The objective was to assess the evidence for relative sea level change.

Numundo Plantation

Two new sites consisting of dense obsidian scatters were recorded on Numundo Plantation at 01/15 and 01/18, both in the north western corner of the plantation which was not systematically surveyed in previous years. In addition, one of the workmen, Te Kera, also took us to Locality 01/18 (located within the region designated as FABL) where he had found a very large ground stone axe. Having surveyed the terraces and surfaces in the area, this appears to represent an isolated find spot. We did not locate associated archaeological deposits in the near vicinity. FABL was only surveyed along the roads by truck before the area was terraced and planted and so it is likely that there are archaeological deposits in the region that have not yet been identified. However, now that the groundcover has grown up, survey along the terraces is no longer likely to be a productive strategy. Hopefully the sharp eyes of the workmen will continue to alert us to other localities with intact stratified material.

We also walked over parts of the very large hill which has been assigned the site code FAAH and identified very dense scatters of obsidian probably dating to the past 500 years at Localities 3 and 4. These merit further investigation by test pitting. At Locality 5, which is on flat land near sea level at the edge of the mangroves on the eastern end of the hill, Specht dug and augured three shovel pits to try to identify ancient beach deposits, but only recent redeposited material was observed before sea level was reached. A sherd with Far Western Lapita decoration found in this locality may indicate the presence of a contemporary beach now deeply buried, but testing this hypothesis would require the assistance of earth moving equipment. Further survey around the base of the FAAH hill also did not reveal any other obvious places to search for a Lapita age beach.

Large proportions of Numundo have been and will continue to be trenched in order to bury coconut trees, thereby destroying many stratified deposits. We examined a few trenches in the areas designated FABE and FABK and found well stratified layers with dense deposits of obsidian primarily in the soil developed on the W-K4 tephra (Cover photo, Figure 11). Test pit XVI was excavated at FABE to investigate a very black soil formed on the W-K3 tephra, but the trench at Locality 01/14 in FABK was accidentally backfilled before we could make collections or record the stratigraphy. Given the great thickness and richness of the deposits in this area, further investigation may be necessary. Torrence made a visit to the FABO area with Bob Wilson to discuss ways to protect the known and suspected archaeological deposits when trenching takes place in this region of the plantation.

Dating

Luminescence Dating

Luminescence dating is absolutely fundamental to our archaeological research for two reasons. Firstly, it is important to have dates for the volcanic tephras which are independent from the archaeological deposits, since it is possible that people abandoned the area before the tephras fell and did not return for some time afterward. Dating the archaeological material would therefore provide false dates for the eruptions. Currently, we are dependent on dates mainly obtained from archaeological contexts in stratigraphic layers above and below the tephras (e.g. Torrence *et al.* 2000). Very few radiocarbon determinations have been made on organic material trapped in the tephras. Secondly, organic material has not survived within the Pleistocene layers at FABM. Luminescence dating provides the best solution for dating human occupation at this and other Pleistocene locations.

Rhodes recorded local dose rates and collected sealed and bulk samples of tephras from FABM (Figure 13), FAAH, and Locality 01/11 at Kulu-Dagi. Sampling at the Garu peat swamp (01/10) was abandoned due to inconsistent dose rates on these waterlogged contexts. In addition, ceramic samples were collected at FAAH and burned stone at FAAH and Localities 01/11 and 01/12. Experimentation with these will provide the opportunity to extend this technique to additional materials and contexts in the future.

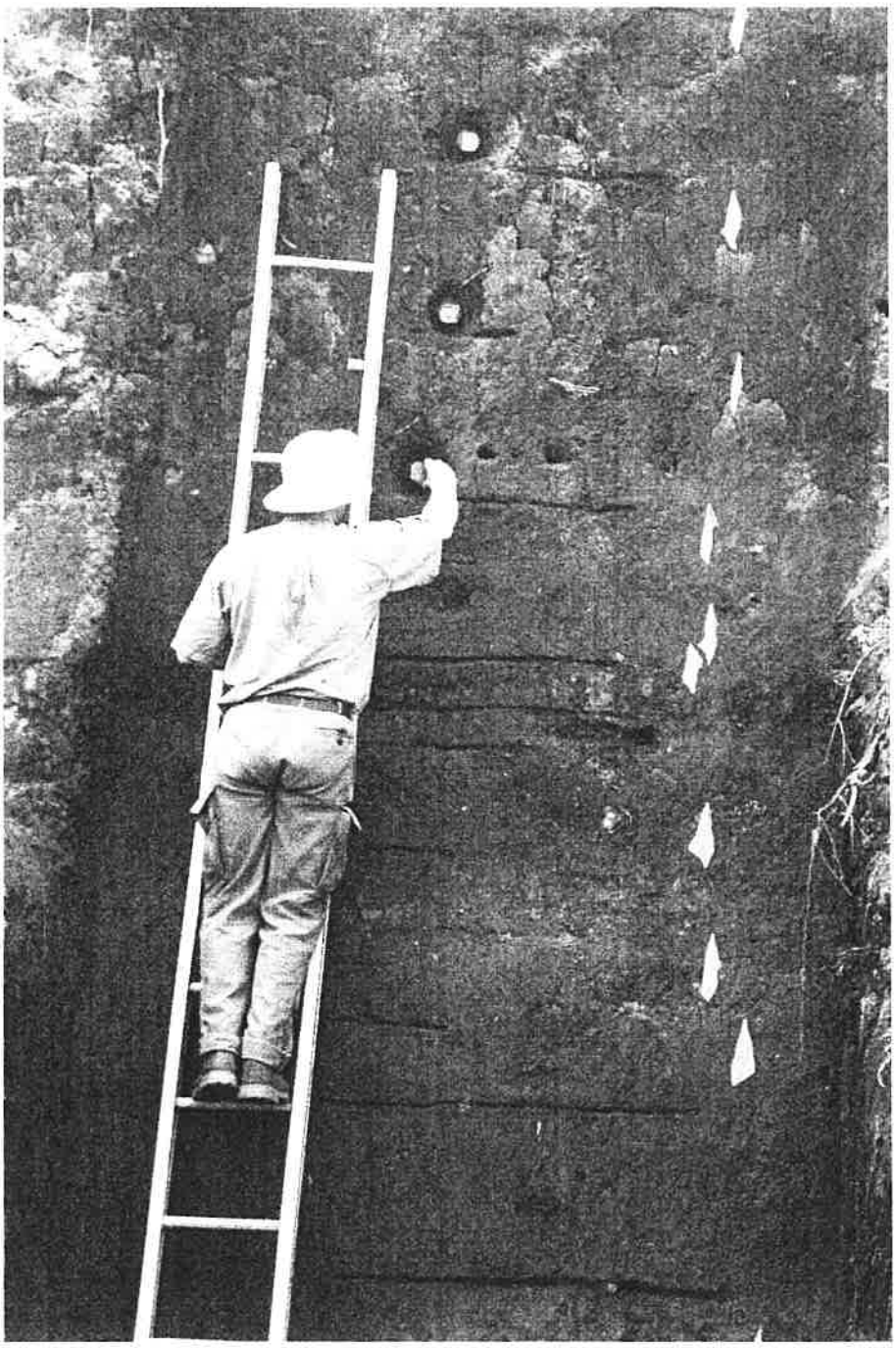

FIGURE 13 Ed Rhodes placing a sample tube for luminescence dating in unit F at FABM. The orange flags show the locations of the stratigraphic units identified by McKee (cf. Figure 4).

Temperature monitoring cells

Relative temperature is a critical variable in the calculation of calendrical dates using the width of the hydration rinds preserved in obsidian artifacts, a technique called obsidian hydration dating (OHD). To obtain accurate estimates, Wal Ambrose, Australian National University, has been experimenting with a number of methods. During the field season in 2000 we placed plastic tubes containing his newly designed cells at one coastal (FABM) and one inland (FACD, the Hoare's garden) sites. The location of the OHD site at FABM is noted on Figure 5. Fortunately these were not disturbed during the year and were successfully recovered at the beginning of the field season. They have been returned to Canberra where Ambrose will assess the effectiveness of his new method and produce readings that will improve the accuracy of obsidian hydration dating both here and elsewhere.

Environmental Studies

In order to understand changes in human land use, the archaeological record needs to be understood in conjunction with changes in the physical and natural components of the environment. To achieve this aim, collaboration with geology, geomorphology and paleobotany is required and so scientists from these fields have been integral to our archaeological research. Ongoing studies of plant microfossils, especially phytoliths, starch and pollen, will help reconstruct the history of vegetation in the region and its relationship to volcanic events and human activity (Therin *et al.* 1998). No new samples were collected this year as studies of samples taken in previous years are still in progress.

This year we were aided by Chris McKee (Geophysical Observatory, Port Moresby), Professor Vince Neall (Massey University, New Zealand) and Professor Bill Boyd (Southern Cross University). McKee and Neall focussed on the FABM site in order to clarify the stratigraphic sequence and to take samples to help us understand the source and nature of the volcanic eruptions and to reconstruct human activities by various analyses of the anthropogenic aspects of the sediments in which the artifacts occur. Neall also sampled site FAAH to get a comparative Holocene sample. McKee continued his analyses of two local eruptions identified in 2000 and visited Lotomgan

to observe the Dakataua tephra. Boyd focused his attention on the geomorphology of Numundo in order to reconstruct the history of landforms and relative sea level in this region. Boyd and Neall also visited the Kulu-Dagi project and Boduna Island.

The 3.5 eruption

In the southern end of the Willaumez Peninsula a thin tephra sandwiched between W-K3 and W-K4--provisionally termed 3.5-- has been observed at many locations. It was not identified in the first formal description of the Witori tephra sequence (Machida *et al.* 1996), and therefore appears to be absent in the source area for Witori tephra. 3.5 is characterised by three components. An orange pumice lapilli occurs at the base. This is overlain by a unit consisting of grey-brown clots of vesiculated, poorly-sorted, fine-coarse ash and aggregates of accretionary lapilli. This unit is evidently phreatomagmatic and is somewhat coherent. The uppermost unit is an orange-brown, fine-medium, friable ash.

A similar thickness was observed at FACC (11 cm), FABE (12-13 cm), Bantam's Hill (10-11 cm.). These are thicker than those observed in 2000, at Tili (3 cm) and at Kulu Dagi (7 cm) and additional data are needed to determine source volcano for 3.5. The greater thickness of 3.5 at the more northerly locations (Haella, Numundo Plantations) suggests that the source lies in this direction, possibly to their north or north west.

One sample of the phreatomagmatic unit of 3.5 collected in 2000 has been chemically analysed and has been shown to have a basaltic andesite composition unlike the more common dacites in the Witori sequence. However, the basaltic andesite SiO_2 content of the WK3.5 sample is similar to that of the dark lithic clasts in WK3. The principal differences between WK3.5 and Witori tephra (at similar SiO_2 levels) are the markedly higher contents of Ti, Fe and Mg in 3.5. Trace element data, particularly higher contents of V, Cr, Ni and Cu, confirm the mafic nature of 3.5.. Another important chemical difference is the greater content of K in 3.5. These results confirm the field studies indicating that 3.5 did not originate from Witori.

Additional samples were collected in 2001 for further analyses. Determining the source, spatial extent, and date of the 3.5 eruption is important for understanding what impacts this event could have had on the prehistoric population living in the area at this time.

Dakataua (Dk) tephra

The Dakataua (Dk) tephra is attributed to a caldera-forming eruption at Dakatau Volcano at the northern end of the Willaumez Peninsula (Machida *et al.* 1996). The full sequence of Dk consists of plinian and phreatomagmatic airfall tephras at the base and phreatomagmatic lithic-rich pyroclastic flows at the top. Deposits of it were examined by McKee at two locations at Lotomgan plantation, in the northern part of the Willaumez Peninsula. At these sites, about 15 km from the southern rim of Dakatau Caldera, no flow phases were observed and the Witori W-K2 tephra was found at the base of the exposures. The overlying sequence interpreted to be Dk consists of a mid-brown fine ash at base which is succeeded by an apparently plinian deposit – distinctively mottled yellow-grey fine ash containing abundant pumice and lithic lapilli. Mud–armouring of the clasts and the presence of mud in the matrix suggests a phreato-plinian mode of eruption. Overlying this unit is a yellow-brown fine ash containing fine pumice lapilli which in turn is overlain by a similar orange-coloured tephra. The top of the sequence consists of a mid-dark brown very fine ash grading into soil. The total thickness of the tephra intepreted to be Dk at these sites is 100 cm and 118 cm.

The Dk sequence present in the Lotomgan area appears to correlate with the (pre-flow) airfall component of Dk described from the south western foot of Dakatau Volcano (Machida *et al.*1996). The overall normal grading in the Dk sequence at Lotomgan may be due to increasing fragmentation of the erupted material caused by increasingly more explosive activity prior to the flow-forming phase. Such a progression would be a consequence of increasing interaction of water with magma. A sample from the basal fine ash and samples of the pumice and lithic clasts from the phreato-plinian layer were collected for chemical analysis.

Tephra Accretion

One of the major aims of the project is to investigate the impacts of volcanic eruptions on human settlement in the region. To achieve this we need to assess the timing and scale of each volcanic event and to compare them to the history of human abandonment and reoccupation (cf. Torrence *et al.* 2000; Torrence in press). Up to

now, the depth of the tephra has been used to monitor the nature of the impacts on vegetation. However, there is a potential flaw with our previous assessments because it has been assumed that each fall of airborne tephra occurred during a relatively short period of time.

Neall's analysis of sections, particularly at FAAH and at site FAO on Garua Island (Figure 2) suggests that our assumption is false for some eruptions, in particular unit H, middle C, W-K3, W-H3, W-H4, W-H5 and Dk (Dakataua). In each of these cases varying depths of very fine ash occur above the major tephra deposit. These indicate that over a relatively long period, small inputs of tephra were constantly added at a rate that did not enable vegetation to recover. The process is known as tephra accretion. In the case of the W-H series, thin layers of ash fell in and among vegetation creating a discontinuous line of small concentrations of tephra ('cream cakes'). Tephra accretion would have created a very unfavourable climate for human settlement and made the region uninhabitable for much longer than had previously been suspected. This is particularly the case for W-K3 and Dk. These new observations help explain why there is very little if any indication of human presence in the region following the W-K3 eruption. For Dk the evidence is not so clear and a better programme of radiocarbon dating of reoccupation is now called for.

Numundo Maar

The existence at the northern edge of Numundo Plantation of a low-relief, explosion crater, of a type called a maar, was confirmed during the 2001 fieldwork. This year more detailed inspection of exposures in the active modern quarry, a matching arcuate ridge about 500m north of the quarry, and at tephra at sites north and south of the maar were carried out.

Exposures at the base of the quarry face, in the southern wall of the maar, indicate that the material making up the ridge is predominantly fine-grained (fine-coarse ash), thinly-bedded (1-15 cm), gently-dipping tephra. The tephra is poorly sorted and contains scattered large clasts (to 0.5 m), particularly abundant at the base of the section. The indurated nature of the tephra and the presence of abundant accretionary lappilli provide evidence that the tephra was wet when deposited. In general, the tephra sequence appears to be laterally continuous on the scale of the

outcrop (≈100m), which would suggest an airfall origin. The presence of impact sags beneath some larger clasts is consistent with this mode of formation. However, some beds are discontinuous and may have been deposited from pyroclastic flows. Near the top of the sequence, lenses of fine grained tephra pinch and swell over a range of a few centimetres. These lenticular beds are characteristic of deposits formed from pyroclastic surges. This mixture of fall and flow deposits would be expected in a maar tephra sequence.

The latest eruption deposits from Numundo Maar comprise a distinctive yellow-grey platy tuff and an underlying, possibly related, scoria lapilli. The tuff is comprised of fine-medium ash, but contains fine lapilli of yellow pumice near its top. Massive to faintly laminated layers alternate with layers consisting of accretionary lapilli and vesicles. The layers are 2.5 -6.0 cm thick at the quarry on the southern rim of the maar. The exposed thickness of the tuff at this location is about 2 m, but the upper part of the unit has been removed by quarrying operations. The scoria deposit beneath the platy tuff consists of fresh-looking dark scoria lapilli. The thickness of this unit at the quarry is about 40 cm. The contact between the scoria and the overlying tuff is sharp and so there appears to be little or no time break between these deposits.

The distinctive platy tuff at the top of the maar tephra sequence at the quarry was previously identified within excavations at FABK and FABO to the south. At Section XV, 650 m south of the quarry, a road cut exposes 1.80 m of dull yellow-grey platy tuff. Probably all of this deposit is airfall tephra. Underlying the platy tuff is a 0.1 m layer of scoria-bearing tephra. This unit in turn is underlain by a thick, dark red-brown soil. The maar deposit is therefore older than the W-K2 tephra which lies above it. How much older is uncertain although the very thin soil separating the scoria-platy tuff sequence and the Witori sequence suggests that there was not a long interval between these tephra sequences. A sample of the soil underlying the deposit was taken for radiocarbon dating.

Immediately north of the maar at the edge of a disused plantation road, about 4 m of platy tuff is exposed. The lower 1.5 m of the section consists of strongly-bedded, yellow-orange platy tuff. The upper part of the section comprises thinly-bedded, grey-yellow tephra which may include pyroclastic surge deposits.

Eruptions at the Numundo maar would have had a significant impact, particularly in the immediate few kilometres. Deposits of the latest eruption are

several metres thick within 1 km from the maar, and retain damaging thickness of at least 0.5 m up to distances of 3-5 km. The much more local pyroclastic flows would have been lethal.

The Numundo maar is related to the volcanic system that constitutes the southern end of the Willaumez Peninsula. This complex includes the stratovolcanoes Krummel, Garbuna and Welcker which form a north-trending alignment of volcanic centres spanning a distance of about 20 km. These centres appear to have developed within the remains of a large ancestral volcano represented now by the arcuate ridge forming the lower eastern flank of the Krummel-Garbuna-Welcker complex. Further research to reconstruct the history of these volcanoes is certainly justified as they are a likely source for the Pleistocene tephras and for the unknown 3.5 as well as a stimulus for the maar.

Geomorphology

Attention was again focused on reconstructing the history of the coastal plain on Numundo and changes in relative sea level in areas bordering the Kulu river system. Mention has already been made of a discovery this year of a major flood dating within the past 500 years in the region of the Garu Plantation and the confirmation of a possible marine incursion just before the W-K4 event. Radiocarbon dates from the peat (in progress) should help clarify the timing of these events.

Only one relevant section at Locality 01/19, located on Road 7 between Avenues 6 and 7, was studied at Kulu-Dagi this year. At this location we observed an unconformity between a marine sediment which was formed under water and the W-K3 airfall tephra which overlies it. The base of the W-K3 tephra has not been reworked in any way and must therefore have been deposited on dry land and not in water. Similarly, there is no evidence for erosion on the top of the marine unit, as would be expected if there had been a significant time interval between the lowering of relative sea level and the emplacement of the W-K3 tephra. In order for this to have been the case, the marine clay must have been raised above water level just prior to the W-K3 event. We propose that the unconformity was created by an earthquake, probably associated with the W-K3 eruption, whereby the land was raised up significantly and therefore relative sea level was lowered. Future work is needed to identify the spatial extent of the earthquake induced uplift and to map the pre and post

W-K3 coastline. The history of the coastline is particularly important for understanding what the contemporary environment was like when the Lapita pottery was deposited at Locality 01/17, which is now significantly inland. Environmental changes are also crucial for explaining the apparent density of pre-Lapita sites in the region as well as the seemingly low population in more recent times. Additional geomorphological work needs to be carried out in the Kulu-Dagi region to answer these questions.

The study of the physical evolution of the Numundo coastal landscape focussed on all except the southern most part of the plantation. It now seems likely that in the region north of the FAAH hill, the location of the coast has been largely determined by the position of a number of fans spreading off the foothills and associated downstream alluvial spreads. The initiation of these fans pre-dates the Witori sequence, therefore suggesting that the general coastal configuration has been stable since the mid-Holocene. Within the region, however, the history of alluviation has altered the distribution of dry land, swamps and streams, beginning with the major emplacement of W-K2. The age of reworked tephras decreases as one moves seaward indicating that a relatively stabilized surface has moved gradually seaward until the time of the W-H tephra series in the past 500 years, after which little change has occurred.

The area south of the FAAH hill on the coastal side of the main road is characterized by inland sediment fans, gullies, and a very low tidally affected and apparently young coastal fringe. The region was mainly tidally affected until very recently when the W-K3 tephra fell onto tidal sediments and mangroves. At one locality alluvial and airfall tephras W-K3 and W-K4 were found lying on top of in situ coral heads that were completely intact and had not been weathered or eroded. Samples of coral and shells have been taken to date the transition from marine to terrestrial conditions.

The picture that is developing at Numundo is of a very dynamic coastal plain during the Holocene. The Pleistocene topography has provided a basic structure, probably an undulating landscape which has been modified by (a) marine flooding during the Holocene transgression, (b) alluvial deposition of upper catchment sediments as fans and alluvial spreads, and (c) the periodic mantling of airfall tephras. The coastline has clearly been a very dynamic feature for a very long time and its evolution has been locally diverse.

FUTURE RESEARCH PLANS

Funds have been obtained from the Australian Research Council for a further period of fieldwork to take place in June-August 2002. In the meantime, scientific studies based on material collected in previous years continues. During the upcoming year analyses of the collected sediments, artifacts, and dating material will continue. The GIS database will be extended and updated. Priority will be placed on dating FABM using luminescence dating. Exploration of new techniques involving the extraction of various minerals, the analysis of aerosolic dust, and fission track dating will be initiated. Radiocarbon samples from a wide range of contexts will be submitted in order to refine the chronology of settlement in the region in relationship to the volcanic history. Refinements of the technique and new application of obsidian hydration dating will be made. Studies of phytoliths and starch assemblages from Numundo and pollen from the peats at Garu Plantation will continue. Bulk geochemical and SEM analyses of the tephras will be expanded. Studies of clay mineralogy are planned. An expanded study of weathering on the manuports from the sites will be conducted. Characterisation studies of obsidian to determine sources and trading patterns are in progress. A Sydney Honours student will complete his study of stone technology for the pre-W-K2 obsidian assemblages. A number of additional scientific studies are also in the early stages of planning.

Now that the basic environmental and geological background work has been completed, the next stage of fieldwork will focus on the excavation of a large number of small test pits distributed throughout the study region. The aim will be to place these in various environmental contexts following a transect running from the coast at Numundo across the peninsula. Expanded excavations will take place at FABM and possibly other Pleistocene localities in future years, if a successful dating method can be found.

This year's work identified the need for additional studies focused on the coastal history at Kulu-Dagi, perhaps expanded to include Garu, and the geological history of the nearby Krummek, Garbuna and Welcker volcanic complex, which may be the source of the Pleistocene and more recent 3.5 eruptions. These expanded studies will take place if further funding can be found to support them.

CONCLUSIONS

Fieldwork conducted in West New Britain by an interdisciplinary team of archaeologists, geologists, geographer, pedologist, and dating expert has significantly expanded our knowledge of the natural and human history of the Willaumez Peninsula region. Brief surveys at Lotomgan and Kulu-Dagi have re-enforced previous work that these regions contain numerous significant archaeological deposits, many of which are under serious threat through erosion following development activities. In contrast, undisturbed archaeological deposits were not located at site FEA on Boduna island and a reconstruction of the landscape history of the island concludes that a combination of human and natural events (including an earthquake and a tsunami) mean that intact prehistoric material is unlikely to be preserved at that location.

The hypothesis put forward in 1999 and 2000 predicting the importance of site FABM has been confirmed. Excavations through the alternating layers of Pleistocene tephras and associated sediments have uncovered relatively high concentrations of artifacts and manuports which indicate repeated occupation of the hill over a very long period. A preliminary study of weathering on oven stones indicates great antiquity for the site. Various new dating techniques will be applied to place these finds in a chronological context.

Excavation at site FAAH has confirmed the existence of a long stratified sequence containing abundant Lapita pottery as well as earlier occupations dating to periods 2 and 3, between 3600-6000 and older than 6000 years respectively. Periods 2 and 3 are also very well represented by earth ovens and dense concentrations of obsidian at Kulu-Dagi. The FAAH hill joins a number of sites on Garua Island for representing an unusual setting for occupation by people using Lapita pottery. Along these lines, a very surprising find this year was the presence of dentate stamped Lapita pottery on a small hill in the middle of the swamp at one Kulu-Dagi Locality 01/17 and a possibly contemporaneous earth oven at another nearby ridge top at Locality 01/12 (Figures 9, 11).

Studies of the history of landscape change in the region have confirmed the existence of a maar volcano at Numundo, probably dated to the early Holocene, and have improved our knowledge of the conditions faced by human communities during the volcanic events responsible for the Dakataua and Witori tephras. The

dramatic impact of earthquakes at Boduna Island and at Kulu-Dagi in suddenly and radically transforming the landscape once again demonstrates the importance of volcanic activity for both setting the limits of human settlement and for determining the contexts in which the evidence for human history is preserved. The exciting task which lies ahead is to unravel the fascinating and story of the complex interaction between volcanoes and humans in the Willaumez Peninsula during the past 40,000 years or so.

COMMUNICATION OF RESULTS

During the course of the fieldwork Torrence met with the following to explain the nature of the fieldwork, to give tours of FABM and FAAH at Numundo, and to show some of the artifacts recovered this season: WNB Administrator Paul Raime; Head of Culture and Tourism Martin Aigal; WNB Provincial Cultural Centre staff Mary Kimbe, Georgina To Waluta, and retired staff member John Namuno; NBPOL management, staff and labourers; board members of the McArthur Foundation (USA); staff from The Nature Conservancy; Johan Ramon, head European Union Nature Centre; staff at Mahonia Na Dari. Special seminars were also presented to the senior staff at Numundo Plantation, to staff at the Dami Oil Palm Research Centre and the Oil Palm Research Association, and to students from Hoskins High School at the Mahonia Na Dari Saturday school. The team also met with the archaeology staff at the National Museum and Art Gallery and with Vincent Kewibu and Hugh Davies from the University of Papua New Guinea to inform them of our findings. Discussions were held with Vincent Kewibu about participation of University students and staff in the research in 2002.

ACKNOWLEDGEMENTS

We are especially grateful to the people of West New Britain for permission to carry out this research and for many forms of hospitality and assistance. Funding was provided by an Australian Research Council grant to Torrence and by a University of Sydney Sesqui R & D Scheme grant to Peter White for Boduna. Torrence was supported by an Australian Research Council Senior Fellowship at the Australian

Museum. New Britain Palm Oil Ltd provided a vehicle for the fieldwork, an excavator for clearing site FABM, access to plantations, and much help with maps and advice. We are especially grateful to Nick Thompson, Bob Wilson, Mike Hoare, Kefu Boromana, Jamie Graham, Ruari MacWilliam and Greg Mamando for their goodwill, hospitality, and many forms of assistance. Mahonia Na Dari Research Station provided excellent facilities and the staff gave logistical support, advice, and good company. Peter Prior of Mahonia na Dari introduced us to the people of Pangalu and piloted the boat to Boduna Island. Bernard Mundaro, senior big man of Pangalu, consented to our work on the island and his nominated workmen, Alphonse, Anton and Andre, were exceptionally helpful. Max and Cecily Benjamin and the staff of Walindi Resort were again welcoming and supportive. John Namuno gave freely of his time to assist us with communicating our results to the people of West New Britain. John Ray shared his private collection and knowledge of Boduna Island with us. Les and Norelle Hartwig of Garua Plantation were hospitable as always. Ben Valuka generously shared his extensive knowledge of Lotamgan. Vince Freedman, Kimbe Bay Shipping Agency, helped once again with accounts and freight. Herman Mandui generously chauffeured us around in Port Moresby. We thank the following for help with permits and visas: archaeology staff at the National Museum and Art Gallery; National Research Institute; West New Britain Provincial Cultural Centre; PNG Consulate in Canberra; Professor Hugh Davies.

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ITINERARY

June 22 Torrence and White travel to Port Moresby. Meet with Mckee and Professor Hugh Davies, University of Papua New Guinea at Geology, Engineering and Mining Conference.

June 23 Torrence, White, Bryne, and Kewibu travel to Mahonia Na Dari, Kimbe, WNB and set up project; Specht travels to Port Moresby.

June 24 Specht travels to Mahonia. Team meets with Ian Dixon, NBPOL.

June 25 Team discusses plans and visit sites with Jamie Graham and Ruari Duncan at Kulu-Dagi. Team meets with staff at WNB Provincial Cultural Centre.

June 26 McKee travels to Mahonia. Specht meets with staff at WNB Provincial Cultural Centre.

June 27 Meet with Mike Hoare and Greg Mamando.

June 28 Fieldwork at Lotamgan assisted by Ben Valuka. Meeting with Bernard Mundaro.

July 2 McKee returns to Port Moresby

July 3 Rhodes, Mulvaney, Perceval arrive.

July 5 Specht meets with senior men from Kilu and Patanga to discuss oral history.

July 6 Meeting with Kefu Boromana at Garu Plantation.

July 8 Torrence, White and Perceval visit Garua Island.

July 9 Give tour of FABM to board members of McArthur foundation.

July 10 Rhodes returns to England. Retrieve thermocells from Hoare's garden. Coroneos arrives.

July 11 Team led by White begins work at Boduna. Tours of sites for Tim Jessup from TNC.

July 17 Coroneos departs. Meet with Nick Thompson, Allen Morrow and Bob Wilson for tour of FABM and FAAH. Specht and Torrence meet with staff at WNB Provincial Cultural Centre and Peter Manasaplo in the Office of the Administrator.

July 18 Meet with Johan Roman, head of European Union Nature Centre.

July 20 White and Perceval depart. Tour of FABM and FAAH for Max and Cecily Benjamin.

July 21 Boyd and Neall arrive.

July 24 Torrence and Specht with John Namuno meet with the Paul Raime, WNB Provincial Administrator, and Martin Aigal, head of Culture and Tourism; give tour of archaeological sites and Provincial Cultural Centre to Johan Ramon; and present seminar about archaeology to field supervisors at Numundo Plantation.

July 26 Bryne departs.

July 27 Team visits OPRA and Dami Oil Palm Research station and Torrence presents seminar on recent archaeological findings.

July 28 Torrence gives talk to students and teachers from Hoskins High School.

July 29 Torrence, Specht, Mulvaney, Neall, and Boyd travel to POM and meet with Hugh Davies and Simon Haberle to discuss environmental studies.

July 30 Team meets with staff at the National Museum and Art Gallery and Vincent Kewibu at the University of Papua New Guinea to report results of fieldwork. Team returns to Australia and New Zealand.

Table 1 Chronological Periods Represented in the Survey Area

Period	Stratigraphic Position	Date (years before present)	Cultural Material
Period 1	Pleistocene tephras	pre-?10,000	Obsidian/chert flakes
Period 2	Under W-K1 tephra and above Pleistocene tephras	?-6,000	Small obsidian flakes, Split cobble
Period 2a	Under phreatomagmatic tephra and above Pleistocene tephras (limited to Areas J and K?)	?	Obsidian flakes
Period 3	Soil on W-K1 tephra and/or under W-K2 tephra	6,000 - 3,500	Obsidian/chert flakes Stemmed tools
Period 4	Soil on W-K2 tephra	3,500 - 1,800	Lapita pottery, Obsidian flakes
Period 5	Soil on W-K3 tephra	1,800-1,200	Obsidian flakes
Period 6	Soil on W-K4 tephra	1,200-500	Obsidian flakes
Period 7	Soils associated with W-H tephras	Less than 500	Obsidian flakes
Period 7a	Between W-H4 and W-H5 tephras	Less than 500	Obsidian flakes
Period 8	Modern topsoil	Less than ?200	Obsidian flakes, Groundstone axes, Sea shells, Pottery, Glass

Table 2 Distribution of artefacts recovered from FABM

Stratigraphic Unit	Squares			Quarry wall/Section IV*	TOTAL
	A	B	C		
H	11	20	18	6	55
G	--	--	--	2	2
F	--	--	25	2	27
E	0	6	--	3	9
D	0	9	--	4	13
C	36	30	--	16	82
B	0	0	--	2	2
TOTAL	47	65	43	35	190

*Includes finds from 1999 and 2000.

Table 3 Cultural Material Found in 2001

(For locations see Figures 2, 3)

LOCALITY/CODE	GPS E	GPS S	PERIOD 1	2	2a	3	4	5	6	7	8
Numundo											
FAAH/1	150° 95' 47.4"	5° 29' 55.7"	--	C	--	C	A, P	R	R	0	0
FAAH/2 XVII	150° 5' 53.8"	5° 29' 59.6"	--	C	--	C	A, P	R	R	0	0
FAAH/3	150° 5' 53.8"	5° 29' 48.2"	--	--	--	--	--	--	--	--	A
FAAH/4	150° 5' 37.5"	5° 29' 50.0"	--	--	--	--	--	--	--	--	A, P, G
FAAH/5											
Pit A	150° 5' 47.9"	5° 25' 58.5		Redeposited material only							
Pit B	150° 5' 48.3"	5° 29' 58.2		Redeposited material only							
Pit C	150° 5' 52.3"	5° 29' 53.3"		Redeposited material only							
FABE XVI	150° 5' 9.2"	5° 31' 50.4"	--	--	--	C	R	A	C	C	--
01/14 FABK	150° 5' 16"	5° 29' 7.5"	--	--	--	--	?R	0	A	0	--
01/15											
Area 1	150° 4' 56.4"	5° 28' 21.8"	--	--	--	--	--	--	--	--	A, S
Area 2	150° 4' 59.1"	5° 28' 19.5"	--	--	--?R	--	?R	--	--	--	--
Area 3	150° 5' 52.6"	5° 28' 19.5	--	--	--	--	--	--	?C	--	--
01/16 FABL	150° 4' 42.6"	5° 31' 20.2"	--	--	--	--	?0	?0	?0	?0	A, X
01/18	150° 5' 9.6"	5° 28' 42.1"	--	--	--	--	--	--	?C	?0	A, S

LOCALITY/CODE	GPS E	GPS S	1	2	2a	3	4	5	6	7	8
Haella											
FACC											
01/01	150° 4' 30.8"	5° 31' 41.1"	--	--	--	C	0	0	0	0	0
01/13 XIX	150° 04' 29.2	5° 31' 41.2"	--	C	--	C	0	0	0	0	0
Garu											
01/10	143° 56' 49.1"	5° 30' 33.4"	Section through peat layers. No cultural material observed.								
Kulu-Dagi											
01/11 XVIII	150° 2' 14.0"	5° 35' 54.3"	--	A	--	C	0	0	0	C	0
01/12 XX, XXI	150 1' 23.4"	5° 36' 11.4"	--	--	--	C	C	0	?C	?C	--
01/17 XXII	150° 0' 58.9"	5° 36' 20.5"	--	--	--	R	R	0	0	R	0
01/19	150° 0' 35.5"	5° 35' 14.6"	Geomorphology section. No cultural material observed.								
Lotomgan											
01/02	150° 3' 43.9"	5° 15' 50.5"	Undated cupmarks								
01/03	150° 3' 43.0"	5° 15' 0.5"	--	--	--	--	R	--	0	--	0
01/04	150° 3' 52.5"	5° 14' 57.5"	--	--	--	--	--	--	--	--	C
01/05	150° 3' 55.8"	5° 14' 30.7"	--	--	--	--	C	--	--	--	?C
01/06	150° 3' 51.2"	5° 14' 26.9"	--	--	--	--	C	C, P	--	--	?C
01/07	150° 3' 24.5"	5° 14' 17.7"	--	--	--	--	--	--	--	--	A, S, X
01/08	150° 3' 12.6"	5° 14' 20.3"	--	--	--	--	C	--	0	--	0
01/09	150° 3' 11.1"	5° 14' 23.1"	Undated obsidian scatter								

Key

-- Period not observed
0, No cultural material observed for Period
P, Pottery present
G, Glass present
S, Sea shells present
X, Groundstone axe present

Obsidian artifacts
R, Rare
C, Common
A, Abundant

Dakataua (Dk) tephra

The Dakataua (Dk) tephra is attributed to a caldera-forming eruption at Dakatau Volcano at the northern end of the Willaumez Peninsula (Machida *et al.* 1996). The full sequence of Dk consists of plinian and phreatomagmatic airfall tephras at the base and phreatomagmatic lithic-rich pyroclastic flows at the top. Deposits of it were examined by McKee at two locations at Lotomgan plantation, in the northern part of the Willaumez Peninsula. At these sites, about 15 km from the southern rim of Dakatau Caldera, no flow phases were observed and the Witori W-K2 tephra was found at the base of the exposures. The overlying sequence interpreted to be Dk consists of a mid-brown fine ash at base which is succeeded by an apparently plinian deposit – distinctively mottled yellow-grey fine ash containing abundant pumice and lithic lapilli. Mud–armouring of the clasts and the presence of mud in the matrix suggests a phreato-plinian mode of eruption. Overlying this unit is a yellow-brown fine ash containing fine pumice lapilli which in turn is overlain by a similar orange-coloured tephra. The top of the sequence consists of a mid-dark brown very fine ash grading into soil. The total thickness of the tephra intepreted to be Dk at these sites is 100 cm and 118 cm.

The Dk sequence present in the Lotomgan area appears to correlate with the (pre-flow) airfall component of Dk described from the south western foot of Dakatau Volcano (Machida *et al.*1996). The overall normal grading in the Dk sequence at Lotomgan may be due to increasing fragmentation of the erupted material caused by increasingly more explosive activity prior to the flow-forming phase. Such a progression would be a consequence of increasing interaction of water with magma. A sample from the basal fine ash and samples of the pumice and lithic clasts from the phreato-plinian layer were collected for chemical analysis.

Tephra Accretion

One of the major aims of the project is to investigate the impacts of volcanic eruptions on human settlement in the region. To achieve this we need to assess the timing and scale of each volcanic event and to compare them to the history of human abandonment and reoccupation (cf. Torrence *et al.* 2000; Torrence in press). Up to

outcrop (≈100m), which would suggest an airfall origin. The presence of impact sags beneath some larger clasts is consistent with this mode of formation. However, some beds are discontinuous and may have been deposited from pyroclastic flows. Near the top of the sequence, lenses of fine grained tephra pinch and swell over a range of a few centimetres. These lenticular beds are characteristic of deposits formed from pyroclastic surges. This mixture of fall and flow deposits would be expected in a maar tephra sequence.

The latest eruption deposits from Numundo Maar comprise a distinctive yellow-grey platy tuff and an underlying, possibly related, scoria lapilli. The tuff is comprised of fine-medium ash, but contains fine lapilli of yellow pumice near its top. Massive to faintly laminated layers alternate with layers consisting of accretionary lapilli and vesicles. The layers are 2.5 -6.0 cm thick at the quarry on the southern rim of the maar. The exposed thickness of the tuff at this location is about 2 m, but the upper part of the unit has been removed by quarrying operations. The scoria deposit beneath the platy tuff consists of fresh-looking dark scoria lapilli. The thickness of this unit at the quarry is about 40 cm. The contact between the scoria and the overlying tuff is sharp and so there appears to be little or no time break between these deposits.

The distinctive platy tuff at the top of the maar tephra sequence at the quarry was previously identified within excavations at FABK and FABO to the south. At Section XV, 650 m south of the quarry, a road cut exposes 1.80 m of dull yellow-grey platy tuff. Probably all of this deposit is airfall tephra. Underlying the platy tuff is a 0.1 m layer of scoria-bearing tephra. This unit in turn is underlain by a thick, dark red-brown soil. The maar deposit is therefore older than the W-K2 tephra which lies above it. How much older is uncertain although the very thin soil separating the scoria-platy tuff sequence and the Witori sequence suggests that there was not a long interval between these tephra sequences. A sample of the soil underlying the deposit was taken for radiocarbon dating.

Immediately north of the maar at the edge of a disused plantation road, about 4 m of platy tuff is exposed. The lower 1.5 m of the section consists of strongly-bedded, yellow-orange platy tuff. The upper part of the section comprises thinly-bedded, grey-yellow tephra which may include pyroclastic surge deposits.

Eruptions at the Numundo maar would have had a significant impact, particularly in the immediate few kilometres. Deposits of the latest eruption are

W-K3 coastline. The history of the coastline is particularly important for understanding what the contemporary environment was like when the Lapita pottery was deposited at Locality 01/17, which is now significantly inland. Environmental changes are also crucial for explaining the apparent density of pre-Lapita sites in the region as well as the seemingly low population in more recent times. Additional geomorphological work needs to be carried out in the Kulu-Dagi region to answer these questions.

The study of the physical evolution of the Numundo coastal landscape focussed on all except the southern most part of the plantation. It now seems likely that in the region north of the FAAH hill, the location of the coast has been largely determined by the position of a number of fans spreading off the foothills and associated downstream alluvial spreads. The initiation of these fans pre-dates the Witori sequence, therefore suggesting that the general coastal configuration has been stable since the mid-Holocene. Within the region, however, the history of alluviation has altered the distribution of dry land, swamps and streams, beginning with the major emplacement of W-K2. The age of reworked tephras decreases as one moves seaward indicating that a relatively stabilized surface has moved gradually seaward until the time of the W-H tephra series in the past 500 years, after which little change has occurred.

The area south of the FAAH hill on the coastal side of the main road is characterized by inland sediment fans, gullies, and a very low tidally affected and apparently young coastal fringe. The region was mainly tidally affected until very recently when the W-K3 tephra fell onto tidal sediments and mangroves. At one locality alluvial and airfall tephras W-K3 and W-K4 were found lying on top of in situ coral heads that were completely intact and had not been weathered or eroded. Samples of coral and shells have been taken to date the transition from marine to terrestrial conditions.

The picture that is developing at Numundo is of a very dynamic coastal plain during the Holocene. The Pleistocene topography has provided a basic structure, probably an undulating landscape which has been modified by (a) marine flooding during the Holocene transgression, (b) alluvial deposition of upper catchment sediments as fans and alluvial spreads, and (c) the periodic mantling of airfall tephras. The coastline has clearly been a very dynamic feature for a very long time and its evolution has been locally diverse.

CONCLUSIONS

Fieldwork conducted in West New Britain by an interdisciplinary team of archaeologists, geologists, geographer, pedologist, and dating expert has significantly expanded our knowledge of the natural and human history of the Willaumez Peninsula region. Brief surveys at Lotomgan and Kulu-Dagi have re-enforced previous work that these regions contain numerous significant archaeological deposits, many of which are under serious threat through erosion following development activities. In contrast, undisturbed archaeological deposits were not located at site FEA on Boduna island and a reconstruction of the landscape history of the island concludes that a combination of human and natural events (including an earthquake and a tsunami) mean that intact prehistoric material is unlikely to be preserved at that location.

The hypothesis put forward in 1999 and 2000 predicting the importance of site FABM has been confirmed. Excavations through the alternating layers of Pleistocene tephras and associated sediments have uncovered relatively high concentrations of artifacts and manuports which indicate repeated occupation of the hill over a very long period. A preliminary study of weathering on oven stones indicates great antiquity for the site. Various new dating techniques will be applied to place these finds in a chronological context.

Excavation at site FAAH has confirmed the existence of a long stratified sequence containing abundant Lapita pottery as well as earlier occupations dating to periods 2 and 3, between 3600-6000 and older than 6000 years respectively. Periods 2 and 3 are also very well represented by earth ovens and dense concentrations of obsidian at Kulu-Dagi. The FAAH hill joins a number of sites on Garua Island for representing an unusual setting for occupation by people using Lapita pottery. Along these lines, a very surprising find this year was the presence of dentate stamped Lapita pottery on a small hill in the middle of the swamp at one Kulu-Dagi Locality 01/17 and a possibly contemporaneous earth oven at another nearby ridge top at Locality 01/12 (Figures 9, 11).

Studies of the history of landscape change in the region have confirmed the existence of a maar volcano at Numundo, probably dated to the early Holocene, and have improved our knowledge of the conditions faced by human communities during the volcanic events responsible for the Dakataua and Witori tephras. The

Museum. New Britain Palm Oil Ltd provided a vehicle for the fieldwork, an excavator for clearing site FABM, access to plantations, and much help with maps and advice. We are especially grateful to Nick Thompson, Bob Wilson, Mike Hoare, Kefu Boromana, Jamie Graham, Ruari MacWilliam and Greg Mamando for their goodwill, hospitality, and many forms of assistance. Mahonia Na Dari Research Station provided excellent facilities and the staff gave logistical support, advice, and good company. Peter Prior of Mahonia na Dari introduced us to the people of Pangalu and piloted the boat to Boduna Island. Bernard Mundaro, senior big man of Pangalu, consented to our work on the island and his nominated workmen, Alphonse, Anton and Andre, were exceptionally helpful. Max and Cecily Benjamin and the staff of Walindi Resort were again welcoming and supportive. John Namuno gave freely of his time to assist us with communicating our results to the people of West New Britain. John Ray shared his private collection and knowledge of Boduna Island with us. Les and Norelle Hartwig of Garua Plantation were hospitable as always. Ben Valuka generously shared his extensive knowledge of Lotamgan. Vince Freedman, Kimbe Bay Shipping Agency, helped once again with accounts and freight. Herman Mandui generously chauffeured us around in Port Moresby. We thank the following for help with permits and visas: archaeology staff at the National Museum and Art Gallery; National Research Institute; West New Britain Provincial Cultural Centre; PNG Consulate in Canberra; Professor Hugh Davies.

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July 6 Meeting with Kefu Boromana at Garu Plantation.

July 8 Torrence, White and Perceval visit Garua Island.

July 9 Give tour of FABM to board members of McArthur foundation.

July 10 Rhodes returns to England. Retrieve thermocells from Hoare's garden. Coroneos arrives.

July 11 Team led by White begins work at Boduna. Tours of sites for Tim Jessup from TNC.

July 17 Coroneos departs. Meet with Nick Thompson, Allen Morrow and Bob Wilson for tour of FABM and FAAH. Specht and Torrence meet with staff at WNB Provincial Cultural Centre and Peter Manasaplo in the Office of the Administrator.

July 18 Meet with Johan Roman, head of European Union Nature Centre.

July 20 White and Perceval depart. Tour of FABM and FAAH for Max and Cecily Benjamin.

July 21 Boyd and Neall arrive.

July 24 Torrence and Specht with John Namuno meet with the Paul Raime, WNB Provincial Administrator, and Martin Aigal, head of Culture and Tourism; give tour of archaeological sites and Provincial Cultural Centre to Johan Ramon; and present seminar about archaeology to field supervisors at Numundo Plantation.

July 26 Bryne departs.

July 27 Team visits OPRA and Dami Oil Palm Research station and Torrence presents seminar on recent archaeological findings.

July 28 Torrence gives talk to students and teachers from Hoskins High School.

July 29 Torrence, Specht, Mulvaney, Neall, and Boyd travel to POM and meet with Hugh Davies and Simon Haberle to discuss environmental studies.

July 30 Team meets with staff at the National Museum and Art Gallery and Vincent Kewibu at the University of Papua New Guinea to report results of fieldwork. Team returns to Australia and New Zealand.

Table 2 Distribution of artefacts recovered from FABM

Stratigraphic Unit	Squares			Quarry wall/Section IV*	TOTAL
	A	B	C		
H	11	20	18	6	55
G	--	--	--	2	2
F	--	--	25	2	27
E	0	6	--	3	9
D	0	9	--	4	13
C	36	30	--	16	82
B	0	0	--	2	2
TOTAL	47	65	43	35	190

*Includes finds from 1999 and 2000.

LOCALITY/CODE	GPS E	GPS S	1	2	2a	3	4	5	6	7	8
Haella											
FACC											
01/01	150° 4' 30.8"	5° 31' 41.1"	--	--	--	C	0	0	0	0	0
01/13 XIX	150° 04' 29.2	5° 31' 41.2"	--	C	--	C	0	0	0	0	0
Garu											
01/10	143° 56' 49.1"	5° 30' 33.4"	Section through peat layers. No cultural material observed.								
Kulu-Dagi											
01/11 XVIII	150° 2' 14.0"	5° 35' 54.3"	--	A	--	C	0	0	0	C	0
01/12 XX, XXI	150 1' 23.4"	5° 36' 11.4"	--	--	--	C	C	0	?C	?C	--
01/17 XXII	150° 0' 58.9"	5° 36' 20.5"	--	--	--	R	R	0	0	R	0
01/19	150° 0' 35.5"	5° 35' 14.6"	Geomorphology section. No cultural material observed.								
Lotomgan											
01/02	150° 3' 43.9"	5° 15' 50.5"	Undated cupmarks								
01/03	150° 3' 43.0"	5° 15' 0.5"	--	--	--	--	R	--	0	--	0
01/04	150° 3' 52.5"	5° 14' 57.5"	--	--	--	--	--	--	--	--	C
01/05	150° 3' 55.8"	5° 14' 30.7"	--	--	--	--	C	--	--	--	?C
01/06	150° 3' 51.2"	5° 14' 26.9"	--	--	--	--	C	C, P	--	--	?C
01/07	150° 3' 24.5"	5° 14' 17.7"	--	--	--	--	--	--	--	--	A, S, X
01/08	150° 3' 12.6"	5° 14' 20.3"	--	--	--	--	C	--	0	--	0
01/09	150° 3' 11.1"	5° 14' 23.1"	Undated obsidian scatter								

Key

-- Period not observed
0, No cultural material observed for Period
P, Pottery present
G, Glass present
S, Sea shells present
X, Groundstone axe present

Obsidian artifacts
R, Rare
C, Common
A, Abundant

Table 3 Cultural Material Found in 2001

(For locations see Figures 2, 3)

LOCALITY/CODE	GPS E	GPS S	PERIOD 1	2	2a	3	4	5	6	7	8
Numundo											
FAAH/1	150° 95' 47.4"	5° 29' 55.7"	--	C	--	C	A, P	R	R	0	0
FAAH/2 XVII	150° 5' 53.8"	5° 29' 59.6"	--	C	--	C	A, P	R	R	0	0
FAAH/3	150° 5' 53.8"	5° 29' 48.2"	--	--	--	--	--	--	--	--	A
FAAH/4	150° 5' 37.5"	5° 29' 50.0"	--	--	--	--	--	--	--	--	A, P, G
FAAH/5											
Pit A	150° 5' 47.9"	5° 25' 58.5	Redeposited material only								
Pit B	150° 5' 48.3"	5° 29' 58.2	Redeposited material only								
Pit C	150° 5' 52.3"	5° 29' 53.3"	Redeposited material only								
FABE XVI	150° 5' 9.2"	5° 31' 50.4"	--	--	--	C	R	A	C	C	--
01/14 FABK	150° 5' 16"	5° 29' 7.5"	--	--	--	--	?R	0	A	0	--
01/15											
Area 1	150° 4' 56.4"	5° 28' 21.8"	--	--	--	--	--	--	--	--	A, S
Area 2	150° 4' 59.1"	5° 28' 19.5"	--	--	--?R	--	?R	--	--	--	--
Area 3	150° 5' 52.6"	5° 28' 19.5	--	--	--	--	--	--	?C	--	--
01/16 FABL	150° 4' 42.6"	5° 31' 20.2"	--	--	--	--	?0	?0	?0	?0	A, X
01/18	150° 5' 9.6"	5° 28' 42.1"	--	--	--	--	--	--	?C	?0	A, S

LOCALITY/CODE	GPS E	GPS S	1	2	2a	3	4	5	6	7	8
Haella											
FACC											
01/01	150° 4' 30.8"	5° 31' 41.1"	--	--	--	C	0	0	0	0	0
01/13 XIX	150° 04' 29.2	5° 31' 41.2"	--	C	--	C	0	0	0	0	0
Garu											
01/10	143° 56' 49.1"	5° 30' 33.4"	Section through peat layers. No cultural material observed.								
Kulu-Dagi											
01/11 XVIII	150° 2' 14.0"	5° 35' 54.3"	--	A	--	C	0	0	0	C	0
01/12 XX, XXI	150 1' 23.4"	5° 36' 11.4"	--	--	--	C	C	0	?C	?C	--
01/17 XXII	150° 0' 58.9"	5° 36' 20.5"	--	--	--	R	R	0	0	R	0
01/19	150° 0' 35.5"	5° 35' 14.6"	Geomorphology section. No cultural material observed.								
Lotomgan											
01/02	150° 3' 43.9"	5° 15' 50.5"	Undated cupmarks								
01/03	150° 3' 43.0"	5° 15' 0.5"	--	--	--	--	R	--	0	--	0
01/04	150° 3' 52.5"	5° 14' 57.5"	--	--	--	--	--	--	--	--	C
01/05	150° 3' 55.8"	5° 14' 30.7"	--	--	--	--	C	--	--	--	?C
01/06	150° 3' 51.2"	5° 14' 26.9"	--	--	--	--	C	C, P	--	--	?C
01/07	150° 3' 24.5"	5° 14' 17.7"	--	--	--	--	--	--	--	--	A, S, X
01/08	150° 3' 12.6"	5° 14' 20.3"	--	--	--	--	C	--	0	--	0
01/09	150° 3' 11.1"	5° 14' 23.1"	Undated obsidian scatter								

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