A Technological Analysis of the Ceramics from Site 14, Podtanéan

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> *The immediate purposes of a ceramic technological investigation are to identify the materials and locate their sources, to study the workmanship and to describe properties by reference to exact impersonal standards . . .* (Shepard 1963:389).

Site 14 is the deepest site that Gifford and Shutler excavated (total depth 78") on the Foué Peninsula. The radiocarbon dates provided to Gifford by Prof. H. R. Crane place the median date for the site at approximately A.D. 250, well after the demise of Lapita pottery (Gifford and Shutler 1956:89). Lapita pottery, characterized by dentate-stamped decoration, red body color, and calcareous or quartz temper, existed in Melanesia from perhaps 1500 B.C. until approximately 500 B.C. when it disappeared. By this point in time some archaeologists believe that the potters were absorbed by other populations, losing their "archaeological identity" (Bellwood 1979:244). In other words, by 500 B.C. the descendants of Lapita potters began to develop local traditions, as the vast inter-island network of Lapita culture began to disintegrate (1979: 255). Incised and applied-relief ceramic decoration began to appear locally, as well as "baggy pot shapes" that were previously unknown in the region (1979:258). Nonetheless, the rate and means of extinction of Lapita pottery is debatable. According to Green "evidence bearing on this point is largely impressionistic" (Green 1982:11). Whether or not Lapita technology died off rapidly due to frequent relocation of settlements or was replaced slowly as potters developed their own local traditions is still open to interpretation and is largely a site-by-site interpretation.

For New Caledonia, Bellwood sees an important shift in pottery decoration from paddle-impression to incision (1979:262). Judging from evidence presented in this paper, combined with the data on pottery decoration elsewhere in New Caledonia, it seems that Bellwood's interpretation of slow change in ceramic styles is correct. In site 14 the change is visible in the few decorated sherds that exist (see Manning, this volume). Paddle-impressed sherds disappear in levels above 60" where incised decoration is present. Green and Mitchell, in their review of the archaeological sequence of New Caledonia, divided site 14 into two phases based on ceramic decoration: *Podtanéan*, characterized by paddle-impression, and *Oundjo*, characterized by incised designs (1983:48). But as Manning (this volume) points out, the sample of decorated sherds in site 14 is limited; thus, a study of ceramic technology may provide further clues to this important technological transition. Gifford and Shutler (1956:73-75) only concentrated on decoration and vessel form in their monograph and divided the sherds into rim lips and types, sherds with suspension holes, handles, carinations, modified sherds and decorated sherds; they did not look closely at attributes such as color, hardness, or firing cores, attributes that can provide clues to ceramic change over time. A detailed examination of these more mundane attributes have been my objective in the present study.

Methodology

Since plain pottery sherds are the most abundant in site 14, it is only appropriate to base this study of ceramic technology on them. The attributes chosen for study can be grouped into two main categories: those pertaining to method of manufacture, and those pertaining to firing technology. Carbonaceous residue present on some sherds from use as well as post-depositional residue and amount of erosion were also noted.

Attributes Relating to Manufacture Method

Attributes relating to method of manufacture are: thickness, the presence or absence of anvil impressions, porosity, the type of surface finishing and the types of non-plastic inclusions present as well as their size and density. Thickness was measured to the nearest millimeter in three different places on the sherd; then the average was computed and recorded.

The paddle-and-anvil method of pot forming is still in use today in such places as Papua New Guinea (May and Tuckson 1982:39). It was also the principal means of making Lapita pottery. The use of paddle-and-anvil is inferred by the presence of anvil impressions on the interior of the sherd.

The porosity or compactness of a pot's walls can be used as an index of firing temperature, but because most traditional pottery is fired to a point after total decomposition of the clay and before vitrification--a point where porosity is stable--a large range of temperatures exists in which the maximum firing temperature could fall (Rye 1981:122). Thus, porosity in this study will be treated simply as an indication of how much the potters compacted the vessel walls using the paddle-and-anvil technique (Bennett 1974:34).

Types of surface finishing on the sherds were recorded as well. Four different types of surface finish were recorded: (1) *Wiping* or striations, caused by either wiping with the fingers or some soft material such as palm fronds while the pot was still wet (Bennett 1974:54). (2) *Burnishing*, accomplished in the leather-hard stage of manufacture by rubbing the pot with a smooth stone or other comparable hard object to compact the surface of the vessel and give it a lustrous finish (Bennett 1974:41). (3) *Impressed paddling*, a technique that uses a carved paddle with the anvil to mark the exterior of the pot (Rye 1981:84). (4) Finally, the use of *slip* was noted. Slip is a watery solution of clay in suspension that is used like a paint and can be added to the pot either before or after firing (Rye 1981: 40).

Non-plastic inclusions ("temper")[1] play an important role in the ceramic manufacturing process whether they are manually added or naturally occurring. Workability of the clay can be improved by the addition of non-plastic inclusions (Rye 1981:31). Their addition also counteracts shrinkage and facilitates uniform drying (Shepard 1971:25). Inclusion type tends to be fairly conservative. As Rye points out, "a successful change from quartz temper to sand would neces-

1. Editor's note: The use of the term "temper" by Pacific region archaeologists is variable. In general, it has been used synonymously with "non-plastic inclusion," regardless of whether such inclusions were manually added or naturally-occuring components of the potting clay. (PVK)

sitate considerable experimentation with new firing techniques" (1981:5). Non-plastic inclusions were coded using a system that allowed relative amounts to be recorded in the order of their abundance (Hunt 1989). Each sherd was examined under a low power microscope to determine temper type. The four predominant types of inclusions present were recorded so that the primary type occupied the first place, the secondary type the second place, etc. Thus, a reading of 3800 would read as follows: Primary type, light minerals or quartz; secondary type, crushed pot sherds (grog). No other type of inclusions were present so that a '0' was recorded in the last two spaces. Inclusion size was recorded as well using the same method with two spaces. A one (1) was recorded for inclusions less than 0.5 mm in size, a two (2) for inclusions 0.5-1.5 mm in size and a three (3) for those over 1.5 mm. Inclusion density was judged according to Bennett's temper density chart (1974:84, 105).

Attributes Relating to Firing Technology

Firing technology is identified by Rye (1981:4) as one of the principal techniques in pottery manufacture (the other two being preparation of the body, and vessel formation). Firing renders the pot into a usable form. Different techniques can be used and attributes associated with the firing process reflect this. For example, hardness is directly related to firing temperature. For this study hardness was measured using Moh's scale, and a zero was recorded for those sherds whose hardness was less than three. Surface color is an important clue to firing and cooling behavior. Red-bodied pots are products of an atmosphere rich in oxygen, while darker, gray wares are the result of an atmosphere depleted of oxygen (May and Tuckson 1982:48). Both exterior and interior surface colors on each sherd were recorded according to the Munsell Soil Color Charts. "Differential access to air during firing and cooling" can cause a fluctuation in color on the body of the pot (Rye 1981:120). These darker areas are termed *fire clouds* and their presence on the sherds was documented as well.

In addition to examining the external attributes of sherds related to firing technique, internal attributes also were examined. A fresh break was made on each sherd in order to look at firing core, core margin, and core thickness. Seven different types of firing core were recorded: (1) total oxidation; (2) total reduction; (3) partial oxidation on both interior and exterior; (4) external oxidation; (5) internal oxidation; (6) oxidation at the surface with interior and exterior indeterminable; and, (7) multiple layers of oxidation throughout the cross section. Multiple cores are normally found in vessels of fine clays with no organic inclusions that have been cooled rapidly in a reducing atmosphere and refired (Rye 1981:116).

Core thickness was measured relatively, based upon the thickness of the sherd. If a core was present, it was recorded as either less than one-third, one-third to two-thirds, or greater than two thirds of the sherd's thickness. Cores are related to firing temperature and cooling technique and can be formed in the following ways: if the pots are fired in an oxidizing atmosphere but the firing temperature is too low, then the vessel will be incompletely fired and leave a dark core in the middle of the sherd. Even if the pots are fired in a reducing atmosphere, if the temperature is not high enough, a dark core of unburned material will be left in the center. Likewise if the pot has been reduced and then cooled rapidly in an oxygen rich atmosphere, an oxidized layer will form on the surface of the pot, again leaving a dark core at the center (Rye 1981:118).

Core margins, in addition to color, are a good indication of cooling behavior. Three degrees of core margins were recorded. Discrete, sharp margins are caused by rapid cooling usually in an oxygen rich atmosphere. Well-defined margins are not as sharp as discrete margins, yet the margin is determinable; they are formed in the same way as discrete margins. Blended or "fuzzy" margins are produced when the pot is cooled down slowly, most likely having been left in the ashes of the fire (Bennett 1974:28).

The presence/absence of carbonaceous residue on sherds was also noted. The presence of such carbon residue relates to the use life of the pot, rather than to post-depositional factors. In addition, the presence/absence of concreted sand and shell on the sherds (especially noticable in the lower levels) was recorded, as well as the degree of erosion the sherds have undergone since deposition.

Results

Site 14 stands out among Gifford's excavations for two reasons. First, it was the deepest site that he dug (total depth 78"), and second, it represents a middle period between site 13 site 26. Gifford and Shutler excavated in arbitrary 6-inch levels; thus, no adjustment was made in artifact collecting for changes in stratigraphy (Table 1). But fortunately Gifford and Shutler left a description of the site's stratigraphy for each of the four squares excavated in their field notes (Gifford and Shutler MS). The top 18" are characterized by black, sandy soil although this soil is different, they report, from the black adobe that characterized the top layers at site 13. Levels from 18-42" were characterized by black sandy soil. At 42" Gifford and Shutler ran into consolidated sand as well as evidence of a hearth in square C2-3/D2-3. Such consolidated calcareous sand forms under situations of wetting and drying (such as occur with tidal fluctuation), causing sand and pieces of shell debris to become cemented together. The number of sherds having concreted material on them jumps from 3% in level 6 (30-36") to 19% in level 7 (36-42") to 59% and 52% in levels 8 and 9 respectively, after which it disappears (see Leonard, this volume). The consolidated matter ends at 54" where coarse, loose, beach sand is encountered along with an increase in water volume that increases with depth to the bottom of the site (Gifford and Shutler MS [1952]). It is in these lower levels that the amount of erosion increases dramatically from an average 17% in level 8 to 39% in level 9 and it keeps increasing in percentage down to level 12 where it again averages out at 25% (Table 2).

Method of Manufacture

Sherd thickness for the entire assemblage averaged 6 mm; the average thickness per level ranged from 4-7 mm. Sherds on the thicker end of the scale, 6-7 mm, tended to rest in levels 1-9 (0-54"), while the thinner sherds, 4-5 mm, were found in levels 10-13 (54-78"). Although a difference in the thickness of the sherds between the lower and upper levels could be due to greater erosion in the lower levels, when other attributes such as color and firing technique are added to the equation, it seems that a shift in technology over time is a better explanation for the variation.

The paddle-and-anvil method was used throughout the occupation of the site by the potters to thin the walls of their vessels. Anvil impressions occur on 50-60% of the sherds per

Table 1
Sherd Distribution by Stratigraphic Zone, Site 14

Stratigraphy	Level	Weight (oz)	Number of Sherds
Black sand	0-6	66	348
	6-12	16	98
	12-18	66	214
	18-24	72	400
	24-30	37	156
Sand	30-36	27	97
	36-42	51	208
Hearth ~250AD	42-48	65	265
Consolidated matter	48-54	5	181
	54-60	25	109
Coarse sand with coral	60-66	6	15
	66-72	3	16
	72-78	1	7

Table 2
Surface Finishing, Site 14

Level (inches)	Undeterminable (%)	Eroded (%)	Striations (%)	Paddle Impressed	Burnishing or Luster (%)	Slip (%)	N
0-6	62	2	15		22	1	107
6-12	64	7	19		11		75
12-18	58	5	29		5		95
18-24	59	6	28		7		123
24-30	64	20	14		2		86
30-36	56	11	25	1	7		91
36-42	61	19	17	1	1		90
42-48	84	7	9	-			88
48-54	75	20	3	1			69
54-60	20	67	6	3	3		64
60-66	30	60	10				10
66-72	88	12					16
72-78	100						7

level (except for level 3 at 68%, and level 5 at 67%) through level 7 (36-42") where the percentage drops to approximately 20-30%. But again, the presence of concreted material on the sherds as well as erosion can cause the identification of anvil impressions on the sherds in the lower levels to be next to impossible. Paddle-and-anvil is a secondary forming technique that usually obliterates any evidence of the primary forming technique such as coiling or slab building (Rye 1981:84). But as Green points out in terms of Lapita pottery: "The use of slab building techniques at the shoulder junctures is very evident . . . . Ring building and hand molding and modeling have also been suggested as methods of performing at least some of the specialized tasks" (Green 1979:40). These methods of primary pot forming still persist in Papua New Guinea (May and Tuckson 1983:35-43).

The porosity or compactness of the sherds is fairly constant as well, with approximately 50% of sherds in each level down to level 10 having a medium porosity. Sherds having a compact porosity averaged 20-30% of the assemblage through level 10 except for level 1 where an unusually high 42% of the sherds had compact porosity (and level 11 at 50% although this only represents five sherds possibly from the same pot.) Thus, one can assume that the potters took great care in preparing their clay for use, as compact vessel walls are in part determined by how well the potter kneaded, built, and thinned the walls of the vessel (Bennett 1974:34). Highly porous sherds averaged a small 15-25% of the assemblage except in those levels which contained either large amounts of concreted sand or large amounts of water. Levels 8 and 9 contain large amounts of concreted sand on the sherds. This concreted layer suggests that at some point the water table fell rapidly or fluctuated inter-tidally, and cemented the sand particles together causing mineral constituents in the sherds to leach out, developing larger pores. Those sherds in levels 10-13 were in sediments that were water-logged when Gifford and Shutler dug the site, and whose mineral makeup was still being dissolved. Thus porosity in the lower levels of the site is a function of post-depositional factors rather than being a function of clay preparation and/or of vessel body formation.

While anvil impressions and porosity remain fairly constant throughout the occupation of the site, the types of surface finishing undergo a change (Table 2). The percentage of sherds having surface finishing is quite small. Slip was found on only one sherd in the uppermost level of the site. Burnishing is present on 22% of the sherds in the top level of the site and then decreases with depth to level 7 (36-42"). Striations also occur in high percentages, 14-29%, in levels 1-7 and then diminish to 3-10% in levels 8-11 after which it disappears. Unfortunately, no mention is made of surface finish in Green and Mitchell's review of New Caledonian archaeology; therefore, one cannot assume that burnishing was peculiar to Oundjo ceramics due to its presence in the upper levels of site 14 that are associated by Green and Mitchell with the Oundjo horizon. Recent work on site 26 ceramics indicate the presence of striations on a significant minority of the pottery studied (see Casella, this volume); thus, this may have been the only type of surface finishing to have carried over into the historic phase of Oundjo ceramics. Despite these conjectures it must be kept in mind that the absence of surface finishing in the lower levels may just as well be a function of the concreted sand and the amount of erosion that the sherds have undergone.

Non-plastic inclusions in the sherds are predominantly quartz/light minerals of less than 0.5 mm in size. This type of inclusion is consistently dominant. This suggests that the potters were using a type of non-calcareous beach sand and crushing it or, at the least, conducting a thorough sort in order to isolate the smallest particles for use in the vessel. Eighty to one hundred percent of the sherds in each level have an inclusion size less than 0.5 mm (Table 3). Quartz and light minerals occur in 25-35% of the pottery in each level except for levels 2 and 9 at 43% and 42% respectively. Other types of inclusions occur in the site as well, such as dark or black minerals, crushed pottery sherds, and lithic fragments. Dark or black minerals make up about 10% of the inclusion types in the assemblage except in level 11 where dark or black minerals occur in 27% of the sherds. (It is possible that they come from the same pot as only 16 sherds were examined in level 11.) Because the dark or black mineral inclusions were fairly isolated, occurring as the sole temper type or as the dominant type accompanied by some lithic material, and because of the low frequency of their occurrence within the assemblage, it is possible that some sort of limited trade was occurring on the island.

Table 3
Non-Plastic Inclusion Type Frequency, Site 14

Level (inches)	Quartz (%)	Grog (%)	Lithic (%)	Black Minerals (%)	N
0-6	52	12	27	6	107
6-12	54	17	14	11	75
12-18	49	24	15	7	95
18-24	52	21	18	5	123
24-30	58	11	21	7	86
30-36	46	11	24	13	91
36-42	52	12	24	9	90
42-48	52	14	22	7	88
48-54	51	19	19	2	69
54-60	41	15	16	11	64
60-66	33	27	11	27	10
66-72	82		11	6	16
72-78	100				7

Grog or crushed ceramics occur in approximately 15% of the sherds. The grog never occurs by itself; it is always mixed with either quartz or light minerals or lithic material. This information suggests that potters were crushing some other type of tempered pot, possibly of Lapita origin, in order to create temper for their own vessels. Unusually high concentrations of grog occur in levels 3 and 4 at 24% and 21% respectively and level 11 at 27% (3 sherds).

Lithic fragments occur in approximately 20% of the sherds except in level 1 at 27%. Most of the lithic fragments occur as rounded, non-sorted inclusions and coincide roughly with those sherds having inclusions 0.5-1.5 mm in size. The presence of lithic fragments as the sole inclusion occurs in only 10% of the pottery. Inclusion density on these sherds is relatively low. One can conclude from this information that the presence of lithic fragments is most likely natural, not having been manually added. In fact the highest percentages of lithic fragments occur in those levels where there is an increase in sherds with a temper density of 5%, namely levels 4-9 (Table 3).

Organic inclusions occur in only 1% of the potsherds and then only as large, unburned particles in the core. Their presence points to the fact that the sherds were not fired thoroughly. Calcareous beach sand occurs in only 4% of the sherds, mostly in the upper levels. Because of the limited number of sherds containing calcareous beach sand as well as the fact that the sand is usually the sole temper type in those sherds in which it occurs, the presence of these sherds, like those containing dark or black minerals, may suggest some inter-regional trade occurring on La Grande Terre.

Inclusion density is usually a good indication of whether or not a potting clay has been manually tempered. If inclusion density is fairly constant, one can assume that the inclusions were being manually added. In the case of site 14 an inclusion density of 10% occurred in 50-60% of the sherds in levels 1-10 except for level 3 at 64% and levels 11 and 12 at 40% (4 sherds) and 19% (2 sherds) respectively. In level 13, 100% (7 sherds) of the sherds have a density of 10%. Because of the stability of inclusion type, density, and size as well as the nature of the inclusion size (e.g., small) one can assume that the inclusions were manually added.

There seems to have been some sort of experimentation going on in the middle phase of the site in terms of the tempering of sherds. While inclusion density remains stable at 10% in 50-60% of the assemblage, the percentage of sherds having a density of 20% drops from 25-30% in levels 1-4 to 15% in levels 5-8 and then returns to its previous amount in levels 9-11. In level 12 (16 sherds) 75% of the sherds have a density of 20% and in level 13, 0%. The opposite happens with those sherds having a density of 5%. Thus, it is possible that an unsuccessful experimentation with the amount of inclusions added pottery took place during the middle phase of occupation at site 14.

Firing Technology

Surface color groups into three main categories: red (Munsell 2.5 YR 5/4 and 5/6), brown (Munsell 5 YR 5/3 and 5/4, and 7.5 YR 4/2 and 5/2), and gray (Munsell 5 YR 4/1 and 5/2). There was some variation of surface color outside of these parameters but the majority of the sherds fell into one of the above listed Munsell colors. The distribution by level of surface color is noteworthy. Sherds in the lower levels are predominately red, ranging from 100% in level 13 (7 sherds) up to 50% in level 7 (36-42"). Above level 7, grays and browns predominate while red sherds hover around 30%. Color was measured on both the exterior and the interior of the sherds and the trend exists for both surfaces except in level 13 where the interior of all seven sherds is gray. This temporal shift from red to gray is important. It may mark a point at which the local ceramic tradition began to develop those attributes more characteristic of the later Oundjo tradition (see Casella, this volume).

Color is related to firing and cooling behavior. In historic times, New Caledonians fired their wares in open fires; ethnographic analogy from elsewhere in Melanesia supports this conclusion (May and Tuckson 1974:45). Redder wares are fired in an atmosphere rich in oxygen while grayer wares are produced in an oxygen-depleted atmosphere (May and Tuckson 1974:48). The shift in sherd color at site 14 coincides with the division of the site into two ceramic traditions by Green and Mitchell (1983:48). The grayer bodies in the upper levels are characteristic of those in site 26, Oundjo, and may be the first indication of a change in ceramic traditions. It is difficult to produce and maintain a true oxidizing atmosphere in open fires; thus, special means of positioning the pots and stacking the fuel must be employed (Rye 1981:98). It is possible that later occupants of the site were positioning their pots in a different manner, thus rendering them gray and reduced. However, the analysis of the firing cores shows that an oxidizing atmosphere for ceramic firing was typical throughout the site's history. Thus, a more plausible explanation for the shift to grayer, Oundjo style wares may be a change in cooling behavior.

Another means of obtaining a red-bodied vessel, aside from firing in an oxidized atmosphere, is to remove the vessel from the fire and to cool it quickly in an oxygen-rich atmosphere. If the vessel is left in the fire to cool with the embers, it will be covered with residual ash and unburned fuel; this depletes the surface of oxygen and leaves the pot gray or black, which may be the best explanation for having a majority of gray sherds in the upper levels of the site (Rye 1981:117). The presence of fire clouds in these levels supports this hypothesis (Table 4).

Fire clouds, as previously stated, are caused by differential access to air during the firing and cooling processes (1981:120). Access to air would be impeded if the pots were left in the ashes to cool; thus, a greater number of fire clouds would occur. In the deeper levels (7-13) fire clouds occur in only 10-20% of the sherds sampled, except in levels 12 and 13 where 56% and 43% of the sherds respectively had fire clouds. This would be remarkable except that the percentages represent only 8 sherds in level 12 and 3 sherds in level 13. In the upper levels fire clouding occurs in 20-40% of the sherds sampled. This increase in fire clouding correlates with the change in color, adding substance to the argument in favor of a shift in cooling technique.

Table 4
Ceramic Fire Clouding, Site 14

Level (inches)	Undeterminable (%)	Exterior (%)	Interior (%)	Absent (%)	Both Sides (%)	N
0-6	2	12	8	73	5	107
6-12	4	12	4	77	3	75
12-18	2	28	8	49	12	95
18-24	2	29	2	62	5	123
24-30	16	27	8	44	5	86
30-36	8	15	8	53	16	91
36-42	10	17	11	52	10	90
42-48	23	11	7	51	8	88
48-54	29	7	1	58	4	69
54-60	44	12	2	42		64
60-66	60	20		20		10
66-72	19		12	12	56	16
72-78		14	57		29	7

Core margins are also a result of cooling technique, but unlike fire clouding or surface color, they are less susceptible to post-depositional modification by forces and other factors. Discrete margins, and well-defined margins that are not quite as sharp as discrete margins, are formed when the vessel is taken out of the fire to cool quickly. Blended margins, in which it is impossible to tell where the core begins and ends, are formed when the pot is left to cool slowly in the ashes. Although approximately 50% of the sherds in each level had no core, the other 50% of the sherds distributed themselves into one of the three categories just described. Well-defined margins (the midpoint between the two extremes) tended to stay constant throughout the site, at 20-30% for each level. Discrete margins occur in smaller percentages in the upper layers, 5-10% in levels 1-5, than the blended margins which range from 15-25% in levels 1-7. The opposite happens in the lower levels. Discrete margins rise slightly in percentage, 10-15%, while blended cores drop slightly, 5-15%. This pattern is present except in the deepest levels of the site (10-13) where cores tend to disappear and are totally oxidized. This fluctuation in margin distribution is important because it corresponds with color and fire clouding distributions, characteristics that mark the Oundjo tradition. It is a small change, but important nonetheless.

Firing cores provide other clues to the development of Oundjo ceramics. Firing cores are a good indicator of firing technique. Most of the pottery was completely oxidized making up 30-45% of the assemblage by level and 88-100% in levels 12 and 13 respectively. External oxidation is constant at 20-30% of the assemblage except for level 2 at 41% and levels 4 and 5 at 40% and 36% respectively. Even the majority of sherds with fire clouds on the exterior had an oxidized or externally oxidized core. Therefore it seems necessary to conclude that the potters who were supplying the pots to the residents of site 14 were able to produce and maintain an oxidizing atmosphere in their bonfires through specialized stacking of fuel and pots, a technology that would be fairly conservative (Rye 1981:98).

The number of reduced (inoxidized) sherds in the site is small, although there is some correlation with the upper/lower division of the site that has already been established on the basis of cooling technique. Reduced sherds average 15% of the assemblage in levels 1-6 except in level 5 where there is an unusually high concentration at 24%. The lower levels of the site average 10% except for levels 12 and 13 where reduction disappears altogether. Most Oundjo ceramics have reduced cores; thus, the concentration of reduced cores in the upper levels, though small, becomes important (see Casella, this volume). Sherds that have been partially oxidized on both the interior and exterior follow this pattern as well, although the percentages are again small. They run between 5-10% in levels 1-6, where sherds are less red, and 15-23% in the lower levels where sherds are more red, disappearing once again in levels 12 and 13. This distribution of both types of cores is based on small changes. But these changes are roughly parallel to those occurring in color and fire-clouding distributions; thus, they become more remarkable. Two other types of cores were present in the assemblage. Internally-oxidized cores were present in approximately 5% of the sherds in levels 1-9, and multiple cores occurred sporadically in levels 1-9 as well, only averaging approximately 1% of the total assemblage. These cores were probably functions of the way that the vessels were stacked during firing.

Core thickness was distributed evenly throughout all levels of the site, lending credence to the supposition that the pots had been fired at roughly the same temperature in the same atmosphere throughout the occupation span of the site; after all, ceramic technology is inherently conservative. Again the majority of the sherds exhibited no core, approximately 50% in levels 1-11 and 88-100% in levels 12 and 13. Observed core thicknesses were divided into three groups based upon the relative sherd thickness: (1) those sherds displaying a core less than one-third the thickness of the sherd; (2) those displaying a core one-third to two-thirds the thickness of the sherd; and, (3) those displaying a core over two-thirds the thickness of the sherd. Sherds with a core of one-third to two-thirds their thickness occurred in 15-25% of the sherds through level 11. Cores less than one-third the sherd's thickness and greater than two-thirds the sherd's thickness were distributed evenly as well, approximately 10% each, down to level 10 where very thin cores disappear. These figures most likely represent a differentiation in the placement of vessels in the fire rather than any significant shift in firing technique. The fact that cores are indeed present in approximately 50% of the sherds that have been fired points to the fact that the fires were not hot enough to cook the pots all the way through.

The hardness of pottery, as measured on Moh's hardness scale, is another important clue to firing temperature. Ninety-six percent of the sherds in the assemblage had a hardness under '3'. The other 4% consisted of a few sherds with a hardness of '3' or '4' in various levels as deep as level 9. These sherds were probably from pots that had been fired at the most intense part of the fire, the other areas of the fire not being hot enough to render the pots any harder.

The presence/absence of carbonaceous residue on sherds in site 14 was also noted (Table 5), its presence being related to vessel function rather than post-depositional factors. The

Table 5
Presence of Residue, Site 14

Level (inches)	Absent (%)	Carbon(%)	Concreted Sand (%)	N
0-6	96	4		107
6-12	96	4		75
12-18	96	4		95
18-24	86	5	9	123
24-30	85	7	8	86
30-36	91	3	6	91
36-42	79	2	19	90
42-48	34	2	64	88
48-54	44	1	55	69
54-60	92		8	64
60-66	100			10
66-72	100			16
72-78	100			7

number of sherds that have carbonaceous residue is small, yet their distribution is remarkable. The percentages vary between 2% to 8% per level, but traces of carbon on the sherds totally disappear below level 8 (42-48"). This is the level at which the consolidated sediment begins (see Leonard, this volume). Whether this disappearance is due to post-depositional factors such as the formation of the concreted layer or is due to a shift in usage (as the presence of carbonaceous material and the hearth may indicate) is hard to determine simply because the changes present in both vessel wall thickness and amount of carbon residue are not that great. The presence of carbon on a sherd possibly indicates that some type of cooking was going on. The build up of carbon is possibly related to the boiling of sugary liquids in the vessels, possibly from cooking tubers such as *Dioscorea* yams. But as May and Tuckson point out in their ethnographic study of the traditional potters of Papua New Guinea "mistakes have been made by assuming a blackened pot is a cooking pot" (1974:53). Carbon build up occurs on a pot as it sits in a hut where a fire is kept continuously going (1974:53). Thus, chemical analysis of the material will be required to provide further clues as to the function of the pots.

Conclusions

Ceramic technology at site 14 was relatively stable over time. It must be remembered that ceramic technology is inherently conservative in nature, even more so than decoration (Rye 1981:4). The fact that a possible shift in cooling technique took place mid-way through the site is significant. This shift is supported by the distribution of surface color from red in the deeper levels to gray/brown in the upper deposits, the increase in frequency of fire clouds in the later part of the site, and the distribution of blended core margins. Thicker vessel walls in the upper levels, as well as the presence of carbon on only those sherds in the later levels, suggests a shift towards ceramics characteristic of the Oundjo tradition. This hypothesis is supported by evidence from site 26 in which the sherds are thicker, grayer and have a significant amount of carbon residue present (see Casella, this volume).

The stratigraphy of site 14 roughly correlates with the ceramic changes documented above (see Leonard, this volume). Level 7 (36-42") is the pivotal level. It is at this level that the sediment changes from consolidated matter underneath to a black, sandy soil on top. And it is in level 8 (42-48") that Gifford found a hearth in square C2-3/D2-3. It is possible that this hearth represents a different period of occupation of the site than the later levels (Green and Mitchell 1983:48). In their monograph Gifford and Shutler point out that beach sites such as site 14, have a bottom layer of beach debris (sand, shell, coral, etc.). They conclude that therefore "the original settlement at such sites...was at first perhaps only temporary and intermittent, followed later by more permanent residence" (Gifford and Shutler 1956:1). Green and Mitchell in their review of the New Caledonian archaeological sequence identify two separate occupations of the site based on decoration and concentrations of potsherds. The first occupation is found between 12-30" and the second between 36-54". They strengthen their argument by correlating these concentrations of pot sherds with the stratigraphy (Table 1). They argue that "the few decorated sherds present in the black sand layer (0-30") belong mainly to the Oundjo pottery horizon with only two ribbed sherds present (1at 0-6", 1at 12-18") . . . in the lower levels (36-78"), however, the ribbed paddle-impressed technique is dominant, forming 89% of decorated sherds" (Green and Mitchell 1983:48). The ribbed paddle-impressed technique is characteristic of Podtanéan. Thus, if one combines this information with the technological data, it seems that two different occupations of the site are, in fact, plausible. In ceramic technological terms, the earlier occupation (which may have been intermittent) is characterized by thinner, redder wares, oxidized firing cores, and fewer fire clouds. Concentrations of sherds are lower in these lower levels suggesting that use of the site was less intense. The formation of black, sandy soil on top of the consolidated matter suggests a change in depositional environment, possibly correlated with relative sea-level change.[2] The pottery in these upper levels consists of thicker, grayer wares, taking on some of the characteristics of those sherds at site 26 (Oundjo), such as an increase in blended core margins as well as firing clouding. Sherd concentration is greater in these levels and may be a function of a more permanent settlement. Site 14 presents a conservative ceramic tradition in the process of making small changes. But because of the conservative nature of ceramic technology, even a small change is not insignificant especially since it possibly signals a change in ceramic traditions.

2. Editor's note: There is considerable geomorphological evidence for a widespread drop in relative sea level from a mid Holocene high stand of between +1-1.5 m, down to the modern level, at around 2000 B.P. in the southwestern Pacific (see Kirch [1996:162-65] for further dis-ussion and citations). (PVK)