Characterisation Without Sources: Early Prehistoric Pottery from the South Coast of New Guinea

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Introduction

Pottery remains one of the most important of artefacts found in sites along the south coast of New Guinea (NG). Exchange of this pottery has been crucial to prehistorians' models of the social organisation of the populations living there (see e.g. Irwin 1991, Allen 1984, Rhoads 1980, Bulmer 1978). Sourcing studies have provided, and continue to provide evidence of long distance exchange of artefacts, but the complexity of pottery raw material selection, manufacturing and distribution processes make interpretations difficult. There remain only patchy descriptions of local potting raw materials along the south coast of NG.

Irwin (1991:503) has presented the most recent model for the Early Period settlement of the south coast. A group of migrants arrived along a coastline in Melanesia, bringing with them the knowledge of pottery making and new languages. They rapidly established lengthy exchange networks involving the pottery, shell ornaments, stone and food. The new languages were probably Austronesian, and the food derived from a generalised economy involving horticulture and the extraction of local marine resources near their settlements. They carried with them obsidian tools despite the long distances to the nearest sources. Yet unlike archaeological phenomenon described as Lapita, this time the events occurred on the southern coast of NG and the pottery was neither dentate-stamped nor did it have "face-motifs". Moreover, this migration took place hundreds of years after Lapita, and perhaps three thousand years after pottery had arrived on the northern coast of NG (e.g., Swadling *et al.* 1989).

The arrival of pottery around 1900 cal BP (see below for calibrated dates) throughout the Massim and southern coast of NG marks a major shift in the prehistory of the region and represents the first archaeologically recovered intense occupation there. Over the next few hundred years, the makers of this "Early" and sometimes red-slipped pottery occupied settlements along much of this coast and nearby islands, with exchange tendrils moving towards the mountainous interior and along the coast to the communities in the Gulf of Papua. Then, starting around 1100 years ago and ending some 400 years later, there was widespread change in settlement patterns and in the designs of pottery (Irwin 1991). Around Yule Island, sites were abandoned (Vanderwal 1973), and exchange between the Yule Island and Port Moresby areas to the Gulf stopped, at least for a while (Rhoads 1982:146).

In the first two to four centuries after this period of change, the south coast populations follow more independent trajectories. There are signs of increasing regional isolation with an attenuation of long-distance trade (e.g., the amount of Fergusson Island obsidian moving from the Massim to the southern coast [Irwin 1991]).

During the last few hundred years of prehistory several exchange networks developed, often involving populations located on small offshore islands such as Mailu (Irwin 1985) and Motupore (Allen 1984) along the south coast, who carried out specialist manufacture or exchange. This increasing specialisation also extended into the Massim area and resulted in long distance exchange networks. The hiri and kula described by early explorers and ethnographers are the most famous of those networks, which continue, in modified form, to the present.

Early Period pottery exchange along the south coast of NG can be summarised as follows:

a) There is local exchange of goods within both the Yule Island and Port Moresby areas during the Early Period (e.g., Allen 1972:121, Bulmer 1978).

b) There is no clear evidence of trade and exchange between the Yule Island and Port Moresby regions although the similarity of the pottery from both areas during this period has been noted (e.g., Bulmer 1978).

c) Swadling (1980) has argued that Port Moresby may be the dominant source of pottery being exchanged along the long distance networks to the Gulf sites. Rhoads (1980) has argued that Yule Island potters were dominant in controlling the long distance pottery exchange to the Gulf during the first few centuries of the Early Period. During the later part of the Early Period, Port Moresby traders became important in competing for the Gulf "market".

The importance of the pottery in the development of these arguments is significant, but prior to the research discussed here only a few Early Period sherds had undergone any sort of chemical or petrographic examination. Frankel *et al.*'s (1994) analysis of sherds from Gulf sites concentrated on sherds from contexts only a few hundred years old but did include 12 sherds from the Early Period Oposisi site. However, no details of these are given and Yule Island pottery has received no further treatment. Studies which did incorporate Early pottery include Worthing (1980) and Swadling (1980), using Port Moresby and Gulf sherds. Mackenzie (1980) analysed 21 sherds from the Kulupuari site in the Gulf, but it is not clear which were from recent and which from Early Period contexts (Rhoads 1980:131-132, A69-73). Irwin (1985) sourced 60 Early Period sherds from Mailu to local clays.

For this research, a sample of Early Period sherds was provided by Chris Gosden from PNG National Museum collections and additional sherds from the Port Moresby area were taken from the surveys and excavations by Susan Bulmer to investigate exchange networks during the Early Period. Three questions were foremost in the investigation:

1) Could the Yule Island pottery "source(s)" be characterised?
2) What "sources" of pottery could be identified in the Port Moresby area?
3) Where was the pottery reaching the Gulf during the Early Period made?

The goal here is to provide a description of Port Moresby versus Yule Island potting traditions and to outline some "rules" for distinguishing them for articulating Early regional exchange networks.

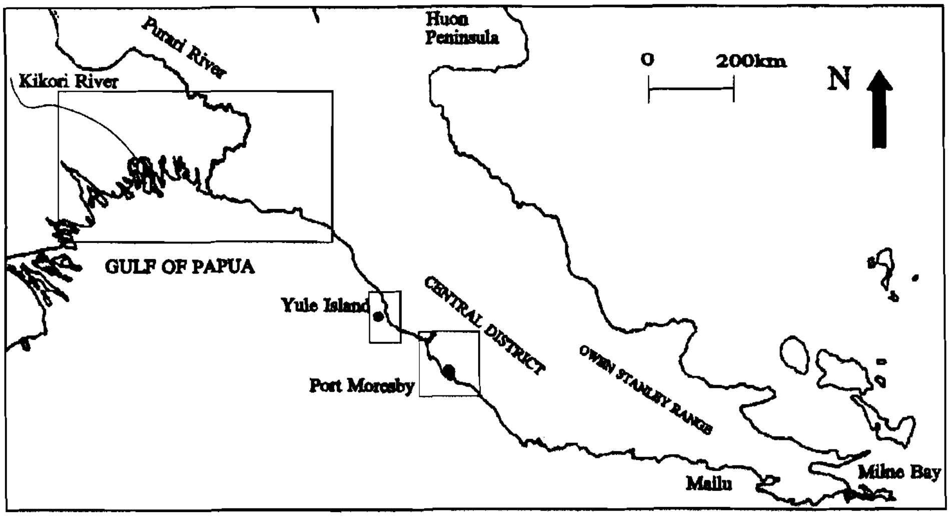

Figure 1
Map of areas in Papua New Guinea mentioned in text.

Characterisation of the Pottery

The collection consisted of 184 sherds from 42 Early Period sites (see Bickler 1991, in press, for details of the sites) and obtained from three main areas (Figure 1):

1) the Gulf of Papua,
2) Yule Island and the mainland opposite, and
3) around modern Port Moresby.

This represents an extensive, not intensive, sample of pottery from Early Period sites.

The compositional analysis undertaken consisted of chemical characterisation using X-ray fluorescence (XRF) of 128 sherds, followed by petrographic examination of 69 of them plus the remaining 56 sherds not submitted for chemical characterisation. The results of the chemical and petrographic work were integrated to produce several "groups" of sherds whose distribution could be studied. Full details of the analytic procedures are detailed in Bickler (in press, 1991: Chapter 4)

XRF samples were prepared by grinding 4g of each sherd into a fine powder and pressing them into pellets with boric acid powder. When possible a cross-sectional sample from the original sherd was used to ensure that the chemical data was representative of the sherd. The samples were analysed using the XRF spectrometer at the Department of Geology, Victoria University of Wellington, and a total of 19 elemental concentrations (Sc, V, Cr, Ba, La, Ce, Ni, Cu, Zn, Zr, Nb, Ga, Pb, Rb, Sr, Th, U, Y, As) were obtained for each sherd (see Bickler 1991: Appendices A-C for complete listings).

There are no published data on the elemental composition of the clay sources in the areas where the sherds were found nor were source samples available for comparative analysis. Statistical tests such as discriminant analysis, which test the probability of a sample being from a particular source of clay and temper, could not be used. The statistical analysis of the elemental concentrations requires an explorative approach.

All 19 elemental concentrations were used as there was no a priori reason to reject particular elements (c.f. Rye and Duerden 1982). The steps used to create groups of sherds from different "sources" are described below.

1) Transform Data: The element distributions were transformed using logarithms (log10) to provide appropriate (normally distributed) data for multivariate algorithms.

2) Multivariate Analysisd: Several multivariate algorithms were used to create groups of sherds which are chemically alike. However, such algorithms not only recognise structures in the data but can create them (Bishop and Neff 1989:62) as the choice of algorithm is in part a choice of structure in the data. The algorithms chosen were principal components analysis (PCA), factor analysis (FA) using the varimax rotation, hie-

rarchical cluster analysis, correspondence analysis (CA), and k-means non-hierarchical analysis. Each identifies a combination of elements that characterise variation in the data.

3a) Hierarchical clustering to provide groups: Cluster the output of PCA, FA and CA algorithms using hierarchical clustering (Average Linkage and Ward's Minimum Variance) techniques, producing dendrograms showing sherd groupings. The dendrograms can then be examined to create groups.

3b)Non-hierarchical clustering to provide groups: K-means non-hierarchical clustering of the original transformed data provided a further set of clusters or groups of sherds. The k-means clustering algorithm is described by Kintigh (n.d.) and uses a simulation approach to determine the likely number of groups present and the membership of the groups.

Bulk chemical analysis suffers from the drawback of being a 'blind' technique as the elemental concentrations can mask complex mineralogy necessary for source discrimination (Bishop and Neff 1989:69; Neff *et al.* 1988, 1989). With petrography, it is possible to examine the amounts of temper and clay in the body of the sherd. Most importantly, however, petrography provides an independent means of evaluating the formation of the groups of sherds generated by the statistical analysis of the chemical data (c.f. Hunt and Graves 1990:108-109).

4) Petrographic groups: Establishing groupings using petrography meant recognising the broad suites of inclusions found in the sherds rather than detailed analysis of each section. The major distinguishing features found by the petrography were the presence of rounded chert in Port Moresby sources, and the larger lumps of quartzite, quartz and feldspars grains characteristic of Yule Island pottery. Nine groups were identified.

The major difficulty with using the exploratory approach is getting different results: five techniques gives five sets of groupings. While there is significant overlap, the variation in these groupings is not insignificant. Furthermore, it is not obvious what variation is due to the particular statistical treatment and what is due to actual "source" variation.

5) Resolving different results: Sherds that consistently clustered together chemically and petrographically were picked out. These provided the new "sources". The remaining sherds could be tested for membership in these groups using discriminant analysis, thereby reducing the complexity of dealing with pottery without actual source materials. Combinations of such source sherds were used to test the stability of the final groupings, and the vast majority of sherds fell consistently into one of nine "source groups".

6) Examine the distribution of final groups: The 9 groups, labelled here A1, A2, B, C1, C2, D, E, F and G, could be examined using the petrography and chemical data for distinguishing features (see Table 1).

GROUPS:	A1		A2		B		C1		C2		D		E		F		G		Y	
Number	22		12		4		11		11		9		7		34		4		10	
	Ave	Std	Ave	Std	Ave	Std	Ave	Std	Ave	Std	Ave	Std	Ave	Std	Ave	Std	Ave	Std	Ave	Std
Sc	11.4	2.9	16.7	4.4	23.5	2.9	17.6	3.1	23.1	4.8	21.5	2.4	19.3	2.0	19.0	2.3	19.8	0.7	20.4	4.7
V	66.9	20.5	82.9	23.8	182.3	48.3	140.8	20.5	209.9	80.3	167.2	23.8	178.2	19.2	167.2	17.4	175.4	8.6	171.3	32.0
Cr	62.3	25.0	67.5	23.8	194.8	58.1	233.0	144.9	512.7	655.4	247.8	117.1	192.3	77.3	99.9	9.1	244.2	184.2	150.5	40.0
Ba	490.7	238.7	514.6	142.9	176.3	36.6	542.9	82.4	611.4	209.9	556.6	106.9	672.4	152.9	469.8	96.8	590.9	105.3	457.1	117.6
La	20.2	7.2	13.7	4.1	18.8	4.2	18.5	3.3	16.3	4.0	38.9	11.7	24.4	9.1	18.7	6.0	14.6	2.1	20.9	4.7
Ce	36.0	13.0	22.5	6.9	51.5	22.4	46.0	11.2	46.7	9.5	111.0	31.0	70.9	17.8	49.4	14.0	36.6	4.5	52.9	10.1
Ni	31.7	7.6	33.6	13.2	48.9	12.6	41.3	10.1	63.0	29.6	70.0	25.8	50.0	7.2	31.6	6.1	25.7	5.9	46.8	11.3
Cu	49.6	14.4	64.3	25.8	42.7	39.6	42.9	9.8	42.1	13.3	46.1	8.3	35.8	3.4	38.2	10.9	64.0	11.1	33.2	13.0
Zn	51.7	22.5	46.1	13.8	63.4	15.7	72.3	13.4	85.7	18.3	96.3	21.1	77.6	20.2	84.3	16.1	537.4	156.3	65.1	35.7
Zr	131.1	37.7	111.7	18.2	134.9	41.8	147.7	19.9	177.9	103.0	144.5	13.5	199.1	34.0	224.0	28.6	155.2	38.2	155.4	18.9
Nb	3.8	0.7	3.4	0.6	6.2	0.5	5.6	0.9	6.7	1.4	5.6	0.9	6.8	1.1	7.6	0.7	6.1	0.7	7.4	1.0
Ga	13.1	1.9	13.5	1.8	17.7	4.8	16.3	1.4	18.5	3.4	17.5	2.5	18.5	3.0	18.6	2.3	16.8	2.9	17.0	1.9
Pb	15.8	2.7	12.9	2.4	15.8	3.6	15.0	1.4	15.9	2.6	19.2	2.3	24.2	5.9	19.9	2.1	13.6	3.0	15.6	2.9
Rb	30.7	13.9	24.4	9.9	27.5	4.6	39.0	9.2	50.4	24.5	40.6	7.4	37.4	18.2	64.7	17.4	48.7	14.1	45.4	13.2
Sr	441.6	271.5	930.0	349.5	176.6	70.3	510.9	168.1	322.1	51.2	382.3	102.3	306.9	69.2	209.6	27.8	229.0	43.1	270.0	102.1
Th	4.4	0.9	4.3	0.7	5.4	2.0	4.9	0.5	5.3	0.6	5.6	0.6	7.7	1.8	6.9	0.9	6.0	1.9	6.1	1.1
U	1.4	0.6	1.3	0.4	2.4	0.7	1.4	0.4	1.3	0.6	1.8	0.5	2.0	0.4	1.8	0.5	4.6	0.7	1.9	0.8
Y	23.8	13.4	13.9	5.9	22.3	4.6	20.0	5.3	22.7	6.2	41.1	12.5	26.5	7.0	23.3	5.5	18.6	2.3	22.0	4.6
As	2.1	1.1	4.3	1.8	27.8	10.5	8.7	3.6	7.7	3.4	7.6	1.6	10.1	2.6	5.7	1.4	15.0	1.7	7.6	3.1

Table 1
Descriptive statistics for chemical groups.

SITE	ZONE/CONTEXT	LAB CODE	MATERIAL	RAW Years BP	DATE ±s.d	CALIBRATED DATE -2s.d.	-1s.d.	Intercepts	1s.d.	2s.d.	MRC	Reference
Oposisi (ADI)	Layer IIA	ANU-726	Charcoal	940	180	1261	1052	904, 853, 835, 806, 797	670	550	N/A	Vanderwal (1973:48-49)
Oposisi (ADI)	Middle IIC	ANU-729	Charcoal	1530	160	1804	1561	1402	1287	1089	N/A	Vanderwal (1973:48-49)
Oposisi (ADI)	Middle IIC	ANU-728	Charcoal	1600	210	1952	1716	1611	1293	1067	N/A	Vanderwal (1973:48-49)
Oposisi (ADI)	Weighted Average	ANU-728/729	Charcoal	1556	128	1716	1556	1411	1308	1259	N/A	
Oposisi (ADI)	Layer IB	ANU-725	Charcoal	1180	200	1494	1291	1067	922	674	N/A	Vanderwal (1973:48-49)
Oposisi (ADI)	Weighted Average	ANU-725/726	Charcoal	1047	134	1268	1067	943	789	674	N/A	
Oposisi (ADI)	Lower IIC	ANU-425	Charcoal	1890	305	2711	2282	1825	1456	1184	N/A	Vanderwal (1973:48-49)
Oposisi (ADI)	IIB (REJECTED)	ANU-727	Charcoal	1920	80	2009	1938	1866	1735	1630	N/A	Vanderwal (1973:48-49)
Kukuba Cave (ADL)	Ceramic Phase	ANU-732	Charcoal	1250	85	1305	1277	1171	1063	966	N/A	Vanderwal (1973:51-52)
Abe (AOD)		ANU-731	Charcoal	1560	85	1683	1533	1412	1342	1293	N/A	Vanderwal (1973:51)
Kulupuari (ODI)	Above Horizon IV & V Interface	ANU-1962	Charcoal	1360	210	1702	1416	1285	1059	797	N/A	Rhoads (1980)
Kulupuari (ODI)	Top of Horizon V	ANU-1963	Charcoal	1480	80	1531	1412	1345	1296	1268	N/A	Rhoads (1980)
Samoa (OAC)	Lowest Level	I-6153	Charcoal	1850	95	1986	1877	1804, 1760	1628	1538	N/A	Rhoads (1983:98)
Samoa (OAC)	Lowest Level	ANU-2061A	Charcoal	2430	370	3374	2872	2428, 2399, 2369	1995	1561	N/A	Rhoads (1983:98)
Mailu 01	F/G Interface	ANU-1229	Charcoal	1800	70	1986	1891	1830	1727	1630	N/A	Irwin (1985:87)
Selai	Layer C1	ANU-1316	Charcoal	1790	90	1891	1821	1706	1568	1517	N/A	Irwin (1985:99)
Selai	Layer D1	ANU-1317	Charcoal	1770	70	1863	1736	1697, 1646, 1636	1568	1526	N/A	Irwin (1985:99)
Selai	Weighted Average	ANU-1316/1317	Charcoal	1778	56	1827	1732	1700, 1640, 1640	1609	1539	N/A	
Loloata Is. (ANT)	Lower Midden	ANU-4808	Shell	2300	100	2146	2021	1896	1789	1665	-5±35	Sullivan and Sassoon (1987:7)
Nebira 4 (ACL)	Level 14	I-5796	Charcoal	1760	90	1875	1804	1694, 1654, 1631	1544	1418	N/A	Allen (1972:120-121)
Eriama (ACV)	Crevice Layer 3	GaK-2670	Charcoal	1930	230	2355	2139	1870	1568	1340	N/A	Bulmer (1978:213)

Table 2
Radiocarbon dates discussed calibrated using CALIB 3.0 (Stuiver and Reimer 1986).
MRC = Marine Reservoir Correction.

Of the 184 sherds, four show absolutely no consistency in being allocated to any of the source groups (Group X). A further 10 always fall intoYule Island groups but do not consistently cluster into any particular one, nor cluster with each other (Group Y).

Analytic "groups" derived by the analysis could only equate to "sources" in the sense that if significant numbers of the sherds allocated to a group were found at a particular location which probably produced pottery, then that might be the potting centre. This is a tenuous link and the interpretation of the results had to take this issue into account (see e.g., Arnold *et al.* 1991).

One approach to evaluating the chemical make up of groups is to use Stepwise Discriminant Analysis (SDA) (SAS Institute Inc. 1985:763-774). This type of algorithm evaluates the contribution each of the chemical elements has in establishing the groups. Each element is first examined as the primary indicator of different groups and the most useful is used as a starting point. Each other element is then added or deleted to see their effect on the predicting the groups. Those effective at distinguishing the groups are kept, and the others removed (Dillon and Goldstein 1984:375-376). In effect this procedure reverses the final discriminant analysis used to assign the sherds to the nine groups and provides a ranked list of the most important elements (see e.g., Bickler 1991:118). This algorithm was used several times with reducing number of groups: on the 9 separate groups all together, on distinguishing between Yule Island and Port Moresby pottery (regional distinction), and then progressively identifying the elements characteristic of each group.

The likely Port Moresby "groups" were A1, A2 and F. Sherds from the Nebira sites mostly clustered together as one group (F) with the two other groups containing sherds from all over the area. The distinction between A1 and A2 was based primarily on the petrography while chemically they were quite similar: Group A1 sherds were generally lower (<13 ppm) in Scandium than A2. The groups A1 and A2 generally had the lowest values of Zinc, Chromium, Scandium and Arsenic compared with group F and the Yule Island sherds. Groups A1 and A2 were generally lower in Vanadium and Rubidium than Group F, but Niobium clearly separated groups A1 and A2 (< 5.3 ppm) from group F (> 6.5 ppm) (Figure 2).

The Yule Island groups were more complicated. Group G sherds from the Kukuba Cave site on the mainland opposite Yule Island were clearly distinct chemically from everything else. They had exceptionally high Zinc concentrations (>380 ppm) compared to all other sherds with Zinc concentrations of less than 200 ppm. Group B had the lowest values of Barium (< 215 ppm) and was generally high in Arsenic (>25 ppm). The single sherd from Taurama (AAL in the Port Moresby region) allocated to Group B exhibited both characteristics. Group D sherds were generally higher in Cesium (>69 ppm) and Yttrium (>27 ppm). Group E was distinguishable with high values of lead (>18 ppm) and Cesium. The separation of C1 and C2 was based on petrography (the large numbers of carbonate grains in group C1) more than the chemical separation but group C1 was generally higher (> 370 ppm) in Strontium and lower (< 20 ppm) in Scandium.

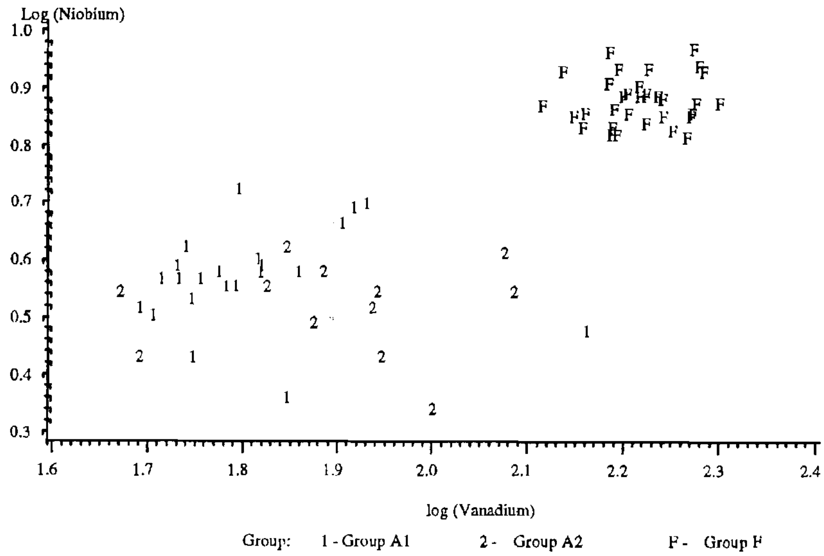

Figure 2
Log10 plot of Niobium versus Vanadium concentrations of Port Moresby sourced sherds, showing the formation of Group F.

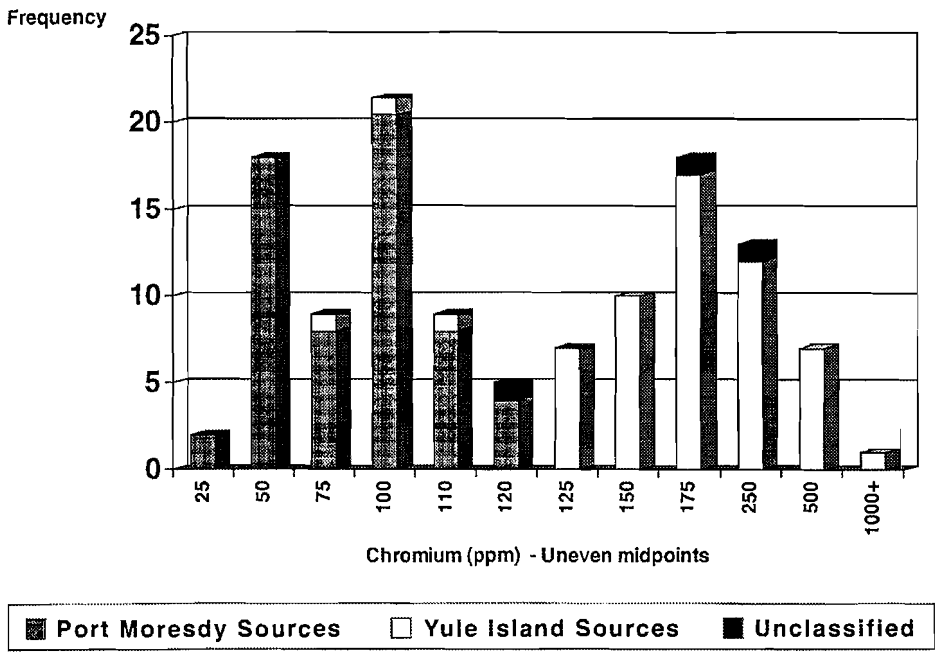

Figure 3
Histogram (with uneven categories) of the concentration of Chromium showing the different distributions of Port Moresby and Yule Island sourced sherds.

Distinguishing Yule Island pottery from Port Moresby pottery was the most important goal of characterisation. Chromium was identified by the SDA as the most important element in distinguishing between Yule Island and Port Moresby. Figure 3 shows the distribution of Chromium. With only a few notable exceptions, a concentration of less than 122 ppm of Chromium identifies Port Moresby pottery. Of the exceptions, two out of three of those that were allocated to Yule Island groups, and the one unclassified potsherd with less than 122 ppm of Chromium came from Port Moresby sites and so might have been mis-classified. Three other unclassified potsherds from Port Moresby sites have high Chromium content.

Interpretation

The collection of sherds lacked both tight chronological control as many came from surface collections. Moreover there is significant debate over the pottery stylistic sequences in the different areas. When possible, the sherds were organised using the available pottery and re-calibrated radiocarbon sequences. Re-calibration of the radiocarbon dates (Table 2) was carried out using the CALIB 3.0 computer program (Stuiver and Reimer 1986). Given the small number of dates involved, the strict protocols for rejection and acceptance of dates currently being debated in Polynesia prehistory (see e.g., Spriggs and Anderson 1993) have not necessarily been invoked.

Calibration of the dates suggests that 1900 cal BP may be a more accurate date than the 2000 years ago commonly associated with the arrival of pottery along the south coast. Moreover, the earliest pottery-related dates from Mailu through to Yule Island contexts all have intercepts clustering around 1900 cal BP, which supports the notion of a relatively distinct "horizon".

The majority of the sherds from Yule Island sites may be part of a particular industry that was probably located at Oposisi. At various times during the Early Period other sources of clay and/or temper in Yule Island were used, possibly by people living on the mainland opposite the island. As noted earlier, all of these sources are distinguishable from Port Moresby pottery. The pottery moved throughout the Yule Island region during the Early Period. Sherds from the Gulf sites are sourced both to the Yule Island and Port Moresby areas (Figure 4). However, while Yule Island pottery is present throughout the Early Period, Port Moresby pottery appears in Gulf deposits only after about 1400 cal BP (Figure 5).

The pottery found in the Gulf may include only a restricted range of the available sources in the Yule Island and Port Moresby areas, but samples sizes are too small to be definitive. In the Port Moresby area, the analysis suggests one source, possibly located at the Nebira sites some distance inland from the coast. As in Yule Island, local exchange within the Port Moresby region is apparent throughout the Early Period.

Three stylistically "datable" sherds tentatively sourced to Yule Island from the Port Moresby region and vice versa appear to be from the earliest part of the sequence suggesting initial social connections or related colonisation which rapidly diminished (c.f. Bulmer 1982:123). Other sherds that lack firm chronological associations hint at links between the two areas during the Early Period (Figure 6).

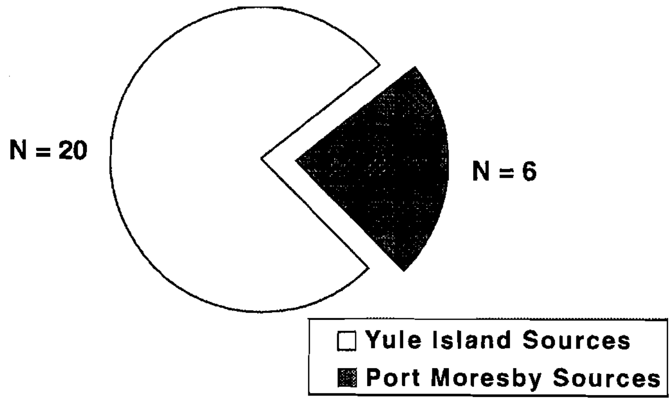

Figure 4 Proportion of sherds sourced to Port Moresby and Yule Island.

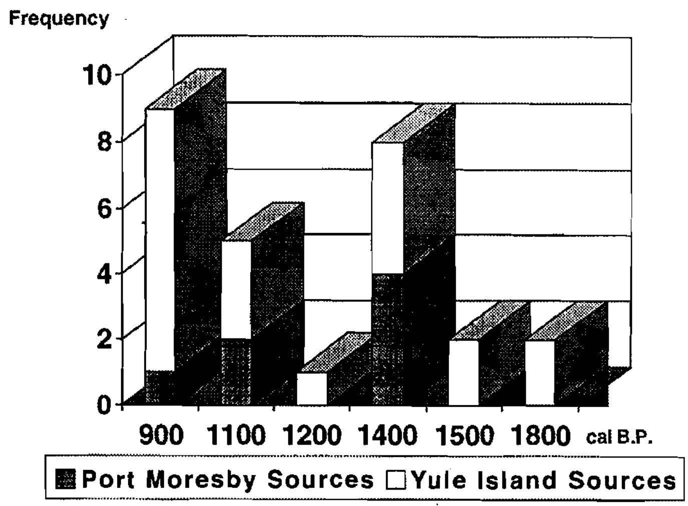

Figure 5 Proportions of Early Period sherds from Gulf sites sourced to Port Moresby and Yule Island sources.

Swadling (1980) has suggested that few Early Gulf sherds could be attributed to the Yule Island sources, but some of the sherds used in her study were unclassified and Yule Island remains a possible source. Frankel *et al.* (1994) studied 78 sherds from the site of Murua (ODR) that were dated to the Early Period around 1500 cal BP (Frankel and Vanderwal 1985, but see Thompson 1982:12 about problems with the sequence). They were unable to match any of their Murua sherds to Port Moresby sources, and suggest that these sherds came from around Bootless Bay. Sherds from Murua (ODR) examined by Worthing (1980) and Swadling (1980) were sourced to Port Moresby.

In contrast, Mackenzie's (1980) petrographic work on sherds from other Gulf sites excavated or collected by Rhoads (1980) suggested sources from the Yule Island and Motu Motu areas. This provided the basis of Rhoads' argument for the dominance of Yule Island pottery in Gulf sites.

This study only included two sherds from Murua but both were sourced to Yule Island groups. Sherds from Eopoe, Kero Hill and Mailovera were also sourced to Yule Island in contrast to Swadling's (1980) analysis of other sherds from these sites. Sherds from the Gulf sites of Herekuna, Kulupuari and Ouloubomoto, however, include Port Moresby sourced sherds. Given the small number of sherds involved in all these studies, much work remains in sorting out any clear pattern.

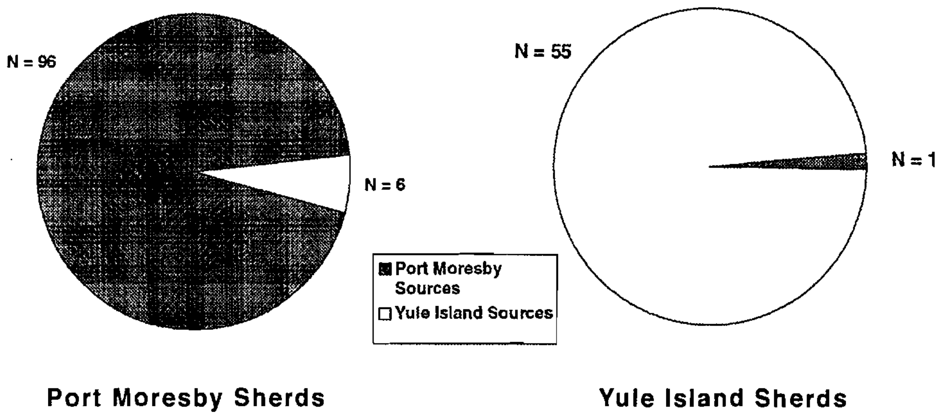

Figure 6
Sherds sourced to Yule Island and Port Moresby areas.

Discussion

In the introduction to one of the seminal volumes of archaeological approaches to prehistoric trade and exchange, Earle and Ericson (1977) suggested two reasons why trade studies have assumed an important role in archaeological research. Firstly, exchange plays a pivotal role in both the continuation and development of cultural systems, and secondly, because the changes in manufacturing technology (such as firing techniques) and both decoration and form allow quantitative archaeological analysis of such exchange.

While chemical analytical techniques have improved, and the statistical processing of the data has become more sophisticated, the use of this information in modelling different trade and exchange mechanisms remains difficult. The basic assumption guiding this type of research is the "provenience postulate" (Weinhard *et al.* cited in Rice 1987:413): that the differences between materials from sources will be greater than differences within any of the sources (see Rice 1987:413-14). Given the complexities of pottery manufacture and distribution, understanding of the social mechanisms involved based on pottery characterisation is difficult (see e.g., Hunt and Graves 1990).

The data discussed here illustrate the difficulties with carrying out such research. In many situations control over the "sources" is not possible and it is not easy to estimate the degree of variation relevant for distinguishing sources. The exploratory method presented illustrates that it is possible to proceed without source information. The quality of the results does depend on the questions asked and the regional perspective adopted gave answerable questions. Distinguishing sources of pottery reaching the Gulf during the Early Period might convincingly be done by measuring the concentration of a single chemical element, in this case Chromium.

The results allow the construction of a basic model (see Figure 7) of "sourcing" using the XRF data. The model is preliminary, but provides both a description of the individual groups and a probability measure (based on mis-classifications of the original sherds) which can be applied to future studies of pottery from Early Period sites along the south coast.

Pottery also provides only one way into the prehistoric paths. Rhoads and Mackenzie (1991:42) have shown how the movement of stone adzes from the western Owen Stanley Ranges to sites in the Gulf occurred prior to the Early Period, throughout the Early Period, and perhaps afterwards when pottery exchange had broken down. Disruptions in pottery exchange may involve only the loss of one or two routes in the network.

The results presented in this study do influence models of exchange during the Early Period:

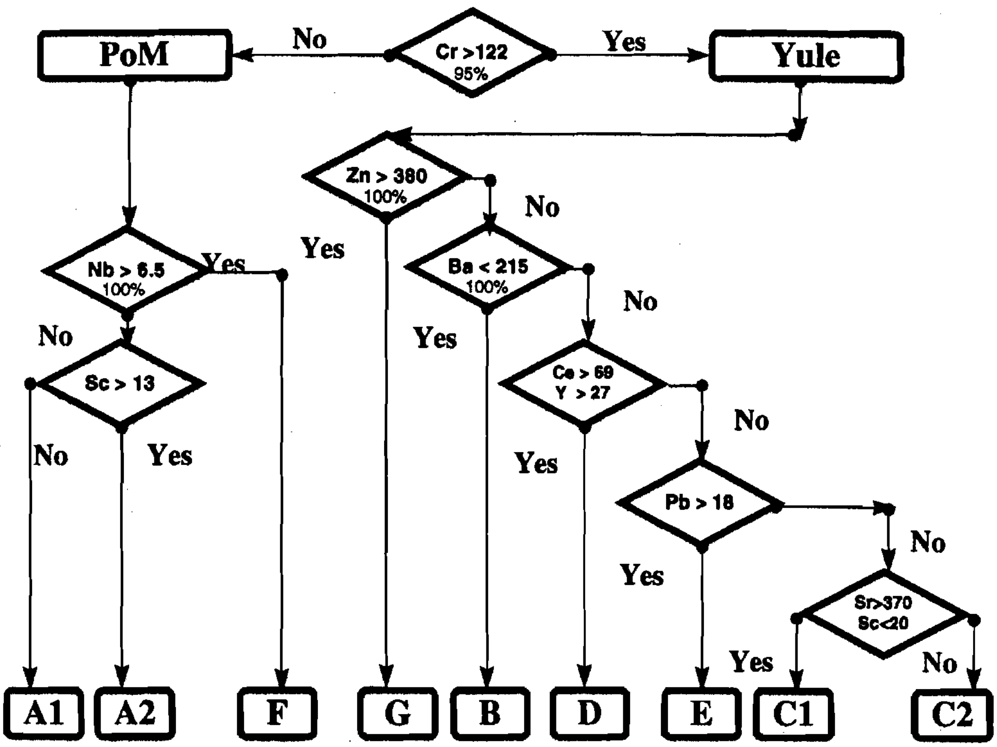

Figure 7
Model for assigning sherds to compositional groups determined by the analysis. Elemental concentrations in parts per million. The percentage numbers are based on the actual misclassifications present in the data. Finer scale values not included as significantly affected by the unclassified and general Yule Island groups (X and Y).

1) Yule Island pottery is distinct chemically and petrographically from other Early Period pottery and it seems plausible to argue that this does confirm Vanderwal's (1973:180) "suspicion" of local production.
2) The results confirm Irwin's (1985) argument that the migrants to the south coast were able rapidly to exploit local resources, and extends this argument to apply to Yule Island potters.
3) The results described here indicate a more favourable view of Yule Island pottery dominating the Gulf sequence during the first 300-400 years of pottery exchange. From around 1400 cal BP, Port Moresby pottery does arrive in the Gulf. It is also likely that the exchange between the Port Moresby potters and the Gulf populations was direct and not via the Yule Island groups, as little Port Moresby pottery has been identified in Yule Island collections.

Much work remains to investigate the nature of the pottery exchange along the south coast particularly in the light of the later specialised networks. It is interesting to note that the pottery exchange during the Early Period had largely the same extent, if not intensity, as during the last few hundred years of prehistory, although in-between times there might have been a sharp contraction (c.f. Allen 1984:442). It remains to be shown how these long-distance networks mediated the regional system which existed 1900 years ago.

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