INDIGENOUS PREHISTORIC POTTERY AND TECHNOLOGY IN PENINSULAR MALAYSIA

Stephen Chia Ming Soon*

INTRODUCTION

Pottery represents one of prehistoric man's most tangible products. Its universal occurrence and its relatively imperishable nature has made it an important "tool" for archaeologists to reconstruct past cultures and also to use it as an indicator of a cultural stage i.e. the "Neolithic".

Up until the 1930s, pottery shape, decoration, and techniques of manufacture had been widely used in extracting and interpreting cultural information on technology, culture contact, population movement, art and even religion (MacNeish *et al.* 1970, Grieder 1975). In Malaysia, this morphological approach has thus far been the only method used in pottery studies. Such a traditional approach, though fundamental, can and has often led to much ambiguities. This is mainly because shape and decoration, the only criteria used in classification, can be replicated through population movement or culture contact.

The "Black Ware" of Bukit Tengku Lembu in Perlis is a good example of the use of the morphological approach that led to ambiguities and controversies. Based on its shape and decoration, the "Black Ware" was said to have originated from Attic Greek (Williams-Hunt 1952), Lung Shan (Peacock 1959), and even Northern India (Sieveking 1962). These findings were highly debatable and were shown to lack strong evidence. In order to avoid such disputable interpretations, pottery studies should incorporate more reliable methods.

In Europe and America, archaeologists have long acknowledged the importance of the compositional approach in pottery studies since the 1930s and 1940s e.g. pioneering studies done by Buttler (1935), Shepard (1942), and Peacock (1968). In Southeast Asia, however, there is yet no adoption of the compositional approach in pottery studies. Archaeologists and prehistorians used only the traditional morphological approach and have only begun in the last decade to use the compositional approach e. g. Vincent 1984, 1987, 1988,

* Stephen Chia is a lecturer in the Centre of Archaeological Research Malaysia (USM). He completed his PhD from USM in 1997.

Pookajorn 1984, McGovern *et al.* 1985, Coutts *et al.* 1985, Copper and Raghavan 1989, and Miksic and Yap 1990a, 1990b. In Malaysia, however, this approach has yet to be used comprehensively and the present study** is, therefore, a pioneering attempt at using such an approach in studying prehistoric pottery in Malaysia.

METHODOLOGY

The present study uses compositional and morphological approaches to study prehistoric pottery in Peninsular Malaysia. The present study hopes that these approaches can be a more objective method in resolving whether the "Black Ware" from Bukit Tengku Lembu was of local or foreign origins.

Distinctive trace elements and minerals in the pottery composition are used in identifying pottery sources. Pottery technology can also be derived using the compositional approach e.g. the choice and preparation of raw materials is often reflected directly by the pottery composition. The range of firing temperatures used can also be known based on thermal changes in certain minerals. Identifying such technological traits in pottery manufacture is a useful way of recognizing cultural connections and provide stronger evidence of tradition and culture than shape and decoration (Kempe and Harvey 1983:312).

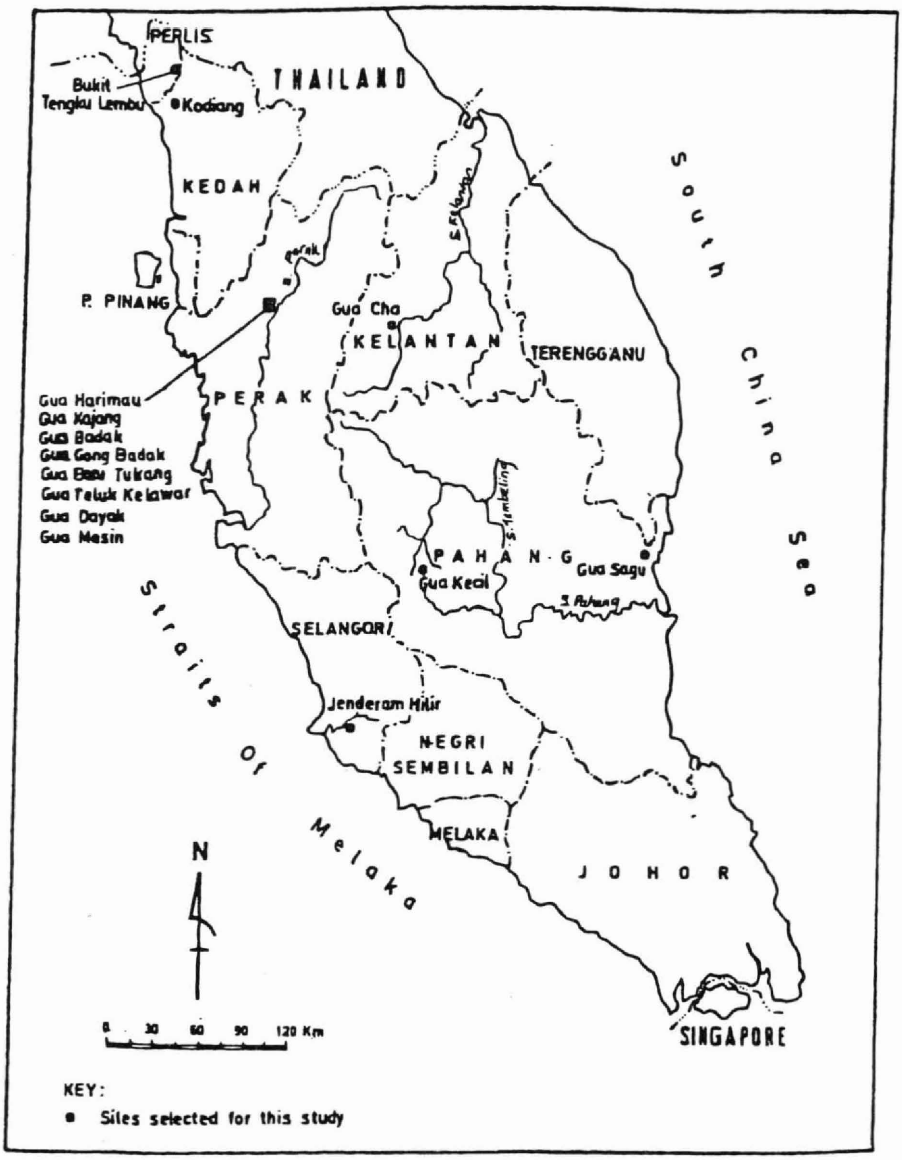
The present study covers mainly prehistoric pottery sherds from dated sites in Peninsular Malaysia. Data on pottery were obtained from two main sources: (1) excavations in Lenggong, Perak and (2) previous excavations in Peninsular Malaysia.

Excavations were conducted in Lenggong in order to obtain pottery samples with dates and contextual data. The sites excavated were Gua Kajang, Gua Badak, Gua Gong Badak, Gua Batu Tukang, Gua Teluk Kelawar, Gua Dayak, and Gua Mesin (Map 1).

Pottery samples obtained from previous excavations included those from the dated sites of Gua Cha in Kelantan, Gua Kecil and Gua Sagu in Pahang, Jenderam Hilir in Selangor, and Gua Harimau in Perak (Map 1). This was done so that comparisons can be made between sites that are more or less contemporaneous. Pottery samples from two undated sites with considerable and significant pottery finds i.e. Bukit Tengku Lembu in Perlis and Kodiang in Kedah were also included in this study (Map 1).

**I would like to express my thanks to Mohamed Zulkifli Haji Abdul Aziz, who as Director-General of the Department of Museums and Antiquities gave support and much encouragement. This article is extracted from my MA thesis submitted to Universiti Sains Malaysia in 1992.

Map 1: Location of Sites Studied in Peninsular Malaysia



Three chemical and mineralogical techniques: (1) X-ray fluorescence analysis, (2) thin-section petrography analysis, and (3) X-ray diffraction analysis, were used to determine the composition of the pottery. For practical reasons, only ninety-seven pottery sherds, representing a small proportion of the total pottery assemblage, were subjected to compositional and morphological studies.

EXCAVATIONS AND POTTERY SAMPLING

Seven sites comprising Gua Badak, Gua Dayak, Gua Batu Tukang, Gua Kajang, Gua Teluk Kelawar, Gua Mesin and Gua Gong Badak were excavated in Lenggong, Ulu Perak (Map 2). Eighteen pottery sherds found in these sites were sampled for study. Besides the Lenggong area, seventy-nine pottery sherds were also selected from earlier excavations at Bukit Tengku Lembu, Kodiang, Gua Harimau, Gua Cha, Gua Kecil, Gua Sagu, and Jenderam Hilir (Map 2). Therefore, a total of ninety-seven pottery sherds were sampled for study.

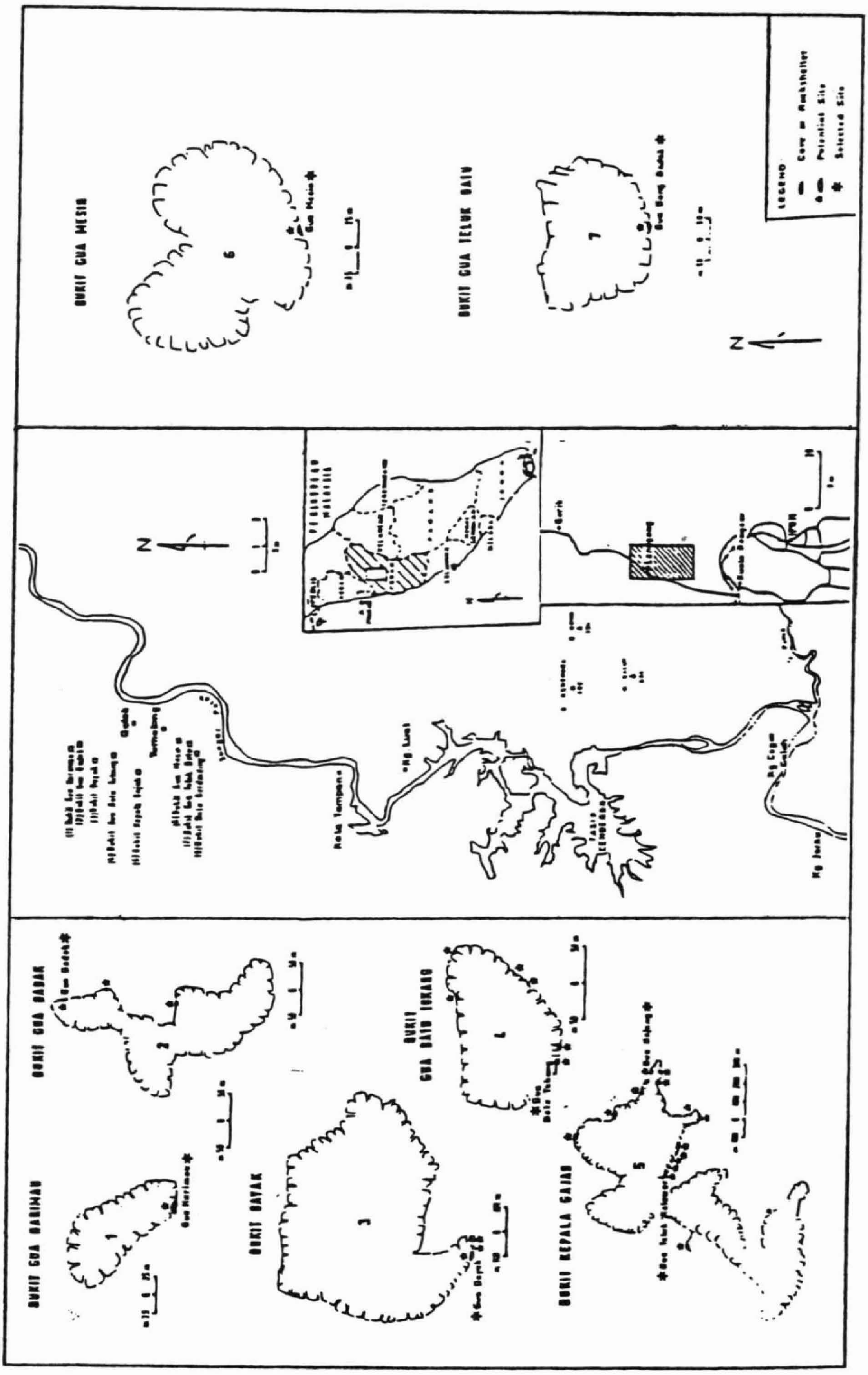
Survey And Excavations

Surveys and excavations were conducted in Lenggong, Ulu Perak, in order to obtain dates and contextual data on pottery. The area surveyed covers all the eight limestone massifs, situated about 5 km in the vicinity of Lenggong town which is located at longtitude 100^{o} 58' and latitude 5^{o} 06' 30" (topo map sheet 30, series L7010, 1972, reference QY313655).

The limestone massifs in Lenggong were chosen for study mainly because: (a) numerous caves and rockshelters located here have produced a large amount of cultural materials, suggesting that this area could have formed a habitation complex, (b) the Lenggong valley has a long chronology (dating back to 30,000 years ago) and has produced key finds in the prehistory of Peninsular Malaysi (Zuraina 1989, 1994, 1996) and (c) this area is strategically situated in relation to Gua Cha in Kelantan, the other chronometrically dated pottery centre in Peninsular Malaysia (Noone 1939, Sieveking 1954, Adi 1985).

The eight limestone massifs surveyed were: (1) Bukit Gua Harimau, (2) Bukit Gua Badak, (3) Bukit Dayak, (4) Bukit Gua Batu Tukang, (5) Bukit Kepala Gajah, (6) Bukit Gua Mesin, (7) Bukit Gua Teluk Batu, and (8) Bukit Batu Berdinding (Map 2). Caves and rockshelters with pottery sherds as surface finds were marked out as potential sites. A total of fourty-one caves and rockshelters were surveyed in all the eight limestone massifs.

Map 2: Sites Studied in Lenggong, Ulu Perak



Based on the surveys, twenty-nine caves and rockshelters were identified as potential sites. However, due to time constraints, only eight caves or rockshelters could be studied (Map 2).

Excavations were carried out at seven of the eight selected sites in July 1991. The seven sites were Gua Badak, Gua Dayak, Gua Batu Tukang, Gua Kajang, Gua Teluk Kelawar, Gua Mesin, and Gua Gong Badak. The site of Gua Harimau was not excavated because dates and contextual pottery sherds were available from a recent excavation (Zolkurnian 1989).

Excavated Pottery

A total of twenty-seven pottery sherds were found in all the seven excavated sites. Spit controlled excavations, covering 10 cm deep for each spit was used. The majority of the sherds were found within the top 20-50 cm levels of the cave floor. Further excavations until 50-70 cm did not reveal any more pottery. The common association of the sherds with hearth areas suggested that pottery has been commonly used as cooking vessels. The following discusses the excavated pottery and dates as obtained in each of the seven sites.

Gua Badak: This rockshelter was badly disturbed, with very little excavation space, due to guano digging and quarrying activities. However, pottery sherds could still be excavated from a small area of the cave. Four sherds, all cord-marked, were recovered at the 20 cm level, but no datable material was found.

Gua Dayak: One of the two test trenches here produced pottery sherds. The sherds, found at the 25 cm level, included six plain and one cord-marked pottery. Radiocarbon dating of associated charcoal samples gave a date of 1610 $\pm$ 140 B.P.

Gua Batu Tukang: One of the two test trenches here revealed pottery sherds in a hearth area at a depth of 20 cm. These sherds comprised one plain and two cord-marked pottery. The other trench yielded three cord-marked sherds at the 20 cm level and the charcoal samples gave a radiocarbon date of 3620 $\pm$ 50 B.P.

Gua Kajang: A total of five pottery sherds were found in the two test trenches here. The sherds comprised two red-slipped, one plain, and two cord-marked pottery, found at about 30 cm deep in a hearth area. Unfortunately, the charcoal samples collected could not be dated as they contained too little carbon.

Gua Teluk Kelawar: Two test trenches here yielded two pottery sherds, one cord-marked and the other black-burnished. These sherds were found associated with a number of stone tools, bones, and shells at the 50 cm level. A shell sample from this level gave a radiocarbon date of 6890 $\pm$ 80 B.P. (Zuraina 1996).

Gua Mesin: A piece of sherd was found at the 20 cm level in one of the two test trenches here. The sherd was found in a hearth area, associated with some charred animal bones and was radiocarbon dated by charcoal to 600 $\pm$ 50 B.P.

Gua Gong Badak: This site was again badly disturbed by guano diggers and excavation at a small undisturbed area of the cave floor revealed two cord-marked sherds at about 25 cm. However, no substaintial amount of associated charcoal samples could be collected for radiocarbon dating.

Pottery Sampling

A total of ninety-seven pottery sherds were sampled for analysis. Eighteen of these samples were selected from the present excavations conducted in Lenggong, Perak. The other seventy-nine samples were selected from earlier excavations done by other researchers at Bukit Tengku Lembu, Kodiang, Gua Cha, Gua Kecil, Gua Sagu, and Jenderam Hilir, which were stored at the National Museum in Kuala Lumpur.

Lenggong: The eighteen pottery sherds selected from the excavations in Lenggong comprised samples GKL1 to GKL4 from Gua Kajang, GBL1 to GBL3 from Gua Badak, GBT1 to GBT4 from Gua Batu Tukang, GTK1 and GTK2 from Gua Teluk Kelawar, GDL1 and GDL2 from Gua Dayak, GGB1 and GGB2 from Gua Gong Badak, and GML from Gua Mesin (Plate 1). These sherds have dates of between 6890 $\pm$ 80 B.P. and 600 $\pm$ 50 B.P.

Gua Harimau: Ten pottery sherds from Gua Harimau, dated to 4920 $\pm$ 270 B.P., were selected from a recent excavation conducted in 1988 (Zolkurnian 1989). Five of the sherds (GH1, 2, 3, 6, and 9) were selected from the cord-marked bowls while the other five (GH 4, 5, 7, 8, and 10) were sampled from the footed vessels (Plate 1).

Bukit Tengku Lembu: Nine pottery sherds were selected from Bukit Tengku Lembu (Plate 2). These included a piece of sherd each from the footed beaker (BTL2), broad-based pot-stand (BTL3), pot-stand (BTL6), bell-mouthed jar with box body (BTL4), carinated bowl (BTL7), and four pieces of sherds from the hemispherical bowls (BTL1, 5, 8, and 9).

Kodiang: Six pottery samples were selected from the site of Kodiang (Plate 3). These samples consisted of three sherds of the tripod legs (K1, 2, and 4), two pieces of body sherds (K3 and K5), and one piece of rim (K6).

Gua Cha: Twenty-seven pottery sherds (Plate 4) were selected from earlier excavations done by Sieveking (1954) and Adi (1985) at Gua Cha. These pottery were radiocarbon dated to 3020 ± 270 B.P. (Adi 1985). Nine of the samples were of known stratigraphic depths. They included GC3 and GC8 from the 0-10cm level, GC10 and GC13 from the 10-20cm level, GC12 and GC14 from 30-40cm level, and GC9,11, and 15 from the 40-50cm level.

Gua Kecil: Fifteen pottery sherds (Plate 5) were selected from previous excavations conducted by Dunn (1964) at Gua Kecil. They include the plain-burnished sherds (GK1 to GK5), cord-impressed sherds (GK6 to GK10), and the red ware (GK11 to GK15). The 14-16 inches level of this site, where all these pottery types were found, was radiocarbon dated to 4800 ± 800 B.P. (Dunn 1966:352).

Gua Sagu: Two cord-marked sherds (Plate 6), radiocarbon dated to 1240 ± 120 B.P. were selected from earlier excavations (Zuraina 1996).

Jenderam Hilir: Ten sherds (Plate 7), dated to 4290 ± 200 B.P., were selected from Jenderam Hilir (Leong 1986). Three of the sherds were fragments of the tripod legs (JH2, 6, and 7), three were rim sherds (JH4, 8, and 10), and four were body sherds (JH1, 3, 5, and 9).

IDENTIFYING CLAY SOURCES USING COMPOSITIONAL ANALYSES

Thin-section petrographic and X-ray diffraction analyses were applied to identify the mineral phases while wavelength dispersive X-ray fluorescence analysis was used to determine the elemental composition of the pottery sherds. Compositional groups among the pottery sherds were then established based on results of the mineralogical studies as well as the elemental data using multivariate statistical analysis.

Grouping Of Sherds Based On Mineralogical Analyses

A few distinct compositional groups were noted. First, the mineralogical composition of Gua Kecil's sherds were characterised by the presence of minerals such as quartz, microcline, orthoclase, plagioclase, augite, and hornblende while minerals such as muscovite and biotite were consistently absent.

Second, all the pottery samples from sites in Lenggong (Gua Harimau, Gua Kajang, Gua Batu Tukang, Gua Dayak, Gua Gong Badak, and Gua Mesin) were found to contain a certain mineral known as garnet (Plate 8). This mineral was later confirmed by X-ray diffraction analysis to be the garnet group known as grossularite or $Ca_3Al_2 (SiO_4)_2$ (Figure 1). Grossularite is chiefly found as a product of contact or regional metamorphism in crystalline limestones (Hurlbut 1971, Kerr 1977). Such rock formation can be found at the limestone cave massifs in the Lenggong area (Tjia, personal communication),* suggesting a high probability that local source(s) of clay and/or temper were exploited.

Temporally, this observation also suggested that prehistoric potters have continuously used local clay and temper in the Lenggong area over a period ranging from 6890 $\pm$ 80 B.P. to 600 $\pm$ 50 B.P.

Another noteworthy observation is that pottery samples, obtained at different stratigraphic depths from Gua Cha, showed no difference in mineralogical composition. These samples were found to contain mainly quartz minerals and other minor minerals such as microcline, orthoclase, plagioclase, augite, muscovite, biotite, iron oxides, hornblende, and zircon. Such similar patterns in mineralogical composition also suggested the possibility that similar clay source(s) were used over time.

Grouping Of Sherds Based On Chemical Analysis

Pottery sherds were grouped using two methods: (1) preliminary analysis of the raw elemental data and (2) multivariate statistical analyses of the elemental data.

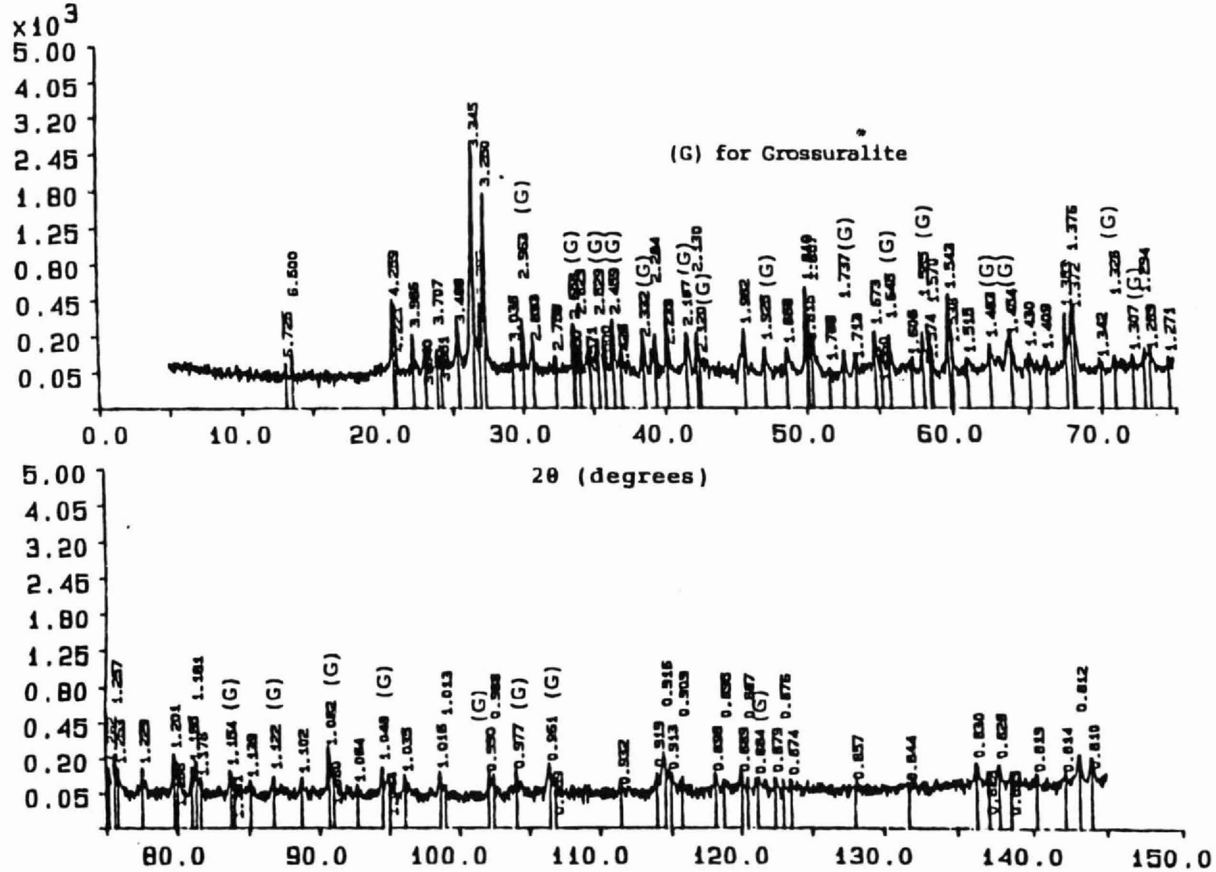
Preliminary Raw Elemental Data Analysis

Preliminary analysis of the X-ray fluorescence elemental data showed distinct differences in elemental composition between pottery samples from Gua Kecil and Jenderam Hilir, about 120 km away. All the samples from Gua Kecil have relatively higher iron and barium content ranging from 7.34% to 10.25% and 730 ppm to 1856 ppm respectively. Samples from Jenderam Hilir, however, showed relatively low iron content of 1.23% to 2.22% and low calcium content

---

* Tjia Hong Djin was a professor of Geology at Universiti Kebangsaan Malaysia for many years and currently he is with Petronas Research and Scientific Services Sdn. Bhd., Kuala Lumpur.

Figure 1: X-Ray Diffraction of Sample GH4.



of between 132 ppm and 264 ppm. Such comparatively low calcium and iron content is probably due to the absence of infiltration by calcium, derived from limestone or calcium carbonate, to the surfaces and pores of the sherds. This would be expected as Jenderam Hilir is located in a non-calcareous region. The low calcium and iron content thus supports a localized clay source(s) used in making the pottery. Confirmation may also be given by the characteristic sandy texture of the sherds that correlated well with the local clayey and sandy deposits of the Gula formation, and the Beruas and Simpang formations located near the site of Jenderam Hilir.

Multivariate Statistical Data Analyses

The elemental data were further analyzed by means of two multivariate statistical analyses: (a) scatterplots and (b) discriminant analysis, performed on a Statgraphic software package.

In both analyses, seven significant elements: titanium, iron, rubidium, strontium, yttrium, zirconium, and barium, were selected for characterizing the different pottery groups as these elements have been reported to be reliable and unaffected by firing or burial (Poole and Finch 1972, Miksic and Yap 1990a). Using the proportions of peak heights in each of the seven selected elements for each sherd as data, scatterplots and discriminant analyses were carried out.

Scatterplots: Scatterplots were conducted to determine if the sherds could be grouped into consistent clusters. Distinct clusters were inferred as sherd groups that utilized the same source(s) of raw materials. These clusters, in accordance with the assumptions of the Provenience Postulate (Weigand *et al.* 1977:24) and the Criterion of Abundance (Bishop *et al.* 1982), were also taken to represent locally manufactured pottery.

The Provenience Postulate assumes that compositional differences between sources are greater than the differences within a single source and that these differences can be recognized by the analytical approach. The Criterion of Abundance holds that a ceramic unit (in this case elemental abundance) strongly represented at a site is presumed to be of local manufacture while those scarcely represented, being non-local.

Twenty-one 2 dimensional x-y scatterplots were plotted for each of the sites using different elemental combinations. Results of the scatterplots e.g. Fe-Sr showed that sherds from each of the different sites clustered into groups of their own. Such group clustering was also observed in the plots of Sr-Fe, Rb-Fe, Y-Fe, Zr-Fe, Ba-Fe, Sr-Ti, Ba-Ti, Ba-Sr, Ba-Rb, Ba-Y, and Ba-Zr.

However, when sherds from all the sites were plotted together in a single plot, only sherds from Gua Cha [4] and Gua Kecil [5] fell into distinct groups separate from the rest (Figure 2). In order to distinguish further compositional groups, an extra element (or dimension) was added to perform the 3 dimensional x-y-z scatterplots. Thirty-five of these scatterplots were made for each of the sites, using all the possible combinations of three elements from the seven selected elements.

Results of the scatterplots e.g. plots of Fe-Sr-Ba showed that each of the sites: Bukit Tengku Lembu [1], Kodiang [2], Lenggong [3], Gua Cha [4], Gua Kecil [5], Gua Sagu [6], and Jenderam Hilir [7] still clustered into separate groups of their own. Such patterns of clustering were also observed in the other twenty-four plots with elemental combinations: Fe-Sr-Ba, Ti-Fe-Sr, Ti-Fe-Y, Ti-Fe-Zr, Ti-Fe-Ba, Fe-Rb-Sr, Fe-Rb-Y, Fe-Zr-Rb, Fe-Rb-Ba, Rb-Sr-Y, Rb-Sr-Zr, Rb-Ba-Sr, Sr-Y-Ba, Ti-Rb-Sr, Ti-Rb-Ba, Fe-Sr-Y, Fe-Sr-Zr, Fe-Sr-Ba, Zr-Ba-Sr, Ti-Sr-Y, Ti-Sr-Zr, Ti-Sr-Ba, Fe-Y-Ba, Fe-Zr-Ba, and Zr-Ba-Rb.

However, when all these sites were plotted together e.g. plot of Fe-Sr-Ba (Figure 3), again only sherds from Gua Cha [4] and Gua Kecil [5] fell into distinct groups of their own while sherds from the other sites overlapped.

Thus 2 dimensional x-y and 3 dimensional x-y-z scatterplots pointed to the Gua Cha and Gua Kecil sherds as distinct groups separate from the rest of the sherds.

Discriminant Analysis: Discriminant analysis is a multivariate technique concerned with separating distinct sets of objects and with allocating new objects to previously defined groups. This technique is useful when you have data classified into two or more groups and you want to find one or more functions of quantitative measurements (in this case, elemental concentrations) for discriminating among the groups.

Discriminant analysis was first carried out among sherds from Bukit Tengku Lembu [1], Kodiang [2], and Lenggong [3]. Results of the analysis showed that these three sites formed their own groups but overlapped each other within the same region (Figure 4). Further discriminant analysis was done among sherds from the other sites of Gua Cha [4], Gua Kecil [5], Gua Sagu [6], and Jenderam Hilir [7]. Results of this analysis showed that these four sites each formed its own distinct group (Figure 5).

However, in a combined discriminant analysis involving all the seven sites, only three distinct groups of sherds were observed. These three sherd groups were from Gua Cha [4], Gua Kecil [5], and Jenderam Hilir [7]. Sherds from the other groups: Bukit Tengku Lembu [1], Kodiang [2], Lenggong [3] and Gua

Figure 2: Plot of Fe-Sr for all the sites [1-7]

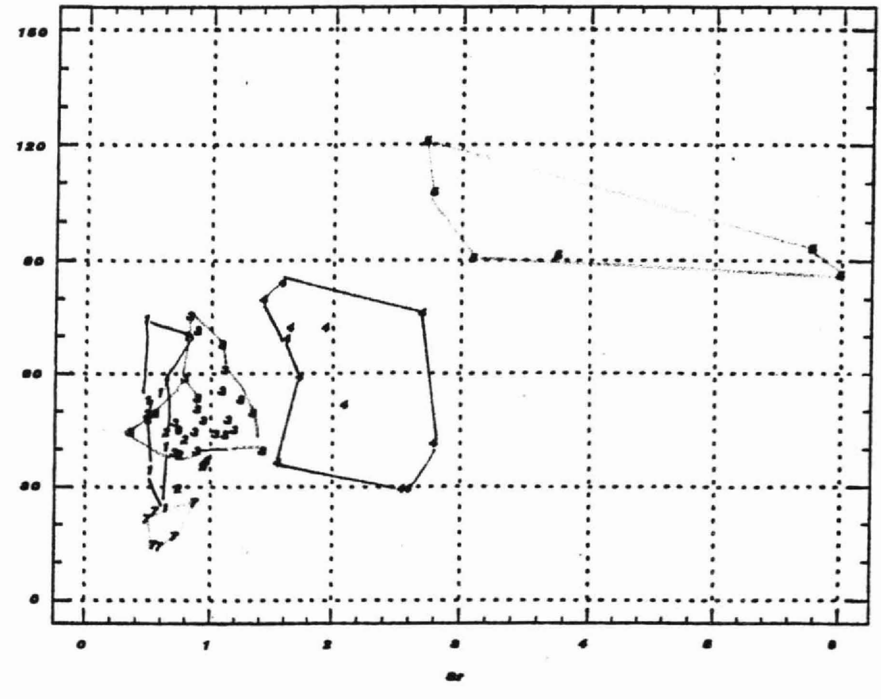


Figure 3: Plot of Fe-Sr-Ba for all sites studied [1-7]

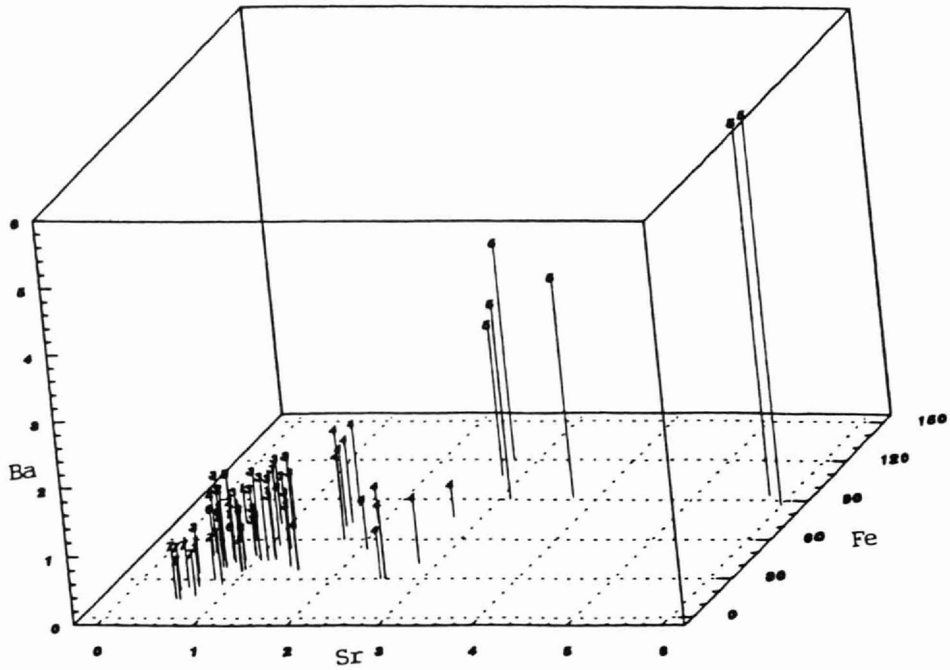


Figure 4: Discriminant plot of sherds from Bukit Tengku Lembu [1], Kodiang [2] and Lenggong [3]

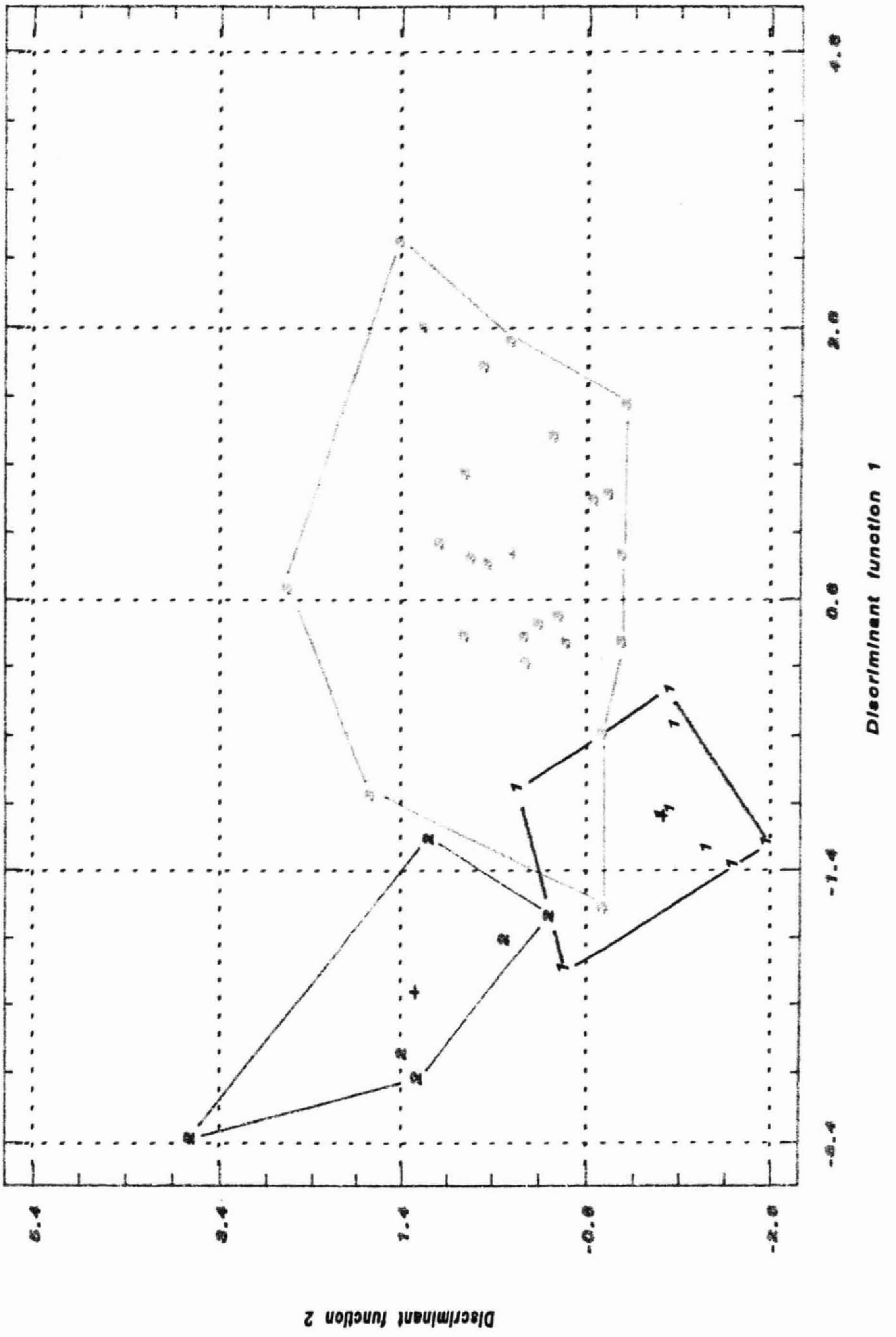
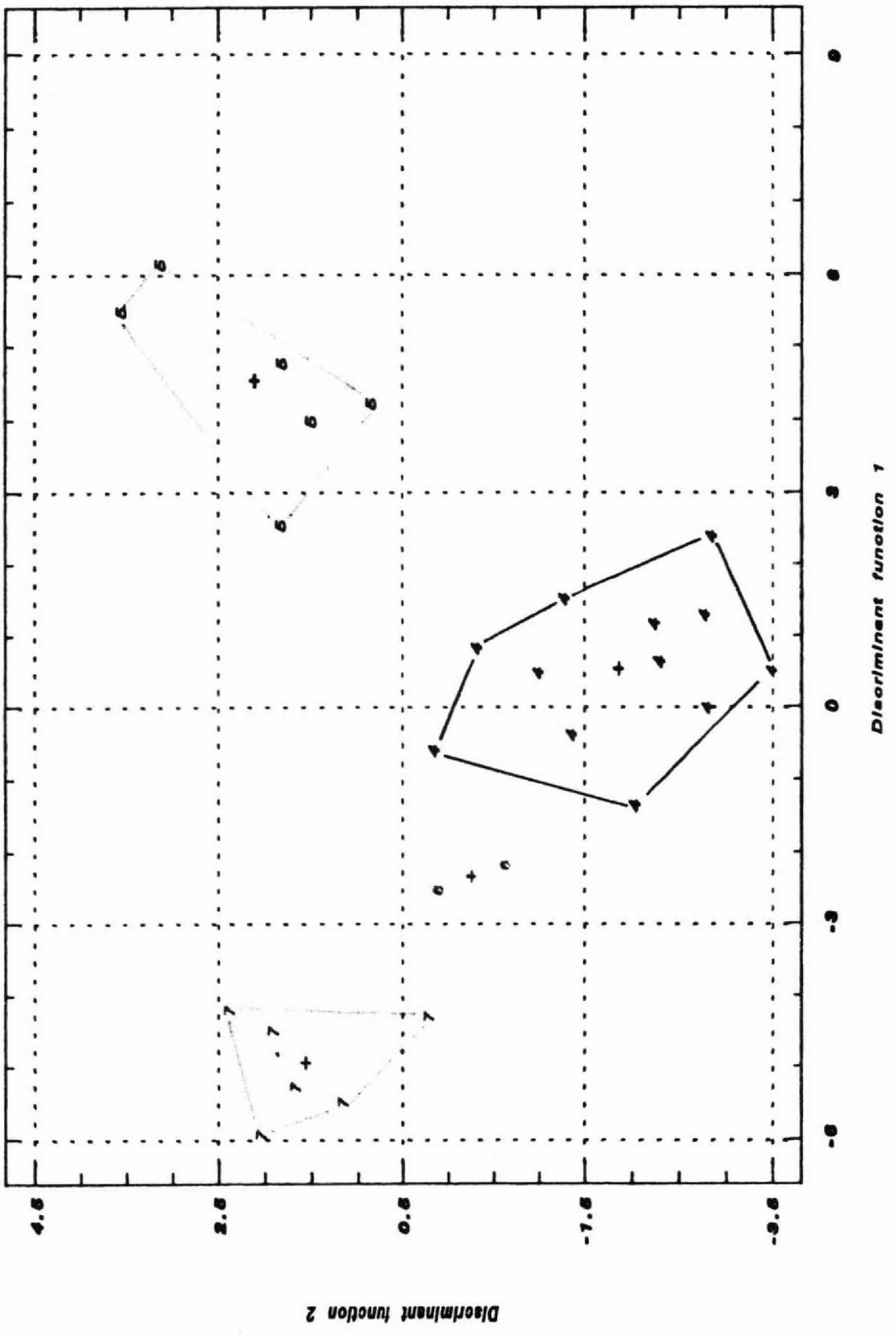


Figure 5: Discriminant plot of sherds from Gua Cha [4], Gua Kecil [5], Gua Sagu [6] and Jenderam Hilir [7]



Sagu [6] still fell into their own respective groups but overlapped each other within the same region (Figure 6).

Discriminant analyses resulted in sherd groups that corresponded well with those of the 2 and 3 dimensional scatterplots. In other words, discriminant analysis similarly attributed most of the sherds to fall into groups within their own respective sites.

POTTERY TECHNOLOGY BASED ON COMPOSITIONAL AND MORPHOLOGICAL ANALYSES

Technological characteristics of the pottery which include colour, temper, texture, thickness, porosity, surface finish, and decoration were analysed in order to understand the techniques of pottery production; paste preparation, forming and shaping methods, firing, surface finishing, and decoration.

Both the compositional and morphological analyses indicated a rather conservative pottery manufacturing technology in Peninsular Malaysia in that the different geographical sites studied are closely related in terms of technological characteristics over space and time. The pottery are often unoxidized (and sometimes smudged) and fired at not more than 600^{o}C, probably in open fires or cooking hearths using low kaolinite clays.

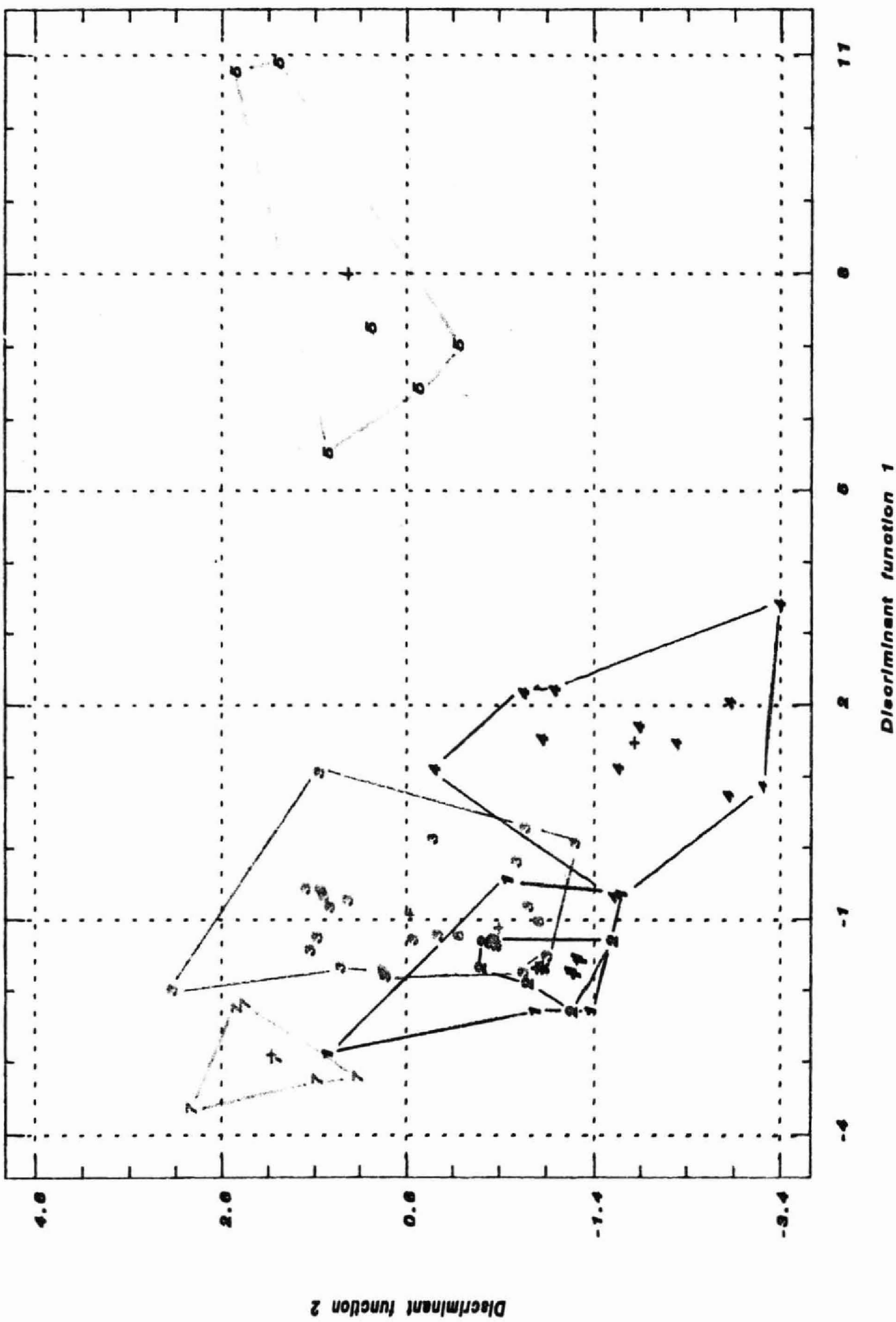
Common tempering materials used include mainly quartz minerals (sand) and grog (crushed sherds). Other minor minerals identified include orthoclase, plagioclase, augite, muscovite, biotite, garnet, iron oxides, hornblende, and zircon.

A majority of the samples from all the different sites also showed medium paste texture with quartz grain sizes measuring between 0.50 mm and 0.25mm, except for pottery from Gua Kecil which has a very fine paste texture, with an average grain size of 0.11 mm. This very fine paste texture suggested that thetempers were finely grounded during paste preparation.

The pottery samples also revealed mainly medium walls, averaging about 8.0 mm in thickness and showed high porosity that averages between 25% and 35%, indicating that they were not used for water transport or storage. Surface finishes and decoration in the form of cord-marking, burnishing, and slipping were noted in the pottery samples.

Colour: Pottery colours were determined for three parts of the sherds: the outer surface, the core, and the inner surface using the Munshell Soil Colour Charts. Colour of the pottery surface or core can tell us about the methods of firing used.

Figure 6: Discriminant plot of sherds from all the sites studied [1 to 7]



Chips of samples were refired in an electric resistance furnace (Phoenix Beta 2 Model, Sheffield, England) in an oxidizing atmosphere and under controlled temperatures until 500°C. This was done in order to distinguish between carbon intentionally deposited by smudging and carbon originally present in the clays. A short refiring at this temperature is usually sufficient to remove carbon deposited by smudging on a piece of sherd (Shepard 1956:220).

Another group of sample chips was similarly refired until 750°C in order to determine whether or not the pottery samples contain unoxidized carbonaceous materials. On refiring at this temperature, all carbon will be burnt out and the pottery usually becomes lighter and clearer in colour.

Results of the colour analysis suggested that two types of firing conditions were generally used: smudging and incomplete oxidation. Smudged pottery sherds were observed in pottery samples BTL1, 3, 5 and 8 from Bukit Tengku Lembu, K1, 3 and 6 from Kodiang, GKL1 from Gua Kajang, GBL1-3 from Gua Badak, GBT1-4 from Gua Batu Tukang, GTK1 and 2 from Gua Teluk Kelawar, and GK1, 2, 4 and 5 from Gua Kecil. Incomplete oxidation of carbonaceous materials were noted in samples BTL2, 6 and 9 from Bukit Tengku Lembu, K2, 5 and 6 from Kodiang, GH1, 2 ,3, 6, 7, 8, 9 and 10 from Gua Harimau, GK2, 3 and 4 from Gua Kajang, GBL2 from Gua Badak, GBT1,2,3, and 4 from Gua Batu Tukang, GTK 1 and 2 from Gua Teluk Kelawar, GDL1 and 2 from Gua Dayak, GGB1 and 2 from Gua Gong Badak, GML from Gua Mesin, GC1, 2, 3, 6, 7, 9, 12, 13, 14, 15, 17, 20, 21, 23, 25, and 26 from Gua Cha, GK1 to 15 from Gua Kecil, GS1 and 2 from Gua Sagu and JH1 to 10 from Jenderam Hilir. Only samples GK11 to 15 from Gua Kecil and Gua Kajang GKL2 and 4 showed firing done in complete oxidation in an oxidizing atmosphere.

Temper: Temper is defined here as any added material to raw clays by the potter. Technically, tempers are added in order to reduce plasticity, to improve the workability of clays, and to reduce excessive shrinkage during drying and firing that can cause the pottery to crack.

Preliminary temper identification was done initially by examining a freshly broken piece of sherd using a 10x hand lens. A more detailed study of the temper was done by preparing thin sections of the pottery sherds for examination under a Leitz Laborlux 11 PO1 polarizing microscope. Eighty-five thin sections of pottery samples used earlier for thin section petrographic analyses were re-examined. The relative amount of temper is described as "sparse" when only a few grains of temper are seen, "moderate" when the grains are abundant and clay paste can be easily seen, and "heavy" when it is difficult to see the clay paste.

The study of temper indicated that ancient potters in Peninsular Malaysia were rather conservative in their usage and selection of tempering materials. A majority of the samples (73%) showed moderate tempers, consisting of mainly quartz minerals, possibly sand. The rest of the samples (27%) have sparse tempers. The use of grog as temper was also commonly found in the samples from all the sites except Gua Dayak and Gua Gong Badak.

Temporally, the sherd samples from Gua Cha and sites in Lenggong, obtained from different stratigraphic depths, dating between 6890 B.P. to 600 B.P., also indicated no change in the types of temper used over time.

Texture: Textural analysis was undertaken as an objective means of comparing and characterizing pottery pastes from the different sites.

Direct quantitative means of textural analysis was done by examining thin sections of the pottery samples. Two thin sections were used to represent each of these sites. One hundred and fifty quartz grains were counted and measured randomly from each thin section using a Swift Basington automatic Point Counter Model C with 1/3 mm trans steps fixed onto a Leitz Laborlux 11 POl polarizing (petrographic) microscope. Measurements were made on a millimeter scale (under x10 magnification).

The abundance of quartz minerals in all the pottery pastes provides enough justification for it to be used for textural analysis. Analysis was centred upon two textural parameters: (1) the size and (2) the shape of the quartz grains.

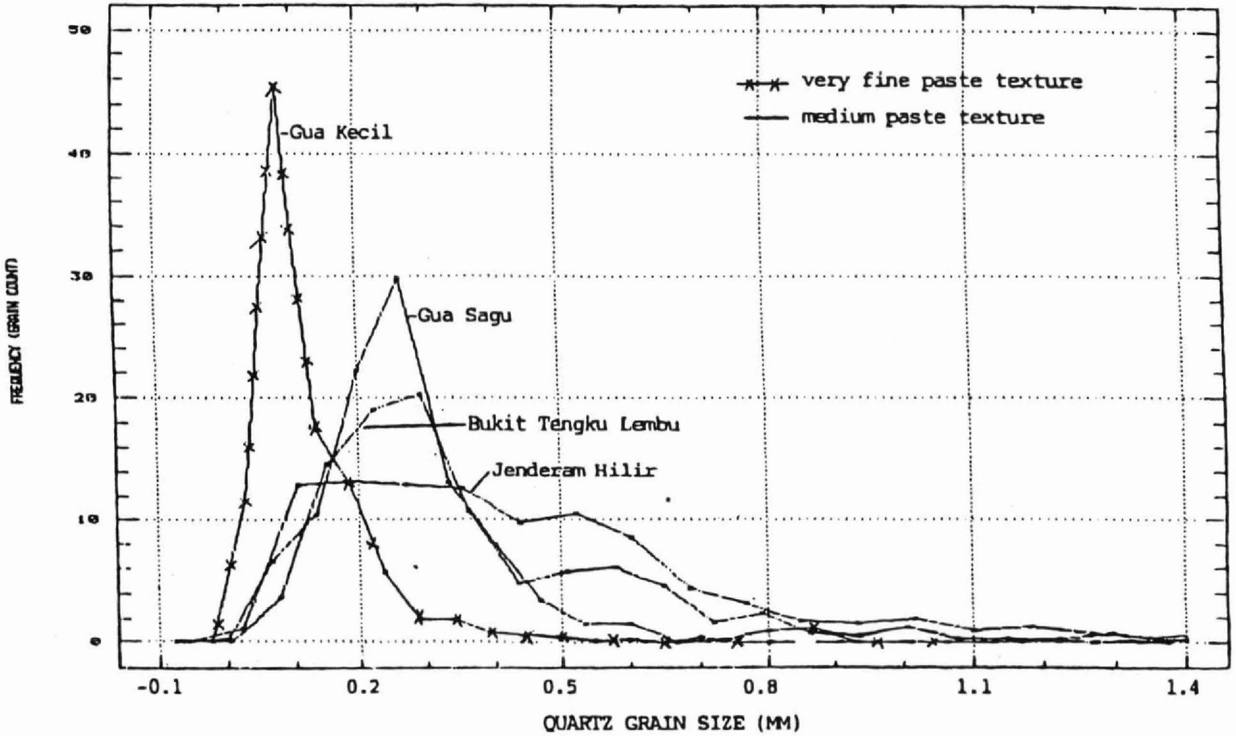
Fifty grains were measured from the top, middle, and bottom of the thin section in order to represent the thin section and to reduce possible errors due to variations within the thin section. The long axis of the quartz grain was used in measuring the grain size.

Two distinct groups of paste texture (Figure 7) can be distinguished from the textural analyses based on the Wentworth's size classification (Shepard 1956:118): (1) The medium paste texture (1/2 mm - 1/4 mm) and (2) The very fine paste texture (1/8 mm - 1/16 mm).

Shape analysis of the quartz grains revealed most of the grains (80%) to be subangular to angular in shape, suggesting that the quartz grains were not natural but were intentionally crushed and added as temper in the process of pottery manufacturing. Naturally occuring quartz grains are usually either subrounded or rounded in shape due to wearing during transport by fluvial processes. The very fine and uniform paste texture of Gua Kecil's sherds suggested further that the primitive potter's techniques of paste preparation could have involved grounding or levigation of clays and temper.

Thickness: The thickness of ninety-eight pottery sherds were measured. Thickness of these sherds was used in this study as an indicator of change or

Figure 7: Textural analysis of grain sizes showing two groups of paste texture



function. Sherds that are 6 mm or less are classified as thin, 6 mm to 10 mm as medium, and 10 mm or more are classified as thick.

On the whole, sherds with medium walls represented the main type of sherd thickness, forming 68.37% of the total samples studied. Thin and thick walls are less common, comprising only 25.51% and 6.12% respectively. The high occurrences of the medium-walled sherds suggests a common function of these pottery vessels as tablewares. However, no spatial distinction and temporal changes in wall thickness was noted from the samples. Overall measurements of the thick, medium, and thin walled sherds gave averages of 11.22 mm, 7.98 mm, and 5.50 mm respectively.

Porosity: Porosity is defined as the ratio of volume of pore space to the volume of the pottery piece. Porosity of the pottery affect other properties of the pottery such as density, strength, and permeability. Determination of porosity was carried out following the procedure recommended by the Committee on Standards of the American Ceramic Society (1928).

Results of the porosity tests conducted on all the pottery samples showed a very wide distribution in porosity among the pottery. Pottery samples from Kodiang, Gua Harimau, Gua Kajang, Gua Badak, and Gua Teluk Kelawar showed close average porosity of between 25% and 27%. Pottery samples from the other sites of Bukit Tengku Lembu, Gua Batu Tukang, Gua Cha, and Gua Kecil also showed relatively similar porosity that averages between 30% and 35%. Samples from Jenderam Hilir, however, have a much lower average porosity of about 18%.

Clays usually becomes more porous in the early stages of firing as water evaporates and carbonaceous materials is removed by oxidation. However, at higher temperatures, clays begin to sinter and vitrify causing the clays to shrink and the porosity to decrease (Shepard 1956:126). Thus, the considerably high porosity of the pottery samples suggested that the clay was not vitrified and there were many unsealed pores. In other words, the pottery was low-fired. The high porosity also indicated that the pottery were not meant for water transport or storage since they would leak due to excessive seepage and evaporation.

Surface Finish: Three main types of surface finish were distinguished: (1) unslipped and unpolished, (2) polished and unslipped, and (3) slipped.

Unslipped and unpolished surface finish was observed in samples, JH1, 2, 3, 8, 9, and 10, from Jenderam Hilir and K1 to K5 from Kodiang.

Polished and unslipped surface finish (also known as burnished), involves polishing or smoothing the drying surface of the pottery with a hard smooth tool before the pottery is fired. Burnishing was noted in samples BTL1 and BTL3 from Bukit Tengku Lembu, K6 from Kodiang, GH4, 5, 7, 8, and 10 from Gua Harimau, GBT2 and GBT3 from Gua Batu Tukang, GGB2 from Gua Gong Badak, GBL2 and GBL4 from Gua Badak, GC1, 2, 4, 6, 9, 10, and 11 from Gua Cha, and GK1 to GK5 from Gua Kecil.

Slipped surfaces are usually applied before the pottery is fired by brushing a liquid of fine clay suspension over the leather-hard pottery. Slips were observed in samples GK11 to GK15 from Gua Kecil (Plate 9) and samples GKL2 and GKL4 from Gua Kajang. These slips, also known as the red-slips, average about 0.30 mm in thickness. Slips were also observed in samples BTL2, 4, 5, 6, and 9 from Bukit Tengku Lembu. These slips measured 0.30 mm, 0.50 mm, 0.36 mm, 0.52 mm, and 0.38 mm in thickness respectively. Samples GC7 from Gua Cha and GS1 from Gua Sagu showed slip washing, where a thin slipping of fine sericit measuring about 0.10 mm in thickness was observed (Plate 10). Sericit is a secondary muscovite found in minute shreds and aggregrates, formed by hydrothermal alteration (Kerr 1977). Sample K6 from Kodiang also has a slip measuring 0.90 mm in thickness.

Decoration: Decoration is defined here as any form of surface patterning such as cord-marking, incising, and stamping. The only form of decoration observed in the pottery samples was cord-marking. About 64.3% of the total samples studied showed cord-marked decoration. The other samples were undecorated, with either plain (28.6%) or red-slipped surfaces (7.15%).

All the sites studied have cord-marked pottery. These include samples BTL5, 7, and 8 from Bukit Tengku Lembu, K1, 2, 3, 4, and 5 from Kodiang, GH1, 2, 3, and 9 from Gua Harimau, GKL1 from Gua Kajang, GBL1, 2 and 3 from Gua Badak, GBT1,2, and 4 from Gua Batu Tukang, GTK1 and GTK2 from Gua Teluk Kelawar, GDL2 from Gua Dayak, GGB1 and GGB2 from Gua Gong Badak, GML from Gua Mesin, GC2, 3, 5, 7, 8, 13, 14, 16, 17, 18, 19, 21, 22, 23, 24, 25, and 27 from Gua Cha, GK6 to GK10 from Gua Kecil, GS1 and GS2 from Gua Sagu, and JH4 to JH7 from Jenderam Hilir.

Indeed, cord-marked pottery has been found in great quantities at archaeological sites all over Peninsular Malaysia. The known decorative technique used for cord-marking pottery is by means of a beater or paddle wrapped with a cord. However, other form of decorations such as the carved-paddle impression, incision, and comb-impression, which can also be found in Peninsular Malaysia, were not noted in the pottery samples.

Techniques Of Pottery Manufacture

This section deals with the techniques of pottery manufacture as derived from the pottery colour, temper, texture, thickness, porosity, surface finish, and decoration. The principle techniques discussed are paste preparation, forming the vessel, and firing.

Paste Preparation

Raw clays usually need to be treated and prepared in order to improve its workability before it can be used to form vessels. Initial preparation is normally done by removing coarse particles of rocks or organic materials. The dark gray or black cores observed in more than 57% of the samples suggested the presence of organic materials. These organic materials could be intentionally added by the potters or they could have occurred naturally in the clays.

The very fine and uniform paste texture of the pottery samples from Gua Kecil as shown in the textural analysis indicated that grounding of clays and temper was done. This was also evident from the fine grog (crushed sherds) found which have sizes measuring only between 0.04 mm and 0.68 mm in diameter. Tempers such as quartz and grog were also found to be commonly used by ancient potters in preparing the paste. These tempers are normally blended and kneaded with the raw clays during paste preparation before forming the vessels.

Forming The Vessel

In this study, only limited inferences on forming techniques can be made as evidence on techniques are rarely preserved in the pottery sherds.

From the sherd samples, only one type of forming technique known as throwing can be clearly recognised. Throwing involves forming and shaping vessels by turning them on some form of turn-table or potter's wheel. This technique which usually produced pottery that are symetrically shaped, with uniform or thin walls which are noted in samples GC6 from Gua Cha and GBL3 from Gua Badak, with the following characteristics:

(1) Ridges and grooves occur as continuous horizontal lines on the exterior of the sherds. The uniform horizontal lines further indicates that the tool used for making these marks was held stationary.

(2) The orientation and alignment of the inclusions are parallel to the surface of the sherds.

Firing

Firing was investigated based on two main types of data: (1) colour of the pottery sherds and (2) thermal changes in clay minerals and other mineral inclusions.

Analyses on pottery colour suggested that two methods of firing were commonly used: (1) incomplete oxidation in an oxidizing atmosphere and (2) smudging in a reducing atmosphere. Most of the pottery samples (72%) showed black or dark gray cores indicating incomplete oxidation of carbonaceous materials that could be caused by either insufficient oxygen, too low firing temperature, or too brief firing period. Such firing conditions usually mean that a kiln was not used but were more suggestive of the use of open fires or cooking hearths. Smudging was also noted in the black-coloured sherds especially those from Bukit Tengku Lembu, Kodiang, Gua Badak, Gua Batu Tukang, and Gua Kecil. Smudging in open firing is normally done during annealing in a reducing atmosphere, achieved by covering the pottery vessels with materials such as grass, ash, or leaves so that air supply is completely cut off and carbon monoxide then acts as the reducing agent.

Thermal changes in the clay minerals and other mineral inclusions was used in estimating firing temperatures. Minerals undergo transformation at consistent temperatures e.g. the crystalline form of quartz changes on heating, at about 573°C, from the low temperature α-quartz to the high temperature β-quartz (Kerr 1977). Because of this, the presence of certain transformed minerals provide an indication of the following maximum firing temperature:

(1) The fact that α-quartz grains were identified by X-ray diffraction analysis in samples from all the sites suggested that, in general, firing temperature above 573°C was not reached.

(2) The absence of kaolinite minerals in the samples examined must consequently be due to the fact that kaolinite poor clays were used rather than that firing temperatures above 585°C which degraded the kaolinite crystal structures (Grim 1962).

In summary, the firing temperature employed by the prehistoric potters in Peninsular Malaysia never exceeded 600°C. This is the temperature associated with open-firing (Rye 1981:25).

CONCLUSIONS

This study showed that there were localised areas of making pottery within each site in Peninsular Malaysia which shared a common pottery-making technology. Potters in these areas consistently used their own local clay source(s) to make pottery. There were no evidence of bartering among the sites studied and pottery was used for household or as burial goods such as those found in the caves of Gua Cha, Bukit Tengku Lembu, and Gua Harimau. The wide variation in pottery shapes and decoration suggested a lack of specialized and large scale production but supports a household level of pottery-making, where pottery was made and used by household units (Peacock 1982).

Therefore, in using the compositional and morphological approaches, this study has been able to conclude that pottery was produced within each of the sites studied. The problem of the "Black Ware" from Bukit Tengku Lembu was also resolved to be of local origin, contrary to previous findings. Also, this study indicates a slow development in pottery technology during prehistoric times and that there was no bartering of pottery among the sites studied.

Localised Pottery Production

The compositional approach used in this study strongly suggested that pottery were made within the vicinity of each of the sites. This was shown in the multivariate statistical analysis (involving the scatterplots and discriminant analysis) of the elemental data using seven distinctive elements: titanium, iron, rubidium, strontium, yttrium, zirconium, and barium. This analysis showed that pottery sherds from each of the sites formed its own compositional group suggesting that they were locally manufactured pottery based on assumptions of the Provenience Postulate and the Criterion of Abundance.

Results of the mineralogical analyses also indicated a high probability that local clay sources were used in making the pottery from sites in Lenggong. These sites were Gua Harimau, Gua Kajang, Gua Badak, Gua Batu Tukang, Gua Teluk Kelawar, Gua Dayak, Gua Gong Badak, and Gua Mesin. All the sherds from these sites were found to contain a distinctive mineral known as grossularite or $Ca_3Al_2(SiO_4)_2$, which was locally available.

The compositional analyses also revealed that the "Black Ware" from Bukit Tengku Lembu was locally made and not foreign as claimed by earlier researchers. This is because the "Black Ware" sherds (1) consistently fell into the same compositional group as the rest of the sherds from Bukit Tengku Lembu which were local, (2) the types of clay minerals and tempers, for example, quartz sand used in the "Black Ware" were locally available, and (3) this pottery was made using similar technology as local sherds from the other sites. The pottery was found to be smudged, tempered with quartz sands and grog (crushed pottery), and fired at a low temperature of between 500°C and 600°C, in a similar manner to sherds from the other sites in Peninsular Malaysia.

However, the question arises as to how close were the "local" clay sources to the sites? Interviews conducted with the present traditional pottery-making communities of Sayong in Kuala Kangsar, Perak, for example, showed that the potters obtained their clays from deposits about two or three kilometres away from their village. This corresponded well with other ethnographic studies of pottery-making communities in many parts of the world. For examples, Arnold (1980, 1985, 1988), Arifin (1990), and Das (1990) showed that potters generally do not travel more than seven kilometres to obtain their clays. Therefore, there is a high probability that "local" clay sources are located within seven kilometres from the site.

The compositional study further suggested that potters exhibit a tendency to exploit the same source(s) of clays continuously over time. This was seen in the pottery sherds from sites in Lenggong and Gua Cha. These sherds, obtained from different stratigraphic levels or periods, all showed the same chemical and mineralogical composition, suggesting that the same source(s) of clays were used over several thousand of years. Such practice of exploiting the same clay source(s) continuously over time can still be seen among the present pottery communities, for example, the Luo potters (Dietler and Herbich 1989:151).

Slow Technological Development

Compositional and morphological analyses showed a rather slow development in pottery technology over several thousand years in Peninsular Malaysia. Technological characteristics prevailent throughout the period include:

1) Low-fired pottery; usually fired to incomplete oxidation at temperatures of between 500°C and 600°C, which indicated open firing.

2) The use of quartz and grog as temper. The use of grog as temper, in particular, indicates that prehistoric potters were aware of the quality of their raw materials. Grog is ideal for use as temper because when fired, they possess similar thermal expansion characteristics to that of clays. Therefore, considerable amount of grog can be used as temper without the risk of cracking.

3) Cord-marking as a common form of surface decoration. Red-slipped, burnished, and incised pottery are also present. Some pottery also have black surfaces caused by smudging under a reducing atmosphere.

4) Techniques of manufacture include mainly wheel-throwing, hand modelling, segmentation, coiling, and the paddle and anvil technique.

5) Pottery walls generally averaged about 8.0 mm in thickness and have an average porosity of between 25% and 35%.

Slow development in prehistoric potting technology has also been documented elsewhere, for example, McGovern *et al.* (1985:112), Rye (1981:5), Shepard (1956:314), and Arnold (1985:221). Among the factors mentioned as barriers to technological change are (1) pottery had little or no economic value, either for sale or exchange. Therefore, any change requiring extra cost, time, and effort would not be necessary, (2) the attitude and beliefs of potters. For example, potters in Chinautla, Guatemala, believed that members of the community should follow tradition and not be innovative as negative sanctions would be brought upon them if they innovated (Arnold 1985:223), and (3) the properties of raw materials have an effect on the technique of manufacture. Therefore, when suitable clays and tempers have been discovered, there is no incentive to try others. Consequently, their potting technology remain unchanged.

Culture Contact

Compositional study indicated that each of the sites used its own clay sources. All the samples from within each site showed no significant difference in composition when compared to other samples from the same group. Hence, there is a high probability that there was no bartering or exchange of pottery among the sites studied. Traditionally, all this would imply less interaction among potters (Graves *et al* 1990). However, this is anomalous in the light of similarity in technological and morphological characteristics among the pottery sherds studied. Technological and morphological characteristics similar among the pottery sherds include low firing temperature (500°C to 600°C), the use of quartz and grog tempers, shape (for example, the pedestalled vessels), and decoration (for example, cord-marking). Therefore, these similarities could suggest culture contact, perhaps in the form of idea exchange within a site or between sites in Peninsular Malaysia.

A good example of idea exchange in this study is the tripod pottery found in Jenderam Hilir (Selangor) as well as Kodiang (Kedah). Compositional studies showed that this pottery was made separately using local clays found in each of the site. Samples of the tripod pottery from Jenderam Hilir were found to contain relatively low calcium (132 ppm to 264 ppm) and iron (1.23% to 2.22%) while those from Kodiang have relatively higher calcium (850 ppm to 2000 ppm) and iron (2.54% to 4.22%) contents. However, both sites produced similar pottery type, i.e. the tripod pottery, although they are located about 400 kilometres apart. This seemed to suggest that ideas exchange or transmission could have occured between these two sites rather than bartering.

Compositional studies also indicated that there was no bartering in pottery among the other sites as each of the sites formed its own compositional group. Bartering in pottery would have been difficult, especially between the west coast (e.g. sites in Lenggong) and the east coast (e.g. Gua Cha) of Peninsular Malaysia, separated by a mountainous terrain (the Main Range). Other unfavourable factors such as the lack of economic value and the fragility of pottery probably also discourage bartering among these sites.

REFERENCES

Adi Haji Taha

1985 *The re-excavation of the rockshelter of Gua Cha, Ulu Kelantan, West Malaysia,* Federation Museums Journal, vol 30, New Series, Kuala Lumpur.

Arifin, K.

1990 "Social aspects of pottery manufacture in Boera, Papua New Guinea", paper presented at 14th Congress of *Indo-Pacific Prehistoric Association,* Yogjakarta, August-September.

Arnold, D.E.

1980 "Localized exchange: an ethnoarchaeological perspective", In Fry, R.E. (ed.), *Models and Methods in Regional Exchange,* Society for American Archaeology, SAA Papers I, 147-150.

1985 *Ceramic Theory and Cultural Process,* Cambridge University Press, Cambridge.

1988 "A universal catchment area for ceramic resources: Update". Paper presented at the symposium, *Ceramic Ecology Revisited, American Anthropological Association annual meeting,* Phoenix, Arizona, November 16.

Bishop, R. L., R. L. Rands, & G. R. Holley
1982 "Ceramic compositional analysis in archaeological perspective", *Advances in archaeological method and theory,* Academic Press Inc, 5, 275-327.

Buttler, W.
1935 "Ein Hinkelsteingefass aus Koln-Lindentral und seine Bedeutung fur die chronologie der rheinischen Bandkeramik", *Germania,* 19, 193-200.

Copper, Z. & H. Raghavan
1989 "Petrographic features of Andamanese pottery", *Indo-Pacific Prehistory Association Bulletin",* 9, 22-32.

Coutts, P. J. F., J. Guy & E. R. Segnit
1985 "Chinese trade ceramics and Philippine earthernware from Panay Island, Philippines; Preliminary results of petrological studies", *Research Conference on Early Southeast Asia,* Bangkok and Nakhon Pathon.

Das, M.
1990 "Pottery technology and its social-economic implications in India", paper presented at 14th Congress of *Indo-Pacific Prehistoric Association,* Yogjakarta.

Dietler, M. & I. Herbich
1989 "Tich Matek: the technology of Luo pottery production and the definition of ceramic style. In Ceramic Technology, *World Archaeology,* 21(1), 148-164.

Dunn, F. L.
1964 "Excavations at Gua Kecil, Pahang", *Journal of the Malayan Branch of Royal Asiatic Society,* 137(2).

1966 "Radiocarbon dating in Malayan Neolithic", *Proceedings of the Prehistoric Society,* 32, 352.

Graves, M. W., T. L. Hunt, & D. Moore
1990 "Ceramic production in Mariana Islands: Explaining change and diversity in prehistoric interaction and exchange", *Asian Perspectives,* 29(2), 211-231.

Grieder, T.
1975 "The interpretation of ancient symbols", *American Anthropologist,* 77, 849-855.

Grim, R. E.
1962 *Applied Clay Mineralogy,* McGraw-Hill Book Co, New York.

Hulburt, C. S. Jr.

1971 *Dana's manual of mineralogy,* 18th ed. Wiley & Sons Inc, New York & London.

Kempe, D. R. C. & A. P. Harvey

1983 *The Petrology of Archaeological Artefacts,* Clarendon Press, Oxford.

Kerr, P.F.

1977 *Optical Mineralogy,* McGraw-Hill Inc, New York.

Leong Sau Heng

1986 "A tripod pottery complex in Peninsular Malaysia", paper presented at the *First Conference of the Association of Southeast Asian Archaeologists,* Western Europe, Institute of Archaeology, London.

MacNeish, R. S., F. A. Peterson & K. V. Flannery

1970 "The prehistory of the Tehuacan Valley", 3, *Ceramics,* Austin, University of Texas Press.

McGovern, P. E., W. W. Vernon & J. C. White

1985 Technology at prehistoric Ban Chiang, Thailand: Physiochemical Analyses", *Museum of Applied Science Centre for Archaeology (MASCA) Journal,* 3(4), 104-113.

Miksic, J. N. & C. T. Yap

1990a "Fine-bodied white earthernwares of Southeast Asia: Some X-Ray Flourescence Tests", *Asian Perspectives,* 28(1).

1990b "X-Ray flourescence data on earthernware pottery trade in Sumatra, 12th to 14th Centuries", paper submitted to the *14th congress of the Indo-Pacific Prehistory Association,* Yogjakarta, Indonesia.

Noone, H. D.

1939 "Report on a new Neolithic site in Ulu Kelantan", *Journal of the Federated Malay States Museums,* 15, 170-174.

Peacock, B. A. V.

1959 "A short description of Malayan prehistoric pottery", *Asian Perspectives,* 3, 121-156.

Peacock, D. P. S.

1968 "A petrological study of certain Iron Age potteries from Western England", *Proceedings of the Prehistoric Society,* 34, 414-427.

1982 *Pottery in the Roman World: An ethnoarchaeological approach,* Longman, London.

Pookajorn, S.

1984 "The chemical analysis of Hoabinhian pottery: New data from the recent Thai excavations in Ban Kao area", *Southeast Asian Archaeology at the XV Pacific Science Congress,* Dunedin, New Zealand.

Poole, A. B. & L. R. Finch

1972 "The utilization of trace chemical composition to correlate British post-medieval pottery with European kiln site materials", *Archaeometry* 14, 79- 91.

Rye, O. S.

1981 *Pottery Technology: Principles and Reconstruction,* Taraxacum, Washington DC.

Shepard, A. O.

1942 *Rio Grande glazed paint ware, a study illustrating the place of ceramic technological analysis in archaeological research,* Carnegie Institute, Washington DC.

1956 "Ceramics for the archaeologist", *Carnegie Institution Publication* 609, Carnegie Institution, Washington DC.

Sieveking, G. de G.

1954 "Excavations at Gua Cha, Kelantan", *Federated Museums Journal,* I & II, 75-138.

1962 "The prehistoric cemetery at Bukit Tengku Lembu, Perlis", *Federated Museums Journal,* 7, 25-54.

Vincent, B.

1984 "The analysis of prehistoric pottery from Ban Na Di, northeast Thailand", *Southeast Asian Archaeology at the XV Pacific Science Congress,* Dunedin, New Zealand.

1987 "The Ceramics", In Higham, C. F. W., R. Bannanurag, B. K. Maloney, & B. Vincent (eds), Khok Phanom Di: the results of the 1984-5 season, *Bulletin of the Indo-Pacific Prehistory Association,* 7, 148-178.

1988 "Prehistoric Ceramics of Northeastern Thailand", In *BAR International Series* 461, Oxford, England.

Weigand, P. C., G. Harbottle & E. V. Sayre

1977 "Turquoise sources and source analysis: Mesoamerica and the South-Western USA", In Earle, T. K. and J. E. Ericson (eds), *Exchange Systems in Prehistory,* Academic Press, London, 15-34.

Williams-Hunt, P. D. R.

1952 "Archaeological discoveries in Malaya", *Journal of the Malayan Branch of the Royal Asiatic Society,* 25(1), 181-190.

Zolkurnian Hasan

1989 "Gua Harimau: Satu Laporan Awal", *Jurnal Persatuan Muzium Malaysia (PURBA),* 8, Kuala Lumpur.

Zuraina Majid

1989 "The Tampanian problem resolved: Archaeological evidence of a late Pleistocene lithic workshop", In Bartstra & Casparie (eds), *Modern Quaternary Research in Southeast Asia,* 11:71-96, Nederland.

1994 *The Excavation of Gua Gunung Runtuh and the Discovery of the Perak Man in Malaysia,* Department of Museums and Antiquity Malaysia, Kuala Lumpur.

1996 *Prasejarah Malaysia: Sudahkah zaman gelap menjadi cerah?* Universiti Sains Malaysia, Penang.

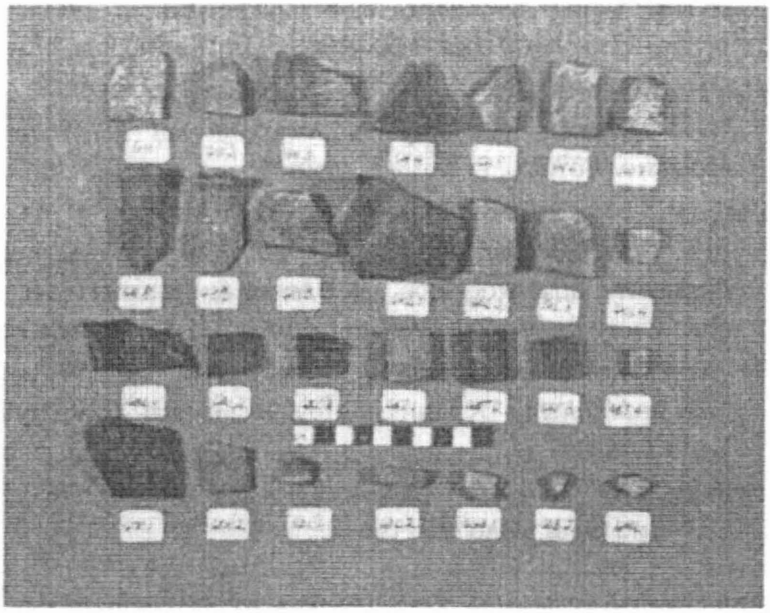


Plate 1: Pottery sherds sampled from sites in the cave massifs of Lenggong, Perak

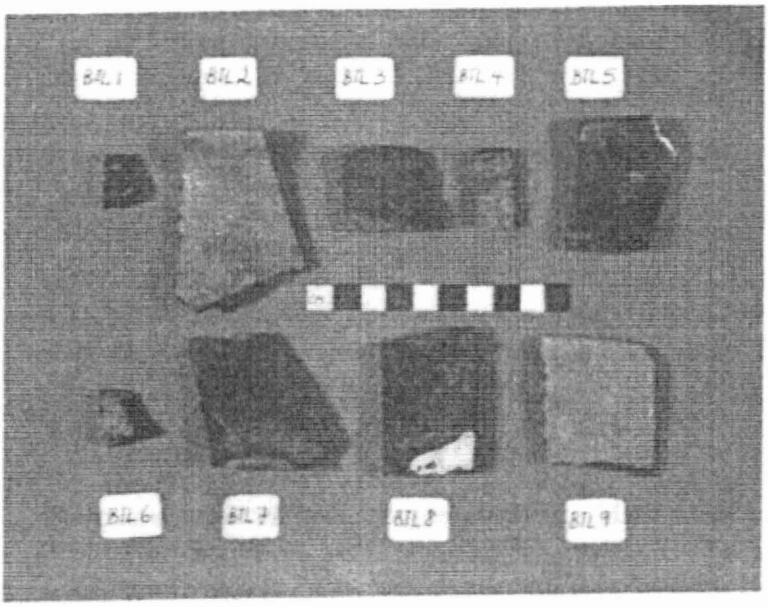


Plate 2: Pottery sherds from Bukit Tengku Lembu in Perlis.

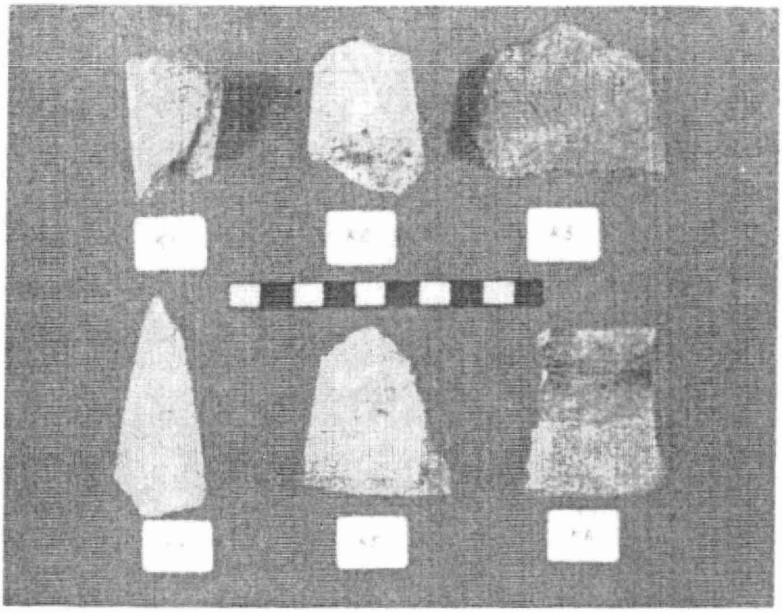


Plate 3: Pottery sherds sampled from Kodiang in Kedah

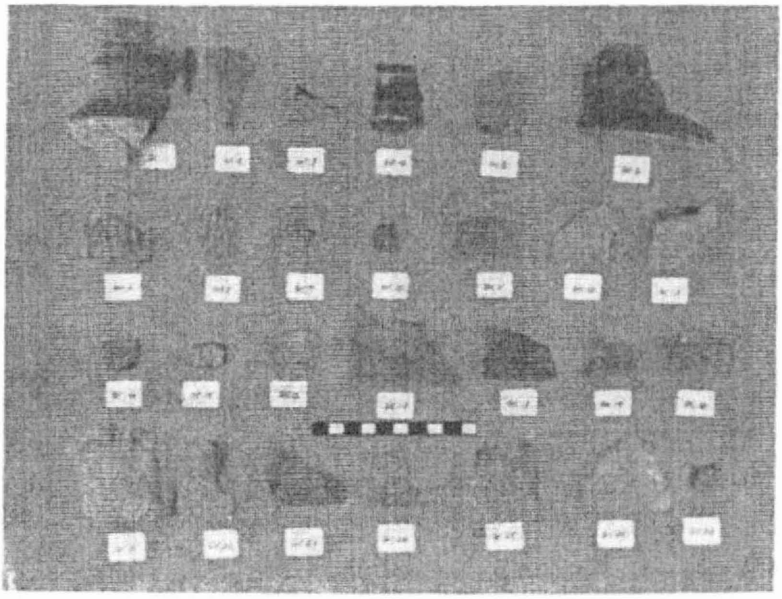


Plate 4: Pottery sherds sampled from Gua Cha in Kelantan

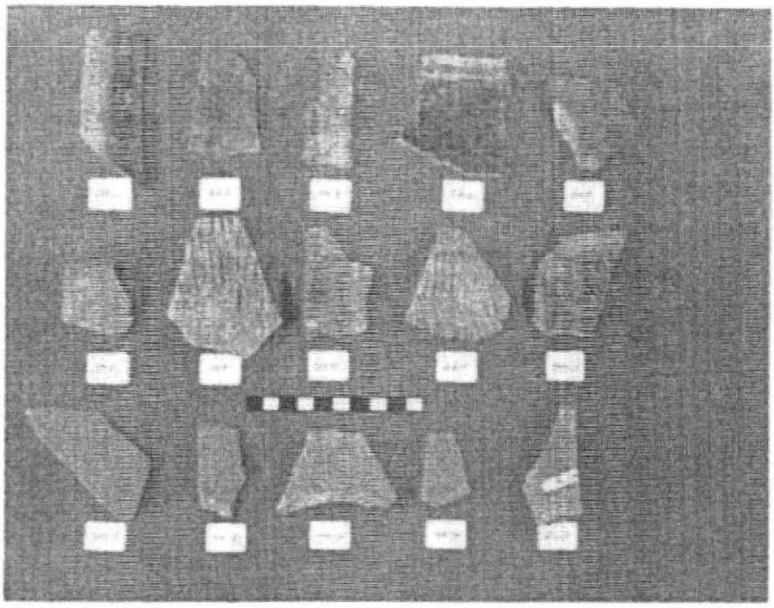


Plate 5: Pottery sherds sampled from Gua Kecil in Pahang

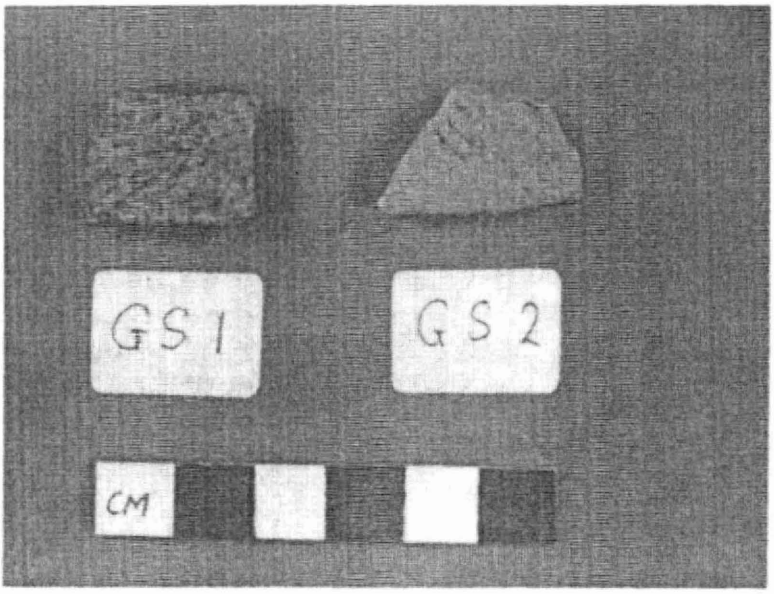


Plate 6: Pottery sherds sampled from Gua Sagu in Pahang