6

An Sơn Ceramic Fabrics

PART I: FABRIC DESCRIPTIONS AND NON-PLASTIC INCLUSIONS

Introduction: Non-plastic inclusion and temper identification with SEM-EDX

Temper is added to clay in ceramic manufacture to reduce the risk of breakage during drying and firing, as a result of rapid shrinkage and/or expansion by distributing heat evenly. Temper can include a variety of non-plastic materials (Shepard 1965: 24-26). The non-plastic inclusions in the An Sơn ceramics were initially identified as sand, fibre or 'other' tempers, using microscopy. The microscopic observations indicated that grains required further analysis with SEM-EDX in order to characterise the tempers in each sample. The method for analysis by SEM-EDX was described in Chapter 3. The temper grains were differentiated from natural non-plastic inclusions in the clays by size, density and shape, including the presence of a waterworn appearance. Small grains, usually silt to very fine sand-sized, were considered to be naturally occurring in non-plastics in infrequent amounts.

The clays within the vicinity of An Sơn were compared to the clay matrices of the ceramic samples to differentiate between the natural and added non-plastic inclusions. Most clays require some kind of processing if they are to be used for ceramic manufacture, usually with the addition of a tempering agent, but the process may also involve the extraction of larger impurities in the selected clay. The coarse size of many of the sand grains implied the manual addition of these grains to the fabrics. In the SEM-EDX analysis it was apparent that simple sand and fibre categories were not sufficient to encompass all of the temper additives at An Sơn. The tempers, in addition to natural non-plastic inclusions, were identified from the EDX compositional data with reference materials (Severin 2004; Deer, Howie and Zussman 1992), as well as from visual observations and SEM backscatter microphotographs.

Chapter 6, Part I describes the temper groups and inclusions, including the temper density, and mineral grain shapes and sizes. It also describes the plastic clay matrices, including the presence of unmixed clays, identification of silt and very fine sand non-plastic natural inclusions, and texture. The rim forms referred to in this chapter are shown in Figure 5.1. This chapter describes the temper groups in the An Sơn ceramic assemblage. The tempers are characterised for the ceramic samples from An Sơn and for non-local ceramics. The clay samples are described, and the non-plastic inclusions at An Sơn are summarised. Chapter 6, Part II reports the clay matrix compositional data.

Temper groups

Five major temper groups (TG) were identified in the analyses (Figure 6.1):

- *Temper group A: Mineral sand*
    - A1: Quartz and feldspars

      The sands predominantly included feldspars (primarily alkali feldspars) and quartz.
    - A2: Lateritic

      Sometimes the sand tempered vessels also incorporated laterite materials, inclusive of iron-rich minerals, micas and amphiboles.
    - A3: Coarse iron-rich and waterworn

      This category was rare but contained coarse and rounded iron-rich phyllosilicate grains.
- *Temper group B: Fibre*

  'Fibre temper' refers to fabrics tempered with plant remains that in most cases were identified as rice chaff. Often rice chaff tempers included spikelets/husk and stems fragments (see Tomber, Cartwright and Gupta 2011, for comparable images).
- *Temper group C: Phosphate*

  While calcium phosphate minerals are often linked to calcareous tempers (see Dickinson 2006), the presences of iron and calcium phosphate grains together have been identified here as fossilised skeletal remains or bioclasts (see Figure 6.1, image C).
- *Temper group D: Calcareous*

  This group was restricted to angular calcareous sands that were most likely crushed shell.
- *Temper group E: No temper*

  This includes sherds that had a smooth matrix without non-plastic inclusions, and sherds with very fine sand to silt-sized inclusions that appeared to be natural inclusions.

Two temper subgroups were rarely identified in the analyses and were always in association with one of the above temper groups. These are orthodox and bleb grogs, which have been identified in ceramics from other Southeast Asian sites, such as Khok Phanom Di (Vincent 2004; 1988: 88):

- *OG: Orthodox grog*

  Crushed ceramic sherds or crushed pre-fired clay that were added to the clay (Vincent 2003: 54).
- *BG: Bleb grog*

  Crushed fired fibre and clay balls that were added to the clay (Vincent 2003: 54).

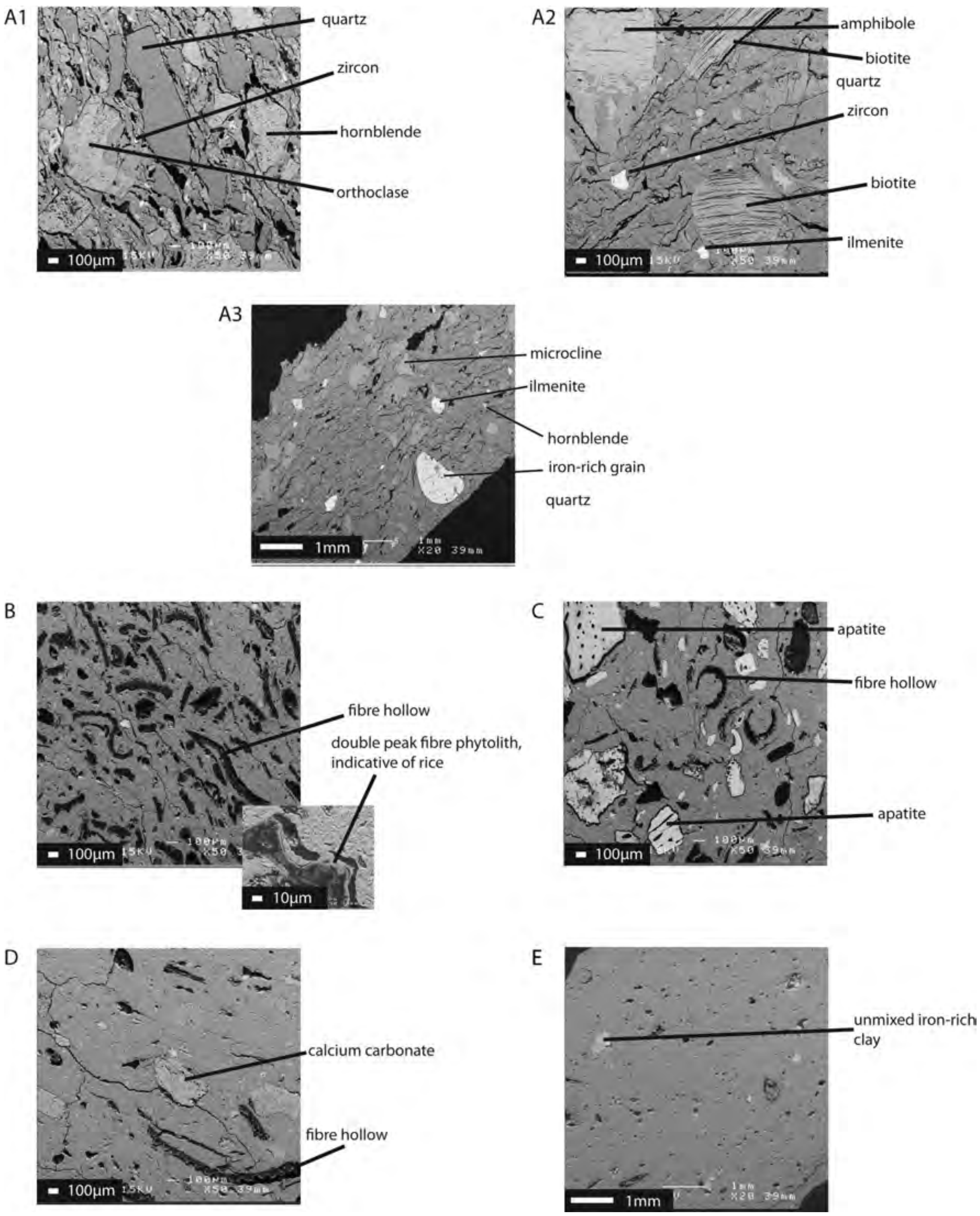

Figure 6.1. SEM backscatter images of the main tempers identified in the An Sơn assemblage. A1. Quartz and feldspar mineral sand (09AS-H1-C1-L1-S1-1) A2. Lateritic mineral sand (09AS-H1-C1-L5/6-S7-3) A3. Iron-rich mineral sand (09AS-H1-C1-L5/6-S9-3) B. Fibre (09AS-H1-C1-L5/6-S9-2) C. Phosphate with fibre (09AS-H1-C1-L1-S1-2) D. Calcareous with fibre (09AS-H1-C1-L5/6-S5-5) E. No temper (09AS-H1-C10-L2-S3-Oc Eo phase-1).

Source: C. Sarjeant.

Discussion of the temper groups

Alongside fibre tempered fabrics, mineral sand was the most prominent temper in the assemblage. Most of the mineral sand tempers consisted of quartz and alkali feldspar grains (TG A1) that were present in a range of sand sizes and were generally angular. Sands were collected by potters as tempers along beaches, rivers and from dug-out deposits. Even though An Sơn's proximity to the ocean may have been much closer in the past, the presence of beach sands as temper has not been recorded since the sands were not uniform in size in the studied ceramics. While fast-flowing rivers can deposit sand, the slow-moving Vàm Cỏ Đông River deposits silt and sand might have been acquired by potters from earlier deposits, such as the Pleistocene alluvial deposits that underlie the site (Ulrike Proske, pers. comm.).

The lateritic fabrics (TG A2) included orange-brown grains of weathered laterite, and consisted of iron oxide, quartz and muscovite. The minerals in the clay matrices associated with the laterite grains included biotite, amphibole, pyroxene, ilmenite, apatite, quartz and alkali feldspar. Macroscopically, the laterite was identified by the presence of iron oxide-stained grains and sometimes shiny inclusions (biotite). 'Lateritic' soils are generally red soils with high clay content as a result of extreme weathering of parent materials and aluminium and iron enrichment; these elements are usually evenly distributed in the soil (Beck and Neupert 2009). TG A2 was differentiated from sand tempered sherds (TG A1) that did not include obvious laterite grains, except as fine-weathered grades in the clay matrix. In fact, most of the sherds in the assemblage included small and large grains that were high in iron: they varied in shape, were orange or red in appearance, and were iron and silicon-rich.

The iron-rich coarse and rounded sand grains (TG A3) were orange to purple in appearance. While they were not pure FeO or Fe_2O_3, they contained more iron oxide than silicon and aluminium oxides and always occurred with other mineral sands in the same sherd (TG A1).

Many sherds were heavily tempered with rice husk (TG B), and these were present from the base of the deposits excavated in 2009, but none were present in the small sample from the very basal layer 3–5 excavated in 1997. Katsunori Tanaka has identified the fibres in some sherds as *Oryza sativa japonica* (pers. comm. to Peter Bellwood). Further species identification is required for the fibres in sherds from the earliest layers of the site to confirm the potential presence of domestic or wild rice species, and other plant remains such as millets and grasses (Tomber, Cartwright and Gupta 2011; Weber *et al.* 2010; Castillo and Fuller 2010). It may be argued that the presence of rice chaff temper indicates an economic reliance on rice and that it was readily available, but the technological significance of using this type of temper should not be underestimated, particularly for the use of pots in cooking that are under thermal shock (Tomber, Cartwright and Gupta 2011; Castillo and Fuller 2010) (see Chapter 5).

Fibre temper was sometimes associated with calcium phosphate (apatite) and iron phosphate (vivianite) grains (TG C), which may have resulted from phosphatic mineralisation of plant fibres (Green 1979) in the temper, or the addition of crushed bone or fossil material (Kuczumow *et al.* 2010; Piga *et al.* 2009) to the clay fabric. Reef debris can consist of skeletal material (bioclasts) which can be found in beach sands as rounded or subrounded particles. While these are often called calcareous tempers, the presence of iron phosphate in association with calcium phosphate has led to a separate phosphate category, independent of the shell calcareous temper category (TG D) (Dickinson 2006: 21, 40). Since reef and possibly beach deposits were not easily accessible from An Sơn, bioclastic deposits were more likely to have been accessed for ceramic tempers by digging into the substrate. The beach was most certainly much closer to An Sơn in the past but the exact relationship the people of An Sơn had with beach resources is not clear: there is no evidence of exploiting marine resources on site or the use of coastal beach sands in the ceramic

fabrics. Earlier Pleistocene deposits that may include bioclastic remains in the region were very hard and would not have been a suitable clay material, therefore the bioclasts were most likely dug from a deposit for use as temper (Ulrike Proske, pers. comm.).

Calcareous, shell tempers (TG D) were rare in the analysed sample. The clays themselves frequently included zircon and ilmenite ($FeTiO_3$), regardless of the selected temper. The shell fabric included grains with jagged edges and a composition of calcium carbonate. The shell-tempered fabrics sometimes also included plant fibres, quartz and amphibole. Calcareous tempered ceramics can be identified macroscopically but may be mistaken for prominently quartz sand tempered ceramics.

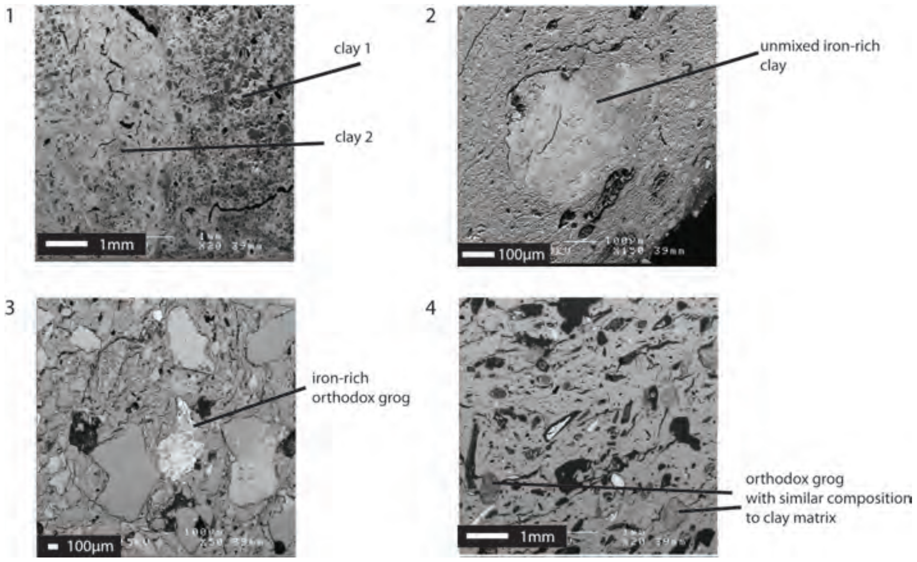

Figure 6.2. SEM backscatter images showing the difference between orthodox grog and iron-rich clay. 1. Unmixed iron-rich clay in raw clay (09-Vàm Cỏ Đông side channel-unfired clay-1). 2. Unmixed iron-rich clay in ceramic sherd (09AS-H1-C1-L7-S10-2). 3. Iron-rich orthodox grog (LG-3-surface). 4. Orthodox grog with similar composition to clay matrix (LG-2-surface).

Source: C. Sarjeant.

Grog was rare and minimal in density (usually only one grain in a sample) when present and was always in association with a primary temper (TG A, B, C and D) in the same sherd. Since it was not a primary temper it was not classified as a group in this analysis but as a subcategory that included orthodox grog (OG) and bleb grog (BG) (Vincent 2004, 1991, 1988). *Orthodox grog* is usually made from crushed ceramic sherds, although it can also include purpose-fired clays. *Bleb grog* is described as 'crushed prefired clay which has been purposefully tempered with rice plant remains, normally featuring varying amounts of rice husk, prior to its initial firing' (Vincent 1988: 88). The appearance and composition of orthodox grog is often similar to iron-rich clay with very fine sand and silt quartz grains that were not always thoroughly mixed into the ceramic paste (Figure 6.2). This iron-rich clay is known to exist locally at An Sơn (Figure 6.2). While bleb grog has been identified in a few ceramic samples from An Sơn, and the technique was undoubtedly present in the ceramic technology of the region, there was little microscopic evidence to substantiate its continuous use. If plant fibre tempers were always added to the ceramic fabric as bleb grog, it was not evident in the studied sherds. There was little evidence of potter investment in creating artificial tempers as grog at An Sơn, suggesting that accessible resources of sand and organic materials were sufficient to meet the needs and traditions of local ceramic production.

Temper characterisation and clay matrix description: An Sơn ceramics

Trench 1: Square C1 ceramic samples

The temper and clay matrices for the sample of sherds analysed from Trench 1 square C1 at An Sơn are described in Table 6.1. Square C1 was selected as a representative square for the 2009 excavation as it was located close to the main mound and contained the main part of the stratigraphic sequence represented in the site. A total of forty sherds were analysed, and this included samples from each 10 cm spit and each layer to represent the entire sequence. The clay matrices are described according to their texture and mineral inclusions. The texture was recorded at high magnification of the clay matrix: 'smooth' matrices had no visible inclusions, 'fibre' matrices incorporated small organic fibres that were remnants of the temper, and 'mineral' matrices included small non-plastic grains, presumably natural components of the clays (Table 6.1).

The majority of the sherds (60%) were purposefully tempered with mineral sand that consisted of quartz and feldspar (TG A1) or laterite (TG A2). The sand grains were most frequently angular, with a mixture of sizes. The lowest layer in square C1 only contained sand tempered ceramics, and no fibre temper (TG B) was observed. In the Trench 1 square C1 sample, only 15% were fibre tempered in all layers, although a further 10% were tempered with mixed fibre and phosphate material (TG B/C), and another 2.5% with mixed calcareous and fibre temper (TG B/D). The remaining C1 sherds were tempered with a mixture of sand and fibre (TG A1/B) (10%), and one sherd with calcareous temper (TG D) (2.5%). In addition to the detailed results in Table 6.1, a summary of the C1 ceramic samples that were analysed and their identified temper groups is presented in Appendix A.1.

Other An Sơn ceramic samples

The temper and clay matrices for each analysed sample from Trench 1 (except the square C1 sample), the Test Square and the 1997 Trench 1, are described in Table 6.2, and the temper groups are characterised for each analysed sample. Once again, fibre temper (TG B) was not present in the lowest layer, layer 3–5 of the 1997 excavation. Bleb grog and untempered wares (TG E) were only observed in more recent layers and in surface sherds, postdating the neolithic occupation of An Sơn. In addition to the detailed results in Table 6.2, a summary of the An Sơn ceramic samples that were analysed and their identified temper groups is presented in Appendix A.2.

Table 6.1. Description of the An Sơn ceramic fabrics, 2009 excavation, Trench 1 square C1.

Layer		Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
1	1	09AS-H1-C1-L1-S1-1	Mineral sand	Quartz Alkali feldspar Amphibole	High	Angular	0.25–1 mm	Clay Quartz, alkali feldspar and zircon inclusions Smooth texture
1	1	09AS-H1-C1-L1-S1-2	Phosphate Fine fibre	Calcium phosphate	Medium in phosphate sand Low in fibre	Rounded to angular	0.1–1 mm	Clay Quartz and alkali feldspar inclusions Fibre texture
1	2	09AS-H1-C1-L1-S2-1	Mineral sand	Quartz Alkali feldspar	Medium	Subangular	0.25–0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar and zircon inclusions Smooth texture
1	2	09AS-H1-C1-L1-S2-2	Fibre	-	Low	-	-	Clay with unmixed iron-rich clay Quartz and impure iron oxide inclusions Fibre and mineral texture
5	3	09AS-H1-C1-L5-S3-1	Mineral sand	Quartz Alkali feldspar	Medium	Subangular to angular	0.5–1 mm	Clay Quartz, alkali feldspar, garnet and chlorite inclusions Smooth texture
5	3	09AS-H1-C1-L5-S3-2	Phosphate Fine fibre	Calcium phosphate Iron phosphate	Low	Subangular to angular	0.2–0.5 mm	Clay with unmixed iron-rich clay Quartz, impure iron oxide and iron rich phyllosilicate inclusions Mineral texture
5	3	09AS-H1-C1-L5-S3-3	Mineral sand	Quartz Alkali feldspar	Medium	Subrounded to subangular	0.2–0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, garnet, ilmenite and rutile inclusions Mineral texture
5/6	4	09AS-H1-C1-L5/6-S4-1	Mineral sand	Quartz Amphibole	High	Subangular to angular	0.2–0.5 mm	Clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture
5/6	4	09AS-H1-C1-L5/6-S4-2	Fibre	-	Low	-	-	Clay with unmixed iron-rich clay Quartz and zircon inclusions Mineral texture

Layer		Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
		09AS-H1-C1-L5/6-S4-3	Mineral sand	Quartz Alkali feldspar	High	Subrounded to subangular	0.2–1.5 mm	Clay Quartz, alkali feldspar, ilmenite and rutile inclusions Mineral texture
	5	09AS-H1-C1-L5/6-S5-1	Mineral sand	Quartz Alkali feldspar	Medium	Subangular to angular	0.2–0.75 mm	Clay Quartz, alkali feldspar, garnet, chlorite, ilmenite and kaolinite inclusions Mineral texture
		09AS-H1-C1-L5/6-S5-2	Fibre	-	Low	-	-	Clay with unmixed iron-rich clay Quartz and impure iron oxide inclusions Fibre and mineral texture
		09AS-H1-C1-L5/6-S5-3	Mineral sand	Quartz Alkali feldspar Amphibole	Medium	Angular	0.5–1 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, garnet, mica and ilmenite inclusions Smooth and mineral texture
		09AS-H1-C1-L5/6-S5-4	Lateritic mineral sand Orthodox grog	Quartz Alkali feldspar Biotite Muscovite	Medium in sand Very low in grog	Angular sand, subangular grog	0.5–1.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, garnet, mica, calcium phosphate and pyroxene inclusions Mineral texture
		09AS-H1-C1-L5/6-S5-5	Calcareous Fibre	Calcium carbonate	Low	Angular	0.2–0.5 mm	Clay Quartz and pyroxene inclusions Mineral texture
		09AS-H1-C1-L5/6-S5-6	Calcareous	Calcium carbonate	Low	Subangular	~1 mm	Clay Quartz and illite inclusions Mineral texture
		09AS-H1-C1-L5/6-S5-7	Mineral sand	Quartz Alkali feldspar Amphibole	High	Angular	0.2–1.5 mm	Clay Quartz, alkali feldspar, garnet and ilmenite inclusions Mineral texture

Layer		Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
	6	09AS-H1-C1-L5/6-S6-1	Mineral sand Fibre	Quartz Alkali feldspar	Medium in sand Low in fibre	Subrounded to subangular	0.2–0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, epidote and zircon inclusions Smooth texture
		09AS-H1-C1-L5/6-S6-2	Fibre	-	Medium	-	-	Clay with unmixed iron-rich clay Quartz, plagioclase feldspar and florencite inclusions Fibre texture
	7	09AS-H1-C1-L5/6-S7-1	Mineral sand	Quartz Alkali feldspar	High	Subangular to angular	0.25–1 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture
		09AS-H1-C1-L5/6-S7-2	Fibre	-	Low	-	-	Clay with another unmixed clay Quartz inclusions Fibre texture
		09AS-H1-C1-L5/6-S7-3	Lateritic mineral sand	Quartz Plagioclase feldspar Pyroxene Biotite	Medium	Subangular to angular	0.5–1.5 mm	Clay Quartz, plagioclase feldspar, pyroxene, mica, ilmenite and zircon inclusions Mineral texture
	8	09AS-H1-C1-L5/6-S8-1	Mineral sand Fibre	Quartz	Medium in sand Low in fibre	Subangular to angular	0.2–1 mm	Clay Quartz and zircon inclusions Mineral texture
		09AS-H1-C1-L5/6-S8-2	Phosphate Fibre	Calcium phosphate Iron phosphate	Medium in phosphate sand Low in fibre	Rounded to angular	0.1–1 mm	Clay Quartz inclusions Fibre and mineral texture
		09AS-H1-C1-L5/6-S9-1	Mineral sand	Quartz Alkali feldspar	High	Subangular to angular	0.2–1.5 mm	Clay Quartz, alkali feldspar, ilmenite and zircon inclusions Mineral texture

Layer		Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
	9	09AS-H1-C1-L5/6-S9-2	Fine fibre	-	High	-	-	Clay with unmixed iron-rich clay Fibre and mineral texture
		09AS-H1-C1-L5/6-S9-3	Mineral sand Iron-rich mineral sand	Quartz Alkali feldspar Impure iron oxide, waterworn	Medium	Rounded to angular	0.2–1 mm	Clay Quartz, alkali feldspar, amphibole and ilmenite inclusions Mineral texture
7	10	09AS-H1-C1-L7-S10-1	Mineral sand	Quartz Alkali feldspar	Medium	Subangular to angular	0.2–1 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, ilmenite and zircon inclusions Mineral texture
		09AS-H1-C1-L7-S10-2	Phosphate Fibre	Calcium phosphate Iron phosphate	Low	Rounded	0.1–0.5 mm	Clay with another unmixed clay Quartz and mica inclusions Mineral texture
		09AS-H1-C1-L7-S10-3	Lateritic mineral sand	Quartz Alkali feldspar Mica	Medium	Subrounded to subangular	0.2–0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, mica, garnet and ilmenite inclusions Mineral texture
		09AS-H1-C1-L7-S10-4	Mineral sand	Quartz Alkali feldspar	High	Subrounded to subangular	0.25–0.5 mm	Clay Quartz, alkali feldspar, amphibole and ilmenite inclusions Mineral texture
	11	09AS-H1-C1-L7-S11-1	Mineral sand Fine fibre	Quartz	Medium in sand High in fibre	Angular	0.2–0.5 mm	Clay Quartz and calcium phosphate inclusions Mineral texture
		09AS-H1-C1-L7-S11-2	Lateritic mineral sand	Quartz Alkali feldspar Biotite	High	Angular	0.2–1.5 mm	Clay Quartz, alkali feldspar, amphibole, mica, ilmenite and zircon inclusions Mineral texture

Layer		Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
		09AS-H1-C1-L7-S11-3	Mineral sand	Quartz Alkali feldspar	High	Quartz is angular Feldspar is subrounded to subangular	0.1–1.5 mm	Clay Quartz, alkali feldspar, ilmenite and zircon inclusions Mineral texture
		09AS-H1-C1-L7-S11-4	Lateritic mineral sand	Quartz Biotite Muscovite	Medium	Subrounded to angular	0.2–1 mm	Clay with unmixed iron-rich clay Quartz, mica, plagioclase feldspar, hornblende, sphene and ilmenite inclusions Mineral texture
8	12	09AS-H1-C1-L8-S12-1	Mineral sand Fibre	Quartz	High in sand Low in fibre	Subrounded to angular	0.1– 0.75 mm	Clay Quartz, calcium phosphate and ilmenite inclusions Fibre and mineral texture
		09AS-H1-C1-L8-S12-2	Mineral sand	Quartz Alkali feldspar Plagioclase feldspar	Medium	Subrounded to angular	0.1–0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, plagioclase feldspar, ilmenite and illite inclusions Coarse mineral texture
		09AS-H1-C1-L8-S12-3	Mineral sand	Quartz Alkali feldspar	High	Subrounded to angular	0.2–0.75 mm	Clay Quartz, alkali feldspar, garnet and ilmenite inclusions Coarse mineral texture
		09AS-H1-C1-L8-S12-4	Mineral sand	Quartz Alkali feldspar	High	Subangular to angular	0.2–0.75 mm	Clay Quartz, alkali feldspar, garnet and ilmenite inclusions Mineral texture
		09AS-H1-C1-L8-S12-5	Mineral sand	Quartz Alkali feldspar	High	Subangular to angular	0.2–0.8 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture

Source: Compiled by C. Sarjeant.

Table 6.2. Description of the An Sơn ceramic fabrics, 2009 excavation Trench 1 and Test Square, and 1997 excavation Trench 1. Key: 09AS = An Sơn 2009 excavation, 97AS = An Sơn 1997 excavation, H1 = Trench 1, TS = Test Square, L = Layer, S = Spit, U/S = Unstratified.

Layer	Spit	Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
Surface	Surface	09AS-U/S-1	Fine fibre (bleb grog)	-	High	-	-	Clay Quartz, amphibole, garnet and iron rich phyllosilicate inclusions Smooth texture
		09AS-U/S-2	Fine fibre (bleb grog)	-	High	Rounded to subrounded	0.2–1 mm	Clay Quartz, amphibole, garnet, ilmenite and iron rich phyllosilicate inclusions Smooth texture
2	3	09AS-H1-C10-L2-S3 -Óc Eo-1	None	-	-	-	-	Clay with unmixed iron-rich clay Quartz and garnet inclusions Smooth texture
		09AS-H1-C5-L2-S3-1	Fibre	-	Low	-	-	Clay with unmixed iron-rich clay Quartz, garnet and ilmenite inclusions Smooth texture
3	10	09AS-H1-C4-L3-S10-1	Mineral sand	Quartz Alkali feldspar	Medium	Rounded to subangular	0.1–0.2 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, amphibole and ilmenite inclusions Mineral texture
5/6	8	09AS-H1-B2-L5/6-S8-1	Mineral sand	Quartz Alkali feldspar	Medium	Subrounded to subangular	0.1–1 mm	Clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture
		09AS-H1-B2-L5/6-S8-2	Fibre Iron-rich mineral sand	Impure iron oxide, waterworn	Medium in fibre Low in sand	Rounded	1.5 mm	Clay with unmixed iron-rich clay Quartz, iron oxide, ilmenite and iron rich phyllosilicate inclusions Mineral texture

Layer	Spit	Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
8	10	09AS-H1-C10-L8-S10-1	Mineral sand	Quartz Alkali feldspar	High	Subrounded to subangular	0.1–0.4 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, plagioclase feldspar, mica, garnet, amphibole and ilmenite inclusions Mineral texture
200-210 cm	200-210 cm	09AS-TS-200-210cm-1	Fibre Mineral sand Phosphate	Quartz Calcium phosphate Amphibole	Medium	Rounded	0.5 mm	Clay Quartz and amphibole inclusions Smooth texture
240-250 cm	240-250 cm	09AS-TS-240-250cm-1	Fibre	-	Low	-	-	Clay with unmixed iron-rich clay Quartz and illite inclusions Fibre texture
		09AS-TS-240-250cm-2	Mineral sand	Quartz	High	Subrounded to subangular	0.2–0.5 mm	Clay Quartz, illite and fibre inclusions Fibre texture
		09AS-TS-240-250cm-3	Mineral sand	Quartz Alkali feldspar	High	Rounded to subrounded	0.1–0.2 mm	Clay Quartz, alkali feldspar, ilmenite and zircon inclusions Coarse texture
		09AS-TS-240-250cm-3b	Mineral sand	Quartz Alkali feldspar Amphibole	High	Subrounded to angular	0.2–1 mm	Clay Quartz, alkali feldspar, amphibole and zircon inclusions Smooth texture
		09AS-TS-240-250cm-4	Fine fibre	-	High	-	-	Clay Quartz, calcium phosphate and illite inclusions Mineral texture
250-260 cm	250-260 cm	09AS-TS-250-260cm-1	Fine fibre	-	High	-	-	Clay Quartz inclusions Fibre and mineral texture
		09AS-TS-250-260cm-2	Lateritic mineral sand	Quartz Alkali feldspar Muscovite	Medium	Subrounded to subangular	0.25–0.5 mm	Clay Quartz, alkali feldspar, mica, amphibole and zircon inclusions Mineral texture

Layer	Spit	Sample ID	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
350-360 cm	3-4	97AS-H1-A1-350-360cm-S3-4-1	Fine fibre	-	Medium	-	-	Clay Quartz, calcium phosphate, impure iron oxide, rutile and illite inclusions Fibre texture
		97AS-H1-B2-350-360cm-S3-4-1	Fine fibre Mineral sand	Quartz	Low in fibre High in sand	Subrounded	0.1–0.2 mm	Clay Quartz and calcium phosphate inclusions Fibre and mineral texture
		97AS-H1-350-360cm-S3-4-1	Fibre (bleb grog)	-	Low	-	-	Clay with unmixed iron-rich clay Quartz, plagioclase feldspar and illite inclusions Fibre texture
360-410 cm	3-5	97AS-H1-360-410cm-S3-5-1	Mineral sand	Quartz Alkali feldspar	High	Angular	0.1–2 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, epidote, ilmenite and zircon inclusions Mineral texture
		97AS-H1-360-410cm-S3-5-2	Mineral sand	Quartz Alkali feldspar	High	Subrounded to subangular	0.2–0.5 mm	Clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture

Source: Compiled by C. Sarjeant.

Temper characterisation and clay matrix description: Non-local ceramic samples

Temper and clay matrices are described in Table 6.3 for samples from various sites in southern Vietnam (Giồng Cá Vồ, Lộc Giang, Đình Ông and Cù Lao Rùa), central Vietnam (Hòa Diêm), northern Vietnam (Cồn Cổ Ngựa, Đa Bút and Mán Bạc) and northeast Thailand (Ban Non Wat) (see Figure 1.2 and Figure 1.3 for site locations). These sites were selected to incorporate pre-neolithic or incipient neolithic phases with Cồn Cổ Ngựa and Đa Bút, and neolithic phases of occupation with Mán Bạc, Ban Non Wat, Lộc Giang, Đình Ông and Cù Lao Rùa. Giồng Cá Vồ in southern Vietnam and Hòa Diêm in central Vietnam were sampled to represent the post-neolithic phase of occupation. Both sites had iron, bronze and jar burials, and have been linked to Sa Huỳnh developments of the central Vietnamese coast (see Lâm 2011; Yamagata 2006; Solheim 1964, 1959) (see Chapter 2). These sites were studied to identify broad similarities over space and time in order to contextualise the ceramic technology at An Sơn.

Fibre temper (TG B) was only identified at Ban Non Wat and at the sites neighbouring An Sơn along the Vàm Cỏ Đông River, Giồng Cá Vồ, Lộc Giang and Đình Ông. The other sites only had sand tempered sherds (TG A1). Less deliberate modes of tempering were evident at early sites, like Đa Bút and Cồn Cổ Ngựa, where large impure iron oxide grains that were natural non-plastic

impurities in the clay were not removed in clay preparation, and incidentally acted as a temper (TG A3). In addition to the detailed results in Table 6.3, a summary of the non-local ceramic samples that were analysed and their identified temper groups is presented in Appendix A.4.

Table 6.3. Description of non-local ceramic fabrics. Key: BNW = Ban Non Wat, CCN = Cồn Cổ Ngựa, CLR = Cù Lao Rùa, DB = Đa Bút, DO = Đình Ông, GCV = Giồng Cá Vồ, HD = Hòa Diêm, LG = Lộc Giang, MB = Mán Bạc.

Site	Layer/ Spit	Sample	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
Ban Non Wat	9:2 Feature 1	08/09BNW-N100-9:surface2-feature1-1	Fibre	-	Low	-	-	Clay with unmixed iron-rich clay Quartz, alkali feldspar, garnet, rutile and barium sulfate inclusions Mineral texture
Cồn Cổ Ngựa	Surface	CCN-1-surface	Mineral sand Iron-rich mineral sand	Quartz Impure iron oxide, waterworn	Medium	Subrounded to subangular	0.2-1 mm	Clay Quartz, epidote and impure iron oxide inclusions Mineral texture
Cù Lao Rùa	Surface	CLR-1-surface	Mineral sand Iron-rich mineral sand	Quartz Alkali feldspar	High	Subangular to angular	0.25 mm	Clay Quartz, alkali feldspar, impure iron oxide and cacoxenite inclusions Mineral texture
		CLR-2-surface	Mineral sand	Quartz Alkali feldspar	Medium	Subangular to angular	0.2-1 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, amphibole, rutile, sheet silicate inclusions Strand mineral texture
		CLR-3-surface	Mineral Sand Fibre?	Quartz Alkali feldspar Plagioclase feldspar	Medium in mineral sand Very low in fibre	Subrounded to angular	0.2-1 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, plagioclase feldspar, cacoxenite, illite, mica, rutile and ilmenite inclusions Mineral texture
		CLR-4-surface	Mineral sand Iron-rich mineral sand	Quartz Alkali feldspar Plagioclase feldspar	Medium	Subrounded to angular	0.25-0.75 mm	Clay Quartz, alkali feldspar, plagioclase feldspar, pyroxene, ilmenite and sheet silicate inclusions Mineral texture

Site	Layer/ Spit	Sample	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
Đa Bút	Surface	DB-1-surface	Mineral sand Iron-rich mineral sand	Quartz Impure iron oxide, waterworn	Medium in quartz Low in iron oxide	Rounded to subrounded	0.25-1 mm	Clay with unmixed iron-rich clay Quartz, impure iron oxide and epidote inclusions Mineral texture
Đình Ông	Surface	DO-1-surface	Fibre	-	Medium	-	-	Clay with unmixed iron-rich clay Quartz inclusions Mineral texture
		DO-2-surface	Mineral sand	Quartz Alkali feldspar	Medium	Subrounded to subangular	0.2-1 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, amphibole, metal oxide and ilmenite inclusions Mineral texture
		DO-3-surface	Mineral sand	Quartz Alkali feldspar Plagioclase feldspar	High	Subrounded	0.1-0.6 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, plagioclase feldspar, amphibole, epidote and ilmenite inclusions Mineral texture
		DO-4-surface	Mineral sand Orthodox grog	Quartz Alkali feldspar	Medium in sand Low in grog	Subrounded to subangular	0.1-0.5 mm	Clay Quartz, alkali feldspar, amphibole, zircon and ilmenite inclusions Mineral texture
Giồng Cá Vồ	Surface	GCV-1-surface	Mineral sand Iron-rich mineral sand	Quartz Alkali feldspar	Medium	Subangular	0.2-0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture
		GCV-2-surface	Fine fibre	-	Medium	-	-	Clay with unmixed iron-rich clay Quartz inclusions Fibre texture
		GCV-3-surface	Fine fibre	-	High	-	-	Clay with unmixed iron-rich clay Quartz inclusions Mineral and fibre texture

Site	Layer/ Spit	Sample	Temper	Temper minerals	Density of temper	Mineral grain shape	Mineral grain size	Matrix description
Hòa Diêm	Surface	HD-1-surface	Mineral sand	Quartz Alkali feldspar	Medium	Subangular	0.2-1 mm	Clay Quartz, alkali feldspar, amphibole, garnet, biotite and zircon inclusions Mineral texture
Lộc Giang	Surface	LG-1-surface	Mineral sand	Quartz Alkali feldspar	High	Subrounded to subangular	0.2-0.6 mm	Clay Quartz, alkali feldspar and ilmenite inclusions Mineral texture
		LG-2-surface	Fibre Orthodox grog	-	Low	Subrounded to subangular	0.5 mm	Clay Quartz, plagioclase feldspar and calcium phosphate inclusions Mineral texture
		LG-3-surface	Mineral sand Orthodox grog	Quartz Alkali feldspar	Medium in sand Very low in grog	Subangular sand Angular grog	Sand is 0.2-2 mm Grog is 0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, amphibole, sphene and ilmenite inclusions Mineral texture
Mán Bạc	Surface	MB-1-surface	None	-	-	-	-	Clay with unmixed iron-rich clay Quartz, plagioclase feldspar, calcium phosphate, amphibole, garnet and rutile inclusions Mineral texture
		MB-2-surface	Mineral sand Lateritic mineral sand	Quartz Impure iron oxide, waterworn	Low	Subrounded to subangular	0.2-0.5 mm	Clay Quartz and impure iron oxide inclusions Mineral texture
		MB-3-surface	Mineral sand Lateritic mineral sand	Quartz Alkali feldspar Plagioclase feldspar	Medium	Subrounded to subangular	0.25-0.5 mm	Clay with unmixed iron-rich clay Quartz, alkali feldspar, plagioclase feldspar, amphibole, garnet, illite, epidote and impure iron oxide inclusions Mineral texture

Source: Compiled by C. Sarjeant.

Description of clay samples

The clay matrices are described in Table 6.4 for each analysed geological clay sample from the Vàm Cỏ Đông River-An Sơn area. The clay samples include unfired clays from natural deposits

and fired clay lumps from archaeological contexts (see Chapter 4). The chemical compositions of the clays, averaged and normalised, are presented (Table 6.5). The mineral grains of the raw clays were frequently small and rounded quartz (see image 1 in Figure 6.2), in comparison to the sand grains of ceramic sherd samples which were angular and varied in size. Feldspar was not common in the clay samples in comparison to the ceramic samples, suggesting that the sand temper chosen by potters was selected from a mixed feldspar and quartz sand deposit. Only one sample had alkali feldspar grains. The sample with very high iron content (09-Vàm Cỏ Đông side channel-unfired clay-1) was purple in colour and included quartz. The high iron content is consistent with the presence of small iron oxide grains in the clay matrix of the ceramic samples. Where clays have been identified with 'lateritic' grains (often indicated by the presence of rusty brown-red coloured grains), the clay had higher iron oxide content, as with the sample 09AS-TS-240-250cm-fired clay-2 in Table 6.5. The analysed clays indicate that the tempers identified were all manually added by potters, except for perhaps lateritic sand (TG A2), which may have been a natural presence in the potting clays and acted like a temper. In addition to the detailed results in Table 6.4, a summary of the clay samples that were analysed is presented in Appendix A.3.

Table 6.4. Description of the An Sơn clay fabrics, 2009 excavation Trench 2 and Test Square fired clay lumps, and unfired clay from the Vàm Cỏ Đông River vicinity. Key: 09AS = An Sơn 2009 excavation, H2 = Trench 2, TS = Test Square, L = Layer.

Layer	Spit	Sample	Sand size inclusions	Density of inclusions	Mineral grain shape	Mineral grain size	Matrix description
3–3	30–40 cm	09AS-H2-B2-L3-3(30-40cm)-fired clay-1	None	-	-	-	Clay Quartz, alkali feldspar and chlorite inclusions Strand mineral texture
3–4	3–4	09AS-H2-D4-L3-4-fired clay-1	None	-	-	-	Clay Quartz, pyroxene and mica inclusions Strand and sand mineral texture
240–250 cm	240–250 cm	09AS-TS-240-250cm-fired clay-1	Quartz	High	Subrounded to subangular	0.1–1 mm	Clay, porous Quartz inclusions Mineral texture
240–250 cm	240–250 cm	09AS-TS-240-250cm-fired clay-2	Quartz	High	Subrounded to subangular	0.1–1 mm	Clay, porous Quartz, rutile and zircon inclusions Mineral texture
240–250 cm	240–250 cm	09AS-TS-240-250cm-fired clay-3	Quartz	High	Subrounded to subangular	0.2–1 mm	Clay Quartz and rutile inclusions Mineral texture
-	-	09AS-fired clay lump-1	Quartz	High	Subrounded to subangular	0.1–0.25 mm	Clay, porous Quartz and zircon inclusions Mineral texture
-	-	09-Vàm Cỏ Đông side channel-unfired clay-1	Quartz	Medium	Subrounded to subangular	0.05–0.1 mm	Clay Quartz, iron oxide and zircon inclusions Mineral texture

Layer	Spit	Sample	Sand size inclusions	Density of inclusions	Mineral grain shape	Mineral grain size	Matrix description
-	-	09-Vàm Cỏ Đông side channel-unfired clay-2	Quartz	High	Rounded to subrounded	0.1 mm	Clay Quartz, mica and rutile inclusions Mineral texture
-	-	09AS-1.5m in borrow pit-unfired clay-1	Quartz	High	Subrounded to angular	0.25–0.75 mm	Clay Quartz and zircon inclusions Mineral texture

Source: Compiled by C. Sarjeant.

Table 6.5. The averaged and normalised chemical composition of each clay sample.

Provenance	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	V_2O_5	MnO	FeO	Total
09AS-H2-B2-L3-3(30-40cm)-fired clay-1	1.78	2.10	19.99	63.44	0.33	0.65	4.08	1.40	0.89	0.03	0.08	5.21	100.00
09AS-H2-D4-L3-4-fired clay-1	0.18	0.46	16.81	77.78	0.14	0.44	0.44	0.77	0.83	0.00	0.00	2.17	100.00
09AS-fired clay lump-1	0.18	0.46	16.81	77.78	0.14	0.44	0.44	0.77	0.83	0.00	0.00	2.17	100.00
09AS-TS-240-250cm-fired clay-1	0.52	0.89	20.53	71.89	0.00	0.45	0.68	1.79	0.83	0.02	0.01	2.40	100.00
09AS-TS-240-250cm-fired clay-2	0.25	1.21	19.58	55.57	1.88	0.37	0.58	1.76	0.65	0.10	0.58	17.47	100.00
09AS-TS-240-250cm-fired clay-3	0.83	1.61	20.60	67.47	0.00	0.41	2.87	1.59	0.89	0.02	0.03	3.66	100.00
09-Vàm Cỏ Đông side channel-unfired clay-1	0.30	0.40	11.93	14.25	0.02	0.69	0.33	0.02	0.28	0.04	0.19	71.56	100.00
09-Vàm Cỏ Đông side channel-unfired clay-2	0.34	1.00	30.21	61.48	0.00	1.16	1.68	0.09	1.26	0.04	0.02	2.72	100.00
09AS-1.5m in borrow pit-unfired clay-1	0.43	0.66	33.53	59.38	0.00	0.34	0.67	0.03	1.59	0.06	0.07	3.23	100.00

Source: Compiled by C. Sarjeant.

Summary: Characterisation of the non-plastic inclusions

Temporal differentiations were not immediately clear in regard to temper selection. However, the occurrence of fibre temper (TG B) in the lower layers at An Sơn was minor, and the density of fibres in these fabrics, when present, was lower than in later deposits. There was a clear dominance of mineral sand (quartz and feldspar; TG A1) and fibre (TG B) tempered ceramics in the An Sơn ceramic sample (Figure 6.3).

The following table (Table 6.6) provides the intentional temper inclusions and the natural non-plastic inclusions within the clay matrix associated with each temper group and subgroup. Like the mineral temper grains, the natural non-plastic inclusions of the clay matrices were analysed with EDX and identified with reference materials (Severin 2004; Deer, Howie and Zussman 1992). Common natural inclusions were ilmenite and other titanium and iron oxides, microcline and biotite, amphibole, zircon, and the minerals that were also identified in the sand tempers, particularly quartz. Many of these minerals were identified in the unfired and fired clays that were analysed, with the larger grains always identified as quartz. There was only one clay sample with alkali feldspar present (see Table 6.4), suggesting that sand sources rich in quartz and alkali feldspar were targeted by potters for tempers, since the local clays appeared to lack this combination. The

temper groups characterised for the An Sơn ceramic sample were only commonly identified at nearby sites such as Lộc Giang, Đình Ông and Giồng Cá Vồ, those along the Vàm Cỏ Đông River, and only rarely at sites outside southern Vietnam.

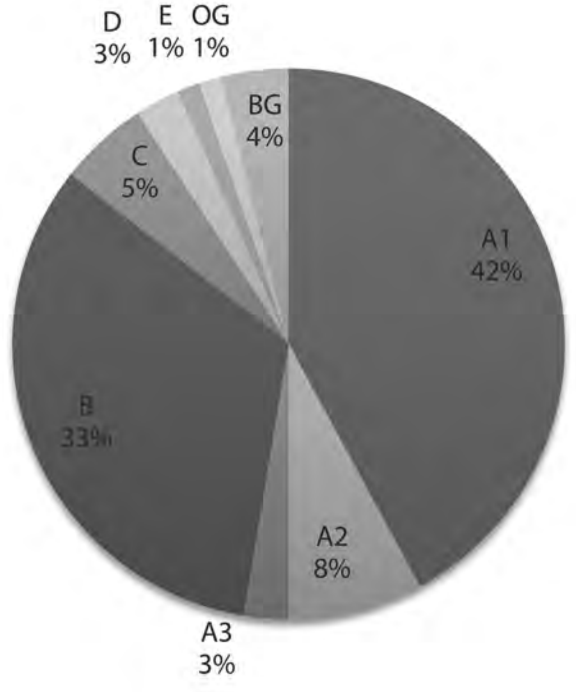

Figure 6.3. Proportion of each temper group in the An Sơn ceramic sample. Key: A1 = mineral sand A2 = lateritic (micaceous) sand, A3 = impure iron oxide (large grains)/almandine sand, B = fibre, C = phosphate, D = calcareous, E = untempered, OG = orthodox grog, BG = bleb grog.

Source: C. Sarjeant.

Table 6.6. Summary of temper groups and samples identified for each group. Key: 09AS = An Sơn 2009 excavation, 97AS = An Sơn 1997 excavation, H1 = Trench 1, H2 = Trench 2, TS = Test Square, L = layer, S = spit, U/S = unstratified, OG = orthodox grog, BG = bleb grog, BNW = Ban Non Wat, CCN = Cồn Cổ Ngựa, CLR = Cù Lao Rùa, DB = Đa Bút, DO = Đình Ông, GCV = Giồng Cá Vồ, HD = Hòa Diêm, LG = Lộc Giang, MB = Mán Bạc.

Temper group	Temper subgroup	Temper	Temper inclusions always include:	Matrix inclusions may include:	An Sơn Trench 1 C1 samples	Other An Sơn samples	Non-An Sơn samples
A1	1	Mineral sand	Quartz Alkali feldspar	Chlorite Epidote Garnet Ilmenite Rutile Zircon	09AS-H1-C1-L1-S2-1 09AS-H1-C1-L5-S3-1 09AS-H1-C1-L5-S3-3 09AS-H1-C1-L5/6-S4-3 09AS-H1-C1-L5/6-S5-1 09AS-H1-C1-L5/6-S7-1 09AS-H1-C1-L5/6-S9-1 09AS-H1-C1-L7-S10-1 09AS-H1-C1-L7-S11-3 09AS-H1-C1-L8-S12-3 09AS-H1-C1-L8-S12-4 09AS-H1-C1-L8-S12-5	09AS-TS-240-250cm-3 09AS-H1-B2-L5/6-S8-1 97AS-H1-360-410cm-S3-5-1 97AS-H1-360-410cm-S3-5-2	LG-1-surface
A1	2	Mineral sand	Quartz Alkali feldspar Plagioclase feldspar	Illite Ilmenite	09AS-H1-C1-L8-S12-2		
A1	3	Mineral sand	Quartz Alkali feldspar Plagioclase feldspar	Amphibole Epidote Ilmenite			DO-3-surface
A1	4	Mineral sand	Quartz Alkali feldspar Plagioclase feldspar	Cacoxenite Illite Ilmenite Garnet Mica Rutile		09AS-H1-C10-L8-S10-1	CLR-3-surface
A1	5	Mineral sand	Quartz Alkali feldspar Amphibole	Garnet Ilmenite Zircon	09AS-H1-C1-L1-S1-1 09AS-H1-C1-L5/6-S4-1 09AS-H1-C1-L5/6-S5-7 09AS-H1-C1-L7-S10-4	09AS-TS-240-250cm-3b 09AS-H1-C4-L3-S10-1	DO-4-surface (OG)
A1	6	Mineral sand	Quartz Alkali feldspar Amphibole	Garnet Ilmenite Mica Rutile Zircon	09AS-H1-C1-L5/6-S5-3		CLR-2-surface DO-2-surface HD-1-surface
A1	7	Mineral sand	Quartz Alkali feldspar	Amphibole Ilmenite Sphene			LG-3-surface (OG)

Temper group	Temper subgroup	Temper	Temper inclusions always include:	Matrix inclusions may include:	An Sơn Trench 1 C1 samples	Other An Sơn samples	Non-An Sơn samples
A1	8	Mineral sand	Quartz	Fibre (trace) Illite		09AS-TS-240-250cm-2	
A1/A3	1	Mineral sand Coarse, waterworn impure iron oxide	Quartz Impure iron oxide	Epidote			CCN-1-surface DB-1-surface MB-2-surface
A1/A3	2	Mineral sand Coarse, waterworn impure iron oxide	Quartz Alkali feldspar Impure iron oxide	Amphibole Cacoxenite Ilmenite	09AS-H1-C1-L5/6-S9-3		CLR-1-surface GCV-1-surface
A1/A3	3	Mineral sand Coarse, waterworn impure iron oxide	Quartz Alkali feldspar Plagioclase feldspar Impure iron oxide	Ilmenite Pyroxene			CLR-4-surface
A1/A3	4	Mineral sand Coarse, waterworn impure iron oxide	Quartz Alkali feldspar Plagioclase feldspar Impure iron oxide	Amphibole Epidote Garnet Illite			MB-3-surface
A1/B	1	Mineral sand Fibre	Fibre Quartz	Zircon	09AS-H1-C1-L5/6-S8-1		
A1/B	2	Mineral sand Fibre	Fibre Quartz	Calcium phosphate Ilmenite	09AS-H1-C1-L7-S11-1 09AS-H1-C1-L8-S12-1	97AS-H1- B2-350-360cm-S3-4-1	
A1/B	3	Mineral sand Fibre	Fibre Quartz Alkali feldspar	Epidote Zircon	09AS-H1-C1-L5/6-S6-1		
A1/B/C	1	Mineral sand Fibre Phosphate	Fibre Quartz Amphibole Calcium phosphate			09AS-TS-200-210cm-1	

Temper group	Temper subgroup	Temper	Temper inclusions always include:	Matrix inclusions may include:	An Sơn Trench 1 C1 samples	Other An Sơn samples	Non-An Sơn samples
A2	1	Lateritic mineral sand	Quartz Alkali feldspar Biotite Muscovite	Amphibole Calcium phosphate Garnet Ilmenite Mica Pyroxene Sphene	09AS-H1-C1-L5/6-S5-4 (OG) 09AS-H1-C1-L7-S11-4 (MS?)		
A2	2	Lateritic mineral sand	Quartz Alkali feldspar Biotite	Amphibole Garnet Ilmenite Zircon	09AS-H1-C1-L7-S10-3 (MS?) 09AS-H1-C1-L7-S11-2	09AS-TS-250-260cm-2 (MS?)	
A2	3	Lateritic mineral sand	Quartz Plagioclase feldspar Biotite Pyroxene	Ilmenite Mica Zircon	09AS-H1-C1-L5/6-S7-3		
B	1	Fibre	Fibre		09AS-H1-C1-L1-S2-2 09AS-H1-C1-L5/6-S4-2 09AS-H1-C1-L5/6-S5-2 09AS-H1-C1-L5/6-S7-2 09AS-H1-C1-L5/6-S9-2	09AS-H1-C5-L2-S3-1 09AS-TS-240-250cm-1 09AS-TS-250-260cm-1	GCV-2-surface GCV-3-surface
B	2	Fibre	Fibre	Florencite Illite Plagioclase feldspar Quartz	09AS-H1-C1-L5/6-S6-2	97AS-H1-350-360cm-S3-4-1 (BG)	
B	3	Fibre	Fibre	Calcium phosphate Mica Plagioclase feldspar Quartz			LG-2-surface (OG)
B	4	Fibre	Fibre	Amphibole Garnet Ilmenite Quartz		09AS-U/S-1 (BG) 09AS-U/S-2 (BG)	DO-1-surface

Temper group	Temper subgroup	Temper	Temper inclusions always include:	Matrix inclusions may include:	An Sơn Trench 1 C1 samples	Other An Sơn samples	Non-An Sơn samples
B	5	Fibre	Fibre	Alkali feldspar Barite Garnet Quartz Rutile			08/09BNW-N100-9:surface2-feature 1-1
B	6	Fibre	Fibre	Calcium phosphate Illite Iron oxide Quartz Rutile		09AS-TS-240-250cm-4 97AS-H1-A1-350-360cm-S3-4-1	
B/A3	1	Fibre	Fibre Coarse rounded iron-rich phyllosilicates	Ilmenite Iron oxide		09AS-H1-B2-L5/6-S8-2	
B/C	1	Fibre Phosphate	Fibre Calcium phosphate	Alkali feldspar Quartz	09AS-H1-C1-L1-S1-2		
B/C	2	Fibre Phosphate	Fibre Calcium phosphate Iron phosphate	Iron oxide Quartz	09AS-H1-C1-L5-S3-2 09AS-H1-C1-L5/6-S8-2		
B/C	3	Fibre Phosphate	Fibre Calcium phosphate Iron phosphate	Mica Quartz	09AS-H1-C1-L7-S10-2		
B/D	1	Fibre Calcareous	Fibre Calcium carbonate	Pyroxene Quartz	09AS-H1-C1-L5/6-S5-5		
D	1	Calcareous	Calcium carbonate	Quartz	09AS-H1-C1-L5/6-S5-6		
E	1	None	None	Quartz		09AS-H1-C10-L2-S3-Óc Eo-1	
E	2	None	None	Amphibole Calcium phosphate Garnet Plagioclase feldspar Quartz Rutile			MB-1-surface

Source: Compiled by C. Sarjeant.

PART II: CLAY MATRIX ANALYSIS

Introduction: Clay matrix analysis with SEM-EDX

The EDX results from the SEM provided raw data for clay matrix areas, similar to those from non-plastic grain analyses, expressed as a compositional value for each analysed element: Na, Mg, Al, Si, P, S, K, Ca, Ti, V, Mn and Fe. Several representative clay matrix areas, usually five, were analysed from a single sample, as described in Chapter 3. The total value of the clay elemental composition was often lower than the readings from a mineral grain due to the texture and porosity of the clay matrix. To ensure comparability between the readings, they were normalised to 100% and an average was taken for the multiple readings for each sample to result in one compositional data set for each sample. These values were then transformed in log ratio against Al_2O_3 (explained further below).

The analysis of the clay matrix data was undertaken to address questions about the sequence of the ceramic technology at An Sơn, the relationship between rim forms and raw material selections, and to characterise the ceramic technology of An Sơn in comparison with other sites of southern Vietnam and beyond. The identified clay matrix compositional groups are summarised. A combination of log ratio principal components analysis (PCA), average-linkage hierarchical cluster analysis and canonical variate analysis (CVA) was implemented to tackle these questions in each section of Chapter 6, Part II. Each CVA focused on one *a priori* group, rim form and vessel components, layers, tempers or archaeological sites, to deduce clay composition similarities and differences between samples within these groups. These statistical methods were described in Chapter 3. The PCAs and CVAs are presented with plots and the hierarchical cluster analyses with dendrograms. The statistical analyses label the plots with numerical identifications (1–91) for each sample. The corresponding archaeological information for each of these samples is provided in Appendix A.

Which elements to include in the statistical analysis?

The matrix readings were normalised initially and then the numerous readings for each sample were averaged for statistical analysis. Aitchison's (1986, 1983) suggestion that log ratio transformations are required when dealing with compositional data was adopted (previously discussed in Chapter 3). The study presented below, of which element oxides to include in the statistical analysis, revealed that Al_2O_3 reduced the variability in bivariate plots and PCA. While Al_2O_3 should not be excluded from the analysis since it is a common and abundant component of clays used in ceramic manufacture, it was applied against the other included element oxides in the log ratio transformation.

There is also substantial discussion (as presented in Chapter 3) about which elements to include in statistical analyses. Of the analysed element oxides, SO_3 and V_2O_5 were in almost undetectable quantities in many cases. Bivariate plots created prior to statistical analysis revealed that MnO reduced the variability of samples, and there have been suggestions that it is a highly migratory element and should be excluded from statistical analyses (Shepard 1966). The post-depositional effects of phosphorus on archaeological ceramic compositions are well-reported (e.g. Freestone, Meeks and Middleton 1985), and phosphorus was also excluded here.

The complete sample of the An Sơn ceramic sherds for fabric analysis was included in the assessment that follows to determine which element oxides to include in the subsequent statistical analyses.

Bivariate plots

The bivariate plots show each analysed element against another element to understand where the variability in the compositional data lies and which elements may be limiting the observed variability (as recommended by Michelaki and Hancock 2011). Each element was plotted against SiO_2 because of its consistent presence in all of the samples (Figure 6.4). All element oxides and analysed ceramic sherds from An Sơn are included in the bivariate plots. The plotted values were normalised and averaged for each sample, but were not log ratio transformed.

The most noticeable element to have an influence on variability is MnO, and its variation is markedly lower than the other elements in the bivariate plots (Figure 6.4). Reducing the variability in statistical analyses will do little to inform about the ceramic compositions and the relationship between ceramic sherds. Therefore, it is justifiable to remove MnO from the statistical analysis, especially in light of other claims that suggest it is a migratory element (Shepard 1966). Al_2O_3 also diminished the variability of the sample and its consistent presence in the samples is due to the clay matrix containing minerals that are hydrous aluminium phyllosilicates with variable amounts of the other elements (e.g. Fe, Mg). The omnipresence of Al_2O_3 in the ceramic clay matrices and its effect of reduced variability in the sample meant it was a suitable element to divide by in the log ratio transformation.

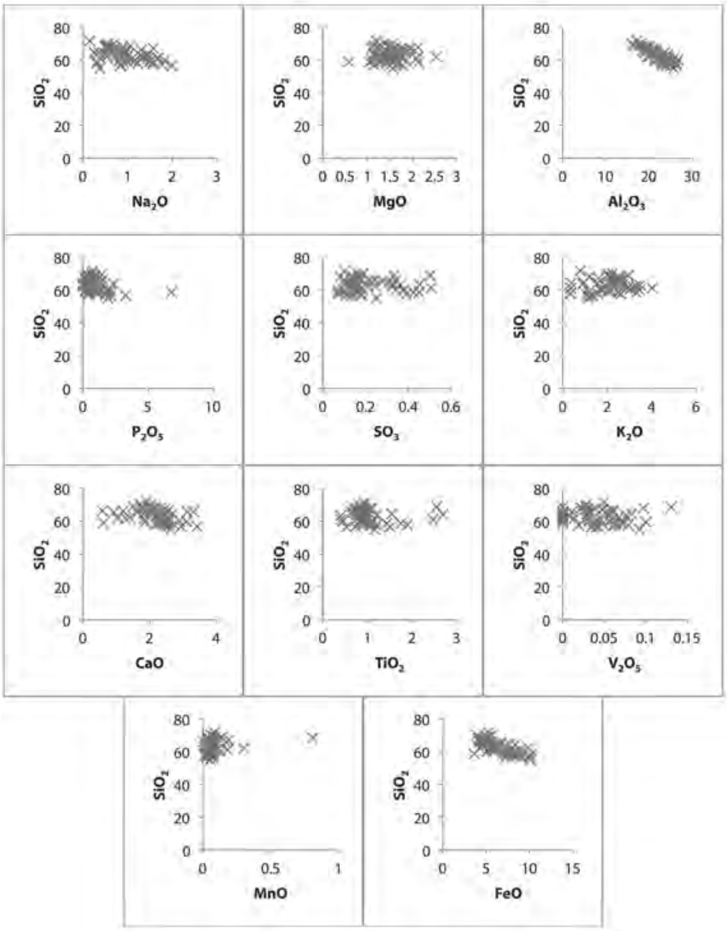

Figure 6.4. Bivariate plots of the concentration of each element oxide against SiO_2 in the analysed sample. The tight distribution of the SiO_3 versus Al_2O_3 plot displays less variability within the An Sơn analysed ceramic sample, and is an appropriate element to divide by in log ratio transformation for subsequent PCAs.

Source: C. Sarjeant.

Principal components analysis

In order to determine which elements should not be included in the PCA of the An Sơn analysed ceramic sample, the bivariate plots of Figure 6.4 were expanded with exploratory PCA, excluding the elements with low compositional values in the fabrics of the ceramic sample. The exclusion of V_2O_5, MnO, P_2O_5 and SO_3 is explored in this section. These PCA plots use log ratio transformed data against Al_2O_3.

PCA excluding vanadium oxide (magnesium, sodium, silicon, phosphorus, sulfur, calcium, potassium, titanium, manganese, iron oxides included)

The negligible quantities of V_2O_5 (Figure 6.4) in the samples meant that the element was to be excluded from all analyses. The following PCA plots (Figure 6.5, Figure 6.6, Table 6.7) should be compared to Figure 6.4 in order to deduce which elements are to be excluded, in addition to V_2O_5, in the PCAs of the An Sơn analysed ceramic sample.

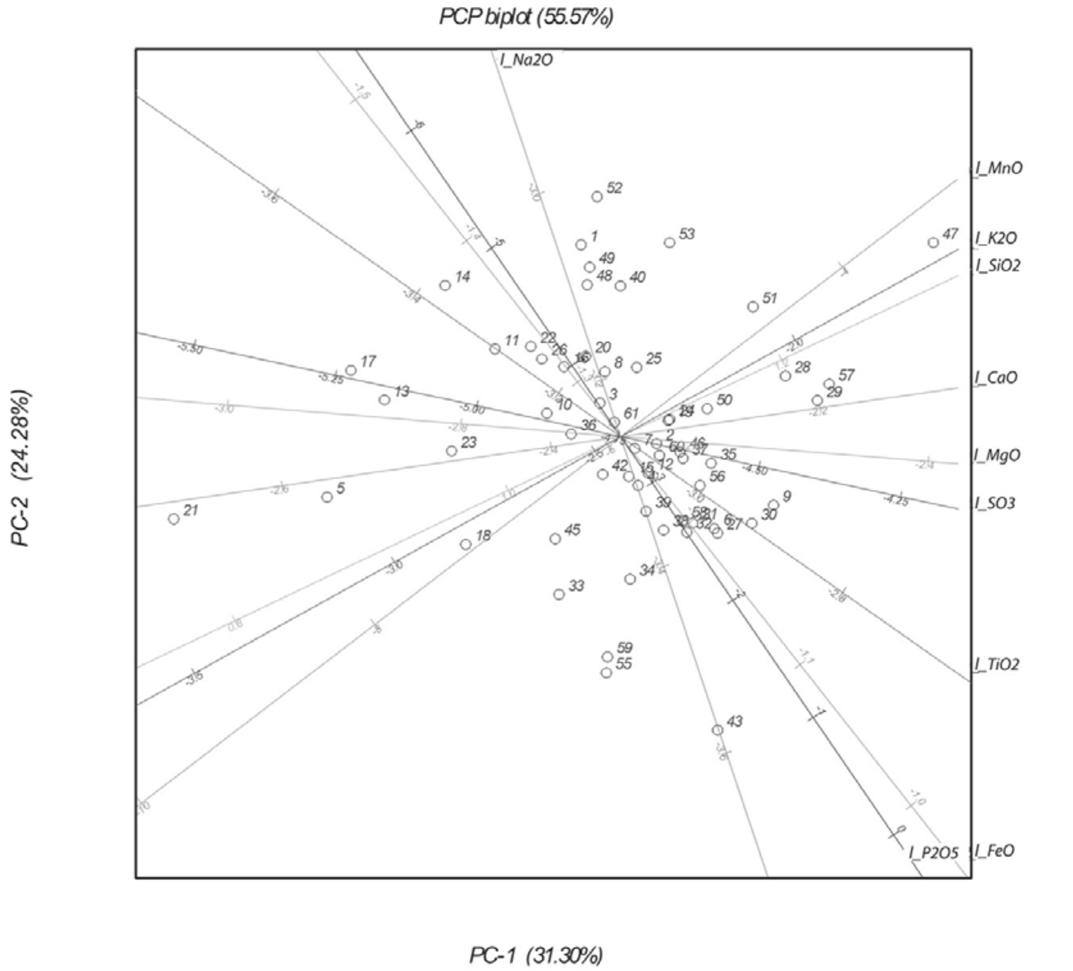

Figure 6.5. PCA biplot, excluding V_2O_5. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

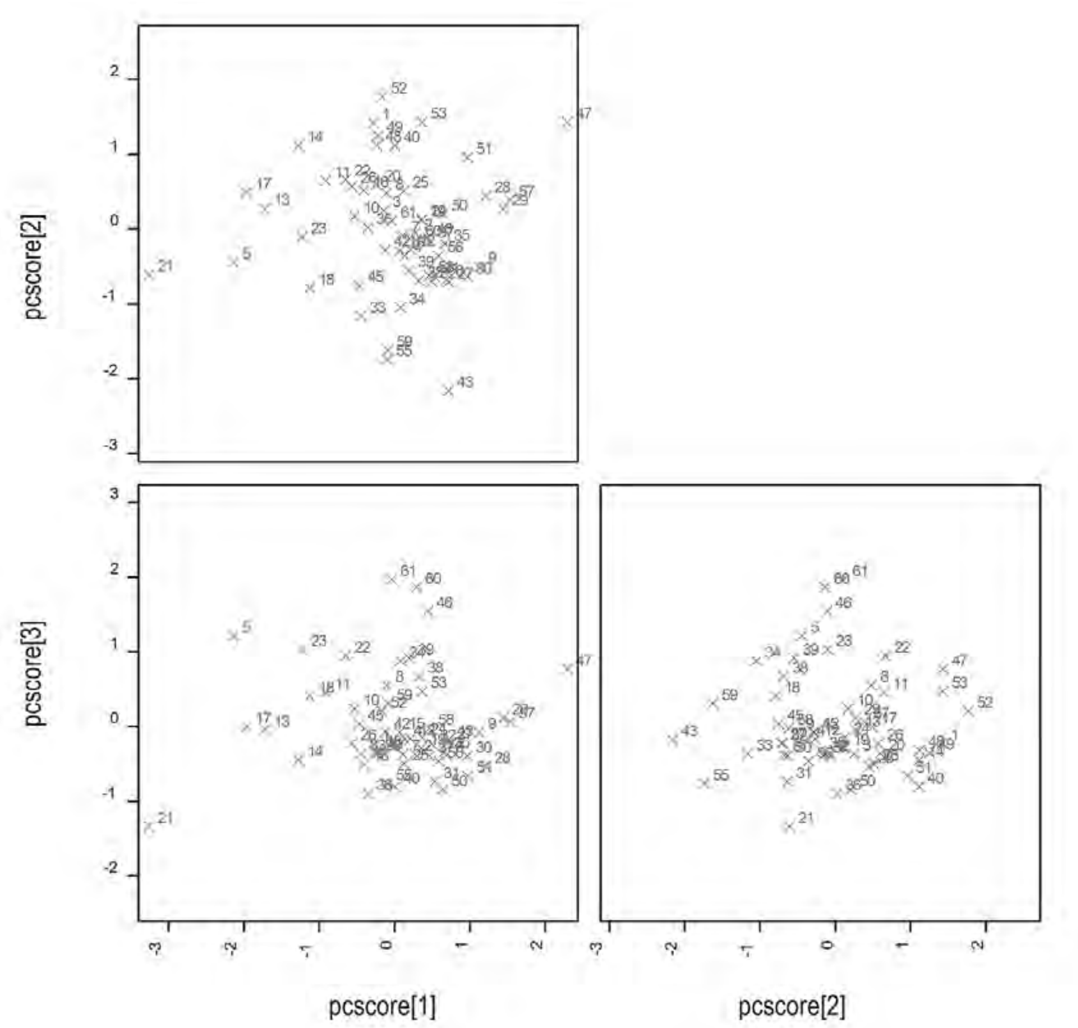

Figure 6.6. PCA plot, excluding V_2O_5. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.7. PCA loadings for Figure 6.5 and Figure 6.6, excluding V_2O_5. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (31.30%)	PC 2 (24.28%)	PC 3 (16.49%)
CaO	0.09947	0.01454	0.12032
FeO	0.04660	-0.05968	0.14920
K_2O	0.25995	0.14536	**-0.68355**
MgO	0.11637	-0.00944	0.00606
MnO	**0.73450**	**0.56573**	**0.27547**
Na_2O	**-0.04350**	0.13111	-0.53070
P_2O_5	0.53750	**-0.79085**	-0.02715
SO_3	0.23117	-0.05012	-0.32273
SiO_2	0.08127	0.03910	-0.01915
TiO_2	0.12840	-0.09100	0.18223

Source: Compiled by C. Sarjeant.

PCA excluding manganese and vanadium oxides (magnesium, sodium, silicon, phosphorus, sulfur, calcium, potassium, titanium, iron oxides included)

The variability of the PCA increases when MnO is excluded, which warrants the removal of the element in the following statistical analyses (Figure 6.7, Figure 6.8, Table 6.8). The samples appeared homogeneous prior to the exclusion of MnO (Figure 6.6).

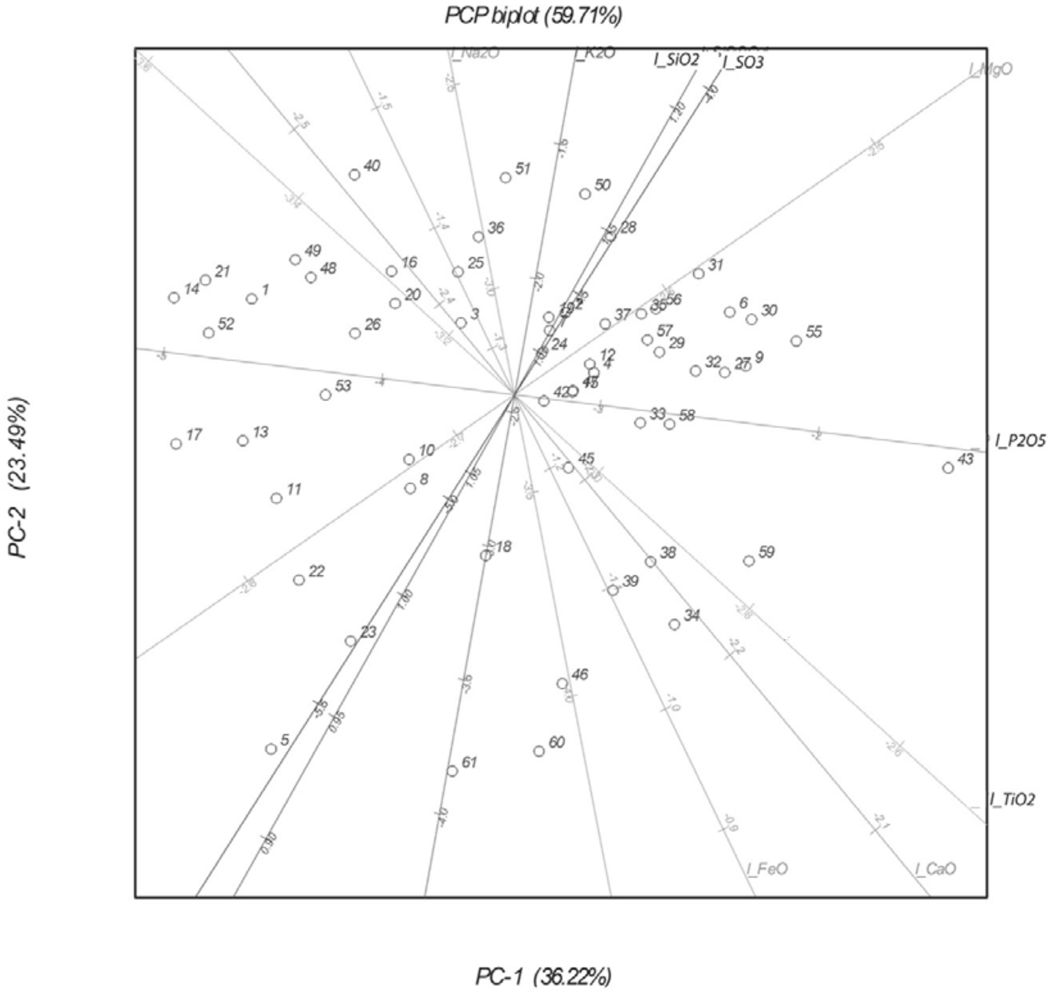

Figure 6.7. PCA biplot, excluding MnO and V_2O_5. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

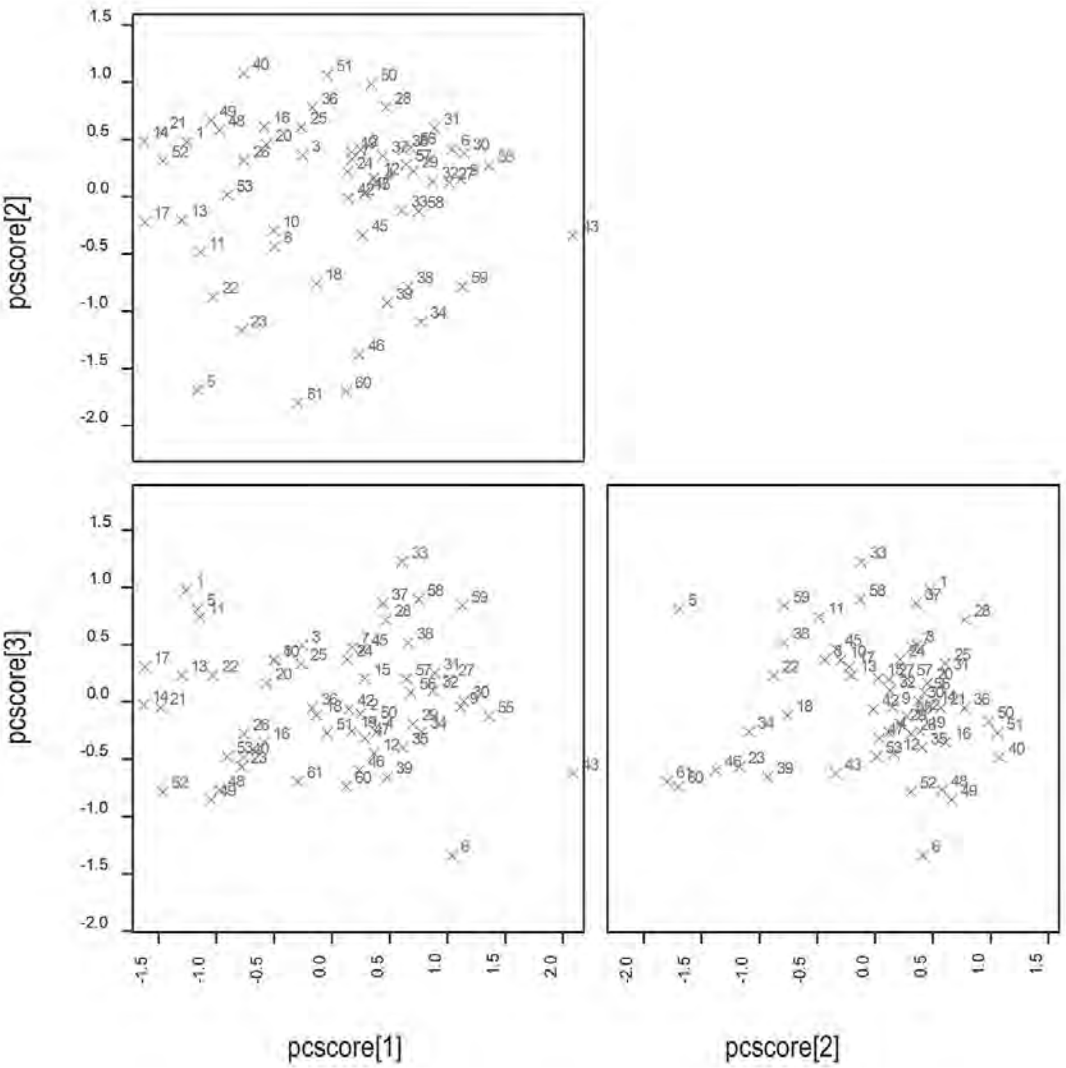

Figure 6.8. PCA plot, excluding MnO and V_2O_5. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.8. PCA loadings for Figure 6.7 and Figure 6.8, excluding MnO and V_2O_5. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (36.22%)	PC 2 (23.49%)	PC 3 (13.99%)
CaO	0.05815	-0.07041	0.18342
FeO	0.06723	**-0.14038**	0.05444
K_2O	0.13412	**0.75120**	-0.07672
MgO	0.06689	0.04678	-0.18306
Na_2O	**-0.09448**	0.49143	**0.56956**
P_2O_5	**0.94031**	**-0.11511**	0.27788
SO_3	0.22892	0.36170	**-0.57604**
SiO_2	0.03628	0.06503	-0.14666
TiO_2	0.15101	**-0.13798**	-0.41115

Source: Compiled by C. Sarjeant.

PCA excluding phosphorus and vanadium oxides (magnesium, sodium, silicon, sulphur, calcium, potassium, titanium, manganese, iron oxides included)

The variability of the sample diminishes markedly when P_2O_5 is removed (Figure 6.9, Figure 6.10, Table 6.9), compared to Figure 6.6 with P_2O_5. By removing P_2O_5 the variability within some of the other element oxides may be heightened, especially if this variation caused by P_2O_5 was a result of post-depositional leaching (Freestone, Meeks and Middleton 1985).

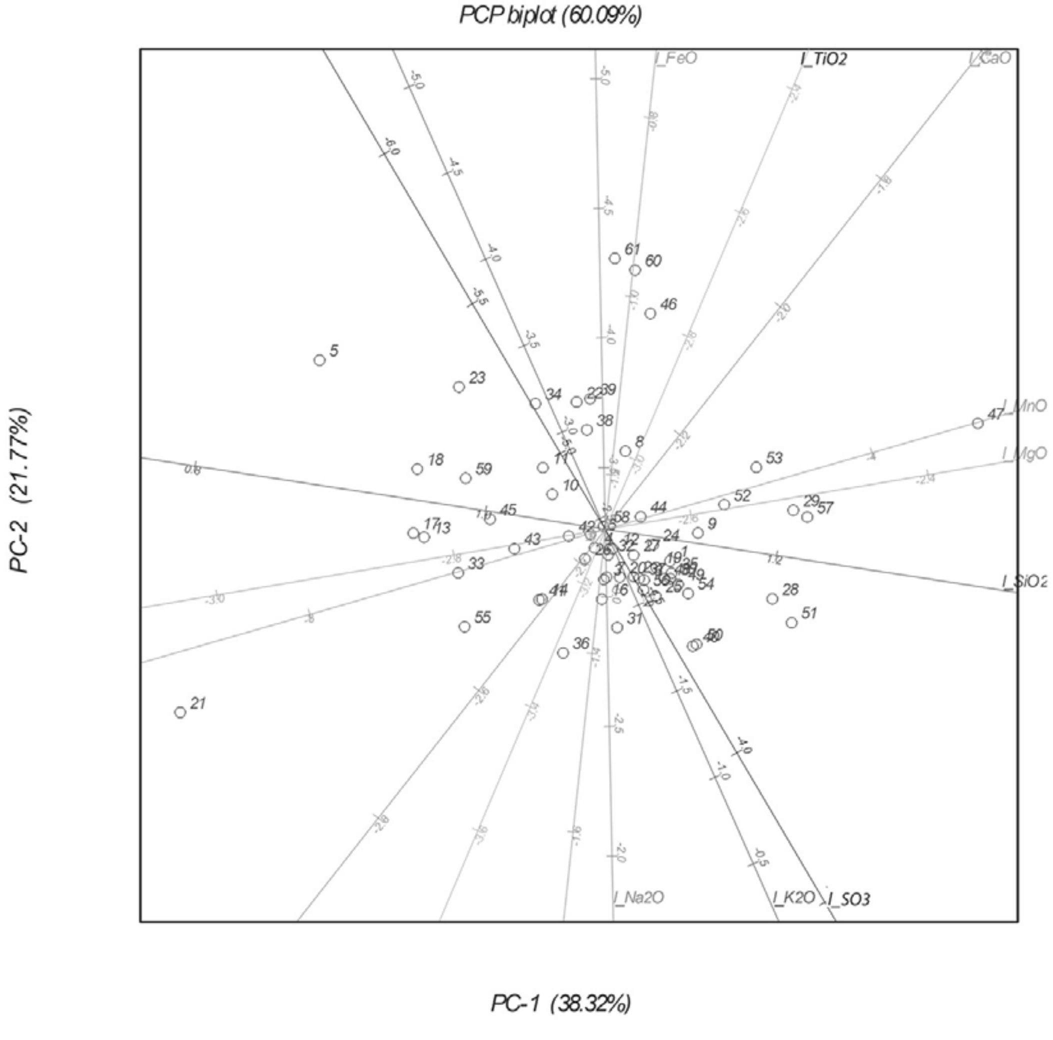

Figure 6.9. PCA biplot, excluding P_2O_5 and V_2O_5. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

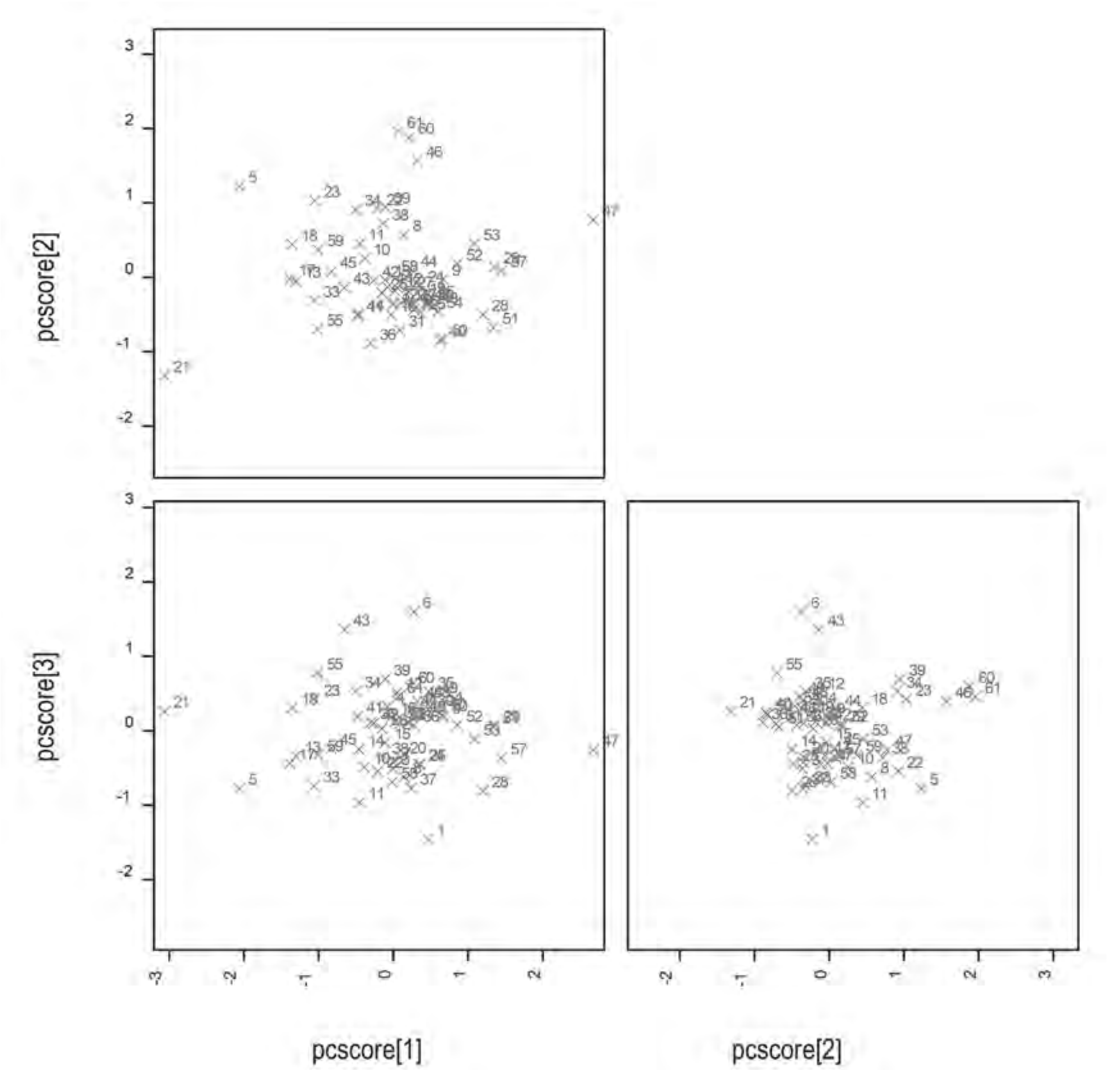

Figure 6.10. PCA plot, excluding P_2O_5 and V_2O_5. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.9. PCA loadings for Figure 6.9 and Figure 6.10, excluding P_2O_5 and V_2O_5. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (38.32%)	PC 2 (21.77%)	PC 3 (14.41%)
CaO	0.10494	0.13416	-0.19052
FeO	**0.01626**	0.15312	-0.02318
K_2O	0.29547	**-0.67050**	0.05271
MgO	0.11396	0.01934	0.13805
MnO	**0.91251**	**0.26368**	-0.20173
Na_2O	**0.01104**	-0.53344	**-0.51149**
SO_3	0.20131	-0.34389	**0.68031**
SiO_2	0.09331	-0.01444	0.09825
TiO_2	0.08003	0.18990	0.40808

Source: Compiled by C. Sarjeant.

PCA excluding sulphur and vanadium oxides (magnesium, sodium, silicon, phosphorus, calcium, potassium, titanium, manganese, iron oxides included)

The values of SO_3, like V_2O_5, were negligible in most cases and as a result the effect on the PCA plots is minimal (Figure 6.11, Figure 6.12, Table 6.10). SO_3 was removed from the subsequent analyses.

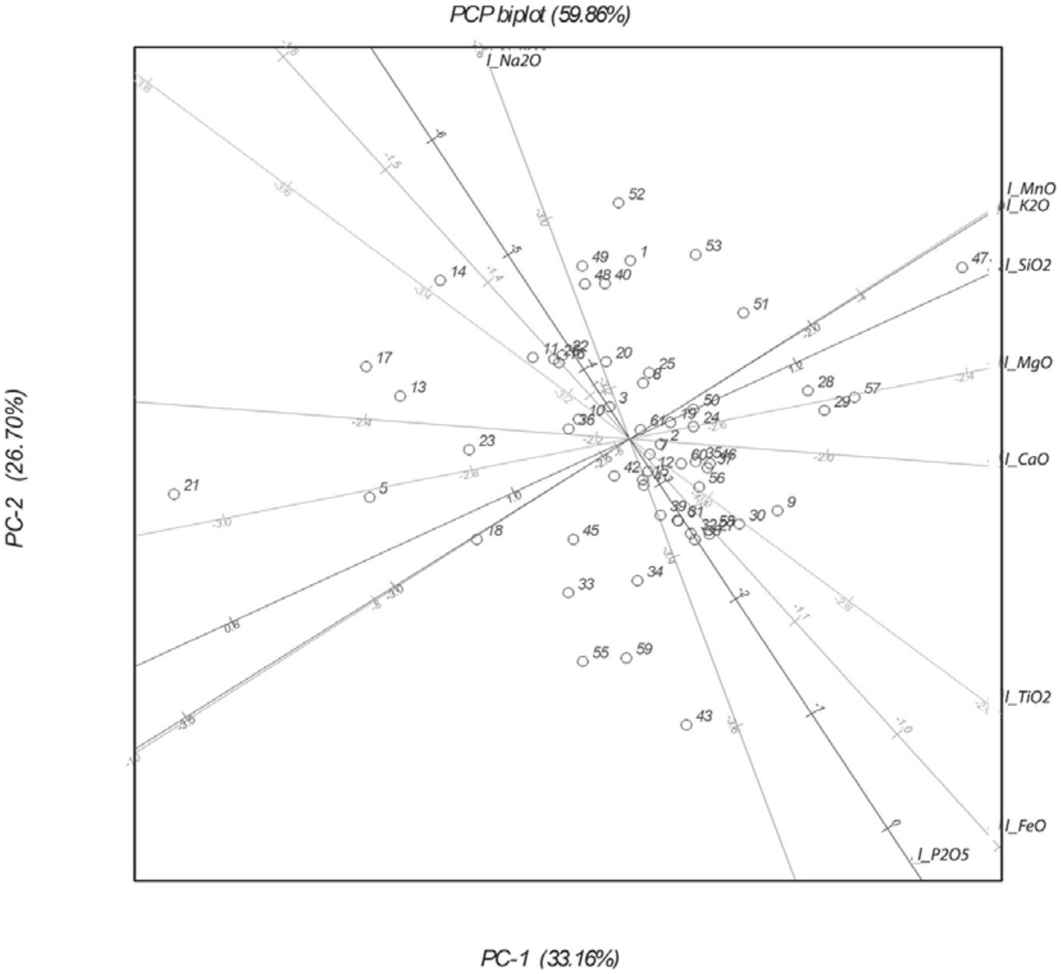

Figure 6.11. PCA biplot, excluding SO_3 and V_2O_5. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

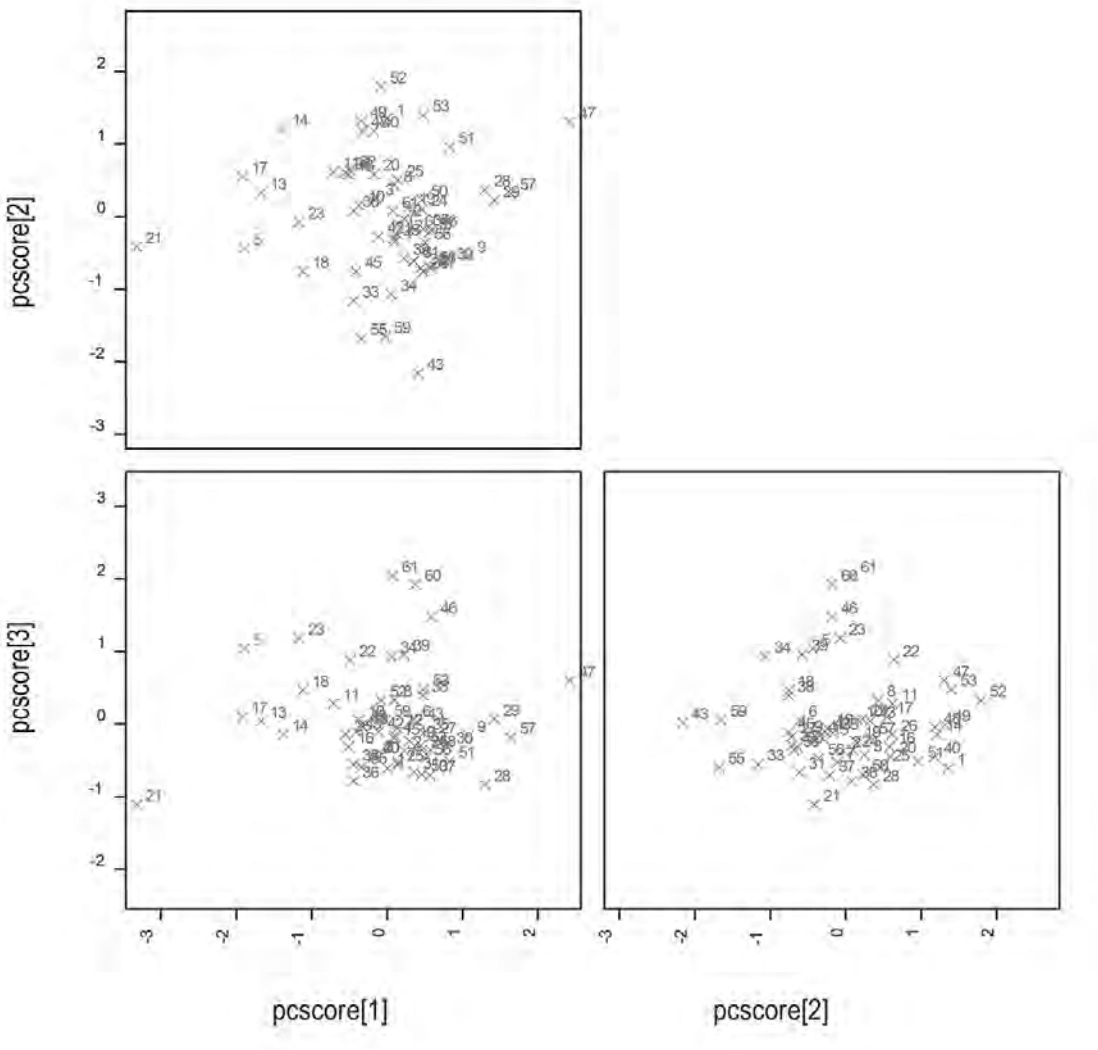

Figure 6.12. PCA plot, excluding SO_3 and V_2O_5. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.10. PCA loadings for Figure 6.11 and Figure 6.12, excluding SO_3 and V_2O_5. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (33.16%)	PC 2 (26.70%)	PC 3 (17.11%)
CaO	0.11815	-0.00926	0.06640
FeO	0.05795	-0.06651	0.12900
K_2O	0.23118	0.15072	**-0.70428**
MgO	0.10648	0.02174	0.02436
MnO	**0.78888**	**0.52043**	**0.20325**
Na_2O	**-0.04999**	0.13830	-0.60735
P_2O_5	0.52118	**-0.81971**	-0.14038
SiO_2	0.07934	0.03790	-0.01016
TiO_2	0.12310	-0.09465	**0.22882**

Source: Compiled by C. Sarjeant.

The greatest variability (i.e. principal component 1) in the above PCA plots (Figure 6.6, Figure 6.8, Fig, 6.10, Figure 6.12) was a result of the concentrations of FeO, MnO, Na_2O and P_2O_5 in the clay matrix compositions (Table 6.7, Table 6.8, Table 6.9, Table 6.10). V_2O_5 and SO_3 were excluded from the subsequent statistical analyses due to their rare occurrence in the ceramic sample, MnO was excluded since it diminished the variability of the sample, and P_2O_5, in contrast, exaggerated the variability, perhaps due to post-depositional effects. With these element oxides excluded and Al_2O_3 applied to the log ratio transformations, the remaining elements for statistical analyses of the clay matrix data were CaO, FeO, MgO, K_2O, SiO_2, Na_2O, and TiO_2.

Clay matrix characterisation: An Sơn ceramics

Trench 1: Square C1 ceramic samples

This section includes the samples from the representative square C1, Trench 1 from the 2009 excavation at An Sơn. The following clay matrix characterisations correspond to the temper identifications.

Principal components analysis

The greatest variability in the following PCA plots (Figure 6.13, Figure 6.14) is a result of the concentrations of CaO, FeO and K_2O in the clay matrix compositions (Table 6.11). When examining all three PCA dimensions, two main groups cluster, with a large number of outliers and variability evident in the An Sơn Trench 1 square C1 sample (Table 6.12). Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1**: Samples 2, 4, 9, 12, 15, 16, 19, 24, 26, 29, 32, 35

  This group consists of ceramic sherds from layers 1, 5/6 and 7, with rim forms A1a, B1a, C1b and D1a. The represented tempers were fibre, fibre/phosphate, fibre/calcareous, calcareous, and lateritic sand. The majority of the sherds from this group were A1a fibre tempered and C1b fibre and fibre/calcareous tempered rims.

- **Main group 2**: Samples 1, 7, 20, 21, 25, 28, 31, 36, 37, 40 (merged with main group 1 in PC 2/PC 3)

  This group consists of ceramic sherds from layers 1, 5, 5/6, 7 and 8, with rim forms A1a, A2a, B1a, D1a and D1b. The represented tempers were sand, fibre and sand/fibre. The majority of the sherds were A2a sand tempered rims.

- **Outlier groups**: Samples 3 / 5 / 6 / 8 / 10, 27 / 11, 17 / 13 / 14 / 18, 38 / 22 / 23 / 30 / 33 / 34 / 39

  These included sherds from layers 1, 5, 5/6, 7 and 8. The represented rim forms included A2a, C2b, D1a and D1b, while the majority of the samples were body sherds. The represented tempers were sand, fibre/phosphate, iron-rich sand, lateritic sand (including one sample with orthodox grog), and sand/fibre.

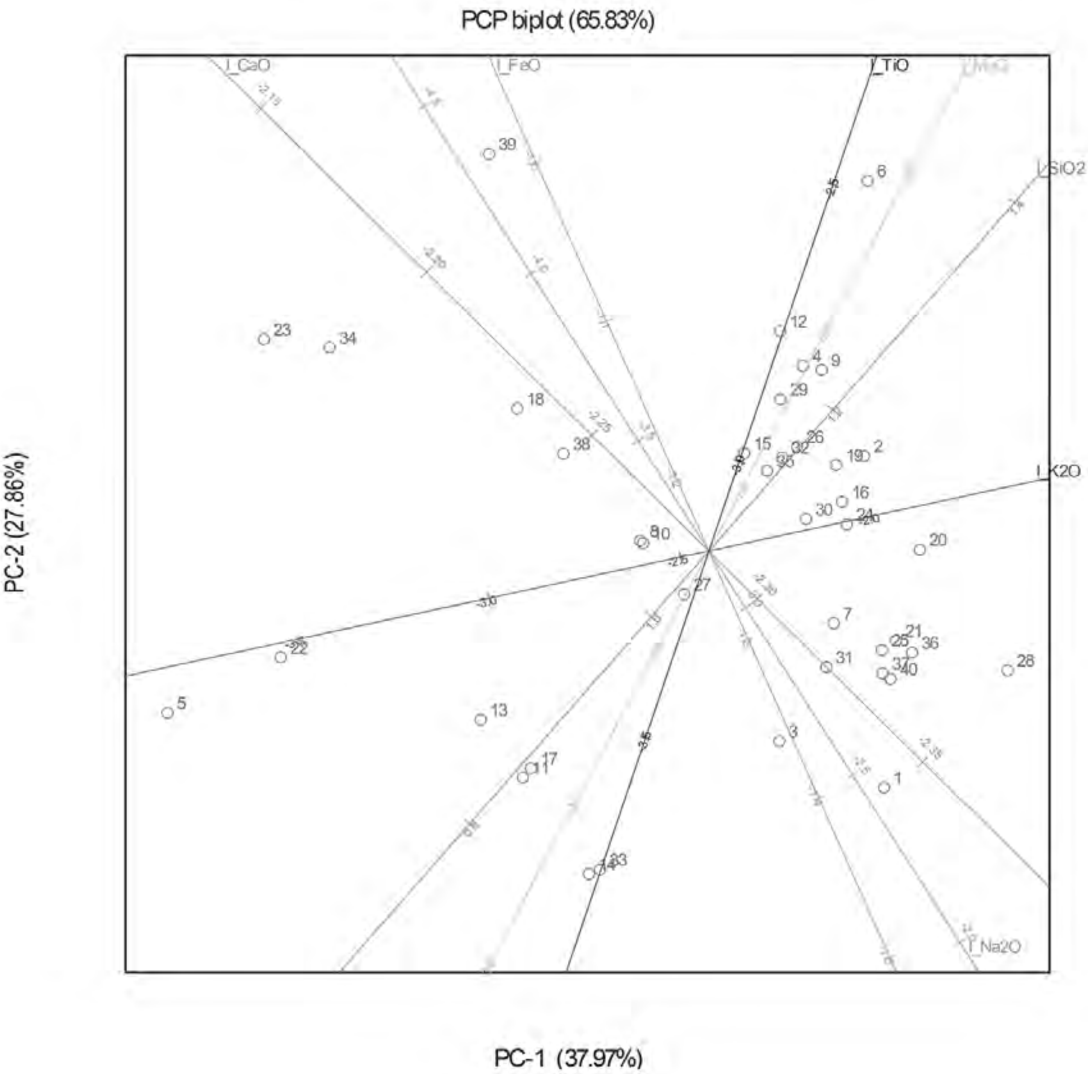

Figure 6.13. PCA biplot of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

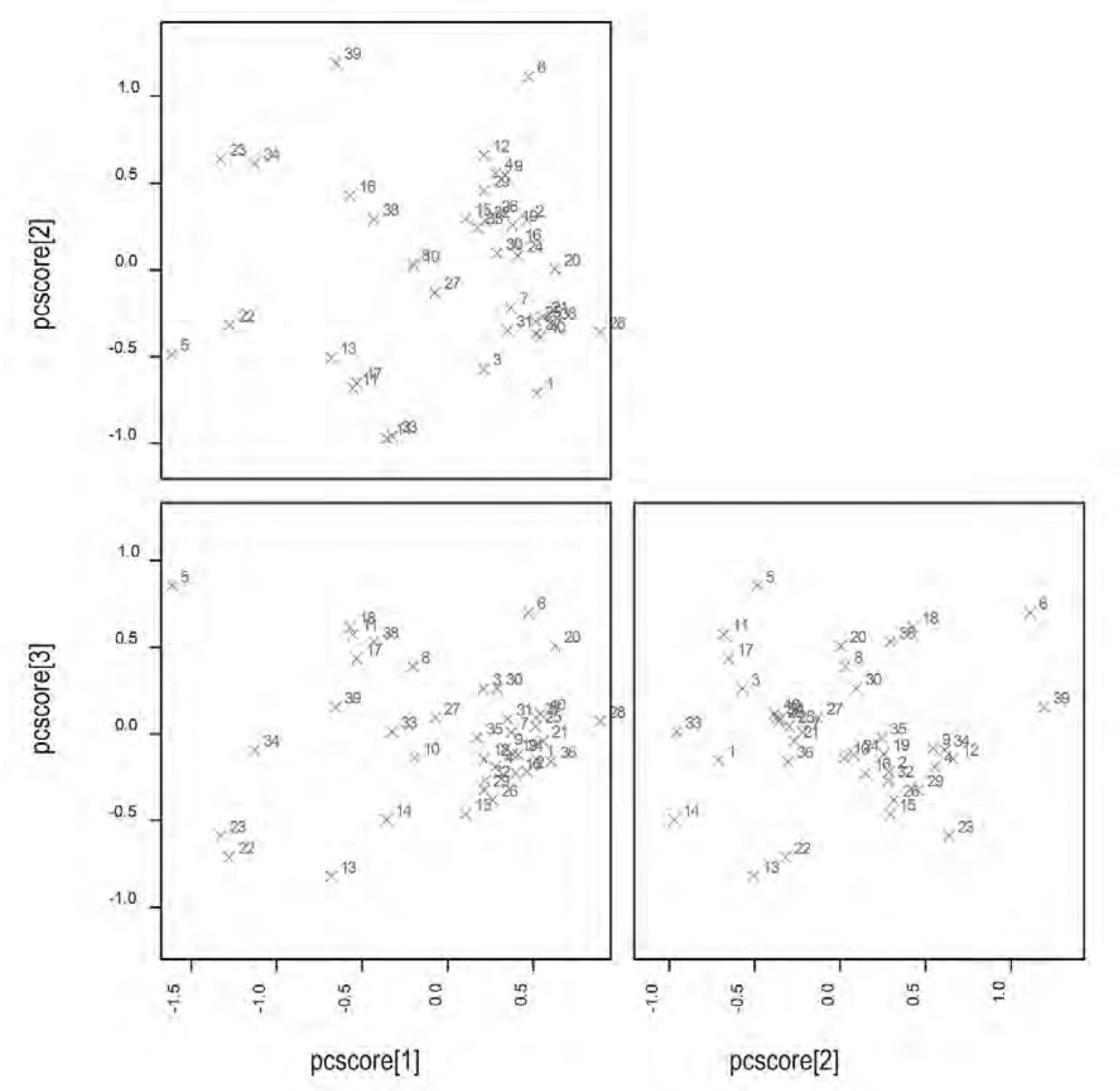

Figure 6.14. PCA plot of the An Sơn ceramic samples, Trench 1 square C1. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.11. PCA loadings for Figure 6.13 and Figure 6.14 of the An Sơn ceramic samples, Trench 1 square C1. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (37.97%)	PC 2 (27.86%)	PC 3 (14.79%)
CaO	**-0.05094**	0.05068	0.02596
FeO	**-0.07733**	0.17506	0.26074
K_2O	**0.83685**	0.18081	**-0.36087**
MgO	0.17252	0.32777	-0.11623
Na_2O	0.45058	**-0.70797**	0.47797
SiO_2	0.15911	0.18275	-0.04667
TiO_2	0.18169	**0.54040**	**0.74630**

Source: Compiled by C. Sarjeant.

Table 6.12. Samples in the PCA groupings in Figure 6.14 of the An Sơn ceramic samples, Trench 1 square C1. Refer to Appendix A for sample identification numbers.

	PC 1/PC 2	PC 1/PC 3	PC 2/PC 3
Main group 1	2, 4, 9, 12, 15, 16, 19, 24, 26, 29, 30, 32, 35 (20)	1, 2, 4, 7, 9, 12, 15, 16, 19, 21, 24, 25, 26, 29, 31, 32, 35, 36, 37, 40 (28)	2, 4, 9, 10, 12, 15, 16, 19, 24, 26, 29, 32, 34, 35
Main group 2	7, 21, 25, 31, 36, 37, 40 (1, 3, 28)	11, 17, 18, 38	7, 21, 25, 27, 28, 31, 36, 37, 40
Outlier group 1	5, 22	5	3, 5, 11, 17
Outlier group 2	6	6, 20	6
Outlier group 3	8, 10, 27	8	8, 20, 30
Outlier group 4	11, 13, 17	13	13, 22
Outlier group 5	14, 33	14	14
Outlier group 6	18, 38	10, 27, 33	18, 38
Outlier group 7	23, 34	22, 23	23
Outlier group 8	30	3, 30	33
Outlier group 9	39	39	39
Outlier group 10		34	1

Source: Compiled by C. Sarjeant.

Hierarchical cluster analysis

Two major groups are evident for the An Sơn Trench 1 square C1 sample in the cluster analysis dendrogram (when cut at 0.825), each with valid subgroups (cut at 0.950) (Figure 6.15, Table 6.13). Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1:**
    - **Subgroup 1**: Samples 1, 20, 25, 37, 28, 31, 40

      This subgroup consists of A2a sand tempered rim sherds from layers 1, 5/6 and 8, a sand tempered body sherd from layer 5/6, a D1b sand tempered rim sherd from layer 7, and a D1a sand tempered rim sherd from layer 8.
    - **Subgroup 2**: Samples 3, 7, 8

      This subgroup consists of form A2a roulette decorated body sherds with sand temper from layers 1 and 5, and an A2a sand tempered rim sherd from layer 5/6.
    - **Subgroup 3**: Samples 5, 11, 17

      This subgroup consists of sand tempered sherds from layers 5 and 5/6, and a C2b sand tempered rim sherd from layer 5/6.
    - **Subgroup 4**: Samples 14, 33

      This subgroup consists of lateritic sand tempered sherds from layers 5/6 and 8, one of which also has orthodox grog.
    - **Subgroup 5**: Samples 13, 22

      This subgroup consists of sand tempered and lateritic sand tempered body sherds from layer 5/6.
    - **Subgroup 6**: Sample 23

      This subgroup consists of a form A2a roulette decorated body sherd with sand/fibre temper from layer 5/6.

- **Subgroup 7**: Ssamples 21, 36

  This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6 and a B1a rim sherd with sand/fibre temper from layer 8.

Main group 1 (Table 6.13) of this hierarchical cluster analysis is most consistent with main group 2, and some outliers, of the previous PCA (Figure 6.14, Table 6.12).

- **Main group 2:**
  - **Subgroup 1**: Samples 2, 26, 32, 4, 19, 24, 15, 16, 9, 29

    This subgroup consists of C1b fibre/phosphate and fibre tempered rim sherds from layers 1, 5/6 and 7, a sand/fibre tempered body sherd from layer 7, A1a fibre tempered rim sherds from layers 1 and 5/6, and fibre/calcareous and calcareous tempered body sherds from layer 5/6.

  - **Subgroup 2**: sample 6

    This subgroup consists of a fibre/phosphate tempered body sherd from layer 5.

  - **Subgroup 3**: samples 10, 18, 38, 27, 30, 35

    This subgroup consists of a form A2a sand tempered roulette decorated body sherd from layer 5/6, a sand/fibre tempered body sherd from layer 5/6, a sand tempered body sherd from layer 8, a D1a sand and iron-rich sand tempered rim sherd from layer 5/6, a D1b lateritic sand tempered rim sherd from layer 7, and a D1a lateritic sand tempered rim sherd from layer 7.

  - **Subgroup 4**: sample 12

    This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6.

  - **Subgroup 5**: sample 34, 39

    This subgroup consists of sand tempered body sherds from layers 7 and 8.

Main group 2 (Table 6.13) is most consistent with main group 1 of the previous PCA (Figure 6.14, Table 6.12).

The dendrogram derived from the hierarchical cluster analysis (Figure 6.15, Table 6.13) suggests that the outliers that were plotted in the PCA (Figure 6.14, Table 6.12) are not in fact chemically distinct from the two main groups that were identified in both the PCA and the cluster analysis. The dendrogram plots only two distinct groups, with no outliers.

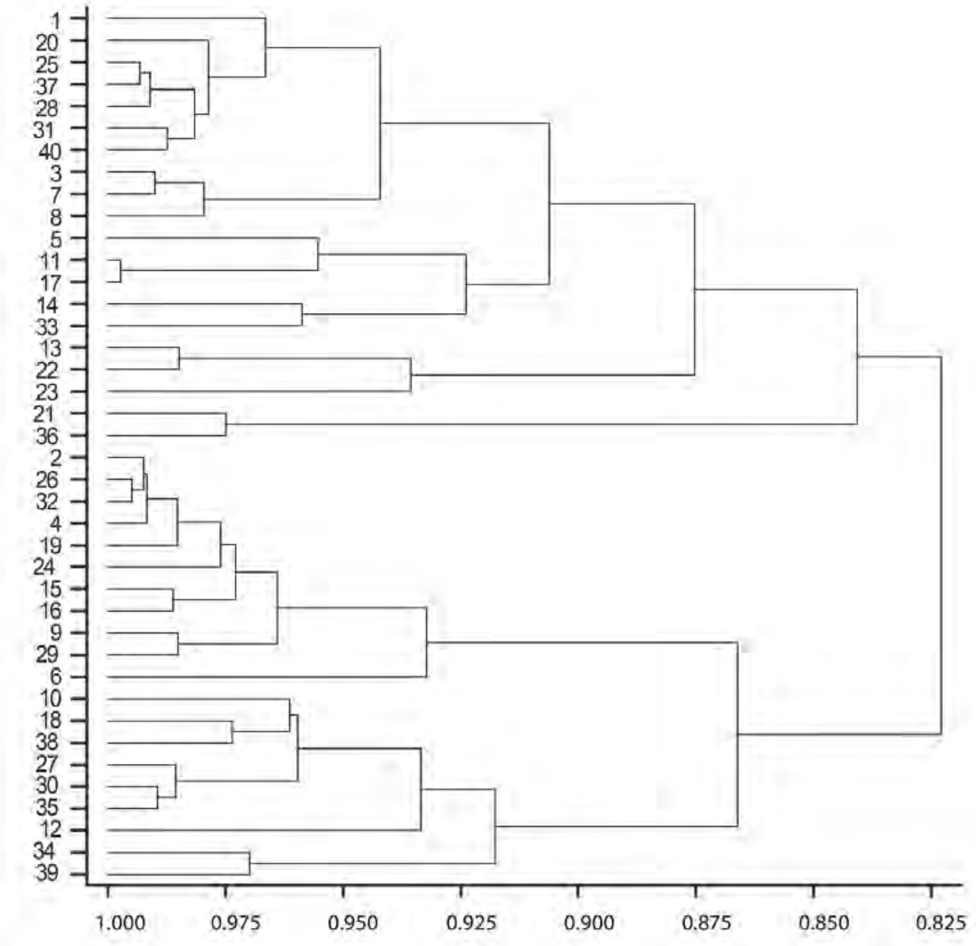

Figure 6.15. Average-linkage hierarchical cluster analysis dendrogram of the An Sơn ceramic samples, Trench 1 square C1. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.13. Samples in the hierarchical cluster analysis dendrogram groupings in Figure 6.15 of the An Sơn ceramic samples, Trench 1 square C1 when cut at 0.825 and 0.950. Refer to Appendix A for sample identification numbers.

Main group (cut at 0.825)	Subgroup (cut at 0.950)	Sample identification number
1	1	1, 20, 25, 37, 28, 31, 40
	2	3, 7, 8
	3	5, 11, 17
	4	14, 33
	5	13, 22
	6	23
	7	21, 36
2	1	2, 26, 32, 4, 19, 24, 15, 16, 9, 29
	2	6
	3	10, 18, 38, 27, 30, 35
	4	12
	5	34, 39

Source: Compiled by C. Sarjeant.

Canonical variate analysis

Three CVAs are presented in this section, one for each *a priori* group, rim form and vessel components, layers and tempers.

Rim forms and vessel components

This CVA was carried out to reveal the relationship between rim form and clay matrix composition for the An Sơn Trench 1 square C1 sample (Figure 6.16, Figure 6.17, Table 6.14). Where a rim form according to the categorisation of Figure 5.1 could not be identified, components were identified (e.g. body sherds, pedestal sherds, etc.). The CVA plots show how similar the clay matrix compositions of the samples are within a designated archaeological grouping, the rim form and vessel component group in this case. The CVA biplot shows the relationship between the samples and the element oxide compositional data (Figure 6.16). The circles in the CVA plot represent 95% confidence around the samples of each group. When these circles overlap, the groups are chemically related (Figure 6.17).

The close distribution of A2a rim forms and roulette decorated body sherds in the CVA plot (Figure 6.17) is indicative of a single clay source for the vessel form A2a, and confirms that the roulette decorated body sherds came from concave rimmed A2a vessels. Rim forms A1a, B1a and C1b have a similar clay matrix composition to each other, while rim forms D1a and D1b have a similar clay matrix composition to each other. The C2b rim form sample does not group with the other represented rim forms in the CVA plot (Figure 6.17). Refer to Appendix A for sample identification numbers.

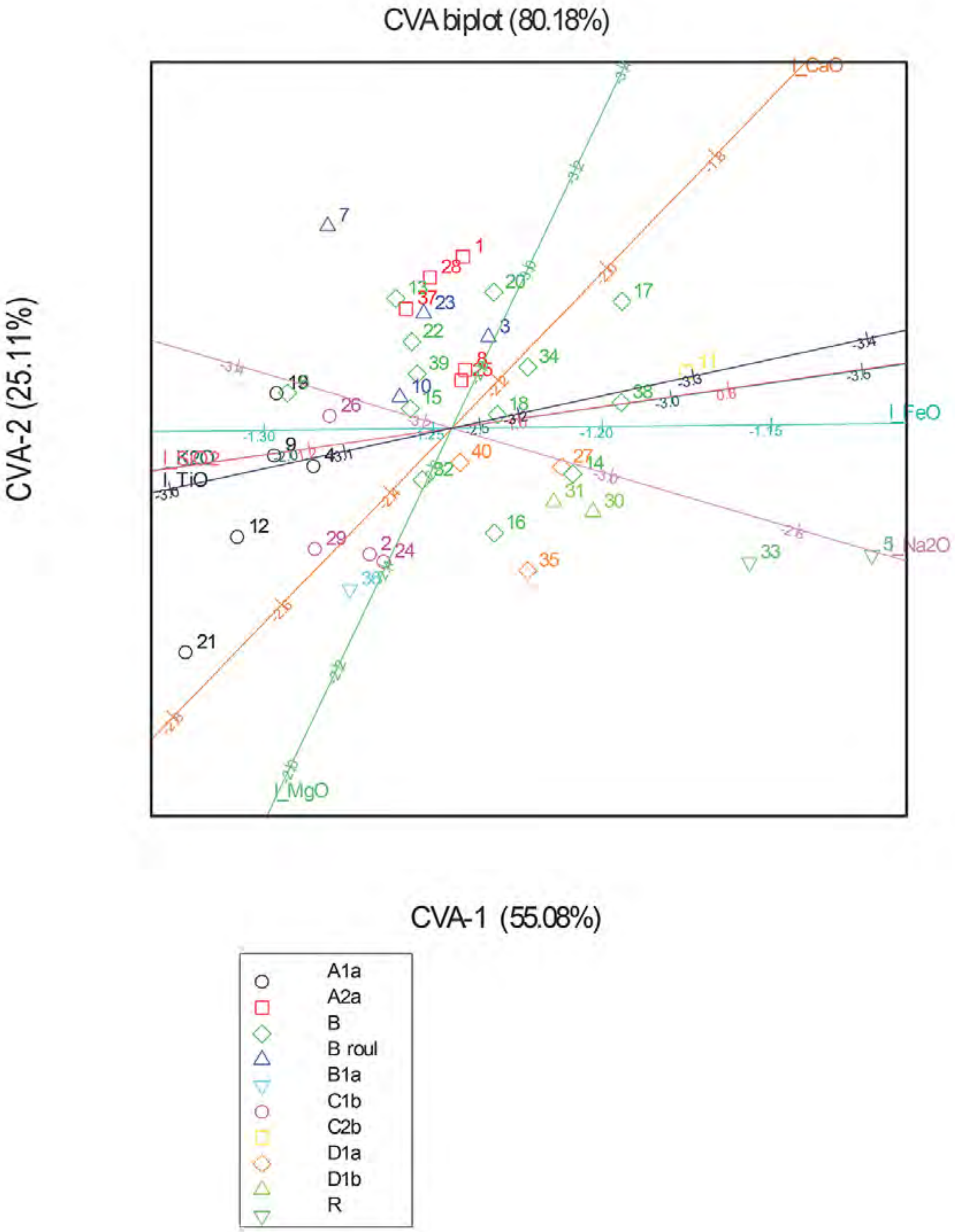

Figure 6.16. CVA biplot of rim forms and vessel components of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images. Key: Rim forms: A1a, A2a, B1a, C1b, C2b, D1a, D1b; Unidentified forms: R = rim sherd, B = body sherd, B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

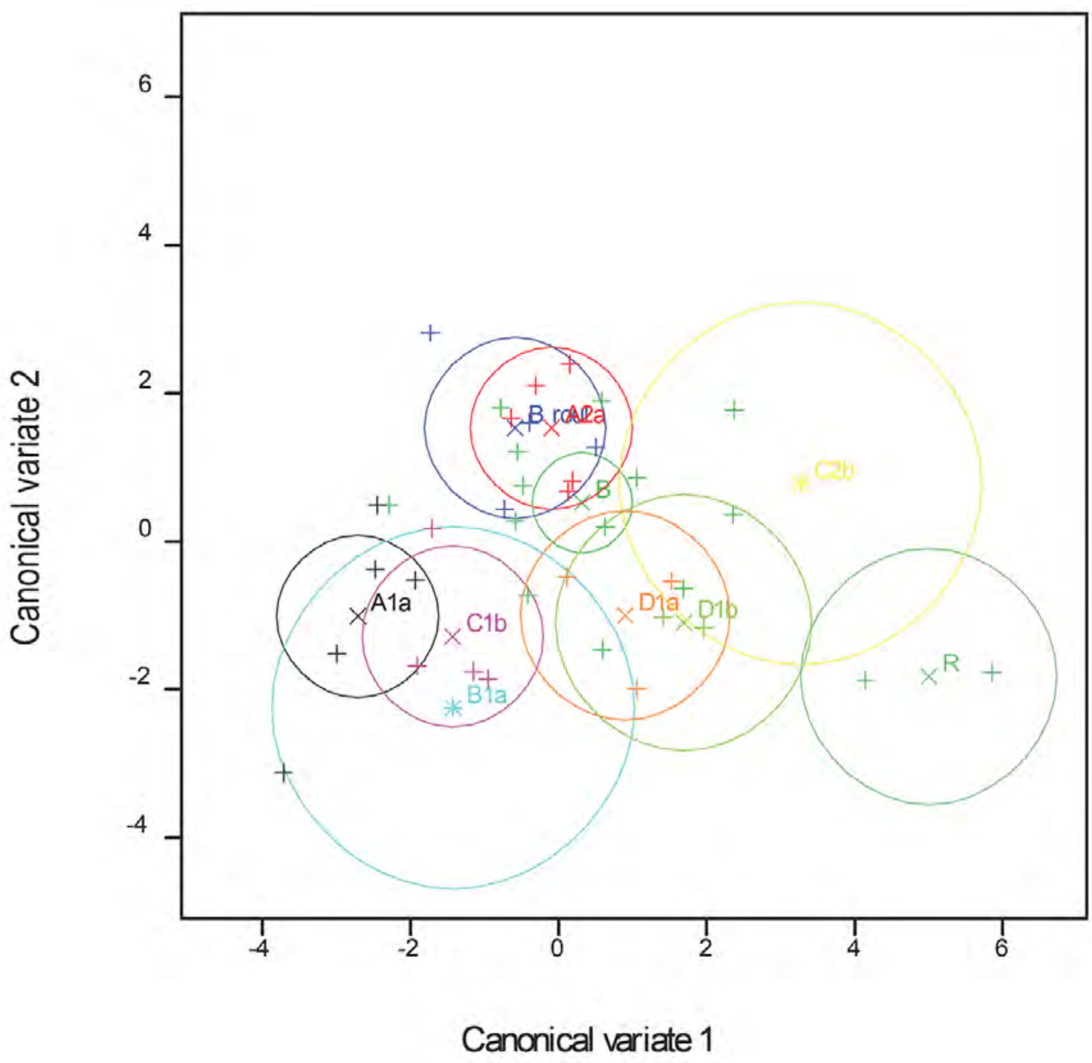

Figure 6.17. CVA plot of rim forms and vessel components with 95% confidence circles of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Refer to Figure 5.1 for rim form images. Key: Rim forms: A1a, A2a, B1a, C1b, C2b, D1a, D1b; Unidentified forms: R = rim sherd, B = body sherd, B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

Table 6.14. CVA loadings for Figure 6.16 and Figure 6.17 of rim forms and vessel components of the An Sơn ceramic samples, Trench 1 square C1. First three dimensions.

	1 (55.08%)	2 (25.11%)	3 (7.90%)
1	2.717	2.178	0.667
2	-0.760	-0.312	-0.379
3	-2.267	1.521	1.873
4	2.171	-7.617	0.114
5	1.966	-1.526	0.825
6	-6.587	2.000	-4.226
7	0.877	0.867	0.642

Source: Compiled by C. Sarjeant.

Layers

This CVA was undertaken to assess if there were any differences in the composition of clay matrices over time in Trench 1 square C1 (Figure 6.18, Figure 6.19, Table 6.15). This section is the most critical for understanding the sequence of ceramics at An Sơn. The CVA indicates that there is wide variation in clay matrix compositions of the sampled ceramic sherds from layers 1, 5 and 5/6, while there is less chemical variation in layers 7 and 8. Refer to Appendix A for sample identification numbers.

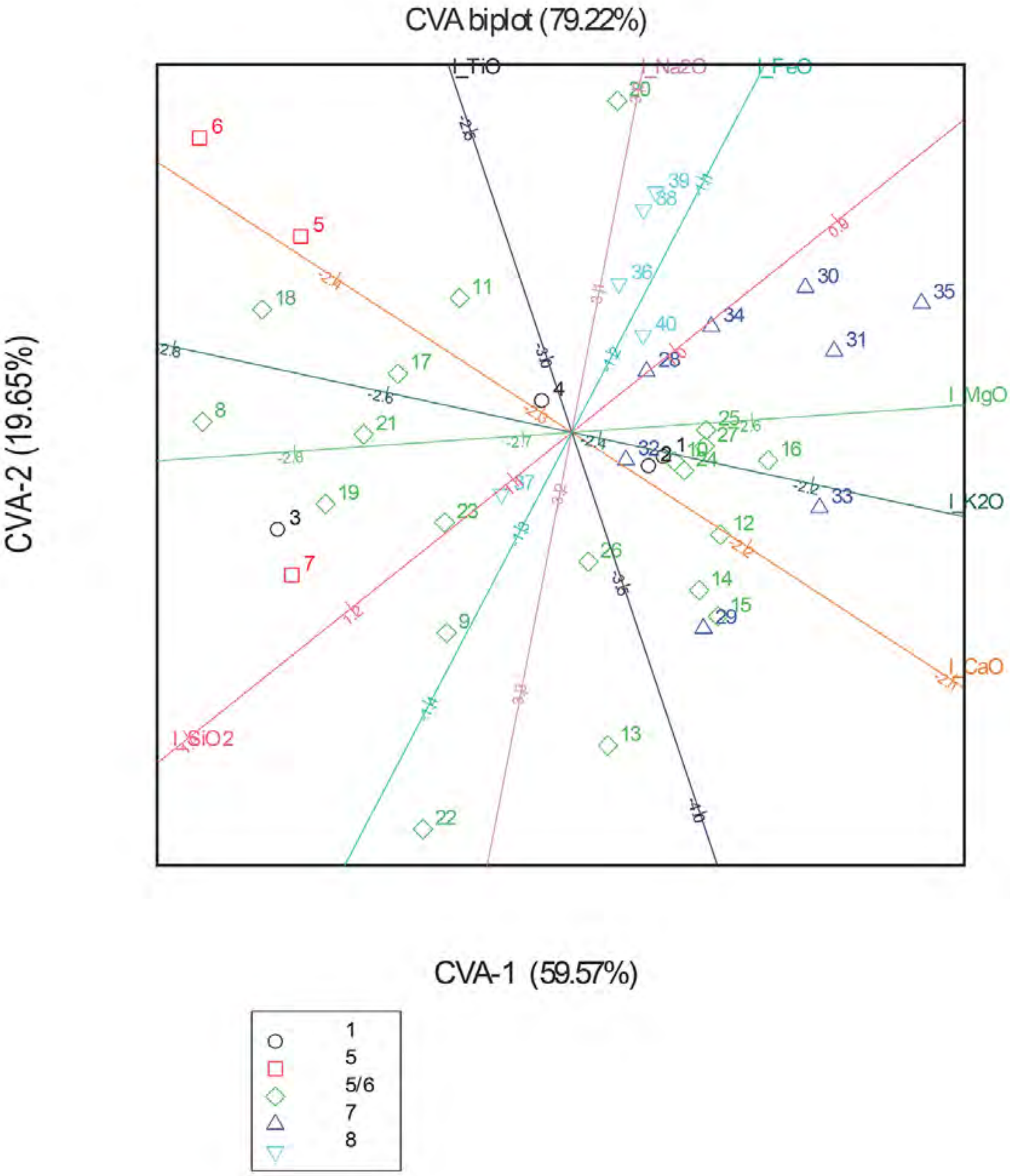

Figure 6.18. CVA biplot of layers of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Refer to Appendix A for sample identification numbers. Key: 1, 5, 5/6, 7, 8 = 2009 Trench 1 square C1 layers.

Source: C. Sarjeant.

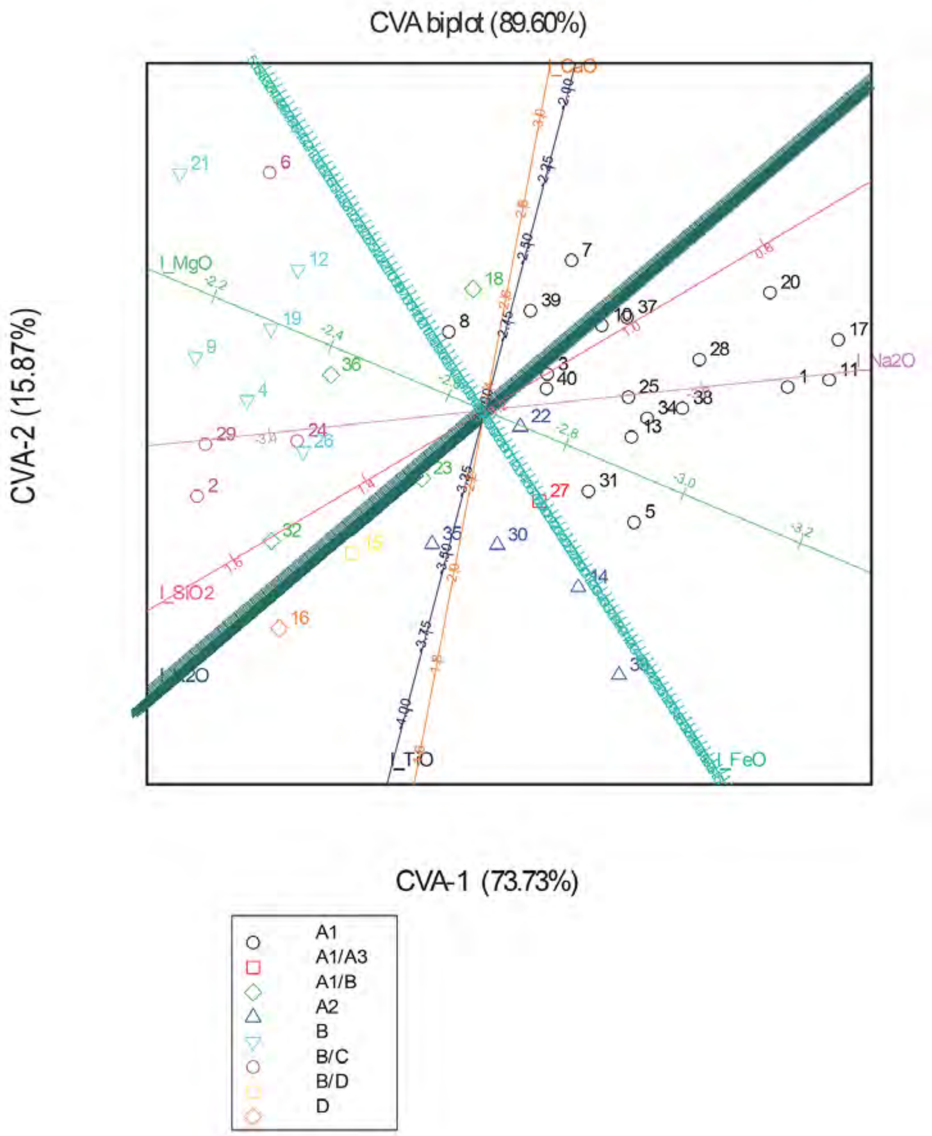

Figure 6.19. CVA plot of layers with 95% confidence circles of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Key: 1, 5, 5/6, 7, 8 = 2009 Trench 1 square C1 layers.

Source: C. Sarjeant.

Table 6.15. CVA loadings for Figure 6.18 and Figure 6.19 of layers of the An Sơn ceramic samples, Trench 1 square C1. First three dimensions.

	1 (59.57%)	2 (19.65%)	3 (11.75%)
1	1.072	0.210	2.273
2	0.837	-1.200	-1.526
3	1.549	-0.025	-0.945
4	3.502	0.739	2.040
5	-0.130	0.426	1.171
6	-7.021	-4.718	0.917
7	-1.014	2.898	0.337

Source: Compiled by C. Sarjeant.

Tempers

This CVA was undertaken to assess whether there was any statistical relationships between the tempers (identified according to TG A, B, C, D and E) and clay matrix compositions in the Trench 1 square C1 ceramic samples (Figure 6.20, Figure 6.21, Table 6.16). The clay matrices have been chemically analysed independently from the tempers, therefore the chemistry of the temper minerals does not affect the chemical characterisation of the clay matrix in the statistical analyses. When the temper groups in the CVA plots do not overlap, it is likely specific clays were used with a particular temper. Conversely, when the temper groups overlap in the CVA, it is likely similar clays were used in the manufacture of many vessels, regardless of the applied temper.

The CVA (Figure 6.21) indicates there is some variation in the clay matrix composition between the sand tempered (TG A1 and TG A2) and the fibre (TG B) and fibre/phosphate (TG B/C) tempered sherds, as indicated by the separation in the distribution of the samples within these temper groups. Refer to Appendix A for sample identification numbers.

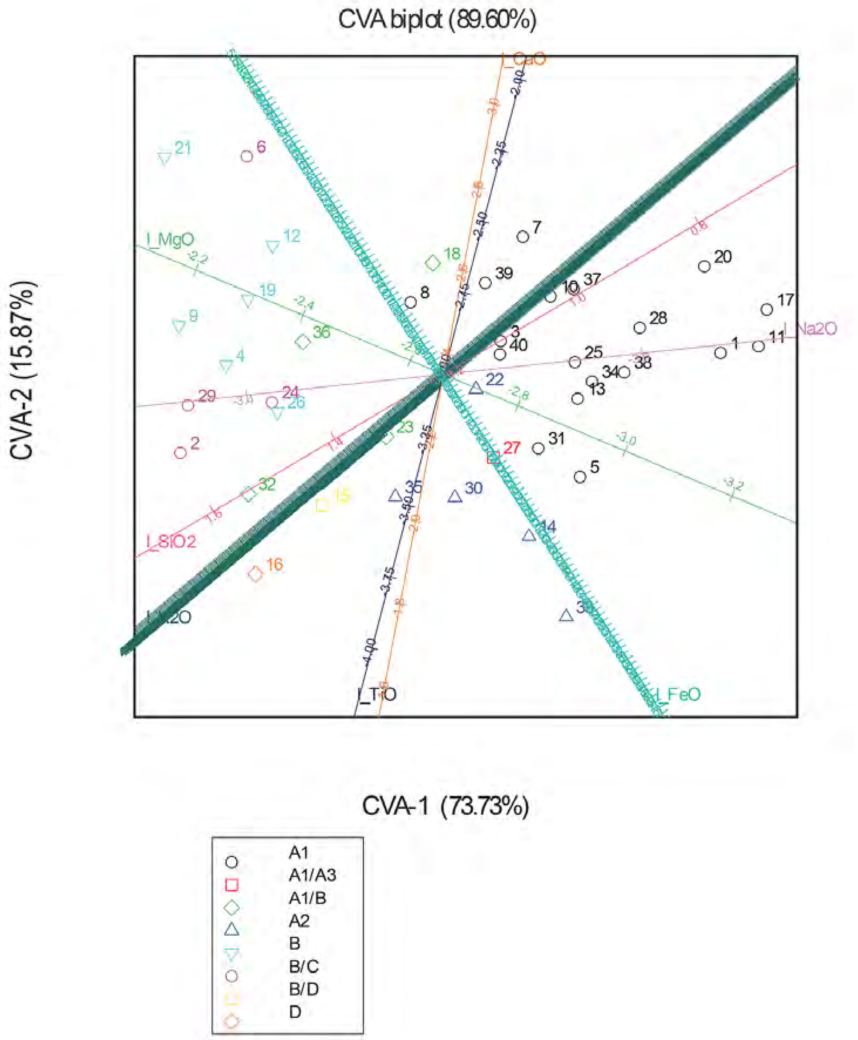

Figure 6.20. CVA biplot of tempers of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Refer to Appendix A for sample identification numbers. Key: A1 = mineral sand, A2 = lateritic (micaceous) sand, A3 = impure iron oxide (large grains)/almandine sand, B = fibre, C = phosphate, D = calcareous.

Source: C. Sarjeant.

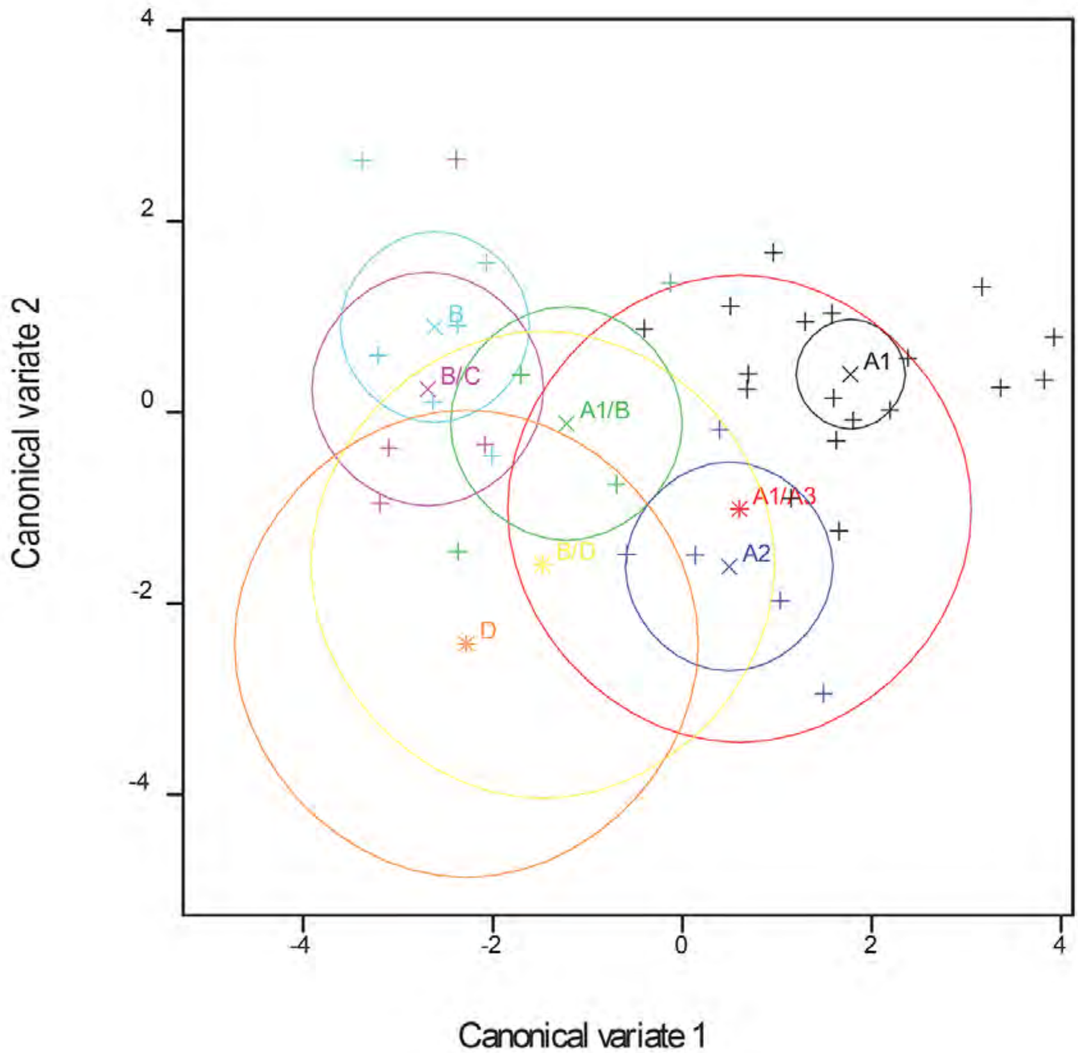

Figure 6.21. CVA biplot of tempers with average value circle perimeters of the An Sơn ceramic samples, Trench 1 square C1. First two dimensions. Key: A1 = mineral sand, A2 = lateritic (micaceous) sand, A3 = impure iron oxide (large grains)/almandine sand, B = fibre, C = phosphate, D = calcareous.

Source: C. Sarjeant.

Table 6.16. CVA loadings for Figure 6.20 and Figure 6.21 of tempers of the An Sơn ceramic samples, Trench 1 square C1. First three dimensions.

	1 (73.73%)	2 (15.87%)	3 (6.32%)
1	2.176	-2.270	-0.150
2	1.137	1.806	5.032
3	0.756	0.642	0.381
4	-5.860	-4.345	0.280
5	0.462	-0.461	1.104
6	-5.550	4.252	3.155
7	0.942	1.169	-1.968

Source: Compiled by C. Sarjeant.

All An Sơn ceramic samples

This section includes the entire ceramic sample for fabric analysis from An Sơn, inclusive of the previously presented Trench 1 square C1. The following clay matrix characterisations correspond to the temper identifications.

Principal components analysis

The greatest variability in the following PCA plots (Figure 6.22, Figure 6.23) is a result of the concentrations of K_2O and TiO_2 in the clay matrix compositions (Table 6.17). The PCA of the fabrics for all of the sampled An Sơn ceramic sherds indicates there were major (and problematic) outliers in the sample. These were sample numbers 43, 60 and 61. These outliers make sense archaeologically as sample 43 is an Óc Eo phase sherd from the upper layers of Trench 1, while samples 60 and 61 were surface collected sherds. They possibly represent markedly different clay collection practices from the neolithic period sherds in the rest of the sample. The presence of these sherds in the PCA diminishes the variability in the remainder of the sample and groups are less clear. Subsequent statistical analyses are presented without the inclusion of these three outlier samples. Refer to Appendix A for sample identification numbers.

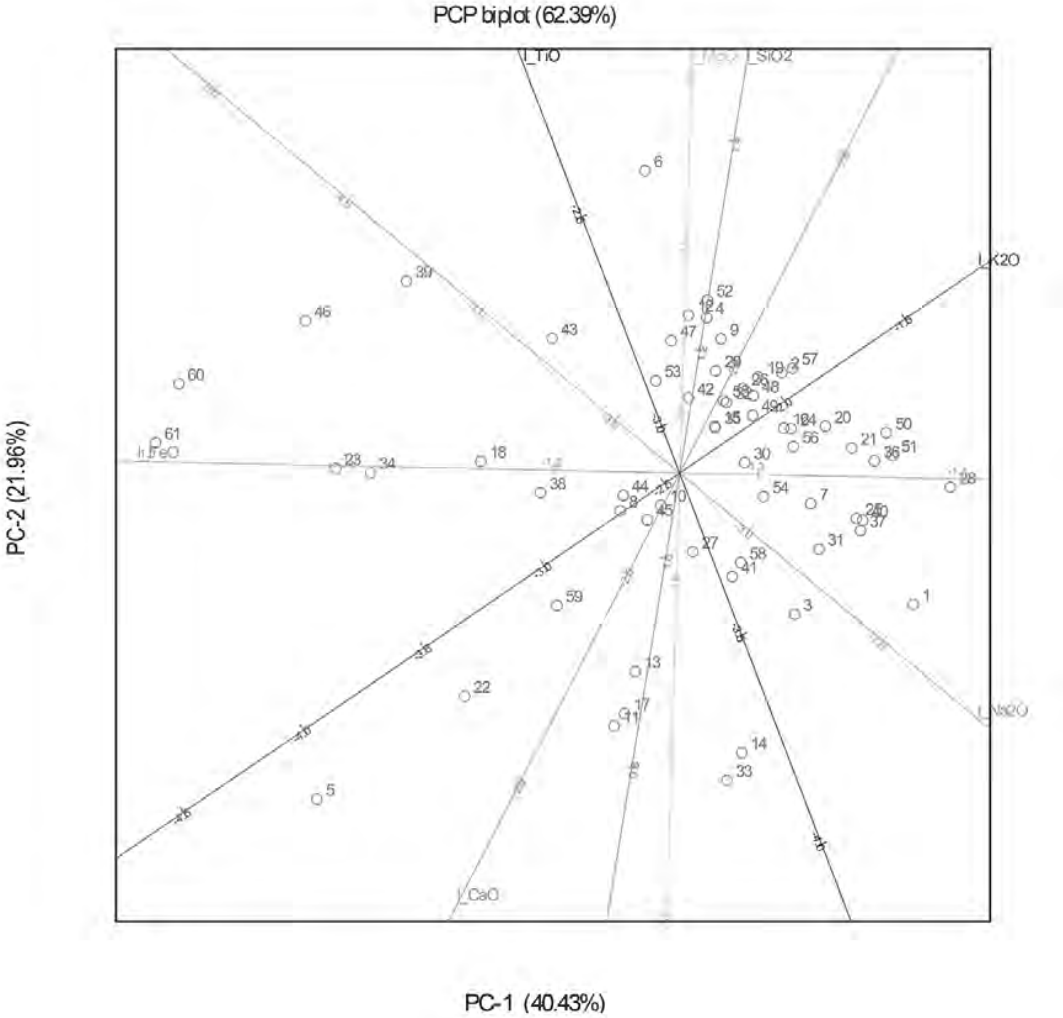

Figure 6.22. PCA biplot of the An Sơn ceramic sample. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

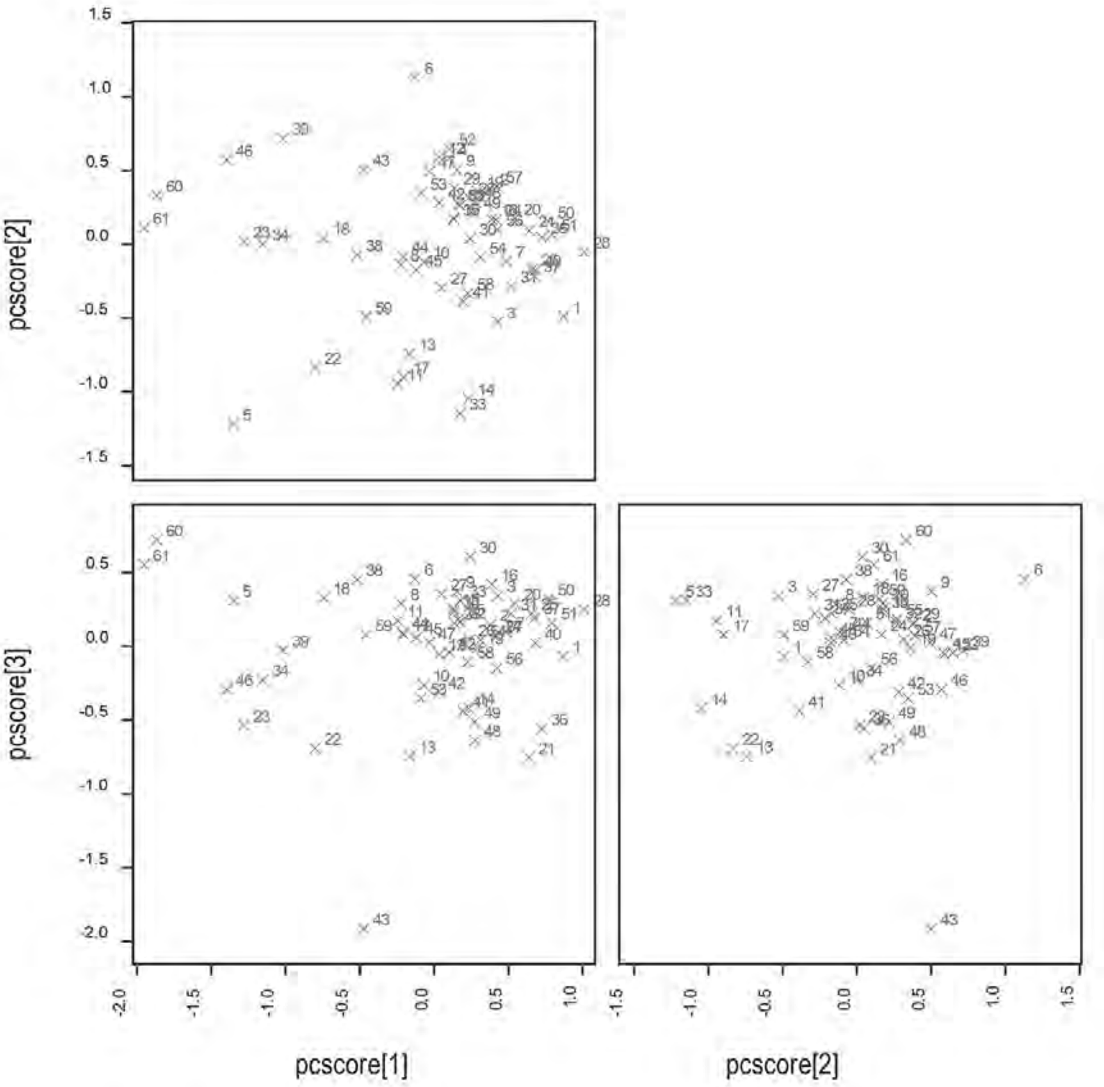

Figure 6.23. PCA plot of the An Sơn ceramic sample. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.17. PCA loadings for Figure 6.22 and Figure 6.23 of the An Sơn ceramic sample. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (40.43%)	PC 2 (21.96)%	PC 3 (17.11%)
CaO	-0.05207	-0.10115	**0.66076**
FeO	-0.13197	0.00279	0.33246
K_2O	**0.75966**	**0.52011**	**-0.13083**
MgO	0.00926	0.31815	0.35255
Na_2O	0.59630	**-0.49304**	0.41452
SiO_2	0.04079	0.25033	0.09930
TiO_2	**-0.21325**	**0.55881**	0.36024

Source: Compiled by C. Sarjeant.

Hierarchical cluster analysis

The dendrogram indicates a similar positioning of the Óc Eo phase sherd, sample 43, and the surface sherds, samples 60 and 61, as outliers amongst the remaining An Sơn ceramic sherds (Figure 6.24). However, a relationship between samples 60 and 61 and some of the sherds can be observed when the dendrogram is cut at 0.90. The other groups of the dendrogram are described below without the inclusion of these three outlier samples. Refer to Appendix A for sample identification numbers.

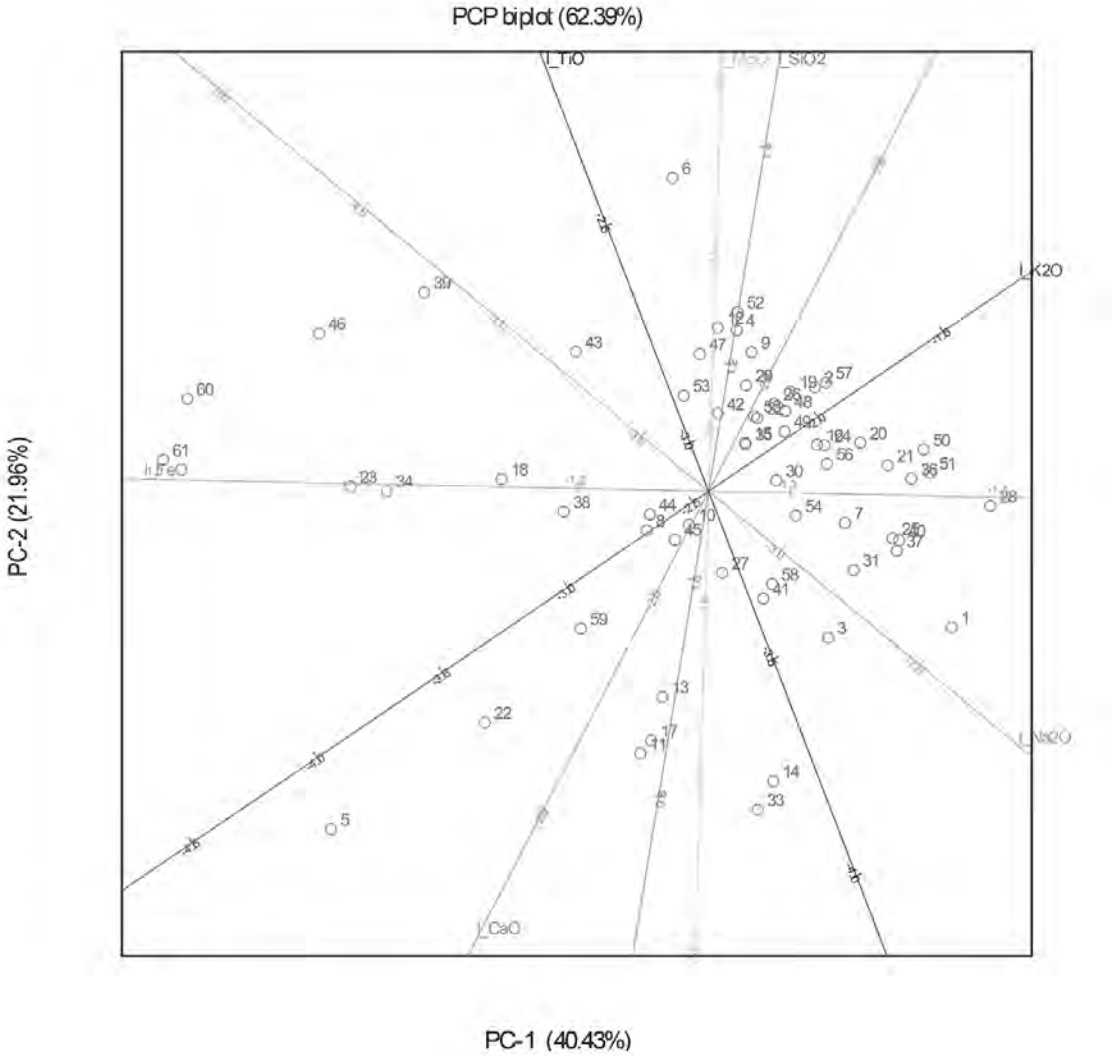

Figure 6.24. Average-linkage hierarchical cluster analysis dendrogram of the An Sơn ceramic sample. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Principal components analysis, excluding samples 43, 60 and 61

The greatest variability in the following PCA plots (Figure 6.25, Figure 6.26) is a result of the concentrations of CaO, FeO and K_2O in the clay matrix compositions (Table 6.18). When examining all three PCA dimensions, three main groups are evident, with a large number of outliers and variability evident amongst the An Sơn ceramic sherds (Table 6.19). Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1**: samples 2, 3, 4, 7, 9, 10, 12, 15, 16, 19, 24, 25, 26, 29, 31, 32, 35, 37, 40, 41, 42, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58

  This group consists of ceramic sherds from layers 1, 2, 3, 5/6, 7 and 8; Test Square 200–210 cm, 240–250 cm and 250–260 cm; and 1997 Trench 1 350–360 cm and 360–410 cm. The forms include A1a, A2a, A2b, B1a, C1b, D1a, D1b and D2a. The represented tempers were sand, fibre (including one sample with bleb grog), sand/fibre, fibre/phosphate, fibre/calcareous, calcareous, and lateritic sand.

- **Main group 2**: samples 8, 27, 38, 44, 45

  This group consists of ceramic sherds from layers 5/6 and 8, with forms A2a, C3a, D1a and D2a. The represented tempers were sand and sand/iron-rich sand.

- **Main group 3**: samples 20, 21, 28, 36

  This group consists of ceramic sherds from layers 5/6, 7 and 8, with forms A1a, A2a, and B1a present. The represented tempers were sand/fibre, sand, and fibre.

- **Outlier groups**: samples 1 / 5 / 6 / 11, 17 / 13 / 14, 33 / 22 / 23 / 34 / 39 / 46 / 59

  The range of ceramic sherds represented by these outliers came from layers 1, 5, 5/6, 7 and 8, and 1997 Trench 1 360–410 cm. The represented rim forms include A2a, B1b and C2b, with many body sherds in the sample. The represented tempers were sand, fibre/phosphate, lateritic sand (including one sample with orthodox grog), sand/fibre, and fibre.

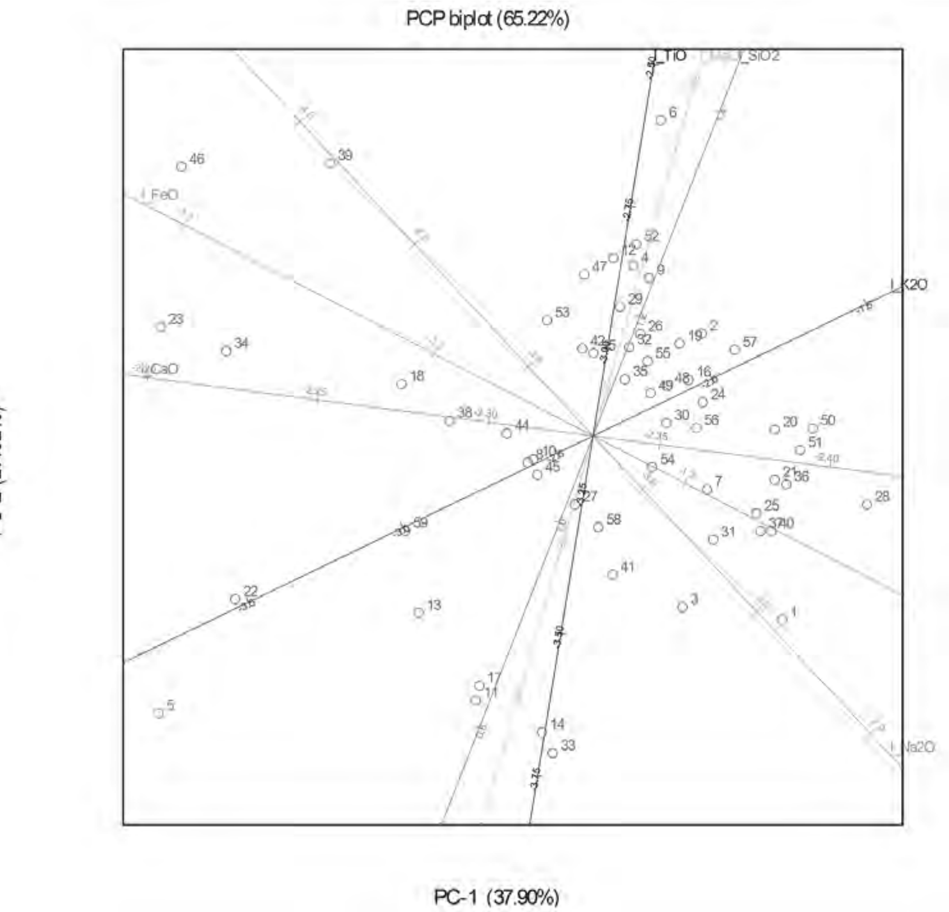

Figure 6.25. PCA biplot of the An Sơn ceramic sample, excluding samples 43, 60 and 61. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

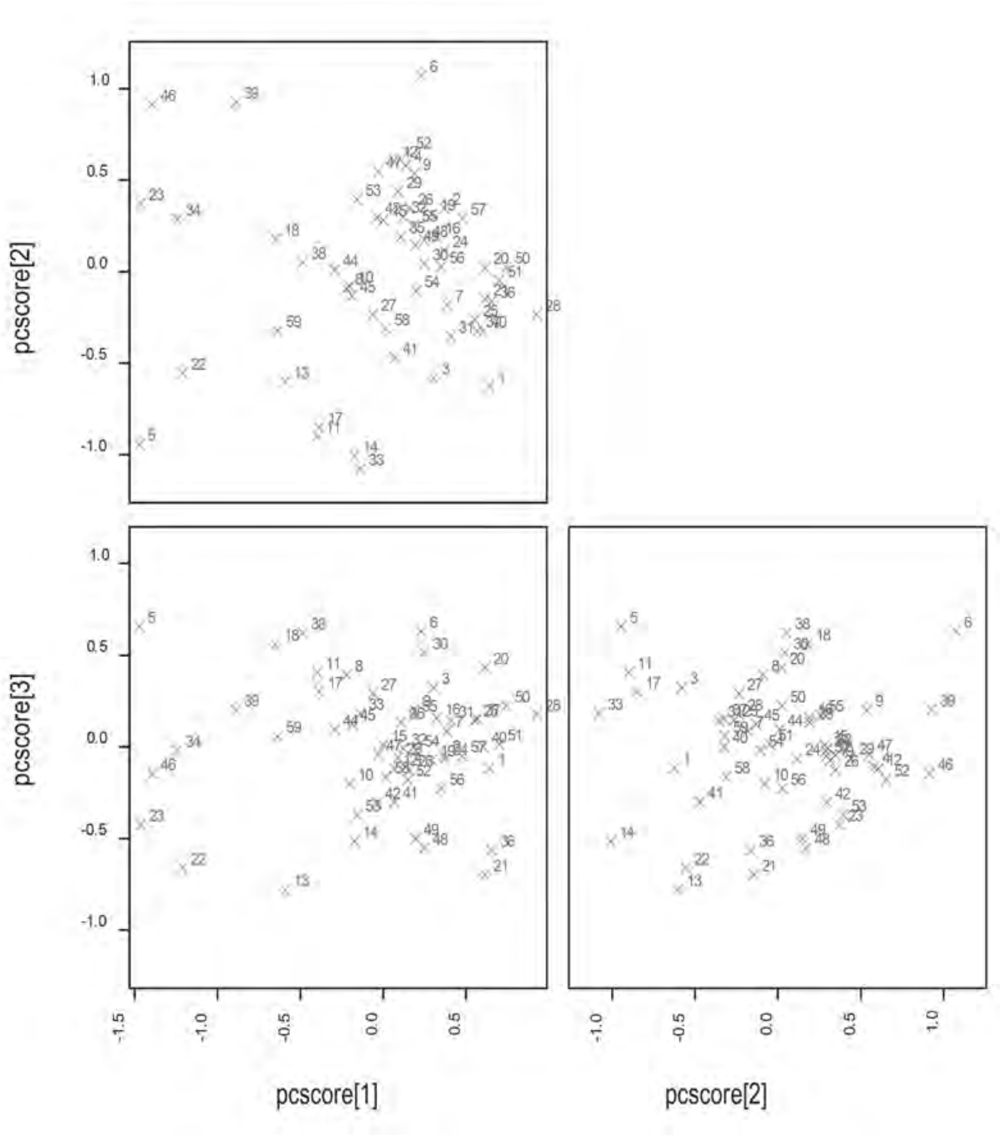

Figure 6.26. PCA plot of the An Sơn ceramic sample, excluding samples 43, 60 and 61. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.18. PCA loadings for Figure 6.25 and Figure 6.26 of the An Sơn ceramic sample, excluding samples 43, 60 and 61. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (37.90%)	PC 2 (27.32%)	PC 3 (13.30%)
CaO	**-0.08502**	0.01118	0.55347
FeO	**-0.09296**	0.04817	0.33781
K_2O	**0.77438**	0.37517	**-0.25944**
MgO	0.10140	0.35449	0.03811
Na_2O	0.59848	**-0.64519**	0.37769
SiO_2	0.09666	0.24883	-0.00045
TiO_2	0.08159	**0.50295**	**0.60675**

Source: Compiled by C. Sarjeant.

Table 6.19. Samples in the PCA groupings in Figure 6.26 of the An Sơn ceramic sample, excluding samples 43, 60 and 61.

	PC 1/PC 2	PC 1/PC 3	PC 2/PC 3
Main group 1	2, 4, 9, 12, 15, 16, 19, 24, 26, 29, 30, 32, 35, 42, 47, 48, 49, 52, 53, 55, 56, 57 (54)	1, 2, 3, 4, 7, 9, 10, 12, 15, 16, 19, 24, 25, 26, 29, 31, 32, 35, 37, 40, 41, 42, 47, 50, 51, 52, 53, 54, 55, 56, 57, 58 (14, 28)	2, 15, 19, 26, 29, 32, 34, 57 (4, 12, 24, 47, 52)
Main group 2	8, 10, 27, 38, 41, 44, 45, 58 (3, 18)	27, 33, 44, 45	8, 18, 20, 30, 38
Main group 3	20, 21, 25, 31, 36, 37, 40, 50, 51 (7, 28)		7, 26, 27, 28, 31, 37, 40, 45, 50, 59
Main group 4			16, 35, 44, 51, 54, 55
Outlier group 1	1	18, 38	1
Outlier group 2	5	5	5
Outlier group 3	6	6, 30	6
Outlier group 4	11, 17	8, 11, 17	11, 17 (33, 35)
Outlier group 5	13	13	13, 22
Outlier group 6	14, 33	20	14
Outlier group 7	22	22	10, 56
Outlier group 8	23, 34	23	23, 53 (42)
Outlier group 9	39	39	39
Outlier group 10	46	34, 46	46
Outlier group 11	59	59	41
Outlier group 12		21, 36	21, 36
Outlier group 13		48, 49	48, 49
Outlier group 14			9
Outlier group 15			58

Source: Compiled by C. Sarjeant.

Hierarchical cluster analysis, excluding samples 43, 60 and 61

Three major groups are evident in the cluster analysis dendrogram (when cut at 0.875), each with valid subgroups (cut at 0.950) (Figure 6.27, Table 6.20). Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1:**
    - **Subgroup 1**: samples 1, 20, 25, 37, 28, 50, 40, 31

      This subgroup consists of A2a sand tempered rim sherds from layers 1, 5/6, 7 and 8; sand tempered body sherds from layer 5/6; D1a sand tempered rim sherds from the Test Square 240–250 cm and layer 8; and a D1b sand tempered rim sherd from layer 7.
    - **Subgroup 2**: samples 14, 33

      This subgroup consists of lateritic sand tempered body (also with orthodox grog) and rim sherds from layers 5/6 and 7.
    - **Subgroup 3**: samples 5, 11, 17

      This subgroup consists of a sand tempered rim sherd from layer 5, a C2b sand tempered rim sherd from layer 5/6, and a sand tempered body sherd from layer 5/6.

Main group 1 in this hierarchical cluster analysis (Table 6.20) is most consistent with main group 3 and the outliers identified in the previous PCA (Figure 6.26, Table 6.19).

- **Main group 2:**
  - **Subgroup 1**: samples 2, 26, 32, 16, 15, 52, 4, 47, 19, 42, 53, 24, 56, 55

    This subgroup consists of C1b fibre/phosphate and fibre tempered rim sherds from layers 1 and 5/6, a sand/fibre tempered body sherd from layer 7, a calcareous tempered body sherd from layer 5/6, a fibre/calcareous tempered body sherd from layer 5/6, fibre tempered pedestal sherds from the Test Square 240–250 cm and 250–260 cm, A1a fibre tempered rim sherds from layers 1 and 5/6, an A2b sand/fibre/phosphate tempered rim sherd from Test Square 200–210 cm, a fibre tempered body sherd from layer 2, a B1a sand/fibre tempered rim sherd from the 1997 Trench 1 350–360 cm, and a fibre tempered pedestal sherd from the 1997 Trench 1 350–360 cm.
  - **Subgroup 2**: samples 9, 29

    This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6 and a C1b fibre/phosphate tempered rim sherd from layer 7.
  - **Subgroup 3**: sample 6

    This subgroup consists of a fibre/phosphate body sherd from layer 5.
  - **Subgroup 4**: samples 12, 57

    This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6 and a B1a fibre bleb grog tempered rim sherd from 1997 Trench 1 350–360 cm.
  - **Subgroup 5**: samples 3, 7, 51, 8

    This subgroup consists of form A2a roulette decorated sand tempered body sherds from layers 1 and 5, a D1a sand tempered rim sherd from the Test Square 240–250 cm, and an A2a sand tempered rim sherd from layer 5/6.
  - **Subgroup 6**: samples 10, 58, 38, 59, 45, 27, 54, 44, 35, 30, 18

    This subgroup consists of a form A2a roulette decorated sand tempered body sherd from layer 5/6, a sand tempered body sherd from 1997 Trench 1 360–410 cm, a sand tempered body sherd from layer 8, a B1b sand tempered rim sherd from 1997 Trench 1 360–410 cm, a C3a sand tempered rim sherd from layer 5/6, a D1a sand/iron-rich sand tempered rim sherd from layer 5/6, a D1b lateritic sand tempered rim sherd from the Test Square 250–260 cm, a D2a sand tempered rim sherd from layer 3, a D1a lateritic sand tempered rim sherd from layer 7, a D1b lateritic sand tempered rim sherd from layer 7, and a sand/fibre tempered body sherd from layer 5/6.
  - **Subgroup 7**: samples 21, 36, 48, 49, 41

    This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6, a B1a sand/fibre tempered rim sherd from layer 8, B1a fibre and sand tempered rim sherds from the Test Square 240–250 cm, and a D2a sand tempered rim sherd from layer 3.

Main group 2 in this hierarchical cluster analysis (Table 6.20) is most consistent with main groups 1 and 2 identified in the previous PCA (Figure 6.26, Table 6.19).

- **Main group 3**:
  - **Subgroup 1**: samples 13, 22

    This subgroup consists of sand and lateritic sand tempered body sherds from layer 5/6.
  - **Subgroup 2**: sample 23

    This subgroup consists of a form A2a roulette decorated body sherd with sand/fibre temper layer 5/6.

- **Subgroup 3**: samples 34, 39

  This subgroup consists of sand tempered body sherds from layers 7 and 8.

- **Subgroup 4**: sample 46

  This subgroup consists of a fibre tempered roulette decorated pedestal sherd from layer 5/6.

Main group 3 in this hierarchical cluster analysis (Table 6.20) is most consistent with the outliers identified in the previous PCA (Figure 6.26, Table 6.19).

The dendrogram (Figure 6.27, Table 6.20) clarifies the subgroups within the larger cluster that was evident in the previous PCA (Figure 6.26, Table 6.19), with a definite number of outliers (main group 3 of the dendrogram).

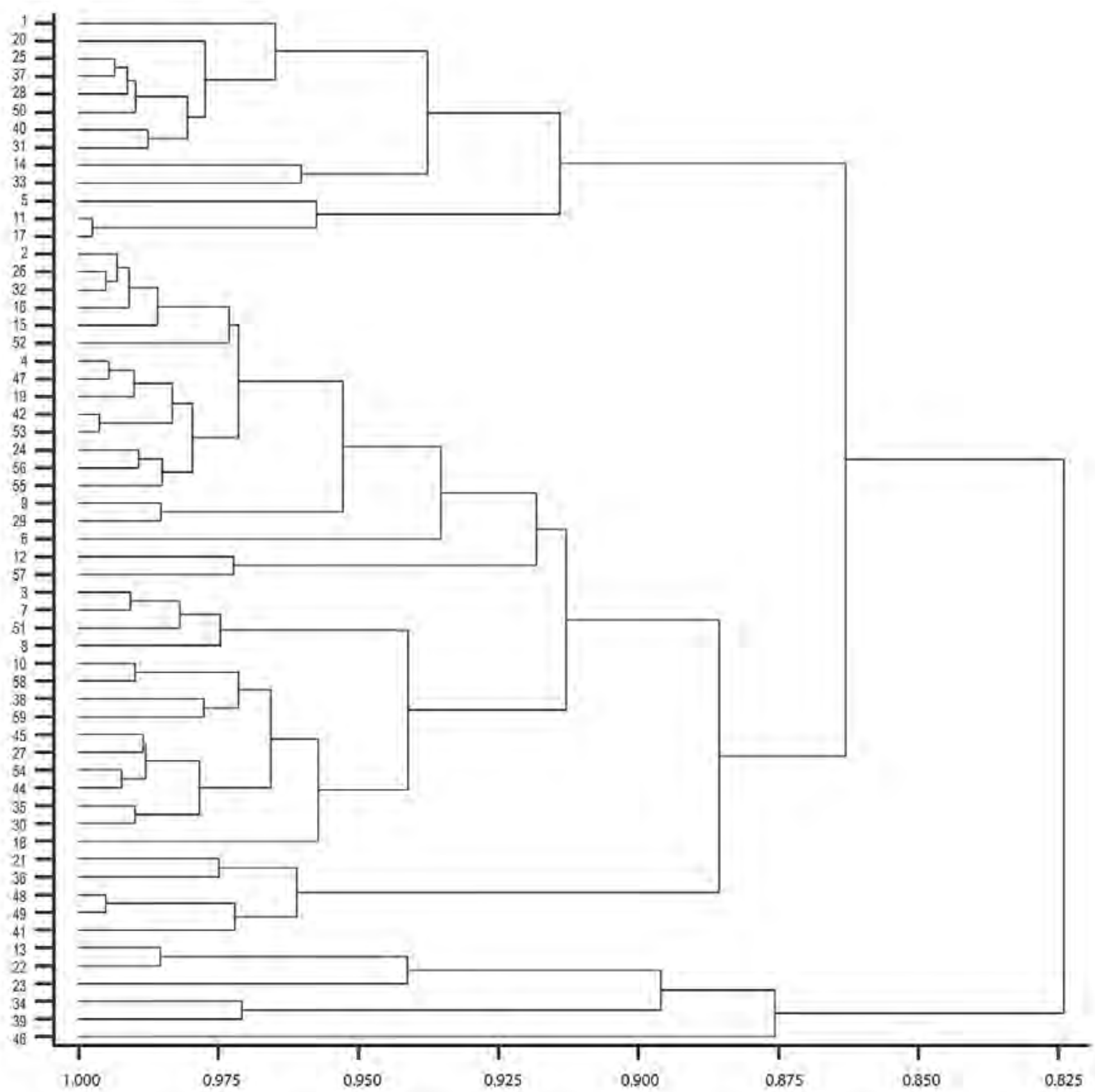

Figure 6.27. Average-linkage hierarchical cluster analysis dendrogram of the An Sơn ceramic sample, excluding samples 43, 60 and 61. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.20. Samples in the hierarchical cluster analysis dendrogram groupings in Figure 6.27 of the An Sơn ceramic sample, excluding samples 43, 60 and 61, when cut at 0.875 and 0.950. Refer to Appendix A for sample identification numbers.

Main group (cut at 0.875)	Subgroup (cut at 0.950)	Sample identification number
1	1	1, 20, 25, 37, 28, 50, 40, 31
	2	14, 33
	3	5, 11, 17
2	1	2, 26, 32, 16, 15, 52, 4, 47, 19, 42, 53, 24, 56, 55
	2	9, 29
	3	6
	4	12, 57
	5	3, 7, 51, 8
	6	10, 58, 38, 59, 45, 27, 54, 44, 35, 30, 18
	7	21, 36, 48, 49, 41
3	1	13, 22
	2	23
	3	34, 39
	4	46

Source: Compiled by C. Sarjeant.

Canonical variate analysis

Three CVAs are presented in this section, one for each *a priori* group, rim forms and vessel components, layers and tempers.

Rim forms and vessel components

This CVA was undertaken to understand whether there is a relationship between clay matrix composition and rim form. Where a rim form could not be identified according to the categorisation of Figure 5.1, vessel components were identified, as previously described. The CVA demonstrates that there was substantial overlap in the clay matrix compositional data when sherds are grouped according to rim form. The greatest overlap is observed between the B1a and C1b rim forms, while there is a separate group that includes rim forms A2a, D1a, D1b and D2a (Figure 6.28, Figure 6.29, Table 6.21). Refer to Appendix A for sample identification numbers.

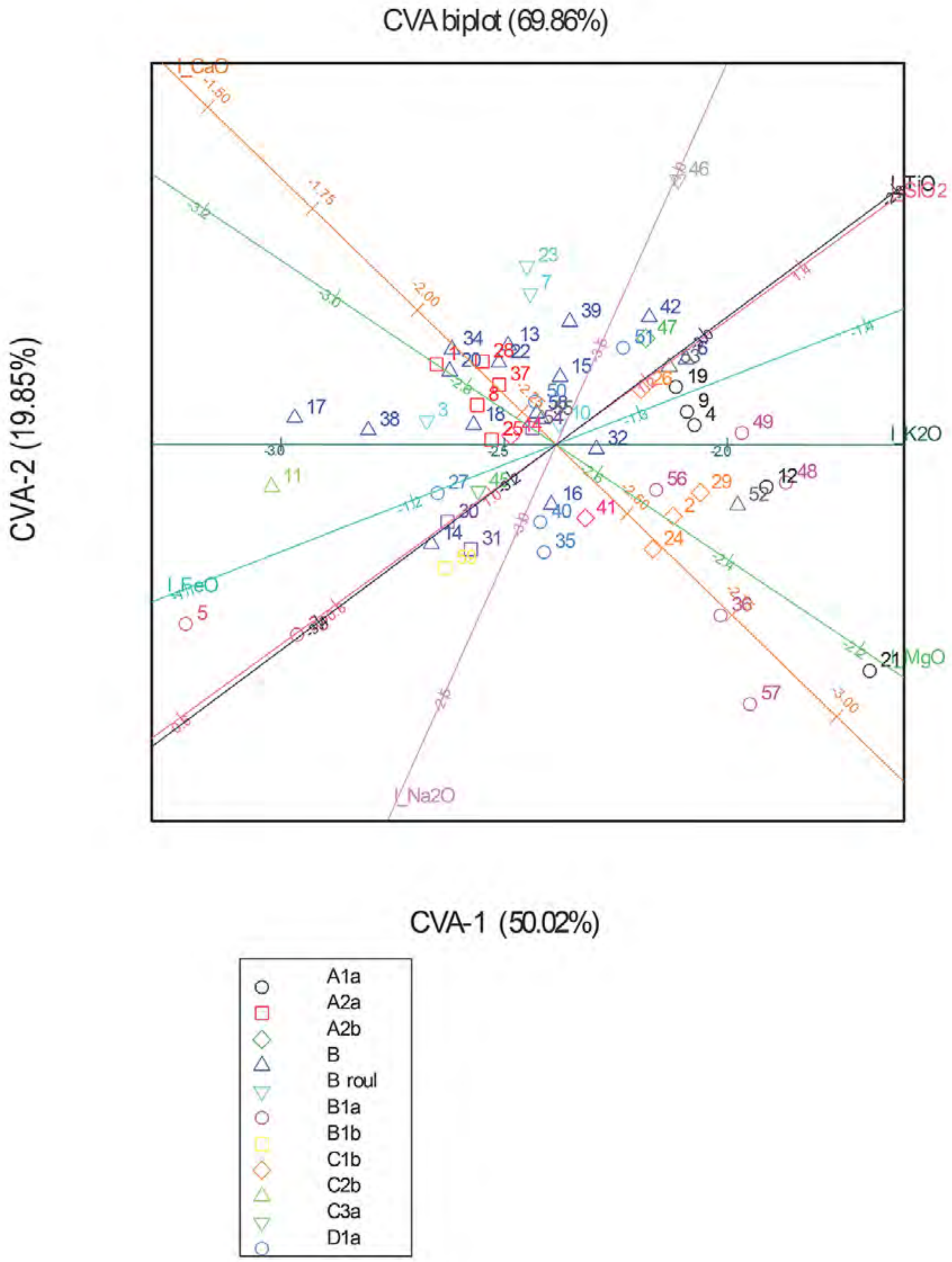

Figure 6.28. CVA biplot of the An Sơn rim forms and vessel components. First two dimensions. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images. Key: Rim forms: A1a, A2a, A2b, B1a, B1b, C1b, C2b, C3a, D1a, D1b, D2a; Unidentified forms: R = rim sherd, B = body sherd, ped = pedestal sherd, B roul = roulette decoration on body sherd, ped roul = roulette decoration on pedestal sherd.

Source: C. Sarjeant.

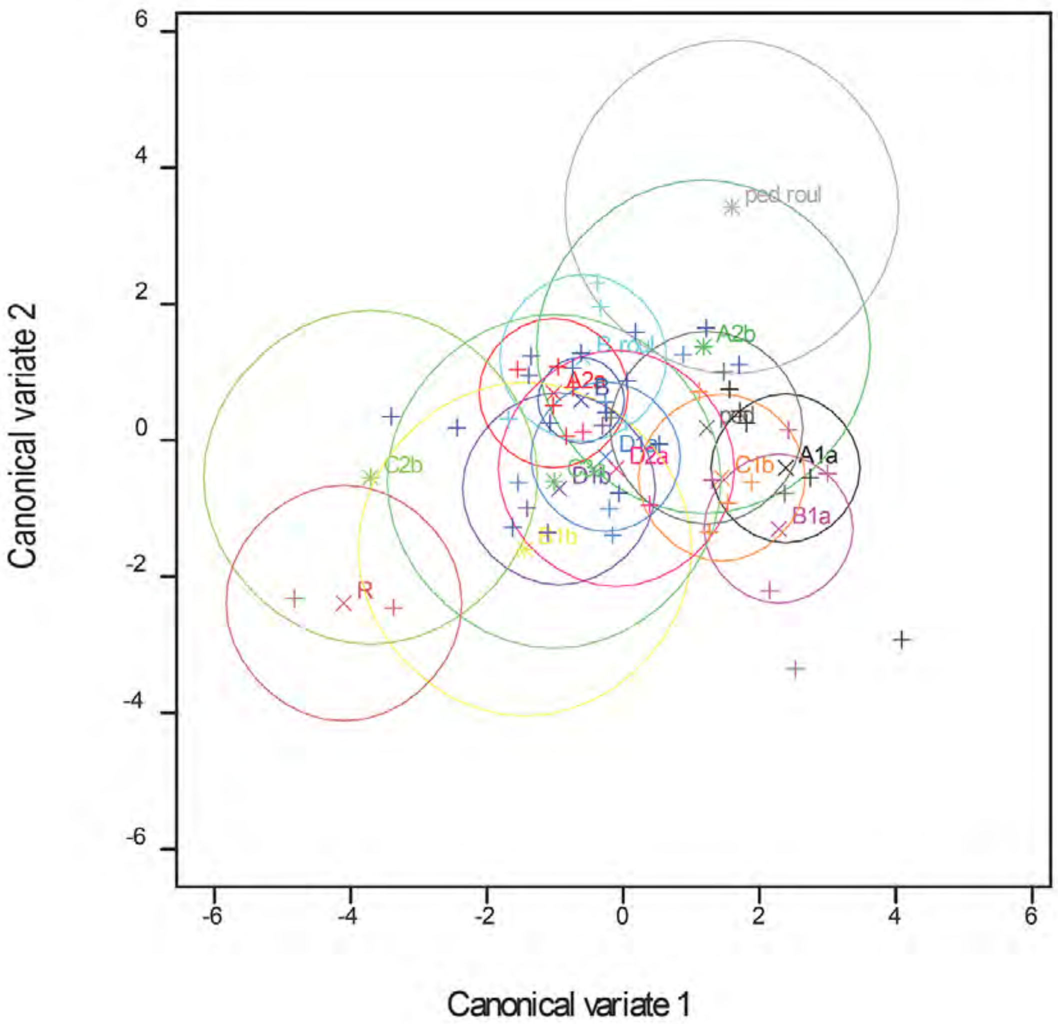

Figure 6.29. CVA plot of the An Sơn rim forms and vessel components with 95% confidence circles. First two dimensions. Refer to Figure 5.1 for rim form images. Key: Rim forms: A1a, A2a, A2b, B1a, B1b, C1b, C2b, C3a, D1a, D1b, D2a; Unidentified forms: R = rim sherd, B = body sherd, ped = pedestal sherd, B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

Table 6.21. CVA loadings for Figures 6.28 and 6.29 of the An Sơn rim forms and vessel components. First three dimensions.

	1 (50.02%)	2 (19.85%)	3 (15.00%)
1	-3.137	1.871	1.062
2	0.180	-0.268	0.190
3	1.504	1.447	2.632
4	1.716	-5.427	-1.875
5	-1.293	-2.194	0.456
6	3.655	2.190	-2.829
7	-0.700	0.735	0.549

Source: Compiled by C. Sarjeant.

Layers

This CVA was undertaken to assess if there were differences in clay matrices over time, within the excavated layers at An Sơn. The CVA includes sherds from the lower deposits of the Test Square and of 1997 Trench 1. The CVA plot reveals a lot of overlap in the clay matrix compositional data of the layer groups (Figure 6.30, Figure 6.31, Table 6.22). There appears to have been some variation between the majority of the sherds and those from the 1997 Trench 1 lower deposit at 360–410 cm. The 2009 Trench 1 layer 8 sherds are variable in their placement in the CVA plot, but the 2009 Trench 1 layer 7 sherds cluster near the 1997 360–410 cm group, while the remaining 2009 layer groups cluster closer together. There appears to be more variation in clay matrix composition in the lower to basal sherds from Trench 1 layers 7 and 8, and also layer 5, and from 360–410 cm of the 1997 excavation. Refer to Appendix A for sample identification numbers.

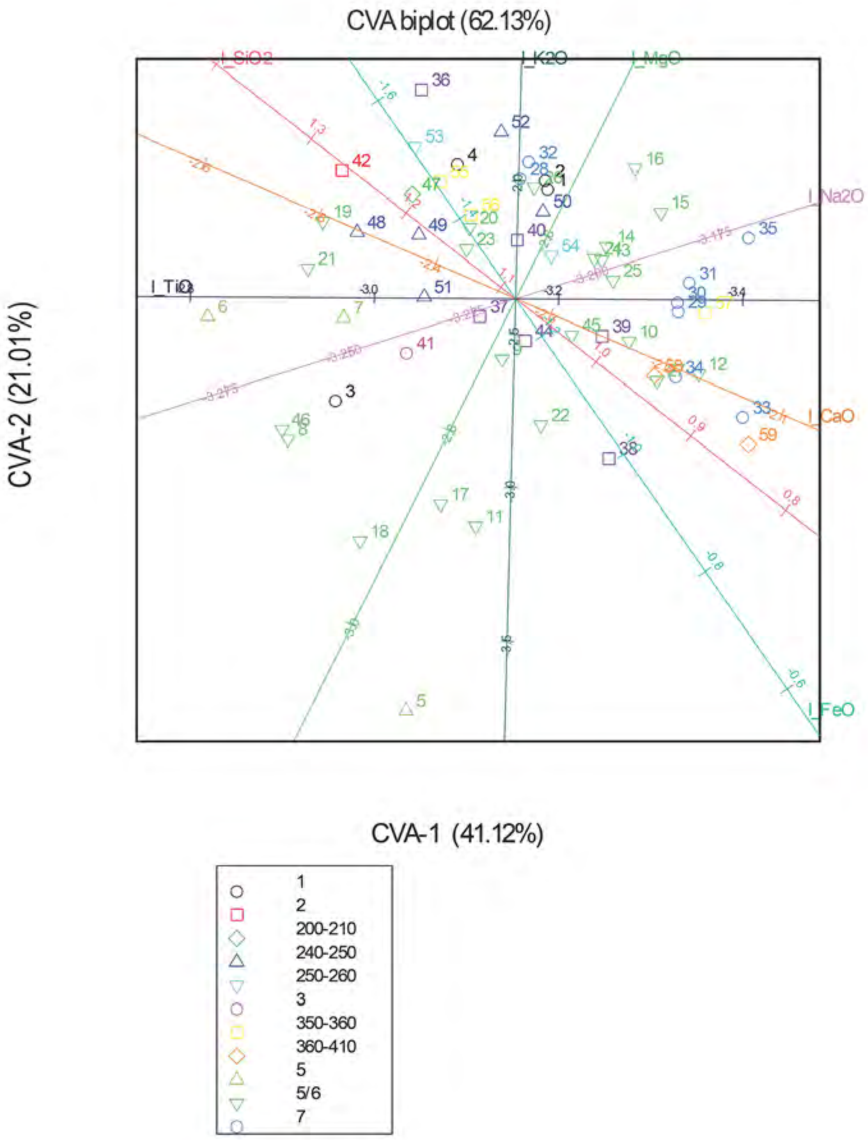

Figure 6.30. CVA biplot of the An Sơn layers. First two dimensions. Refer to Appendix A for sample identification numbers.
Key: 1, 2, 3, 5, 5/6, 7, 8 = 2009 Trench 1 layers; 200–210 cm, 240–250 cm, 250–260 cm = Test Square spits; 350–360 cm, 360–410 cm = 1997 excavation spits.

Source: C. Sarjeant.

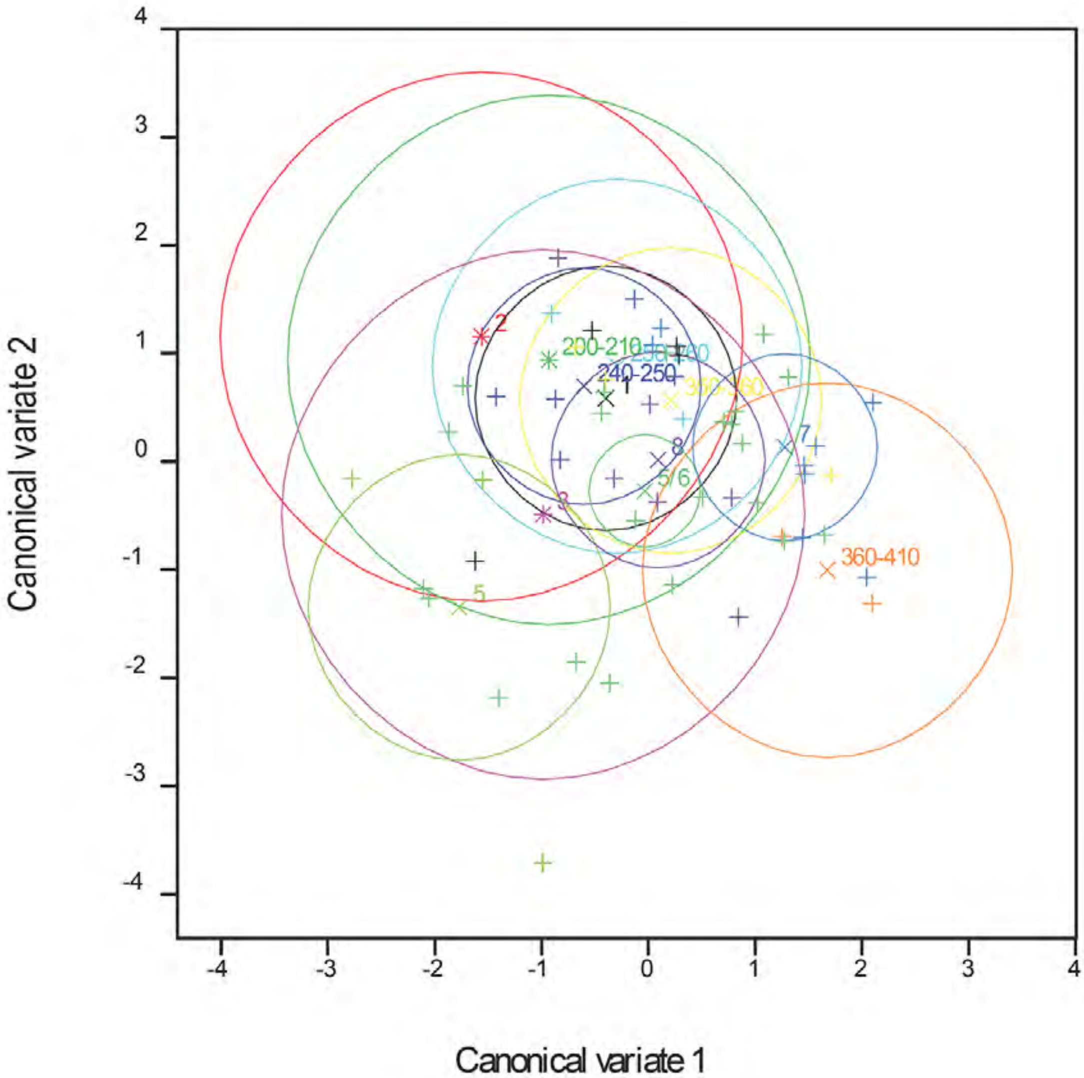

Figure 6.31. CVA plot of the An Sơn layers with 95% confidence circles. First two dimensions. Key: 1, 2, 3, 5, 5/6, 7, 8 = 2009 Trench 1 layers; 200–210 cm, 240–250 cm, 250–260 cm = Test Square spits; 350–360 cm, 360–410 cm = 1997 excavation spits.

Source: C. Sarjeant.

Table 6.22. CVA loadings for Figure 6.30 and Figure 6.31 of the An Sơn layers. First three dimensions.

	1 (41.12%)	2 (21.01%)	3 (15.69%)
1	1.108	0.444	1.716
2	2.307	-2.937	-2.069
3	0.959	2.064	-0.528
4	2.952	0.723	1.963
5	-0.250	-0.903	0.838
6	-4.948	-2.889	-3.497
7	-1.739	0.157	2.586

Source: Compiled by C. Sarjeant.

Tempers

This CVA was undertaken to assess whether there was any statistical relationships between the tempers (identified according to TG A, B, C, D and E) and clay matrix compositions. While the CVA plot presents a close arrangement of the samples, there is separation between the fibre temper (TG B) and sand temper (TG A1, A2, A3) groups, as indicated in the CVA temper plot for the Trench 1 square C1 sherds (Figure 6.32, Figure 6.33, Table 6.23). This suggests there was a distinction, albeit slight, in clay compositions between the sand and fibre groups. This is consistent with the previous hierarchical cluster analysis dendrogram (Figure 6.27, Table 6.20), where the sand tempered sherds were associated with main group 1 and main group 2 (subgroups 5–6), and the fibre (TG B), fibre/phosphate (TG B/C), fibre/calcareous (TG B/D) and calcareous (TG D) tempered sherds were associated with main group 2 (subgroups 1–4). The mixed sand/fibre (TG A1/B) tempered sherds also form a separate group; subgroup 7 of main group 2. Refer to Appendix A for sample identification numbers.

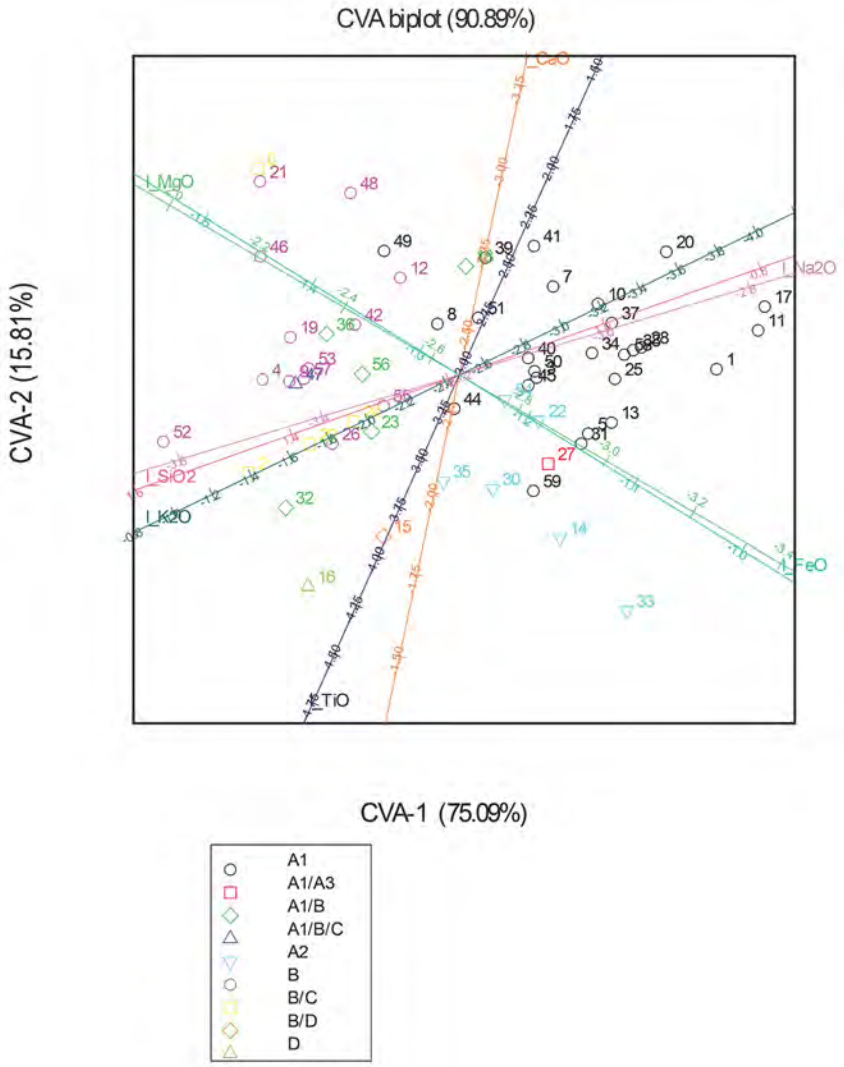

Figure 6.32. CVA biplot of the An Sơn tempers. First two dimensions. Refer to Appendix A for sample identification numbers. Key: A1 = mineral sand, A2 = lateritic (micaceous) sand, A3 = impure iron oxide (large grains)/almandine sand, B = fibre, C = phosphate, D = calcareous.

Source: C. Sarjeant.

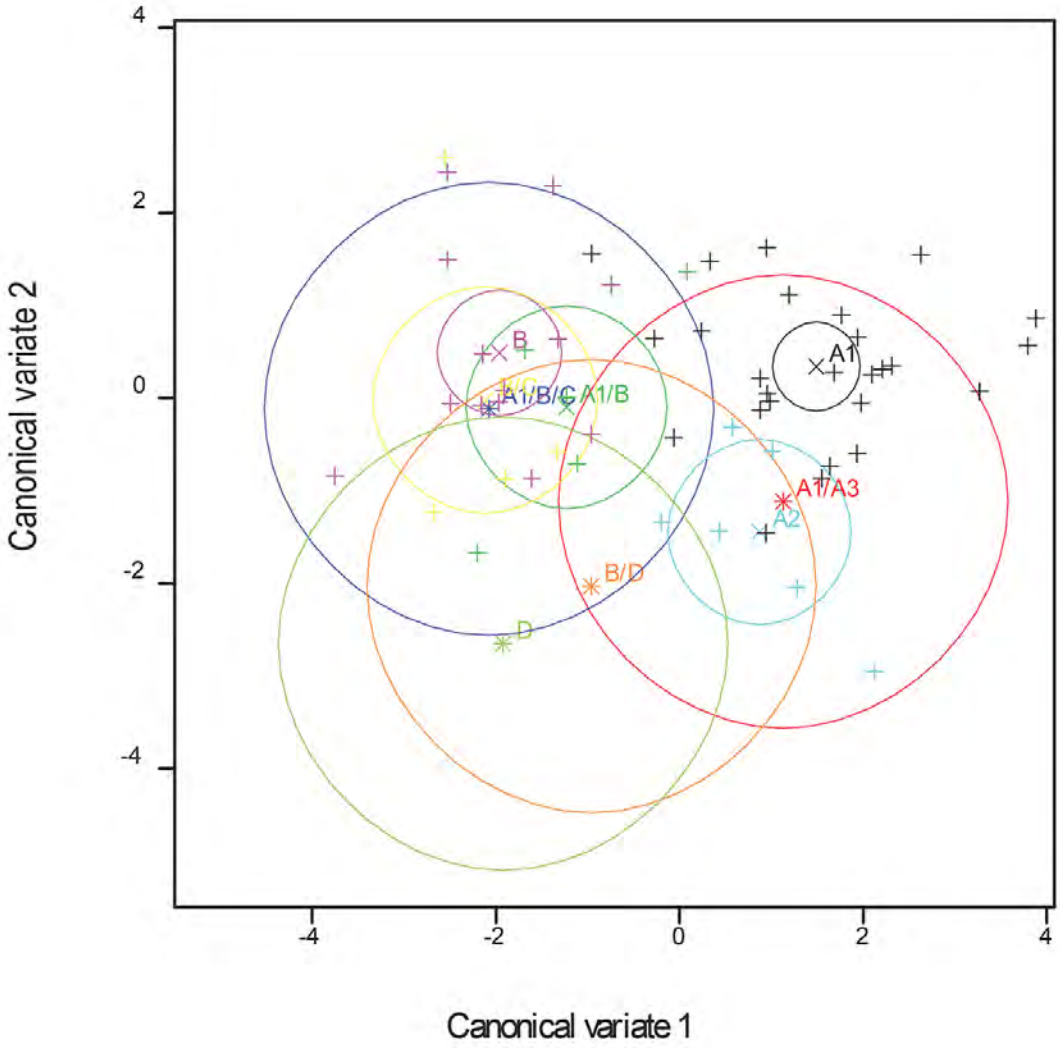

Figure 6.33. CVA biplot of the An Sơn tempers with 95% confidence circles. First two dimensions. Key: A1 = mineral sand, A2 = lateritic (micaceous) sand, A3 = impure iron oxide (large grains)/almandine sand, B = fibre, C = phosphate, D = calcareous.

Source: C. Sarjeant.

Table 6.23. CVA loadings for Figures 6.32 and 6.33 of the An Sơn tempers. First three dimensions.

	1 (75.09%)	2 (15.81%)	3 (5.19%)
1	1.613	-2.239	0.724
2	2.566	1.484	3.906
3	0.624	0.512	0.570
4	-5.033	-4.034	0.031
5	0.745	-0.471	0.680
6	-3.989	2.624	3.264
7	-0.054	1.667	-0.407

Source: Compiled C. Sarjeant.

Rim form and clay selection

A selection of diagnostic An Sơn rim sherds was chosen to investigate the relationship between rim form and clay matrix composition. The selected forms were each represented by numerous samples including: A2a rim sherds and roulette decorated body sherds from these concave rimmed restricted vessels; B1b thickened rims from restricted vessels; C1b rims from shouldered vertical or slightly inverted lipped unrestricted vessels; D1a and D1b wavy rims; and D2a serrated rims (see images of these rim forms in Figure 5.1). These rim forms were identified as characteristic ceramics at An Sơn because they were frequently identified in the assemblage over time and were part of a regional ceramic tradition. These aspects are discussed further in regard to vessel forms in Chapter 10.

Principal components analysis

The greatest variability in the following PCA plots (Figure 6.34, Figure 6.35) is a result of the concentrations of MgO and Na_2O in the clay matrix compositions (Table 6.24). When examining all three dimensions, three main groups are evident, with a number of outliers (Table 6.25). However, the variability is minimal in the three dimensions of the PCA of these specific forms from An Sơn. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1**: samples 2, 8, 26, 29, 35

  This group consists of ceramic sherds from layers 1, 5/6 and 7, with rim forms A2a and D1a, but predominantly C1b rim sherds. The represented tempers were sand, fibre and fibre/phosphate.

- **Main group 2**: samples 1, 3, 7, 25, 28, 31, 37, 50, 51

  This group consists of ceramic sherds from layers 1, 5, 5/6, 7 and 8, and from the Test Square 240–250 cm, with form A2a roulette decorated body and rim sherds, and D1a and D1b rim sherds. The represented tempers were predominantly sand, but there was one fibre tempered body sherd.

- **Main group 3**: samples 24, 54, 56

  This group consists of ceramic sherds from layers 5/6, the Test Square 250–260 cm, and 1997 Trench 1 350–360 cm, with the forms B1a, C1b and D1b present. The represented tempers were fibre/phosphate, sand and lateritic sand.

- **Outlier groups**: samples 10 / 23 / 27, 30 / 36 / 40 / 41 / 44 / 48 / 49 / 57

  These outliers included sherds from layers 3, 5/6, 7 and 8, the Test Square 240–250 cm, and 1997 Trench 1 350–360 cm. The forms included A2a roulette decorated body and rim sherds, D1a, D1b and D2a rim sherds, and a majority of B1a rim sherds. The represented tempers were sand, fibre (including one sample with bleb grog), sand/lateritic sand, and sand/fibre.

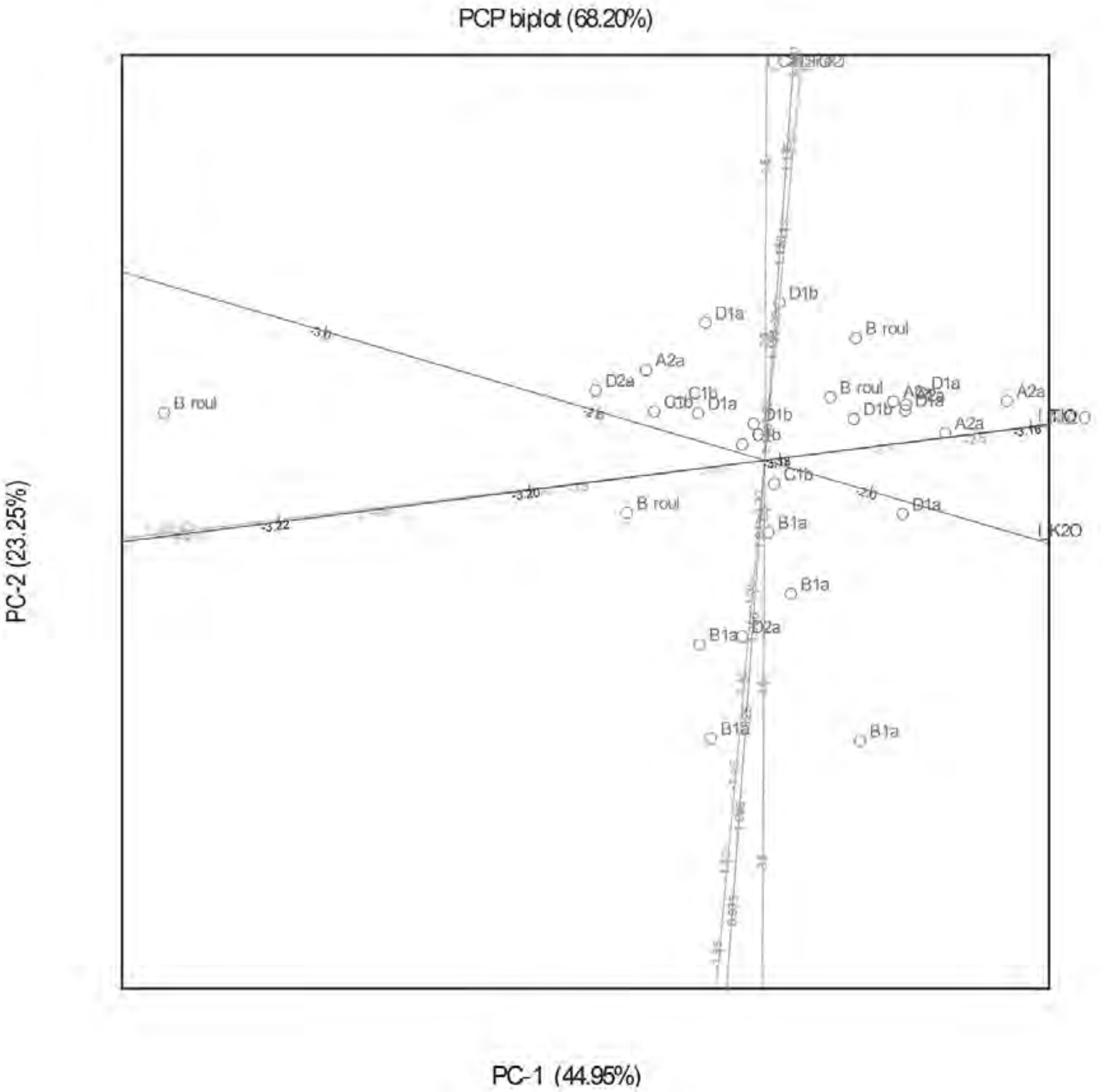

Figure 6.34. PCA biplot of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First two dimensions. Refer to Figure 5.1 for rim form images. Key: Rim forms: A2a, B1b, C1b, D1a, D1b, D2a; Unidentified forms: B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

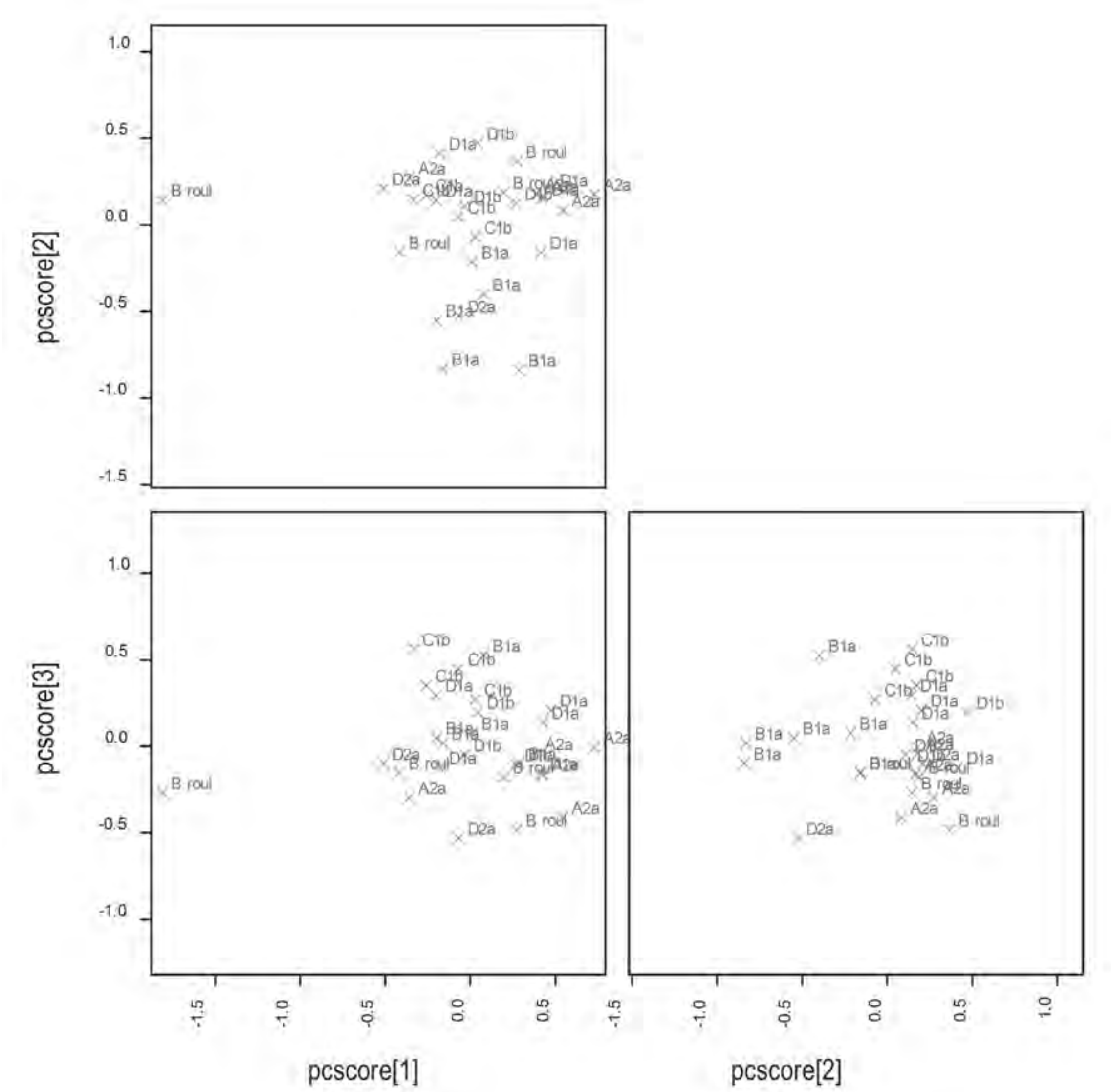

Figure 6.35. PCA plot of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First three dimensions. Refer to Figure 5.1 for rim form images. Key: Rim forms: A2a, B1b, C1b, D1a, D1b, D2a; Unidentified forms: B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

Table 6.24. PCA loadings for Figures 6.34 and 6.35 of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (44.95%)	**PC 2 (23.25%)**	**PC 3 (15.85%)**
CaO	0.00456	0.96008	0.07069
FeO	0.01706	0.18380	0.24047
K_2O	0.56012	**-0.16304**	0.54442
MgO	**-0.09441**	-0.01182	**0.69410**
Na_2O	**0.82239**	0.09976	**-0.30405**
SiO_2	0.00638	0.08815	0.16545
TiO_2	0.02604	0.00328	0.19796

Source: Compiled by C. Sarjeant.

Table 6.25. Samples in the PCA groupings in Figure 6.35 of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First three dimensions.

	PC 1/PC 2	PC 1/PC 3	PC 2/PC 3
Main group 1	2, 8, 26, 29, 35, 44, 54	2, 26, 35, 57 (29)	26, 35, 50, 51 (2, 24, 29)
Main group 2	25, 37, 50, 51 (1, 3, 7, 28, 31)	7, 25, 31, 36, 37, 40 (50, 51)	1, 7, 8, 23, 25, 28, 31, 37, 44, 54 (3, 27)
Main group 3	24, 56	24, 27, 30, 48, 49, 54, 56 (8, 10, 44)	
Main group 4	41, 49, 57		
Outlier group 1	10	1	10, 40
Outlier group 2	23	23	41
Outlier group 3	27, 30	3	30
Outlier group 4	36	28	36, 48
Outlier group 5	40	41	49
Outlier group 6	48		56
Outlier group 7			57

Source: Compiled by C. Sarjeant.

Hierarchical cluster analysis

This dendrogram has been presented with An Sơn rim forms instead of the sample numerical codes to clarify the relationships between the rim form groups and clay matrix compositions. Two major groups and one major outlier are evident in the cluster analysis dendrogram (when cut at 0.80), each with valid subgroups (cut at 0.925) (Figure 6.36, Table 6.26). Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1**:
    - **Subgroup 1**: rim form A2a
    - **Subgroup 2**: form A2a roulette decorated body sherd, rim form D2a
    - **Subgroup 3**: rim form B1a (n=3)

Main group 1 of the hierarchical cluster analysis (Table 6.26) is most consistent with the outliers of the previous PCA (Figure 6.35, Table 6.25).

- **Main group 2**:
    - **Subgroup 1**: rim forms C1b (n=4), B1a
    - **Subgroup 2**: rim forms A2a (n=2), D1b (n=3), D1a (n=3), D2a
    - **Subgroup 3**: form A2a roulette decorated body sherd (n=2), rim forms D1a (n=2), A2a
    - **Subgroup 4**: rim form A2a
    - **Subgroup 5**: rim form B1a

Main group 2 (Table 6.26) is most consistent with main group 1, particularly subgroup 1, and main group 2 of the previous PCA (Figure 6.35, Table 6.25).

- **Outlier**: form A2a roulette decorated body sherd

The dendrogram (Figure 6.36, Table 6.26) suggests there are links between rim forms and the clay matrix compositions in the An Sơn ceramics. Notably, the B1a and C1b rim forms are distinct, and the sherds within these form groups are closely related to each other. This is similarly the situation for C1b rim forms. The D1a, D1b and D2a rim forms cluster together, but also cluster with the A2a rim and roulette decorated body sherds.

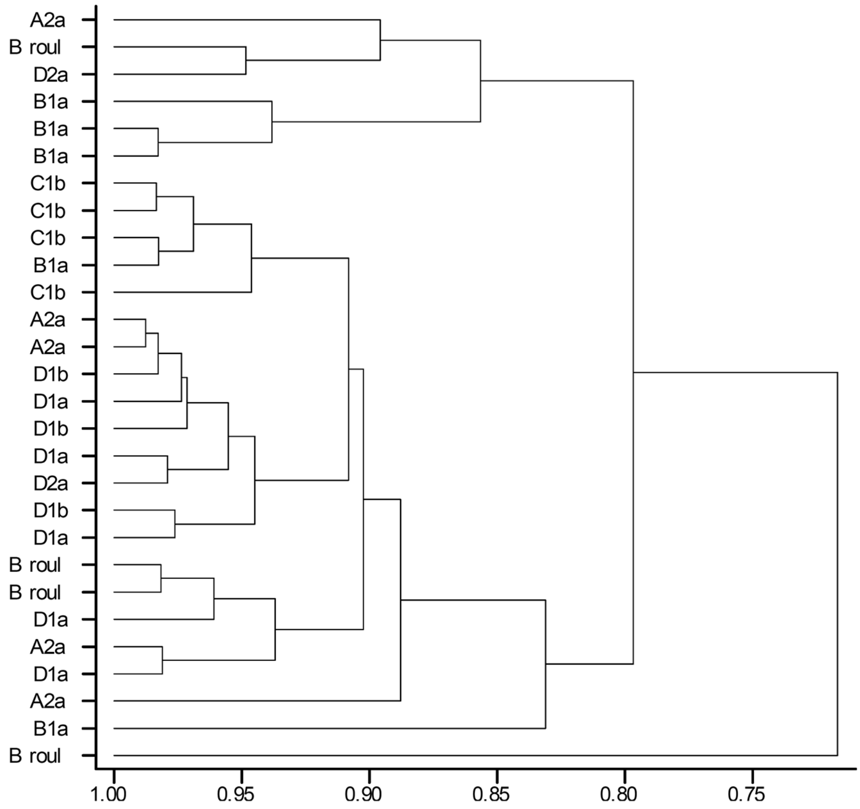

Figure 6.36. Average-linkage hierarchical cluster analysis dendrogram of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. Refer to Figure 5.1 for rim form images. Key: Rim forms: A2a, B1b, C1b, D1a, D1b, D2a; Unidentified forms: B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

Table 6.26. Samples in the hierarchical cluster analysis dendrogram groupings in Figure 6.36 of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a when cut at 0.80 and 0.925.

Main group (cut at 0.80)	Subgroup (cut at 0.925)	Forms
	1	A2a
1	2	A2a roulette stamped body, D2a
	3	B1a
	1	B1a, C1b
	2	A2a, D1a, D1b, D2a
2	3	A2a, A2a roulette stamped body, D1a
	4	A2a
	5	B1a
Outlier	1	A2a roulette stamped body

Source: Compiled by C. Sarjeant.

Canonical variate analysis

To follow on from the PCA and cluster analysis, the rim form *a priori* group was applied to this CVA to assess how chemically similar the rim forms at An Sơn were, and which forms were more closely related to each other. The CVA (Figure 6.37, Figure 6.38, Table 6.27) supports the

previous PCA (Figure 6.34, Figure 6.35, Table 6.25) and dendrogram (Figure 6.36, Table 6.26), in that it differentiates the B1a and C1b rim forms from the rest. It also shows a close link in the clay matrix composition of rim form A2a sherds and roulette decorated body sherds to confirm that the latter are the shoulder components of the former. While the D1a and D1b rim forms were similarly plotted in the CVA as in the PCA (Figure 6.35) and dendrogram (Figure 6.36), the CVA plotted rim form D2a with more variation, suggesting that the clay matrix composition differs between classes D1 and D2. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

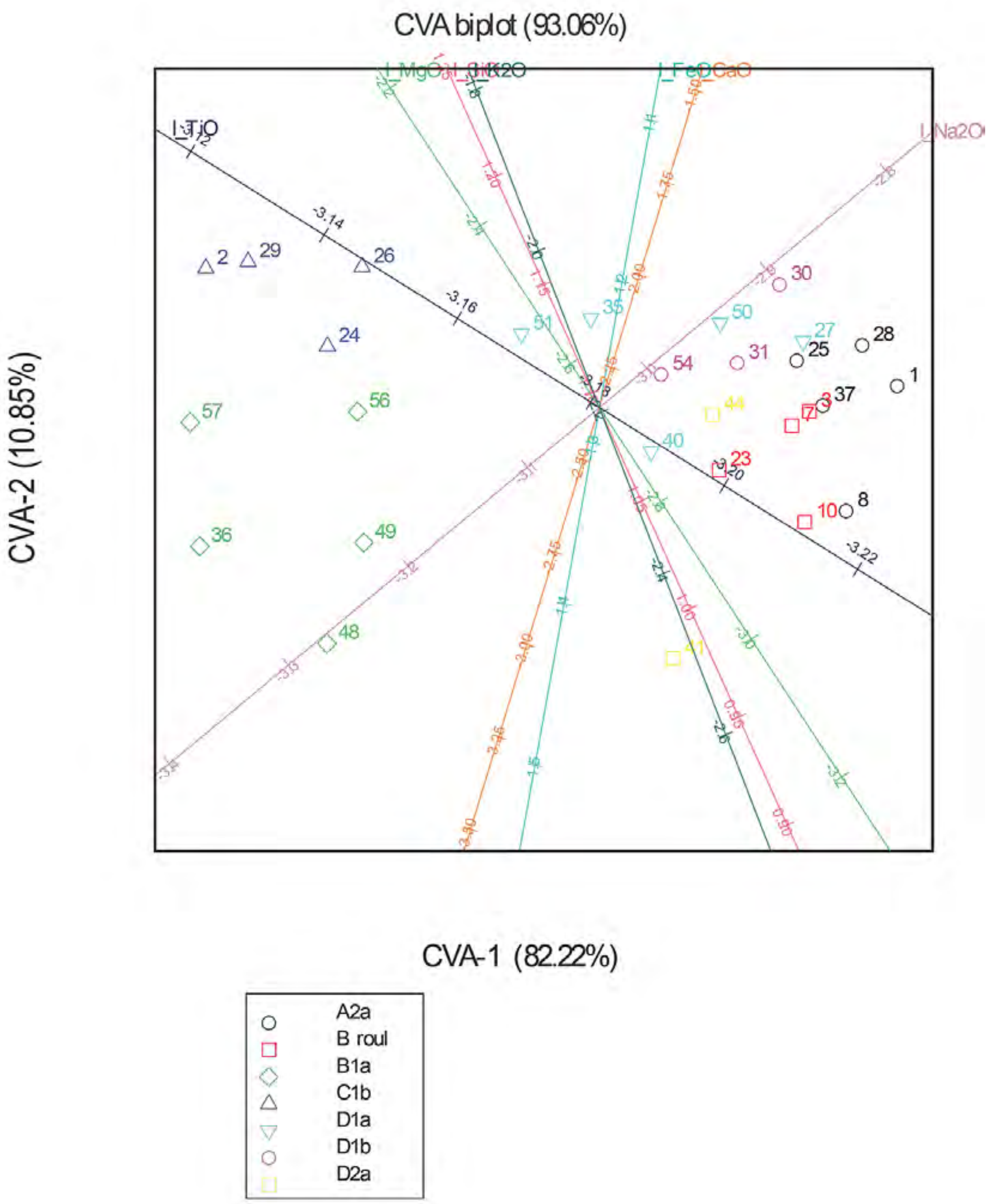

Figure 6.37. CVA biplot of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First two dimensions. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images. Key: Rim forms: A2a, B1b, C1b, D1a, D1b, D2a; Unidentified forms: B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

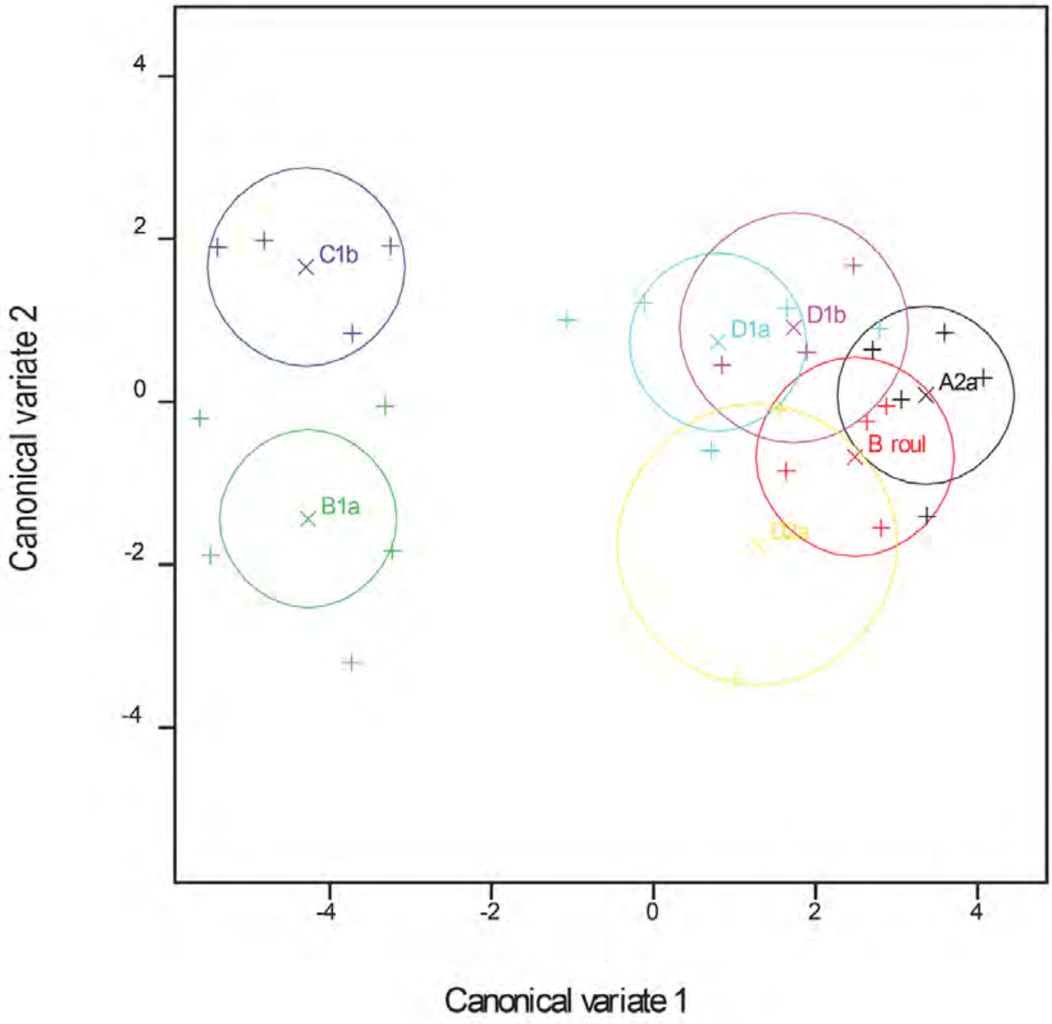

Figure 6.38. CVA plot of the An Sơn rim forms and vessel components with 95% confidence circles, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First two dimensions. Refer to Figure 5.1 for rim form images. Key: Rim forms: A2a, B1b, C1b, D1a, D1b, D2a; Unidentified forms: B roul = roulette decoration on body sherd.

Source: C. Sarjeant.

Table 6.27. CVA loadings for Figure 6.37 and Figure 6.38 of the An Sơn rim forms and vessel components, rim forms A2a, B1b, C1b, D1a, D1b and D2a. First three dimensions.

	1 (82.22%)	2 (10.85%)	3 (5.05%)
1	5.367	3.605	0.040
2	3.520	-0.565	0.548
3	-1.561	1.565	-2.004
4	-11.224	3.550	0.257
5	0.524	0.100	-0.692
6	-7.692	-0.411	5.410
7	5.616	-2.110	-4.893

Source: Compiled C. Sarjeant.

Clay matrix characterisation: An Sơn ceramics compared with clay samples and non-local ceramics

This section compares the previously analysed An Sơn ceramics with unfired and fired clays from the vicinity of the site, sherds from neighbouring sites in the Vàm Cỏ Đông valley, and sites further afield in southern Vietnam and elsewhere. These non-local ceramic and clay samples were described in the temper and non-plastic characterisations. Similar statistical methods were applied as previously with a focus on CVA, applying archaeological sites as *a priori* groups.

Do the An Sơn rim forms and associated clay selections occur in other sites in southern Vietnam?

Continuing from the above section, a CVA was undertaken to reveal any non-local relationships for An Sơn forms A2a, B1a, C1b, D1a, D1b and D2a (see Figure 5.1 for rim form images). Comparative southern Vietnam samples were analysed from neolithic contexts at Đình Ông, Lộc Giang, and Cù Lao Rùa, and metal age contexts at Giồng Cá Vồ (see site locations in Figure 1.3). Background information regarding Cù Lao Rùa, Đình Ông and Lộc Giang are provided in Chapter 2, and Chapters 8, and for Giồng Cá Vồ are in Chapter 2. The CVA plot also includes unfired clay from natural deposits and fired clay lump samples (see Chapter 4) that were identified during excavation in archaeological contexts (see descriptions of the clay samples in this chapter). The clay matrix compositions of the unfired clays were outliers and are not shown in this CVA plot (Figure 6.39, Figure 6.40, Table 6.28).

The CVA plot indicates that there was little relationship, in terms of clay matrix composition, between the An Sơn rim sherds and those from Cù Lao Rùa (Figure 6.39, Figure 6.40, Table 6.28). The An Sơn B1a and C1b rims group closely with the An Sơn fired clay lumps and Giồng Cá Vồ sherds, suggesting that they have similar clay matrix compositions. This is surprising considering the much later date for occupation at Giồng Cá Vồ. In the CVA plot the remaining rim forms, A2a, D1a, D1b and D2a, overlap with each other, and with the Đình Ông sherds, but less so with the Lộc Giang sherds.

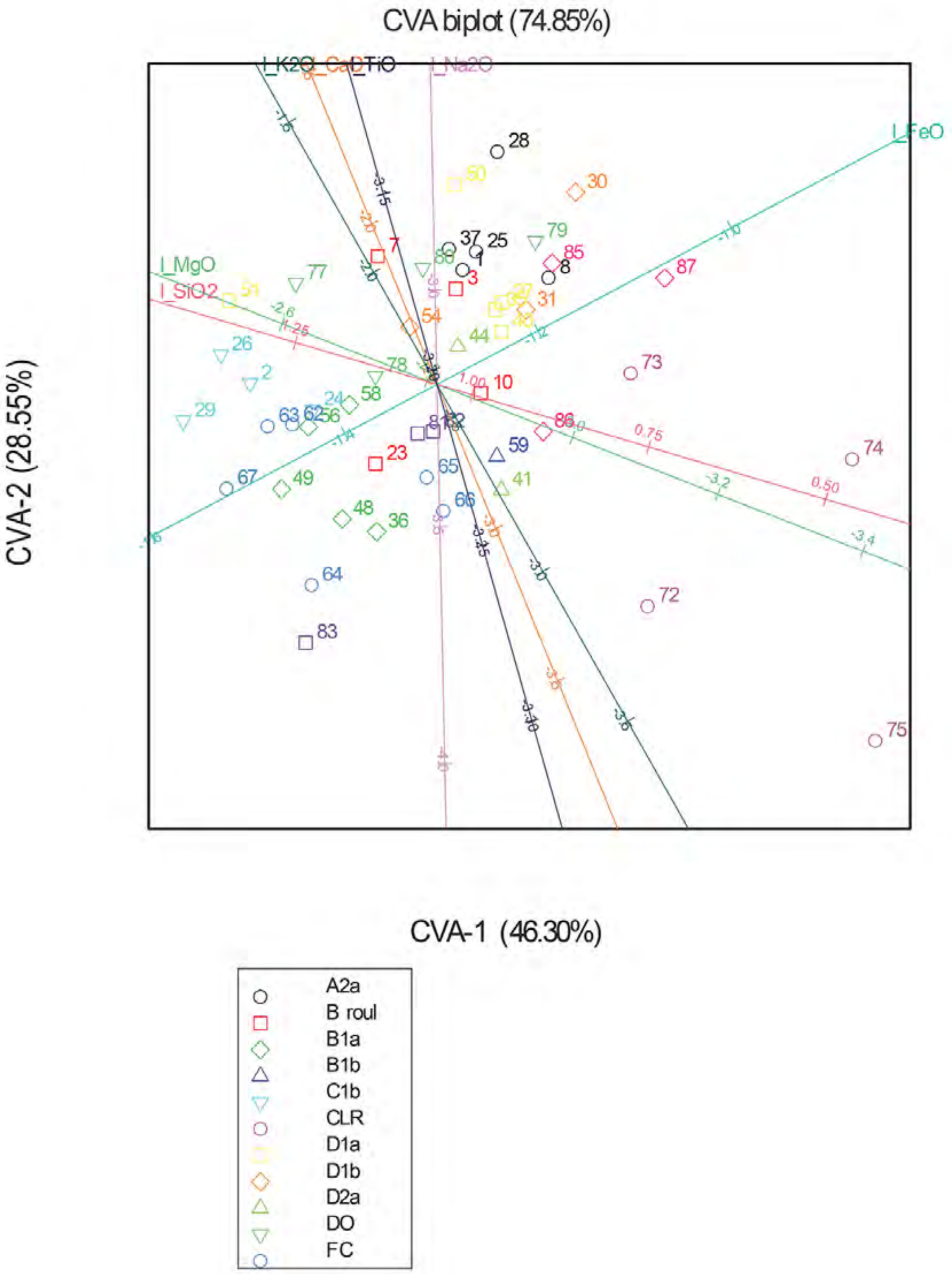

Figure 6.39. CVA biplot of the An Sơn rim forms and vessel components, clays and other site samples. First two dimensions. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images. Key: Rim forms: A2a, B1a, C1b, D1a, D1b, D2a; Body sherds: B roul = roulette decoration; Clay: FC = An Sơn fired clay; Other sites: CLR = Cù Lao Rùa, DO = Đình Ông, GCV = Giồng Cá Vồ, LG = Lộc Giang.

Source: C. Sarjeant.

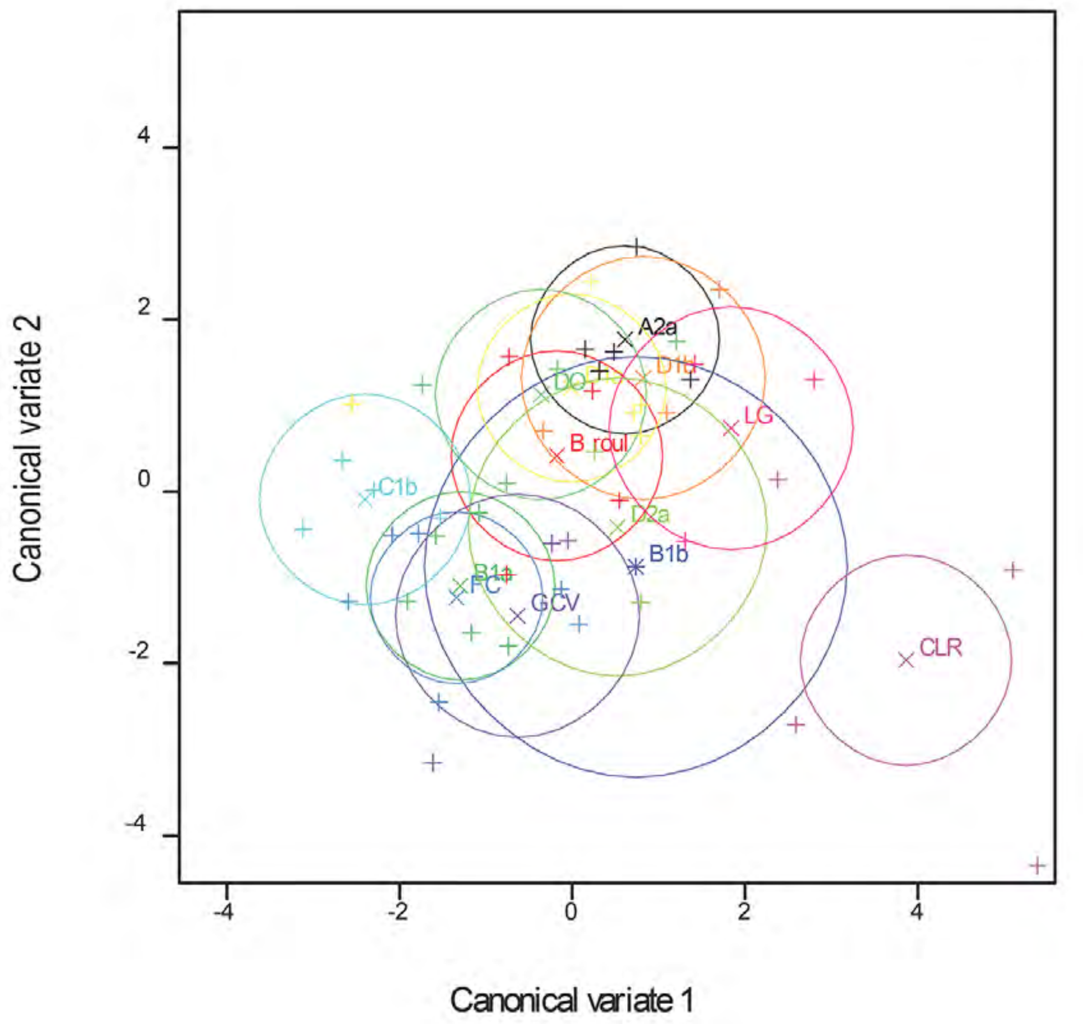

Figure 6.40. CVA plot of the An Sơn rim forms and vessel components, clays and other site samples with 95% confidence circles. First two dimensions. Refer to Figure 5.1 for rim form images. Key: Rim forms: A2a, B1a, C1b, D1a, D1b, D2a; Body sherds: B roul = roulette decoration; Clay: FC = An Sơn fired clay; Other sites: CLR = Cù Lao Rùa, DO = Đình Ông, GCV = Giồng Cá Vồ, LG = Lộc Giang.

Source: C. Sarjeant.

Table 6.28. CVA loadings for Figures 6.39 and 6.40 of the An Sơn rim forms and vessel components, clays and other site samples. First three dimensions.

	1 (46.30%)	2 (28.55%)	3 (12.03%)
1	1.161	3.300	-1.505
2	0.527	0.456	0.833
3	-1.553	1.246	2.098
4	-2.024	-2.470	-1.706
5	1.279	0.270	-0.668
6	-6.890	-1.974	1.030
7	4.883	3.527	1.487

Source: Compiled C. Sarjeant.

What is the relationship between the ceramics and clays of southern Vietnam, and beyond southern Vietnam?

This section includes all of the An Sơn studied ceramic sherds and archaeological fired clay lumps (see Chapter 4), together with unfired clays collected near the site. Included in the analysis were the sherds from Cù Lao Rùa, Đình Ông, Giồng Cá Vồ and Lộc Giang, as well as sites located further afield, Hòa Diêm, Ban Non Wat, Mán Bạc, Cồn Cổ Ngựa and Đa Bút (see site locations in Figures 1.2 and 1.3). Hòa Diêm is a metal age site in coastal central Vietnam (see background information in Chapter 2). Ban Non Wat, northeast Thailand and Mán Bạc, northern Vietnam are neolithic sites (see background information in Chapters 2 and 9). Pre-neolithic or incipient neolithic occupations are represented by Cồn Cổ Ngựa and Đa Bút, northern Vietnam (see background information in Chapter 2).

Principal components analysis

This PCA includes the major outliers in the An Sơn sample (samples 43, 60 and 61) already described. The PCA groupings presented above are obscured here, since the sherds from the more distant sites increased the variability of the sample. Since the clay matrix compositional groups of the An Sơn ceramic sample has already discussed, this section focuses on samples from other sites and their clay compositional relationship with the An Sơn sample as a whole. These relationships are clearer in the following hierarchical cluster analysis dendrogram and CVA plots.

The greatest variability in the following PCA plots (Figure 6.41, Figure 6.42) is a result of the concentrations of CaO and FeO in the clay matrix compositions (Table 6.29). When examining all three PCA dimensions, there is evidence of a main cluster consisting of the majority of An Sơn sherds, and two smaller groups (Table 6.30). Refer to Appendix A for sample identification numbers.

- **Main group 1**: all unlisted An Sơn ceramic sherds, and samples 62, 63, 65, 67, 73, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91

  This group consists of the majority of the An Sơn ceramic sherds, in addition to fired clay lump samples from An Sơn, a sand tempered sherd from Cù Lao Rùa, sand (including one sample with orthodox grog) and fibre tempered sherds from Đình Ông, sand/iron-rich sand and fibre tempered sherds from Giồng Cá Vồ, a sand tempered sherd from Hòa Diêm, sand (including one sample with orthodox grog) and fibre (and orthodox grog) tempered sherds from Lộc Giang, sand/iron-rich sand tempered and untempered sherds from Mán Bạc, and a fibre tempered sherd from Ban Non Wat.

- **Main group 2**: samples 5, 66

  This group consists of a sand tempered rim sherd from layer 5 at An Sơn, and a fired clay sample from the Test Square 240–250 cm.

- **Main group 3**: samples 60, 61

  This group consists of the two surface collected fibre bleb grog tempered sherds from An Sơn.

- **Outliers**: samples 43, 74 / 64 / 68 / 70 / 71 / 72 / 75 / 76

  The outliers include the Óc Eo phase sherd from An Sơn, fired and unfired clay samples from An Sơn, sand and sand/iron-rich sand tempered sherds from Cù Lao Rùa, and sand/iron-rich sand tempered sherds from Cồn Cổ Ngựa and Đa Bút.

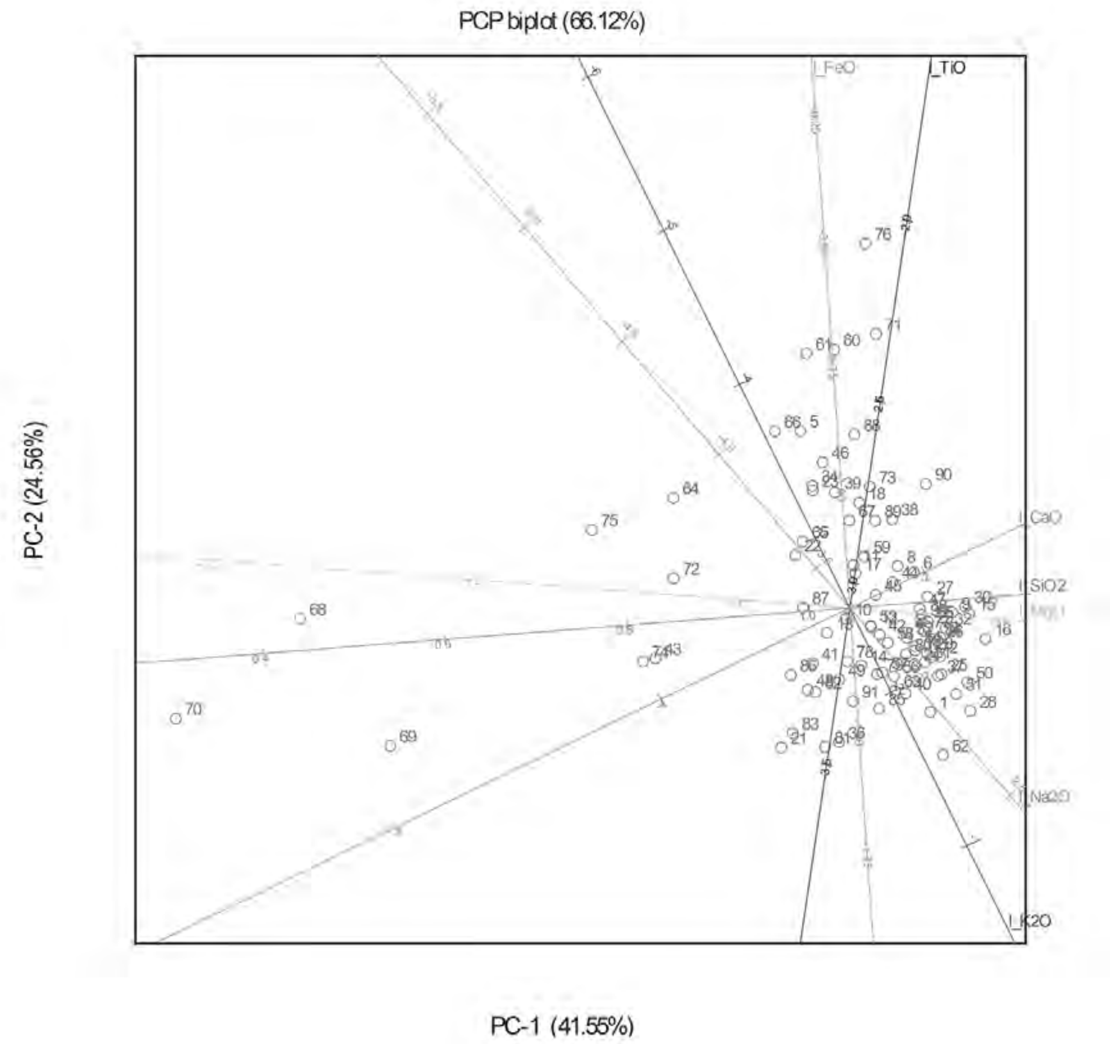

Figure 6.41. PCA biplot of the An Sơn ceramic samples, clays and other site samples. First two dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

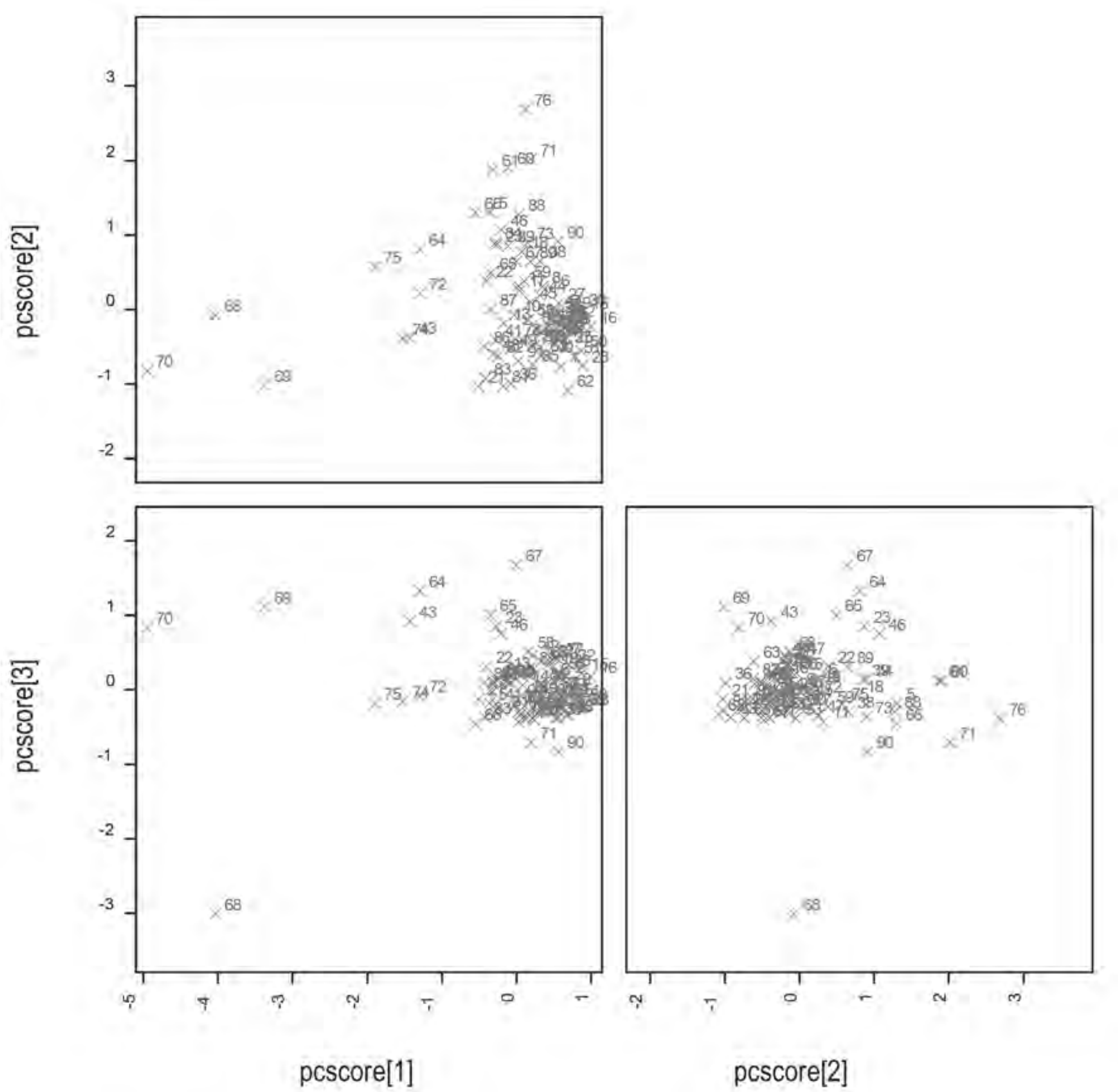

Figure 6.42. PCA plot of the An Sơn ceramic sample, clays and other site samples. First three dimensions. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.29. PCA loadings for Figures 6.41 and 6.42 of the An Sơn ceramic sample, clays and other site samples. First three dimensions. The bold values indicate the element oxides that presented the greatest variability in the PCA.

	PC 1 (41.55%)	PC 2 (24.56%)	PC 3 (12.94%)
CaO	**0.83680**	**0.40520**	0.10621
FeO	**-0.01925**	0.27590	**-0.84683**
K_2O	0.34916	**-0.71074**	-0.01478
MgO	0.25605	-0.01923	0.00183
Na_2O	0.29489	-0.34632	-0.46502
SiO_2	0.14853	0.01156	**0.23047**
TiO_2	0.05389	**0.36619**	0.04486

Source: Compiled C. Sarjeant.

Table 6.30. Samples in the PCA groupings in Figure 6.42 of the An Sơn ceramic sample, clays and other site samples. Refer to Appendix A for sample identification numbers.

	PC 1/ PC 2	PC 1/ PC 3	PC 2/ PC 3
Main group 1	all unlisted An Sơn samples, and 62, 63, 65, 67, 73, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91	all unlisted An Sơn samples, and 62, 63, 65, 66, 71, 73, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91	all unlisted An Sơn samples, and 62, 63, 67, 72, 74, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 89, 91
Main group 2	5, 66	23, 46, 65	5, 66, 73, 88 (90)
Main group 3	60, 61, 71		60, 61
Main group 4			18, 34, 38, 39, 75
Outlier group 1	43, 74	43, 64	43, 69, 70
Outlier group 2	64	67	64, 65
Outlier group 3	68	68	68
Outlier group 4	69	69	23, 46
Outlier group 5	70	70	67
Outlier group 6	72	72, 74, 75	71
Outlier group 7	75		
Outlier group 8	76		76

Source: Compiled by C. Sarjeant.

Hierarchical cluster analysis

This dendrogram includes the major outliers (samples 43, 60 and 61) already described. Four main groups are evident in the cluster analysis dendrogram (when cut at 0.950), and a number of samples that are not closely related to the rest of the sample are also present, akin to the outliers in the previous PCA (Table 6.30). A large number of subgroups are evident (when cut at 0.9875) (Figure 6.43, Table 6.31). Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.

- **Main group 1***:*
  - **Subgroup 1**: sample 91

    This subgroup consists of a Ban Non Wat fibre tempered sherd.
  - **Subgroup 2**: sample 51

    This subgroup consists of a D1a sand tempered rim sherd from the Test Square 240–250 cm.
  - **Subgroup 3**: sample 3

    This subgroup consists of a form A2a roulette decorated sand tempered body sherd from layer 1.
  - **Subgroup 4**: samples 1, 81, 85, 7, 80, 79, 84

    This subgroup consists of A2a sand tempered rim sherds from layers 1 and 5/6, a Giồng Cá Vồ sand/iron-rich sand tempered sherd, a Lộc Giang sand tempered sherd, Đình Ông sand tempered sherds (including one sample with orthodox grog), and a Hòa Diêm sand tempered sherd.
  - **Subgroup 5**: samples 20, 25, 40, 31, 28, 37, 50

    This subgroup consists of a sand tempered body sherd from layer 5/6, A2a sand tempered rim sherds from layer 5/6 and 8, a D1a sand tempered rim sherd from layer 8, a D1b sand tempered rim sherd from layer 7, and a D1a sand tempered rim sherd from the Test Square 240–250 cm.

- **Subgroup 6**: samples 10, 78, 48, 49, 82

  This subgroup consists of a form A2a roulette decorated sand tempered body sherd from layer 5/6, a Đình Ông sand tempered sherd, B1a fibre and sand tempered rim sherds from the Test Square 240–250 cm, and a Giồng Cá Vồ fibre tempered sherd.

- **Subgroup 7**: samples 27, 45, 44, 54, 58, 41

  This subgroup consists of a D1a sand/iron-rich sand tempered rim sherd from layer 5/6, a C3a sand tempered rim sherd from layer 5/6, D2a sand tempered rim sherds from layer 8, a D1b lateritic sand tempered rim sherd from the Test Square 250–260 cm, and a sand tempered body sherd from 1997 Trench 1 360–410 cm.

- **Subgroup 8**: samples 21, 36, 83

  This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6, a B1a sand/fibre tempered rim sherd from layer 8, and a Giồng Cá Vồ fibre tempered sherd.

- **Subgroup 9**: sample 62

  This subgroup consists of a fired clay sample from Trench 2 30–40 cm.

- **Main group 2***:*
  - **Subgroup 1**: samples 2, 16, 15, 26, 32, 29

    This subgroup consists of C1b fibre/phosphate tempered rim sherds from layer 1, 5/6 and 7, a calcareous tempered body sherd from layer 5/6, a fibre/calcareous tempered body sherd from layer 5/6, and a sand/fibre tempered body sherd from layer 7.

  - **Subgroup 2**: samples 4, 47, 77, 52, 9

    This subgroup consists of A1a fibre tempered rim sherds from layer 1 and 5/6, an A2b sand/fibre/phosphate tempered rim sherd from the Test Square 200–210 cm, a Đình Ông fibre tempered sherd, and a fibre tempered pedestal sherd from the Test Square 240–250 cm.

  - **Subgroup 3**: samples 19, 24, 56, 63, 55

    This subgroup consists of an A1a fibre tempered rim sherd from layer 5/6, a C1b fibre/phosphate tempered rim sherd from layer 5/6, a B1a sand/fibre tempered rim sherd from layer 1997 Trench 1 350–360 cm, a fired clay sample from Trench 2 40–50 cm, and a fibre tempered pedestal sherd from 1997 Trench 1 350–360 cm.

  - **Subgroup 4**: samples 42, 53, 12

    This subgroup consists of a fibre tempered body sherd from layer 5/6, a fibre tempered pedestal sherd from the Test Square 240–250 cm, and an A1a fibre tempered rim sherd from layer 5/6.

  - **Subgroup 5**: samples 30, 35, 57

    This subgroup consists of a D1b lateritic sand tempered rim sherd from layer 7, a D1a lateritic sand tempered rim sherd from layer 7, and a B1a fibre bleb grog tempered rim sherd from 1997 Trench 1 350–360 cm.

  - **Subgroup 6**: samples 8, 18, 38

    This subgroup consists of an A2a sand tempered rim sherd from layer 5/6, a sand/fibre tempered body sherd from layer 5/6, and a sand tempered body sherd from layer 8.

  - **Subgroup 7**: samples 59, 73

    This subgroup consists of a B1b sand tempered rim sherd from 1997 Trench 1 360–410 cm and a Cù Lao Rùa sand tempered sherd.

- **Subgroup 8**: samples 86, 11, 17

  This subgroup consists of a Lộc Giang fibre and orthodox grog tempered sherd, a C2b sand tempered rim sherd from layer 5/6, and a sand tempered body sherd from layer 5/6.

- **Subgroup 9**: samples 14, 33

  This subgroup consists of a lateritic sand tempered body sherd (also with orthodox grog) from layer 5/6 and a lateritic sand tempered rim sherd from layer 7.

- **Subgroup 10**: samples 13, 22

  This subgroup consists of a sand tempered body sherd from layer 5/6 and a lateritic sand tempered body sherd from layer 5/6.

- **Subgroup 11**: samples 72, 87

  This subgroup consists of a Cù Lao Rùa sand/lateritic sand tempered sherd and a Lộc Giang sand and orthodox grog tempered sherd.

- **Main group 3**: samples 6, 89, 90

This group consists of a fibre/phosphate tempered body sherd from layer 5 and Mán Bạc sand/iron-rich sand tempered sherds.

- **Main group 4**:
  - **Subgroup 1**: samples 23, 34

    This subgroup consists of a form A2a roulette decorated sand/fibre tempered body sherd from layer 5/6 and a sand tempered body sherd from layer 7.

  - **Subgroup 2**: sample 66

    This subgroup consists of a fired clay sample from the Test Square 240–250 cm.

  - **Subgroup 3**: sample 46

    This subgroup consists of a fibre tempered roulette decorated pedestal sherd from layer 5/6.

  - **Subgroup 4**: samples 39, 88

    This subgroup consists of sand tempered body sherd from layer 8 and a Mán Bạc untempered sherd.

  - **Subgroup 5**: samples 60, 61

    This subgroup consists of the surface collected A2a fibre bleb grog tempered rim sherds.

- **Outliers**: samples 64, 65, 67 / 5 / 75 / 71 / 76 / 68 / 69 / 43 / 74 / 70

The outliers included fired clay samples from the Test Square 240–250 cm, a sand tempered rim sherd from layer 5, a Cù Lao Rùa sand/lateritic sand tempered sherd, a Cồn Cổ Ngựa sand/iron-rich sand tempered sherd, a Đa Bút sand/iron-rich sand tempered sherd, unfired geological clay samples from the Vàm Cỏ Đông alluvium, the Óc Eo phase sherd from layer 2, and a Cù Lao Rùa sand tempered sherd.

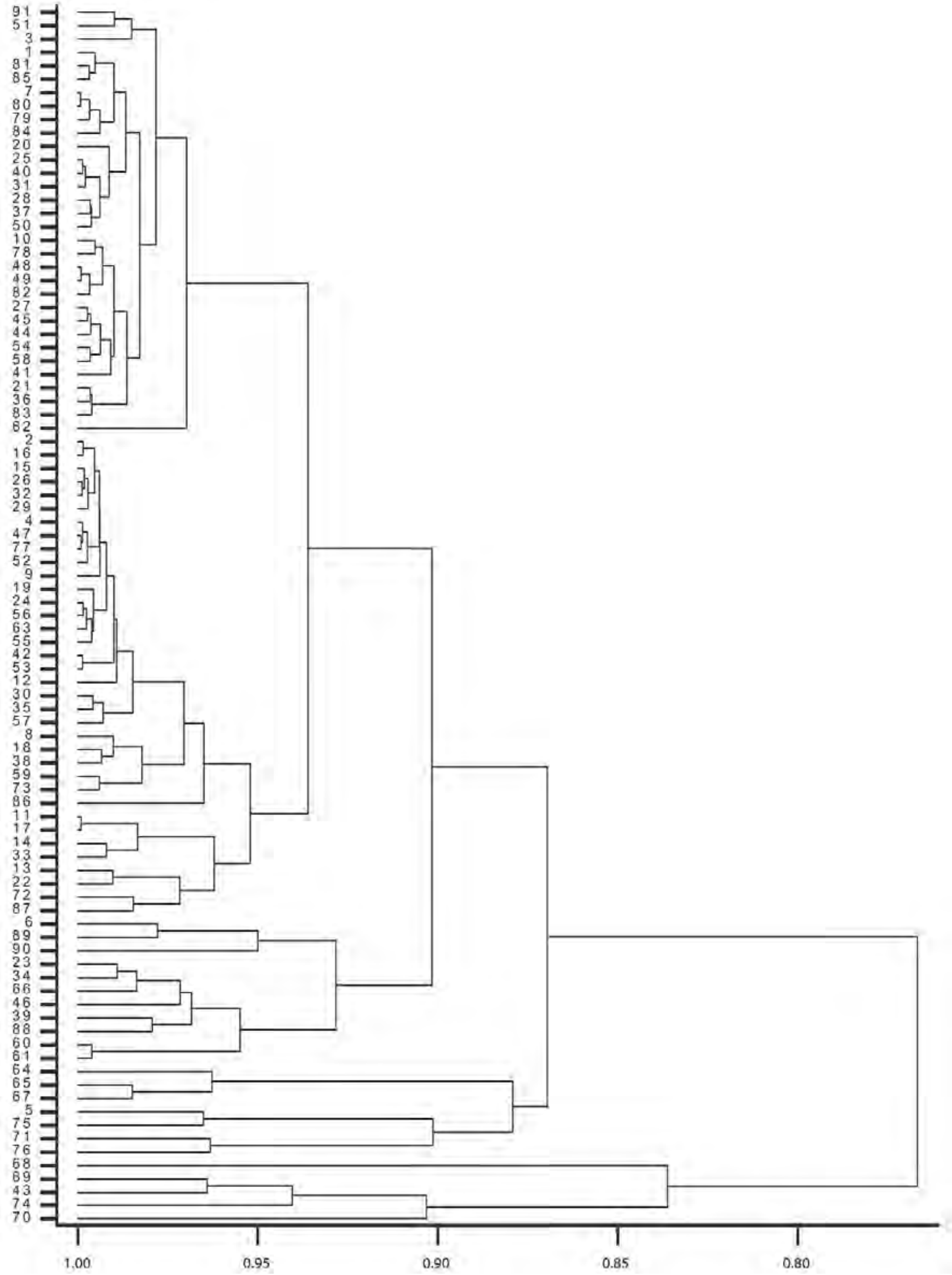

Figure 6.43. Average-linkage hierarchical cluster analysis dendrogram of the An Sơn ceramic sample, clays and other site samples. Refer to Appendix A for sample identification numbers.

Source: C. Sarjeant.

Table 6.31. Samples in the hierarchical cluster analysis dendrogram groupings in Figure 6.43 of the An Sơn ceramic sample, clays and other site samples when cut at 0.950 and 0.9875. Refer to Appendix A for sample identification numbers.

Main group (cut at 0.959)	Subgroup (cut at 0.9875)	Sample identification number
	1	91
	2	51
	3	3
	4	1, 81, 85, 7, 80, 79, 84
1	5	20, 25, 40, 31, 28, 37, 50
	6	10, 78, 48, 49, 82
	7	27, 45, 44, 54, 58, 41
	8	21, 36, 83
	9	62
	1	2, 16, 15, 26, 32, 29
	2	4, 47, 77, 52, 9
	3	19, 24, 56, 63, 55
	4	42, 53, 12
	5	30, 35, 57
2	6	8, 18, 38
	7	59, 73
	8	86, 11, 17
	9	14, 33
	10	13, 22
	11	72, 87
3	1	6, 89, 90
	1	23, 34
	2	66
4	3	46
	4	39, 88
	5	60, 61
	1	64, 65, 67
	2	5
	3	75
	4	71
	5	76
Outliers	6	68
	7	69
	8	43
	9	74
	10	70

Source: Compiled by C. Sarjeant.

Canonical variate analysis

The first CVA biplot (Figure 6.44, Table 6.32) includes all fired and unfired clay and ceramic sherd samples, except for the surface and Óc Eo phase ceramic sherd outliers (samples 43, 60 and 61). This CVA biplot showed that the An Sơn unfired clay samples were outliers (Figure 6.44, Table 6.32). A second CVA that included the fired clay samples, but excluded the unfired clay outliers, was also plotted. This CVA plots the samples according to site groups (Figure 6.45, Figure 6.46, Table 6.33). The outlier composition of the unfired clay samples in Figure 6.44 may be the result of a chemical change during firing. It is also probable that either the sampled alluvial clay deposits were not used in prehistory, have altered since their use, or a combination of these factors.

The second CVA (Figure 6.45, Figure 6.46, Table 6.33) shows the differences between the clay matrix compositions of the Cồn Cổ Ngựa and Đa Bút sherds and those from the other sites. The Mán Bạc and Cù Lao Rùa sherds are also chemically distinct from the other sampled sherds, while the Lộc Giang and Giồng Cá Vồ sherds do not overlap closely with the other site groups. The groups of the An Sơn ceramic samples, the An Sơn fired clay samples, and the sherds from Ban Non Wat, Cù Lao Rùa, Đình Ông and Hòa Diêm overlap each other. Note that only one sherd was sampled from Ban Non Wat and Hòa Diêm and this overlap is not representational of a long-distance link between these sites and An Sơn (in terms of clay matrix composition).

The Đa Bút, Cồn Cổ Ngựa, Mán Bạc, Hòa Diêm and Ban Non Wat sherds were included in the CVAs to show any commonalities in ceramic technology between these sites and An Sơn. The Đa Bút and Cồn Cổ Ngựa sherds with their very coarse non-plastic inclusions display an incipient neolithic or pre-neolithic technology that is quite different to An Sơn. Mán Bạc, also in northern Vietnam, shows a closer link to the ceramic technology at An Sơn, with a preference for mineral sand tempers (TG A1). Similarly to An Sơn, Ban Non Wat exhibits the trend for fibre tempering (TG B) in ceramic manufacture in neolithic mainland Southeast Asia, while Hòa Diêm indicates that neolithic technologies with mineral sand tempers (TG A1) continued to be applied in the metal age.

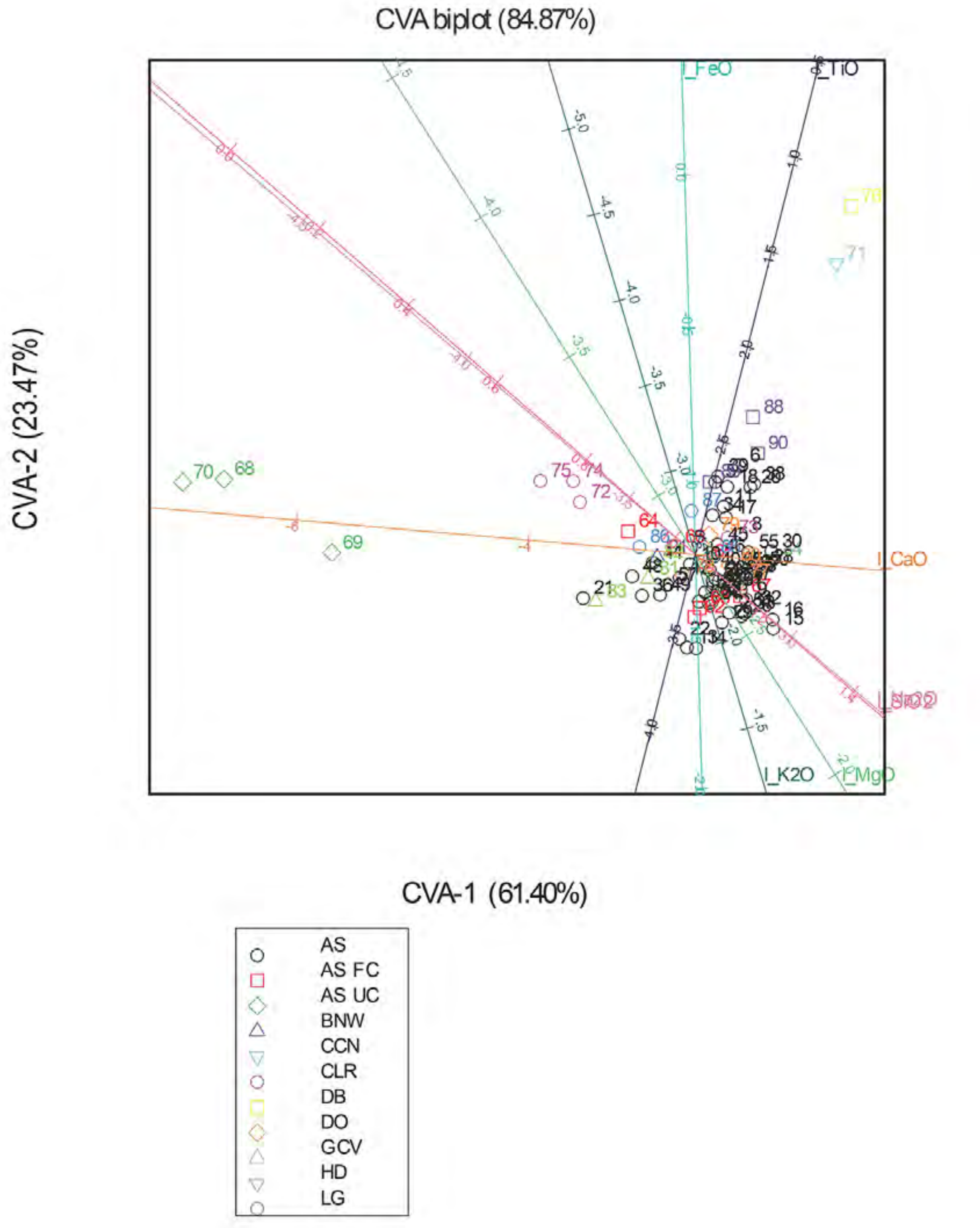

Figure 6.44. CVA biplot of the An Sơn ceramic samples, clays and other site samples. First two dimensions. Refer to Appendix A for sample identification numbers. Key: AS = An Sơn AS, FC = An Sơn fired clay, AS UC = An Sơn unfired clay, BNW = Ban Non Wat, CCN = Cồn Cổ Ngựa, CLR = Cù Lao Rùa, DB = Đa Bút, DO = Đình Ông, GCV = Giồng Cá Vồ, HD = Hòa Diêm, LG = Lộc Giang, MB = Mán Bạc.

Source: C. Sarjeant.

Table 6.32. CVA loadings for Figure 6.44 of the An Sơn ceramic samples, clays and other site samples. First three dimensions.

	1 (61.40%)	2 (23.47%)	3 (6.82%)
1	2.830	0.212	-0.902
2	-0.208	0.538	0.351
3	0.272	-0.576	-1.582
4	-0.389	-1.501	1.294
5	0.235	0.105	0.722
6	-0.263	-1.775	5.375
7	0.662	2.950	0.020

Source: Compiled by C. Sarjeant.

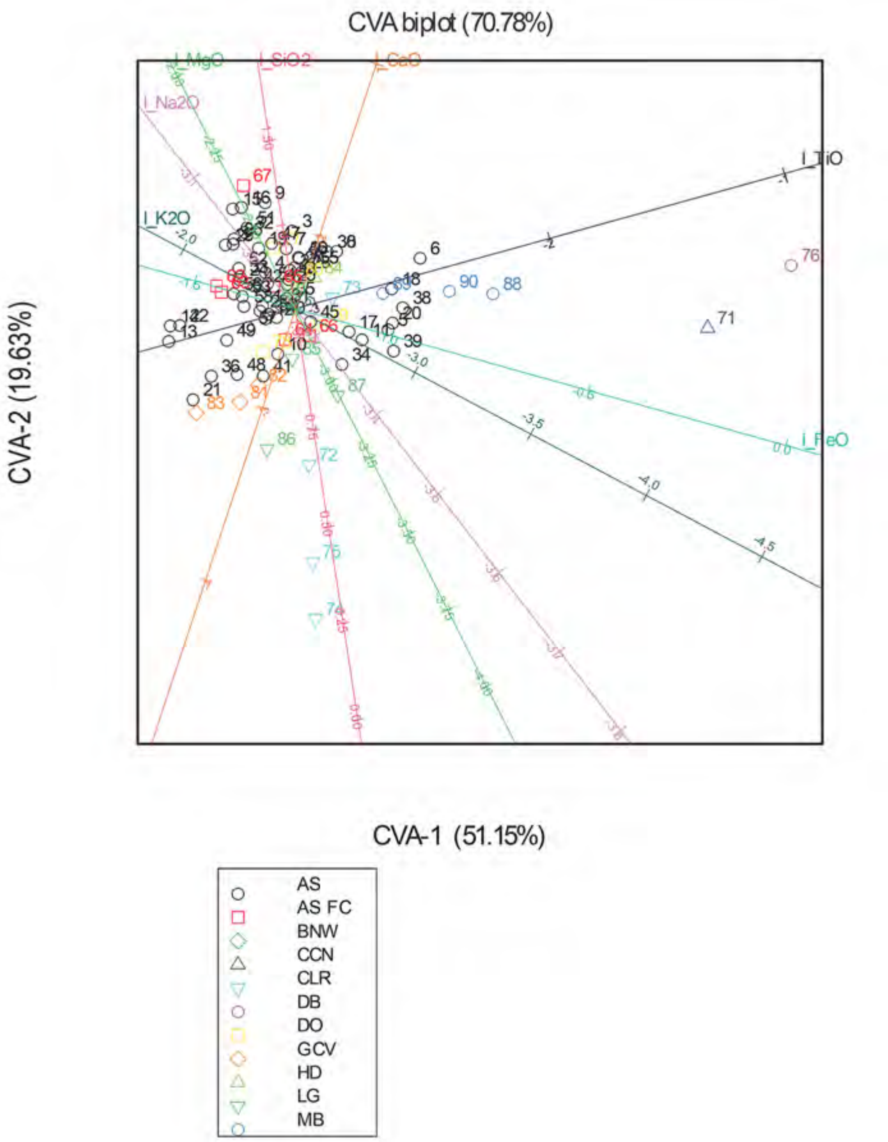

Figure 6.45. CVA biplot of the An Sơn ceramic samples, clays and other site samples. First two dimensions. Refer to Appendix A for sample identification numbers. Key: AS = An Sơn, AS FC = An Sơn fired clay, BNW = Ban Non Wat, CCN = Cồn Cổ Ngựa, CLR = Cù Lao Rùa, DB = Đa Bút, DO = Đình Ông, GCV = Giồng Cá Vồ, HD = Hòa Diêm, LG = Lộc Giang, MB = Mán Bạc.

Source: C. Sarjeant.

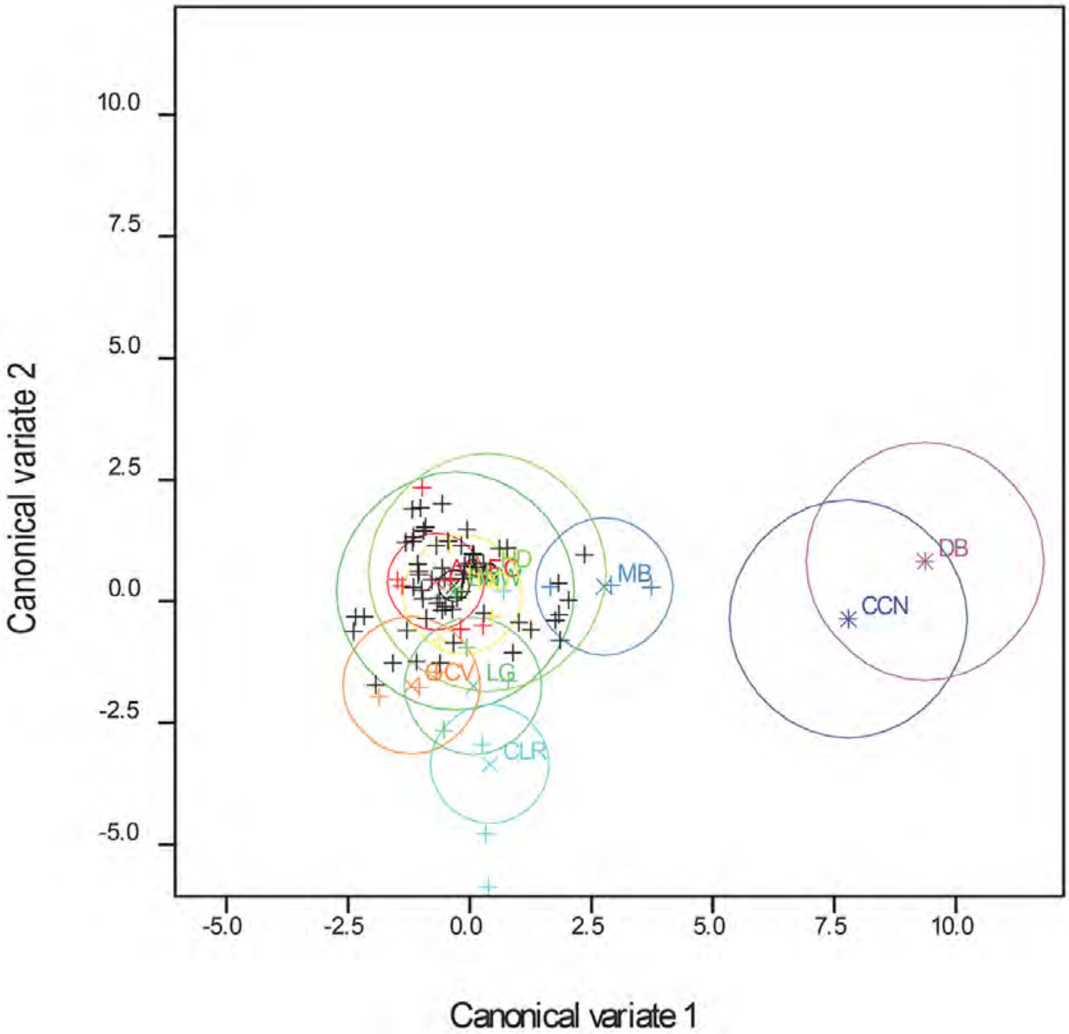

Figure 6.46. CVA biplot of the An Sơn ceramic samples, clays and other site samples with 95% confidence circles. First two dimensions. Key: AS FC = An Sơn fired clay, BNW = Ban Non Wat, CCN = Cồn Cổ Ngựa, CLR = Cù Lao Rùa, DB = Đa Bút, DO = Đình Ông, GCV = Giồng Cá Vồ, HD = Hòa Diêm, LG = Lộc Giang, MB = Mán Bạc.

Source: C. Sarjeant.

Table 6.33. CVA loadings for Figures 6.45 and 6.46 of the An Sơn ceramic samples, clays and other site samples. First three dimensions.

	1 (51.15%)	2 (19.63%)	3 (11.88%)
1	1.022	1.846	-1.967
2	0.760	-0.161	0.138
3	-0.495	-0.090	-2.019
4	-1.493	0.577	1.857
5	0.252	0.404	0.562
6	-1.345	3.059	3.399
7	2.865	-0.234	0.093

Source: Compiled by C. Sarjeant.

What is the relationship between the An Sơn ceramics, the clays collected from An Sơn, and the ceramics from other sites in southern Vietnam?

The PCA and hierarchical cluster analysis have been excluded from this section since the results were similar to those presented in the previous section. The analyses presented in this section exclude the samples from sites outside of southern Vietnam.

Canonical variate analysis

The first CVA includes all fired and unfired clay and ceramic sherd samples, except for the surface and Óc Eo phase ceramic sherd outliers (samples 43, 60 and 61). This CVA plots the samples according to site groups (Figure 6.47, Figure 6.48, Table 6.34). The CVA shows that the unfired clays from An Sơn have little in common with any archaeological sherds from southern Vietnam sites.

The second CVA plot included the fired clay samples, but excluded the unfired clay (and samples 43, 60 and 61) outliers. The CVA examines the samples according to site (Figure 6.49, Figure 6.50, Table 6.35). This CV, reveals that the fired clays are dispersed and do not always group with the clay matrix compositions of the An Sơn sherds. There is a close relationship in clay matrix composition between the An Sơn ceramic and Đình Ông sherds. The other samples, from Cù Lao Rùa, Giồng Cá Vồ and Lộc Giang did not group closely with the An Sơn ceramic sherds.

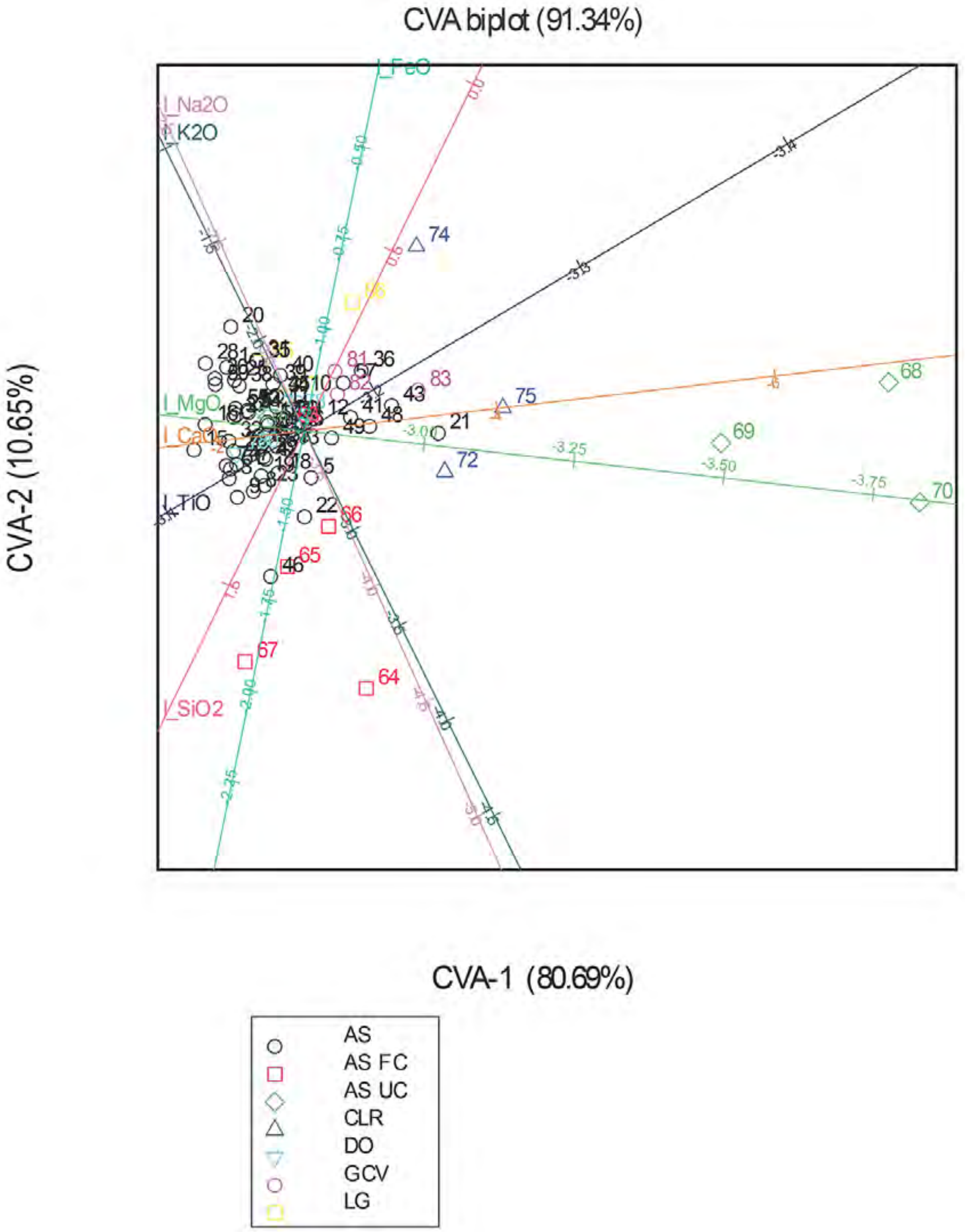

Figure 6.47. CVA biplot of the An Sơn ceramic samples, clays and other site samples. First two dimensions. Refer to Appendix A for sample identification numbers. Key: AS = An Sơn, AS FC = An Sơn fired clay, AS UC = An Sơn unfired clay, CLR = Cù Lao Rùa, DO = Đình Ông, GCV = Giồng Cá Vồ, LG = Lộc Giang.

Source: C. Sarjeant.

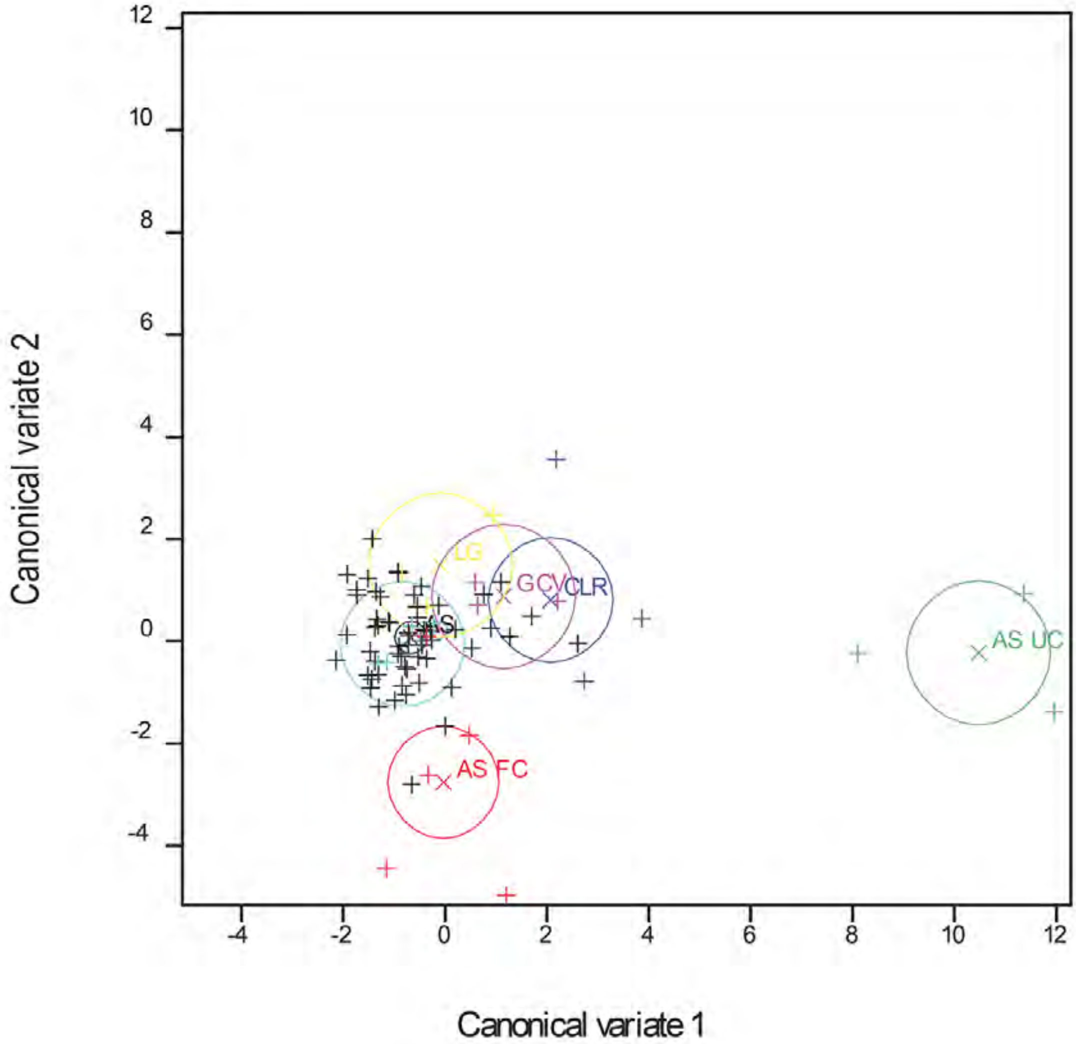

Figure 6.48. CVA plot of the An Sơn ceramic samples, clays and other site samples with 95% confidence circles. First two dimensions. Key: AS = An Sơn, AS FC = An Sơn fired clay, AS UC = An Sơn unfired clay, CLR = Cù Lao Rùa, DO = Đình Ông, GCV = Giồng Cá Vồ, LG = Lộc Giang.

Source: C. Sarjeant.

Table 6.34. CVA loadings for Figure 6.47 and Figure 6.48 of the An Sơn ceramic samples, clays and other site samples. First three dimensions.

	1 (80.69%)	2 (10.65%)	3 (4.74 %)
1	-2.747	0.323	-0.936
2	0.273	-0.080	0.589
3	-0.659	1.330	1.335
4	0.824	0.554	-0.450
5	0.054	0.196	0.368
6	0.249	-5.614	3.891
7	-0.361	0.895	-0.969

Source: Compiled by C. Sarjeant.

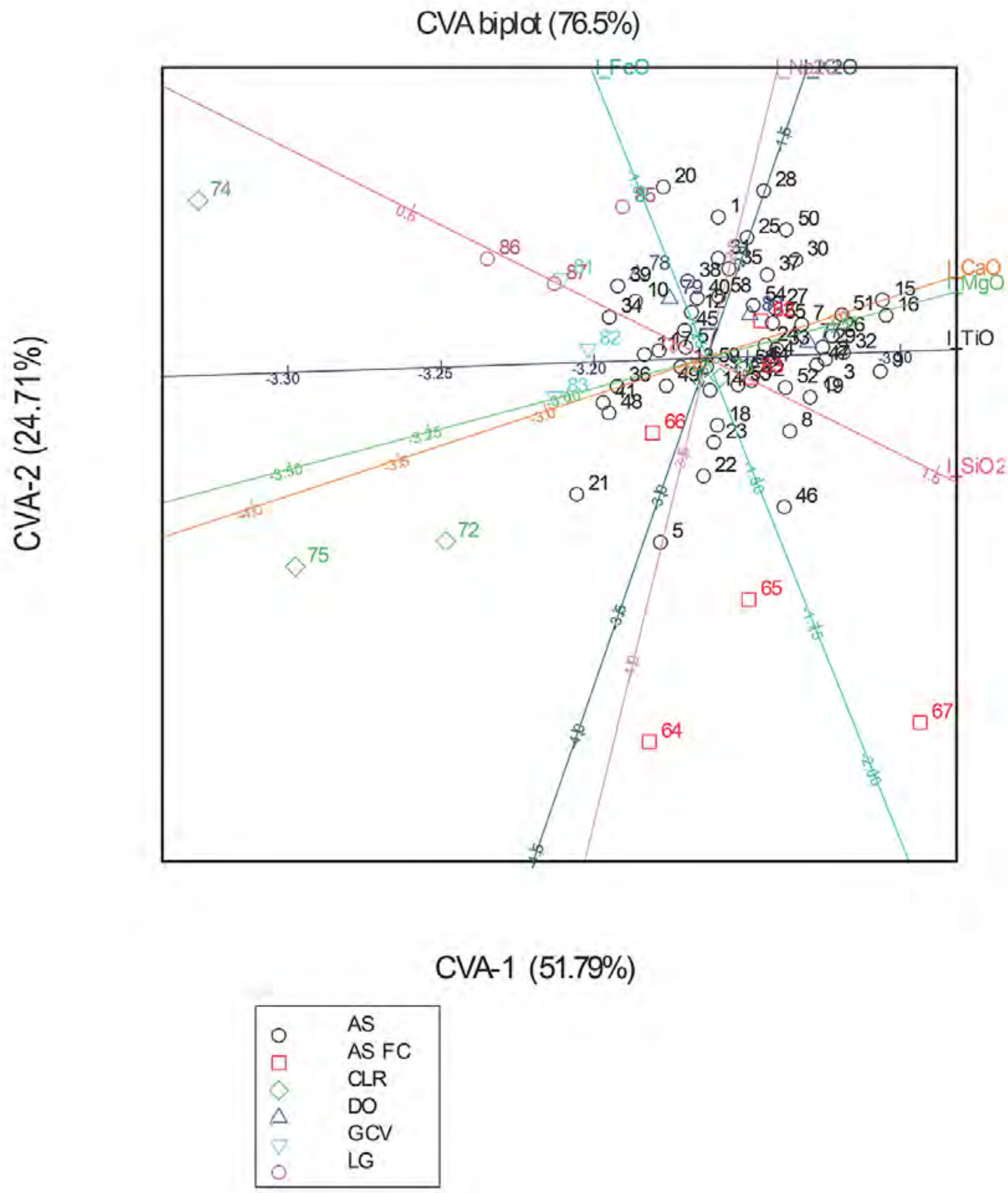

Figure 6.49. CVA biplot of the An Sơn ceramic samples, clays and other site samples. First two dimensions. Refer to Appendix A for sample identification numbers. Key: AS = An Sơn, AS FC = An Sơn fired clay, CLR = Cù Lao Rùa, DO = Đình Ông, GCV = Giồng Cá Vồ, LG = Lộc Giang .

Source: C. Sarjeant.

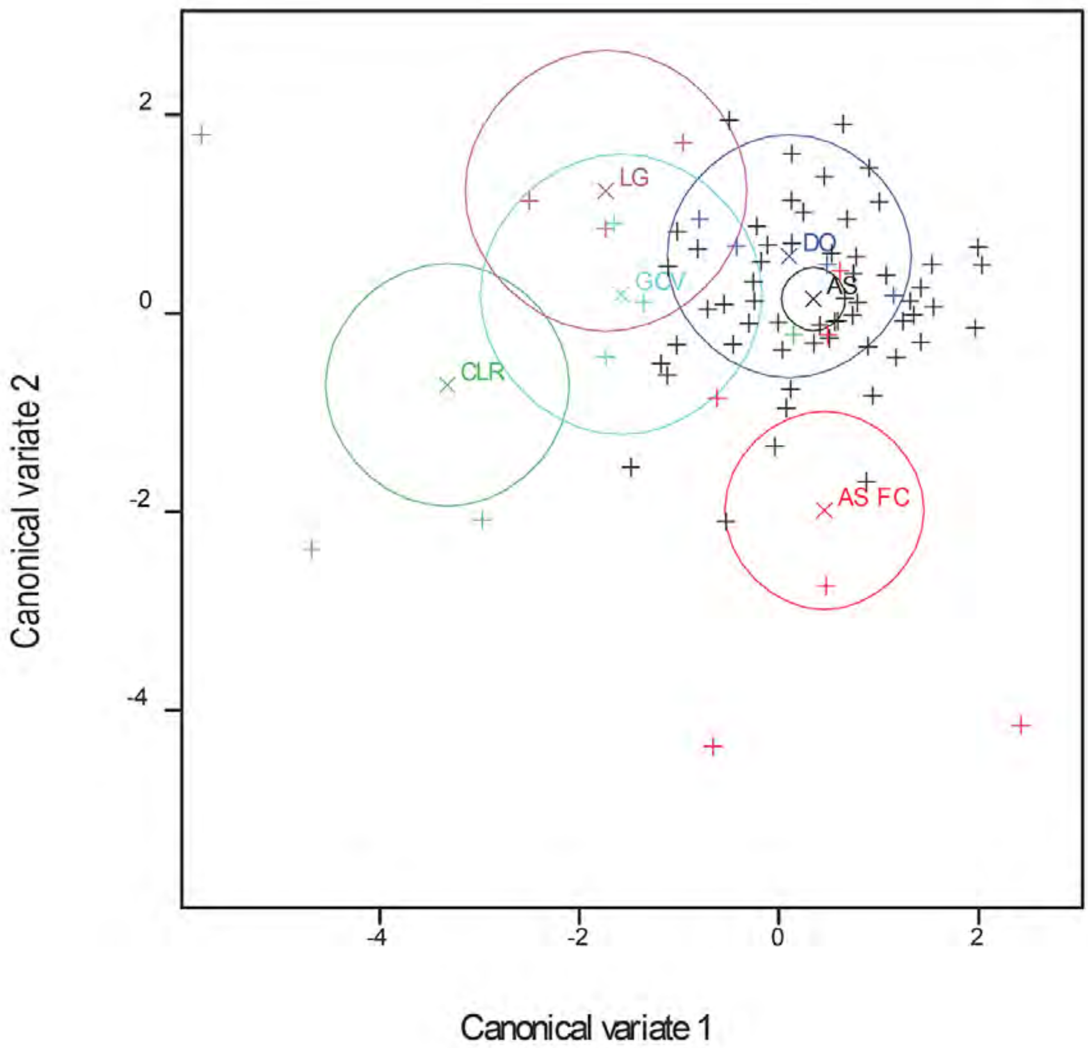

Figure 6.50. CVA plot of the An Sơn ceramic samples, clays and other site samples with 95% confidence circles. First two dimensions. Key: AS = An Sơn, AS FC = An Sơn fired clay, CLR = Cù Lao Rùa, DO = Đình Ông, GCV = Giồng Cá Vồ, LG = Lộc Giang.

Source: C. Sarjeant.

Table 6.35. CVA loadings for Figures 6.49 and 6.50 of the An Sơn ceramic samples, clays and other site samples. First three dimensions.

	1 (51.79%)	2 (24.71%)	3 (16.07%)
1	1.716	1.439	0.325
2	-0.338	0.800	-0.200
3	-0.052	1.851	-1.423
4	0.846	-0.821	3.371
5	0.372	-0.144	0.490
6	2.970	-3.304	-3.495
7	0.477	0.367	-0.577

Source: Compiled by C. Sarjeant.

Summary: Characterisation of clay matrices

To summarise the PCAs, hierarchical cluster analyses and CVAs of Chapter 6, Part II, two Chemical Paste Compositional Reference Units (CPCRUs) were identified based on the clay matrix chemical compositional data. There are also a number of outliers that did not cluster with these main groups. The averaged chemical composition of each CPCRU is presented in Table 6.36.

1. CPCRU 1 is largely represented by fibre-inclusive tempers (TG B) and rim forms A1a and C1b from An Sơn, and also a sherd from Đình Ông. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.
    - Samples: 53, 42, 55, 63, 56, 24, 19, 9, 52, 77, 47, 4, 29, 32, 26, 15, 16, 2
    - Fibre pedestal sherds (*n*=3)
    - Fibre body sherd
    - Sand/fibre body sherd
    - Fibre/calcareous body sherd
    - Calcareous body sherd
    - A1a fibre rim sherds (*n*=3)
    - A2b sand/fibre/phosphate rim sherds
    - B1a sand/fibre rim sherd
    - C1b fibre rim sherd
    - C1b fibre/phosphate rim sherds (*n*=3)
    - Fired clay
    - Đình Ông fibre sherd
2. CPCRU 2 is largely represented by sand-inclusive tempers (TG A1) and the rim form A2a, and includes identifiable subgroups (SG). This group also includes sherds from Đình Ông, Giồng Cá Vồ, Hòa Diêm and Lộc Giang. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.
    - SG1
        - Samples 83, 36, 21
        - A1a fibre rim sherd
        - B1a sand/fibre rim sherd
        - Giồng Cá Vồ fibre sherd
    - SG2

      Samples: 41, 58, 54, 44, 45, 27, 82, 49, 48, 78, 10
        - Roulette decorated sand body sherd
        - Sand body sherd
        - B1a sand rim sherd
        - B1a fibre rim sherd
        - D1a sand/iron-rich rim sherd
        - D1b lateritic sand sherd
        - D2a sand rim sherd (*n*=2)
        - C3a sand sherd
        - Đình Ông sand sherd

    - Giồng Cá Vồ fibre sherd
- SG3
  Samples: 50, 37, 28, 31, 40, 25, 20
    - Sand body sherd
    - A2a sand rim sherd (*n*=3)
    - D1a sand sherd (*n*=2)
    - D1b sand rim sherd
- SG4
  Samples: 84, 79, 80, 7
    - Roulette decorated sand body sherd
    - Đình Ông sand and orthodox grog sherd
    - Giồng Cá Vồ sand sherd
    - Hòa Diêm sand sherd
- SG5
  Samples: 85, 81, 1
    - A2a sand rim sherd
    - Giồng Cá Vồ sand/iron-rich sand sherd
    - Lộc Giang sand sherd
- SG6
  Samples: 91, 51, 3
    - D1a sand rim sherd
    - Roulette decorated sand body sherd
    - Ban Non Wat fibre sherd
- SG7
  Sample: 62
    - Fired clay

3. Outliers were chemically distinct from CPCRU 1 and 2 but some shared chemical relationships with some of the other samples. Refer to Appendix A for sample identification numbers and Figure 5.1 for rim form images.
    - Sample: 70
        - Unfired clay
    - Sample: 74
        - Cù Lao Rùa sand sherd
    - Sample: 43
        - Óc Eo phase untempered sherd
    - Sample: 69
        - Unfired clay
    - Sample: 68
        - Unfired clay
    - Sample: 76
        - Đa Bút sand/iron-rich sand sherd

- Sample: 71
    - Cồn Cổ Ngựa sand/iron-rich sand sherd
- Sample: 75
    - Cù Lao Rùa sand/iron-rich sand sherd
- Sample: 5
    - Sand body sherd
- Samples: 65, 67
    - Fired clays (*n*=2)
- Sample: 64
    - Fired clay
- Samples: 60, 61
    - A2a fibre and bleb grog surface sherds (*n*=2)
- Samples: 88, 39
    - Mán Bạc untempered sherd
    - Sand body sherd
- Sample: 46
    - Fibre pedestal sherd
- Samples: 66, 34, 23
    - Fired clay
    - Sand body sherd
    - Sand/fibre body sherd
- Sample: 90
    - Mán Bạc sand/iron-rich sand sherd
- Samples: 89, 6
    - Mán Bạc sand/iron-rich sand sherd
    - Fibre/phosphate body sherd
- Samples: 87, 72
    - Lộc Giang sand and orthodox grog sherd
    - Cù Lao Rùa sand/iron-rich sand sherd
- Samples: 13, 22
    - Sand body sherd
    - Lateritic sand body sherd
- Samples: 14, 33, 11, 17
    - Lateritic sand and orthodox grog body sherd
    - Lateritic sand rim sherd
    - C2b sand rim sherd
    - Sand body sherd
- Sample: 86
    - Lộc Giang fibre and orthodox grog sherd
- Samples: 73, 59, 38, 18, 8
    - B1b sand rim sherd
    - Sand body sherd

    - Sand/fibre body sherd
    - A2a sand rim sherd
    - Cù Lao Rùa sand sherd
- Samples: 57, 35, 30
    - B1a fibre and bleb grog body sherd
    - D1a lateritic rim sherd
    - D1b lateritic rim sherd
- Sample: 12
    - A1a fibre rim sherd

While there are a number of outliers in the studied sample, there are some clear associations between CPCRUs and temper groups. Since the temper analysis revealed a close link between temper group and rim form, it may be suggested that certain tempers were selected for particular clays with the intention of making a ceramic vessel to a preconceived form. CPCRU 1 was more consistently used for fibre tempered (TG B) ceramics, and CPCRU 2 included a number of subgroups with fibre (TG B), mixed sand (TG A1), and mixed sand/fibre (TG A1/B) tempered sherds. The chemical differences between the CPCRUs are in the concentrations of sodium and iron oxides, which were elevated in CPCRU 2 compared to CPCRU 1. The outliers were characterised by elevated concentrations of iron oxide and decreased concentrations of silicon dioxide (Table 6.36).

The temper and clay combinations that have been identified in this chapter also relate to vessel form selection, suggesting there was a template for the manufacture of certain ceramic forms (described further in Chapter 10). For example, forms A2a, B1a, C1b and D were frequently made with the same temper and CPCRU. The chemistry of the unfired Vàm Cỏ Đông alluvial clay was not consistent with the sherds from An Sơn, however the fired clays from the site were similar in some cases. This suggests that past clay resources were not located during the field season and/or the clay chemistry changes substantially during firing.

The clay matrix compositions of the analysed ceramic sherds from southern Vietnam largely grouped together, particularly the sites along the Vàm Cỏ Đông River, An Sơn, Lộc Giang and Đình Ông. This is likely due to the similar environmental settings of these sites. Giồng Cá Vồ also grouped with these sites, indicating that similar clay resources were utilised later in prehistory. Cù Lao Rùa, however, did not group with the Vàm Cỏ Đông River sites, indicating that the clay resources may have differed along the Đồng Nai River, where Cù Lao Rùa was located.

In the north, very different clay compositions were present at Mán Bạc, which in turn appeared to have little relationship with the earlier ceramics of Đa Bút and Cồn Cổ Ngựa. The technology of ceramic manufacture changed dramatically, in temper, clay and vessel form, between the late Hoabinhian Đa Bút and Cồn Cổ Ngựa sites and neolithic Mán Bạc.

The potters of An Sơn are positioned within a ceramic tradition that shares features with sites beyond southern Vietnam, including aspects of form, decoration and temper. However, the environment influenced clay selection, and the strongest ties with An Sơn were with other sites along the Vàm Cỏ Đông River. An Sơn also exhibited distinctive locally restricted innovations, including the class D wavy rimmed vessels. These local and shared traditions are discussed further in Chapter 10.

Table 6.36. The averaged and normalised chemical composition of each CPCRU group.

Clay group	Na_2O	MgO	Al_2O_3	SiO_2	P_2O_5	SO_3	K_2O	CaO	TiO_2	V_2O_5	MnO	FeO	Total
CPCRU 1	0.64	1.62	19.11	67.67	0.81	0.20	2.23	2.06	0.89	0.03	0.10	4.63	100.00
CPCRU 2	1.24	1.33	22.16	62.51	0.67	0.24	2.64	1.89	0.93	0.04	0.08	6.28	100.00
CPCRU 2-SG1	1.36	1.69	22.73	63.21	0.36	0.22	3.04	0.77	0.91	0.04	0.04	5.64	100.00
CPCRU 2-SG2	0.88	1.40	22.78	62.20	0.65	0.25	2.21	1.82	0.91	0.05	0.06	6.78	100.00
CPCRU 2-SG3	1.51	1.36	22.00	60.89	0.90	0.26	3.14	2.32	1.04	0.03	0.09	6.45	100.00
CPCRU 2-SG4	1.17	1.08	22.67	62.59	0.36	0.16	1.97	2.40	0.99	0.03	0.11	6.47	100.00
CPCRU 2-SG5	1.69	0.99	23.95	59.24	1.29	0.18	3.46	1.88	0.80	0.03	0.07	6.42	100.00
CPCRU 2-SG6	1.26	1.05	17.88	69.63	0.39	0.21	2.22	1.74	0.83	0.02	0.13	4.64	100.00
CPCRU 2-SG7	1.78	2.10	19.99	63.44	0.33	0.65	4.08	1.40	0.89	0.03	0.08	5.21	100.00
Outliers	0.72	1.37	22.84	58.61	1.84	0.29	1.32	1.98	1.41	0.05	0.15	9.42	100.00
Outliers-SG1	0.43	0.66	33.53	59.38	0.00	0.34	0.67	0.03	1.59	0.06	0.07	3.23	100.00
Outliers-SG2	0.68	0.73	31.44	37.40	15.29	0.34	2.49	0.76	1.04	0.04	0.07	9.73	100.00
Outliers-SG3	0.31	0.58	24.87	58.79	6.79	0.42	2.51	0.61	1.43	0.04	0.04	3.61	100.00
Outliers-SG4	0.34	1.00	30.21	61.48	0.00	1.16	1.68	0.09	1.26	0.04	0.02	2.72	100.00
Outliers-SG5	0.30	0.40	11.93	14.25	0.02	0.69	0.33	0.02	0.28	0.04	0.19	71.56	100.00
Outliers-SG6	0.40	0.45	17.26	56.15	1.27	0.17	0.30	3.81	6.08	0.09	0.32	13.70	100.00
Outliers-SG7	1.05	0.62	22.94	46.01	1.59	0.27	0.46	4.73	3.99	0.06	2.96	15.33	100.00
Outliers-SG8	0.92	1.22	33.22	51.29	0.22	0.41	0.58	0.72	1.22	0.04	0.05	10.11	100.00
Outliers-SG9	1.23	1.44	26.27	58.01	0.45	0.07	0.35	2.72	1.20	0.06	0.02	8.18	100.00
Outliers-SG10	0.68	1.25	20.57	69.68	0.00	0.43	1.77	1.69	0.86	0.02	0.02	3.03	100.00
Outliers-SG11	0.18	0.46	16.81	77.78	0.14	0.44	0.44	0.77	0.83	0.00	0.00	2.17	100.00
Outliers-SG12	0.38	1.91	20.32	62.75	0.59	0.16	0.37	2.29	2.58	0.00	0.10	8.57	100.00
Outliers-SG13	0.35	1.31	20.76	59.44	1.39	0.24	1.21	2.22	1.95	0.06	0.06	11.00	100.00
Outliers-SG14	0.16	1.20	17.23	71.60	0.73	0.10	0.80	1.89	0.94	0.05	0.09	5.23	100.00
Outliers-SG15	0.29	1.42	22.93	58.41	1.38	0.26	0.89	2.36	0.87	0.08	0.22	10.88	100.00
Outliers-SG16	1.27	2.66	21.97	51.16	2.38	0.43	0.99	2.85	2.16	0.09	0.07	13.96	100.00
Outliers-SG17	0.51	2.22	18.15	66.79	0.59	0.47	1.64	1.55	2.68	0.09	0.04	5.28	100.00
Outliers-SG18	0.75	0.86	24.37	57.54	5.27	0.21	1.37	1.21	1.08	0.04	0.06	7.24	100.00
Outliers-SG19	0.61	1.18	25.04	62.47	0.34	0.15	1.31	2.26	0.41	0.00	0.06	6.18	100.00
Outliers-SG20	1.71	1.32	25.74	58.24	0.73	0.21	1.31	2.72	0.75	0.02	0.04	7.20	100.00
Outliers-SG21	0.66	1.60	25.86	50.77	8.26	0.36	3.32	1.15	1.18	0.01	0.02	6.81	100.00
Outliers-SG22	0.78	1.57	21.78	60.21	2.03	0.15	1.10	2.49	1.17	0.04	0.05	8.63	100.00
Outliers-SG23	1.01	2.18	21.37	60.11	1.36	0.33	2.60	2.21	1.04	0.05	0.15	7.57	100.00
Outliers-SG24	0.53	1.80	19.61	62.18	0.78	0.21	2.61	1.41	0.97	0.07	0.05	9.78	100.00

Source: Compiled by C. Sarjeant.

This text taken from *Contextualising the Neolithic Occupation of Southern Vietnam: The Role of Ceramics and Potters at An Son*, by Carmen Sarjeant, published 2014 by ANU Press, The Australian National University, Canberra, Australia.