

SHORT ARTICLES

THE COMPOSITIONAL RELATIONSHIP BETWEEN POTTERY AND ITS SOURCE CLAY PART 1: AN EXAMPLE FROM THE WORK OF A TRADITIONAL POTTER ON THE FARM NONNASHOEK, BETHLEHEM, FREE STATE*

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ABSTRACT

Chemical data for a small number of potsherds and the clays from which they were made is presented. The sherds closely resemble the clays in composition, and although the sherds came from unused vessels, it does satisfy the assumption made in provenance studies that clays and their fired products can be chemically matched.

INTRODUCTION

A basic assumption of pottery provenance studies assumes a close relationship between a clay source and ceramics made from that source such that the two can be uniquely related. This, however, can and has been challenged as there are a number of processes in the sequence from a raw clay to the archaeological sherd which could alter the original chemical signature such that the two are no longer recognisably the same (Arnold *et al.* 1991, Neff *et al.* 1988, 1989). These include the preparation of the clay, the usage of the vessel and the effects of being discarded and buried after use. The paper will present data which shows that, under certain specific conditions and stages in this process, a fired vessel can be directly and unambiguously linked to its source clay.

THE SAMPLES

The samples for analysis were collected from Mrs Evelina Mokoena of the farm Nonnashoek in the Bethlehem District, who at the time was making pottery

using traditional methods (Dreyer 1988) (Fig 1). The potter used two types of clay, one a blackish clay from the nearby vlei, the other a whitish clay from a road cutting through a ridge near the house (referred to in Dreyer 1988) as "rooi klei" or red clay; when seen in situ this clay was yellow but subsequently dried white). A number of vessels, including a few broken fragments as well as clay samples, had been collected and it was from these that specimens were made available for analysis. Both types of clay were analyzed as well as fragments from the broken but unused vessels. It was not known from which clay the sherds had been made.

A brief description of the manufacturing process is necessary as this could have a material effect on the original clay compositional profile. Once collected, the clay was processed by breaking up the lumps with a grindstone and ground into a fine powder from which all stones and grit were removed. Temper, in the form of finely ground potsherds, was added in order to give strength to the vessel and prevent it from exploding during the firing process. Water was then added and the

METHODOLOGY

X-ray fluorescence was chosen for the analysis (Jacobson *et al.* 1994) and a Phillips PW 1404 XRF apparatus was used. All samples were prepared according to the method of Norrish & Hutton (1967). This consists of initially grinding the sherds to a fine powder at -300 mesh; a 10 gram sample is then pressed into a powder briquette, bound with Mowiol and a boric acid backing for the analysis of trace elements and Na₂O. The rest of the powder is heated to 110°C for a minimum of 12 hours in order to determine moisture content (H₂O-) by weight loss. The sample is then heated to 1000° C for three hours to similarly determine loss on ignition (LOI) of all organic material, C, CO₂ and crystalline water. The sample is then combined with Spectroflux 105 and melted to form a glass bead for which the major elements are determined (in oxides as weight percent). International geological standards were used for calibration.

RESULTS

Table 1 presents the results of the analysis. Major elements are presented as oxides in weight per cent whilst traces are in parts per million (ppm). To compare major elements, they need to be normalised to 100 % after H₂O- and LOI are removed. Note how the samples fall into two very clearly defined chemical groups, each consisting of a clay and two or three sherds (for the white and black clays respectively). The white clay is enriched in SiO₂, TiO₂ and Zr, whilst depleted relative to the black clay in most of the other elements although a few, *e.g.*, Nb and V, show little difference between groups. The origins of the difference must lie either in the source rocks from which these clays were developed or else mixing or winnowing or some other process such as inclusion of organic material (see below) during the formation of the deposits. The local area is underlain by sandstone, shale and basalt exposures from various Karoo Sequence formations any of which could contribute to the observed differences.

The sherds follow the clay results closely enough for them to be assigned to one or the other. The only exceptions appear to be Cr and Co which are slightly enriched in the black clay relative to its sherds and Zr, which is enriched in the sherds relative to the black clay. The overall differences between the white and black clays and their sherds are obvious but more samples are needed before definite conclusions can be reached for some of the apparent differences between the clays and their sherds are obviously but more samples are needed before definite conclusions can be reached for some of the apparent differences between the clays and the sherds.

CONCLUSIONS

From this, there are two obvious conclusions. Firstly, the sherds closely resemble the clays from which they were made. Note, however, that the sherds had never been used or discarded and buried and thus two critical steps



1a



1b

Fig. 1a. Mrs Mokoena shaping a pot using traditional methods; b, example of pots made by Mrs Mokoena.

clay thoroughly mixed and left for a while to 'ripen'. The vessel was then formed in a cool place out of the wind and finally left to dry out thoroughly before firing which took place in a hollow in the ground.

It is important to note that clay is not often found 'clean', *i.e.*, without any stones or grit or other impurities. These may be removed by hand, but they will always form a small fraction of the total composition depending upon how thoroughly the cleaning is carried out during the preparation. These natural inclusions could have an influence on the chemical profile of the total vessel if their composition is widely divergent from the clay. In itself, this does not really matter as, being a natural component of the clay deposit, they form part of the clay's chemical fingerprint. Where it could matter is if this material is not evenly distributed throughout a clay body or if different potters prepared the same raw clay on an individual basis with regards their own assessment of what was an acceptable amount of natural impurities in clay.

Table 1. Data for the five potsherds and two clays. Base, rim and body refer to the type of sherd analyzed; "bc" is the black clay and "wc" the white clay. Major elements as oxides in weight per cent, traces as ppm. See text for further details.

	bc 8	base 0	rim 4	body 7	wc 9	base 5	body 6
SiO ₂	67.00	76.27	74.74	73.39	76.81	81.04	80.62
TiO ₂	0.44	0.54	0.58	0.58	0.67	0.71	0.72
Al ₂ O ₃	13.78	13.78	14.37	14.96	10.99	11.23	11.68
Fe ₂ O ₃	6.24	5.29	5.55	5.71	3.39	3.76	3.98
MnO	0.02	0.02	0.03	0.01	0.01	0.01	0.01
MgO	0.54	0.57	0.60	0.61	0.28	0.28	0.28
CaO	0.54	0.46	0.51	0.52	0.25	0.25	0.27
Na ₂ O	0.12	0.23	0.18	0.21	0.04	0.00	0.00
K ₂ O	1.51	1.82	1.86	1.86	1.40	1.52	1.54
P ₂ O ₅	0.03	0.04	0.04	0.03	0.03	0.03	0.03
H ₂ O-	3.70	0.21	0.26	0.66	1.88	0.29	0.27
LOI	6.57	0.79	1.97	1.67	3.93	0.65	0.85
TOTAL	100.49	100.02	100.69	100.21	99.68	99.77	100.25
Rb	116	119	119	127	81	88	88
Sr	72	71	73	76	45	49	49
Y	32	36	37	38	26	30	31
Zr	195	243	253	261	358	381	390
Nb	7	10	10	11	11	13	13

in the sequence from a raw clay to the archaeological sherd which could change or contaminate the original chemical signature (*e.g.*, Freestone *et al.* 1985) are missing. Although some temper had been added to the clay, this had obviously had very little effect on the overall composition. This could either be due to the temper having the same composition as the clay or because not enough was added to materially alter the composition. The influence of temper on the clay composition is currently being investigated (by L.J. & W. vd W) and will be reported on elsewhere. Suffice to say that it requires the addition of approximately 10-20% temper to make a significant difference to the compositional profile of clay depending, most importantly, upon the relative values of the elements being measured (Neff *et al.* 1988, 1989), a temper with a profile similar to the

clay having no effect. These results, however, do show that the firing process has no effect on the composition of these vessels.

The second point relates to interpretation. As demonstrated here, one needs to be cautious when interpreting the chemical variability of pottery from any one site in terms of trade or exchange before the geochemical variability of the local clays and substrate is understood. This is easier said than done as knowledge of clay sources near most archaeological sites is totally lacking particularly from a potter's perspective. As traditional pottery making is still carried out in parts of South Africa, it is imperative that studies be undertaken of the entire pottery making process from both an ethno-archaeological as well as a geochemical perspective in order to complement future provenance studies and before this knowledge is lost forever. In the meantime, archaeologists can assist by consulting local communities about pot making traditions, collecting vessels and sherds in current use as well as taking a selection of clay samples from the vicinity of their sites (even if chosen on geological grounds only). These can then be curated with the excavated site materials until needed.

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