Surrey whiteware clays; recent research into a likely source

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SUMMARY

This note describes recent research into the likely source of white-firing clays used in the medieval Surrey Whiteware industry. White-firing clay samples from Claypit Wood, Farnham Old Park are compared, using ICP-AES analysis, with samples from the medieval production centre at Eden Street, Kingston upon Thames. The clay sample is also tested for its potting qualities, plasticity and the range of temperatures at which it can be fired to produce both earthenware and stoneware vessels.

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In the 13th and 14th centuries Surrey whiteware clay was a superior clay in all its potting properties. It is not surprising that the Kingston potters exploited the source supply, probably an outcrop of the Reading beds in Claypit Wood, Farnham Old Park. Samples of white-firing clay recently taken from this source appear on visual examination to be indistinguishable from medieval Surrey clay. ICP analysis discloses that Farnham Old Park is very likely to be the source of clay used in making Kingston whiteware pottery, although at least some Coarse Border Ware has a different, undiscovered source (see Hughes, below).

The raw clay is a light grey colour, very plastic and fine-grained. It can be used straight from the ground but benefits from a little slaking. It is an excellent throwing clay and will tolerate extremely thin throwing, for example of the sort found on Tudor green ware. In the raw state the clay contains almost no sand and is a useful example of what Surrey clay was like before the addition of sand by medieval potters. Throwing experiments show that the clay is improved by sand, and in fact it can tolerate up to 30% of sand.

Samples of the Reading beds white clay fired in a controlled kiln to 1240-60C were transformed into vitrified stoneware (Fig. 1). This somewhat surprising result was repeated when re-firing a selection of Surrey whiteware medieval sherds (Kingston from the Eden St. kiln site, Cheam from the Cheam High St. kiln, and CBW from the City). Instead of bending or collapsing at cone 8 stoneware temperature the sherds showed no deformation and also emerged as stoneware (Fig. 2). They were mounted on plaques, monitored by digital pyrometer and Orton cones,

Fig. 1 Two vessels made from the same clay. Left, surrey whiteware clay (Farnham Old Park) stoneware jug, 1240-60C; right, Surrey whiteware clay (Farnham Old Park) earthenware jug, 1000C

Fig. 2 Kingston sherd, Eden St. kiln site. Fired to stoneware at 1240-60 with Orton cone 8 down

and the firing was largely oxidising. With cone 8 down the terminal temperature was estimated at 1240-1260C and biscuit pots fired to stoneware at the same time confirm this. The pyrometer ambient temperature is recorded at 1245C. All experimental tests were performed twice with similar results.

The fact that Surrey whiteware clay could be fired to stoneware meant that the clay itself put no upper limit on the temperatures which medieval potters could use. The normal firing temperature for most mid-14th century Surrey whiteware vessels was probably between 950-1100C. This temperature, while less than stoneware requires, could produce sintered fabrics yielding pottery that is stronger, harder and less porous than that of other competing clays. Whiteware clay's main rival seems to have been London clay, often used in the manufacture of London-type ware, which has a temperature ceiling of about 1000C. This clay is especially sensitive to oxidation, so much so that in the raw state its dark blue-grey colour becomes a muddy brown where exposed to weathering. In a normal, mainly reducing firing even slight reoxidation will give a red surface to the dark reduced core. London clay can have problems with 'black core', has a high degree of shrinkage and at stoneware temperatures it bloats and melts. For efficient potting Surrey whiteware clay from Farnham Park or elsewhere is a great improvement. The other alternatives available to London potters were mainly low temperature local earthenware clays of varying quality, for example the South Hertfordshire clays, and the Essex Mill Green clay.

Late 14th-century Surrey whiteware pottery was certainly intended to be fired within the higher range of earthenware temperature. As the clay from which it is made could sustain much greater stoneware temperatures, why was this restricted range maintained? Any answers here, even obvious ones, will be uncertain. Much more fuel and an extended firing time would have been needed to reach stoneware temperatures, especially for the final push to the 1200's, and this may not have been seen as economic. A stoneware firing would have precluded the use of lead glaze which has a practical limit of about 1100-1150C. Beyond this the glaze becomes excessively runny and is apt to volatilise. The great unknown is how well 13th and 14th-century kilns would have performed at stoneware temperatures. It seems likely that Musty type-2 kilns could reach temperature, but with fuel problems and not very efficiently. The lack of a better kiln technology may have put a stop to any stoneware production.

Was there a need for stoneware? Much late14th- century pottery is what might be called 'near stoneware' just as it is. Cheam pottery is almost impermeable. Pottery that is highly sintered if not semi-vitrified, like most CBW, would be adequate for cooking and heating. Dense stoneware fabrics are liable to crack in an applied flame, a defect that may in part account for the relative lack of German stoneware cooking pots. Of course whiteware potters may have been unaware of the pyrometric properties of the clay they were using, although this does seem doubtful. Orton records that an 18th-century agreement 'for the supply of clay from Cheam to a Lambeth stoneware pottery' is in the Surrey Records Office; and Marshall notes that Cheam clay was used for goldsmiths' crucibles (Orton, 1985; Marshall, 1924).

The situation on the ground in Claypit Wood is complicated by disturbance from years of digging, tree growth and landslips. There are several different kinds of clay, including London clay and gault. The white Surrey clay is difficult to locate and there is very little of it, which suggests possible exhaustion at some point in the past.

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Report on the analysis by inductively-coupled plasma atomic emission analysis (ICP-AES) of a clay from Farnham Old Park and of medieval Surrey whiteware pottery

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INTRODUCTION

The aim of the investigation was to see whether a clay found at Farnham Old Park (clay 'B') was the source of the clay used for making Kingston medieval whiteware pottery. Chemical analysis was undertaken to see whether there was a similarity in chemical composition between the Farnham clay and the Kingston pottery. The items for analysis consisted of a fired sample of the Claypit Wood, Farnham Old Park 'B' clay (no sand added, and dated '15/2/03'): this is a white-firing clay. A single sherd of whiteware pottery from the Eden Street kiln, Kingston was also analysed, as well as a sample of Coarse Border Ware found in the City of London (via Jacqui Pearce). The method of analysis used was inductively-coupled plasma atomic emission spectrometry (ICP-AES – often known as 'ICP'), which has been extensively used for analysis of medieval and other pottery in the London area and elsewhere (e.g. Allan 1999).

Chemical analysis

Powdered samples were obtained from each item using a hand-held 12 volt drill fitted with a 2 mm diameter tungsten carbide drill bit. The powders were analysed for 29 elements by ICP-AES at the Department of Geology, Royal Holloway, University of London by Dr.J.N.Walsh using their routine technique (Thompson and Walsh, 1989). The list of samples analysed is given in Table 1 with the full ICP-AES results. They were analysed in ICP-AES batch L and are L13-15 inclusive.

INTERPRETATION OF THE CHEMICAL ANALYSES

Since there are only three analyses, the results were interpreted 'by eye' rather than resorting to the usual technique of multivariate statistical techniques, in particular principal component analysis. Such methods are more appropriate when there are large numbers of samples, and when analyses of more Surrey whitewares and related pottery become available in future, it would be worthwhile to test the present analyses against them. There is an extensive database of Surrey whitewares by neutron activation analysis (Cowell in Pearce and Vince, 1988) against which these analyses could be tested. However the two analytical methods do not analyse for the same range of chemical elements – only about seven elements are measured in common – so until there is a specific question to test, this comparison has not been made (except, see below for comments on the CBW sherd analysed by ICP-AES). There do not appear to be any other analyses made to date of Surrey whitewares by ICP-AES against which a comparison could be made, except some recent unpublished results (see below).

Table 1 Chemical analysis results by inductively-coupled plasma atomic emission spectrometry (ICP-AES) of fired clay from Farnham Old Park, a sherd from Eden Street kiln, Kingston and a sherd of Coarse Border Ware

Analysis results on three samples of clay/pottery by inductively-coupled plasma atomic emission spectrometry (at Royal Holloway, Dept of Geology)

Sample	Al2O3	Fe2O3	MgO	CaO	Na2O	K2O	TiO2	P2O5	MnO	Ba	Co	Cr	Cu	Li	Ni	Sc	Sr	V	Y	Zn	Zr*	La	Ce	Nd	Sm	Eu	Dy	Yb	Pb
L13	15.89	3.27	0.72	0.19	0.17	1.96	0.76	0.03	0.01	295	22	53	17	57	23	12	114	92	14	29	101	51	72	50	4.1	0.8	2.3	1.8	65
L14	20.52	2.75	0.72	0.22	0.21	1.87	0.86	0.06	0.01	322	57	59	20	58	19	17	91	94	20	29	156	47	69	47	3.0	0.9	2.9	2.3	747
L15	16.51	2.17	0.69	0.65	0.24	2.13	0.67	0.83	0.01	438	44	51	20	47	24	14	234	77	22	142	109	79	144	78	8.3	1.7	4.3	2.3	286

L number	Description	Location
L13	modern clay	Farnham Old Park B
L14	kiln sherd	Kingston, Eden St kiln
L15	Coarse Border ware	London, City

Key: Al2O3 aluminium; Fe2O3 iron; MgO magnesium; CaO calcium; Na2O sodium; K2O potassium; TiO2 titanium; P2O5 phosphorus; MnO manganese
Ba barium'; Co cobalt; Cr chromium; Cu copper; Li lithium; Ni nickel; Sc scandium; Sr strontium; V vanadium; Y yttrium; Zn zinc; Zr* zirconium; Pb lead
Rare earth elements: La lanthanum; Ce cerium; Nd neodymium; Sm samarium; Eu europium; Dy dysprosium; Yb ytterbium.
The results from Al2O3 to MnO inclusive are given as the oxide, in weight percent; all the rest are given as the element, in parts per million.

The ICP-AES analyses produced some striking results. The analysis of the Farnham clay and the Eden St, Kingston sherd are very close indeed, apart from slightly higher alumina and lower iron in the Kingston sherd. Otherwise, the rest of the major elements and practically all the trace elements are very similar indeed in these two items. The chances of getting two analyses which match so closely purely by chance are very slim indeed, and these two would be attributed to the same clay source. Multivariate statistics simply looks for differences in chemistry between items, and very little overall differences are apparent here between the Farnham clay and Eden St pottery. This is a very positive match. A possible explanation of the higher alumina in the Eden Street kiln is that the 'as dug' clay has been refined, and some quartz has been lost. Since quartz contains effectively only pure silica, the effect of removing quartz from a clay is to increase in relative terms all the concentrations of the other elements. This doesn't fully explain the differences, because most of the rest of the elements are at the same concentration in both items, and increasing the alumina in the clay would one expect be accompanied by all the other elements being increased too, which would make the two analyses less similar than at present. An alternative explanation for the higher alumina is that the clay may contain less kaolinite that the Eden Street pottery – kaolinite being an alumina/silica matrix.

Coincidentally, in the same batch of samples sent for ICP-AES analysis was a group of four sherds of wasters of whiteware pottery found in Kingston, dating to the 13th century, but not associated with a kiln (analyses to be published elsewhere – carried out on behalf of Chris Jarrett of PCA). All four are very close together in composition, and match very closely the Farnham/Eden Street analyses. This is further evidence of the use of the Farnham clay at Kingston.

The Coarse Border Ware (CBW) sherd in contrast has a rather different analysis, with higher lime and phosphate, and notably different in the rare earth elements (lanthanum, cerium, neodymium, samarium, europium and dysprosium). The rare earths tend to concentre in the heavy minerals. Of the other trace elements, while some have similar concentrations to the Farnham/Kingston analyses, the strontium and zinc are higher and the vanadium lower. So the CBW has rather a different analysis. It is quite striking that the neutron activation database mentioned above threw up some CBW sample with high rare earth elements (Pearce and Vince 1988, 183, samples 80 and 81). They comment 'They are rather easily identified since all contain considerably enriched amounts of the lighter lanthanide series (lanthanum, europium, cerium and samarium)'. This feature, and the actual concentrations of these four elements in their samples 80 and 81 correspond very closely to the ICP-AES results for the CBW sherd, and extend to (for example) the iron content which is very similar in all three samples. We have therefore identified a further example of this rather unusual CBW whiteware fabric.

Conclusions

Chemically, the ICP-AES analyses have shown that the Farnham Old Park clay 'B' is very close indeed in chemical composition with a sherd from the Eden Street kiln, Kingston. A sherd of Coarse Border Ware has a different composition, matching two previously analysed by neutron activation analysis.

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Résumé

Cette note décrit les recherches récentes sur les sources probables d'argiles blanches utilisées dans l'industrie médiévale de « Surrey Whiteware ». A partir d' analyses chimiques par ICP-AES, des échantillons d'argile blanche de Claypit à Farnham Old Park sont comparés à des échantillons du centre de production médiévale à Eden Street (Kingston upon Thames). L'argile est aussi testée pour ses qualités de tournage, sa plasticité et les températures auxquelles elle peut être cuite pour produire à la fois de la vaisselle en terre cuite et grésée.

Zusammenfassung

Dieses sind Anmerkungen zu einer Studie über den wahrscheinlichen Herkunftsort des weißgebrannten Tons, wie er im Mittelalter in der Surrey-Weißwarenindustrie verwendet wurde. Es werden Proben des weißbrennenden Tons von Claypit Wood, Farnham Old Park, unter Verwendung der ICP-AES-Analyse mit Proben von dem mittelalterlichen Produktionszentrum in Eden Street, Kingston-upon-Thames, verglichen. Die Tonprobe wurde auch auf ihre Herstellungsqualität hin untersucht, auf ihre Formbarkeit und die Temperaturspanne, in der sie gebrannt werden kann, um Töpfe und Steingutgefäße herzustellen.