Proc Soc Antiq Scot 141 (2011), 249–267

Sourcing Scottish medieval ceramics – the use and success of chemical analysis

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INTRODUCTION

The aim of this summary paper is to review the success of chemical sourcing in the study of the Scottish medieval Whiteware and Redware ceramic industries and outline the methods and protocols that the authors feel should be used to take the technique forward.

In 1996, a group of Scottish medieval ceramicists and geochemists met at the offices of the British Geological Survey in Edinburgh to discuss modern analytical techniques that offered the opportunity of identifying the location of pottery production sites. ICP-OES and ICP-MS (inductively coupled plasma optical emission spectrometry and mass spectrometry respectively) were beginning to be more widely used in the study of ceramics (Pollard et al 2007: 62–9, 208) and it was felt that Scotland's distinctive geochemistry ought to lend itself very well to those methods of analysis. A pilot study, funded by Historic Scotland, was undertaken on the Scottish Redware industry; its remarkably consistent results were published by the Medieval Pottery Research Group (henceforth MPRG) (Chenery et al 2001: 45–54). This was followed by a pilot sourcing project on Scottish White Gritty Ware, again funded by Historic Scotland (Will et al 2003). These results led on to the completion of a major study of Scottish medieval whiteware industries (Jones et al 2006). Returning to Scotland's redwares, a report prepared for Historic Scotland (Chenery et al 2004), was well received and instrumental in them funding our largest ICP project to date. This highly successful undertaking, covering both medieval and later Scottish redwares, has recently been published as a monograph by the MPRG (Haggarty et al 2011).

THE STUDY OF SCOTTISH MEDIEVAL POTTERY

For many years, archaeological studies in Scotland had a perceived bias towards the Prehistoric and Roman periods and therefore a proper, considered understanding of medieval Scotland suffered as a result. It is very striking that a careful study of the contents of the *Proceedings of the Society of Antiquaries of Scotland* reveals that it is not until 1913 that anything except for an occasional stray find was published on medieval pottery: a note and drawings of some pottery from a small excavation at the motte in Hawick (Curle 1913: 21–3). It is

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only with the work of the then chief inspector of Ancient Monuments, Stewart Cruden, in the 1950s, and Lloyd Laing, also working in the inspectorate in the 1960s, that the first proper published studies of medieval pottery cleared from Monuments in State Care appeared (Cruden 1952; 1953; Laing & Robertson 1969). On the back of his studies of the material from Bothwell Castle and Glenluce and Melrose Abbeys, Cruden then published a first consideration of the Scottish medieval pottery industry in 1958 but relied very much on English parallels supplied by Jope and Dunning (Cruden 1958). Although based heavily on subsequently discredited rim morphology, Laing's important paper on cooking pots in the early 1970s set the foundations for much of the modern study of medieval ceramics in Scotland (Laing 1973). The study of Scottish medieval redware only really came to the fore in the mid to late 1970s with the commencement of Scottish urban archaeology, the foundation of the Aberdeen Archaeology Unit and major excavations in Elgin and Perth (Hall 2000). In 1982, the publication of excavations in Aberdeen represented the first synthesis of a group of ceramics from a Scottish medieval burgh (Murray 1982). Excavations in Elgin (1976–7) and Perth (1975–7) also produced sizeable, well stratified groups of pottery. In recent years, thanks to funding from Historic Scotland, the sizeable assemblage from 75 High Street, Perth, has finally been worked on and is due for publication in 2012 (Haggarty et al forthcoming), the Elgin assemblage remains unpublished.

The study of the Scottish Whiteware industry was moved on a step further by Eoin Cox (1984: 386–95), and George Haggarty's (1984: 395–8) important papers on the dating and fabric categorisation of Scottish White Gritty Ware pottery from excavations at Kelso Abbey (illus 1).

ILLUS 1 Straight-sided jar in Scottish White Gritty Ware used for cooking, Kelso Abbey, Scottish Borders. (Courtesy Trustees National Museums Scotland)

SCOTTISH WHITE GRITTY WARES AND MEDIEVAL REDWARES

INTRODUCTION

The term 'Scottish White Gritty Ware' is a general term that covers a wide range of visually similar pottery fabrics recovered from excavation throughout large areas of Scotland, from at least the mid-12th through to the late 15th century. The fabrics are usually hard with a quite finely grained matrix often encompassing a range of rock fragments and inclusions which makes them gritty to the touch. In colour the vessels range, when oxidised, from the very common white or cream to the occasional buff or pink. Under more reducing conditions in the kiln, they are generally a light to medium-grey but can, on occasions, be almost black. The main vessel types are jars/cooking pots and jugs,

although a limited range of other vessel types have been recorded, with some evidence for regionalism, especially in the 12th and 13th centuries. The Historic Scotland funded ICP-OES pilot study suggested that there were a great many undiscovered production centres awaiting discovery; however, at present only three have been identified with any confidence (Colstoun, East Lothian (Brooks 1980; Hall 2007); Ceres and Coaltown of Wemyss, Fife (Jones forthcoming)). In the areas of Fife, Lothian and the Borders, SWGW are the dominant fabric groups, often representing over 90% of the medieval pottery recovered. Presently, the full extent of this industry and the distribution of its wares, especially in areas in the west of Scotland, are little understood

In the early days of Scottish urban archaeology it soon became obvious to pottery specialists that the manufacture of most indigenous Scottish Redwares appeared to be localised, and indeed for many years these perceived redwares groups were named after the burgh in which they were found, for example, Elgin Local, Perth Local and Forfar Local (MacAskill et al 1987; Scott 1982). This terminology was subsequently qualified by referring to it as Scottish East Coast Redware, but, now that it is recognised to be considerably more widespread, the term Scottish Redware is more commonly used.

SCOTTISH WHITE GRITTY WARE

PROJECT AND AIMS

In recent years, archaeological excavations have produced large amounts of White Gritty sherds from both rural and urban sites throughout Scotland. As a number of these new stratified assemblages originated from outside what was traditionally thought to be the core area of production – the East coast – it became imperative to address the old unanswered problems of origin, typology, chronology and demise.

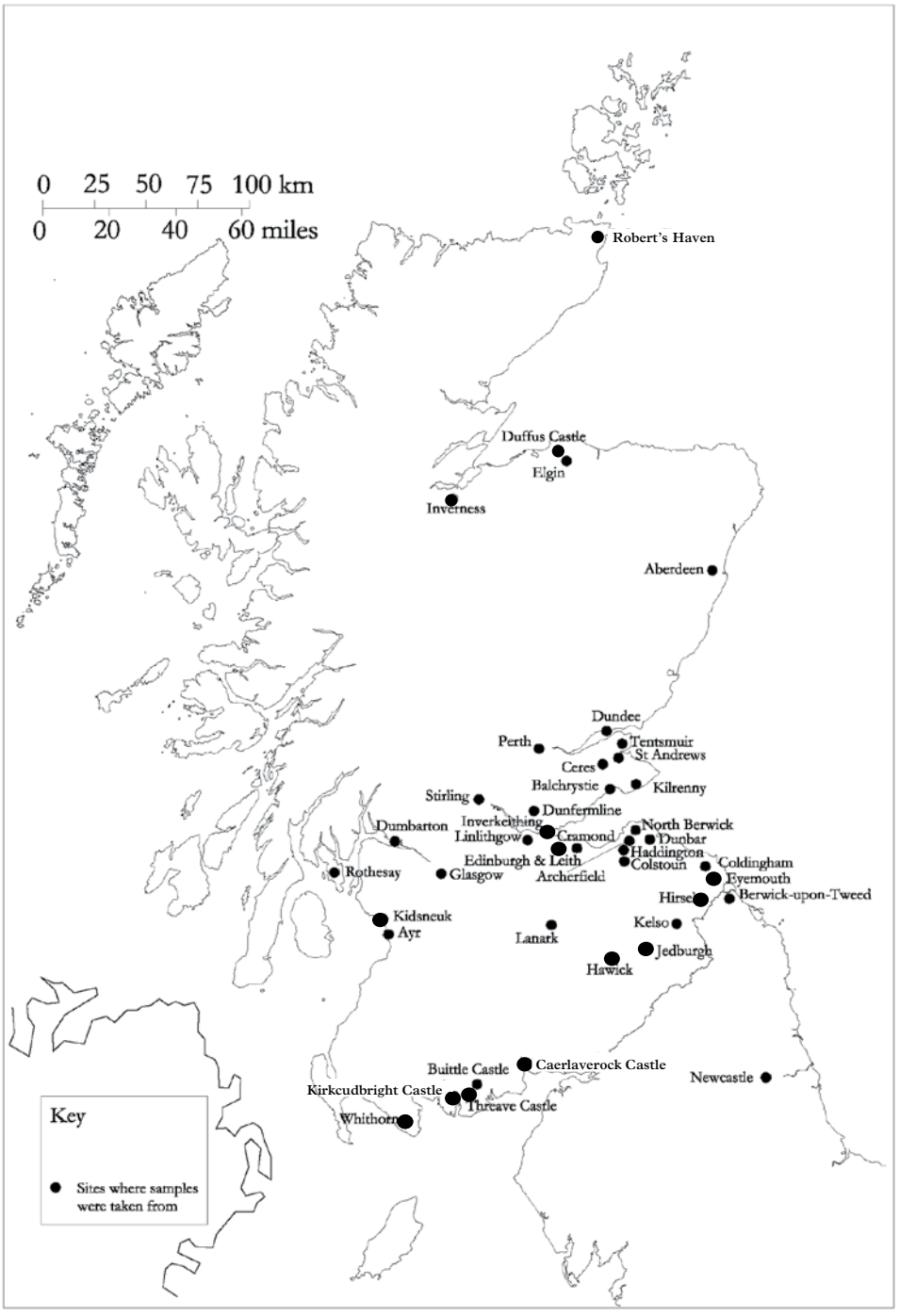
Aims:

- Our primary aim was to apply modern analytical techniques to groups of SWGW pottery. The combination of chemical sourcing by ICP-OES and petrographic examination of thin sections would, we hoped, allow us to characterise a range of sub fabrics, which in turn would be the basis of a nationally held SWGW fabric reference collection.
- To develop a recognised and agreed terminology for the description of SWGW pottery, which would be flexible enough to be adapted and developed as required in the future.
- To produce, if possible, a workable field guide to SWGW based on any visual characteristics, supported by thin section work and ICP-OES.
- To produce a provisional vessel typology for the SWGW industry.

Sampling

Five hundred and sixty-six new samples, in addition to the 50 samples used in the pilot study, were collected from 40 Scottish rural and urban sites (illus 2). The county town of Elgin was the most northerly and Buittle Bailey castle in Dumfries and Galloway was the most southerly. However, as might be expected, the main concentration was from the Borders, Lothian and Fife, areas where SWGW has traditionally been found in greatest quantity.

Samples were selected from either complete vessels or sherds for which vessel profiles were available, where a good range of vessel forms were present or where there was external dating and the samples were from well stratified deposits. In this way we hoped to bring together existing information concerning vessel shape, form, distribution



ILLUS 2 Map of Scotland showing the sites mentioned in the text and those where Scottish White Gritty Ware samples have been taken from

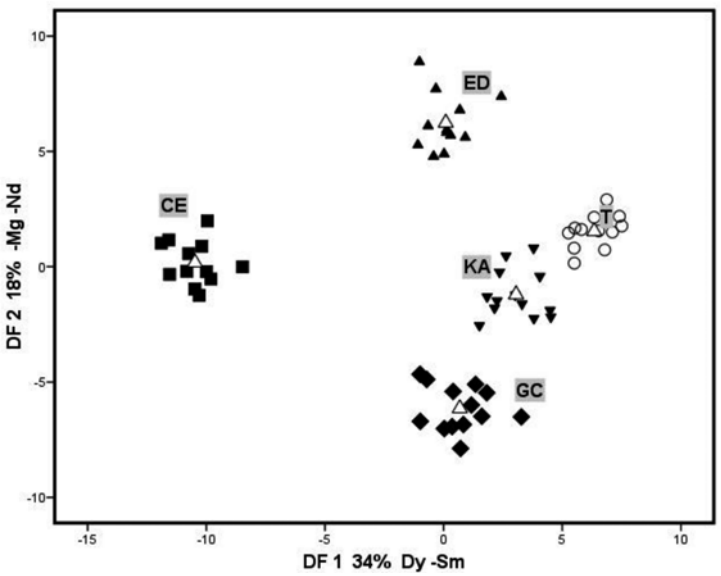
and dating. In a few cases, small body sherds were the only ones available and these were included if the site was particularly important in terms of geographic position. For the larger towns and cities, samples were often selected from more than one site.

Analyses

ICP-OES was selected as the technique of chemical analysis because it determines with suitable accuracy and precision the contents of a wide range of elements (major, minor and trace), 30 in all. Jones et al (2006) describe the sample preparation (by crushing small cleaned fragments) and data treatment. The ability to differentiate between these site-specific groups was then tested using multivariate statistical procedures. Applying discriminant analysis to SWGW from Ceres, Edinburgh (Parliament site), Kelso Abbey, Tentsmuir and Glasgow (Cathedral site), illus 3 shows that the compositions belonging to each of these five site-specific groups are uniform, and moreover, these five groups can be differentiated from each other, the Ceres group especially so, the Tentsmuir group rather less well. Furthermore, groups representing Kelso Abbey, Colstoun, Ceres and Elgin are confidently discriminated (illus 4). On the other hand, there were some findspots, for example, St Andrews, for which the compositions were not internally uniform, a result in itself of interest and requiring further investigation. But overall, the encouraging picture emerging from chemical analysis was that the data was consistent with multiple SWGW production centres.

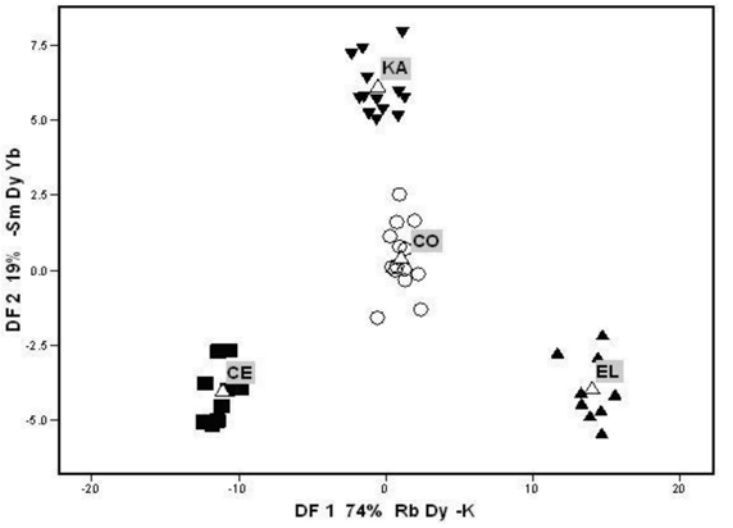
Recognising that questions about the identity of white wares are general ones confronting Scotland as well as north-east England has emphasised the need to extend comparison of the SWGW chemical groups with those obtained by Vince (1998) using the same analytical technique. So far, Doncaster and Whitby WGW can be differentiated from Colstoun (ibid 1998).

The corresponding petrographic data set, although less amenable to interpretation in terms of origin, was useful in the way it



ILLUS 3 Results of discriminant analysis (DA): plot of discriminant functions 1 and 2 (DF1 and DF2) for the SWGW chemical groups for Ceres (CE), Kelso Abbey (KA), Tentsmuir (T), Edinburgh (Parliament site) (ED) and Glasgow (Cathedral site) (GC). Ceres is well discriminated from the other four groups, discrimination between these four groups being more subtle as they occur along DF2. All 30 elements, apart from Ba, P and Pb, were utilized in the DA. The chemical data for Ceres was obtained after the publication of Jones et al (2006)

highlighted potential diagnostic features, ranging from the presence of particular inclusions such as igneous rock fragments at Lanark, the frequency of voids and the occurrence of the same fabric among samples at St Andrews and Dunfermline. Furthermore, recent analysis has shown that the quartz to quartzite ratio appears to differentiate Ceres from Colstoun and other find spots. As the project progresses, it seems likely that its petrographic component will assume increasing importance.



ILLUS 4 Discriminant analysis (DA) plot of the SWGW chemical groups for Ceres (CE), Colstoun (CO), Elgin (EL) and Kelso Abbey (KA). Differentiation of Ceres from Colstoun, Kelso Abbey and Elgin along DF1 is strong, while that between Kelso Abbey and Colstoun along DF2 is rather weak

Locating the deposits of the kind of pale clays employed in SWGW production through clay prospection was a necessary direction of enquiry. It failed at Colstoun and Lempittlaw in the Scottish Borders. Where present, glaze was found (by scanning electron microscopy (SEM) with energy-dispersive X-ray analysis) to be lead based; among the very few exceptions was a tin-rich lead glaze in an example from Dunfermline.

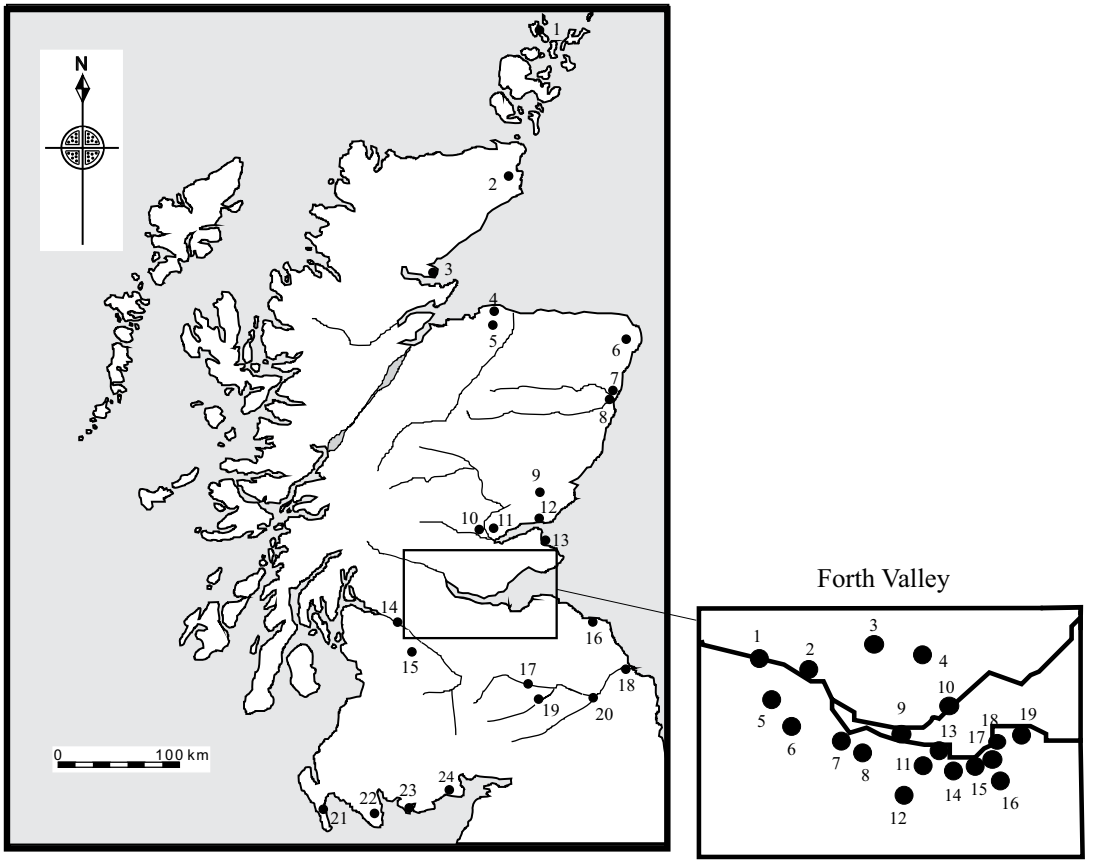
The appearance (under the scanning electron microscope) of the microstructure of the fabric in all the samples examined was relatively unvitrified, indicative of firing temperatures not exceeding 900°C. Hand-held XRF has proved to be a useful technique to screen a large number of glazed examples for the presence of the main colourants in glaze, iron and copper; this technique surely has potential for many further applications. Finally, scope exists for defining the source of the glaze's lead base using lead isotope analysis. Such analysis follows a routine laboratory procedure as some exploratory measurements at the Scottish Universities Environmental Research Centre (SUERC) have encouragingly indicated. Rather it is interpretation of the results which is more challenging: lead from different sources may well have been mixed, thereby confusing the lead isotope signature, our knowledge of the locations and size of lead sources in Scotland or northern England is still incomplete, and the likelihood that lead was imported from the Continent cannot be excluded.

SOURCING SCOTTISH REDWARES

PROJECT AND AIMS

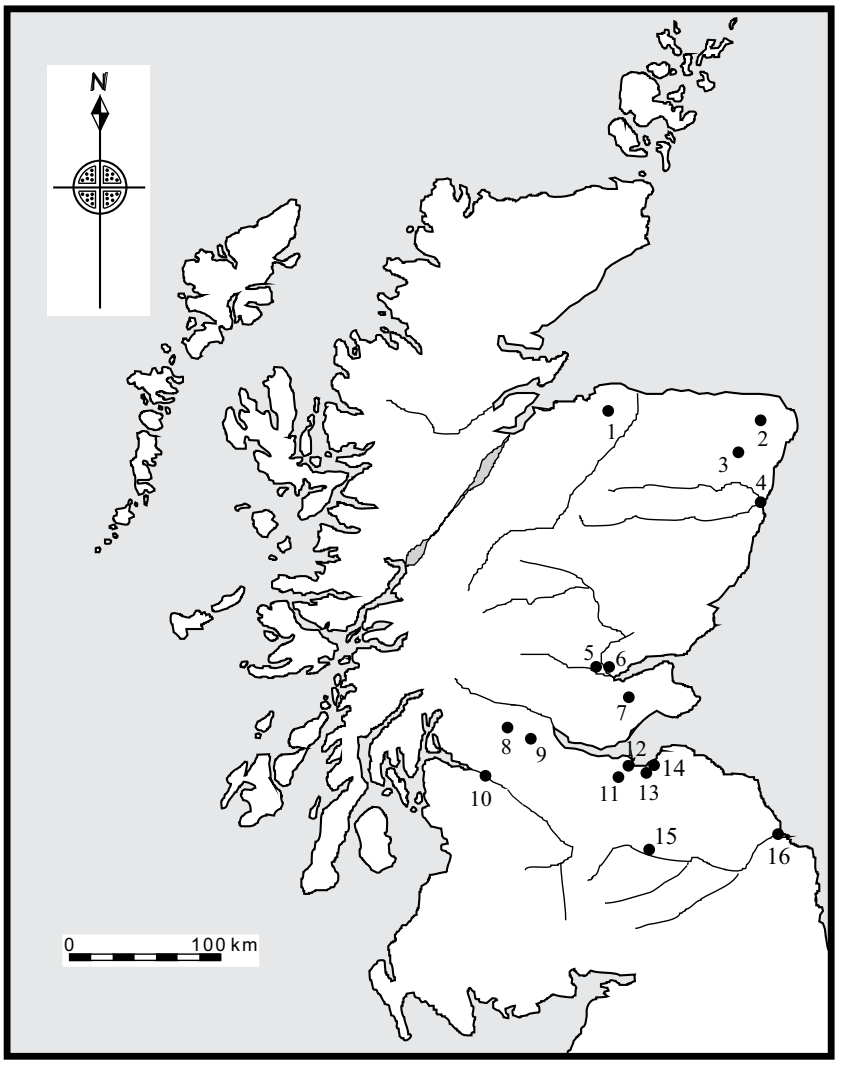
From the middle of the 13th century onwards, many of Scotland's extensive iron rich

clay sources were exploited for the production of pottery, tiles and later, bricks. In an attempt to understand these industries better, a geochemical pilot programme was instigated in 2003, using ICP-MS. This was carried out on small groups of post-medieval iron-rich pottery from a range of known Scottish production sites covering a wide geographical area (Chenery et al 2004: 45–54). The study utilized both the British Geological Survey's national geochemical database stream sediment analyses (http://www.bgs.ac.uk/gbase/index.html) and a rigid statistical approach. The results strongly indicated that these redware industries, especially on a regional basis, were far more complex than



ILLUS 5 Scottish Redware sample locations: 1. Quoygrew; 2. Caithness; 3. Dornoch; 4. Spynie Palace; 5. Elgin; 6. Rattray; 7. Seaton; 8. Aberdeen; 9. Melgund Castle; 10. Perth; 11. Kinnoull; 12. Dundee; 13. St Andrews; 14. Glasgow (Shuttle Street; Cathedral; Gallowgate; Govan); 15. Cadzow Castle; 16. Dunbar; 17. Melrose Abbey; 18. Berwick upon Tweed; 19. Kelso Abbey; 20. Jedburgh Abbey; 21. Whithorn; 22. Glenluce Abbey; 23. Caerlaverock Castle; 24. Hayknowes Farm

Forth Valley inset: 1. Stirling; 2. Alloa Tower; 3. Kinross; 4. Cupar; 5. Throsk; 6. Stenhouse; 7. Linlithgow; 8. Niddrie Castle; 9. Inchcolm Abbey; 10. Sinclairtown; 11. Edinburgh (Canongate; Castle; Chambers Street); 12. Newbattle Abbey; 13. Leith; 14. Newhailes; 15. Westpans; 16. Dirleton Castle; 17. Portobello; 18. Morrison's Haven; 19. North Berwick



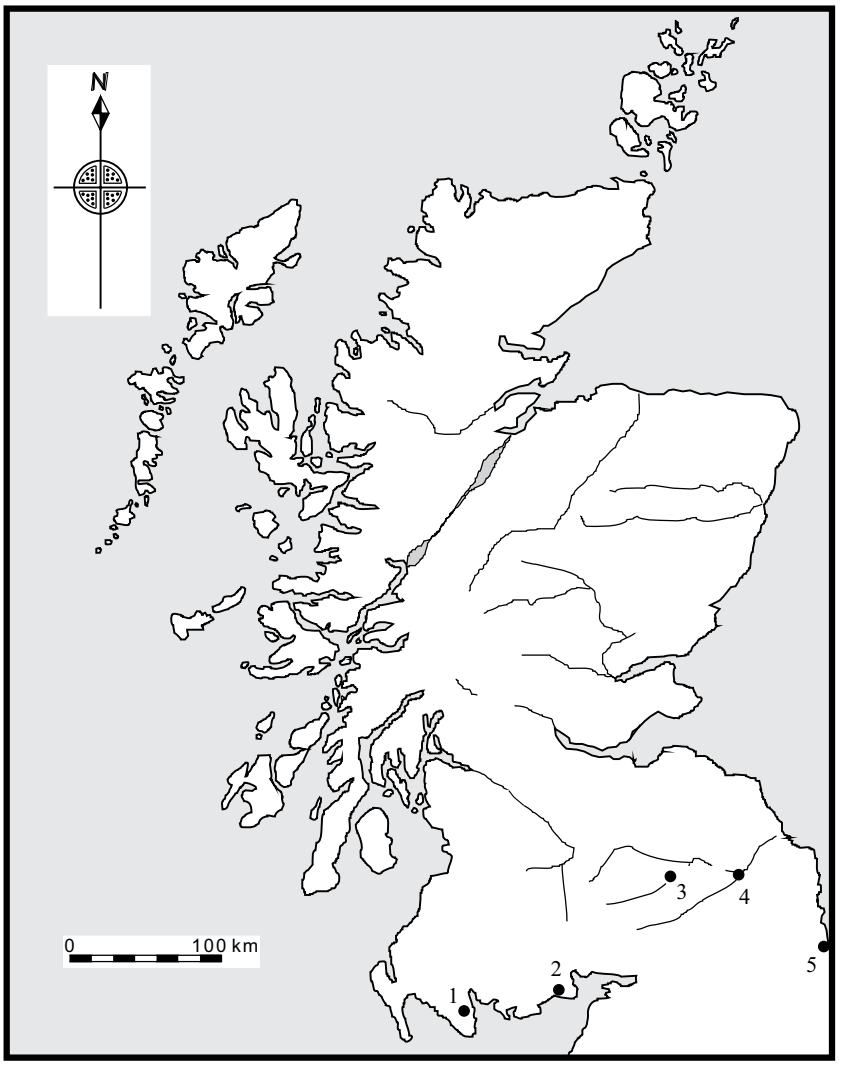
ILLUS 6 Known Scottish Redware production sites: 1. Elgin; 2. Rattray; 3. Auchleuchries; 4. Seaton; 5. Perth; 6. Kinnoull; 7. Cupar; 8. Throsk; 9. Stenhouse; 10. Gallowgate; Glasgow; 11. Edinburgh; 12. Portobello; 13. West Pans; 14. Morrison's Haven; 15. Melrose; 16. Berwick upon Tweed

had previously been believed. It seems likely that many more Scottish kiln sites, exploiting iron-rich clays, await discovery.

From the outset, it was decided that only pottery and tile material which could be retained as part of the national ceramic database would be sampled (http://repository.nms.ac.uk/). This was to ensure that our research findings could be repeated and, if necessary, checked again in the future.

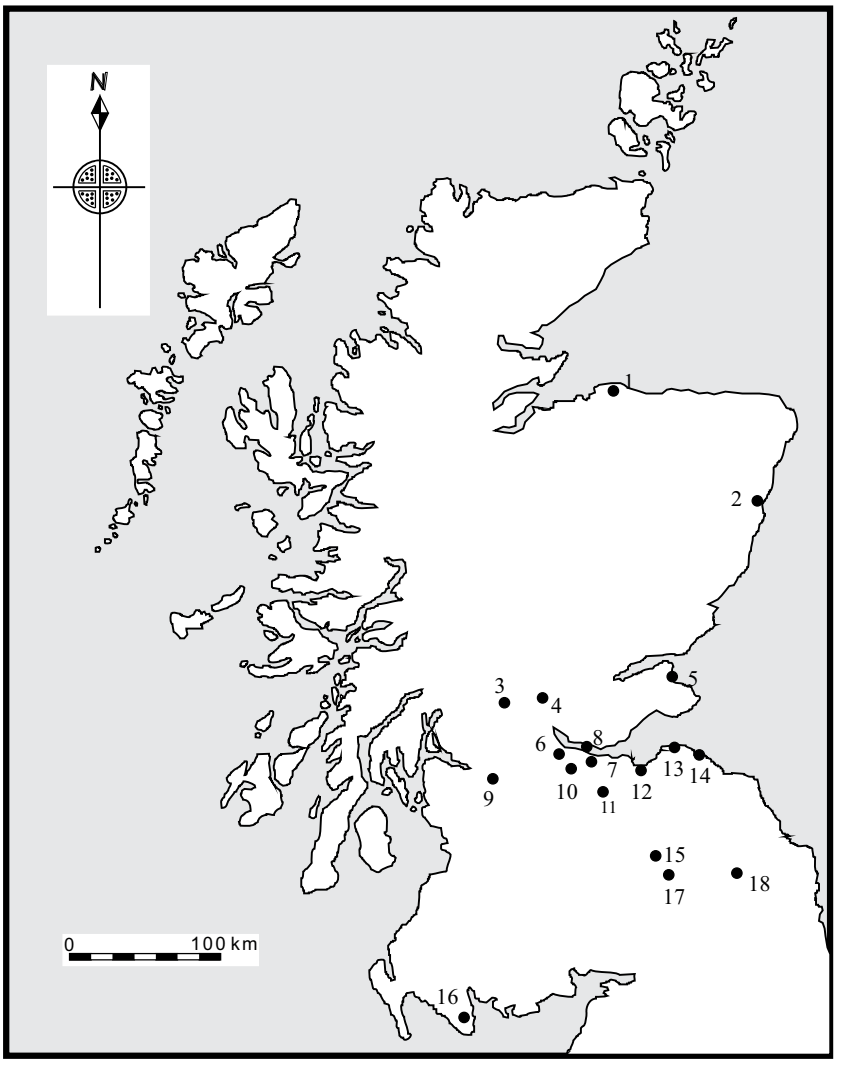
Sampling

In total, 613 ICP redware samples, including 42 from the pilot study (Chenery et al 2001:



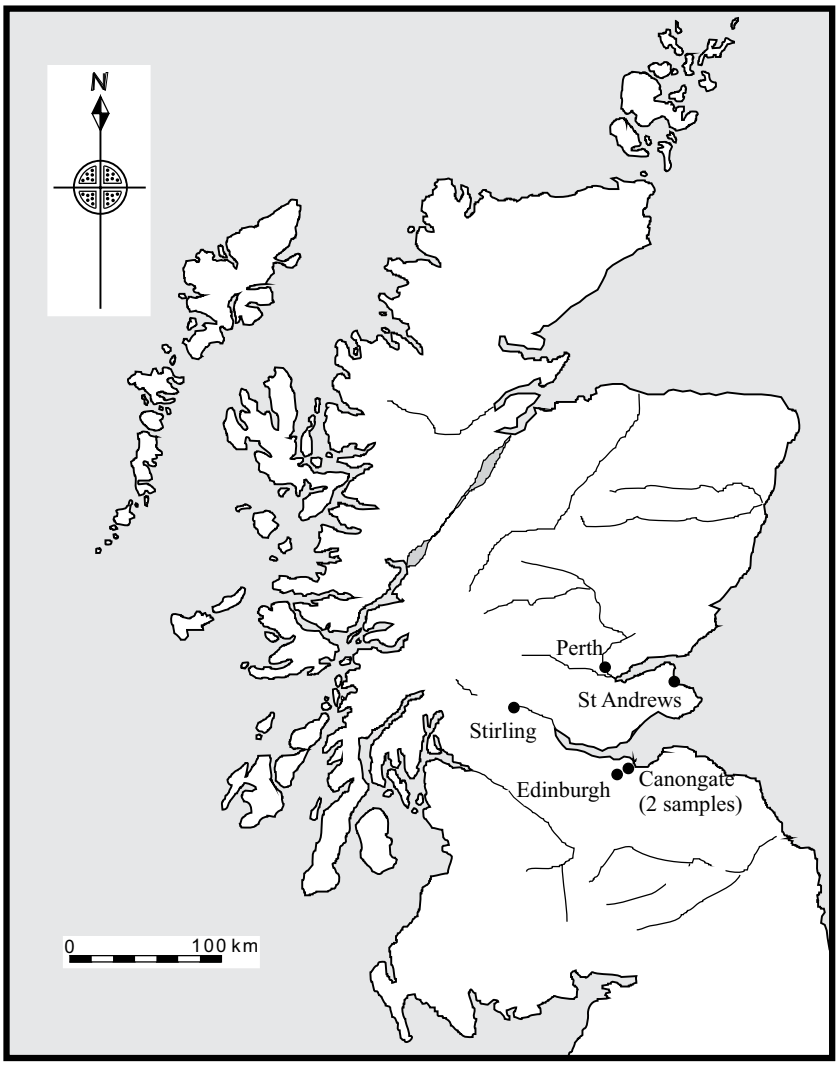
ILLUS 7 Locations of Early Redware sampled: 1. Whithorn Priory; 2. Hayknowes Farm, Annan; 3. Jedburgh Abbey; 4. Kelso Abbey; 5. Dog Bank, Newcastle

45–54) and nine published in the West Pans ceramic report (Haggarty 2006: Folder 16 Word File 1), were selected from sites around Scotland (illus 5). Sherds of tiles and other forms of red-firing pottery were analysed from several sites. From the outset it was decided that known Scottish redware production sites (illus 6) would have priority, and that the project would sample statistically large enough groups from each, in order to create strong data sets. The sherds and residual powders have been deposited in the National Museums Scotland as part of the national fabric reference collection. The material was divided into a number of groups and sub-groups. These included early redwares,



ILLUS 8 Locations of floor tile sampled: 1. Spynie Palace; 2. Aberdeen Carmelite Friary; 3. Stirling Castle; 4. Alloa Tower; 5. St Andrews; 6. Linlithgow Palace; 7. Edinburgh Castle; 8. Inchcolm Abbey; 9. Glasgow Franciscan Friary; 10. Niddrie Castle; 11. Newbattle Abbey; 12. Dirleton Castle; 13. North Berwick nunnery tile kiln; 14. Dunbar Customs House; 15. Melrose Abbey; 16. Glenluce Abbey; 17. Jedburgh Abbey; 18. Kelso Abbey

which seem to predate, or run concurrently with, the 12th-century Scottish Borders white gritty industries (illus 7); medieval redwares, considered to have mainly a north-east and south-west distribution; floor tiles, both locally produced, and imported from the Low Countries (illus 8); and a small group of what we wanted to demonstrate were Continental stove tiles (Haggarty & Hall 2010: 67–74 (illus 9). Also sampled were post-medieval redwares which have a general Scottish distribution,

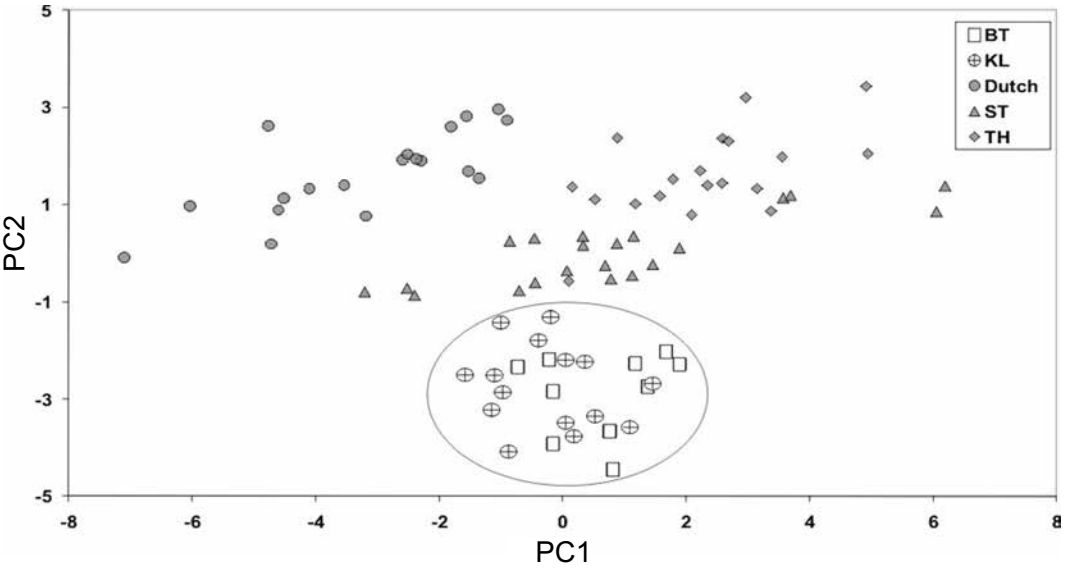


ILLUS 9 Locations of stove tile sampled

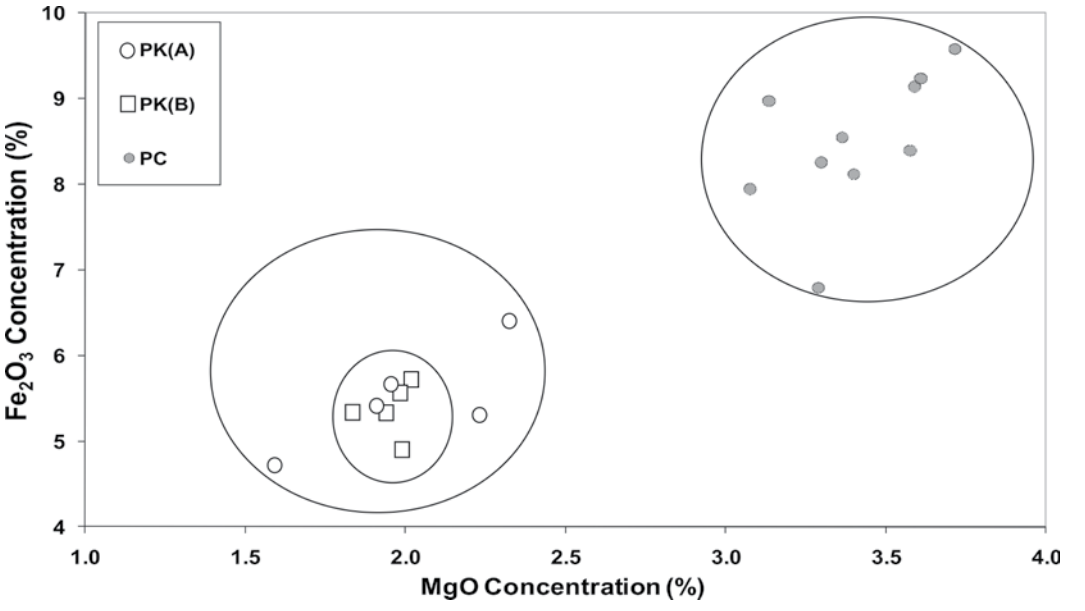
and industrial redwares, mainly confined to the Forth and Clyde river systems. Sherds from four Low Countries' production sites and from three north-eastern English kilns were added for comparison. A very limited number of raw and fired clay samples were analysed for source identification. The authors accept this limitation as they realised early on in the programme of work that a definitive study of such source material was beyond the scope of the main study for a number of reasons including: (i) the small number of identified production/kiln sites; (ii) much early material was probably sourced from small ephemeral clay deposits long since worked out.

Analyses

As a first stage of the Scottish Redware pilot study, 19 out of 20 blind samples were successfully identified to source, thus



ILLUS 10 Bi-variate plot of principal components PC1 and PC2 demonstrating the differences between Kelso Roxburgh Street (KL) and Berwick upon Tweed (BT) material and Dutch type (Dutch) or Forth Valley type material (TH & ST)



ILLUS 11 Bi-variate plot of MgO and Fe_2O_3 concentrations demonstrating the differences between Perth Canal Street (PC) and either Perth Kinnoull (PK(A) and PK(B))

confirming the strength of this analysis (Haggarty et al 2001: 45). The full project confirmed that none of the Redwares analysed matched the sampled Dutch Redwares and were very likely to be of Scottish origin. For an appreciation of the nature and results of the complete study the reader is directed to the published monograph (Haggarty et al 2011), however, a few important results have been selected here to indicate the effectiveness of this type of analysis. In each example, the question or proposal asked of the data is put forward, followed by a statistical consideration of the results.

1. *How does Kelso Roxburgh Street (KL) material compare with Berwick upon Tweed (BT), the Dutch Redwares and the Forth Valley kiln site material at Throsk (TH) and Stenhouse (ST)?*

Kelso Roxburgh Street and Berwick upon Tweed are significantly different from the Dutch and Forth Valley samples, as demonstrated by principal components analysis (PCA) using 22 key elements (illus 10). However, it has proved impossible to separate completely the KL from BT samples, even when they are considered on their own. The partial separation suggested a limited relationship between the two sets, based on a Tweed Valley signature.

2. *Compare Perth Kinnoull A (PK1-5) and Kinnoull B (PK6-10) against Perth Canal Street (PC).*

There were clear differences in many element concentrations between Perth Canal Street (PC) and both Perth Kinnoull PK (A) and Perth Kinnoull PK (B). Perth Kinnoull is located on the other side of the River Tay to the Perth Canal Street site, and illus 11, a bi-variate plot of MgO versus Fe_2O_3 concentrations, demonstrates that different raw materials were accessed.

However, Kinnoull A and Kinnoull B appear indistinguishable from each other using multivariate plots of cluster and principal components analyses.

3. *Compare Linlithgow Palace (LP) with Cadzow Castle (CZ), Niddrie Castle (NC) and the Forth Valley type material.*

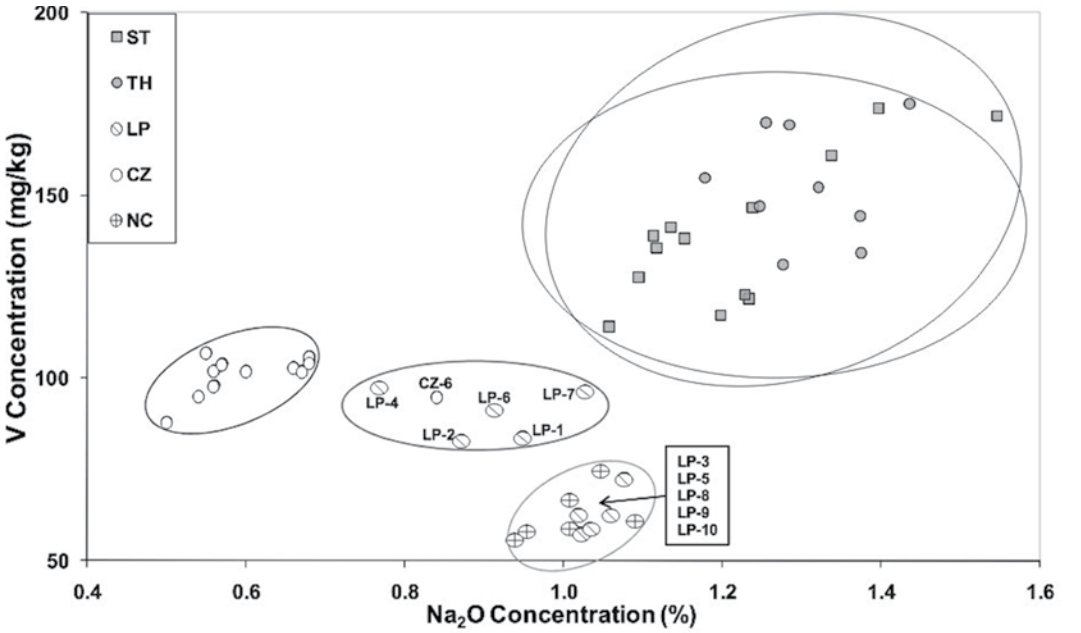
The Na_2O versus V plot (illus 12) shows Linlithgow Palace, Cadzow Castle and Niddrie Castle clearly separate from the Forth Valley kiln sites (ST and TH).

The relationships become more obvious when LP, CZ and NC samples are compared amongst themselves in a multivariate fashion using PCA (illus 13). All of the Cadzow Castle samples form a separate coherent group, except CZ-6 which forms a group with four Linlithgow Palace samples (LP-2, LP-4, LP-6 & LP-7). The remaining Linlithgow Palace samples form a separate group, as do the Niddrie Castle samples. However, samples LP-3, NC-1 and NC-2 are in an overlapping region between these two groups.

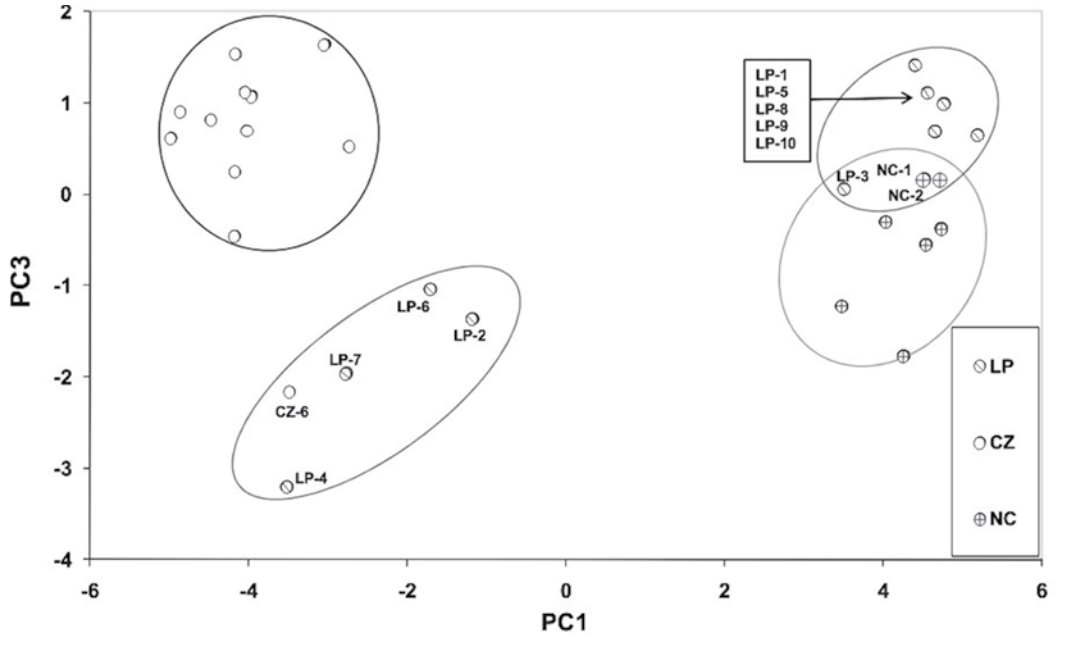
CONCLUSIONS

SCOTTISH WHITE GRITTY WARE

The major outcome of this project is the way it has demonstrated that there were many production centres of White Gritty Ware in Scotland. To the core area of production in the south-east and east of Scotland can now be added evidence for production in central and west Scotland and Elgin in the north. An important methodological result of the project is that it confirms what was written in 1984 regarding the examination (with ×20 magnification) of the fabric of a selection of white gritty ware from an excavation at Kelso Abbey: 'This quantitative technique is suitable as a comparative method of



Illus 12 Bi-variate plot of Na_2O and V concentrations demonstrating the lack of relationship between the Linlithgow Palace (LP), Cadzow Castle (CZ), Niddrie Castle (NC) material and the Forth Valley type samples (ST and TH)



Illus 13 Bi-variate plot of principal components PC1 and PC2 demonstrating the differences between Cadzow Castle (CZ), Linlithgow Palace (LP) and Niddrie Castle (NC) material

studying a collection of pottery, but with regard to provenance it is not sufficiently controlled to be pursued further' (Cox 1984: 391). We would go further and suggest that such a programme of fabric examination of SWGW must be backed up with additional laboratory-based analysis; on its own, it gives restricted, subjective information which does not provide value for money and is therefore best avoided. For the foreseeable future, we believe the only cost-effective means of characterising SWGW from well-stratified or important pottery assemblages is by chemical analysis (preferably using ICP-OES), backed up, where appropriate, with petrographic examination. Since the chemical distinctions between many of our ceramic groups are very small, sourcing of 'blind' samples is almost impossible and again not cost effective until the data set has been expanded.

Of the many science-based studies of SWGW previous to this one, very few had any long-term validity or results that can still be verified. In the light of this negative experience we propose that all sherds, samples, and thin sections from the SWGW project should be housed in the National Museums of Scotland as an adjunct to the fabric reference collection.

One of our principal aims was to produce a field guide to SWGW. However, this has proved an almost impossible task largely due to the difficulty already alluded to, namely, the difficulty of assigning fabrics using low-power microscopy. We have now taken a major step towards the creation of a comprehensive SWGW vessel typology. In carrying out that task it has been possible to ascribe a number of specific vessel forms on a regional basis. The best example is the 12th-century straight-sided jar, which, on present evidence, is thought to have been produced in the Scottish Borders, but which has been identified in assemblages from as far north as Caithness (illus 1). The frilled bifid rim is another distinctive SWGW type, apparently produced in Fife (Laing 1973) but which has also been found in Perth, Leith, Cramond and Newbridge.

Looking further to the future, the results of the chemical and petrographic analyses presented in the full published report have created an important resource and framework which should encourage further field-, museum- and laboratory-based work (Jones et al 2006). One of the tasks of field work should be directed towards locating kiln sites. Although the recent discovery of a kiln site at Ceres in Fife is very welcome, the relative lack of relevant kiln sites in Scotland severely limits our ability to tie down the chemical data from excavations. Colstoun has rightly featured prominently in this study, and yet there is more to be done at this site; the pottery workshops there may be more extensive than initially thought. There is also more to be done in terms of locating and characterising production centres in the west of Scotland, as well as publishing the pottery assemblages from the Manpower Services Commission-sponsored excavations in Glasgow. At the laboratory level, there is scope for integrating the chemical results of English Heritage's pilot study of Northern English Medieval White Ware (Vince 1998) with the studies described above. One beneficial outcome would be to investigate those potential production sites supplying both English and Scottish markets that are presently not being identified. It is relevant to point out here that we have no definite evidence that some SWGW is not imported to Scotland from either England or even Continental Europe.

Future analysis of SWGW that has been identified from sites in the north-east of Scotland, the Northern Isles and Norway (Reed 1994: 61, fig 2) should determine whether vessels in this ware were coming from a common source or a number of

production areas. The identification of a distinctive Scottish White Gritty Ware fabric from Elgin is important, especially as it cannot be matched with any of the fabric groups from the core production areas. Study of the sherds from northern Scotland, although limited in number, should help to develop a regional typology for the area around the Moray Firth. Finally, we draw attention to one feature of the raw material of SWGW, that is, the pale or white coloured clay. We have argued here, if indirectly, that potters operating in different areas of Scotland were able to locate sources of this type of clay. But that point can be set against two observations – first, that our admittedly limited efforts at clay prospection have, as mentioned above, largely failed to find significant deposits of such clays today, and second, the production of SWGW probably ended in the late 15th century to be replaced by the tradition that worked with the widely occurring red clays. The latter point raises the distinct possibility that the white clays, perhaps discovered initially in the course of prospection for another material (probably coal), may have been limited in extent. The sources of these clays may have been exhausted in antiquity.

SCOTTISH REDWARES

Thanks in the main to Scotland's distinctive geology, the red firing clays used in this widely distributed industry have proved ideal for chemical sourcing. This was clearly demonstrated early on in the project, when remarkably accurate results were produced by a program of blind sampling (Chenery et al 2001). Subsequent research on various ceramics types being produced throughout the medieval to modern periods of the Scottish Redware industries is now importantly allowing us to begin isolating specific regional signatures (Haggarty et al 2011). Presently, the main hurdle in our understanding of Scotland's medieval redware tradition is that of its commencement and conclusion. This lack of absolute regional production chronologies is principally due to the dearth of excavated production sites.

The authors genuinely believe that continued sampling of Scottish Redware ceramics, including material from later potteries and bricks/tile work, must be developed further by sampling on both a regional and site specific basis. This will allow us to tighten our focus on those areas that seem most likely to be the locations of missing production centres. Once these have been identified, it is vitally important that the opportunity is taken for proper targeted survey, excavation and scientific dating. In recent years, it has been suggested that, in or around some burghs, the manufacture of redwares might actually have continued from the medieval period through into the 19th century using the same clays. For example, Blanchard, in a published note, demonstrates that industrial redwares were being produced in the centre of Perth in the 19th century (1979: 75), however, this is an area requiring further research. It is also clear to the authors that it would be of enormous benefit if our foreign colleagues in the Low Countries, Scandinavia and elsewhere were to instigate a program of analysis on their Redware kiln assemblages using ICP, thus providing a comparable database of chemical signatures.

We also firmly accept as true, that the identification of a geographical source is crucial to the study of all excavated ceramic material, especially in identification of its movement, whether in the form of trade or exchange. Therefore, where appropriate, excavation budgets must incorporate monies for suitable fabric analyses. That said, ICP-

MS, thin section analysis, or other scientific techniques such as XRF, are not, and can never be panaceas for all our questions. It is essential that our excavated assemblages are also categorised visually against a good local or, preferably, national fabric reference collection in an effort to construct rigorous research strategies in a bid to make our ceramic reports of regional, national, or even international, significance.

Finally, to date we have been spectacularly unsuccessful in getting Scottish ceramic specialists from other periods, especially Roman, to get involved with the Redware project. This can only be seen as a lost opportunity with sites such as Inveresk lying adjacent to later industrial kiln sites like West Pans, there must be opportunities for cross period co-operation.

RECOMMENDATIONS

1. Where feasible, ensure that sherds are selected from well stratified deposits. Sherds should be from a recognisable part of the vessel (eg rim, base) and large enough for the original vessel form to be identified.
2. Expect to take at least 10 samples from a site and 20 samples if a kiln site.
3. Sampling of tiles should combine features of both size and thickness.
4. Keep a photographic record of each sherd/tile fragment prior to analysis.
5. We recommend retaining half the sherd/tile fragment (and powder residue) for archiving. These samples must eventually become part of the NMS fabric reference collection, thereby ensuring that all our analyses are repeatable.
6. We try and pick sherds for ICP analysis from unglazed areas of the pot or try to ensure that any glaze is removed from the surface of the sample shard.
7. ICP, in the form of either ICP-MS or ICP-OES, is the recommended technique of elemental analysis of pottery.
8. The success of a project that is quantitatively and statistically based depends on asking well-defined plausible questions.
9. Constant good communication between pottery specialists and analysts is required to refine hypotheses and produce valid solutions.
10. Other techniques, such as non-destructive XRF, should be borne in mind for rapid, qualitative or semi-quantitative analysis of paints, slips and glazes. The new dating technique of rehydroxylation should also be considered (Wilson et al 2009). Carbon 14 dating of carbonised residues has also proved valuable (Hall et al 2005).

ACKNOWLEDGEMENTS

No projects of the size and complexity of these two could be carried out without the help and goodwill of many friends and colleagues, in numerous institutions. The authors would therefore like to thank David Caldwell, George Dalgleish and Jackie Moran at the National Museums Scotland for their support; Jackie, in particular, was extremely helpful, as were the late Sarah Jennings from English Heritage and Alan Vince for constructive discussions. Alice Blackwell, Liz Thoms, Bill Brown, John Lawson, Biddy Simpson, Mike Cressey, Melanie Johnson. Alison Cameron, Tom Addyman, Julie Franklin, Fiona Baker, Paul Humphries, Julie Edwards, Bob Will, Marjorie Haggarty, Jim Gray and Sheila Forbes are all thanked for their help with both projects. Staff at Elgin, Edinburgh, Perth, St Andrews and Kirkcaldy Museums have all gone out of their way to be of assistance, while Dr Nick Walsh and his staff at Royal Holloway amazed us with their ability to process the ICP-MS samples in such a short time,

while Chris Connor and Gert Petersen at Glasgow did thin section and chemical sample preparation. We appreciative generous funding from the Russell Trust and our thanks also go to the AOC Archaeology Group. In GUARD, Caitlin Evans, Jill Sievewright, Gill McSwan, John Arthur, Jen Cochrane and Olivia Lelong all provided assistance at various times for which we are grateful. These important ceramic projects would never have seen the light of day had it not been for the far sighted, robust backing, and financial support of Historic Scotland. We are therefore especially grateful for the interest and help of Patrick Ashmore, Nick Bridgland, David Breeze, Olwyn Owen, Ann MacSween, Jane Flint, Richard Wellander and Noel Fojut.

REFERENCES

Blanchard, L 1979 'Perth Enters the List', *Scottish Pottery Society Archive News* 4: 75.

Brooks, C M 1978–80 'Medieval pottery from the kiln site at Colstoun, East Lothian', *Proc Soc Antiq Scot* 110: 364–403.

Chenery, S, Haggarty, G, Hall, D, Murray, J C & Thoms, L 2004 *Sourcing Scottish Redwares*, a report prepared for Historic Scotland.

Cox, E 1984 'Ceramic Material', *in* Tabraham, C J 'Excavations at Kelso Abbey', *Proc Soc Antiq Scot* 114: 386–95.

Cruden, S 1951–2 'Scottish Medieval pottery: the Bothwell castle collection', *Proc Soc Antiq Scot* 86: 140–70.

Cruden, S 1952–3 'Scottish Medieval pottery: the Melrose Abbey collection', *Proc Soc Antiq Scot* 87: 161–74.

Cruden, S 1958 'Scottish Medieval Pottery', *Proc Soc Antiq Scot* 89: 67–82.

Curle, A 1913 'Account of some slight excavations at the Mote of Hawick', *Proc Soc Antiq Scot* 48: 21–3.

Haggarty, G 1984 'Observations on the ceramic material from phase 1 pits BY and AQ', *in* Tabraham, C 'Excavations at Kelso Abbey', *Proc Soc Antiq Scot* 114: 395–7.

Haggarty, G 2006 'West Pans Pottery Resource Disk', *The Northern Ceramic Society Journal* 22: 110.

Haggarty, G, Chenery, S & Phillips, E 2001 'An evaluation of geochemical fingerprinting for the provenancing of Scottish redware pottery', *Medieval Ceramics* 25: 45–54.

Haggarty, G & Hall, D W 2010 '"Throw some more fuel on the fire" – the stove tiles of medieval Scotland', *in* De Groute, K, Tys, D & Pieters, M (eds) *Exchanging Medieval Material Culture: Studies on archaeology and history presented to Frans Verhaeghe*. (=Archeologie Monuments- & Landschapsonderzoek in Vlaanderen). *Relicta Monografieen* 4: 67–74.

Haggarty, G, Hall, D & Chenery, S 2011 *Sourcing Scottish Redwares* (= Medieval Pottery Research Group Monograph Series, 4).

Haggarty, G, Hall, D W & Vince, A G forthcoming 'The medieval pottery', *in* Thoms, L & Hall, D W *Excavations at 69–75 High Street*, Perth. Fascicule 2 Ceramics, metalwork, religious and wooden objects.

Hall, D W 2000 '25 years of urban archaeology in Scotland's medieval burghs', *in Conservation and change in Historic Towns*. Council for British Archaeology research report 122.

Hall, D W 2007 'Excavations at the pottery production centre of Colstoun, East Lothian, in 1939, 1969, 1971, 1977 and 1999/2000', *Medieval Ceramics* 28: 32–71.

Hall, M, Hall, D & Cook, G 2005 'What's Cooking? New radiocarbon dates from the earliest phases of the Perth High Street excavations and the question of Perth's early medieval origin', *Proc Soc Antiq Scot* 135*:* 273–85.

Jones, R E forthcoming *A chemical and petrographic characterisation of Scottish White Ware production at Ceres and Coaltown of Wemyss*.

Jones, R, Will, B, Haggarty, G & Hall, D 2006 'Sourcing Scottish white gritty ware', *Medieval Ceramics* 26 & 27: 45–84.

Laing, L R & Robertson, W N 1969–70 'Notes on Scottish Medieval pottery', *Proc Soc Antiq Scot* 102: 146–54.

Laing, L R 1973 'Cooking pots and the origins of the Scottish medieval pottery industry', *Archaeol J* 130: 183–216.

MacAskill, N L, Brittain, J & Scott, C 1987 'Pottery', *in* Holdsworth, P *Excavations in the*

Medieval Burgh of Perth, 1979–81, 89–120. Edinburgh: Society of Antiquaries of Scotland Monograph 5.

Murray, J C 1982 'The pottery', *in* Murray, J C (ed) *Excavations in the Medieval Burgh of Aberdeen, 1973–1981*, 116–76. Edinburgh: Society of Antiquaries of Scotland Monograph 2.

Pollard, M, Batt, C, Stern B & Young, S M M 2007 *Analytical Chemistry in Archaeology*. Cambridge: Cambridge University Press.

Reed, I 1994 'Late Medieval Ceramics in Norway', *Medieval Ceramics* 18: 61 (Fig 2).

Scott, C 1982 'Appendix 2 Pottery', *in* Spearman, M 'Excavation at 17–21 Castle Street, Forfar', *Proc Soc Antiq Scot* 112: 455–64.

Vince, A 1998 *A pilot study of Northern English Medieval White Ware*. Report prepared for English Heritage.

Will, R, Chenery, S, Haggarty, G, Jones, R, Hall, D W, Marchand, A & Vince, A 2003 *Sourcing Scottish Medieval White ware: results of the pilot study*.

Wilson, M A, Carter, M A, Hall, C, Hoff, W D, Ince, C, Savage, S, McKay, B & Betts I 2009 'Dating fired-clay ceramics using long-term power law rehydroxylation kinetics', *Proc Royal Society A: Mathematical, Physical & Engineering Sciences*: 10.1098/rspa.2009.0117.

This paper is published with the aid of a grant from Historic Scotland