# CERAMIC TRADITIONS - THE EVIDENCE FROM CLAY SAMPLING AT TWO LATE PREHISTORIC SITES: BIRNIE (MORAY) AND TRAPRAIN LAW (EAST LOTHIAN), SCOTLAND

Daniel Sahlén
University of Glasgow
Department of Archaeology
United Kingdom
Email: sahlen.d@gmail.com

**Introduction**

Clay sampling in archaeological studies has predominantly been used to answer questions of the provenance of ceramic materials, but recent literature has increasingly focused on further issues concerning material choices and selection (e.g. Martineau *et al.* 2007). These studies have often highlighted social mechanisms behind the selection of clays and tempering materials (e.g. Gosselain and Livingstone Smith 2005). The purpose of this article is to look at the relation between different ceramic materials and sampled clays from two late prehistoric Scottish sites (Figure 1A): Birnie (Moray) and Traprain Law (East Lothian). This work is based on the results of the writer's PhD thesis (Sahlén 2011), which looked at the ceramic technology of metalworking ceramics, ceramic materials used for the processing of metals, in late prehistoric Scotland.

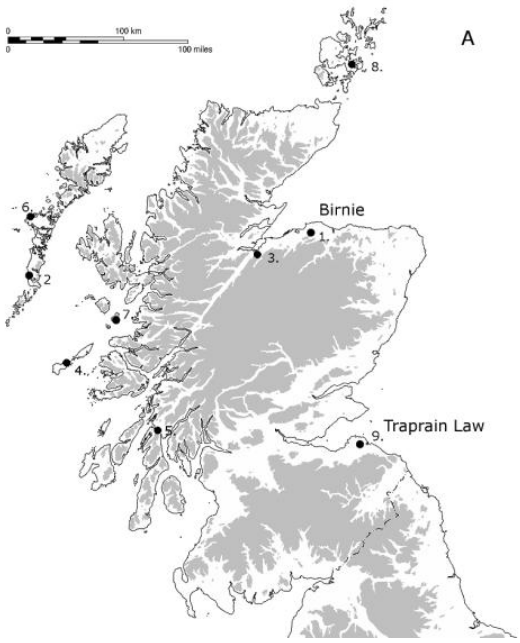


*Figure 1A. Map of Scotland with the location of Birnie and Traprain Law marked; numbered locations mark sites included in the writer's PhD thesis (Sahlén 2011).*

In this work a key question in relation to clay sampling was to assess whether different groups of ceramic materials were made from local or non-local clays, rather than to determine their exact provenance. Several scholars have highlighted the difficulties in determining the exact provenance of a particular ceramic material following the often high variability of ceramic materials, due to both anthropogenic and natural causes (cf. Tite 1999: 197). However, previous studies looking at the provenance of pottery from late prehistoric Scotland (e.g. Topping and MacKenzie 1988; MacSween 2007) have demonstrated that local resources were predominantly used, following the trends seen elsewhere in Britain (Morris 1996).

Moulds and crucibles, used for casting of non-ferrous metals, are the main ceramic materials in focus, but comparison of other ceramic materials, particularly pottery, will be made. Clay was in prehistoric and early historic times the main material constituent for tools used in the processing of metals, including tuyères, furnace linings, crucibles, and moulds, even if tools in stone were also used (cf. Freestone 1989).

The material analysis of sampled clays and ceramics was based on an integrated approach (cf. Tite 1999), using a series of archaeometric techniques, chiefly ceramic petrography, Scanning Electron Microscopy combined with Energy Dispersive X-Ray Spectroscopy (SEM-EDX), and X-Ray Diffraction (XRD). Ceramic petrography, supported with chemical analysis, were the main methods used to characterise the material and its technology. The use of XRD was limited to a case study of clays and ceramic materials from Traprain Law, with the goal to investigate the mineralogy beyond that possible with thin section petrography (see Sahlén 2011: 72-98 for a full methodological statement). The use of different techniques allows for a more robust interpretation about material technology and composition (cf. Tite 1999; Spataro 2011).

**The sites – background and clay samples**

A larger study (Sahlén 2011) looked at ceramic materials from nine different sites, but ceramics and clays from only two of the sites will be discussed here in detail (Figure 1 A, B, C). Clays were sampled and analysed from four different sites, but the sampling of clays from Birnie and Traprain Law was more thorough and provided therefore a more detailed picture of clays in the regions and their relation to the ceramic materials. An extensive sampling of clays in the areas around Birnie and Traprain Law was judged suitable since these sites showed evidence of settlement and casting production both in the Late Bronze Age (LBA) and the Iron Age (IA). This gave the possibility to compare the use of clays in two periods, at two independent sites.

The clay sampling programme at Birnie and Traprain Law aimed to examine a number of different types of clays available in the region around both sites. The threshold model of Arnold (1985) was used as a starting point to define the distances a potter in a traditional society would travel to obtain clay. Arnold

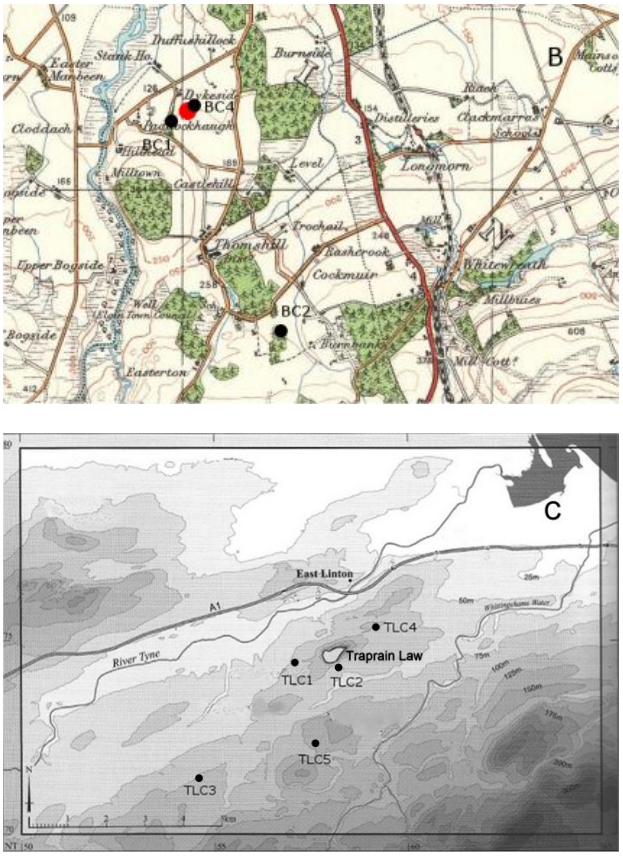


*Figure 1 B, Map location of Birnie clay samples BC 1, 2 and 4,sample 3 was collected ca. 7km north of the site (off map), the red circle marks the approximate location of the archaeological site (Ordnance Survey map 1930); C, Location of sampled clays from Traprain Law. All numbers refer to Table 2*

argued that a potter would rarely travel beyond 7km radius to collect clay and often would use clays in a much closer range, 1-3km. In the current study it was a central goal to link the practice of clay selection with technological traditions, following the recent focus in ethnoarchaeological studies on the social framework of clay collection and use (e.g. Gosselain and Livingstone Smith 2005). I looked for and sampled clays available within 10km of each site, and defined clays within a 3km radius as local. I used geological and historical sources to locate possible clay sources in each region. I also used local knowledge, which often was an essential source. I am

not claiming to have sampled all clays available around the two sites, but I have tried to make a representative collection of different clays present today. I collected on average 5-10kg clay from each clay source sampled. The clays were later analysed and described in their raw state and as fired briquettes, noting colour, plasticity and workability, following the advice of professional potters. Two sets of briquettes were made from each clay: one fired to 600 °C for three hours, and one fired additionally to 1100 °C for one hour. The former firing was intended to replicate the alteration of the clay after pottery firing in prehistoric Scotland; the latter was meant to replicate the temperatures used in casting of copper and copper alloys (bronze melts at *ca.* 950 °C) and copper at 1083 °C). The firing was done in an electric kiln at a controlled temperature and atmosphere and cannot be seen as an authentic firing of the material.

### *Birnie*

Birnie, south of Elgin in Moray, in the northeast corner of Scotland, was excavated between 1998 and 2011 by National Museums Scotland, under the direction of Fraser Hunter. The site consists of a series of roundhouses, indicating a continuous settlement from the Late Bronze Age to the Roman Iron Age, with some later occupation in the medieval period. The nature of the site is not fully understood yet, but the picture that emerges from the excavations is of a high status late prehistoric farmstead or rural settlement. The ceramic material analysed from Birnie included LBA and IA pottery and crucibles, and LBA moulds (Table 1; see also Figures 2 and 3). Although most of the potsherds were not diagnostic, they were attributed to the Iron Age on stratigraphic evidence, but one sherd of LBA pottery was also included in the analysis.

| Material | Br | TL |
|---|---|---|
| Crucibles, LBA | 2 | 3 |
| Crucibles, MIA | 2 | 7 |
| Moulds, LBA | 3 | 8 |
| Moulds, MIA | - | 3 |
| Pottery, LBA | 1 | |
| Pottery, IA | 2 | |
| Pottery, Misc. | 7 | 12 |
| Total | 15 | 33 |

*Table 1. List of ceramics sampled from Birnie (Br) and Traprain Law (TL); divided according to material category and period. Pottery Misc. refers to pottery which is vaguely dated. See Sahlén 2011 for full details of the ceramic material.*

The site is located within a large flat landscape, with the river Lossie crossing the plain not far from Birnie. The underlying bedrock formation of the area is dominated by metamorphic rocks of the Grampian group (e.g. granulite and quartzite); sedimentary rocks of middle and upper sandstone overlie these to the north and east of Elgin (Peacock 1968; Sinclair Ross pers. communication). The area is largely covered by glacial tills, mainly of sand and gravels, obscuring the bedrock. Deposits of clay in the area are rare, but clay was industrially worked until the 20th century at the now dried-out Loch Spynie (about 8km to the north of the site) and clayish sand has been recorded from the sand tills around Birnie in the Statistical Account of Scotland (Anderson 1791-99: 156).

I collected four clays in the region around Birnie (Table 2). The first clay sample (BC1) was collected from a natural pocket of clayish sand just to the south of the archaeological site. This deposit is similar to those mentioned in the Statistical Account of Scotland. A second sample (BC2) was collected from Clay Pot, a farm marked on the first Ordnance Survey map (1881). According to a local farmer this was previously the site of a small farm, where the presence of good white clay was used for the improvement of roads in the area. One further clay was sampled (BC3) from the now dried-out Loch Spynie to the north of Elgin. This clay was given to me by Mr Christie, a local potter who uses this clay for the manufacture of some of his pottery. In addition to these, a pit of clay (BC4) was found in area AF during excavations in 2007 and it is believed to have been a prehistoric supply of clay stored at the site.

| S. no. | Location | NGR | Deposit type | Distance |
|---|---|---|---|---|
| BC1 | S of Birnie, the Sand Quarry | NJ210 585 | Natural | <1km |
| BC2 | SE of Birnie, Clay Pot | NJ221 567 | Clay pit | ca. 3km |
| BC3 | N of Birnie, Loch of Spynie | NJ235 665 | Clay pit | >7km |
| BC4 | At the site | NJ210 585 | Archaeological | 0 |
| TLC 1 | W of Traprain, Cairndinnis | NT571 747 | Natural deposit | <1km |
| TLC 2 | S of Traprain, Luggate | NT581 743 | Natural deposit | <1km |
| TLC 3 | SW of Traprain, Renton Hall | NT546 720 | Clay pit | ca. 7km |
| TLC 4 | E of Traprain, Sunnyside | NT595 755 | Natural deposit | <1km |
| TLC 5 | S of Traprain, West Mains | NT577 725 | Natural deposit | ca. 3km |

*Table 2. List of sampled clays from Birnie and Traprain Law respectively, with details of location, type of deposit and approximate distance to the archaeological site.*

### *Traprain Law*

Traprain Law, a LBA and Iron Age hillfort, was one of the largest sites in late prehistoric Scotland. The

site was extensively excavated by the antiquarians Alexander Curle and James Cree from 1914 to 1923. Minor excavations have subsequently been carried out at and around the hill to target particular questions (cf. Sahlén 2011: 136-39). The site has shown a large fortified LBA and IA occupation, and some sporadic medieval activity. The samples from Traprain Law include LBA and IA moulds and crucibles, and late prehistoric pottery. The sampled pottery, from recent excavations (Hunter 2000), is largely undiagnostic and can only be dated to a broad late prehistoric context, which has limited the interpretation of the material.

The landscape of East Lothian is framed by the Lammermuir Hills in the south and the Firth of Forth at the north, and a series of hilltops stands out in the otherwise plain area. The bedrock geology of the area around Traprain Law is dominated by igneous intrusions, mainly trachytic and basaltic rocks, part of the Garlton Hills Volcanic rocks (McAdam and Tulloch 1985: 43). The geology towards the west of Traprain is mainly formed by sedimentary deposits, and further towards the west limestone coal measures which were worked for coal up to the 20th century. Traprain Law, a phonolitic trachyte plug, is one of several trachytic intrusions in the region. The phonolite of Traprain Law has a complex mineralogical background, but is mainly formed by phenocrysts of oligoclase, sanidine and cryptoperthite, with some small amounts of clinopyroxene, hornblende and apatite.

I sampled five different clays at a distance of 10km or less from Traprain Law (Table 2); three samples in the vicinity of Traprain Law (TLC1, TLC2, and TLC4); one sample from a disused industrial clay pit to the southwest (TLC3); and one boulder clay at the south towards Lammermuir hills (TLC5). The sampled clays showed some geological variation, suggesting that an enquiry of provenance would be feasible. But this was, as said earlier, not done in full in the current study. Industrial use of clays in East Lothian has been more extensive than was the case of Moray (see above). Two industrial clay pits were within the 10km range of my clay sampling programme, but I was only able to sample one of these (TLC3), since the other (Seafield Pond, Dunbar) currently is filled with water and within a caravan and camping park. Further clays were extracted and used in the medieval period at Colstoun (Jones *et al.* 2003), and in early modern times fireclay was extracted at Prestongrange (McAdam and Tulloch 1985). But both these deposits were beyond the 10km range.

## Result and discussion

### *Birnie*

The nature of the clay samples and the low number of clays sampled from Birnie has limited the interpretation of the material, but some important points can be made. The clay samples from the Sand Quarry (BC1) and Clay Pot (BC2) show obvious similarities; they both have a fine sandy to silty texture with low plasticity (Table 3). There is a clear difference in that the clay from Clay Pot contains a larger quantity of clay and metamorphosed coarse sandstone. The clay sampled at Loch Spynie (TLC3) is different, with a larger quantity of clay and a much higher plasticity. The analyses of the excavated clay (BC4) were limited, but indicated a close mineralogical and textural relationship with the clay from the sand quarry (BC1). It is not clear to what extent this was a modified clay or only a storage of unworked clay.

It is clear from the petrographic analysis that the LBA material was made from a local clay, similar to that sampled at the Sand Quarry (BC1) (Figure 3A and C). This is supported by the chemical analysis of the ceramic material and sampled clays (Figure 2). The two IA crucibles sampled show considerable difference: one is made from a fine ceramic paste while the other contains several large quartz and sandstone inclusions. Also this difference is supported by the chemical analysis. The variation between the two samples can partly be explained by alteration following vitrification, but possibly also because of the use of different clay sources.

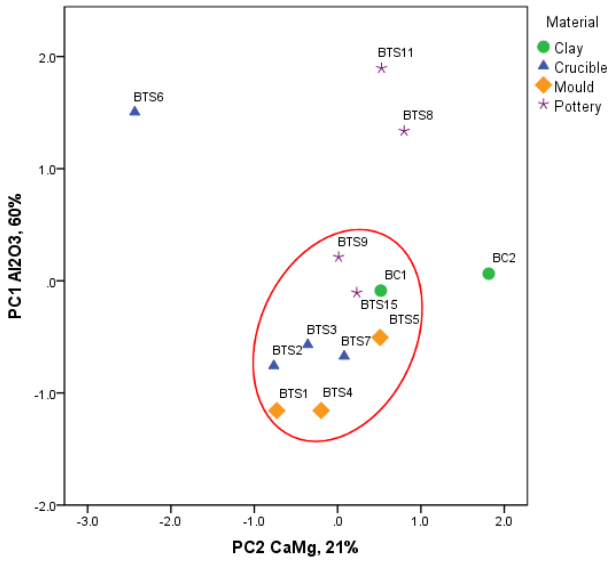


*Figure 2. Scatterplot of the first two principal components of LBA and MIA ceramic materials from Birnie; the red oval marks a cluster of all LBA samples, two IA samples and BC1.*

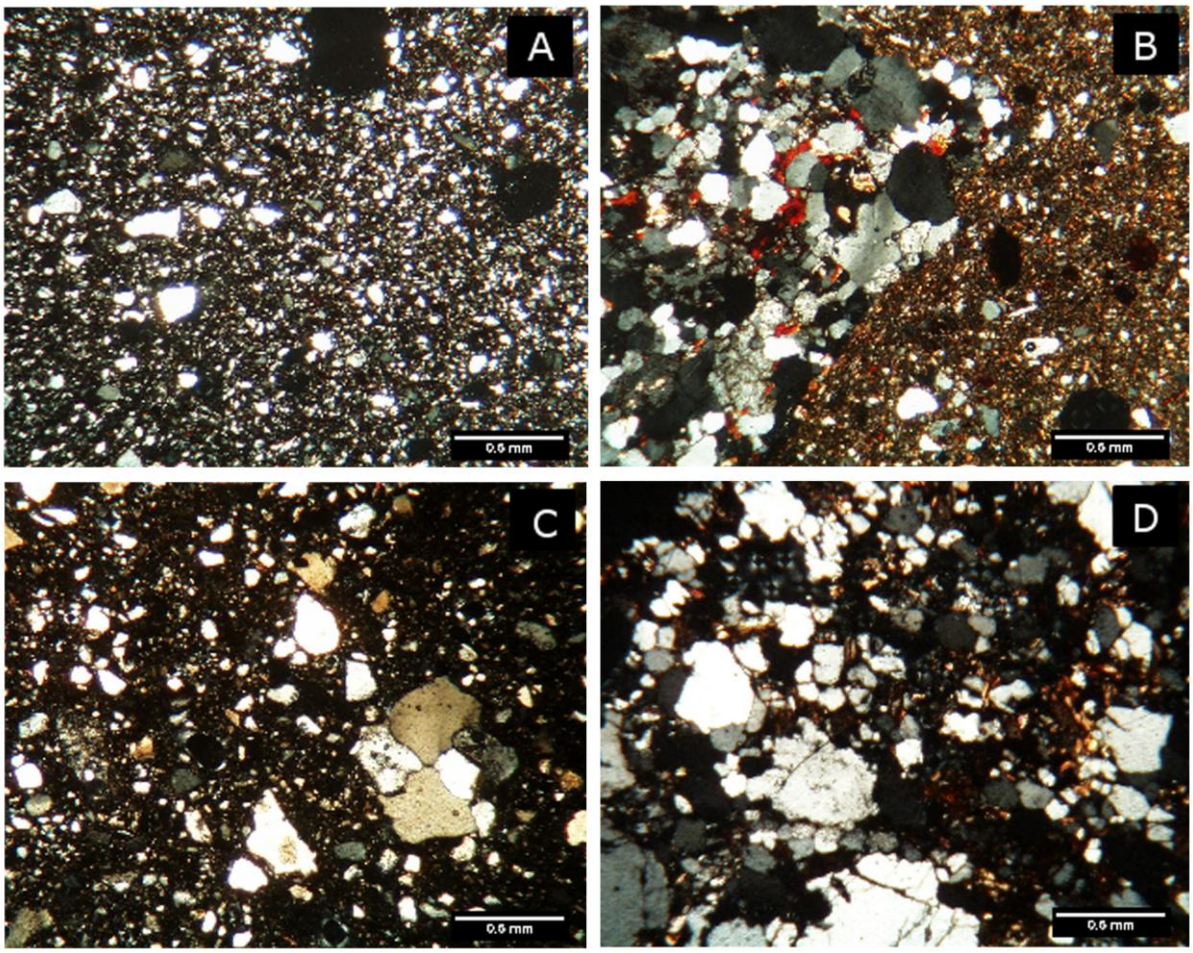


*Figure 3. Thin section micrographs of samples A) BC1; B) BC2; C) LBA mould BTS4; D) large sandstone inclusion in IA pottery sherd (BTS8). All images in XPL, the scale bar is 0.5mm (photographs by the author).*

| ***S. no.*** | ***Unfired*** | ***600 °C*** | ***1100 °C*** | ***Plasticity*** | ***Lithic incl.*** |
|---|---|---|---|---|---|
| *BC1* | 10YR6/3, Pale brown | 10YR 7/4, Very pale brown | 5YR 5/6-4/6, Yellowish red | Very low plasticity | A few quartzite and sandstone fragments |
| *BC2* | 10YR6/2, Light greyish brown | 5YR5/6-4/6, Yellowish red | 5YR 6/6-6/8, Reddish yellow | Low plasticity | Quartzite and (coarse) sandstone fragments |
| *BC3* | 10YR4/2, Dark greyish brown | 2.5YR5/6, Red | 10R5/8, Red | High plasticity | None present |
| *BC4* | 10YR7/6, Yellow | 10YR7/4, Very pale brown | 7.5YR6/6, Reddish yellow | Low plasticity | Rare sandstone fragments |
| *TLC1* | 2.5YR, Dark red | 2.5YR4/4, Reddish brown | 10R 4/4, Weak red | High plasticity | Weathered fragments of phonolite |
| *TLC2* | 5YR7/8, Reddish yellow | 2.5YR5/6, Red | 5YR3/4, Dark reddish brown | High plasticity | Sandstone, weathered fragments of phonolite |
| *TLC3* | 10YR 6/2, Light brownish grey | 7.5YR6/4, Light brown | 7.5YR4/4, Light brown | Very high plasticity | Rare minor fragments of sandstone |
| *TLC4* | 10YR 5/6, Greyish brown | 5YR5/6, Yellowish red | 10R4/8, Red | High plasticity | Fine texture sandstone |
| *TLC5* | 7.5YR, Light Brown | 2.5YR6/6, Light red | 2.5YR5/6, Red | Low plasticity | Sandstone and a greywacke |

*Table 3. Description of the colour, plasticity and lithic inclusions of the clay samples from Birnie and Traprain Law; details of the colour has been given for the unfired clay and when the samples have been fired to 600 °C for 3h and 1100 °C for 1h. Full petrographic analysis of samples can be found in Sahlén 2011, appendix Ib.*

Most of these sources have not been identified. It is possible that at least part of the pottery was made from the clay from Clay Pot. One fabric contains the same metamorphosed sandstone inclusion as seen in the clay from Clay Pot (Figure 3B and D). This relationship was not examined in full, however. A continued use of clay sources similar to that used in the LBA cannot be ruled out considering the close relationship in composition between the LBA material and some of the IA material (Figure 2).

### *Traprain Law*

The larger amount of clays available in the region around Traprain Law gave a better opportunity to look at the selection and use of particular clay sources. Like the material from Birnie, the moulds and crucibles are made from a sandy clay and show little evidence of modification from the original clay. The difference between the finer inner valve and the coarser outer wrap of the mould is more pronounced than was the case for the material from Birnie, where such distinction were less visible (cf. Cowie *et al.* forthcoming). The LBA ceramics contain diagnostic lithic inclusions, abraded phonolite fragments (Figure 4), which are absent in the Iron Age material. These inclusions are natural to the clay, but it is possible that their occurrence in outer wrap and the crucibles has been enhanced, since the phonolite inclusions in these fabrics are larger and more frequent. Phonolite is one of the main components of Traprain Law, and similar fragments were found in the clay sampled at Cairndinnis (TLC1) and Luggate (TLC2) (Table 3). This inclusion is absent in the clay sampled at Sunnyside (TLC4), which strongly suggests that the crucibles and the moulds were made from clay from the vicinity of Traprain Law, and possibly from one particular source.

The ceramic material from the Iron Age is more varied and difficult to link to a particular clay source. This is probably due to a higher level of modification of the original clay, and possibly because of the use of different sources.

The mould material analysed from Traprain Law is possibly made from local clays, but lacks diagnostic lithic inclusions such as the phonolite seen in the LBA material, and therefore it has not been possible to link this material to a specific clay source or sources. The crucibles from Traprain Law also show an unusual degree of variation, with the presence of three distinct fabrics with refractory properties (cf. Sahlén in preparation). The XRD analysis indicated that the dominant mineral in all three crucible fabrics, excluding quartz, is mullite (Figure 5), which was not detected in the LBA material, the IA moulds or the pottery analysed from the site (cf. Sahlén 2011: 208-09). Mullite forms from decomposed kaolinite heated to a temperature beyond 1100 °C. The presence of this mineral in the crucibles from Traprain Law indicates that the crucibles were made from a clay rich in kaolinite, a mineral associated with coal measures and the main clay mineral in refractory fireclay. The nearest known location of fireclay is the coal measure exploited by the coal works at Prestonpans in west East Lothian (see above). Three of the clays sampled around Traprain showed the possible presence of kaolinite, Cairndinnis (TLC1), Luggate (TLC2) and Renton Hall (TLC3). The presence of kaolinite is clearest in the clay from Renton Hall, while in TLC1 and TLC2 it is only vaguely marked. This raises the possibility that the craftworkers at Traprain travelled some distance towards the west to collect a particular clay or clay with specific properties for the manufacture of Middle IA crucibles.

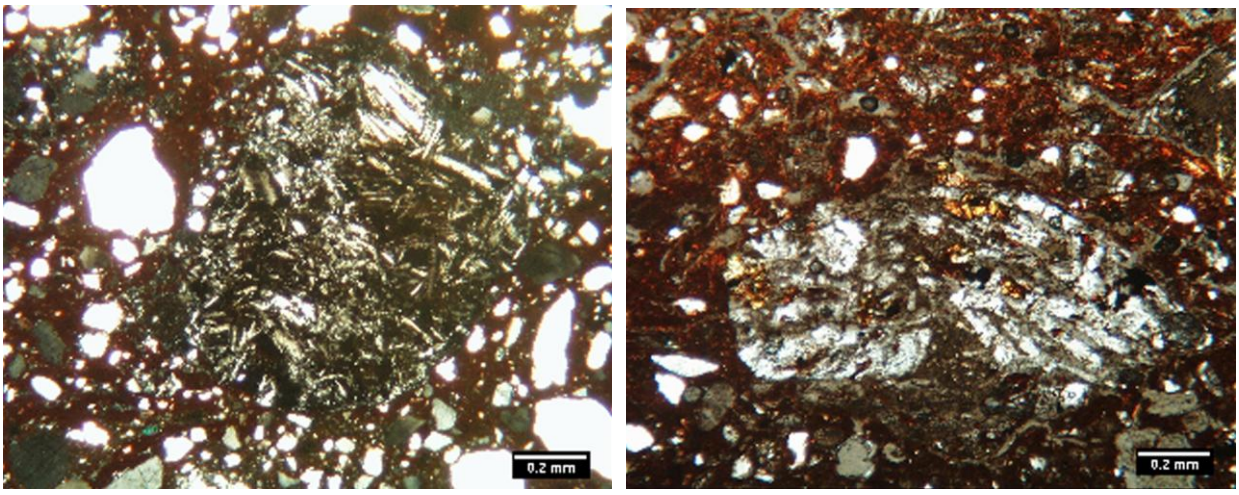


*Figure 4. Thin section micrographs comparing phonolite inclusions in TLC2 (left) and TLC3 (right). XPL, the scale bar is 0.2mm (photographs by the author).*

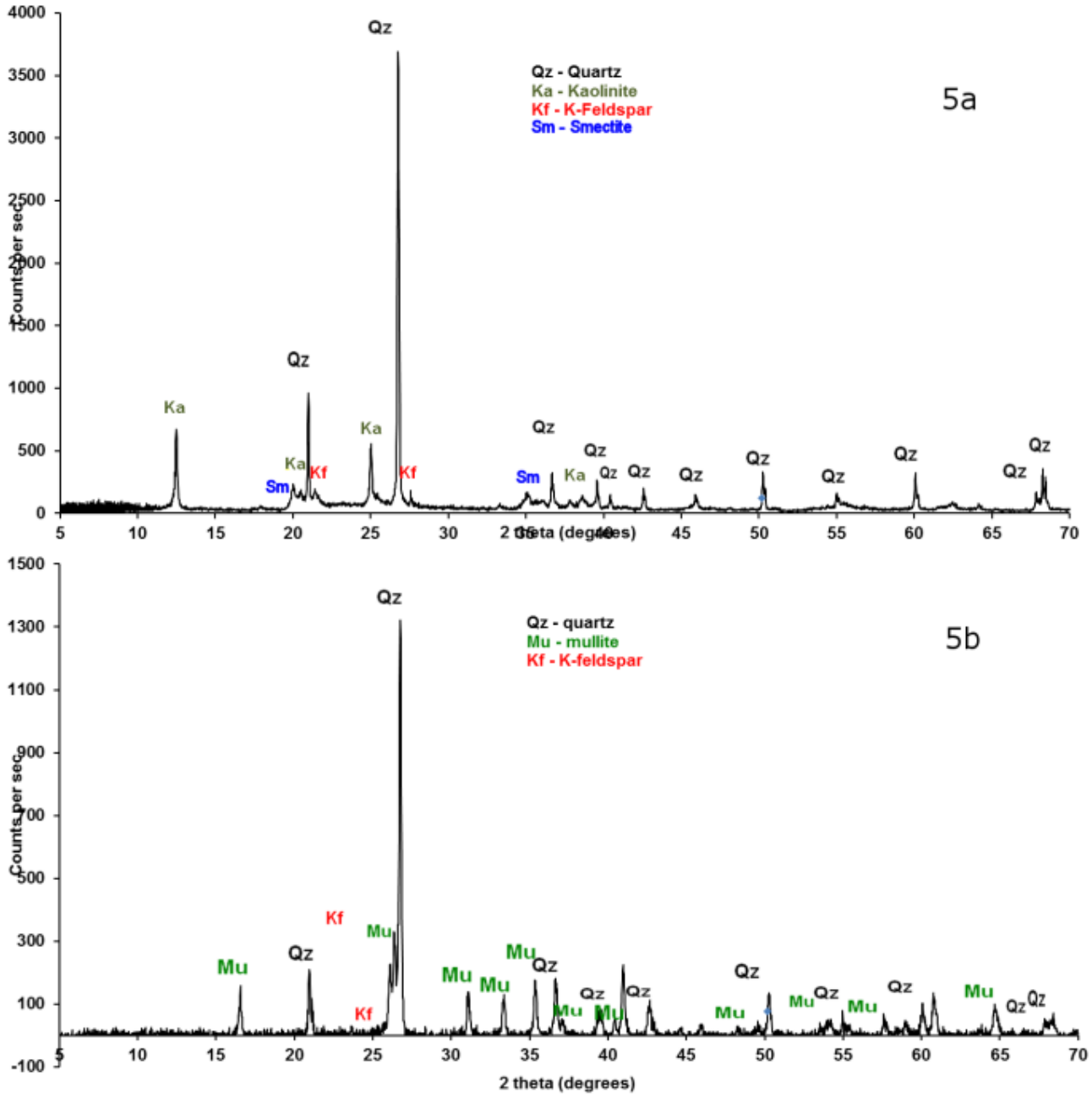


*Figure 5. XRD spectra of a) unfired clay from Renton Hall (TLC3) and b) crucible sample from Traprain Law (TLF8).*

## Conclusions

The two case studies presented here demonstrate that craftworkers in late prehistoric Scotland predominantly used local resources for the manufacture of metalworking ceramics and pottery, and in some cases it was possible to pin-point particular sources. The use of local sources is particularly clear in the Late Bronze Age, where we can see the use of the same clay for the manufacture of different ceramic materials; while in the Iron Age there is an indication that a wider range of clay sources were exploited for the manufacture of different groups of ceramics. The production of LBA metalworking ceramics at both Birnie and Traprain Law was carried out using clays within 1km from the site, suggesting little material specialisation.

The IA material from Birnie indicated the use of at least two local clay sources; there was also evidence for the use of alternative sources, but it was not possible to identify these in the current study. The continued use of local resources for different ceramics through the late prehistoric period, particularly the possible use of a clay source which today is still known for its material properties (the

clay at Clay Pot) is interesting. This suggests a traditional concept of what sources to use and where to find them.

The manufacture of Iron Age moulds and crucibles at Traprain Law also indicates the use of different clays, but it is possible that not all of these were local. The material from Traprain Law is particular in that the crucibles seem to be made from a clay defined as non-local, beyond the 7km threshold. This is unusual in a Scottish perspective (Sahlén, in preparation), where material from a series of late prehistoric and Early Historic sites has shown that crucibles and other metalworking ceramics were made predominantly from local, non-refractory clays. It is tempting to speculate that this can be linked to a more pronounced shift in cultural/material traditions at Traprain Law, than seen at Birnie and other late prehistoric sites in Scotland.

**References**


Anderson, J. 1791-99. *The Statistical Account of Scotland*, Volume 9, County of Elgin, Parish of Birnie: 155-64.

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

Cowie, T.G., O'Connor, B. and Sahlén, D. forthcoming. Remains of bronze metalworking technology in Late Bronze Age Scotland and their implications. In Boulud-Gazo, S. and Nicolas, T. (eds.) *Artisanats, et productions à l'âge du bronze*, Journée de la Société Préhistorique Française, Nantes 2011.

Freestone, I.C. 1989. Refractory materials and their procurement. In Hauptmann, A., Pernicka, E. and Wagner, G. (eds.) *Old World Archaeometallurgy, Proceedings of the International Symposium, Heiderberg 1987*. Bochum, 155-62.

Gosselain, O.P. and Livingstone Smith, A. 2005. The source: clay collection and processing practices in sub-Saharan Africa. In Livingstone Smith, A., Bosquet, D. and Martineau, R. (eds.) *Pottery Manufacture Processes; reconstruction and Interpretation*, British Archaeological Report International Series 1349. Oxford: 33-47.

Hunter, F. 2000. Late prehistoric pottery, in Rees, T. and Hunter, F. Archaeological excavation of a medieval structure and an assemblage of prehistoric artefacts from the summit of Traprain Law, East Lothian, 1996-97. *Proceedings of the Society of Antiquaries of Scotland*, 130: 419-25.

Jones, R., Will, R., Haggerty, G. and Hall, D. 2003. Sourcing Scottish White Gritty ware. *Medieval Ceramics* 26/27: 45–84.

MacSween, A. 2007. The Pottery. In Hunter, J. (ed.) *Investigation in Pool, Sanday, Orkneya Multi-Period Settlement from the Neolithic to late Norse Times, Kirkwall:* Orcadian in association with Historic Scotland: 287-352.

Martineau, R., Walter-Simonnet, A.V. and Grobéty, B. 2007. Clay resources and technical choices for Neolithic pottery (Chalain, Jura, France): chemical, mineralogical and grain-size analyses. *Archaeometry*, 49: 23-52.

McAdam, A.D. and Tulloch, W. 1985. *The Geology of the Haddington District*, Memoir of the British Geological Survey, London: HMSO.

Morris, E. L., 1996. Iron Age production and exchange. In Champion, T. C. and Collis, J. (eds.) *The Iron Age in Britain and Ireland: recent Trends*. Sheffield, J.R. Collis Publications: 41-65.

Peacock, J.P. 1968. *The Geology of the Elgin District,* Memoirs of the Geological Society, Edinburgh: HMSO.

Sahlén, D. 2011. *Ceramic technology and technological traditions: The manufacture of metalworking ceramics in Late Prehistoric Scotland,* unpublished PhD thesis, University of Glasgow.

Sahlén, D. in preparation. *Selected with care? – The technology of crucibles in late prehistoric Scotland. A petrographic and chemical assessment.*

Spataro, M. 2011. A comparison of chemical and petrographic analyses of Neolithic pottery from South-Eastern Europe. *Journal of Archaeological Science*, 38(2): 255-269.

Tite, M. S. 1999. Pottery production, distribution, and consumption - the contribution of the physical sciences. *Journal of Archaeological Method and Theory*, 6: 181-233.

Topping, P.G. and MacKenzie, A.B. 1988. A test of the use of Neutron Activation Analysis for clay source characterisation. *Archaeometry*, 30: 92-101.