October 2017

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The following is taken from an article in Surrey Archaeological Collections, 97, 2013, by Peter Boyer and Lynne Keys, Saxon iron smelting in Bermondsey? Archaeological excavations at 150-156 Abbey Street.

Ramsbury had been considered to represent the earliest re-introduction of slag tapping technology in post-Roman iron smelting. The process allows slag to be removed during the smelt through holes in the side of the furnace. The bloom can be retrieved relatively easily and the furnace reused. This is more efficient than the slag block process used in Romsey. The re-dating of the Ramsbury furnace would explain the difference between the two sites. Romsey wasn't less efficient, it was earlier - a Middle Saxon compared with a Late Saxon technology.

Note the difficulties involved in interpreting C14 dates...

There is, however, reason to believe that Ramsbury's Furnace 4, dated to the 9th century AD at publication (Haslam *et al* 1980, 30 and 54), could be later in date than originally proposed. A recent re-analysis for this report of the sequence of radiocarbon dates from Ramsbury (A Bayliss, pers comm) suggests the dated sample from Furnace 4 (HAR-1607; 1320±70BP) is too early because it contained a high proportion of mature oak with an appreciable age-at-death offset (Bowman 1990, 51)). This is because the carbon in tree-rings is fixed from the atmosphere during the year in which the tree-ring formed. Consequently, the rings at the centre of a long-lived tree can contain carbon that is several centuries older than the burning event. If this age-at-death offset is unknown, the radiocarbon date may be much older than the archaeological activity with which the sample is associated. Based on a Bayesian analysis of the other radiocarbon dates (including those from the earlier furnaces on the site) (Jordan *et al* 1994, 141–2) and on the location of Furnace 4 within the stratigraphic sequence, a 10th century date for this furnace can be tentatively proposed (cal AD 830–1020 at 95% probability; model not shown; cal AD 890–990 at 68% probability). This would move slag tapping at Ramsbury from the Middle Saxon to the Late Saxon period.

The diagram and text are from HENRY F CLEERE THE IRON INDUSTRY OF ROMAN BRITAIN, 1981. Furnace A2 is a non-tapping, slag block type as found in Romsey. The highlight in the text is mine. This clearly indicates that the iron smelting in Romsey is Anglo-Saxon.

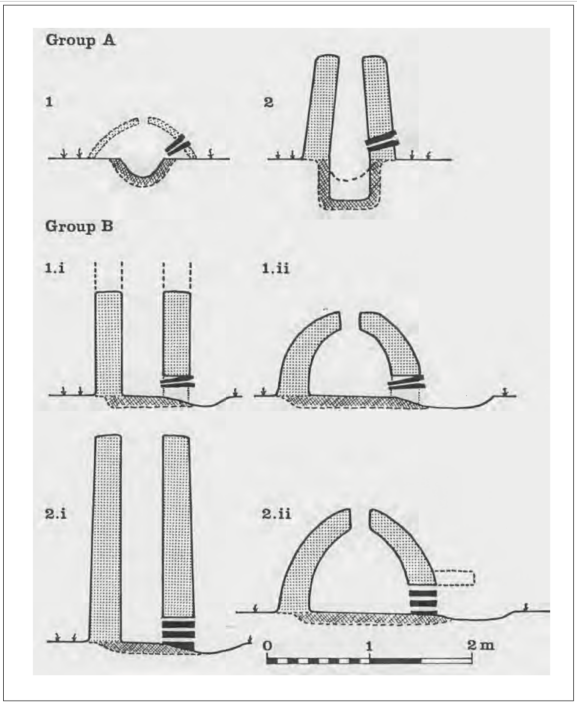


Figure 7: Classification of early iron-smelting (bloomery) furnaces (from Cleere 1972)

5.1 Spread of ironmaking technology into Britain
The diffusion of knowledge of iron metallurgy across Europe from a presumptive Near Eastern origin is still imperfectly understood. The distribution map prepared by Pleiner (1965), however, suggests that two discrete ironmaking technological traditions can be observed, distinguished by the type of smelting process used.
The eastern route, using non-slag-tapping furnaces of type A.2 (Cleere 1972),
is found in Austria (Ohrenberger & Bielenin 1969; Bielenin 1977), Hungary (Nóváki 1966; Gömöri 1977), Bohemia (Pleiner 1958, passim), southern Poland (Bielenin l974), northern Germany, Schleswig-Holstein (Hingst 1952), and Denmark (Voss l964). **There is no evidence that this technology reached Britain before or during the Roman period.** There are in fact, only three finds that suggest that this process was ever worked in Britain. A large slag cake in the Castle Museum, Norwich, probably from an Anglo-Saxon context, and a similar object from an early Anglo-Saxon ditch fill at Mucking (M U Jones, pers comm) may be identified as Schlackenklotze (slag block) of
the type familiar in the Holy Cross Mountains of southern Poland and in southern Denmark, and there is evidence that a furnace from St Peter's Street, Northampton (Williams 1979, 278-9) from a Middle Saxon horizon was of the A.2 type, although the only other iron-smelting furnace attributed to the Anglo-Saxon period in Britain, at Ramsbury, Wilts (J Haslam, unpublished), is clearly of the slag-tapping type B.1.i.

This article describes the Iron Age iron smelting site at Michelmersh. I have added highlights to comments discussing the rarity of smelting sites in Wessex. There must have been a good source of ore nearby. This site, like Romsey, is near the Test. Was the ore transported by river?

EARLY IRON AGE METALWORKING AND IRON AGE/EARLY ROMANO-BRITISH SETTLEMENT EVIDENCE ALONG THE BARTON STACEY TO LOCKERLEY GAS PIPELINE

By Robert De'Athe

Mitigation Area 08

Mitigation Area 08 (NGR 433677 125865; 60 x 46 m; Fig. 4), was situated on land south of Staff Road, Michelmersh. A uniform topsoil/subsoil overburden c. 0.20–0.25 m overlay Upper Chalk. A series of Early Iron Age pits, several post-holes and tree-throw hollows were excavated. One tree-throw hollow produced a single sherd of Late Bronze Age pottery and evidence of potential in situ burning.

Slag

by Thérèse Kearns

The excavations at MT08 yielded approximately 66 kg of slag, the majority of which is derived from iron smelting, as well as a few fragments of iron ore. The slag is indicative of smelting in a non-slag tapping, slagpit, furnace. This type of furnace consisted of a pit under a super structure generally thought to be of the low-shaft kind — the pit was used to collect slag as it formed during the smelt (Paynter 2007).

The assemblage consists of a number of 'furnace bottoms' which are more or less plano- convex in shape. Also present are substantial blocks of flow slag with clear flow structures which in many cases have been in contact with relatively large pieces of either wood or charcoal which was used to fill the pit.

There is little evidence of smithing from the site; however, one small plano-convex cake (160 x 100 mm) closely resembles a smithing hearth bottom and therefore may point to small scale smithing activity on site.

The evidence for prehistoric iron manufacture at MT08 is of considerable importance. The archaeology of Iron Age Wessex has been the subject of considerable study which has had an impact on the Iron Age of most of the British Isles. **Prehistoric iron artefacts from the region have been studied intensively (Ehrenreich 1985; Hedges and Salter 1979) but very few iron production sites are known.**

Only a handful of iron production sites have been identified within Wessex and many of these do not stand up to close scrutiny. Evidence for prehistoric iron smelting has been claimed for Cow Down at Longbridge Deverill and All Cannings Cross (Tylecote 1986, 139) but none of the claimed slag has been accessioned by Wiltshire Heritage Museum and it cannot now be traced.

Hedges and Salter (1979) examined the slag inclusions in iron currency bars from a hoard excavated within the hillfort at Danebury and compared the results with currency bars from Beckford and Hunsbury. The compositions of the slag inclusions for each hoard were distinguishable from each other and, while local ore sources could easily be suggested for both Beckford and Hunsbury, the source of the Danebury currency bars was not identified. **Ehrenreich (1994) notes that few iron production sites are known in Wessex and suggests that most iron was imported into the region. The detailed investigation of the iron smelting slags from Michelmersh provides an opportunity to examine prehistoric iron manufacture in this important region.**

Further study of the assemblage is being undertaken and will be published elsewhere. This will include a detailed investigation of the various types of slags (furnace bottoms, flows and possible smithing hearth bottom) as well as the ore. Chemical analysis and metallographic examination of slag, furnace lining and ore will be used to identify possible ore sources, smelting procedure and possible types of product (iron/steel). The results will be compared with data from the Danebury currency bar hoard as well as other prehistoric iron smelting slags (Paynter 2006).

Slag Cakes

The assemblage has around 30kg of slag cake fragments (Table 3). These are characteristic due to their usually flat top surfaces and rounded bottoms (plano-convex in profile). These cakes are often referred to as furnace bottoms (Bayley et al 2001; Dungworth 2007; 2009) but to avoid mis-representation before detailed analysis is done the author prefers to use the more general descriptive term, slag cake. They are characteristic of smelting furnaces where the slag was not tapped but allowed to collect at the bottom of the furnace or in a purposely dug pit (Paynter 2007).

The ones represented here have both surviving top and bottom surfaces (complete depth – Figs 2 and 3) but are quite fragmentary with no complete cakes in the assemblage. This is not surprising as they were all found in secondary fill layers of pit 28039. Re-deposition would have required some form of handling or moving around of the debris making breakage likely.

All the slag cakes have a reasonably flat and rough top surface. This is usually well consolidated to a two to four cm thickness. Below this top crust is less consolidated flow slag (Fig 3). This is consistent for the majority of the fragments. The flow slag appears as overlapping dribbles/networks of slag and reveals the direction of the flow. This flow is usually vertical and in some cases diagonal when the slag runs over/around an obstacle or on the bottom of the enclosing structure (eg SC13). These flow features resemble the flow slag tendrils which will be discussed below. All fragments have a similar depth/thickness ranging from seven to eleven centimetres suggesting that they are the result of a similar technology. Nine out of the fourteen fragments have clay residues on one side (Fig 4). These are all curved meaning that they were probably in contact with the furnace wall or that the pit was lined with clay. The curves revealed an approximate internal diameter of the structures (pits or furnaces) to be around 45-50cm.

Slag Blocks

Slag blocks are the second most numerous type of slag making 19.2kg of the assemblage. These fragments are named as such because they have no surviving diagnostic surfaces making their provenance (in the furnace) harder to determine. The fragments range in size from about five to sixteen cm in length and are all amorphous in shape. Their colour is similar to the slag cakes ranging from dark grey to dark brownish red with patches of light grey and orange.

Ore

Approximately 1.8kg of ore was found on site (Table 1). The remains seem to be hematite and although it is hard to determine the majority appear to have been roasted. The bulk of the ore was found in pit 28039 with 380g recovered from context 28048, 95g from 28067, 1065g from 28068 and 54g from 28069. Some of these (90g in 28048 and 42g in 28067) are very magnetic which may be indicative of roasting; the heats reducing the iron oxides and turning the ore into hematite/magnetite (personal communication Paynter 2010). All the ore remains are fragmentary (no more than a few centimetres) with exception to context 28068. These are larger non magnetic fragments and were the only finds in this context. This may be suggestive of ore processing in that layer but the possibility that they are discarded fragments cannot be ruled out.

The XRD analysis of the ores revealed that they were all hematite. However, as mentioned earlier they showed signs of having been roasted making it likely that their crystalline structure was altered. Their compositions (Table 9 – for all spectra please refer to Appendix 4) show high levels of manganese and seem to be a good match for the slags analysed. This would indicate that these ores (or a similar type) may indeed have been the ones smelted but it cannot rule out that the ones found and analysed in this study could have been discarded by the smelters.

According to Tylecote (1986, 125) the Tertiary strata of the Hampshire area yielded ore deposits worked in the Iron Age and 19th century. This could be the source exploited at Michelmersh. It may also be relevant that the area around Berkhamsted and Amersham have similar Tertiary strata. It is therefore probable that similar ore deposits (and other natural resources) were being exploited explaining the comparable levels of manganese found in the slags. Another interesting coincidence are the high levels of manganese (up to 3.3wt%) reported by McDonnell (1988) in the post-Roman smelting assemblage from Romsey. Romsey is only a few kilometres from Michelmersh and although they may have been using a different technology it is possible that the same (or very similar) ore source was exploited. This adds further credence to Paynter's research and the slag assemblage analysed in this study could be part of a new geological group.

Cunliffe (1984, 436) and Tylecote (1986, 125) state that the Tertiary strata of Hampshire were rich in iron and may have been the ore source(s) exploited.

The following is from: Wilson, D. M. and Hurst, D. G. (1964). 'Medieval Britain in 1962 and 1963', Med Arch, viii, 294.

LINCOLNSHIRE: STAMFORD (TF/031072). An iron-smelting works was excavated by W. G. Simpson and A. M. Burchard for M.P.B.W. on land to be developed by the Peterborough Co-operative Society N. of the *High Street*, near the centre of the medieval and modern town. A slag heap, resting on natural clay and associated with Saxo-Norman pottery, occupied the front of the site. Its maximum height was 3½ ft. and it was made up of alternating layers of red ash or sand with charcoal patches, and iron slag, and was finally sealed by a layer of sterile clay. The base of a clay-built shaft furnace, 1 ft. 2 in. long by 10 in. wide, lay under the edge of the dump. Its slag basin, which still contained slag, was on the E. side. Near by were two hearths either for roasting the ore, or for the further reduction of impurities in the bloom.

A stratified sequence of pottery, almost all Stamford ware, was obtained from the slag heap and is the first sequence to come from the town. The forms are mostly unglazed bowls and cooking-pots, some with rouletted decoration; there were also spouted bowls, a lamp and many fragments of a glazed storage jar decorated with applied thumbed bands. The latter came from the top level of the slag heap and probably belongs to the late 11th or early 12th century.

More recently another slag heap of similar date was observed during roadworks on the site of *St. Paul's Gate*, 300 yds. to the E.

Outcrops of ironstone occur on the outskirts of the town in *St. Martin's*, S. of the River Welland, and *Scotgate*, NW. of the town.

The Stamford furnace and one from West Runton are discussed in: Wilson, D. M. (1976). The Archaeology of Anglo-Saxon England, 262-63.

Note that the Stamford kiln was found in the centre of town. The iron smelting on the Creatures site would have been of a similar date

ton,[107] the three latter belonging

The only type of furnace so far documented is a shaft-furnace. Examples have been excavated, or evidence of them found, at Mucking, Essex,[107a] at Stamford, Lincs., at West Runton, Norfolk, and at Wakerley, Northants.[108] The one from Stamford was clay built, the base measured 35 by 25 cm and its slag basin survived. It was associated with a slag heap and two hearths, either for roasting the ore or for the further reduction of impurities in the bloom. It has been dated by archaeomagnetic methods to the eleventh century.[109] It was found on a site in the High Street in the centre of the medieval town and not, as one would expect, on the edge of the town away from the risk of fire. The furnace is dated to the eleventh or twelfth century and probably drew its ore from the outcrops of ironstone which occur on the edge of the town.[110]

The bloomery site at West Runton has been thoroughly investigated by Dr Tylecote.[111] As at Stamford, a shaft-furnace was found together with an outcrop of raw material. The site is loosely dated to the late Anglo-Saxon or early Norman period on the basis of Thetford-ware pottery found in association with the bloomery. At West Runton 'small flattish nodules which consist almost entirely of hydrated iron oxides' are found

in the sands and formed the raw material for the furnace. A series of pits was dug to obtain the ore which occurred in a dark layer of manganiferous iron pan. Tylecote calculates that the excavated pits would each yield about 600 lbs weight of ore yielding on roasting an iron oxide plus manganese oxide content of over 75 per cent. The furnace base of burnt red clay was associated with a roasting hearth and a charcoal pit.[112] The furnace is reconstructed in fig. 6.5.

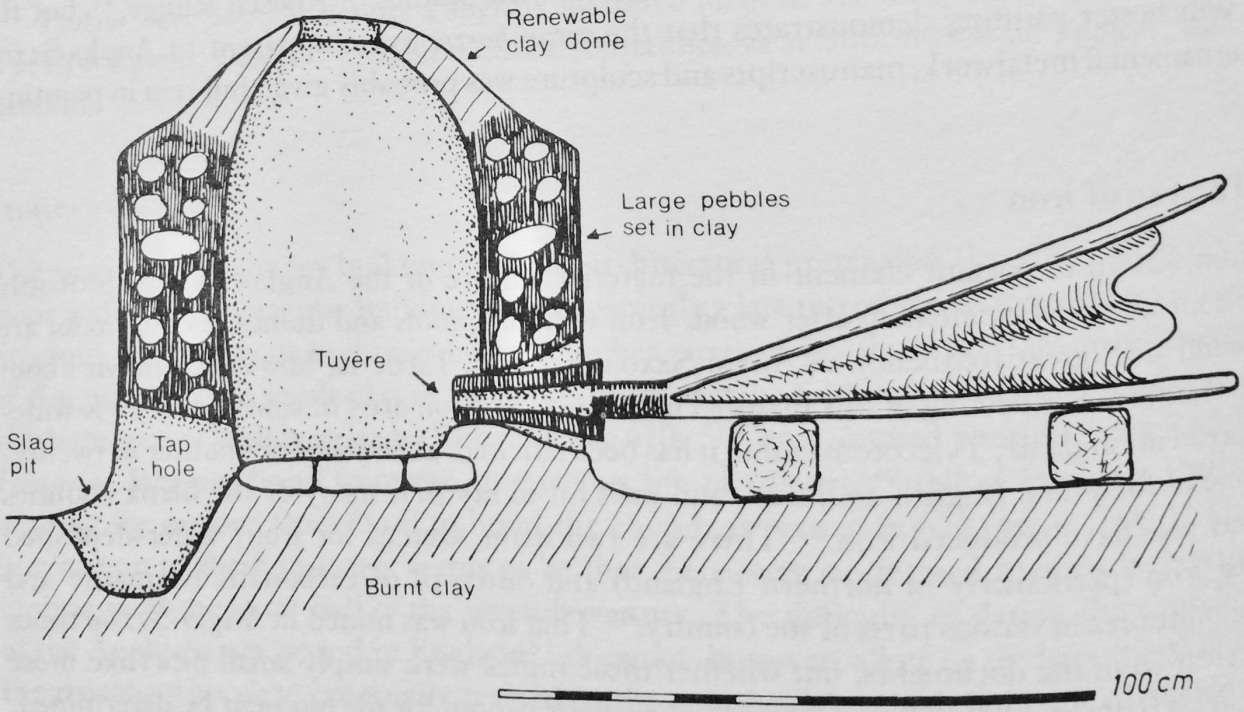
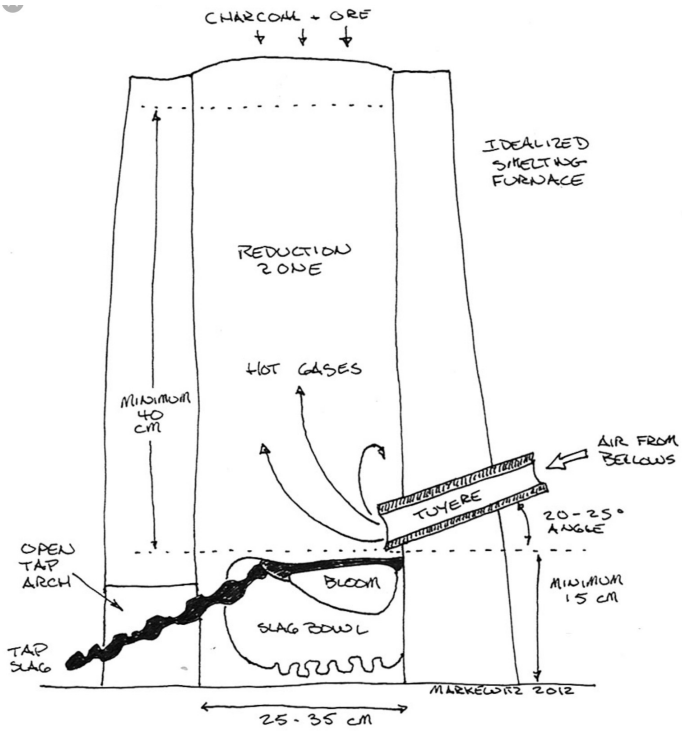


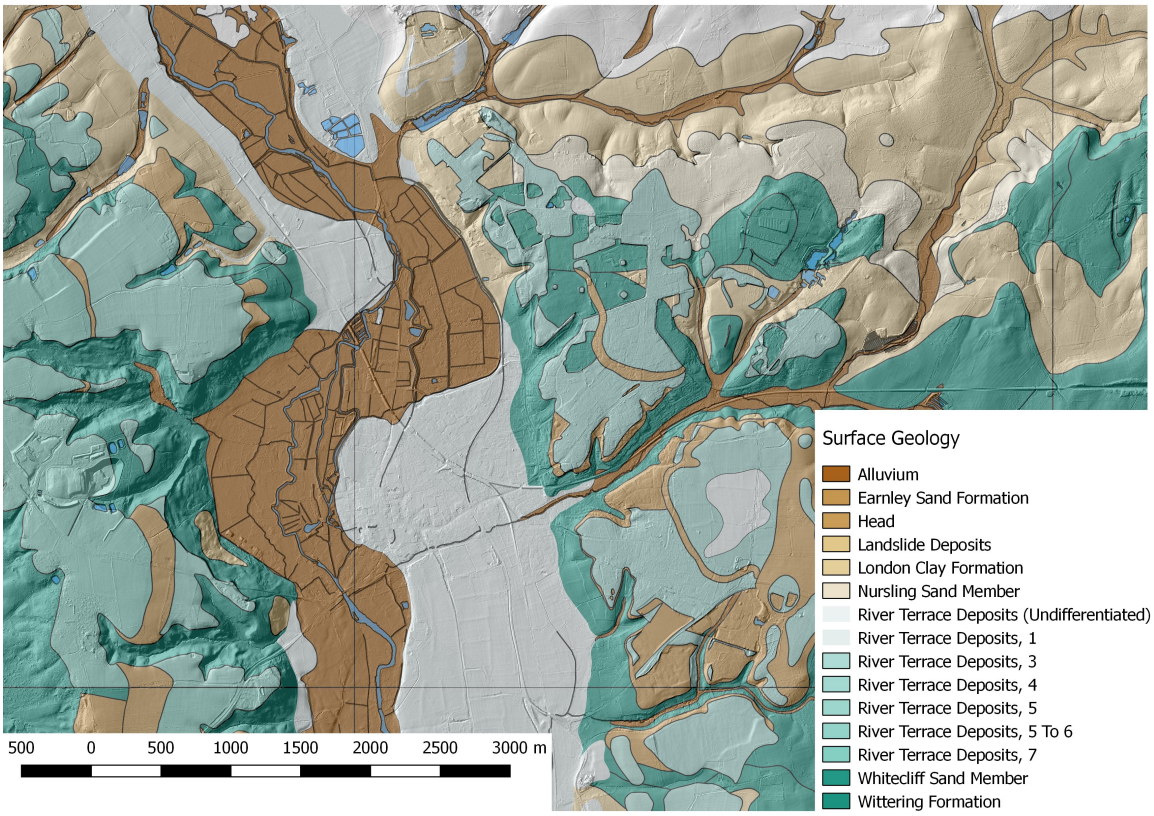
Figure 6.5 West Runton, Norfolk: reconstruction of furnace



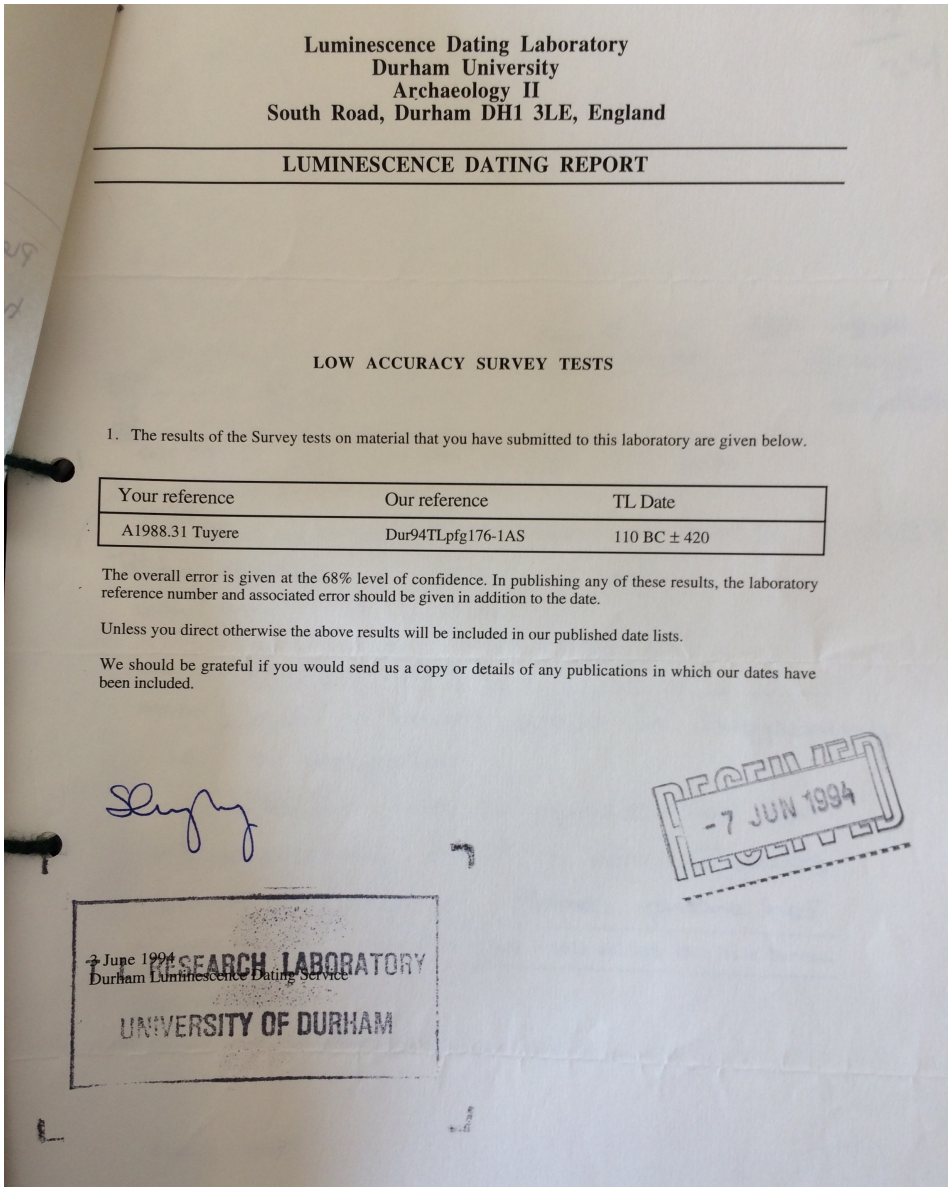
Siderite ($FeCO_3$) – A common iron carbonate, which occurs in clay layers of coal measures, shale layers, limestones and so on, where it forms ore lenses. Typically contains no sulphur or phosphorous and relatively rich in iron. Works well in a bloomery, provided that it is roasted well first, thus turning it into an iron oxide and making crushing possible.

A siderite geode from Germany. (Photo: Hannes Grobe)

We found samples of siderite within the Wittering beds at Foxbury. The Wittering formation outcrops on the scarp slopes on the western side of the Test valley opposite Romsey. We need to look for evidence of mining.



Below is a letter giving the results of the thermoluminescence dating of the tuyere from the La Sagesse excavation. Frank Green has suggested that it could have been used for bronze rather than iron smelting.



Luminescence Dating Laboratory
Durham University
Archaeology II
South Road, Durham DH1 3LE, England

LUMINESCENCE DATING REPORT

LOW ACCURACY SURVEY TESTS

1. The results of the Survey tests on material that you have submitted to this laboratory are given below.

Your reference	Our reference	TL Date
A1988.31 Tuyere	Dur94TLpfg176-1AS	110 BC ± 420

The overall error is given at the 68% level of confidence. In publishing any of these results, the laboratory reference number and associated error should be given in addition to the date.

Unless you direct otherwise the above results will be included in our published date lists.

We should be grateful if you would send us a copy or details of any publications in which our dates have been included.

RECEIVED -7 JUN 1994

3 June 1994
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