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Evaluation of archaeometallurgical residues from Cinderhill, Cutacre, Salford, Greater Manchester (CC06)

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Abstract

The Cinderhill site yielded approximately 200kg of macroscopic slags, of which approximately 116kg were unstratified. The slags were dominated by residues from iron-smelting in a slag-tapping bloomery furnace. Most of these iron-smelting slags had been tapped from the furnace. They were divided between slags which were extremely dense, with rather few vesicles and which formed generally rather thin, strongly lobate flows (the classic tap-slag texture) and forms with a very high vesicularity, apparently forming large vertically differentiated slag puddles. Such a division of tapped slags is a feature commonly seen on medieval bloomery sites.

Certain distinction, purely on the basis of morphology, of the origin of small fragments of slag with a basal crust is extremely difficult. Those slags with basal crust from stratified contexts were all equally-likely to have been furnace slags or the lower section of vertically-differentiated flows, as to have produced during smithing. In contrast the unstratified material includes over 27kg of material with thick basal crusts, much of which was extremely likely to have been smithing residue. The fragmentary remains indicated that these smithing hearth cakes (SHCs) would have been large (>4kg in two case), but no complete examples were recovered. One stratified context yielded a single example of what is likely to be a very small SHC, probably produced during blacksmithing.

In addition to the macroscopic slags, there were also some sieved residues from the lower parts of furnaces. Four of these five samples contained tiny slag spheres, resembling spheroidal hammerscale, but the context indicates these should be smelting residues.

Unprocessed bulk samples were also supplied, but these will principally be useful when the project enters the analysis phase and did not require intervention for the evaluation.

Contents

Methods

All materials were examined visually, using a low-powered binocular microscope where necessary. All materials were weighed and recorded to a database.

As an evaluation, the materials were not subjected to any high-magnification optical inspection, nor to any other form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional.

Results

Iron-smelting residues

The iron-smelting slags were present in three separate forms: dense tapped slags, vesicular low-density tap slags, and a heterogeneous group of possible furnace slags. Alongside these main forms were lining slags, vitrified lining, and spheroidal microresidues.

Dense tapped slags: these slags are the classic indicators of bloomery iron smelting in a slag-tapping furnace. They are extremely dense, they have fairly low vesicularity, a characteristic ropey surface texture (due to their accumulation as small rivulets of slag) and typically a smooth, shiny surface, often with a slightly maroon tint.

They occurred in small flows, often just a single layer of flow lobes in thickness, but usually less than 35mm thick. There were no substantial accumulations, apart from material from (701), which included a block including the steep side of an accumulation of dense flow lobes.

There were some slags of an intermediate degree of vesicularity between the main group of dense slags, and the extremely vesicular group described below, but in general the two classes were distinct.

Vesicular tapped slags: these slags included slags with a morphology close to that of the dense tap slags, but also some much more massive vesicular blocks. Some of the material formed rounded masses which appeared to have been less fluid than the typical tapped slag textures.

Some blocks provided evidence for vertical differentiation within the slag accumulation, with a moderately dense basal crust, overlain by extremely vesicular material, which in turn graded up into a slightly denser upper surface with or without flow lobes. This upper layer was seen to be cut by vertically aligned tubular vesicles in several specimens, suggesting degassing of the lower parts of the slag puddle. The differentiated textures occurred in blocks likely to have been from accumulations from 30-80mm thick.

Where strongly flow-lobed textures (resembling those of the dense slags described above) were seen, they either seemed to be in thin flows or to form the margins of the more substantial puddles. The vesicular slags showed no evidence for accumulation as a stack of lobes, but appear homogeneous, except, as mentioned above, where lobation developed as a result of small rivulets of slag at the margins of the main mass.

In the case of the largest blocks of vesicular slag, a possible origin within the furnace cannot be ruled out.

Furnace slags: various slag textures may be indicative of slags which cooled inside the furnace, including the more massive vesicular blocks described above, but also a variety of slags with evidence for a high content of metallic iron (now highly weathered), a high proportion of included charcoal debris (or charcoal moulds) or internally brecciated textures. These slag textures are not entirely diagnostic; many are similar to textures seen in smithing slags, so appear in the tables as “indeterminate”. However, in the context of such slags being retrieved from within assemblages of smelting slags it is likely that they too are a part of that assemblage.

Lining and lining slag: this material was not common on the site; a feature typical of redeposited or reworked assemblages. Significant quantities did occur in (577), (589), (597) and (723). This material does not contribute, unfortunately, to understanding of the morphology of the furnaces or hearths, but this is material which may aid the construction of furnace mass balance (see below).

Microresidues: Although the microresidues have not been examined in detail for the evaluation report, examination of the sieved residues shows that along with the small slag debris to be expected in the base of smelting furnaces, these assemblages are rich in slag spheres. These are normally associated with smithing, and in particular with fire-welding, in which liquid slag is expelled from the closing weld to chill in the air as spheroidal hammerscale (Allen 1986; Crew, 1996; Starley 1995). The other main smithing microresidue, flake hammerscale, is absent, so it would appear these spheres are genuinely associated with smelting.

Iron-working residues

Smithing hearth cakes: probable smithing hearth cakes are mainly found within the material from (500). They posses thick basal crusts of up to 35mm thickness, forming a bowl shape, which may either have a flat top, or if concave, posses an infill of more charcoal-rich textures. The crusts may possess bladed olivine crystals, which in some cases were observed to have a crystal length equivalent to the entire thickness of the crust (30mm).

There were three examples that were more complete than typical: one weighing 3785g was probably approximately 85% of the original, a 2600g fragment was about 60% of the original and an 800g fragment probably less than 30%. These give estimates of original weights of 4550g, 4330g and >2670g respectively. These weights are extremely high for SHCs but are potentially compatible with an origin during bloomsmithing in the later medieval period. Not all the fragments will, however, relate to such large SHCs. One examples from (718) weighing 280g is probably most of a small example, most likely to have been generated in the late stages of bloom refining or during blacksmithing.

Other materials

Ore: the site yielded a low level of finds of claystone ironstone nodules and it is hard to exclude a natural origin for these materials on the site. More significant perhaps would be the occurrence in (597) of magnetic claystone ironstone. This is not a natural feature of sideritic claystone ironstone nodules, and indicates that in this case the ore has been heated, perhaps as a deliberate roasting prior to smelting.

Coal: the occurrence of coal in the assemblages may be entirely natural. Coal cannot be used in a bloomery furnace, and does not appear to have been used in bloomsmithing, although was widely used in blacksmithing from Roman times. The site only yielded burnt coal residue from topsoil.

The context of the assemblage

The various slag collections are all rather similar (Table 2) with a dominance of tapped smelting slags. Smithing residues are essentially absent from the stratified contexts, but present in topsoil. This suggests reworking of the smithing slag into the topsoil from an origin outside the immediate excavated area. Has the bloomsmithing been undertaken immediately adjacent to the smelting complex, it would have been expected that smithing slags would be present in the pit fills.

Environmental sampling of some of the more problematic features may clarify whether they represent truncated furnaces or smithing hearths.

Interpretation

The site provides good evidence for iron smelting in the form of slag-tapping furnaces, with good associated macro- and micro-residues. The site also provides, although largely within unstratified material, evidence for bloomsmithing (the compaction and reworking of the raw blooms).

The smelting furnaces produced two quite different forms of tapped slag – thin flows of dense classic tap-slag and larger flows (or puddles) of a much more vesicular slag. Current accounts of medieval smelting do not adequately explain this feature, which has been observed by the author as characteristic of other late medieval sites (e.g. Ned's Garden and Fiddle bloomeries in Shropshire, the Oakamoor bloomeries in Staffordshire and a bloomery near Otley, West Yorkshire; author's unpublished observation). Some authors favour the adoption of "high bloomeries" in the medieval period, which are supposed to have been capable of producing either a bloom or cast iron, and hence produce two distinct slag types, as desired. However, a more mundane explanation of this feature may be possible for high throughput, large volume furnaces smelting Carboniferous claystone ironstones (as all four examples given above were).

The features identified in the field as bloomery furnaces appear correctly identified on the basis of the slag assemblages. The assemblages from all the features seem similar enough to suggest derivation from a single phase of working. The only possible exception is that (701) yielded only dense tap slags, which might just indicate a different mode of working, although the sample size was very small.

Evaluation of potential

The site is important for it yields good tapped slag assemblages in conjunction with the furnaces; a link between residue and furnace type raises the significance of the site. The assemblage can also shed light, through detailed analysis, on the unexplained dichotomy between the dense and vesicular tap slag classes. The identification of high bloomeries, and indeed their very existence within British medieval iron-production, has become a controversial issue in archaeometallurgy. No slag assemblage from a supposed high bloomery has yet been published, although reference has been made in passing to the dual nature of the slag assemblage from Timberholme (e.g. Vernon *et al.* 1999). This site has enormous potential to contribute to this debate.

Analytical studies will also clarify whether the furnaces were smelting claystone ore, or whether the local bog ore deposits identified at the southern end of the site, played any part in the resources for the operation

The materials are suitable for attempting to construct a mass balance model for the smelting after the methodology of Thomas & Young (1999a and 1999b). This would enable modelling of the size of bloom being produced and the efficiency (in terms of iron yield) of the furnace. This method requires knowledge of ore, lining and slag compositions and all three are available.

Analysis of the micro-spheroids from the smelting furnaces is also highly desirable, to clarify how these examples might differ (chemically or texturally) from similar appearing particles produced smithing.

Finally, the apparent smithing slags from this site are also unusual in being extremely large. The occurrence of large SHCs in medieval bloomsmithing contexts is not entirely unexpected. Although not recorded from Britain, SHCs of this size are commonplace in medieval assemblages from Ireland (e.g. Young 2006). The distinction between slags formed in SHCs and some formed within the base of smelting furnaces is not entirely certain on morphological grounds, however, so analysis of these examples would be desirable to clarify their attribution.

In summary, the slag assemblage from this site would justify a programme of detailed analysis, which would have potential not just to contribute to improved understanding of this site, but also to improving understanding of this poorly-known phase of bloomery development.

References

ALLEN, J.R.L. 1986. Interpretation of some Romano-British smithing slags from Awre, Gloucs. *Historical Metallurgy*, **20**, 97-104.

CREW, P. 1996. *Bloom refining and smithing, slags and other residues*. Historical Metallurgy Society, Archaeology Datasheet No 6.

STARLEY, D. 1995. *Hammerscale.* Historical Metallurgy Society, Archaeology Datasheet No 10. THOMAS G.R. & YOUNG, T.P. 1999a. Bloomery furnace mass balance and efficiency. *In:* POLLARD, A.M. (ed) *Geoarchaeology: exploration, environments, resources*, Geological Society of London, Special Publication, 165, 155-164.

THOMAS, G.R. & YOUNG, T.P. 1999b. A graphical method to determine furnace efficiency and lining contribution to Romano-British bloomery iron-making slags (Bristol Channel Orefield, UK). *In:* YOUNG, S.M.M., BUDD, P.D., IXER, R.A. and POLLARD, A.M. (eds). *Metals in Antiquity*, British Archaeological Reports International Series, **792**, 223-226. Archaeopress, Oxford.

VERNON, R.W., McDONNELL, G. & SCHMIDT, A. 1999. Medieval iron and lead smelting works: a geophysical comparison. *In:* POLLARD, A.M. (ed) *Geoarchaeology: exploration, environments, resources*, Geological Society of London, Special Publication, 165, 15-34.

YOUNG, T.P. 2006. Evaluation of archaeometallurgical residues from sites on the N25, Co. Waterford (Woodstown 6, Adamstown 1,2,3). *GeoArch Report 2006/15.* 38pp

Context	Sample	Wt (kg)	Description
500	1203	13.79	3765g dense tap slag; 3558g pieces with crust, possible SHCs; 64g claystone ironstone; 118g vitrified lining; 6205g highly vesicular, porous slags.
500	1204	11.655	3785g large weathered SHC, 85% present? 185mm diameter, 70mm deep, dished top; 2600g, ?60% of biconvex SHC or biconvex unlobed flow, 200mm diameter 70mm deep; 1135g, 586g, 1690g, 650g dense tap slag blocks; 1150g curved charcoal rich block - furnace/hearth slag?
500	1205	7.95	200g 18 pieces of coal; 2g coke; 2390g 63 pieces of dense tap slag; 624g 13 pieces of dense crust - origin uncertain; 512g 3 pieces of very dense slag - could be abnormally thick tap lobes or SHCs; 480g 3 amorphous dense slag lumps; 34g 2 stones; 166g rusty concretion; 3415g 83 pieces of vesicular flow.
500	1213	14.61	3805g 62 pieces of dense tap slag; 5430g 18 pieces with thick crusts - probably all SHCs of 800 g fragment in this is probably <30% of an SHC; 768g 5 pieces of thinner crust of uncertain origin; 1685g 26 pieces of vesicular slag probably mainly flows; 116g 3 stones; 8g 2 pieces of coal. 2265g 63 pieces of indet. slag; 260g 4 rounded dense Fe-rich concretions; 78g iron rod; 146g 3 pieces of rusty slag; 22g fired clay lining; 20g small claystone nodule.
500	1214	13.903	1815g cf. SHC; 6332g low density, vesicular slags; 5460g dense tap-slags; 260g stones; 36g coke (plus 2 potsherds and clay pipe fragment)
500	1220	14.29	200g iron sphere; 300g 5 stones; 5140g 98 pieces highly vesicular slag; 4890g 88 pieces dense tap slag; 1500g 13 smaller slag pieces with dense crust; 1595g 5 larger pieces with dense crust - possibly SHC fragments; 256g 6 rusty slag pieces; 84g vitrified wall; 48g lining slag; 122g 6 pieces of coal.
500	1223	10.78	470g possible brecciated furnace slag block; 3300g 72 pieces of dense tap slag; 25 pieces of low density tapped slag and vesicular massive material 2545g; 186g 2 concretions around iron; 30g 3 pieces of coal; 28g 3 stones; 444g 2 massive vesicular blocks; 62g 1 massive rusty slag fragment - dense slag with iron?; 706g block of fired and slagged wall; 2930g 14 pieces of dense slag with crusts - possible SHC material at least in part.
500	1224	13.305	4850g normal dense tap slag; 94g slag rod; 3280g SHC-like material with thick crust; 4900g highly vesicular slags.
500	1225	13.325	6700g normal dense tap slag; 5200g vesicular flowed material; 1200 SHC material, some with very with coarse crystals; iron ore; coal
500	1228	4.475	2350g 49 pieces of dense tap slag; 1100g 15 pieces of material with crusts - most of this probably SHC; 950g 36 pieces indet. Slag; 2g coal
501	1232	1.275	456g 2 very rusty blocks of vesicular slag; 664g 6 pieces of dense tap slag; 16g 4 pieces coal; 128g rusty piece with charcoal moulds - maybe most of small SHC.
503	1247	2.86	862g 11 pieces of dense tap slag; 1310g 16 pieces of vesicular flow; low density crust piece with tubular vesicles - may be flow; 146g 3 indet slags; 314g 5 indet slags; 96g 7 pieces of claystone ironstone; 1g coal.
505	1246	3.76	256g small piece of thick crust probably from SHC; 488g 6 pieces with dense crusts of uncertain origin; 496g 32 pieces of indet. dense slag; 930g 13 pieces of dense tap slag; 1230g 31 pieces of moderately dense but vesicular tap slag; 228g very irregular lump of dense slag with dimpled surfaces; 100g 4 pieces of rusty concretionary slag.
571	1243	3.3	670g 7 pieces with medium thick crusts, dense, uncertain origin; 1195g 30 pieces of dense tap slag; 58g tiny slag runner; 764g 33 pieces of indet. dense slag; 620g 12 pieces of dense slag featuring thin crusts; 4g stone.
577	1221	9.635	6810g vesicular flows, total 101 pieces; 22 pieces, 1670g, dense tap slag; 1650g 5 blocks of dense slag, not quite certainly flows, but probably so.
577	1226	8.67	5620g 158 pieces low density flow; 1705g 27 pieces of dense tap slag; 414g block of fired lining; 458g 7 pieces of dense crust - possibly mainly of flow origin; 56g 2 stones; 388g moderately dense stack of flow lobes formed against convex steep surface.

Context	Sample	Wt (kg)	Description
577	1229	3.58	574g large block of vesicular slag, horizontal flow lobes in margin show this to be the margin of a deflated puddle; 1985g 55 pieces of vesicular flow; 20g claystone ironstone; 946g 13 pieces of dense flow.
577	1238	6.405	3905g 122 pieces low density flows; 1720g 43 pieces dense tap slag; 44g lining slag; 86g claystone nodule; 538g 4 pieces with dense crusts with uncertain origin.
577	1245	4.39	1055g 24 pieces of dense tap slag; 24g stone; 684g 6 pieces of dense crust - origin not clear; 2605g 90 pieces of vesicular flow - some extremely low density.
584	1212	3.36	1695g 30 pieces of dense tap slag; 116g thin, dense crust, seems to have been in contact with curved surface rather than having a void above; 70g small ball of charcoal-rich slag with internal void; 1450g 50 pieces of vesicular slag , probably all flows.
587	1244	4.89	2575g 22 pieces of low density vesicular flow; 1015g 14 pieces of dense tap slag; 200g 15 indet. slag fragments; 790g 5 blocks of vesicular and ?charcoal-rich slag; 244g 2 pieces of slag attached to lining.
589	1211	2.985	334g dense crust with dimpled lower surface and charcoal rich layer above; 832g fired clay with attached lining slag; 744g moderately dense lining-influenced slag; 548g 3 pieces of vesicular but moderately dense flow; 296g 5 pieces of charcoal rich slag with some lining attached; 118g 5 pieces of fired clay; 68g part vitrified lining.
597	1222	7.13	56g 5 pieces of coal; 58g stone; 1520g massive block of vitrified wall; 86g very rusty charcoal-rich slag; 1045g 4 pieces of dense slag with well-developed crust - largest has vesicular texture like SHC with very large crystals; 1470g 31 pieces of dense tap slag; 2845g 52 pieces of vesicular slag - mainly clearly tapped.
597	1239	5.048	190g possible bloom fragment; 112g 2 pieces of magnetic ore; 146g magnetic slag; 186g 2 pieces of crust; 1325g highly vesicular slags; 54g coal and coke; 3035g dense tap slag.
598	1227	4.09	2040g 76 pieces of low-medium density vesicular flow; 1385g 30 pieces of dense tap slag; 108g coal; 286g 6 pieces of thin crust - base of flows?; 44g iron lump; 212g 4 stones.
598	1241	2.64	1430g 40 pieces vesicular flow; 718g 14 pieces of dense tap slag; 220g 2 concretions with iron; 10g stone; 248g dense slag lobe with degassing tubular vesicles at top.
600	1242	1.74	792g 18 pieces of diesel oil impregnated tarmac; 938g pale stone with coal on surface - concretion from coal seam?
701	1236	4.42	3650g 27 pieces dense tap slag, some in shallow hollow, but largest block shows 60° steep slope margin 80mm deep; 626g 11 pieces with dense crust, 10mm, overlain by irregularly prilly layer, probably from below tap slag flow as similar prilly texture seen on base of tap slag specimens in this sample; 1g coal; 20g iron concretion; 50g claystone ironstone nodule.
704	1248	1.97	120g 2 extremely vesicular slag fragments; 486g 13 indet. slag fragments; 758g 14 pieces of highly vesicular flows; 574g 12 pieces of dense tap slag.

Context	Sample	Wt (kg)	Description
718	1240	1.645	420g 3 pieces dense tap slag; 336g 9 pieces of rusty concretionary slag with charcoal, must have had iron inclusions?; 82g irregular slag lump, penannular, with central 10mm hole - poker mark?; 196g 15 pieces of indet. weathered and concretionary slag; 318g 4 pieces with granular slag on a basal crust - origin not certain; 280g lump probably from a smallish SHC, dimpled top, some large vesicles; 1g stone.
720	1249	1.36	830g 8 pieces of vesicular irregular slag lumps; 350g 3 pieces of vesicular slag with denser pieces inside; 168g 3 pieces dense tap slag.
723	1233	1.02	284g 4 pieces dense tap slag; 224g 3 pieces of slag with a thin dense crust; 502g 9 pieces of lining and associated slag
733	1237	5.39	1000g part of thin crust cake, complex granular charcoal rich slags internally, only a very small part; 86g charcoal-rich slag fragments 8 pieces; 354g dense lobe with distinct top layer with tubular vesicles -flat top very smooth, probably a flow; 396g slab of crust with slightly flowed surface, origin uncertain; 660g 5 medium-low density vesicular flow pieces; 68g 3 small pieces of dense horizontal prill; 676g large block of rusty irregular slag with small charcoal- hearth or furnace?; 518g highly concreted slag block - possibly part of SHC?; 442g 10 indet. slag pieces, all fairly dense; 1065g irregular mass of concretionary slag with charcoal apparently with several separate iron masses; 80g 2 small iron concretions.
739	1234	0.516	206g 15 pieces indet. Slag; 194g 7 pieces dense tap slag; 112g 2 pieces of thin crust (all very weathered and orange)

Table 1: Summary catalogue of macroscopic slag samples

Context	Context description	Residue: dense tap	vesic. tap	SHC?	charcoal-rich	brecciated	other crust	indet.	lining	ore	coal	concretion	iron object	Total slag
500	topsoil	41.571	35.422	27.293	1.150	0.470	2.892	4.909	0.978	0.084	0.400	0.612	0.278	*114.685*
501	topsoil	0.664	0.456		0.128						0.016			*1.248*
503	poss hearth/furnace	0.862	1.310					0.460		0.096	0.001			*2.632*
505	black layer	0.930	1.230	0.256			0.488	0.824						*3.728*
571	fill of pit 572	1.256		0.670			0.620	0.764						*3.310*
577	fill of ?578	7.484	21.489				1.680	1.650	0.458	0.106				*32.761*
584	fill of rake-out pit 581	1.695	1.450				0.116	0.070						*3.331*
587	fill of rake-out pit 581	1.015	2.575		0.790			0.200	0.244					*4.824*
589	fill of furnace 588	0.548		0.334	0.296			0.744	1.018					*2.940*
597	fill of pit 596	4.505	4.170	1.045	0.086		0.186	0.146	1.520	0.112	0.596		0.190	*11.658*
598	fill of ?pit599	2.103	3.718				0.286				0.108	0.220	0.044	*6.107*
600														*0.000*
701	fill of linear 700	3.650					0.626			0.050		0.020		*4.276*
704	fill of ?roothole 705	0.574	0.878					0.486						*1.938*
718	fill of poss pit 719	0.420		0.280			0.318	0.278				0.336		*1.296*
720	cut of rake pit	0.168	1.180											*1.348*
723	fill of small furnace 722	0.284					0.224		0.502					*1.010*
733	fill of pit 734	0.422	0.660	1.000			0.396	0.960				1.145		*3.438*
739	fill of root disturb 738	0.194					0.112	0.206						*0.512*
		68.345	*74.538*	*30.878*	*2.45*	*0.47*	*7.944*	*11.697*	*4.72*					***201.042***

Table 2: Summary of residue type by context.

Context	Description			
fraction:-	*coarse*	*medium*	*fine*	*hammerscale*
589	slag (including tap slag) fired clay lumps and pebbles. Also fire shattered stone fragments	mainly fired clay and stone, but some small fragments of slags and prilly particles	mainly fired clay, but a few slag droplets	degraded fired clay
582	Tap slag, slag fragments, small pebbles	mainly slag, some stone and some charcoal	charcoal with blebs, spheres and some fired clay	charcoal dust?
723	mainly porous vesicular slag, one possible crust fragment, small dense slag fragments	slag, stone and two pieces of coal	lots of slag, mainly as irregular blebs, some spheres (large quantity of material)	mainly charcoal debris
725	coarse angular slag flows and accretions, fired clay	rich assemblage of slag sheets, blebs and "coffee bean" spheroids in charcoal	fired clay, spheres and blebs in charcoal (large quantity of material)	slag spheres in charcoal dust
503	pebbles, tap slag	slag, ironstone, one large sphere, stone, one sherd of pottery	stone, slag, few spheres	

Table 3: Summary notes on sieved residues.

Context	Context Description	Sample	Weight (kg)	Material Description
594	fill of furnace 588 (basal?)	70	7.4	burnt material from drip gully between 588 and 581
744	clay in furnace 588	71	5.142	heat altered clay, from furnace 588
745	clay in rake pit for furnace 588	72	2.93	burnt clay from within "rake pit"
746	fired clay in 720/722	73	0.48	burnt clay at base of furnace 720
747	natural in 720/722	74	11.4	heat affected natural in furnace 720
898	iron pan in site 42south	104	10.8	iron pan

Table 4: Bulk samples.

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