

# Evaluation of slag from Celbridge Site 5, County Kildare (01E0306)

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## Abstract

*Slag from Site 5 at Celbridge was derived from three furnaces and shallow pit. The slag assemblage from each of the furnaces was similar, and indicative of iron smelting. The truncated furnace bases were largely filled with smelting debris, including fragmented slags, charcoal and clay. It is likely that only the basal charcoal deposit represents an in-situ deposit associated with furnace use (rather than disuse).*

*The slag assemblage bears close comparison with those from Tullyallen and Carrickmines. Like those assemblages it is interpreted as being derived from iron smelting in a low shaft slag-pit furnace. There are, however, a few notable differences with those other sites, notably in the abundance of a low iron, resinous-appearing slag, and in the narrower and deeper form of the slag pits.*

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along the furnace floor. Some large blocks of this type are suggestive of accumulation at the foot of the wall below the blowing hole.

Dense slags of the first class are gradational into a second group of slags, the dominant group, which also show flowage, some having reached the furnace floor, but which are of a slightly lower density and which have a paler, browner colour with a resinous lustre. The group also includes material interpreted as accumulating at the foot of the wall. The material in this group tends to occur in larger pieces than that of the first class.

A third category of slags is provided by those with abundant charcoal inclusions and a granular texture. These materials (equivalent to those in the main slag block in the Tullyallen furnace) are rather rare.

The fourth class of slag is provided by material which is typically associated with a white ash. Some of these slags contain abundant fine organic material, some may show dark iron oxide patches, and the slags themselves are brownish. It is possible that this class includes some part-reacted ore.

The final class of slag is material derived from the furnace lining. Most of these are small fragments of fired clay with a pale grey colour, and probably derived from the basal part of the furnace. Some pieces, however, are more oxidised and may be derived from the superstructure. One piece shows a significant slab of vitrified internal wall, from a level above the blowhole.

## Description

### The furnaces and their fills

Three furnaces were found in Celbridge site 5, each with steep to vertical, or even overhanging sides. The precise profiles are difficult to interpret since the feature sections and profiles give slightly conflicting evidence; mainly because it is not clear how the recorded furnace linings relate to the natural and to the supposed cut.

Nonetheless, the interior sizes of the furnaces are apparently all of the order of 0.28 - 0.30m diameter, and with depths ranging from 0.17 to 0.27m below the level of truncation. Each of the furnaces contains multiple fills, most bearing some slag. In each case the basal layer was dominated by charcoal, and it seems likely that this layer at least is in an in-situ deposit related to the use of the furnaces.

### The slags

The slags can be divided into five main categories, although some pieces may include material of more than one category:

Firstly there are dense slag prills, flows and blebs, including small coffee-bean sized spheroids. These are fayalitic slags that have flowed well. Several pieces show this class of slag descending and then flowing

## Interpretation

A full discussion of the implications of the iron-smelting slags from this and other recent sites is presented in a separate report (Young 2003b). That report draws parallels and comparisons between the material from Celbridge and that from Carrickmines (Young 2003a) and Tullyallen (Young 2003c).

The Tullyallen furnace was apparently abandoned with its last slag still in-situ, and so provides a basis for

interpreting this slag assemblage. There is little slag here which corresponds to the textures of the material comprising the main slag block at Tullyallen. In East Yorkshire, Iron Age slag dumps are known which comprise almost entirely of the large slag blocks from furnaces of this type. It is possible to speculate that a similar disposal of the main, large slag blocks may have taken place away from the furnace at Celbridge, and that the deposits recovered represent the "fines" from the cleanings of the very basal part of the slag pit.

The slag recovered does not appear to be in-situ. The large block of slag tentatively suggested to be in-situ by the excavator (Furnace 2, context 40) in fact appears to have originated at the foot of the wall, and is therefore displaced. It appears likely that the deposits within the furnaces may largely be of slag dumped into the furnaces.

One rather bizarre, but in-situ, material, is the slag flow recorded as Furnace 1, Find 1071. This rivulet of dense fayalitic slag was found extending at depth away from the furnace base. This flow must have penetrated along a void such as a root- or animal- hole. It appears very unlikely to have been deliberate.

The appearance of the main class of slags at Celbridge, with its low density, brownish colour and resinous lustre, differentiates this site from other bloomery sites. The site is also differentiated from Tullyallen and Carrickmines, in having apparently narrower and deeper furnaces. The significance of these differences should be investigated as part of the aims of the follow-up analytical programme

## Further work

It is recommended that additional analytical work is undertaken to determine the mineralogy and chemical composition of the main slag classes and components. A programme of work including the preparation of polished blocks for examination under the analytical SEM (3 samples), together with elemental analysis (6 samples), should be undertaken to characterise the material and permit its comparison with other sites and provide data for provenancing the ore source.

## References

- YOUNG, T.P. 2003a. Evaluation of slag from the SE Motorway, Co. Dublin (02E0428, 02E0272, 02E0074 and 02E0076). *Geoarch Report 2003/02*.
- YOUNG, T.P. 2003b. Is the Irish iron-smelting bowl furnace a myth? A discussion of new evidence for Irish bloomery iron making. *Geoarch Report 2003/09*.
- YOUNG, T.P. 2003c. Evaluation of slag from Tullyallen 6, Co. Louth (00E00944). *Geoarch Report 2003/10*.

<i>Context</i>	<i>Find #</i>	<i>Weight (g)</i>	<i>Notes</i>
<b>Furnace 1</b>			
20	177-191	275	14 pieces, mixture includes dark prills, dense charcoal coatings, lining frags, brown resinous appearing slags & ? Secondary reduction rim fragment
20	192	1875	single large block, apparently from intersection of straight wall with flat floor. Slightly more Fe-rich than 194?
20	193	5	lining with vitrified face
20	194	865	single slag block attached to wall or floor, big charcoal cavities, much of slag is low-iron brownish plastic-looking.
20	195-241	1065	46 pieces, 395 g of vitrified lining, 650g charcoal rich and prilly furnace slags
32	2557-2765	240	many pieces of prills, individual blebs and spheres, few pieces granular (ashy?)
32		675	42 pieces "good", 450g, 29 "coarse" 230g. Good =flow lobes, coarse=charcoal voids. Greenish, resinous appearing !
33	314-326	135	12 pieces, 110g dense lobes / prills, 40g green plastic looking irregular lobes
33	3156-3239	200	some dark smooth fayalitic prills, some brown, crystal-surface resinous appearing slags, many small blebs and spheres
33	3617-3692	45	some broken prills but mainly small spheroids
46	347-352	45	mainly brown resinous appearing prills and charcoal impressions
46	353	50	flow cf 1071
50	3023-3156	325	mixed assemblage of blebs, prills and fine charcoal rich slags
50	371-395	410	24 mainly dense flow prills, but some granular slag and 1 piece of ?melted lining, prills brownish cf 1071
50	371-395	465	15 dense flows, 1 large, 1 piece resinous appearing
?	1071	175	flow of grey vesicular slag with brown, shiny, polished-looking surface; rivulet running Se of furnace

Context	Find #	Weight (g)	Notes
<b>Furnace 2</b>			
19	2-103	2155	large blocks are from wall/floor angle, iron poor massive + dense, lobate base, flow at edges, smaller pieces are low iron flows, prills and enclose large charcoal. Charcoal certainly up to 3x5x2
19	131-144	10	fired clay debris
19	158-171	110	dense low Fe prills and flows
19	172-176	5	4 pieces of dull slag, some with polished surfaces, variably resinous appearing
19	854-863	65	dense but Fe-poor prills
19	864-888	100	burnt clay oxidised, curved face - superstructure?
19	889-921	245	32 pieces, 50% low Fe prills and 50% corroded and orange granular material, partly resinous appearing
19	922-923	<5	single broken polished surface with porous interior, resinous appearing, maybe part reacted ore?
19	3565-3617	45	Fe-rich tiny prills, and granular fragments
40	396-562	1960	fairly homogeneous collection of 166 pieces of prills and flows. Show vertical down wall and horizontal across floor movement. Low iron somewhat resinous appearing slags.
40	563-575	60	1 prill with hair, small prills, mod-low Fe, dense
40	924-936	95	medium sized brownish prills and flows, probably lowish Fe
40	937-1011	410	greyish resinous appearing low Fe flows, some pieces are granular internally
40	1012	960	fairly well flowed block of dominantly dark grey plastic slag, flowed down and away from wall over major step in floor - wood/charcoal?
40	2552	80	flow of dense but Fe-poor slag. Brownish surface, smooth polished resinous appearing, v large charcoal
40	3239-3403	125	mainly dark dense prills and spheroids, some more granular material, secondary crusts etc
52	576-588	170	low iron dense prills and flows, brown slightly resinous appearing
52	1013-1037	330	low iron dense prills and flows, brown slightly resinous appearing, one piece granular - ore?
59	1038-1070	190	low iron dense prills and flows, brown slightly resinous appearing
52	3692-3733	30	dark Fe-rich prills and spheroids

Context	Find #	Weight (g)	Notes
<b>Furnace 3</b>			
16	145	20	11 pieces fired clay debris
16	156	5	small dark prill
16	104-130	255	26 pieces, granular vitrified material, some flowed, plastically green, very low density material
16	328-337	70	low density flowed and granular resinous appearing slags. Also a glazed lump of clay
16	338-343	35	fired clay debris
17	1072-1081	45	mixed bag of ashy slags, lumps of fired grey clay - near floor debris?
17	1082-1084	20	brown blebs, partially flown around charcoal
17	1085	10	fired clay
17	2518-2524	110	7 pieces, no special features
43	344-345	5	small brown prills
43	346-370	130	blebs and runs of brownish resinous appearing slags, mixed with some pale matrix/organic rich material
43	1086-2014	150	29 pieces, mixed assemblage of v resinous appearing small slag blebs and charcoal rich material, some lightly granular
43	2015-2053	925	19 pieces, dense material flowed around large charcoal fragments. Evidence for floor/wall angle?
51	sample 13	250	tiny pieces of mainly pale ashy material with organic debris
51	589-629	380	mainly dense grey resinous appearing slags in blebs, prills and flowage around v coarse charcoal, 1 piece with pale/org material adhering
51	630-632	5	1 piece vitrified lining, 1 piece resinous appearing granular slag.
51	637-641	20	fired clay lumps
51	642-824	960	182 pieces, curious material - pale matrix bearing lots of organic material - presumably this is an ash
51	2034-2086	160	mainly dense grey prills and charcoal coatings, a few pieces of less dense, grey clay inclusions amongst prills
51	2260-2326	240	67 pieces, pale matrixed material with abundant organics of 51/642-824 + 60/2057-2199
56	825-834	80	10 pieces, grey resinous appearing prills of varying density - some v dense, a few spheroids and bunch-of-grapes
56	835-846	70	various mainly granular slags - all v plastic looking. Are these glazed lumps of lining or poor ore...?
56	2327-2427	1020	101 pieces, mainly dense descending prills, lobes and charcoal coatings, some granular glazed & ashy material
56	2428-2517	425	55g well formed, khaki resinous prills, 195g plastic coated khaki granular, rest intermediate
56	3403-3565	65	hard dense granular slag plus dark blebs and spheroids
60	2057-2199	1125	143 pieces, approx 25% flowed material and 75% pale + organics cf. 642-824
60	2200-2259	495	dark dense prills and blebs flowing around charcoal, 1 piece with floor or wall contact, 1 small piece with adhering pale matrix + organic material
<b>Scorched pit</b>			
21	2532-2536	5	small pieces of burnt stone and one possible piece of corroded iron
34	2765-3023	360	dense prills and blebs of fayalitic slag - including lots of few mm diameter spheres

