Report on the metalworking remains excavated at the Stradbally Waste-Water Treatment Plant site, Stradbally More, Co. Waterford (14E0431)

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Introduction

Excavations ahead of the construction of a waste-water treatment plant near Stradbally, Co. Waterford revealed an area characterised by copper-production waste dumped in and around a shallow hollow and other nearby features. The c. 50kg of material related to metalworking consisted mostly of slag, but also had substantial amounts of technical ceramics, both crucibles and tuyeres. Radiocarbon analysis on material from one of the contexts with metalworking debris returned a date suggesting a fifth- to early sixth-century AD date for the activity.

The site

The site consists of a large hollow surrounded by various smaller features. The hollow C. 14, measuring 5.2 by 3.5m and 0.55m deep, was filled with two layers: C. 4, a clayey layer at its base, which yielded tuyere material together with small amounts of slag and crucible material, and C. 3, the upper layer containing the bulk of the slag and crucibles sherds recovered from the site. C. 3 also continued into a slightly curving linear feature C. 15 starting at the south-west of hollow C. 14. Deposit C. 8 overlying a pit at the south-eastern edge of hollow C. 14 yielded small amounts of slag and crucible fragments. A heart-shaped feature C. 7, located just north-west of hollow C.14, had a charcoal-rich basal fill C. 6 that included further slag and crucible material. Finally, a thin spread of material (C. 11) 11m east of hollow C. 14 also contained some slag, crucible and tuyere fragments.

Description of the material

The bulk of the assemblage consists of slag (42.7kg). This material is remarkably homogeneous and nearly exclusively consists of rather light to rather dense amorphous lumps (Pl. 1). The slag lumps mostly weigh below 100g with a maximum of 243g (Fig. 1) and have frequent inclusions of angular quartz. Nearly all have rusty patches that indicate an iron content, while some of the heavier pieces also contain copper as shown by green staining on their exterior. The iron content of the slag was also indicated by many pieces being mildly to strongly magnetic. Other slag material consists of dense pieces, often showing flow structure and is reminiscent of bloomery iron slag (Pl. 2). The weights of this type of material vary between 21g and 803g. More than half of these heavier pieces have copper staining.

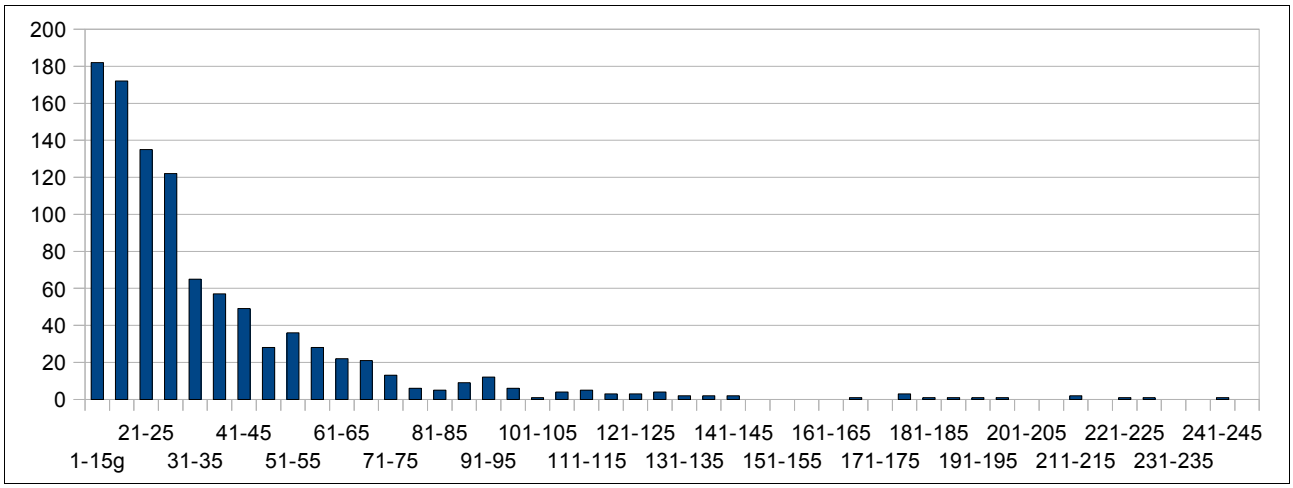


Fig. 1. Weight distribution of lumpy slag pieces from C. 3

The remaining material in the assemblage comprises of two types of technical ceramics. A first type are sherds of coarsely-made vessels of which over 200 sherds were recovered (6.7kg). Their fabric consists of clay with frequent stony inclusions, mostly angular quartz. The insides of the vessels are consistently vitrified, with sporadic instances of embedded copper droplets, mostly oxidised but in one case in pure metallic form. As such they are identifiable as crucibles. Many sherds show overhanging lips (Pl. 3), very likely to facilitate holding and handling the vessels. The vitrification is often to such a degree that it becomes difficult to reconstruct the dimensions and shapes of the vessels. The surviving thickness of the sherds varies from c. 3mm to c. 12mm and while some deformation certainly took place, it is clear that both thick- and thin-walled crucibles were part of the assemblage. Approximate diameters at rim level of 160mm (thin-walled) to 220mm (thick-walled) can be suggested. From some thick-wall fragments it would appear that their walls were maximal 50mm high, while others had walls higher than 70mm. The same thick-walled pieces show the walls to be slightly convex, while their bases were nearly flat (Fig. 4).

Next to the crucible sherds, about 0.4kg of tuyere fragments were recovered. The largest piece is a well-preserved and heavily vitrified front of a slightly bottle-shaped tuyere (Pl. 5 and 6). It has a maximum preserved length of 90mm, a frontal diameter of 50mm and a frontal opening of 35mm. Its largest preserved external diameter (assuming it had a symmetrical cross-section) is 100mm, while its largest preserved internal diameter is 35mm. A rim sherd with adhering tuyere material (Fig. 7) indicates that the crucibles were blown from the top.

The flotation residues from the soil samples from contexts C. 3 (2 samples), C. 6 and C. 11 were extensively checked for relevant material. Visual examination revealed frequent small slag

fragments and lumps, while magnetic scanning exclusively picked up the magnetic portion of the slag pieces. No pieces of potential ore were observed. An object described as a 'possible clay mould' is a piece of sandstone that very likely only shows natural fractures.

A sample of charcoal from C. 4 returned a radiocarbon date of 1610 +/- 30 BP or cal. AD 390 to 540 (2Σ). The copper production activity very likely took place in the fifth to early sixth century AD.

Nearby copper mines

Five remains of copper ore extraction in the immediate area of the site are recorded on old 6in. maps in the possession of the Geological Survey of Ireland (Fig. 2).[1] About 400m west of the site, in the townland of Woodhouse, lies what is described as a small copper mine (1).[2] To the east and along the coast are three more locations of copper exploitation: two in the townland of Ballyvoony where 'ancient adits' for copper were observed (2 and 3) and an 'ancient copper mine' in the townland of Killelton (4). About 2.4km northwest of the site, a further disused copper mine was noted as present in the townland of Kilminnin Lower (5) with its lode, or ore-body, extending into the neighbouring townland of Woodhouse.[3]

Fig. 2. Copper mines near the site. 1. Woodhouse, 2. Ballyvoony I, 3. Ballyvoony II, 4. Killelton, 5. Kilminnin Lower

1 Visible on the GSI Website http://spatial.dcenr.gov.ie/imf/imf.jsp?site=GSI_Simple Accessed 22 July 2015. The Kilelton and Kilminnin mines are also mentioned by Griffith (1854: 328) and subsequent list of mines based on the same.

2 On the GSI Website, this mine is stated as in the townland of Stradbally More 'south of the town of Stradbally' but located in the townland of Woodhouse on the map. The mine could be located slightly further north.

3 On the map on the GSI Website, this mine is erroneously placed just east of the Kilelton mine (4).

Early copper production technology

Copper ores occur mainly in three economically exploitable forms: as pure metal, as oxides/carbonates and as sulphides. Pure metallic copper requires no smelting, but is rather rare. The smelting of copper oxides and carbonates is relatively straightforward. The oxygen is burnt off, the remaining material is workable metal and no or very little slag is produced.

Sulphides are the most common copper ores, but most of these also have considerable iron contents. When sulphidic ores are smelted, their sulphur is readily removed and the resulting product is a mixture of iron and copper known as 'matte'. To separate the iron from the copper, the matte needs to be repeatedly melted again together with a flux, often quartz. Both the smelting of sulphidic copper ore and the refining of matte can be undertaken in furnaces as well as in crucibles (Zwicker et al. 1985; Meyerdirks et al. 2004: 651).

The most common form of slag from early copper ore smelting is characteristic plate slag, but other forms are known (Bourgarit et al. 2008: 2). Plate slag has also been identified as matte refining slag (Hanks and Doonan 2008: 346) and on one site coarse slag was identified as resulting from smelting, 'massive slag' from primary refining and plate slag from secondary refining operations (Addis et al. 2015). No information on the use of either furnaces or crucibles was available in the latter two publications.

Early medieval copper production in Ireland

There is very little evidence for early medieval copper production in Britain (Dungworth 2012), but Ireland has the Ross Island site, Co. Kerry where remains of seventh- to eighth-century copper production were recovered and extensively examined (O'Brien 2004: 405-424; Meyerdirks et al. 2004). These were found over five areas in the vicinity of a Bronze age mine and consisted of deposits of slag and technical ceramics. At two of the five areas the hollow bases of smelting furnaces were excavated. The slag comprised mainly of plate slag but also included occasional lumpy pieces. The technical ceramics consisted of tuyere fragments as well as pieces of vitrified furnace wall. Analyses on the material led to the conclusion that the site represented the remains of the production of pure copper from rich sulphidic ores.

Conclusions

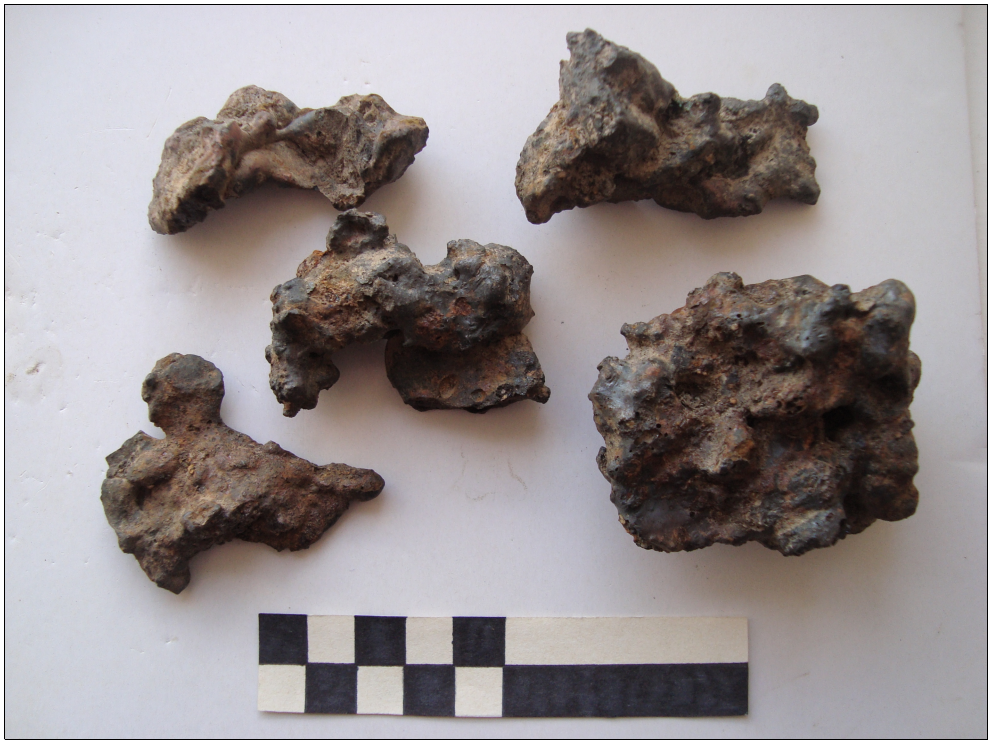
Because linking the remains of copper production to their technology and production stage remains complex and as this study does not include analytical data, the conclusions below must be considered as tentative.

The site likely represents subsequent stages of matte refining in crucibles which were blown from above with slightly bottle-shaped tuyeres. It is unclear if the dense slag pieces with flow-structure then represent a first refining step or if they are the result from smelting. The lack of ore particles in the soil samples, however, would suggest that no smelting took place on the Stradbally site. The varying sizes of the crucibles could then reflect the different stages of this matte refining, as could the size and density of the slag lumps.

The site at Stradbally, although still poorly understood, is an early medieval copper production site of national and international importance. The site clearly represents a different technology to that used at the site at Ross Island about two centuries later, but also to many sites further afield. It is strongly advised that funding could be sought to further investigate and understand the full significance of the Stradbally remains.

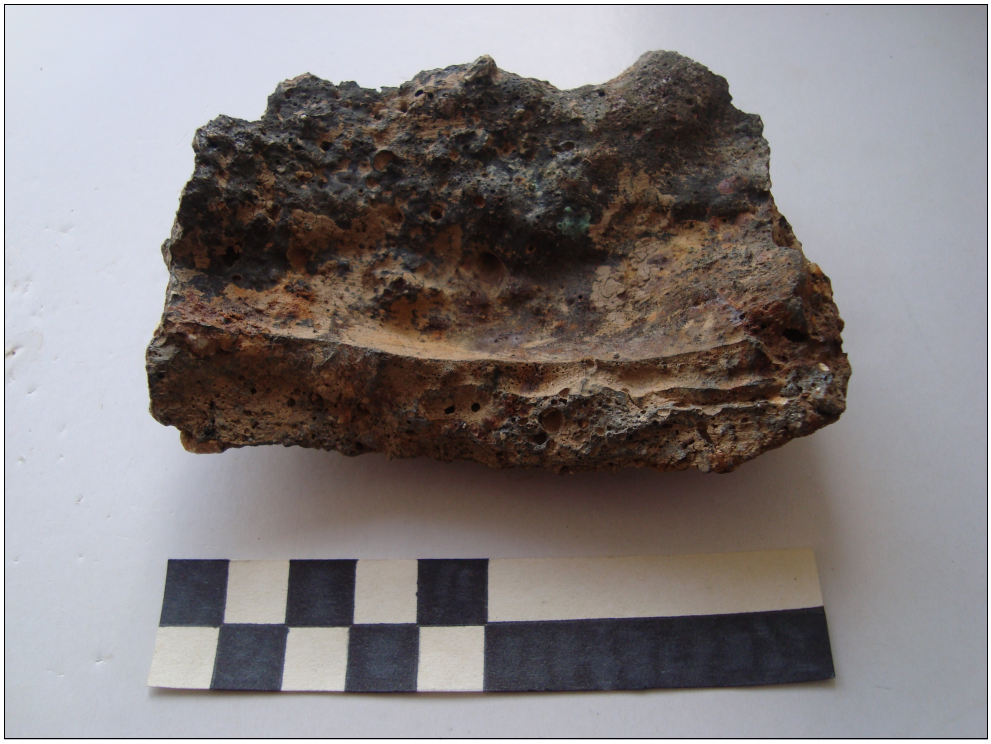
Plates

Plate 1. Lumpy slag



Pl. 2. Dense slag, some with flow structure

Pl. 3. Crucible rim sherd with overhanging lip



Pl. 4. Thick-walled sherd with rim and flat base

Pl. 5. Side view of the tuyere front

Pl. 6. Front view of the tuyere front

Pl. 7. Crucible rim sherd with adhering tuyere material

Catalogue

Context	Sample/Find	Description	Weight (g)
C. 3	S. 1 (soil)	Multiple small pieces of amorphous slag	367
C. 3	S. 2 (soil)	Multiple small pieces of amorphous slag	740
C. 3	S. 7	Large amount of amorphous lumps of slag (max. weight 243g). Some of the heavier pieces have copper-staining	33800
C. 3	S. 7	Around 160 pieces of dense slag, some showing flow-structure. Max. weight 803g. Most pieces show copper-staining	5040
C. 3	S. 7	Crucible fragments (description see text)	6388
C. 4	S. 4	Nine amorphous lumps of slag	305
C. 4	S. 4	Three crucible fragments	59
C. 4	S. 4	Eight tuyere fragments	58
C. 4	F. 2	One complete frontal piece of a tubular tuyere and five smaller fragments	351
C. 4	F. 2	Two light pieces of copper-rich material	5
C. 6	S. 3 (soil)	Handful of small slag fragments	24
C. 6	S. 6	Around 25 amorphous lumps of slag, max. weight 95g	1263
C. 6	S. 6	Technical ceramics: 4 thick-walled crucible sherds of which two rim fragments + 1 thin-walled piece with oxidised Cu on the outside	110
C. 8	S. 11	Seven amorphous lumps of slag	543
C. 8	S. 11	Three sherds of crucibles	91
C. 11	S. 9 (soil)	Handful of small slag fragments	145
C. 11	S. 8	Nine amorphous lumps of slag	492
C. 11	S. 8	Three crucible fragments	41
C. 11	S. 8	Three tuyere fragments	17

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