APPENDIX 1 - SLAG AND METALWORKING DEBRIS

1.1 Assessment of the Iron Working Debris

by Lynne Keys

Introduction

1.1.1 A small quantity of material identified as iron slag was recovered during the fieldwork at Tutt Hill, both by hand collection and from sieved soil samples. None of the slag had been washed before assessment. The slag was collected to determine the type of metalworking which had produced it and to attempt to locate the area(s) where ironworking was taking place.

1.1.2 Activities involving iron can take three forms:

- The manufacture of iron from ore and fuel (and, in later periods, a flux) in a *smelting* furnace. The resulting products are slag (waste) and a spongy mass called an unconsolidated bloom which consists of iron with a considerable amount of slag still trapped inside.
- *primary smithing* (hot working by a smith using a hammer) of the bloom, usually near the smelting furnace, to remove excess slag.
- *secondary smithing* (hot working) of an iron shape by a smith to turn it into a utilitarian object or to repair it.

These activities - smelting and smithing - generate slags, some of which are diagnostic of the process being carried out and others of which are not. Other types of non-iron slag debris (such as vitrified hearth lining) may be the result of various kinds of high temperature activity - including domestic fires - and cannot be taken to indicate that ironworking was taking place.

Methodology

1.1.3 The whole assemblage was examined and was categorised on the basis of morphology and colour. Occasionally identification of small fragments was difficult. Each type of slag from each context examined was weighed and recorded. The soil samples were opened, some being emptied onto a tray, and examined for hammerscale and other microslags by running a magnet through them. These samples were not weighed as they usually contained stones, but the type of debris in them was recorded.

Quantification

1.1.4 The total amount of slag examined and quantified was just under 3 kg. The breakdown by context of each type and its total weight is given in Table 4.1.

1.1.5 From Table 4.1 it will be seen that much of the slag had to be allocated to the *undiagnostic* category. This is because it could have been produced by either smelting or smithing, or because it was broken to such a small size its original form could not be determined.

1.1.6 *Tap slag* is a dense, low porosity, fayalitic (iron silicate - 2FeO.SiO2) slag with a ropey flowed structure rather like lava. The characteristic structure of tap slag is the

result of the liquid slag being allowed to flow out through a hole at the bottom of the smelting furnace. It is generally thought this type of smelting furnace was introduced during the Roman period.

1.1.7 *Dense slag* is of low porosity and very similar to tap slag, but without the flowed surface. It also represents smelting activity.

1.1.8 *Hammerscale* is a micro-slag produced by smithing. It is of two types: spheroidal and flake. Spheroidal hammerscale consists of small solid droplets of liquid slag expelled from within the iron during the primary smithing of a bloom or the fire welding of two pieces of iron. Flake hammerscale resembles silvery fish scales and is the product of the ordinary hot working and hammering of a piece of iron where fragments of the oxide/silicate skin flake off from the iron and fall to the ground. The presence of hammerscale, mainly broken flake, in the soil samples reveals the smithing activity consisted mainly of simple hot hammering of pieces of iron to produce objects or repair them. The presence of some spheres may indicate either high temperature welding (to join two pieces of iron) or the primary smithing of a bloom after smelting.

1.1.9 It is worth noting the absence of smithing hearth bottoms, the most characteristic macro-slag of smithing. As both flake and spheroidal hammerscale are present it is to be expected that at least one or more smithing hearth bottoms would have been present. These would have been dumped in features such as pits or ditches which were open at the time of the metalworking activity.

1.1.10 *Vitrified hearth lining* comes from nearest the tuyère region (the region of highest temperature) of the hearth or furnace. By itself it is not diagnostic of smelting or smithing activity but its association with other diagnostic material provides support for the process.

Provenance

1.1.11 Most of the iron slag found on the site was from pits and plough soil, except for a small group from a furnace or oven (336). This group is of interest because it appears to consist of smelting slag. This feature, consisting of two pits, set inside a large pit, all of which had been subjected to considerable heat could have been a smelting furnace.

Conservation

1.1.12 The slag although unwashed is stable and unlikely to be affected by any factors of preservation. Iron slag, being fayalitic, requires no special storage conditions and is unlikely to be affected by further analysis. Decisions as to whether the assemblage can be discarded should only be made after more detailed work on the assemblage has been carried out and other relevant CTRL sites with iron slag have been examined and assessed.

Comparative Material

1.1.13 Many sites produce small amounts of smithing slag and occasionally smelting slag. Roman iron smelting furnaces are now known from all over the country where ores are found and examples should not be difficult to find.

Potential for further work

1.1.14 The small group of smelting slag, in itself, would usually not merit further work. However, its provenance within a feature which may be a smelting furnace is of some interest. Although the feature falls outside the main prehistoric range of interest for the site, it has the potential to contribute to study of the Roman rural economy, for the research period Towns and their Rural Landscapes, sub-period 1 (100 BC - AD 410). The CTRL fieldwork has recovered numerous examples of Roman rural ironworking, including similar sites in Kent such as Beechbrook Wood and South of Snarkhurst Wood. Evidence for iron working on a larger scale has been recovered at Westhawk Farm, Ashford. In this context, the evidence from Tutt Hill can contribute to a broader understanding of the range and type of features to be associated with iron exploitation and working in the Weald of Kent in the Iron Age and Roman period, and certainly deserves further work to determine its type and to locate similiar examples.

1.2 Assessment of the Copper Working Debris

by Chris Hayden and Ian Scott

1.2.1 A small quantity (221 g) of copper working debris was unexpectedly found amongst iron working slag following the sieving of sample 6 from context 36, the fill of probably late Iron Age pit 35 (Table 4.2). The debris is of two types: One is probably low density crucible slag containing much entrapped gas, the other consists of coarse, sandy iron-stained fragments of the furnace to which fragments of copper slag adhere. The slag suggests that the debris derives from reworking of copper alloy rather than smelting. Fragments of a broken copper alloy artefact perhaps intended for reworking (see Appendix 3) were also found in the same sample. The pit also contained a larger quantity of iron slag and thus appears to have been used to dump both iron and copper working debris.

1.2.2 The small assemblage of copper working debris has the potential to provide more detailed information on the kind of copper working being undertaken on the site and should be examined further by a specialist with skills in this specific area.

Table 4.1: Summary of iron slag and metalworking debris

Context	Sample No	Type	Weight (g)	Comments
2	1	Undiagnostic	42	Recovered from colluvium in test pit
2	1	Undiagnostic	78	Poss. broken smithing hearth bottom Recovered from colluvium in test pit
2	1	Hammerscale sample	0	Broken flake and one sphere. Recovered from colluvium in test pit
2	1	Sample	0	Broken slag and one sphere hammerscale Recovered from colluvium in test pit
19		vitrified hearth lining	22	From ploughsoil. Black glassy vitrification.
19		Undiagnostic	142	From ploughsoil
32		Tap slag	74	Unstratified
36	6	hammerscale sample	0	From Pit 35. Large percentage of flake, some spheres
36	6	undiagnostic	146	From Pit 35. Cu working also taking place
36	6	vitrified hearth lining	76	From Pit 35
38		undiagnostic	70	From fill of Pit 39. Possibly smelting.
103		undiagnostic	72	From fill of ring ditch 90
168	27	undiagnostic	18	From fill of ring ditch 156

Context	Sample No	Type	Weight (g)	Comments
327		Tap slag	132	Recovered from fill associated with furnace
327		dense slag?	1714	Recovered from fill associated with furnace
329		Tap slag	338	Recovered from fill associated with furnace
Total			**2924**	

Table 4.2: Summary of copper working debris

Context	Sample No	Type	Weight (g)	Comments
36	6	crucible slag	78	From Pit 35
36	6	Furnace fragments	143	From Pit 35. Slag adhering to fragments
Total			**221**	