2 See note 7 for contemporary accounts; note 1 for the more full summaries.

3 For a preliminary analysis see D.H. Kennett, 'The Anglo-Saxon Cemetery found at Kempston, Bedfordshire: a re-consideration' (typescript, 1968). Copies are available Bedfordshire County Record Office, Bedford, and the Department of Medieval and Later Antiquities, British Museum, London.

4 N. Aberg, *The Anglo-Saxons in England* (1926), fig 11.

5 Smith, 1904, col. pl.

6 E.T. Leeds, 'The Early Saxon Penetration . . ', *Ant J.* 13 (1933), 229-251; pl. 33b.

7 S.E.Fitch, 'Discoveries of Saxon Remains at Kempston', *A.A.S.R.*, 7 (1863-4), 269-299 of which pp. 279-299 is reprinted in C. Roach Smith (ed.), *Collectanea Antiqua* VI (1868), 201-221.

8 E.T. Leeds and H. Shortt, *An Anglo-Saxon Cemetery at Petersfinger, near Salisbury, Wilts.*, (1953), 13-16.

9 F.R. Aldsworth, 'The Droxford Anglo-Saxon cemetery', *Proc. Hants. Field Club* 35 (1978), 138 and fig 33.46.

10 D.H. Kennett, 'Graves with swords at Little Wilbraham and Linton Heath', *Proc. Camb. Ant. Soc.* 63 (1971), 9-26.

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12 Kennett, 1971, 13-15 with list 24-25.

13 S.C. Hawkes and G.C. Dunning, 'Soldiers and Settlers . .. .', *Med Arch.* 5 (1961), fig 1.3 uppermost item.

14 Hawkes and Dunning, 1961, fig 2 d and e.

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17 Hawkes and Dunning, 1961, fig 1.5-10.

18 J. Werner, 'Kriegergraber aus der ersten Halfte des 5 Jahrhunderts . . .' *Bonner Jahrbucher*, 158 (1958), 372-414, esp. 385-387 with abb. 10-12.

19 Collections of the Rijksmuseum G.M. Kam, Nijmegen, Netherlands. References to the available literature were not to hand when these notes were written.

20 A. Dasnoy, 'La Necropole de Furfooz', Annales de la societie archaeologique de Namur 55 (1969), 121-193; A. Dasnoy, 'La Necropole de Samson', A.S.A.N., 54 (1968), 277-33; A. Dasnoy, Quelques ensembles archeologiques du bas empire provant de la region namuroise', A.S.A.N. 53 (1966), 169-231.

21. Werner, 1958, abb. 19; G. Behrens, Das fruchristliche und merowingerisch Mainz (1950), 17 and abb. 34.

22 Paper completed 28 November 1982; work done in May 1982. Literature sited is that readily available to the author. It is not intended to be comprehensive.

The Excavation of an Iron-smelting site at Easton Maudit, Northamptonshire

DAVID HALL

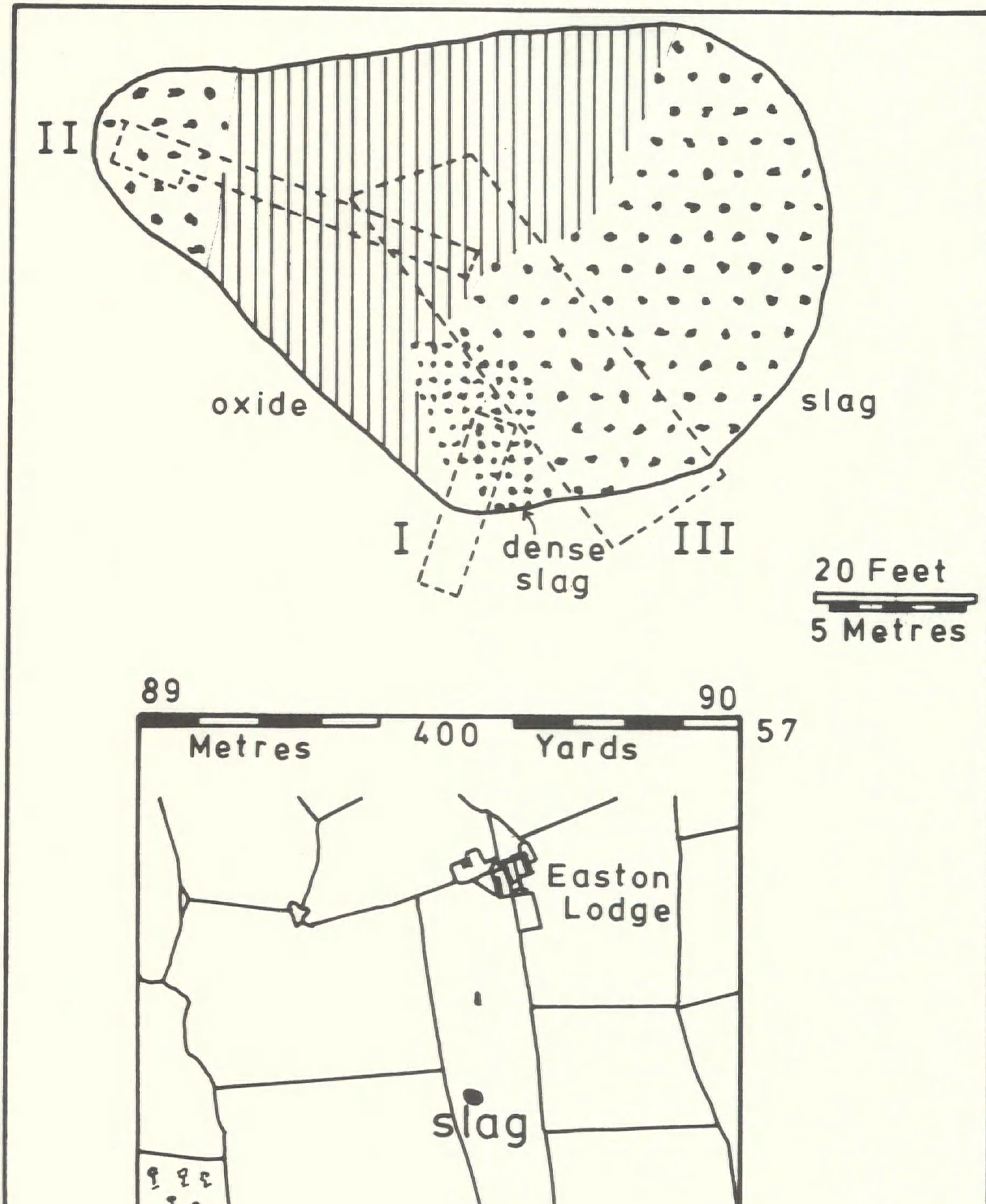
An extensive tract of boulder clay lies between the rivers Great Ouse and Nene, spanning the borders of the counties of Bedford, Buckingham, Huntingdon and Northampton. Place-name evidence and surviving authentic medieval woodland, show that, once, much of the area was forest.

Over most of this woodland area, particularly in Bedfordshire, are to be found iron smelting sites. On the ground the sites are readily detected as dark areas containing charcoal, much dense black iron slag, and sometimes reddish patches of roasted ore. The distribution of the sites has already been given at the state of knowledge in 1972[1] and further discussed recently.[2]

In an attempt to understand the nature and working of smelting sites one of the best examples available was excavated at Easton Maudit, Northamptonshire.

The site, coded E3 in previous publications, lies on boulder clay at 107 metres OD (SP89585-636) in an area with a preponderance of wold names.[3] In 1964 the field had not been long ploughed up from earthwork ridge-and-furrow, and this was still plainly visible as light-and-dark strips.

Figure 1 shows the location and plan of the smelting site, and the positions of the areas excavated in 1964 and 1967. Superficially there was a central reddish area with slag and charcoal at each


II
oxide
slag
I
dense
slag
III
20 Feet
5 Metres
89
90
57
Metres
400
Yards
Easton
Lodge
slag
366
56

end. The whole formed a pear shape of approximate dimensions 28m by 20m. In the southern part of the site was an area too dense for a probe to pass through.

Grid I (1½m by 7m) was dug entirely by hand, as it was considered the most likely region for survival of any structure. The only features encountered were ancient soils, and a dump of tipped slag and klinker mixed with large pieces of charcoal (see Fig 5 for plans and sections). There were also many fragments of burnt clay, lying thicker towards the centre of the smelting area. The subsoil was not burnt, so none of the slag could have lain *in situ.*

Grid II (3¾m by 40½m) was also dug by hand to examine the relation of the main clay area to the various red and black areas. Very little material was left undisturbed by ploughing, modern and medieval. Again no structure was discovered and all the slag had been dumped i.e. did not lie as run off from a furnace. Some of the iron oxide areas were entirely slag free (Fig 5 Grid II section).

A larger area (16m by 5m) was examined in 1967, the topsoil being cleared mechanically. Again all the features (i.e. patches of different coloured soils) were shallow and only just survived. Their condition had deteriorated since 1964. The plan shows the approximate position of the diffuse areas. No structure was detected. The unexcavated area was closely probed to ascertain the presence of stone or baked clay furnace, but none was found. A total excavation was therefore considered worthless.

The excavation demonstrated the following points. The first activity had been the roasting of iron ore: these patches were found at the lowest level and were entirely slag free. The remains discovered were no doubt the 'fines' sieved off to prevent clogging of a charge of ore and charcoal. The local iron ores consist of limonite and siderite, hydrated iron oxide and carbonate respectively, so an initial roasting is essential to achieve a high temperature during smelting.

Dumped on top of the oxide fines were various refuse heaps of charcoal fines and tapped slag. None of the slag was *in situ* because nowhere was the subsoil burnt, and often pieces of slag were upside down. Most of the refuse heaps included broken pieces of burnt red-and-black clay which doubtless represents the fabric of small furnaces. There was clearly no large furnace dug into the subsoil.

Fig 4 Easton Maudit, Northamptonshire, location and plan of iron-smelting site.

The excavation of a surviving smelting 'furnace' at Wakerley showed that the structure can be very small, as little as 20cm in diameter and about 40cm high. Such a structure would be easily destroyed by ploughing, and dispersed. Most of the ploughed smelting-sites are therefore likely to yield little information about structures, but sites where the refuse still lies in abundant heaps are likely candidates for survival such as, Harrold Park Wood, Beds., (SP93825853) and Gretton, Northants, (SP8940-9284).

The charcoal samples were examined at the Department of Forestry, Oxford. The species identified are given in table I.

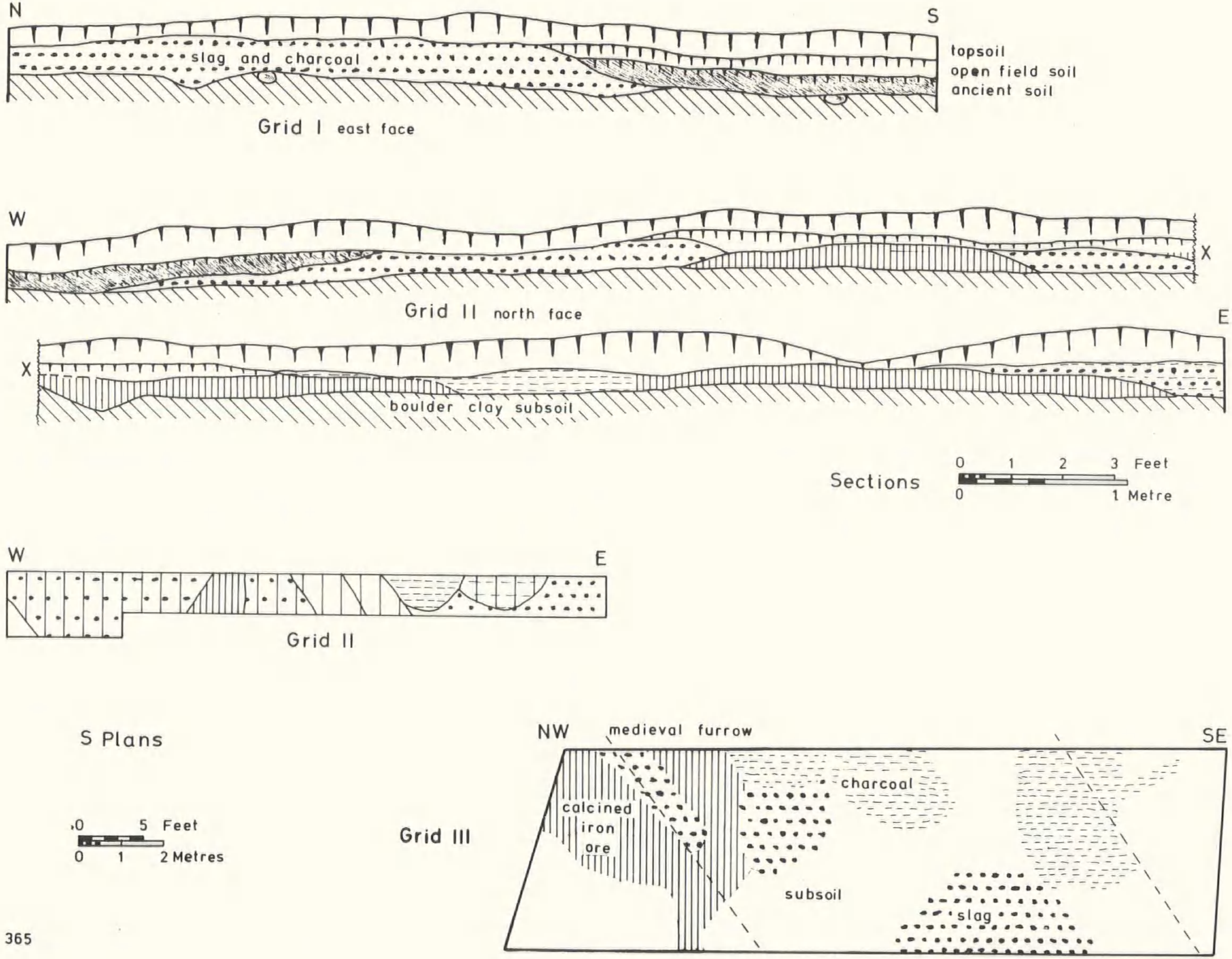
If this represents a true distribution of the species present in the surrounding woodland then it suggests an ancient oak dominated forest There is of course no way of knowing whether it is just that the charcoal burners preferred oak. Even if oak was really the dominant species there is no proof of 'primaeval' woodland; most of the charcoal had been made from small branches and twigs, so that source could equally well have been a forestry-managed coppice, cut down every 20 years or so.

The nature of the slag shows a primitive knowledge of the smelting process, with much loss of iron in the form of intractable silicate, there being no flux added. Typical analyses are:

Calcium oxide	(CaO)	5.3	6.4
Magnesium oxide	(MgO)	1.6	1.5
Silicon oxide	(SiO_2)	19.1	21.4
Iron	(Fe)	46.0	40.8

A modern slag would contain no iron, consisting mainly of calcium silicate ($CaSiO_3$).

Samples from site Harrold I (SP956566) examined for iron only (after treatment with hydrofloric and sulphuric acids) gave valves of 45.7% and 46.7% iron. Some of the iron is acid extractable, i.e. must be present as ferrous oxide FeO. Easton Maudit slag gave an acid-soluble value of 12.78 leaving iron present as silicate at an average value of 37.5%. From which it is calculable that the slag has an approximate composition $FeSiO_3$-FeO. The admixture of small quantities of calcium and magnesium which come as accidental impurities in the iron ore accounts


N
S
slag and charcoal
topsoil
open field soil
ancient soil
Grid I east face
W
X
Grid II north face
E
X
boulder clay subsoil
Sections
0 1 2 3 Feet
0 1 Metre
W
E
Grid II
S Plans
0 5 Feet
0 1 2 Metres
NW
medieval furrow
SE
Grid III
calcined iron ore
charcoal
subsoil
slag

365

TABLE I
Charcoal Samples

Species	1	2	3	4	5a	5b	Total	%
Oak	42	45	19	9	9	9	133	84.7
Hazel	1	1					2	1.3
Willow		1			1	1	3	1.9
Elm				1	8	6	15	9.5
Sweet chestnut					3	1	4	2.5
							157	

satisfactorily for the analyses given above.

If the quantities of slag for each site could be determined (assuming that an average value is taken for the sand content of the local iron ore), then it would be possible to calculate the total tonnage of iron smelted, and thus estimate the minimum amount of wood required.

The melting point of the slag would be at least 1100°C, and this temperature must have been reached juding by the manner the material has run into flat cakes. The two occurring forms of calcium silicate melt at 1540° and 1200°, ferrous silicate melts at 1550°, but a mixture of them would cause an eutectic lowering of the melting point.

The date of the smelting site was ascertained by the radiocarbon method.[5] A sample of charcoal was pretreated with acid and alkali, and using the Libby half life of 5570 years, gave a date of 1240 AD ± 100.

This is consistent with the historical evidence when the area on the periphery of the parish would be expected to be cleared for agriculture by the end of the thirteenth century. The actual date may be slightly before the mean value because the section shows there was an accumulation of an ancient soil on the lower parts of the slag.

The general significance of smelting sites has been recently discussed,[6] clearly they represent a woodland activity, and probably wood clearance. It is expected that they should be found on woodland sites, and not necessarily near the source of iron ore, because it is easier to carry ore than bulky loads of wood and charcoal. Potentially the sites are useful for interpreting the landscape at a given period, but unfortunately there is no easy way of dating them. At Harrold slag was found in context with Iron Age and Roman features, as was the Wakerley material. The Easton Maudit one was clearly medieval. So without a carbon 14 determination on each site no clear answer can be given. The correspondence of slag distribution with areas of known medieval woodland is no proof of a medieval date – there may have been Roman woodland there as well in approximately the same area. Boulder clay is always to be thought of as marginal land, except perhaps very recently.

Nevertheless the recognition and recording of smelting sites and the collection of slag and charcoal samples is essential. At some time in the future, when analysis costs are less, it may be possible to give a more satisfactory interpretation of the landscape implications of these interesting features.

Fig 5 Easton Maudit, Northamptonshire, plans and sections of iron smelting site.

NOTES

1 D.N. Hall and J.B. Hutchings, The distribution of archaeological sites between the Nene and Ouse valleys, *Beds. Arch. J.*, 7 (1972) 6.
2 D.N. Hall, The countryside of the south-east Midlands and Cambridgeshire, CBA Roman Conference at Oxford, January 1981.
3 See note 1, Fig 4 for a plan of the site location.
4 D.A. Jackson, 'Excavations at Wakerley, Northamptonshire, 1972-5', *Britannia* 9 151-66; and 'Roman Iron Working at Bulwick and Gretton', *Northants Archaeology* 14 (1979) 31-7.
5 F.W. Shotten, *Radiocarbon* 17 (1975).
6 See f.n.2.

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