Part 1

Design

Plate 1 (a) Sutton Hoo in 1983, looking north towards Tranmer House; (b) Deben Valley, looking south towards the North Sea. Photographs by Cliff Hoppitt.

Chapter 1

Five campaigns
The exploration of Sutton Hoo

Martin Carver

Location

A small group of Early Medieval burial mounds lies on a scarp at 33 m AOD on the left bank of the River Deben about 16 km (10 miles) from the sea in the county of Suffolk, south-east England (NGR TM2848; SMR Sut 004; Plate 1, Figure 1). To the west, across the river, lies the town of Woodbridge, which has a restored tide-mill and a marina, and to the north of Woodbridge, further upstream, is the village of Melton. Wilford, by Melton, is the site of an ancient ford and is the first point upstream at which the river, still just tidal, is bridged. The mounds lie on the east side of the Deben (pronounced 'Deeben') in open farmland. There is one prominent dwelling nearby, a country house built in 1910, and the nearest village is Sutton, 2.5 km to the south-east.

In topographical terms, Sutton Hoo is the name of the promontory ('hoo' from OE *hoh*, Gelling 1992: 61) on which the country house stands (formerly Sutton Hoo House, now Tranmer House). Sutton Hoo is also the name given to the archaeological site, which comprises the visible burial mounds and the small area of about 20 ha. that surrounds them. It is the discoveries made in the mounds and their surroundings that have made the name of Sutton Hoo famous and are the subject of this book.

Previous investigations

The first major campaign of excavation at Sutton Hoo occurred during the sixteenth to seventeenth centuries, and took the form of large pits dug into the centre of the mounds. Evidence of this campaign was rediscovered through subsequent excavations, but it is otherwise unrecorded. A second comprehensive campaign took place in the mid-nineteenth century and consisted of east–west trenches cut through a majority of the mounds. This campaign was also rediscovered during the recent investigations, and may have included the opening of a mound reported in the *Ipswich Journal* for 24 November 1860. The mound in question was probably Mound 2, one of at least five mounds then recognized. Figure 2 shows a plan of all the mounds and the numbers by which they are now known. The fifty-six archaeological operations at Sutton Hoo for which records exist, termed here 'Interventions' (*Int.*), are listed in Table 2. The 1860 excavation, the first to leave a record, is designated 'Int. 1'.

The 1938–9 campaign

On Monday, 20 June 1938 Mrs Edith Pretty, the owner of the Sutton Hoo estate and the resident of Sutton Hoo House, caused a long probing iron to be driven into the top of the largest of the mounds, Mound 1. So began the twentieth-century investigation of the Sutton Hoo site. During the next eight weeks (until 10 August) the Suffolk archaeologist Basil Brown, whom Mrs Pretty employed as her excavator, cut trenches through Mounds 3, 2 and 4 (in that order), defining in each case a central burial pit. Each of the burials had already been 'robbed', that is excavated without record, but from the fragments and features remaining it could be said that the burials in Mounds 3 and 4 had been cremations, and that the original arrangement in Mound 2 had included a ship, indicated by the presence of iron rivets or clench nails used to hold the planking of the ship together. All three burials were determined from the finds as being Anglo-Saxon (sixth to seventh centuries AD) in date (Ints 2, 3 and 4).

In 1939 Basil Brown was again commissioned to excavate at Sutton Hoo, and he was invited by Mrs Pretty to undertake an investigation of Mound 1 (Int. 5). On 8 May he drove a trench through the mound from east to west and shortly discovered iron rivets. By leaving the rivets in position he eventually defined the form of a clinker-built timber ship some 90 ft (27 m) long, which had been placed in a trench below ground level. On 30 May he noted a robber pit cut down through the mound. On 14 June he had his first sight of a collapsed wooden burial chamber situated amidships. On 10 July a new team was convened under Charles Phillips, a fellow of Selwyn College, Cambridge, to undertake the excavation of the burial chamber, and over the next 17 days Phillips and his colleagues recorded and lifted 263 objects from the chamber and mapped the traces of its timbers. But no body was found. The objects, which included some of the most spectacular finds from Anglo-Saxon England, were given

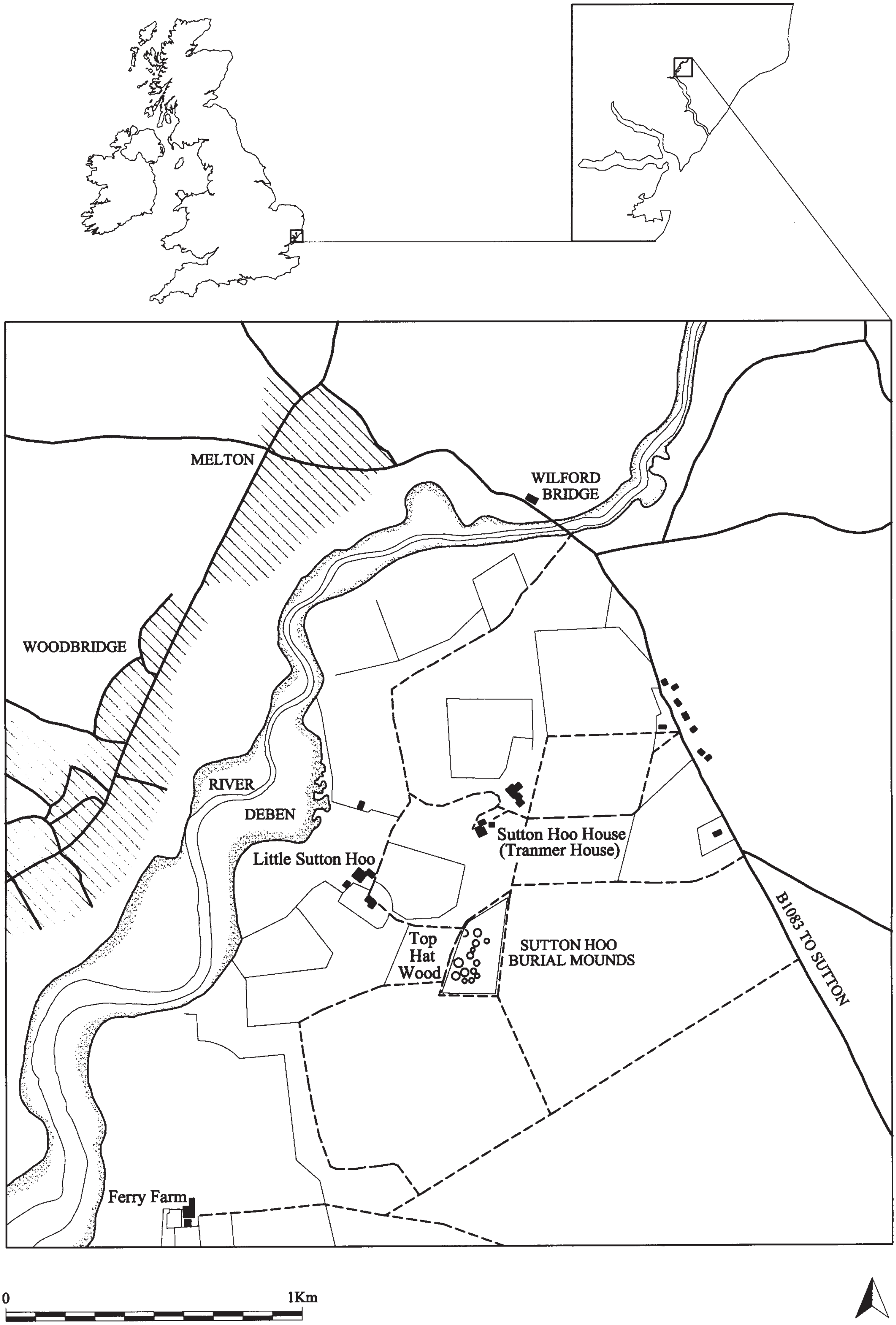


Figure 1 The situation of the Sutton Hoo cemetery.

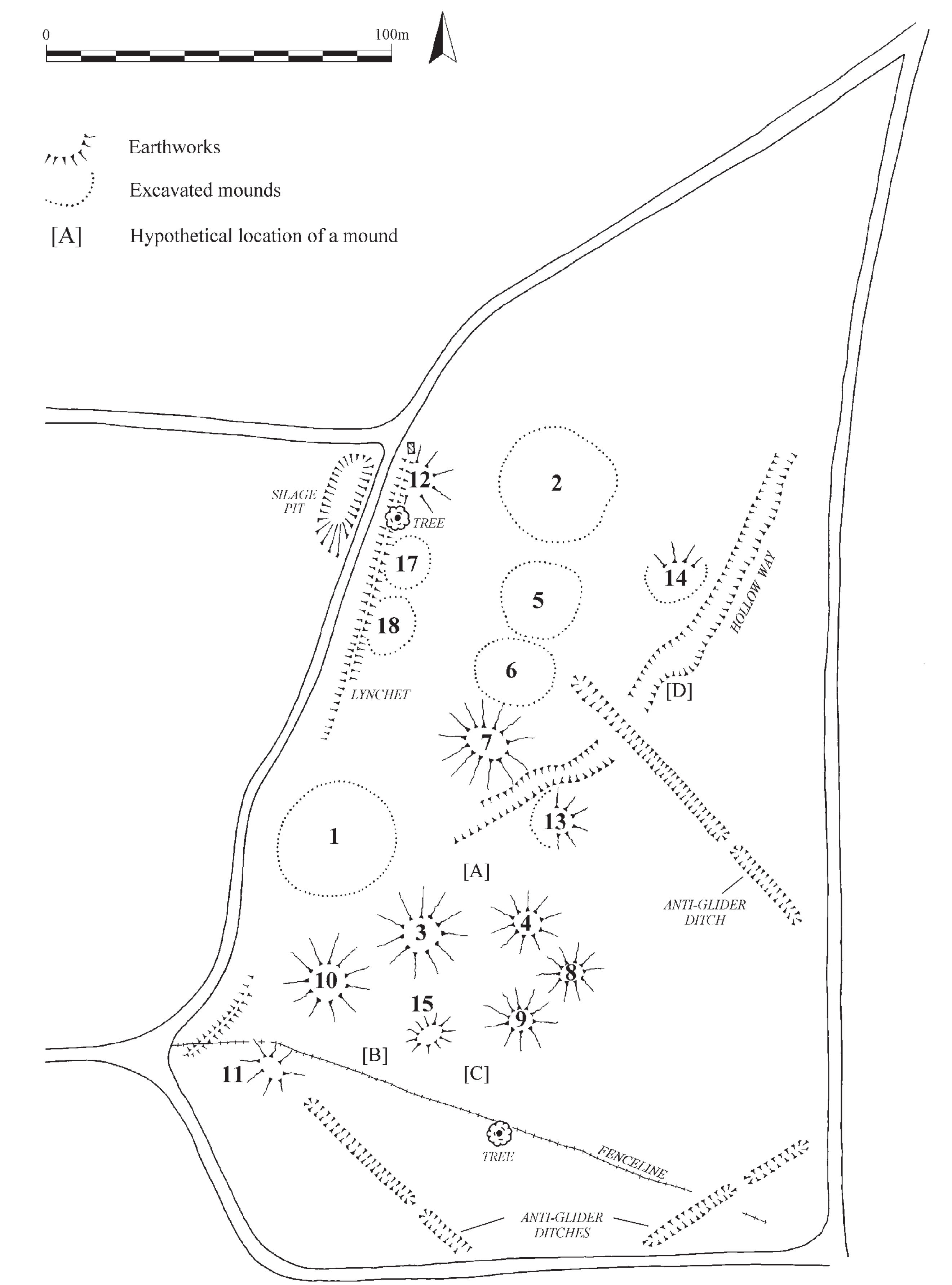


Figure 2 Map of the Sutton Hoo cemetery, showing numbered mounds. The current numbering is in bold. Letters in brackets are hypothetical locations for mounds: A= 'Mound 19', disproved 1991; B was numbered Mound 16 in SHSB I: fig. 4; C was numbered Mound 17 in SHSB I: fig. 4 – these mounds were excluded from the later BM handbook (Evans 1986: 15). Mounds 16, 17 and 18 were proposed in 1986. Mounds 17 and 18 were subsequently confirmed by excavation, but Mound 16 remains uncertain (= D on plan). Basil Brown also numbered the mounds: Mound 1 = 'Tumulus I'; Mound 2 = 'Tumulus D'; Mound 3 = 'Tumulus A'; Mound 4 = 'Tumulus E'.

Table 2
List of interventions at Sutton Hoo

	Date	Description	Field Report
Int. 1	1860	Survey of mounds and later and separate excavation of a mound by Mr Barritt (landowner). Reported in *Ipswich Journal* for 24 November 1860.	FR 2/3.1
Int. 2	1938	Excavation of Mound 3 by Basil Brown for Mrs Pretty (landowner) – Bruce-Mitford 1975: 100.	SHSB I: 100
Int. 3	1938	Excavation of Mound 2 by Basil Brown for Mrs Pretty (landowner) – Bruce-Mitford 1975: 100.	SHSB I: 100
Int. 4	1938	Excavation of Mound 4 by Basil Brown for Mrs Pretty (landowner) – Bruce-Mitford 1975: 100.	
Int. 5	1939	Excavation of Mound 1 by (1) Basil Brown, (2) Charles Phillips, (3) Cdr. Hutchison, instigated by Mrs Pretty (landowner) –Bruce-Mitford 1975: ch. 4.	FR 2/7.1
Int. 6	1965–7	Re-excavation of Mound 1 by R.L.S. Bruce-Mitford for British Museum (Bruce-Mitford 1975: ch. 4).	
Int. 7	1967–70	Excavation of spoil heaps and Mound 1 by P. Ashbee for British Museum (Bruce-Mitford 1975: ch. 4).	
Int. 8	1971	Excavation of a trench in the vicinity of Mound 1 by P. Ashbee for British Museum (unpublished).	
Int. 9	1971	Excavation of a trench in the vicinity of Mound 1 by P. Ashbee for the British Museum (unpublished).	
Int. 10	1971	Excavation of a trench in the vicinity of Mound 1 by P. Ashbee for the British Museum (unpublished).	
Int. 11	1966	Excavation of an area ('Area A') near Mound 17 by I. Longworth and I. Kinnes for the British Museum (Longworth and Kinnes 1980: 7–17).	
Int. 12	1970	Excavation of an area ('Area C') over Mound 5 by I. Longworth and I. Kinnes for the British Museum (Longworth and Kinnes 1980: 21–8).	
Int. 13	1968–9	Excavation of a trench ('Area B') east of Int. 12 by I. Longworth and I. Kinnes for the British Museum (Longworth and Kinnes 1980: 17–21).	
Int. 14	1968–9	Excavation of a trench ('Area B') east of Int. 13 by I. Longworth and I. Kinnes for the British Museum (Longworth and Kinnes 1980: 17–21).	
Int. 15	1968–9	Excavation of a trench ('Area B') east of Int. 14 (Longworth and Kinnes 1980: 17–21).	
Int. 16	1968–9	Excavation of a trench ('Area B') east of Int. 15 by I. Longworth and I. Kinnes for the British Museum (Longworth and Kinnes 1980: 17–21).	
Int. 17	1982	Recording by S. West for Suffolk Archaeological Unit of a fresh robber pit made in centre of Mound 11.	FR 2/7.3
Int. 18	1983–4	Surface mapping of plants over Zone A by A.J. Copp and J. Rothera for Sutton Hoo Research Trust.	FR 3/4
Int. 19	1983–4	Surface collection of artefacts over Zones D, E and F by A.J. Copp and C. Royle for Sutton Hoo Research Trust.	FR 3/4
Int. 20	1984	Excavation of 100 m long trench to the east of the burial mounds in Zone F by M.O.H. Carver for Sutton Hoo Research Trust.	FR 3/4
Int. 21	1984	Excavation of a trench across a buried anti-glider ditch in Zone F by M.O.H. Carver for Sutton Hoo Research Trust.	FR 3/4
Int. 22	1984	Excavation of a 100 m long trench to the south of the burial mounds in Zone D by M.O.H. Carver for Sutton Hoo Research Trust.	FR 3/4
Int. 23	1984	Re-excavation of a length of anti-glider ditch in Zone A by M.O.H. Carver for Sutton Hoo Research Trust.	FR 3/4
Int. 24	1984	Excavation of a trench in Top Hat Wood, Zone B, by M.O.H. Carver for Sutton Hoo Research Trust.	FR 3/4
Int. 25	1984	An attempt to smother vegetation over the area of Mound 5 preparatory to total excavation, by M.O.H. Carver for Sutton Hoo Research Trust.	FR 4/3.13
Int. 26	1984–5	Re-excavation of the central point of Basil Brown's trench across Mound 2 by M.O.H. Carver, A.C. Evans and G. Hutchinson for Sutton Hoo Research Trust.	FR 4/7.1
Int. 27	1983–4	Metal-detector survey of Zone A by C.L. Royle for Sutton Hoo Research Trust.	FR 3/4
Int. 28	1984	Magnetometer survey on pilot area in Zone F by M. Gorman for Sutton Hoo Research Trust.	FR 3/4
Int. 29	1984	Soil-sounding radar test on pilot area in Zone F and over Mound 2 and Mound 12 by M. Gorman for Sutton Hoo Research Trust.	FR 3/4
Int. 30	1983–4	Topographic survey of the burial mound (Zone A) by J. Bruce, E. Ingrams and M. Cooper for Sutton Hoo Research Trust.	FR 3/4
Int. 31	1984	Re-excavation of east edge of silage pit, Zone C, by M.O.H. Carver for Sutton Hoo Research Trust.	FR 3/4
Int. 32	1985	Excavation of an area in Zone F by M.O.H. Carver and P. Leach for Sutton Hoo Research Trust.	FR 8ii
Int. 33	1966	Topographic survey of the burial mounds by British Museum.	
Int. 34	1980	Topographic survey of the burial mounds by British Museum.	
Int. 35	1984	Fluxgate gradiometer survey over a pilot area in Zone F by A. Bartlett for Sutton Hoo Research Trust.	FR 3/4
Int. 36	1985	Resistivity survey over a pilot area in Zone F by R. Walker for Sutton Hoo Research Trust.	FR 3/4
Int. 37	1985	Phosphate survey over Zones D and F by P.A. Gurney for Sutton Hoo Research Trust.	FR 3/4
Int. 38	1986	Stripping and recording of Horizon 1 of an area in Zone F, north of Int. 32, by M.O.H. Carver for Sutton Hoo Research Trust.	FR 8ii
Int. 39	1986	Excavation of an area in Zone F east of Int. 32 by M.O.H. Carver for Sutton Hoo Research Trust.	FR 8iii
Int. 40	1986	A sieving experiment on the ploughsoil in Zone F, by M.O.H. Carver for Sutton Hoo Research Trust.	FR 8ii/3

Table 2 *continued*

Int. 41	1986–8	Excavation of an area in Zone A containing Mounds 2 and 5, by M.O.H. Carver and A.J. Copp, with A.C. Evans (Mound 5).	FR 4
Int. 42	1986	Establishment of a permanent l00 m grid over Zone A by C.L. Royle for Sutton Hoo Research Trust.	FR 3/2
Int. 43	1986	An experiment to determine the inorganic chemical signatures of deteriorated human remains by P. Bethell for Sutton Hoo Research Trust/Leverhulme Trust.	FR 9/71
Int. 44	1988–9	Excavation of an area in Zone A containing Mounds 6 and 7 by M.O.H. Carver and A.J. Copp, with A.C. Evans (Mound 7).	FR 5i
Int. 45	1988	Magnetic susceptibility survey: pilot studies in Zones A, D and F by C.L. Royle and A. Clark for Sutton Hoo Research Trust.	FR 3/6
Int. 46	1988	Soil-sounding radar survey over Mounds 6 and 7 (Zone A) by Oceanfix Ltd.	FR 3/6
Int. 47	1988	Resistivity survey (Zones A, D and F) by I. Lawson.	FR 3/6
Int. 48	1989–92	Excavation of an area on the west side of Zone A containing Mounds 17 and 18 by M.O.H. Carver and M.R. Hummler, with A. Roe (Mound 17) and A.C. Evans (Mound 18) for Sutton Hoo Research Trust.	FR 6
Int. 49	1989	Resistivity survey in Zones D and F by K. Clark for Sutton Hoo Research Trust.	FR 3/6
Int. 50	1990–1	Excavation of an area between Ints 32 and 41 containing Mound 14, by M.O.H. Carver and J. Garner-Lahire, with G. Bruce (Mound 14), for Sutton Hoo Research Trust.	FR 7
Int. 51	1991	Resistivity survey of northern half of Int. 50 prior to excavation by J. Dunk and I. Lawton for Sutton Hoo Research Trust.	FR 3/6
Int. 52	1991	Excavation of the trench between Int. 50 and Int. 32 by M.O.H. Carver and A.J. Copp for Sutton Hoo Research Trust.	FR 8i
Int. 53	1991	Excavation of a trench in the valley below Top Hat Wood (Zone G) to obtain environmental samples, by M.O.H. Carver for Sutton Hoo Research Trust.	FR 9/6.1
Int. 54	1991	Excavation of organic materials buried experimentally in Int. 43 to investigate their rate of decay, by P. Bethell for Sutton Hoo Research Trust.	FR 9/7.4
Int. 55	1991–2	Excavation of an area to the south of Mound 7, containing parts of Mounds 13, 3 and 4, by M.O.H. Carver and M.R. Hummler for Sutton Hoo Research Trust.	FR 5ii
Int. 56	1993	Reconstitution of the areas excavated and reconstruction of the original form of Mound 2 by M.O.H. Carver, A.J. Copp and P. Berry for Sutton Hoo Research Trust.	
Int. 57	1995	Topographic survey of burial ground (Zone A) and Top Hat Wood (Zone B) after the completion of excavations and consolidation of site, by A.J. Copp and FAS Ltd for Sutton Hoo Research Trust.	
Int. 58	1999	Geophysical survey of Tranmer House area (Zone E, north) by J. Garner-Lahire and FAS Ltd for National Trust.	
Int. 59	2001	Geophysical survey in areas north of Sutton Hoo and north of Tranmer House by Paul Linford, English Heritage, for Martin Carver.	*Centre for Archaeology Report* 12 (2002)

to the British Museum by Mrs Pretty, who was their legal owner under the Treasure Trove legislation then current.

The 1938–9 campaign was a heroic venture carried out in difficult circumstances on the eve of war. Full accounts of the investigations, the objects recovered and their detailed study and interpretation have been published elsewhere and are referred to frequently in this book (Bruce-Mitford 1974: 141–69 for Basil Brown's diary, henceforward BBD; Bruce-Mitford 1975 for the excavations, henceforward SHSB I; Bruce-Mitford 1978 and 1983 for the objects, henceforward SHSB II, III; Phillips 1987: 70–80 for a memoir by Charles Phillips; Evans 1986 and Carver 1998a for summaries).

The 1965–71 campaign

After the Second World War, Rupert Bruce-Mitford was appointed by the British Museum to study the findings at Sutton Hoo and particularly the great ship-burial. He directed the conservation and restoration of the artefacts and studied their context, analysed the excavation records and interpreted the burial rites that had been used. He also investigated the countryside surrounding Sutton Hoo and collected and assessed what was known about the nearby Anglo-Saxon sites at Rendelsham and Snape (Bruce-Mitford 1974; SHSB I–III). In 1965 the British Museum returned to the Sutton Hoo burial ground itself. The site was mown and surveyed, and the likely positions of 15 mounds were identified and mapped, with two other possibles (SHSB I: 6; Evans 1986: 15 for the latest BM plan).

The first objective was to complete the excavation of Mound 1, where the remains of the ship and chamber had been left in the ground, covered over with bracken (Int. 6). Under Bruce-Mitford's direction, the line of the ship was studied and surveyed and parts of it preserved in moulds (SHSB I: 230–302); the 1939 spoil heaps were sieved and thirty-five artefact-fragments were added to the overall inventory of finds (SHSB I: 455). The surviving parts of Mound 1 and the buried soil beneath it were excavated by Paul Ashbee (Int. 7; SHSB I: 303–44) and the original form of the barrow deduced. Traces of an extensive settlement of the Early Bronze Age (Beaker period) were mapped under the buried soil. Ashbee later cut three trenches across a boundary bank which ran north–south at the west end of Mound 1 (Ints 8–10) in the hope of establishing its date, which, however, remained elusive.

The second objective was to improve knowledge of the plan of the cemetery as a whole, by testing for mounds, flat graves or settlement in an area to the north of Mound 1. Excavations were undertaken in three areas by Ian Longworth and Ian Kinnes from the Department of Prehistoric and Romano-British Antiquities at the British Museum. Area A (Int. 11) was sited west of Mound 5, Area C (Int. 12) over Mound 5 and Area B (Ints 13–16) in four further trenches (Figure 3). In Area C, the existence of Mound 5 was confirmed, and a robbed burial pit was located beneath it, with three unfurnished inhumation graves adjacent (belonging to the Group 2 execution cemetery, see below). In Area A, a skull and some Anglo-Saxon artefact-fragments were found in a pit (Burial 56) and two cremations were excavated, one in an Anglo-Saxon pot (Burials 13 and 14). The skull was radiocarbon-dated to the eighth century AD. A major sequence of ditches was defined as belonging to the Early Bronze Age and traced through Areas A and C, and into B (Longworth and Kinnes 1980).

Bruce-Mitford initiated a large number of additional researches in connection with the site and its finds. Geoffrey Dimbleby studied the environmental history using sequences of soil pollen under Mound 1 and in Area A, and showed that the area had begun as oak woods and that there had been cereal cultivation before the mounds were built (SHSB I: 48). C. E. Everard showed that the water level of the Deben had been much the same in the seventh century as it was in the twentieth (SHSB I: 78). The absence of a body in Mound 1 was addressed by chemical analysis of objects and of new samples taken on site (SHSB I: ch. viii). Special studies were undertaken of the ship (Evans in SHSB I: 353–412), the coins (Kent in SHSB I: ch. ix) and all the artefacts (SHSB II, III). Bruce-Mitford also caused the site of the burial mounds to be registered as a Scheduled Monument in the protection of the Department of the Environment.

The conclusions of nearly forty years' work were published from 1975–83 (SHSB I–III and Longworth and Kinnes 1980). The site had been occupied in the Neolithic period, and there was a settlement in the Early Bronze Age. The site had been under the plough before the Anglo-Saxon period. The Anglo-Saxon cemetery was thought to have consisted of at least 15 mounds, many of which were reckoned to be still intact (SHSB I: 16–18), those with east–west depressions in their summits perhaps containing ships. Mound 1 had originally covered a sea-going, clinker-built ship about 27 m long placed in a trench. Amidships was a burial chamber, and in the chamber had been laid the body of a man provided with weapons, regalia and feasting equipment. The date of the burial, from the date of the coins and the style of the metalwork, was early seventh century. Sutton Hoo was seen as a 'royal' cemetery and Mound 1 as the grave of Raedwald, King of East Anglia, 599–624/5. Elsewhere in the cemetery were cremations under mounds (Mounds 3 and 4), a ship-burial (Mound 2), unfurnished cremations (Burials 13 and 14), and unfurnished inhumations (Burials 45, 50 and 51). The question of whether Sutton Hoo was also a folk cemetery (serving a whole community) and a settlement area was unresolved.

These studies stimulated and provided points of departure for much new research on early England, and there were consequent calls for more work. High on the agenda was a proposal, led by Rupert Bruce-Mitford, to renew excavations at the site of Sutton Hoo itself. The proposal was publicly launched at a conference on Anglo-Saxon cemeteries held in Oxford in 1979 (Rahtz, Dickinson and Watts 1980: 313–70). In cooperation with Rosemary Cramp (University of Durham), Philip Rahtz (University of York) and Mrs Pretty's son and heir, Robert Pretty, Bruce-Mitford eventually provoked an agreement between the Society of Antiquaries of London and the British Museum to support a new campaign of research. In early 1982, while these negotiations were in train, a clandestine dig took place on Mound 11 (Int. 17), offering a fortuitous reminder of the site's vulnerability (Plate 2). The new campaign was to be managed by an executive committee (later the Sutton Hoo Research Trust) chaired by the President of the Society of Antiquaries, then Christopher Brooke (University of Cambridge). The Committee announced its broad intentions in the *London Gazette* on 9 July 1982, and on 30 October appointed the author as its Director.

Plate 2 Mrs Tranmer, the landowner, inspecting damage to Mound 11 in 1982. Sutton Hoo (now Tranmer) House is just visible in the background (*East Anglian Daily Times*).

Findings of the 1983–2001 campaign

The circumstances and motivations that surrounded the initiation of the 1983 campaign are described (from the author's viewpoint) in Carver 1998a. Here I propose only to recount the work that was undertaken, its rationale, its results, how they were recorded and where they will be found in this book. A key to the abbreviations and glossary of terms used is in Table 1.

Design

The first three years (1983–5) of the new campaign were dedicated to evaluation and design. Published sources were studied, principally the official account of previous excavations (SHSB I–III), and Bruce-Mitford himself briefed the new Director. Additional consultation was sought by means of a sequence of Sutton Hoo Seminars, attended by scholars from England and overseas. The site was mown, managed and surveyed, and test excavations were carried out, mainly in disturbed areas. It was now thought that a total of eighteen mounds could be located (Figure 2). The area around the barrow-cemetery was also intensively surveyed (Ints 18–31).

As a result of this learning process, a project was designed. It would be aimed principally at the history of the Early Medieval cemetery, and the history of Early Medieval settlement in the area. This history would be related to that of the early kingdom

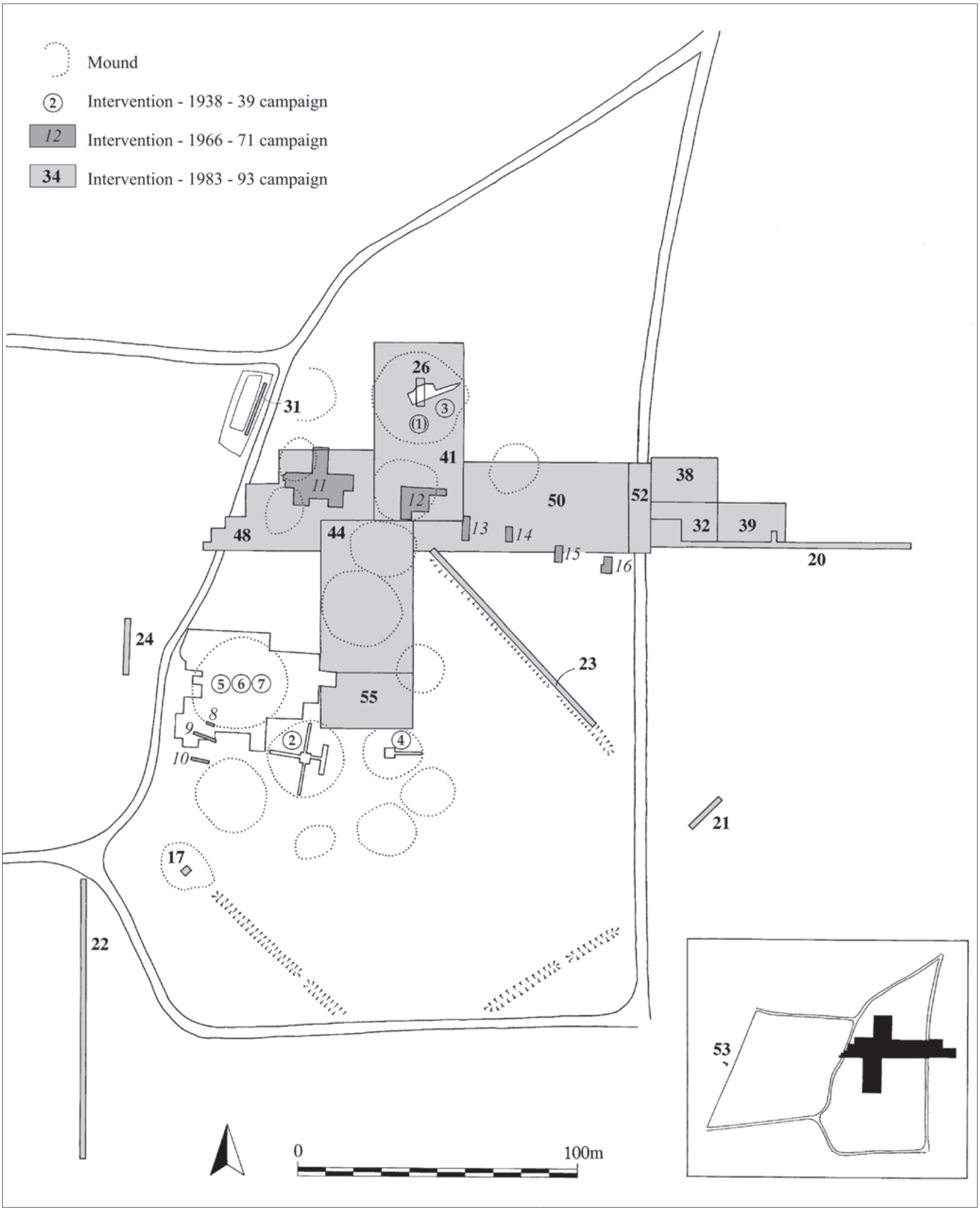


Figure 3 Map of the Sutton Hoo cemetery showing the location of interventions.

of East Anglia, and of the early kingdoms expected to have formed among the peoples living along the coastline of the North Sea in the period of the sixth to eighth centuries. The programme would comprise the excavation of 1 hectare of the cemetery, together with surveys around it and in the Deben Valley. It would also address the question of the long-term management and presentation of the site. The project design was published in 1986 (*Bull.*: 4) and is summarized in Chapter 2.

The proposed field programme was carried out over the next seven years (1986–92; Ints 32, 41, 44, 48, 50 and 52; Colour Plates 1 and 2). Six burial mounds (Mounds 2, 5, 6, 14, 17 and 18) were completely excavated, and two (Mounds 7 and 13) had only their quarry ditches and robber trenches excavated. A hectare of ground between the mounds was examined and 2000 features were recorded, 70 per cent of them Prehistoric in date. The excavation was completed and back-filled in 1992, and analyses and surveys continued until 2001. The field programme and the analyses undertaken are reviewed in Chapter 3.

The Early Medieval cemetery

The new discoveries and researches on the Early Medieval cemetery are presented in Part II. Mounds 5, 6, 7 and 18 had covered cremations, originally in bronze bowls. They are described in Chapter 4, in which the previously discovered cremations (in Mound 3 and 4, Burials 13 and 14) are also re-assessed. Five new furnished inhumation burials were excavated. Mound 14 was the robbed burial of a woman in a chamber grave. Mound 17 had covered the un-robbed burial of a young man with weapons and an ornamented bridle. A horse lay in a parallel and adjacent pit. Burials 12, 15 and 16 were simple, barely furnished inhumations to the east of Mound 5. The 'skull pit' excavated in 1966 (Burial 56; Int. 11) was re-interpreted. These furnished inhumations are brought together in Chapter 5. The excavation of Mound 2 showed that the robbed burial here was the chamber grave of a man provided with weapons and feasting equipment, which had been covered by a ship about 24 m long. It was comparable to the Mound 1 burial in style and wealth. The evidence for the Mound 1 burial (Int. 5 and 6) was also revisited in the light of the 1983–92 experience, and new models were proposed for the formal layout in the chamber. Sutton Hoo's two known ship-burials are presented together in Chapter 6.

The Early Medieval artefacts recovered during the 1983–92 campaign were neither numerous nor especially glamorous, but they do include the first complete Anglo-Saxon horse-harness. Many of the objects from the other mounds were very fragmentary: pieces of corroded grave goods abandoned in the pits and trenches of robbers. The artefacts have been conserved by the British Museum, and have been researched and presented by Angela Evans (Chapter 7). In the same chapter are the results of researches on bone from the burials (by Frances Lee on the human bone, Julie Bond on the animal bone and Terry O'Connor on the horse from Mound 17). In Chapter 8 the Sutton Hoo burial rites are reviewed – with assessments of their date, local and international affiliations and likely order of enactment – making use of additional research by Christopher Fern. Furnished burial at Sutton Hoo is shown to have been concentrated in the seventh century.

In addition to the sixteen furnished burials under and beside mounds, thirty-nine unfurnished inhumation graves were found located in two groups. Group 1, with twenty-three burials, was situated at the eastern edge of the burial ground; Group 2, with sixteen burials, was situated around Mound 5. Both groups contain examples of execution by hanging or beheading. They are dated within the period of seventh to twelfth centuries by radiocarbon, and are assigned by additional arguments to a period from the eighth to the eleventh century. A study of these burials and a consideration of why they should be found at Sutton Hoo are contained in Chapter 9.

A list of all the mounds and burials found so far at Sutton Hoo will be found in Table 3.

Context studies

The context of the Early Medieval cemetery was studied in a number of projects presented in Part 3. The environmental sequence is the subject of Chapter 10. Steve Rothera surveyed the existing flora, Rob Scaife chronicled the pollen sequence off-site in the Deben valley, and Charlie French used micromorphology to write a history of the soils beneath the mounds. This work enhanced the results obtained by Dimbleby in the 1965–71 campaign, and was correlated with the on-site stratigraphy to assist understanding of how the archaeological deposits had formed.

The Prehistoric sequence that preceded the Early Medieval cemetery was studied by Madeleine Hummler (Chapter 11). She found that, although the Prehistoric layers were very disturbed, settlement areas and boundaries could be mapped in some detail, making use of over a hectare of excavation and some 10 hectares of field survey. The slightly better preservation of pits and post-holes within buried soils under the mounds allowed ploughed-out structures to be inferred elsewhere. The sequence thus obtained begins with settlement zones 70 m apart in the Neolithic, and sees a major transformation of the land in the Early Bronze Age, with large-scale boundaries and settlement zones 50 m apart. New land divisions arrive in the Iron Age: the familiar 'Celtic fields', which here survived as earthworks that influenced the siting of the later burial mounds. The overall sequence shows an oscillation between arable and pastoral farming, which was to resume in the Middle Ages and continue thereafter.

The afterlife of the burial mounds is reviewed in Chapter 12, which concentrates on unravelling the date and outcome of the two looting or excavation campaigns that had been rediscovered and recorded on site. The argument also relies on new researches into the documentary and cartographic history of the local landscape, its tracks, fields and landowners. The chapter ends at the point when the site was handed over to the National Trust for England and Wales, the body that now owns and manages it.

The local historic landscape, researched archaeologically, also provided an important context for the Early Medieval burial ground. In 1984 the Sutton Hoo Research Trust initiated a survey of the Deben Valley, which was carried out by John Newman of the Suffolk County Council Archaeological Unit (Chapter 13). Over six years, he walked all accessible fields in the sample area, mapping Prehistoric, Roman, early, middle and later Saxon pottery-scatters. He demonstrated changes in the settlement pattern at the time the Sutton Hoo burial ground began, in the late sixth to early seventh centuries. Adjacent to Sutton Hoo House (now Tranmer House), and 400 m north of the burial mounds, an Anglo-Saxon cemetery of the sixth century was discovered in the year 2000, during excavations in advance of the construction of a Visitor Centre for the National

Table 3

Investigated mound-burials

<table>
<tr><th>Burial no.</th><th>Mound</th><th>Burial type</th><th>Orientation</th><th>Structure/container</th></tr>
<tr><td>Burial 1</td><td>Mound 1</td><td>inhumation, ship-burial</td><td>west–east</td><td>coffin (?) in a chamber in a ship</td></tr>
<tr><td colspan="5">This was richly furnished with weapons, regalia and feasting equipment. There was an attempted robbing c. 1600. It was discovered intact and excavated in 1939 (Int. 2), re-excavated 1966–71 (Int. 5–10), and published in Bruce-Mitford 1975, 1978 and 1983.</td></tr>
<tr><td>Burial 2</td><td>Mound 2</td><td>inhumation, ship-burial</td><td>west–east</td><td>chamber beneath ship</td></tr>
<tr><td colspan="5">Original grave-goods included a sword, a shield, a gilt belt-buckle (?), a silver buckle, a drinking horn, a tub, an iron-bound bucket, a cauldron (?), a bronze bowl, a blue glass jar, a silver-mounted box, a silver-mounted cup, five knives in sheaths, and textiles. It was robbed c.1600 and in 1860 (Int. 1), and re-excavated in 1938 (Int. 3, Bruce-Mitford 1975) and 1986–9 (Int. 26, 41).</td></tr>
<tr><td>Burial 3</td><td>Mound 3</td><td>cremation</td><td></td><td>wooden tray or dug-out boat</td></tr>
<tr><td colspan="5">A cremated man and horse. Original grave goods included incised a limestone plaque, bone facings, a bronze ewer lid, a francisca, a comb, and textile. It was robbed c.1600, and re-excavated 1938 (Int. 2, Bruce-Mitford 1975).</td></tr>
<tr><td>Burial 4</td><td>Mound 4</td><td>cremation</td><td></td><td>under cloth in a bronze bowl</td></tr>
<tr><td colspan="5">A cremated man, woman and horse. Original furnishing included playing pieces. Robbed c.1600, and re-excavated 1938 (Int. 4, Bruce-Mitford 1975).</td></tr>
<tr><td>Burial 5</td><td>Mound 5</td><td>cremation</td><td></td><td>under cloth in a bronze bowl</td></tr>
<tr><td colspan="5">The cremation of a young person (sex indeterminate) with a blade injury. Original grave goods included playing pieces, iron shears, a silver-mounted cup, a comb, a knife in sheath, an ivory fragment, glass fragments, and horse and sheep. Robbed c.1600 and c.1860, and re-excavated 1970 (Int. 12, Longworth and Kinnes 1980) and 1988 (Int. 41). It is surrounded by satellite burials of Group 2.</td></tr>
<tr><td>Burial 6</td><td>Mound 6</td><td>cremation</td><td></td><td>under cloth in a bronze bowl</td></tr>
<tr><td colspan="5">The cremation of an adult (sex indeterminate). Original grave goods included combs, gaming pieces, sheep, goat, pig, cattle, possibly horse and probably a sword-pyramid (found on the surface). Robbed c.1860, and re-excavated 1989–91 (Int. 44).</td></tr>
<tr><td>Burial 7</td><td>Mound 7</td><td>cremation</td><td></td><td>under cloth in a bronze bowl</td></tr>
<tr><td colspan="5">The cremation of an adult (sex indeterminate). Original furnishing included facings from a bone casket, a cauldron, gaming counters, a silver-gilt fragment, horse, cattle, sheep, pig, red deer and probably a reticella glass bead (found on the surface). Robbed c.1600 and c.1860, and re-excavated 1990–1 (Int. 44).</td></tr>
<tr><td>Burial 8</td><td>Mound 14</td><td>inhumation</td><td>probably west –east</td><td>in a chamber, possibly on a bed or couch</td></tr>
<tr><td colspan="5">Probably the inhumation of a woman. Original grave goods included silver cup- and box-fittings, a purse-frame and a châteleine. Robbed c.1600, and re-excavated 1991 (Int. 50).</td></tr>
<tr><td>Burial 9</td><td>Mound 17</td><td>inhumation</td><td>west–east</td><td>in coffin</td></tr>
<tr><td colspan="5">The inhumation of a man. Grave goods include a sword, a purse, a bronze buckle inlaid with garnets, spears, a shield, a bucket, a cauldron, a ceramic pot, a ‘haversack’ containing sheep ribs, and a bronze bowl. The harness, saddle and tub were placed at the west end. Excavated in 1991 (Int. 48).</td></tr>
<tr><td>Burial 10</td><td>Mound 17</td><td>horse burial</td><td></td><td></td></tr>
<tr><td colspan="5">The inhumation of a horse in a pit without grave goods. Excavated in 1991 (Int. 48).</td></tr>
<tr><td>Burial 11</td><td>Mound 18</td><td>cremation</td><td></td><td>in a bronze bowl under cloth</td></tr>
<tr><td colspan="5">The original assemblage included a bone comb. It was disturbed by robbing and ploughing, and re-excavated in 1989 (Int. 48).</td></tr>
</table>

Other possible mound-burials or furnished graves

<table>
<tr><th>Burial no.</th><th>Mound</th><th>Burial type</th><th>Orientation</th><th>Structure/container</th></tr>
<tr><td>Burial 12</td><td></td><td>inhumation</td><td>north-west to south-east</td><td>in a coffin</td></tr>
<tr><td colspan="5">The burial of a child. It was furnished with an iron spearhead (or arrow head), a bronze buckle and a bronze pin, and was originally beneath a mound. Excavated in 1987 (Int. 41).</td></tr>
<tr><td>Burial 13</td><td></td><td>cremation</td><td></td><td>none</td></tr>
<tr><td colspan="5">Excavated in 1966 (Int. 11/Aiii; Longworth and Kinnes 1980), it is undated.</td></tr>
<tr><td>Burial 14</td><td></td><td>cremation</td><td></td><td>in pottery urn</td></tr>
<tr><td colspan="5">Excavated in 1966 (Int. 11/Aiv; Longworth and Kinnes 1980). Dated to the sixth to seventh century by the pot.</td></tr>
<tr><td>Burial 15</td><td></td><td>inhumation</td><td>west–east</td><td>in a coffin, extended on its back</td></tr>
<tr><td colspan="5">This was furnished with two bronze buckles and a knife in a sheath (Int. 50).</td></tr>
<tr><td>Burial 16</td><td></td><td>inhumation</td><td>west–east</td><td>in a coffin, extended on its back</td></tr>
<tr><td colspan="5">Furnished with a bronze needle-case, a châteleine, a ring-headed pin and a perforated white bead (Int. 50).</td></tr>
<tr><td>Burials 17–39</td><td>unfurnished inhumations</td><td>Group 1</td><td>execution burials</td><td></td></tr>
<tr><td colspan="5">Dated seventh to thirteenth century.</td></tr>
<tr><td>Burials 40–55</td><td>unfurnished inhumations</td><td>Group 2</td><td>execution burials</td><td></td></tr>
<tr><td colspan="5">Dated seventh to thirteenth century.</td></tr>
<tr><td>Burial 56</td><td></td><td>a displaced skull</td><td></td><td></td></tr>
<tr><td colspan="5">This was in a pit, and was excavated in 1966 (Int. 11, Pit 1; Longworth and Kinnes 1980). It probably represents an inhumation under a mound which had been robbed. The original assemblage included a glass bead and a bronze fitting.</td></tr>
</table>

Mounds unexplored in modern times

Mounds 8, 9, 10 (possibly robbed), 11 (attempted robbing 1982, Int. 17), 12, 13 (robbed in nineteenth century, and sectioned in 1991–1, Int. 44/55), 15 (not securely located), 16 (not securely located) and 19 (shown not to have existed).

Trust (the Tranmer House cemetery Bromeswell 018, see Chapter 13). This cemetery contained both inhumations and cremations, and it may have spread further into the fields to the north in Bromeswell parish, where a decorated Byzantine bucket was ploughed up in 1986.

Chapter 14 defines a still larger context for the Sutton Hoo cemetery and its mound-burials: in Suffolk, in East Anglia, in England and in the North Sea region. There seems to be a flourishing of large rich mounds in the early seventh century, not only in Suffolk but also further afield in Europe, which the author has linked with resistance to the Christian missions. The Sutton Hoo cemetery is seen as a group of princely burials commemorating pagan leaders and their families on the eve of the conversion of East Anglia. It is not excluded that some of these leaders may have been styled or remembered as kings.

Changes to interpretations previously published by the author

Chapter 14 represents a synthesis belonging to its time, and it will be revised and refashioned by future scholars, who will hopefully find their arguments assisted by this book. The present interpretation itself updates several previous accounts that have appeared in interim reports. For readers of these earlier versions, there follows a short list of published interpretations that have since been modified.

Early Medieval princely cemetery

A radiocarbon date has been received for the horse from Mound 17 of between 596–660 AD cal. This date, as well as new studies of the objects and the burial rite (Chapters 7 and 8), has suggested that Mound 17 is one of the later, rather than (as supposed in Carver 1992a: 364–5) one of the first, burials. The coffin in Mound 17 is now thought to be a tree-trunk, rather than (as in Carver 1998a: 112, fig. 69) a plank, coffin. A new reconstruction of the bridle will be found in Chapter 7, p. 235. This is based on strap-widths, has buckles on the reins and omits the martingale of Carver 1998a: 113. The coffin in Mound 1 is now thought to be a tree-trunk, not a plank (as in Carver 1998a: 127–31), coffin, and is presented here as only one of three options for the layout of the burial in the Mound 1 chamber (Chapter 6).

Execution cemetery

Human sacrifice (suggested in Carver 1992a: 355) remains improbable, as argued in Carver 1998a: 140, 168 and here (Chapter 9).

The earliest execution could be after Mound 5 had grassed over, and does not need to be contemporary with its construction (as in Carver 1998a: 139). According to the radiocarbon dates, executions could have happened between the mid seventh and the early thirteenth centuries, but are assigned here to a period between the eighth and the tenth.

Prehistoric period

The boundary ditches are Early Bronze Age (not Late Neolithic to Early Bronze Age, as in *Bull. 8*: 2).

Robbing and ploughing

The first ploughing and robbing after the mounds were built is here assigned to the sixteenth century, or at any rate before 1601, with the robbing following the ploughing. The excavation campaign of about 1860 was followed by resumed ploughing.

Sutton Hoo resources

The original *Field Records* made on site during all the archaeological campaigns at Sutton Hoo have been deposited in the British Museum, where they may be consulted in the Department of Medieval and Modern Europe. They comprise many thousands of notebooks, context cards, drawings and photographs (for the structure of the field records, see Guide to the Field Reports and the Field Records, p 505). All the finds, including the 85,000 finds from the most recent campaign, are also the property of the British Museum. The records include several kilometres of 16 mm film made on site by the BBC for their television programmes. Four films have been made and broadcast from this material: *The Million Pound Grave* (August 1985), *New Beginnings* (August 1985), *The Last of the Pagans* (April 1987) and *Sea Peoples* (August 1989).

Detailed *Field Reports* were written for each intervention in the 1983–2001 campaign by the appropriate supervisor. These reports represent the critically assessed versions of the data gathered on site and were used to write this book (which is designated as the *Research Report*). The *Field Reports* also contain all the specialist reports as originally delivered, an index to all the finds and records of analyses undertaken, whether useful or not. The *Field Reports* will be found online at the Archaeological Data Service (http://ads.ahds.ac.uk; see Guide to the *Field Records* and the *Field Reports*). References to the *Field Reports* will be found throughout this book in the form FR 4/7.3, meaning *Field Report* volume 4, section 7, paragraph 3. For an index to the *Field Reports* see the Index at the end of this book.

The results of each season of fieldwork were published in a series of *Bulletins of the Sutton Hoo Research Committee* 1–8 (1983–93), Boydell Press, Woodbridge – referred to here in the form *Bull.*, as in *Bull.* 4: fig. 5.

The excavations of 1938–83 (Mounds 1–4) are published comprehensively in SHSB I–III, and are summarized in Evans 1986. The campaign of 1983 is summarised in Carver 1998a.

Since 1998, the Sutton Hoo site has been owned and managed by the National Trust, which entertains visitors at a visitor centre and museum, opened by the poet Seamus Heaney in 2002. Visitors are shown round by the Sutton Hoo Society, whose website www.suttonhoo.org contains details of how to visit the site and how to access other resources – pictures, discoveries, information and ideas – intended for those who want to know more about what happened at Sutton Hoo.

Chapter 2

Project design (1983–6)

Evaluation, and the resulting research and management programmes

Martin Carver

Aim

The purpose of the design phase was to decide objectives for the project and to choose areas and methods for excavation and survey. In brief, to decide what we wanted to know and how we might come to know it. An additional but related aim was to ensure the long-term security of the site and its public appreciation.

There were four stages to the design phase:

1 to draw up a list of academic targets, a *research agenda*
2 to survey the site in depth and to produce an image of what remained there, a *deposit model*
3 to match the research agenda to the deposit model, to see which of the research objectives were achievable in practice
4 to consult with scholars and members of the public who had an interest in the outcome

This work resulted in a *project design*, first published in *Bull.* 4. It proposed two programmes:

- The *research programme*, with the areas for excavation and survey
- The *management programme*, with measures for the conservation of the monument and its presentation to the public.

The project design was accepted by the Sutton Hoo Research Trust on 4 December 1985 and was has not been substantially altered thereafter. It was then carried out in practice, with a few exceptions mentioned in Chapter 3.

Research agenda

The discoveries made at Sutton Hoo before 1983, and their comprehensive publication by the British Museum, had awakened numerous questions in the scholarly community, on topics that ranged from the very general to the over-particular. To know something of the early English was an aim to which all could subscribe; but knowing the names of the people buried in the mounds was a desire that archaeology would be unlikely to satisfy.

A high-status burial ground would probably reflect the organization and ideology of a community. The burial discovered in Mound 1 belonged to a period in English history, that of the Christian conversion, when ideological change was in the air, and was likely to have been accompanied by political and economic changes. These changes might be reflected in changing burial practice in the cemetery, provided that levels of investment were continuously high. If investment was withdrawn from the cemetery the changes might appear instead, for example, in buildings and settlement. The strategy for new research would therefore need to address both the history of burial rites in the cemetery and the history of settlement beyond it (Carver 1986).

Other parts of the research agenda related to the fact that Sutton Hoo was a Prehistoric site, that it was a rare surviving piece of grassland in an intensively cultivated area and that it formed part of the long-term study of the history of Suffolk. The Prehistoric site might be a settlement of the Beaker period, a period for which there are fewer known examples of settlements than monuments and burials (Ellison in *Bull.* 4: 39). Opportunities for improving knowledge of the environmental sequence would bring dividends for the management of the area as well as for knowledge of its past. In this case there seemed to be some doubt about when cultivation had first occurred and podzolization had ensued, information probably obtainable from the study of the buried soil under mounds. The strategy therefore included excavation and survey on a scale appropriate to the mapping of the Early Bronze Age settlement and the examination of the buried soil under mounds.

An additional area of research was perhaps especially rooted in the current context of archaeological practice. Much of the field archaeology community was of necessity dedicated to rescuing sites, the fail-safe prescription of the cultural resource management system of the time. This contract work was undertaken by archaeological companies that had little time or opportunity to develop research-led projects. The Sutton Hoo Research Trust was keen to field a project that was not only led by research but which also contributed to the development of field archaeology in a more general way. The agenda was to include developing new approaches to the fieldwork process (beginning with the evaluation itself), chemical experiments, trials of different remote mapping and excavation techniques, and new methods of recording. A number of these techniques were applied to the deposit-modelling exercise to be described next. Some of them are now common practice or were previously tried but not published, so their description here may have a mainly historic value – which will hopefully be accepted as a value none the less.

Plate 3 The surface of the turf at the north end of the scheduled area, after mowing, showing lynchet S31 overlying Mound 12 (to the right of the tree), Mound 17 (to the right of the furthest scale) and Mound 18 (to the right of the centre scale).

Deposit model

The purpose of making the deposit model (or *resource model*) was to discover as much as possible about the buried strata using, where they existed, methods which would not disturb the ground (here termed 'remote-mapping methods'). A research area of about 20 ha. was defined with the barrow-cemetery at its centre and divided into *zones* (Figure 4; Colour Plate 1). These zones reflected the variations in topography and current vegetation of the land, which would in turn differently affect what had survived underground and our ability to see it. Zone A was the scheduled area and contained the burial mounds. Zone B and C were in Top Hat Wood, a copse with thick undergrowth and a breeding area for pheasants. There was a flat spur at the top (Zone B) and the land then sloped sharply down towards the river. Zone D was under a crop of potatoes. Zone E had a new plantation of young trees at its southern end, followed by a series of tracks, the garden of Sutton Hoo House and a field as it followed the line of the scarp. Carrots were grown in Zone F. Zone G was an area of light woodland and meadow that was not evaluated. The techniques used were surface collection, floral mapping, phosphate survey, geophysical survey (including radar) and test excavation (using pre-existing holes where possible).

Zone A was the Scheduled Monument, which was under the legal protection of the state, but in 1983 was overgrown with

Plate 4 The surface at the north end of the scheduled area, illuminated by oblique lighting at night.

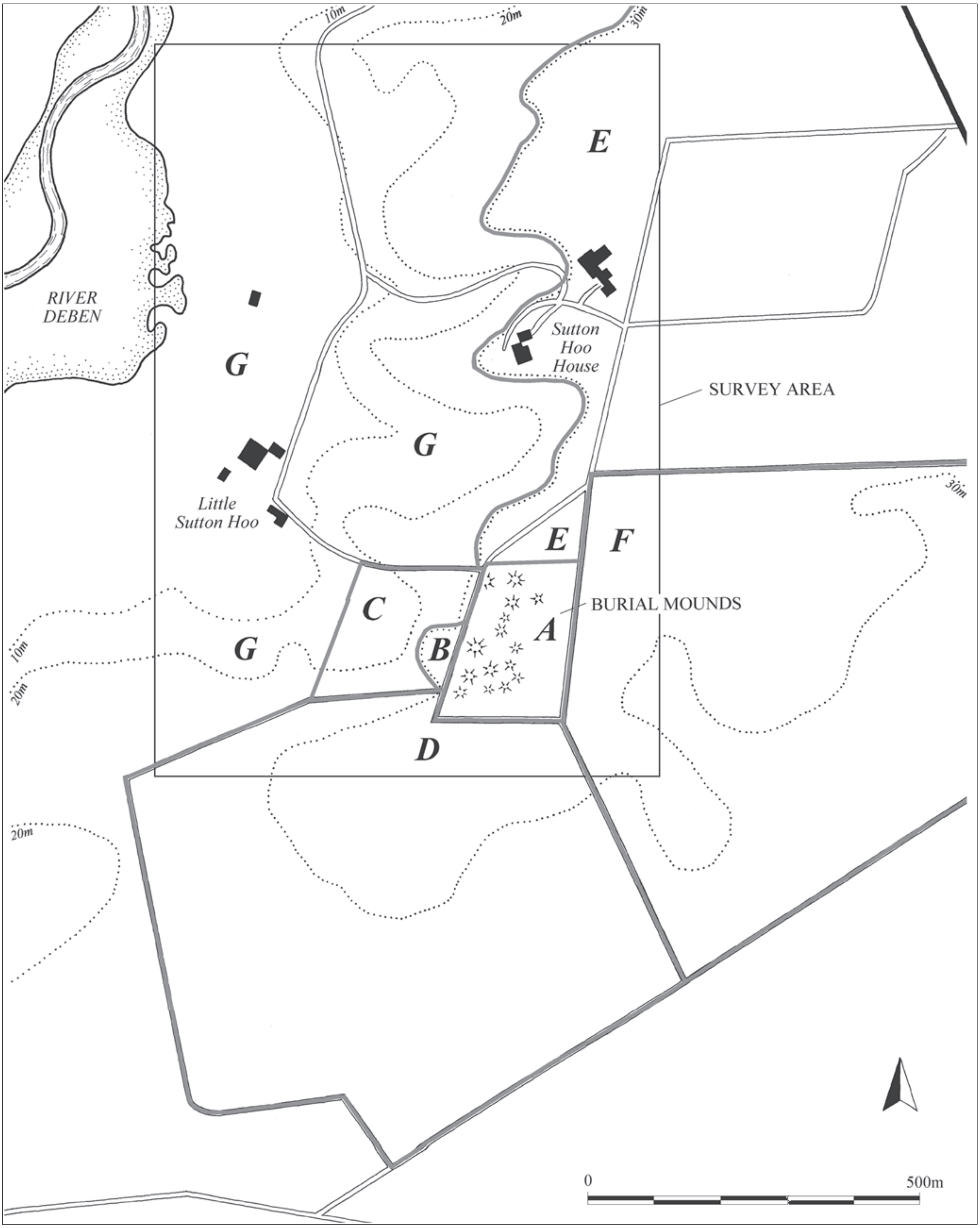


Figure 4 The zones used in preparing the deposit model. A: The scheduled area, initially overgrown by bracken, latterly under grass. B: Top Hat Wood, conifers and thick undergrowth; the spur opposite Mound 1. C: Top Hat Wood, the remaining part. D: the south field, under cultivation for potatoes. E: a new plantation of trees. F: the east field, under cultivation for carrots. G: the west field, below Top Hat Wood.

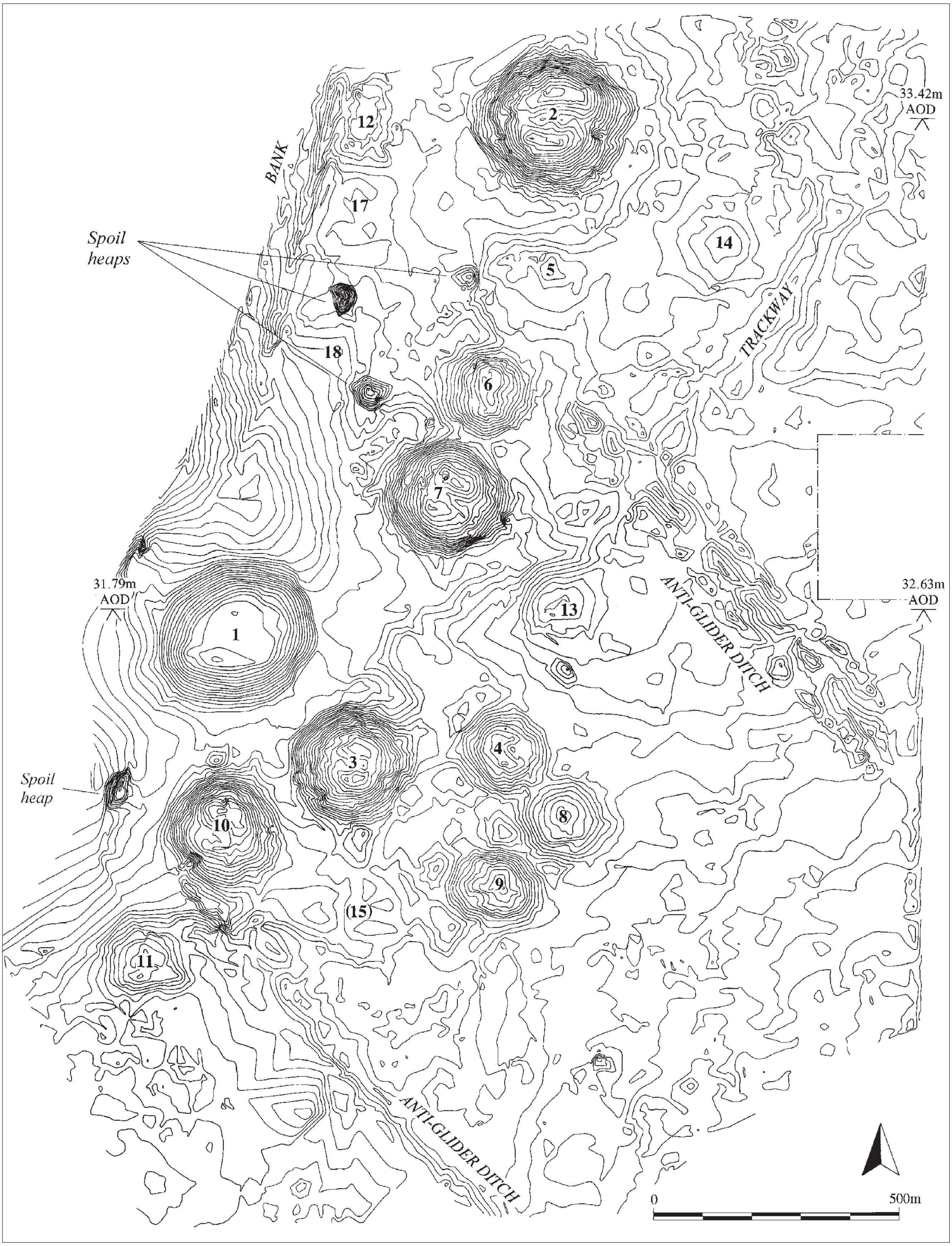


Figure 5 Contour survey of Zone A before excavation. Contours at 100 mm vertical intervals. Survey by Bruce, Ingrams, Cooper and Royle.

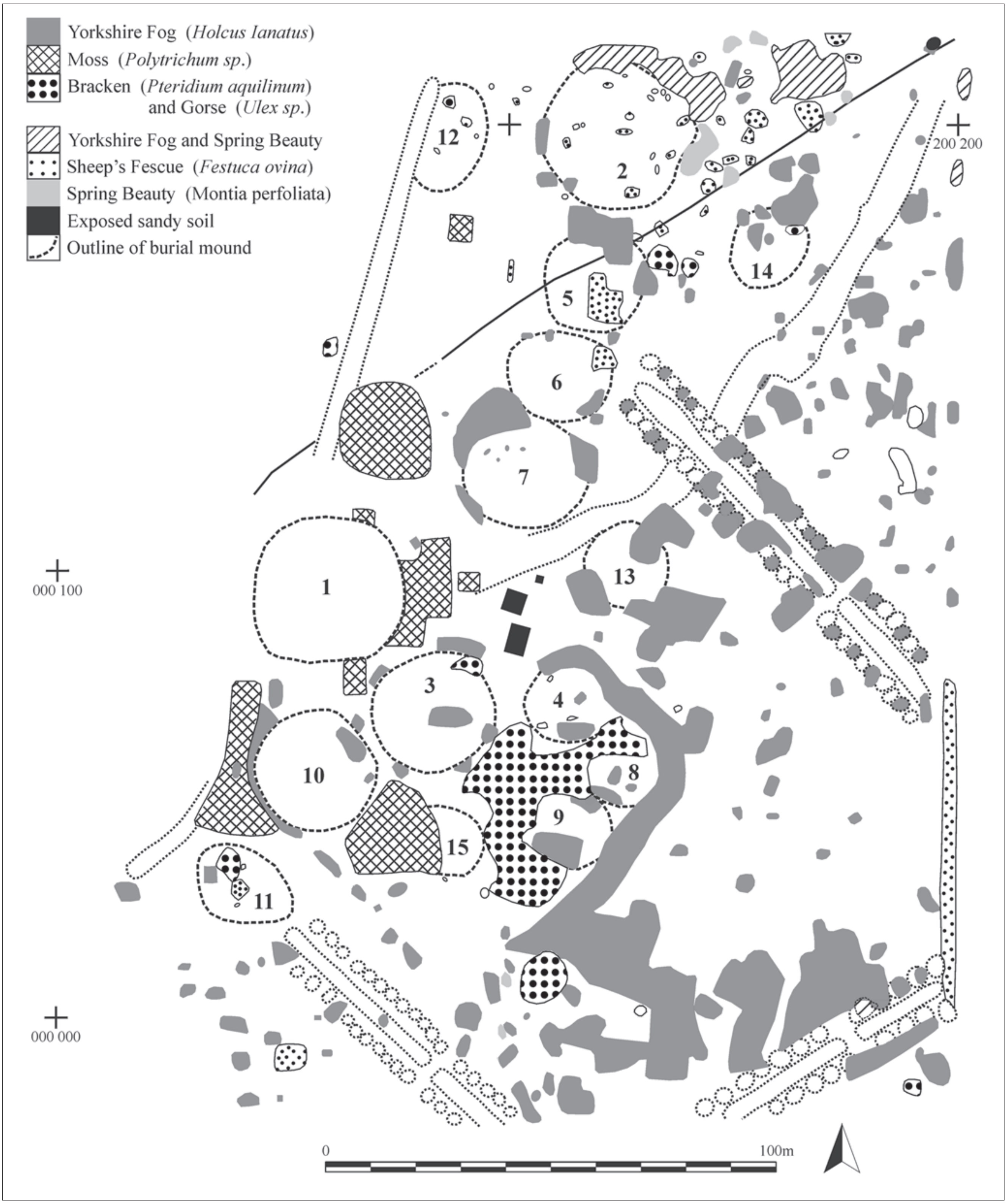


Figure 6 Surface mapping. The differential growth of vegetation observed and recorded in 1984. See Rothera, Chapter 10, for an inventory of the recorded species. Survey by Copp.

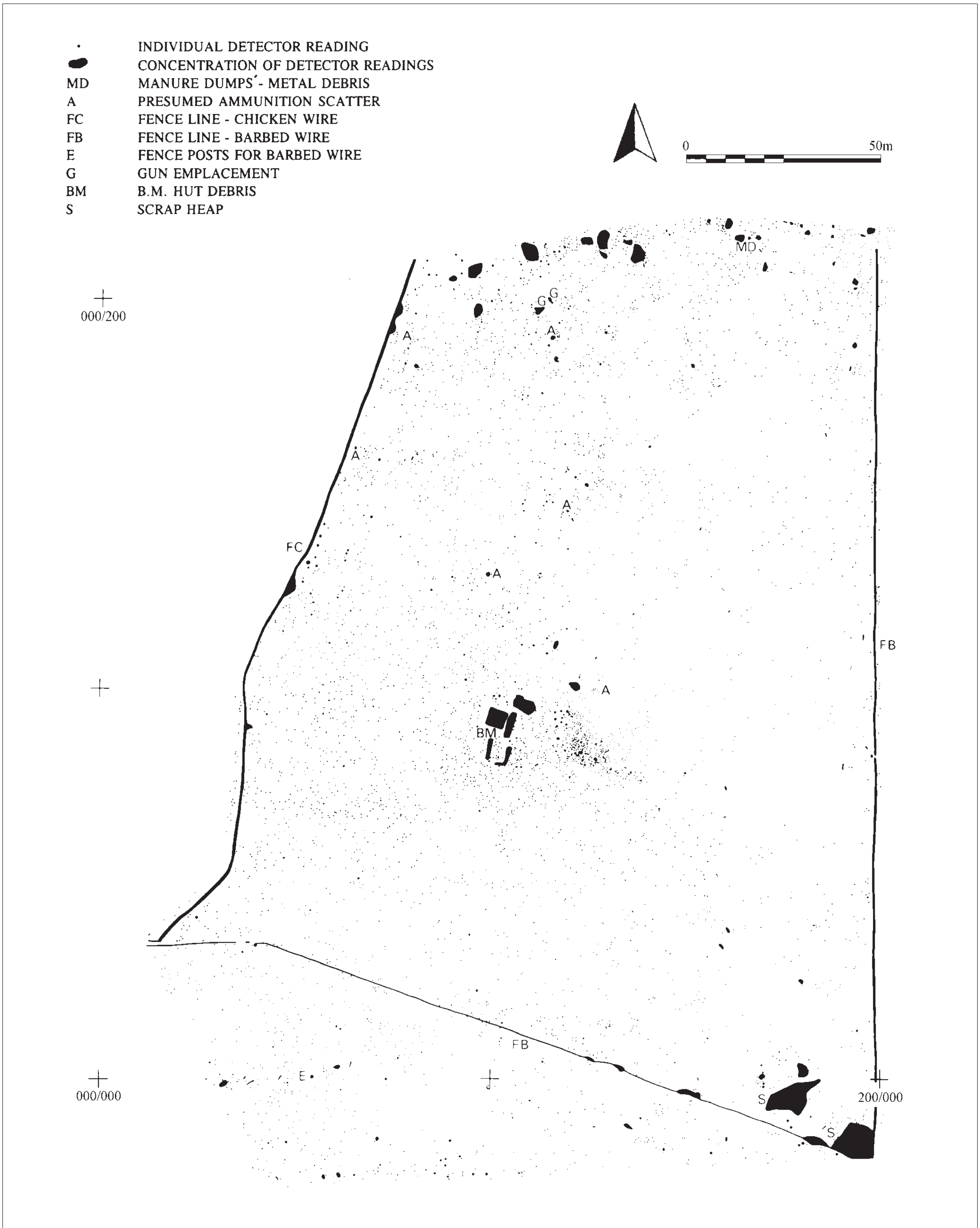
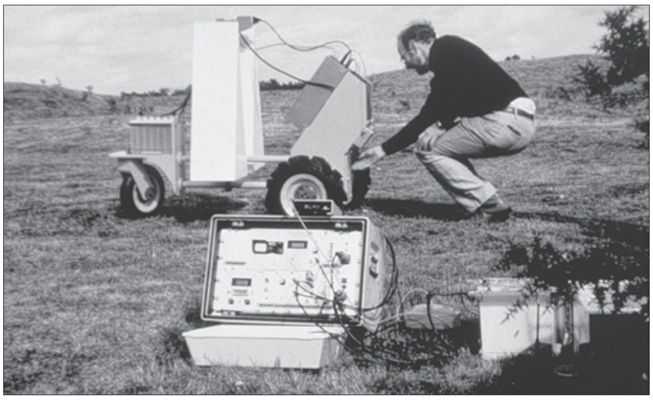


Figure 7 Metal-detector survey by Royle, using a metal detector with a ferrous/non-ferrous discriminator. The black dots and lines represent signals from a ferrous source. Most are likely to be ammunition. The group to the east of the BM hut are bottle tops from the soft-drink dispenser installed during the BM excavation of 1966–71. The straight lines are rust stains from vanished wire fences.



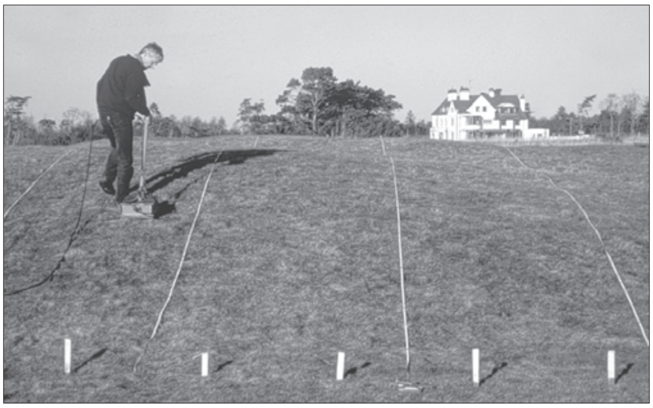


Plate 5 Remote mapping: (a) magnetic susceptibility, with the late Tony Clarke; (b) fluxgate radiometry, with Alastair Bartlett; (c) soil-sounding radar, with Mike Gorman and prototype; (d) Oceanfix on Mound 7.

bracken and overrun by rabbits. It was soon mown and fenced off from rabbits, and has been kept under short grass ever since (Colour Plate 3). Zone A was the only part of the research area to contain visible earthworks, and a new topographical survey of it was prepared (Int. 30, updating Ints 33 and 34; Figure 5). This survey resulted in the location of Mounds 17 and 18 (Plate 3). The site was also photographed at night under oblique lighting to bring out some of the slighter variations in topography, such as the quarry ditch around Mound 2 (Plate 4).

After the bracken had been removed and the site had been mown, a varied flora appeared, representing a large proportion of the species associated with the acid grassland before equilibrium was established. This floral pattern was mapped (Int. 18; Figure 6) and the species populations were assessed as a control for subsequent environmental research (see Chapter 10). The mapping showed a number of strongly patterned plant communities signalling underground features that could occasionally be identified. The patches of moss north and south of Mound 1, for example, related to the campaign of 1965–71: spoil heaps, excavations or other areas where sand was near the surface. The numerous patches of Yorkshire Fog (upwards of 200), many of them square, most likely represent areas where the soil had been turned over, probably by treasure hunters.

If treasure hunters had used metal detectors, they would have encountered a great deal of sub-surface metal, as our own detector survey showed (Int. 27; Figure 7). Most of this metal consisted of bullets, cartridge cases and shrapnel from the use of the site, in 1939–45, as a training area and rifle range. In the centre was a concentration of metal (including bottle tops) that marked the site where the British Museum hut had stood during the 1965–71 campaign. Lines of positive signals were also obtained from the edges of the area, where wire fences were or had been. The line of the vanished fence at the southern end of the site was to prove important, because it marked the original boundary of a small parcel of the scheduled site owned by the contiguous landowner to the south (Sun Alliance Assurance) that was subsequently given to the Sutton Hoo Research Trust.

The carpet of metal over Zone A would affect the performance of geophysical instruments. For this, or other, reasons they were not very useful in Zone A, although they were effective elsewhere (see below). The burial mounds were the subjects of some early British experiments with soil-sounding radar. A machine built by Mike Gorman of the Scott Polar Institute (Int. 29; Plate 5) detected a burial pit or robber trench under Mound 12, and the method received useful promotion from television appearances. Later radar surveys took advantage

Plate 6 A Bronze Age burnt mound, seen in the 'free' section in the side of a twentieth-century silage pit (Int. 31). The plough furrows belong to nineteenth-century cultivation from the west.

of more dedicated hardware and software developed in the USA and Japan (see Conyers and Goodman 1997 for an update; Int. 46; Plate 5). The lines of an old trench traced by soil-sounding radar in successive sections across Mound 2 were subsequently attributed to a nineteenth-century excavation campaign (see Chapter 6, p.173).

Zone A also offered opportunities for obtaining 'free' sections by re-opening recent interventions. A farmer's silage pit offered a preview of the strata at their deepest in the north-west corner of the site (Int. 31; Plate 6). A wartime anti-glider ditch (Int. 23) gave a section across a large part of the site that had remained impervious to other methods of remote mapping. In addition to indicating the depth of Prehistoric strata, the section also showed the destruction due to the bracken roots that had sought out the occupation soils in buried pits and ditches (Plate 7). One of Basil Brown's 1938 trenches was re-opened and used to take a preliminary look at the inside of a burial mound (Mound 2) so that methods of investigation and recording could be prepared (Int. 26). Combined with such documentation as existed for other early observations of the strata, these non-destructive interventions below ground allowed the central part of the deposit model to be constructed.

Zones B and C were under woodland: mainly tall conifers with tangled undergrowth. No remote-mapping technology seemed to be able to cope with this terrain. Zone B was therefore tested with a trench (Int. 24), which revealed very little, save that the root mantle of the conifers was not deep, generally spreading over the subsoil rather than penetrating it. Many of these trees were subsequently uprooted in the great storm of 1987; in the clearing operation that followed it became possible to undertake a topographical survey (Int. 57).

The south end of Zone E, a new plantation, was a no-go area during the evaluation phase, but it subsequently became possible to enter it, mow it and, since the young trees were widely spaced, to undertake a geophysical survey there. Zone E stretched along the scarp to Sutton Hoo House and the field beyond. Here John Newman's fieldwalking, which began in

Plate 7 (a) Bracken roots in Int. 23 (a re-excavated anti-glider ditch); (b) Int. 20, a transect into the east field.

1984, had picked up sherds of Middle Saxon (seventh-century) pottery (*Bull. 4*: 33, fig. 22; *Bull.* 5: 12), suggesting that the site of a settlement contemporary with the Sutton Hoo cemetery lay in this area. It later proved to be the site of an Anglo-Saxon cemetery of the sixth to seventh century (see Chapter 13).

Zones D and F, being under the plough, were first intensively fieldwalked in winter, the result being a scatter of Prehistoric material (Figure 8). The scatter showed a fall off of material at about 70 m east and 130 m south of Zone A, as well as a variation in concentration within the 100 m strip. To test the hypothesis that this was a reflection of the settlement beneath rather than a result of fertilization of fields (with scattered middens), test

Figure 8 Results of surface collection, phosphate survey and aerial photography in Zones D and F.

trenches 100 m long were cut (Ints 20 and 22; Plate 7). Prehistoric settlement features were certainly present (see Chapter 11). A phosphate survey (Int. 37; Figure 8) showed that the concentrations of organic detritus were uneven, and should relate to clusters of occupation. The composition of the assemblage from fieldwalking suggested the occupation was mainly Prehistoric. Aerial photographs taken since 1946 by the Cambridge University Committee for Aerial Photography (CUCAP) were plotted (through the courtesy of the Committee) and revealed an extensive Prehistoric field system (Figure 8) beneath a lattice of anti-glider ditches dug in 1940 (for which see Chapter 12, pp. 470–2).

Since the project design was expected to include the systematic geophysical mapping of a large area, pilot studies were undertaken on an area 30 m by 30 m to see which instruments were likely to be most effective (Ints 28, 35, 36 and 45). This pilot area was subsequently excavated and the sensitivity of the different instruments to different kinds of feature was assessed (Figure 9). The cleaning of this area (Int. 32) was also used to learn something of the possible yield from excavation under the ploughsoil. The amount of erosion due to ploughing since 1940 was assessed for management purposes by cutting a trench through an anti-glider ditch at a point where it now lay beneath the ploughsoil (Int. 21). The degree of erosion was found to have been very small.

Although graves were present in Int. 32 (see Chapter 9), the geophysical instruments had in general failed to find them. This made it difficult to assess the size of the cemetery in advance (for a later attempt to find graves with the caesium magnetometer, see Chapter 3, p. 56). Finding graves was another function of the two major test transects (Ints 20 and 22). From the examples of well-known and comprehensively mapped Early Medieval cemeteries (in particular Spong Hill: Hills 1977) it was supposed that a cemetery could not escape detection by a 2 m wide transect. In the eastern test trench (Int. 20) a grave and a body duly appeared and several more examples were revealed on the stripping of Int. 32. This suggested that the cemetery extended eastwards about 25 m beyond the scheduled area. It was subsequently shown that the burials did not actually extend further east (Int. 39), and four years later, more surprisingly, that they also did not extend much further west (Ints 52 and 50). At the time though, it was felt that graves would stretch continuously from Zone F to the mounds. In the example first located (Burial 17), the excavated body proved to consist almost

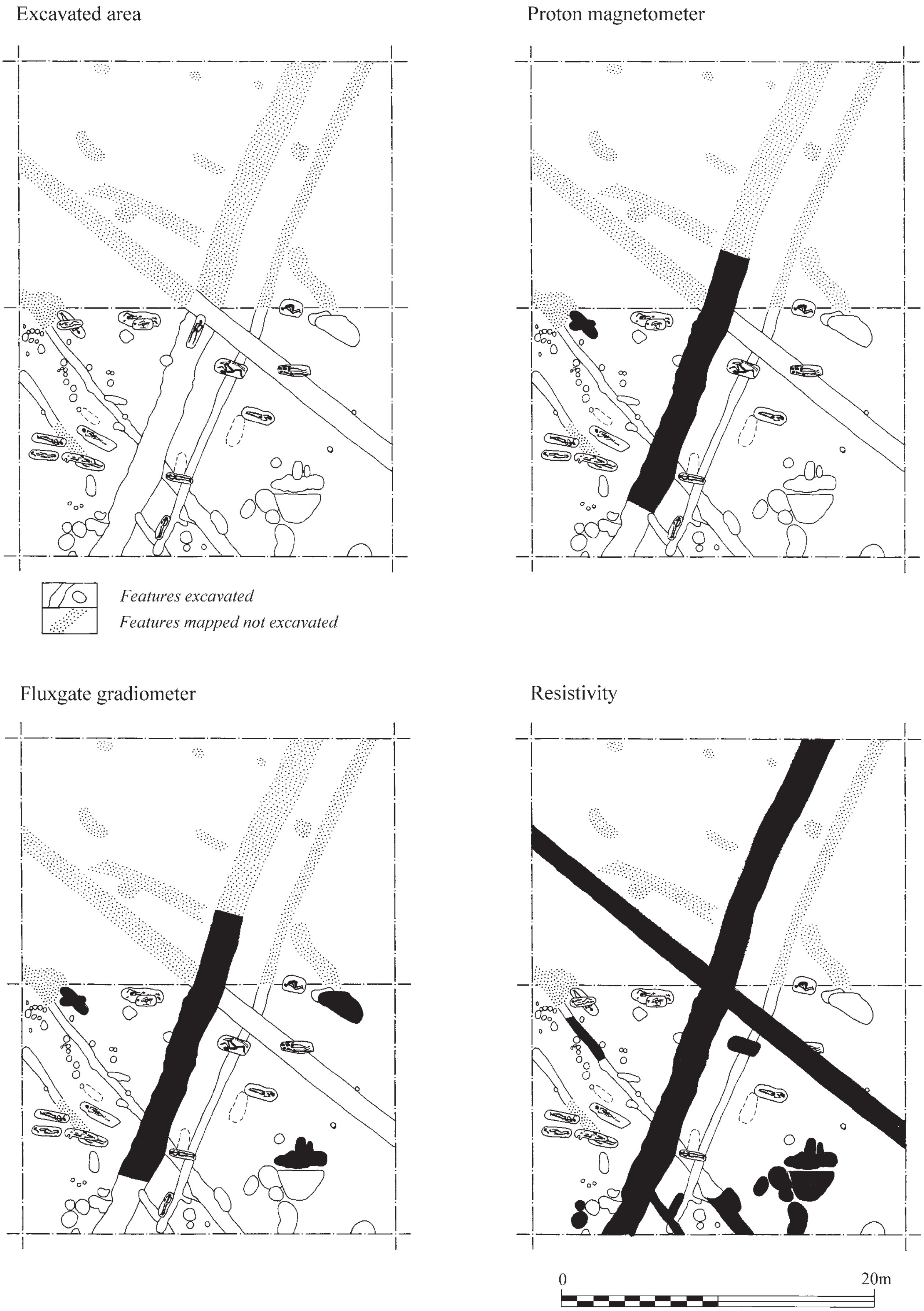


Figure 9 Geophysical test area in Int. 32. The area eventually excavated is shown at the top left; the features predicted by the different surveys are shown in black.

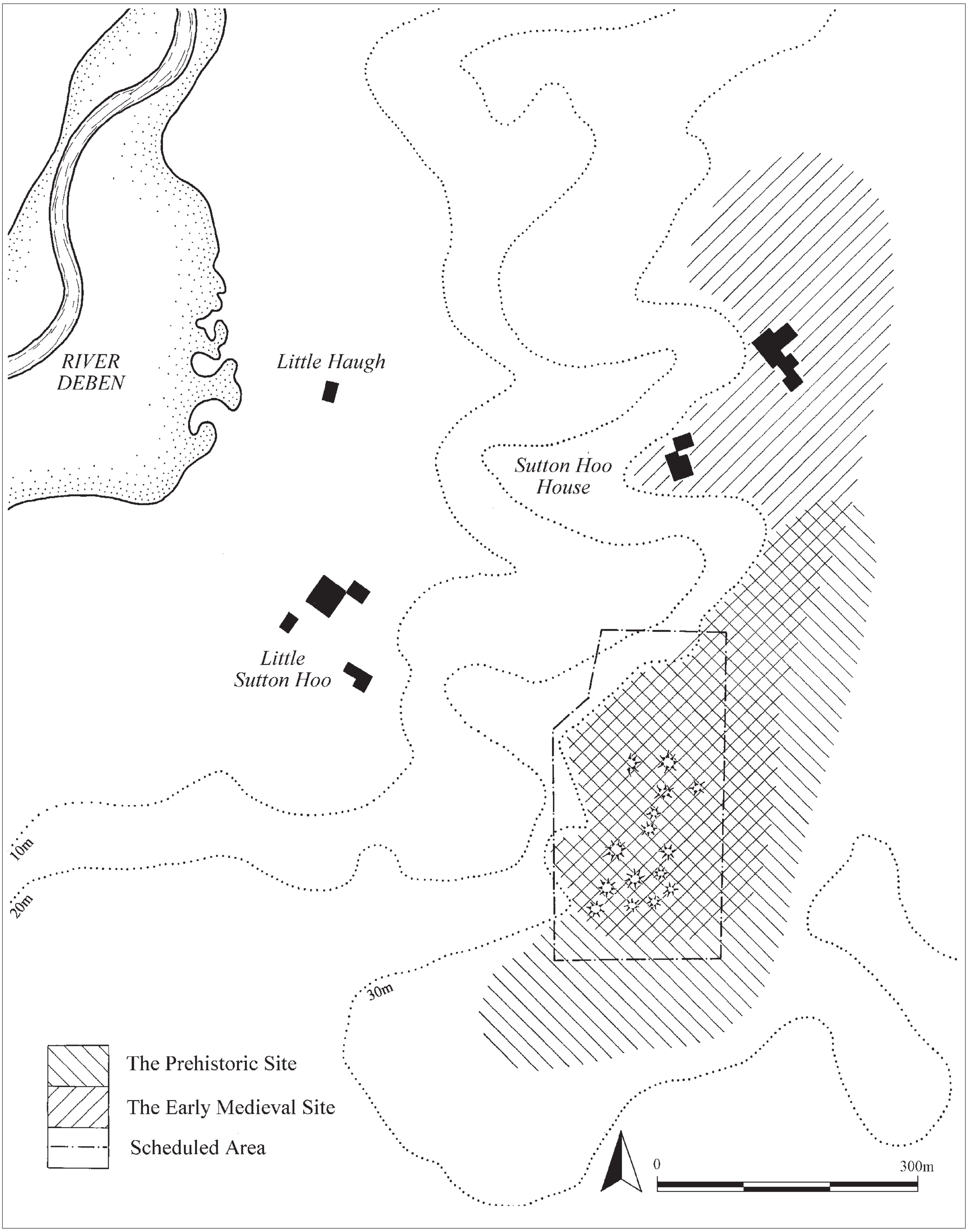


Figure 10 Predicted extent of Prehistoric and Early Medieval sites in 1986.

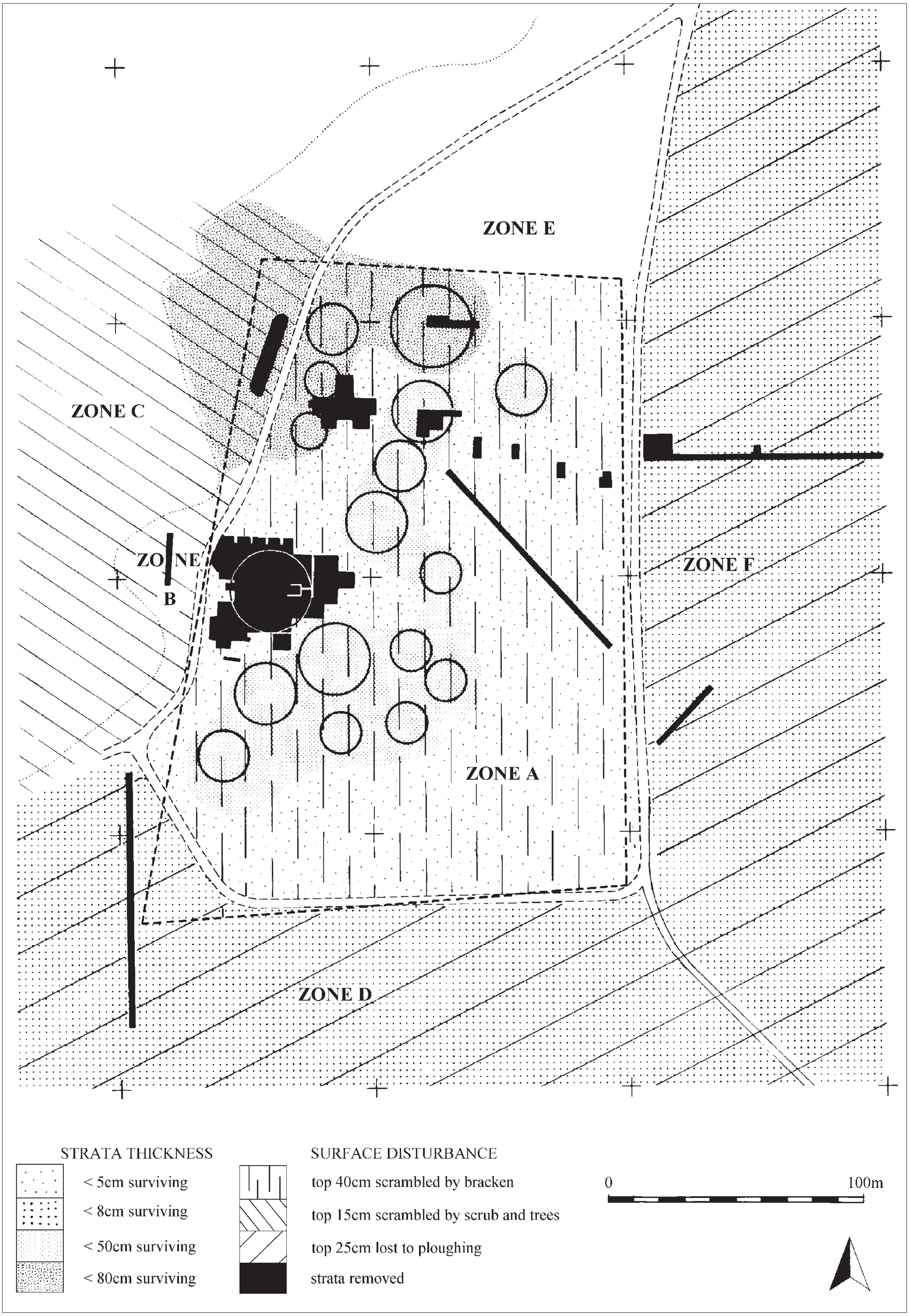


Figure 11 Deposit model.

Table 4

Information recovery levels used at Sutton Hoo (*Bull.* 4 1986: fig. 6)

A 'structure' (for example an interpreted building) is a set of 'features' (for example an interpreted post-hole). A 'feature' (for example a post-hole) is a set of 'contexts' (for example defined layers and interfaces). Contexts consist of 'components', the smallest definable elements (for example a pebble), and 'finds' (for example a flint flake), finds being those components that are kept. All strata were recorded as contexts. Additional higher order interpretations were recorded as features and structures.

Level	Component	Find	Context	Feature	Structure	Example of application
A	(not recovered)	surface finds plotted two-dimensionally	not defined	inferred by sensing given outline plan	inferred by sensing inferred by sensing	surface survey
B	(not recovered)	selected examples located in two dimensions and kept	defined by shovel describe	defined by shovel given outline description and planned	defined by shovel given outline description and planned	modern tracks
C	(not recovered)	all located in two dimensions and kept	defined by coarse trowel describe on context card planned at 1:20	defined by coarse trowel describe on context card planned at 1:20	defined by coarse trowel describe on context card planned at 1:20	not used
D	sample sieving of spoil on site	all located in three-dimensions and kept	defined by fine trowelling given analytical description with Munsell color on context card mapped at 1:10	defined by fine trowelling given analytical history on feature card planned at 1:10 sectioned 1:10 given contour or hachure plan	defined by fine trowelling recorded as tableau	Bronze Age pit
E	total sieving of spoil on site	all located in three-dimensions and kept	defined by spatula etc. as at Level D planned individually at 1:10 or 1:5	defined by spatula etc. as at Level D planned at 1:10 or 1:5	defined by spatula etc. recorded as tableau	Grave
F	micro-sieving of soil blocks	all lifted as a consolidated block	dissected in lab. recorded as at Level E			degraded composite artefact

entirely of sand, with hardly any surviving bone suitable for ageing, sexing or dating. Although most of the graves proved to have contained these 'sand bodies', the initial assessments proved pessimistic. Subsequent examples did yield sufficient bone for ageing, sexing and radiocarbon dating (see Chapter 3, pp. 47–9).

The results of these invasive and non-invasive investigations were expressed in three ways. Figure 10 shows the extent of the Prehistoric and Early Medieval sites predicted by surface and remote mapping. The Prehistoric site was seen to be concentrated on the 12 ha. of high ground enclosed by the 30 m contour. The extent of the Early Medieval site was harder to know. The graves petered out to the east about 25 m from the eastern edge of the monument, and no graves were contacted to the south. To the west the ground sloped rapidly down hill, and to the north lay a re-entrant. No mounds had been reported north or south of the present group since about 1601 (SHSB I: ch. 1). The cemetery was thus proposed as a group of about twenty mounds with an accompanying group of flat graves (without mounds) spreading in all to about 4.5 ha. There was, however, possible Early Medieval activity in Zone E, north of the re-entrant. This area (on the promontory which carried Tranmer House) was expected to feature a Middle-Saxon settlement, which it may yet, although later excavations (in 2000) have revealed part of a sixth-century cemetery (see Chapter 13).

The second analysis (Figure 11) showed the predicted depths of strata in Zone A and the likely degree to which they had already been disturbed. The deepest strata survived in the north-west corner of the site, where a depth of up to 800 mm of strata were viewed in the side of the silage pit. The lower parts included Prehistoric features (hearths and pot-boiler dumps); the upper half is liable to have been re-deposited and had been ploughed (Plate 6). About 400 mm of buried soil lay under the burial mounds. Outside the mounds the soil also lay up to 400 mm thick, but within Zone A most of this had been (anciently) ploughed and was currently very disturbed by bracken roots, leaving less than 50 mm of legible deposit. Zones D and F were under the modern plough, but this regime was (ironically) more benign: with no bracken and with shallow ploughing that only reached a depth of about 250 mm, some 80 mm of strata survived here and there, and the surface of the subsoil was generally more readable than in Zone A.

Table 5

Recovery template for the Sutton Hoo site (Zone D)

Along the left-hand margin are the techniques that have been applied, and across the top are the sizes of feature and find. A cross marks where finds and features were successfully detected in the evaluation stage. Features larger than 1.5 m across included the early Bronze Age ditch system. Finds includes artefacts and macroscopic biological remains (e.g. nutshells and bones of small mammals).

Technique	*Features >1.5 m across*	*Features >1.0 m across*	*Features >0.5 m across*	*Graves >0.4 m across*	*Finds >20 mm across*	*Finds >10 mm across*	*Finds >1 mm across*
Survey							
Aerial photos	X						
Contour	X						
Surface mapping	X						
Magnetometer	X						
Radar	X						
Fluxgate	X	X					
Resistivity	X	X	X				
Field walking					X	X	
Metal detector					X	X	
Phosphate							
Excavation							
Level A	X				X		
Level B	X	X			X		
Level C	X	X	X		X	X	
Level D	X	X	X	X	X	X	X
Level E	X	X	X	X	X	X	X

Table 6

Intervention strategy at Sutton Hoo

The range of effective techniques is listed on the left-hand side; and their application within each zone, and to specific types of anticipated strata (along the top), is marked with a cross.

Technique	*Zone A*	*Zone B/C*	*Zone D/F*	*Zone E*	*Topsoil*	*Subsoil surface*	*Features*	*Graves*	*Mounds*
Survey									
Aerial photos			X						
Surface mapping	X								
Radar	X								X
Resistivity	X	X	X	X					
Field walking			X						
Metal detector	X				X			X	X
Excavation									
Level A					X				
Level B					X				
Level C									
Level D						X	X		
Level E								X	X

The third analysis attempted to estimate which methods, particularly remote-mapping methods, would be successful in which zones; where useful results could not reasonably be expected except by excavation; and at which levels of precision excavation would be required. These levels of precision or *recovery levels* derived from a standard operating procedure that had been found useful elsewhere and was adapted for Sutton Hoo (Table 4). This device ordained and monitored the techniques that were to be used and the records that were to be made. It also assisted with the calculation of costs. The *recovery template*, Table 5, was produced to show the sensitivity of different buried finds and features to detection by instruments, and their susceptibility to definition by excavation at different recovery levels. Table 6, the *intervention strategy*, was a statement of which remote-mapping methods and which levels of excavation would be needed to meet the anticipated research targets in each zone, followed.

Such studies helped with the modelling of the archaeological assets of the site and its surroundings and how they could be researched. In summary, the deposit was best preserved where it was covered by the mounds. The buried soil of pre-Saxon date was up to 400 mm thick, but it had already been ploughed so that Prehistoric features were still difficult to define other than in the surface of the subsoil. Outside the soil platforms protected by the mounds, the ground had been extensively quarried by the Anglo-Saxons to build their mounds. It later transpired that the whole Sutton Hoo burial ground had been ploughed from the later Medieval period, a ploughing which had rubbed the mounds almost flat. But this was not known when the excavation started in 1986.

The preservation of materials was shown to be generally very poor, the original assemblage having been greatly reduced by both natural and human agents. There was pollen in the soil, but in most contexts the risk of intrusive disturbance was high. Human and animal bone appeared to be (and was to prove) much decayed, often to invisibility; the Prehistoric assemblage would be dominated by pottery and flint and the Early Medieval assemblage by metalwork. It was doubtful if the Anglo-Saxon skeletons could be aged or sexed, although a trial had shown that the sand bodies contained enough carboniferous material for radiocarbon dating.

However, much useful information was in reach of survey, particularly for the Prehistoric phase. It could be seen that in Zones D and F the larger features, such as pits and boundary ditches, could be mapped by air photography and geophysical survey, with resistivity or fluxgate gradiometry suggested as the most sensitive methods. The larger Prehistoric finds would be recoverable through surface collection, and the pattern in which they lay would reflect the pattern of Prehistoric land use. Where excavation was to be undertaken in these zones, the top 250 mm, already mapped through surface collection, could be taken off at Recovery Level A and shovel-cleaned (at Level B). The surface of the intact deposit would be cleaned and the features defined. Prehistoric features would be excavated at Recovery Level D. For the Early Medieval period the ring ditches of barrows should be discoverable by survey; but graves and any close reading of burial rites would require excavation at Level E. In Zone A, both the mounds and the spaces in between, were generally impenetrable by instruments. The Early Medieval, Prehistoric and environmental programmes all required examination of the buried soil under mounds.

Formulating the research agenda

The fruitful prospects for fieldwork were assessed by matching the deposit model to the research agenda – the list of what we wanted to know. Informal consultation on this matter was available from the members of the Sutton Hoo Research Trust and the Sutton Hoo Research Committee, who met regularly on and off site, and were generous with their time and effective advice. More formal consultation from a broader constituency was sought in a series of invitation seminars, each addressed to a particular problem. The first occasion was actually a public meeting to which all members of the Society for Medieval Archaeology were invited. It was held at University College London on 15 April 1983 and helped to expose and reconcile the hopes and fears raised by the prospect of further work at Sutton Hoo (Carver 1998a: 49).

The second was held at Cambridge on 13–15 September 1984, and focused on princely burials and how new understandings of the Early Medieval period could be gained by studying them in the context of the kingdoms of northern Europe. Sutton Hoo was clearly a major contributor to the subject already, and might contribute further if more princely burials were excavated and compared with other examples of lesser rank in the same community. The third seminar, held in Ipswich on 3–5 October 1984, addressed the agenda for finding the kingdom of East Anglia, mainly through field surveys. Settlements of different sizes, dates and rank were detectable from surface scatters, particularly if metal detectors were used. The pattern and its changes would throw light on the way society was altering. This reinforced the Trust's resolve to support intensive surveys in the Deben Valley. The fourth seminar held in Oxford from the 3–5 April 1987 attempted to assess the value of the Prehistoric site and how far resources should be invested in excavating it. The main points to emerge were that the Prehistoric features would need to be carefully disentangled from the Early Medieval features on the ground, but that the two sites were probably discontinuous (Bradley 1988b). In the event, this verdict was over-cautious: the Prehistoric sequence was a useful one and the earthworks of the Prehistoric site did turn out to have significance for the Early Medieval people.

These seminars were valuable occasions designed to involve a broad international constituency in the construction of the field programme and the subsequent interpretation of its findings. A fifth invitation seminar was held at the University of York on 29 September – 1 October 1989, 50 years after the Mound 1 ship-burial was excavated and abandoned beneath a mantle of bracken. The seminar was held to review progress in understanding since then of the site itself, of East Anglia and of the early kingdoms of the North Sea, and its proceedings were subsequently published (Carver 1992a).

Project design

The results from the deposit model were matched with the research agenda, in the light of the consultation, to give an evaluation of the site and its surroundings from which programmes of research and management could be proposed. One prescription, in tune with the time (Barker 1977), would have been simply to excavate the whole of Zone A, thus retrieving all the Early Medieval burials and a sizeable chunk of the prehistory. This was Rupert Bruce-Mitford's own preferred option and his advice (20 July 1981) to the Sutton Hoo Steering Committee: 'Total excavation of the site has always been the aim of the project and should remain so'. In this way of thinking no prior questions are necessary or desirable, and all archaeological features merit the same level of recovery. Subsequent generations would have all the information at their disposal and, incidentally, no management problem, since the site would no longer exist.

'Total excavation' was not entertained by the author for three reasons: stratigraphic, financial and ethical. The deposits were certainly disturbed and damaged, but applying a high degree of precision, for example to a robbed burial mound, could allow some appreciation of, say, the burial rite. To excavate 4 ha. with that degree of precision would be unrealistic, so choice was inevitable. Money would not be available for such an enormous and speculative exercise, estimated to take, from the evidence of projects of comparable quality, about 25 years.

Excavating the entire monument, supposing it could be defined, would also be unethical. It was not known to be a site within a 'type', in which human activity would be reliably replicated elsewhere. It was certain that future archaeologists would have new questions to put and new, probably less destructive, ways of answering them. Therefore the task should not be to excavate the maximum possible without asking questions, but exactly the opposite: to pose questions, and to

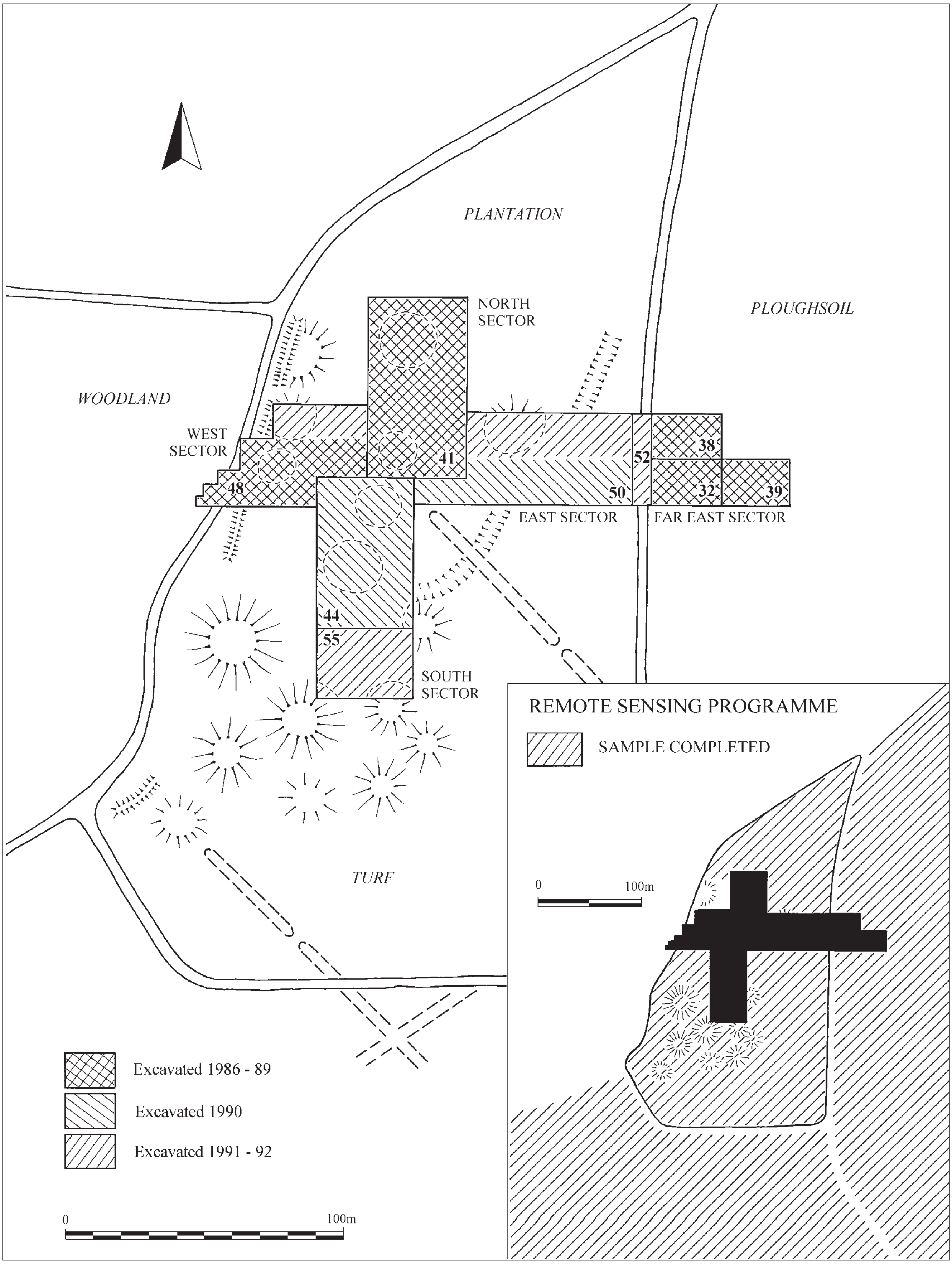


Figure 12 Excavation strategy and remote-mapping strategy, as decided in the research design.

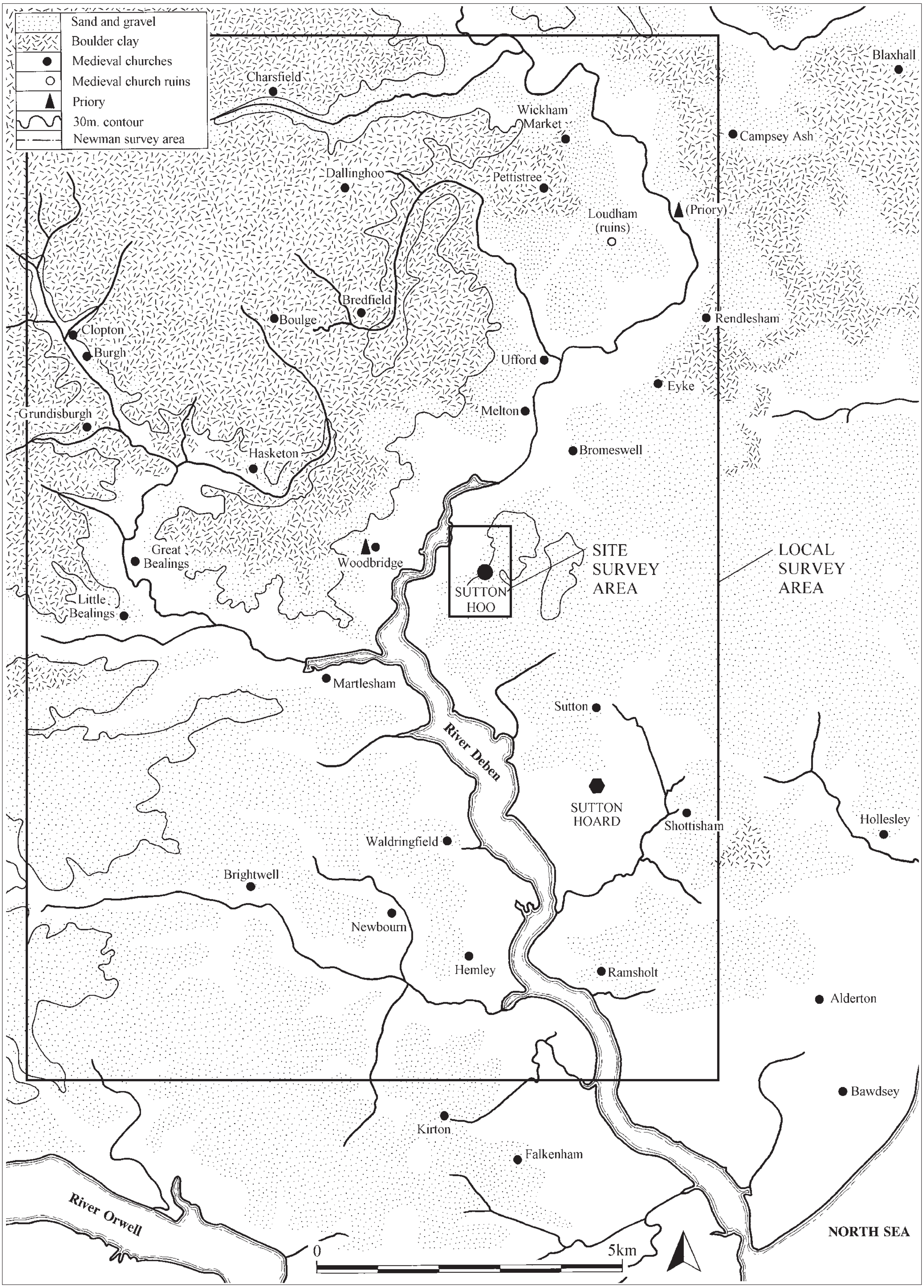


Figure 13 Deben Valley survey: search area.

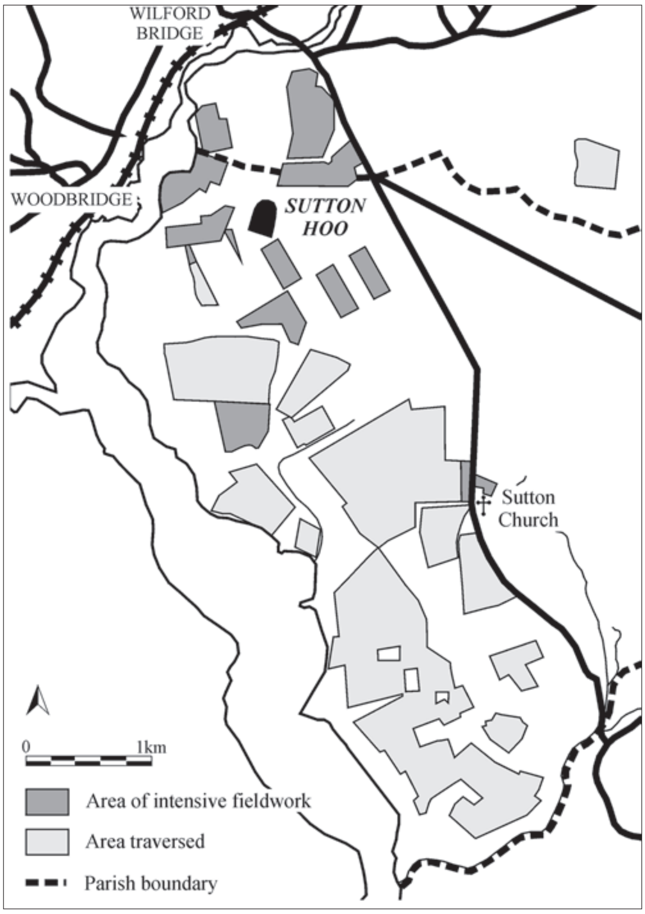


Figure 14 Deben Valley survey: areas accessible for sampling.

Figure 15 The East Anglia kingdom survey: sample areas.

excavate the minimum required to answer them. If our questions required the excavation of the whole cemetery, then they were the wrong questions, and we should think again. Alternatively, the programme should not involve excavation on any scale at all, and the site should be conserved. This too had its responsible advocates.

The principal questions for the Early Medieval period (above) were:

- Which burial rites were employed, and in what order? (A question that would have to be addressed by excavation in Zone A.)
- How did the settlement pattern change? (A question that could be addressed by survey in the region.)

The principal questions for the Prehistoric period were:

- What was the extent of the settlement in each period? (A question that could addressed through site survey.)
- What was the function of the settlements in each period? (A question that would need excavation, preferably within the buried soil.)

The general environmental questions concerned the population and uses of flora and fauna through time, as well as land usage. It was plain that faunal data would be very low and that the site was best disposed to the collection of soil history, using the technique of micro-morphology on soil profiles that had been preserved under mounds. An undisturbed pollen sequence would be most readily obtained in the valley between the site and the river, where hill-wash may have accumulated.

Accordingly, the research programme was designed as follows. An excavation area of 1 ha. was proposed (originally as *Bull.* 4: fig. 33, but finally as Figure 12). This addressed the Early Medieval agenda in that it would cross from one side of the cemetery (as known) to the other, west to east. It was hoped that this transect, running inland from the edge of the scarp above the river, would reflect the development of the cemetery. In 1986, on the basis of the evaluation, this east–west transect was expected to contain 500 flat graves. But there could be no guarantee that the cemetery had developed in that linear manner, and a second transect was therefore placed at right angles to the first. This followed the line of mounds which, at that time, Bruce-Mitford thought represented the original axis of the cemetery (SHSB I: 5). Between them the two transects ought to catch the sequence of the mounds and the other burials that were expected.

The excavation area contained seven mounds and omitted eleven, three of which were already known from recorded excavations. The buried-soil platforms of the selected mounds ought to be intact, and those of Mound 2 and Mound 5 had already been seen in section. The excavation ran up to and over the eastern edge of Zone A, so that it made contact with the Prehistoric field boundaries located as crop-marks, as well as with the graves excavated in Int. 32. It was felt that the excavation area thus proposed would serve the Prehistoric, as well as the Early Medieval, agenda. However, the nature of some of the anticipated features (e.g. long ditches) suggested that once the Prehistoric repertoire was recognized excavation could be selective. As the excavation area contained several platforms of buried soil, it would also serve the environmental agenda. In addition, in order to obtain an off-site pollen sequence a trench, from which sample columns were taken, was cut in the valley side below Top Hat Wood (Int. 53; Chapter 10). The cruciform transect seen in Figure 12 should thus serve most items on the research agenda.

A subsidiary project on chemical mapping was also designed, and funding for it successfully solicited from the Leverhulme Trust. This was intended to offset the anticipated difficulties of finding human bodies that had almost entirely disappeared. The excavators of Mound 1 had first faced this problem in an otherwise intact burial deposit. The British Museum's researches had concluded that there had been a body in Mound 1, but that a group of very experienced excavators had not seen it (SHSB I: ch. 8). In 1966 excavators had encountered a 'sand body' near Mound 5, and another had been unearthed during the evaluation on the eastern periphery of the burial ground (Int. 20). Such sandy effigies would be hard to see against wood and impossible to discern in the event of any disturbance. The Leverhulme project was designed to develop chemical means of mapping the decay products of a human body that had left a 'chemical signature' where it had lain (see Chapter 3).

A programme of site surveys would run alongside the excavation (Figure 12), looking to map the broader Prehistoric settlement and any burial mounds that were betrayed by their ring ditches.

To investigate the changing settlement pattern, a broader regional survey of the Deben Valley was undertaken by the Suffolk Archaeological Unit (Suffolk County Council) and the results are summarized by John Newman in Chapter 13. The area of south-east Suffolk is known as the Sandlings, because of its acid, sandy soils. The Deben Valley sample area included a part of the Sandlings, as well as the more clayey soils of the Deben headwaters (Figure 13). Access was dependent on permission from landowners and the land under cultivation; the fields chosen with regard to these pragmatic restrictions provided the sampling template (Figure 14). Keith Wade and Stanley West (Suffolk Archaeological Unit) saw the Deben Valley survey as one of six sample areas representing settlement in different zones of East Anglia (Figure 15). These would show, in their changing geography, the development of the Anglo-Saxon kingdom. The strategy as a whole thus comprised a series of nested areas to which different levels of enquiry were addressed (Figure 16). The cost of excavating the sample area and doing the surveys was forecast at £1.35m. (*Bull.* 4: table 11). The actual cost was slightly over half that figure (see Table 10).

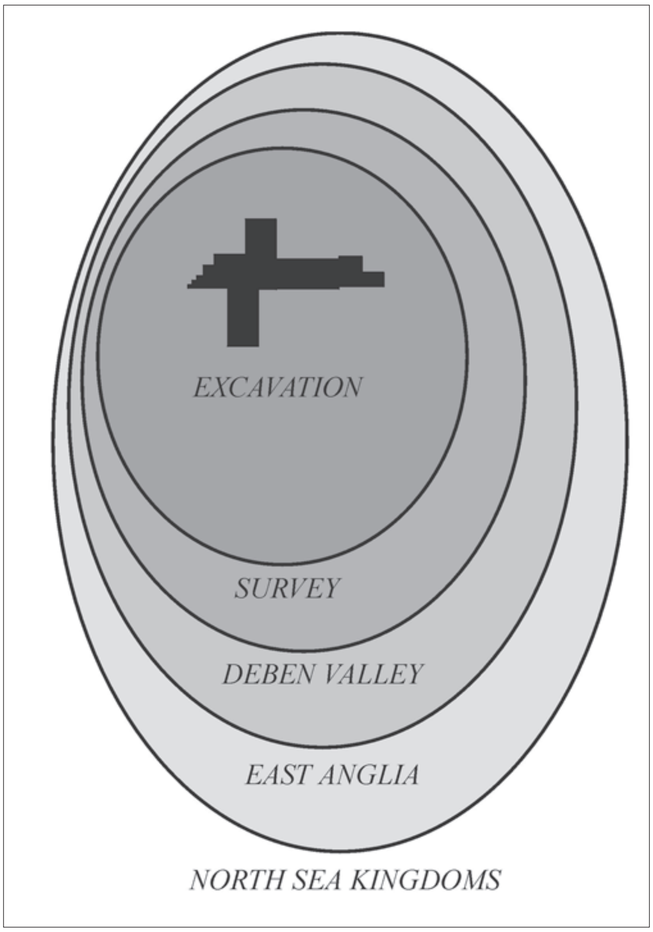


Figure 16 Concept of the investigation.

The management programme

The proposed excavation programme would affect 1 ha. out of the 4.5 thought to be the extent of the barrow cemetery (less than 25 per cent); and 1 ha. out of 12 thought to represent the extent of the Prehistoric settlement (about 8 per cent). It involved seven out of an estimated twenty mounds, although only seven of those left for the future were likely to have much stratigraphic information remaining (and all may have been previously robbed). The excavation transect was placed at the north end of the site, so as to subsume Mounds 2 and 5 (known to be already damaged) and areas already excavated in the 1965–71 campaign. This would not only mean that the excavation could build on previous work, but would also leave the maximum continuous area intact. A strategy of selective excavation for the Prehistoric site would also leave intact deposits for future inquiries and different techniques.

The conservation plan for the site consisted of eliminating the bracken and rabbits, and of keeping the site under more or less full-time surveillance. The site was largely maintained and guarded through the tireless voluntary work of Mr Peter Berry, site caretaker. The excavation campaign and its results were to be presented to the public in a number of different media, including a television series and site visits (*Bull.* 4: fig. 42), and negotiations began immediately (April 1983) for the long-term curation and presentation of the site (see Chapter 3, p. 57).

Conclusion

The design phase was used to draw up a programme in which the research value of the project would be justified in terms of its cost and the proportion of the archaeological site that would be destroyed. Excavation was to be limited and targeted and coupled with surveys, in an attempt to achieve maximum information for minimum attrition. The project design was submitted to the Sutton Hoo Research Trust, to the Department of the Environment and to friends and colleagues to see if they believed that it served the common interest and promised proportionate rewards. In general the reaction was positive. On 15 January 1986 the Sutton Hoo Research Trust undertook to support the programme to its conclusion and on 7 August Scheduled Monument Consent was received from the Secretary of State. The project design was then put to the test.

Chapter 3

Fieldwork and analysis (1986–2001)

Conditions, techniques and results of excavation

Martin Carver

Programme and team

Following the project design, a cruciform transect (1 ha. in extent) was to be opened and all Early Medieval features in it identified and excavated, while the Prehistoric features were to be mapped and selectively excavated. The transect was divided into *sectors* (north, east, far east, south and west), which were further divided into numbered *interventions* marking each excavation area or archaeological operation (Table 2). Int. 32 (far east sector), outside the scheduled area, was completed first (1986) and then the north, south, west and east sectors in that order (Table 7). There were several minor changes to the form of the original sample. In 1986 the reserved extensions of the north–south transect (*Bull.* 4: fig. 33) were put on ice. The short transect (*Bull.* 5: fig. 3) was extended in 1989 (*Bull.* 7: fig. 1) to

Table 7
What was done each year

Year (length of season in months)	1986 (12)	1987 (12)	1988 (12)	1989 (3)	1990 (3)	1991 (5)	1992 (2)
Int. 32	X						
Group 1	X					X	
Int. 41	X	X	X	X			
Mound 2		X					
Mound 5			X				
Group 2			X	X			
Prehistory			X	X			
Int. 44			X	X	X	X	
Mound 6				X	X	X	
Mound 7				X	X	X	
Int. 48				X	X	X	
Mound 18				X			
Mound 17						X	
Int. 50					X	X	
Mound 14						X	
Prehistory					X	X	
Int. 52						X	
Int. 55						X	X
Field school			X	X	X	X	
Manpower Services Scheme	X	X	X				

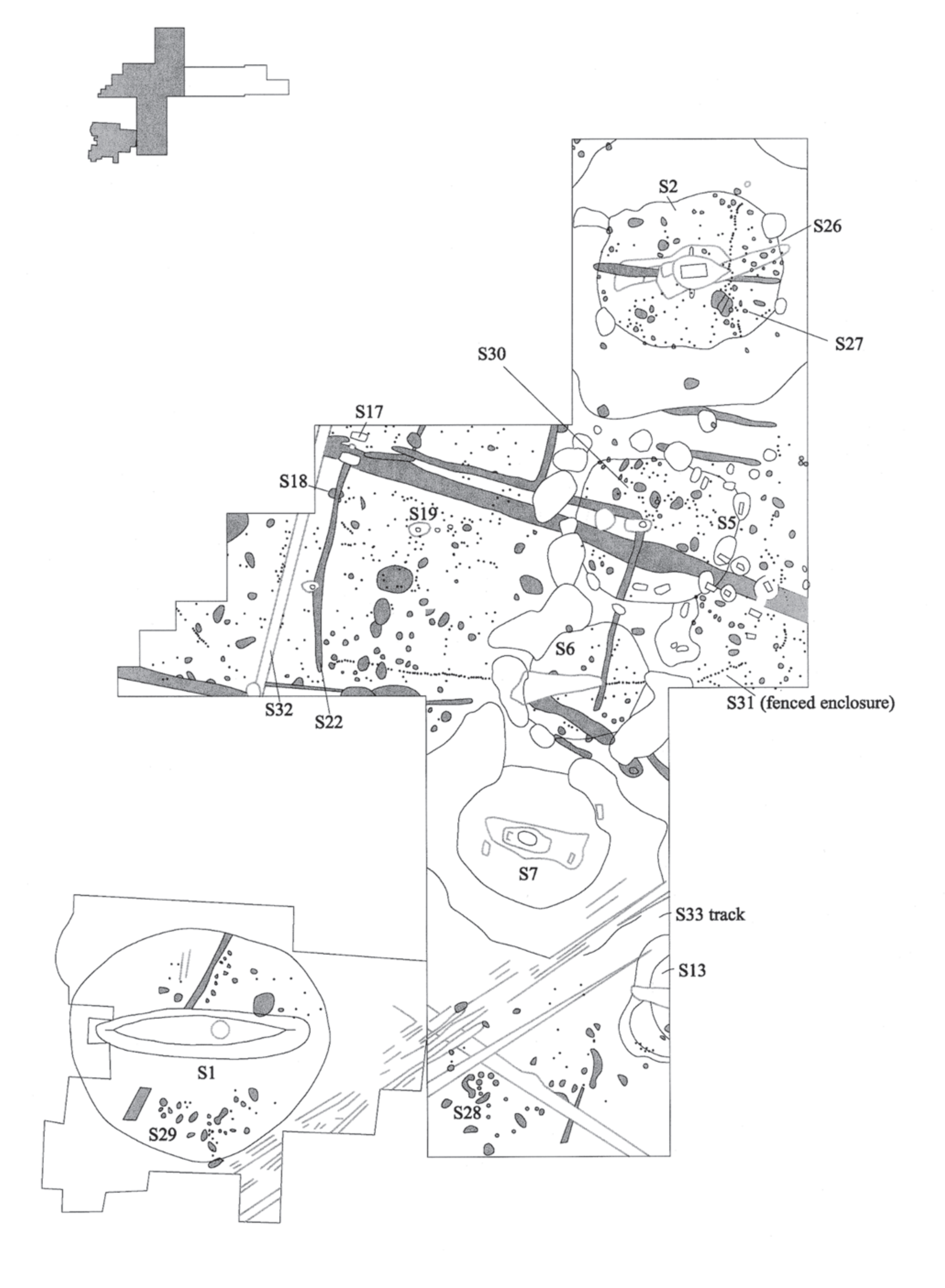
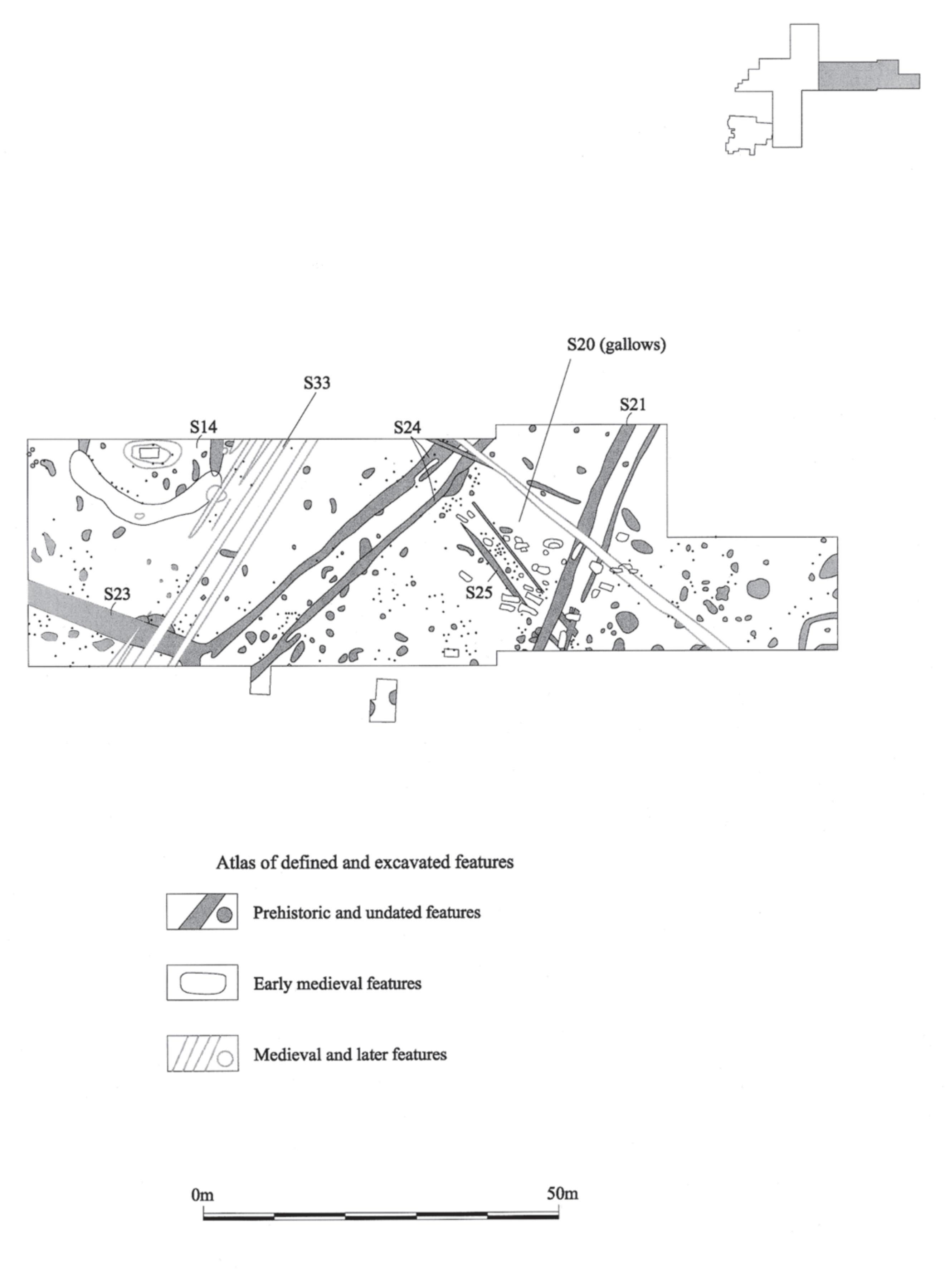


Figure 17 A map of all defined and excavated features, 1992. Prehistoric and undated features are in grey, Early Medieval graves and burial pits in black, other Early Medieval features in outline, and Medieval and later features in dashed lines.


S20 (gallows)
S33
S21
S14
S24
S23
S25
Atlas of defined and excavated features
Prehistoric and undated features
Early medieval features
Medieval and later features
0m
50m

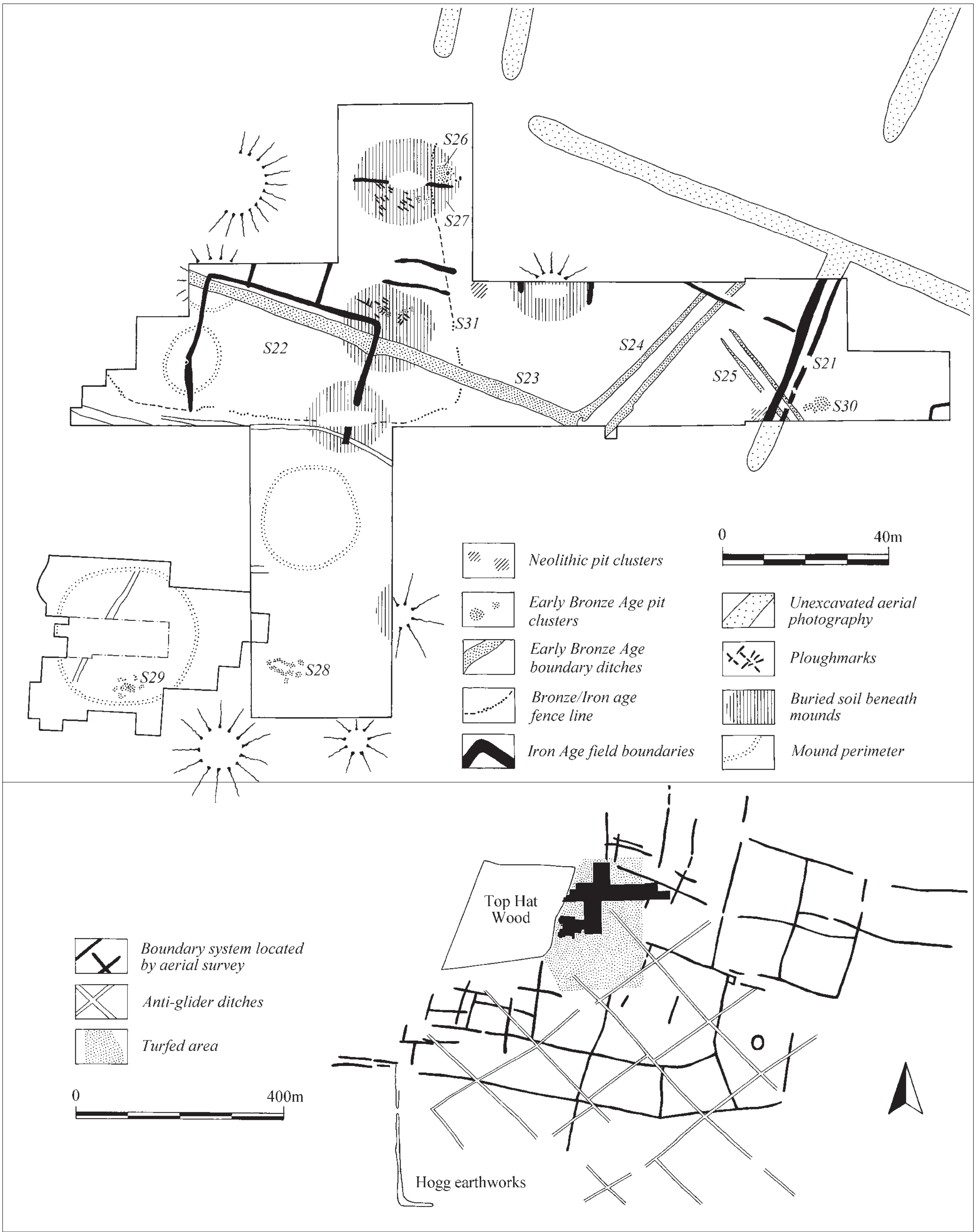


Figure 18 Map of principal Prehistoric features.

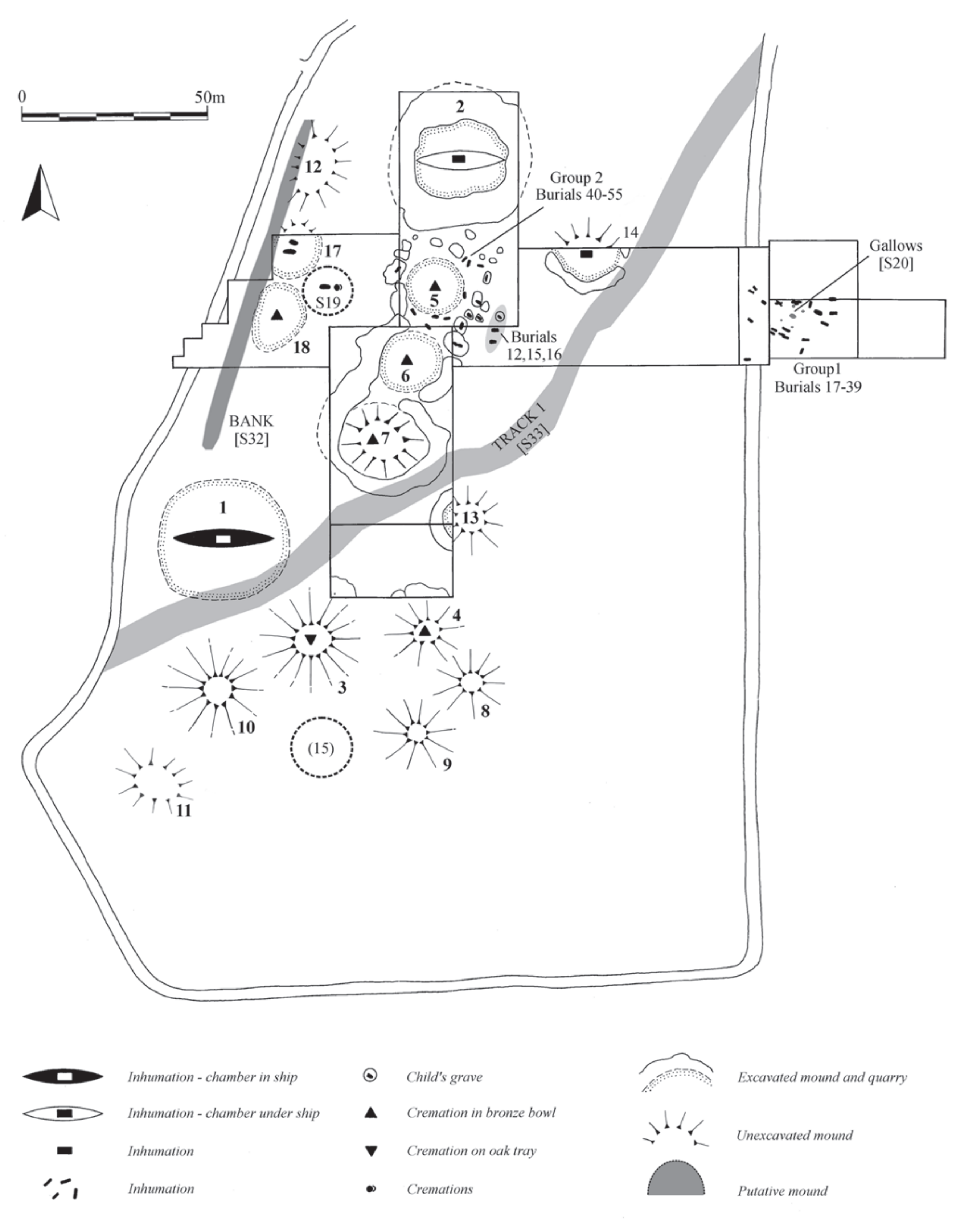


Figure 19 Map of the principal Early Medieval features: 1–18 are Early Medieval mounds and S19 is the site of a disturbed inhumation burial (Burial 56) with two cremations (13 and 14). Mounds 3–7 and 18 contained cremations and are described in Chapter 4. Mounds 14 and 17 and Burials 12, 15 and 16 were inhumations, and are described in Chapter 5. Mounds 1 and 2 contained ships and are described in Chapter 6. Group 1 comprised twenty-three execution burials (Burials 17–39) around the site of a possible gallows. Group 2 comprised sixteen execution burials (Burials 40–55) around Mound 5. S32 is a bank or lynchet (nineteenth century). S33 is a track-way of the Medieval and later periods.

Plate 8 The site towards the end of the fieldwork in 1991, looking west. The site offices are top left, with the marquee and campsite for the excavation team adjacent. The cruciform transect is centre, with spoil heaps (including topsoil mounds) to north and south.

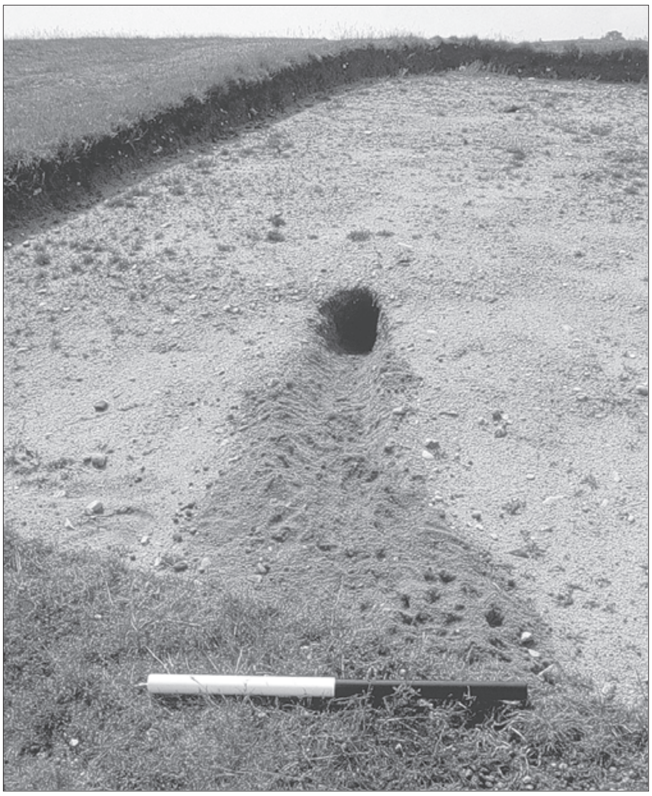
include the area between Mounds 1, 3, 4 and 7 (Int. 55) and to test for 'Mound 19' (which proved to be non-existent). Mound 17 was omitted from the sample in 1989 but returned to it in 1991 following the sparse result from Mound 18 (*Bull.* 8: fig. 1). In the same year the robber-trench across Mound 7 was excavated, and it was decided that it would serve no identifiable part of the research programme to remove the mound or the buried soil beneath it. Both were accordingly left intact. A plan of all excavated features is given in Figure 17; for an index of all features by mound or burial group see Index to Contexts and Features, p. 531. Figure 18 shows the principal Prehistoric structures and Figure 19 those that are Early Medieval and later. A list of structures is given in Table 8.

Each intervention had a supervisor who directed the fieldwork, monitored the recording and kept the journal, and there were supervisors in charge of finds and environmental sampling. The workforce consisted of a core team of four full-time professional supervisors, and a seasonal team of volunteers and students. Among the volunteers were professional archaeologists on holiday, and among the students were those who attended a formal three-week field school. Archaeologists were also seconded to the project from the British Museum, academic institutes in Europe and what was then Soviet Russia (see Participants, p. xxvii). For three years the project also employed a team supported by the Manpower Services Commission, a job creation agency. The number of people on site was fifty in the summer months (May to September) and twelve in the winter (October to April). During the summer the team camped and ate together (Plate 8).

Character of the deposits

The Sutton Hoo site lies on a post-glacial terrace of acidic yellow sand. Patches and lenses of small gravel, black and beige grit (the 'sickly grit') and laminar iron pan occurred in the sands down to 2 m below the surface. On the sand a brown forest soil had developed, which had been more than a metre thick in the Neolithic period, and which had been reduced to a thickness of 400 mm under the mounds and 250 mm outside them, mainly through ploughing and mound-building (see Chapter 10). The deposits were porous and acid (pH 6–3.5), creating a hostile environment for most materials of archaeological interest. Of metals, only gold was untarnished; silver objects were surrounded by a penumbra of purple oxide (Plate 9:a), bronze objects were encased in green copper salts, and iron was oxidised to craggy lumps of hard, dark sand. Many artefacts made of metal had been placed in graves in the Early Medieval period; but often the graves had then been robbed, breaking the objects into fragments and exposing them to further corrosion. Textiles in contact with bronze survived as metallic fossils. Leather could sometimes be noted as a dark patch or stripe in the sand. No stone or building materials had been brought onto the site other than timber. Wood, generally reduced to dark brown–black sand, was detectable from its locus: thin lines where planks were seen edge-on and patchy bands when viewed in plan. Partially preserved lumps of wood were black and blocky, as though burnt, with a squamous surface easily confused with bark. Turf could sometimes be recognised as grey layers or lumps (Plate 9:c). Skeletons were detectable as brown–dark brown crusts, lumps or bars of sand, which often

Plate 9 Soil conditions (clockwise): (a) fragments of decorated bone and fluted silver mounting in the Mound 5 robber trench; (b) a sand body, Burial 36, under excavation by Andy Copp; (c) a wooden box placed for protection over the legs of Burial 45 in 1970, as excavated in 1988; (d) a rabbit tunnel into Mound 7.



concealed flakes of bone (Plate 9:b). These flakes might include the outer shell of the more robust bones and the crowns of teeth. Exceptionally, as in the horse burial (Mound 17), the bones had defeated the local chemistry, were in good condition, and could be readily identified in the ground and lifted by hand. These humic skeuomorphs of skeletons are referred to in this report as *sand bodies*. At every level archaeological strata were interlaced with the curved dark (wood-like) lines of bracken roots and the random tunnels of rabbits (Plate 9:d) which habitually obliterated key context- and feature-intersects.

The Sutton Hoo strata thus presented a daunting prospect: a partially blended chaos of yellow, brown and black sands, laced with powdery slicks of modern disturbance, amongst which the more regular lines of early features could sometimes be discerned. The burial-mounds were hairy, stony, sandy heaps, riddled with rabbit runs, through which the ghostly trenches of previous excavators had steered. Scattered around these ragged early diggings was a gallimaufry of bone fragments and tiny artefact-pieces from the ransacked chambers. The unfurnished Early Medieval graves were usually undisturbed but, instead of skeletons, contained body-fossils made of sand, buried in sand, and often in body-positions that an excavator could not easily guess. Prehistoric features were heavily truncated, even under mounds, and offered assemblages mainly limited to pottery and flint.

Methods of definition

The challenge of excavation was therefore to develop methods of seeing clearly and to apply them evenly. The excavation of all areas, including mounds, began with the exposure and mapping of the interfaces defined above and beneath the plough-zone, the large open surfaces called horizons (see below). Context definition within these surfaces was dependant on colour

Plate 10 Recovery levels in action in Int. 50. In the background, the surface, already opened by machine (Level A) and cleared by shovel-scraping (Level B), is being coarse-trowelled (Level C). In the centre, a group of trowellers are preparing a horizon for mapping (Level D). The surface is being sprayed with the 'rainer' built by Peter Berry, which provides a targeted light drizzle. In the foreground, Annette Roe begins the excavation of Burial 15 (Level E).

differences that endured long enough to be recorded. The wind would deposit fresh sand or silt, which quickly obscured the colour contrast. Light rain improved the contrast and stabilised the sand. But heavy rain washed silt over the surfaces and cut channels into the sloping sides of mounds. In winter the moisture content stayed longer, but the wind was high, the light poor and the days short.

It was found that the best conditions could be created artificially in summer, using screens and a spray machine. Various types of agricultural shelter were tried, in order to protect large areas, but they were too low for horizon photography (see below) and ultimately none survived even the summer winds. Smaller, bespoke, shelters and wooden covers were used successfully to protect individual grave excavations. The most essential commodities were sandbags, of which several thousand were used. They buttressed the edges of the excavation, built steps for access, weighed down shelters, supported plank runs used to cross the open surfaces, filled in excavated holes and revetted the spoil heaps. Elaborate sandbag constructions provided access, security and soft protection for standing sections and unexcavated sand-layers during the excavation of burial pits.

With these measures in place, 75 per cent of the time was spent cleaning the surface or keeping it clean. The clean surfaces were viewed and recorded from above in areas no less than 4 × 8 m, to ensure that excavators were not being misled by surface trends seen too close or at too small a scale (see below). Contexts were then defined and excavated. Context definition relied on both colour contrast (the principal determinant) and texture contrast between fill and adjacent subsoil. Where features coincided, the stratigraphically earlier, but locally more strongly contrasted, contexts might be seen first. For example, in Int. 32, F4, a Prehistoric pit, was seen before F9, the Anglo-Saxon grave that cut into it.

Recovery levels used

The system of definition and recording was controlled by the recovery levels assigned by the project design (see Chapter 2); they can be seen operating in Plate 10. The site was opened by hand or machine (see below) at Level A; then shovel-scraped at Level B; then trowelled at Level C. The horizons were mapped using fine trowelling, after spraying, at Level D. When a grave had been recognised and defined, it was dug with a screen or shelter at Level E, using spatulas, pastry brushes and other precision tools. Special targets were addressed at Level F with chemical mapping (e.g. Mound 2 chamber) or lifting en bloc (e.g. Mound 17 bridle).

Recording concept

'Digging and recording' does not really describe the process of excavation at Sutton Hoo. As in many other rural sites, it was rather a matter of 'defining and studying'. The definition was achieved in a hierarchy of recovery levels (see above), and the studies of what was seen and measured were recorded in a hierarchy of records: find, context, feature and structure. A find was anything kept, whether artefact or sample. They were located in two dimensions at Levels A–B, and in three dimensions at Levels D–E. Finds were listed in a Finds Index, and those with significant shape were described in a finds inventory. At Level E finds were also given a Finds Location Record, which showed which way up and which way round they were. This 'skyward indicator' usually took the form of a small, white, sticky patch of paper that showed which part of the artefact had lain uppermost. An arrow on the patch pointed north. A group of Neolithic pits (Group b) in Int. 50 shows the use of the Finds Location Record. The record showed that the pits were lined with large sherds placed concave side in, but refitting after recording and lifting showed that none had joined to the one adjacent (see Chapter 11, p. 401).

All finds were allocated to a *context*, which was the basic stratigraphic unit. Examples of contexts are a layer in a pit, a cluster of stones or a sand body. In general, the more precise the recovery level, the more contexts were defined. At Level A, for instance, the top 250 mm of the site was removed as one context. By contrast, at Level F, inside the Mound 2 chamber, contexts were defined chemically, invisibly to the eye (see below). At Level D contexts were individually planned at 1:10, bulk-sieved and selectively wet-sieved. All contexts were recorded on context cards, e.g. Field Record Y2 (see Guide to Field Reports and Field Records). These written descriptions include Munsell colour and the percentage of components present. Both were used in analyses such as that of the tintogram for Mound 2 (see below). Contexts were numbered from 1000 onwards, with a separate series for each intervention.

Certain sets of contexts were grouped together and defined as *features*. The feature was a higher-order stratigraphic concept involving more interpretation than a context, examples being pits, post-holes and graves. The contexts making up a feature included its edge and its contents. Features were studied on site (while they could still be seen) and were excavated at Level D, or Level E for graves. They were planned at 1:10 and photographed before and after excavation, and a feature card (Field Record Y3) composed; this addressed particular questions about how the feature began and ended. In the field records, features are generally filed with the contexts that belong to them in a 'feature pack'. Features are numbered from 1 onwards (F1…), with a separate series for each intervention.

Certain features were grouped together and defined as *structures*. The structure was a higher order stratigraphic concept involving more interpretation than a feature. Examples

Table 8
List of structures

S1–18	Mounds 1–18
S19	Possible mound over Burial 56
S20	Gallows in Int. 32
S21	IA enclosure in Int. 32: F1 and F130
S22	IA enclosure (west)
S23	EBA boundary ditch Int. 41
S24	EBA double-ditch in Int. 50
S25	EBA double-ditch in Int. 32
S26	EBA house in Int. 41
S27	EBA pit-cluster in Int. 41
S28	EBA pit-cluster in Int. 55
S29	EBA pit-cluster under Mound 1
S30	EBA pit-cluster under Mound 5
S31	BA/IA fence-line in Ints 41 and 48
S32	Lynchet or boundary bank on the west edge of the site (medieval and nineteenth century)
S33	Medieval track crossing the site south-west to north-east (also known as 'Track 1')

Plate 11 Opening the site by machine: (a) a back-hoe served by a dumper, used to remove ploughsoil on Int. 39; (b) use of a machine in the scheduled area (Int. 48), following the confirmation that the turf covered an old ploughsoil. The tracked excavator, a 'Drott', right, removed the turf and then 'ploughed' the surface with the fork on its front bucket. The surface was systematically fieldwalked (background) and metal-detected, and then removed by back-blading (right). On the left, a trowelling-line prepares Horizon 2 on Mound 6.

of structures are burial mounds or the Early Bronze Age boundary ditch. Most structures at Sutton Hoo were defined after the excavation of their component features, and the records are not grouped together. Structures are numbered from S1 in a single series for the Sutton Hoo site (see Table 8).

The excavation was logged, the recovery levels, staffing and recording monitored, and continuous interpretations were sketched in site notebooks, of which there was one for each major feature, each Intervention and for the site as a whole. A long established standard practice on research projects, site notebooks provide an essential chronicle of free observations, reactions, discussions and decisions at all levels, running alongside the proforma-based data acquisition of the stratigraphic units and horizons.

All written, drawn and photographic records are held by the British Museum (field records). Studies of the field records by the supervisors and other specialists will be found in the *Field Reports* (see p. 505 for an index to the *Field Reports*).

Opening the site

The opening of Int. 32 in the fields to the east of the barrow cemetery entailed the removal of modern ploughsoil, and was undertaken (following surface collection: Int. 19) by a wheeled mechanical excavator (Plate 11). The top 200 mm was forked off with the front bucket and the remaining 50 mm scraped with the back-actor (a 'back-hoe' that had had its teeth removed). This usually resulted in a series of adjacent clean surfaces with slight ridges between them, which would be shovelled off by hand.

The evaluation (1983–6) had not indicated whether the ground between the mounds in Zone A was intact or disturbed, so it was assumed that it could be intact, and that the distribution of finds would be diagnostic of settlement. The turf over Int. 41 was therefore lifted by hand, each turf shaken, and the finds plotted to the square metre. Over the area of Mound 5, in which finds might have survived to within a few centimetres of the surface, an attempt was made to kill the turf by smothering it with black plastic (Int. 25). However, after three years this had had no effect and was discontinued.

The turf on Int. 44 was removed by a turf cutter (1988), which speeded the process. Meanwhile, analysis of the finds from the stripping of Quadrant Q in Int. 41 had shown that their distribution indicted material concentrated in mounds and subsequently spread by ploughing (*Bull.* 7: fig. 8; see also Chapter 10). The pattern of the finds was not diagnostic of the Prehistoric settlement but simply of mound-making and relict buried-soil platforms. Plough-marks were also noted on the summit of Mound 7, suggesting that all the mounds had been ploughed and spread.

A new procedure was therefore adopted for the opening of Ints 48, 50, 52 and 55. The turf was removed by a tracked mechanical excavator (a 'Drott') and the remaining topsoil 'ploughed' using the teeth of the Drott's front bucket. The ploughsoil thus created was surveyed by surface collection and metal-detection, with efficiency monitored by salting the area with modern coins. This surface-collection provided a sample of the distribution of finds equivalent to that obtained in the fields. It compared well with the sample that had been laboriously taken from the whole depth of topsoil on Int. 41. In the new procedure, following a surface survey the topsoil was lowered by machine, and the surface (equivalent to Horizon 1) was 'back-bladed'. The surface produced was very clean and level, with a slight ridge between swathes that was subsequently removed by shovel-scraping. At the opening of Int. 50 in 1991 a second 'ploughing' was undertaken, followed by agitation with rakes. This improved the quantity of surface finds in an area where they were relatively sparse, but did not change the overall character of the assemblage.

Horizon mapping

Each intervention containing mounds was divided into *quadrants*, so that continuous sections could be studied from mound to mound (Plate 12). *Leading* quadrants were those excavated first; they were followed by the *trailing* quadrants, which were excavated leaving a 500 mm wide balk along the quadrant boundary. Quadrants were generally lowered to a horizon, at which point the section was drawn and the balks demolished so that the horizon could be viewed in plan before re-establishing the quadrant lines in the same place.

Horizon was the term used for the horizontal interface between the main parts of the soil system. The horizon was similar in concept to the 'primary horizontal sections' used by Brian Hope-Taylor at Yeavering (1977: ch. 2), except that it was not flat but instead attempted to follow an actual interface. At Sutton Hoo, Horizon 0 was the turf itself; Horizon 1 was the bottom of the root mantle, at which point modern features (such as World War 2 slit trenches) became visible. Beneath Horizon 1 was a mixed soil that appeared to have been cultivated, and at the bottom of this soil lay Horizon 2. Between and beside the mounds, Horizon 2 was taken as the top of the subsoil, although patches of buried soil did survive in Int. 32.

Under Horizon 2, on mounds that had survived to a reasonable height, was a varying thickness of mound make-up that had been disturbed (as it transpired by Medieval ploughing, see Chapter 10). When this was removed it gave Horizon 3, intended as a surface belonging to the original, undisturbed, mound make-up and quarry ditch. Beneath the mound make-up lay Horizon 4, the surface of the buried soil, and the old ground surface of the mound builders. This itself was an anciently ploughed soil in which only features of the mound-building period and later were visible. Plough-marks were seen against Horizon 5, about 150 mm down, or against Horizon 6, about 300 mm down from Horizon 4. The soil between Horizons 5 and 6 was dark brown, and showed darker than the soil between Horizons 4 and 5. Under a mound, Horizon 7 was the surface of the subsoil, an average of 400 mm below Horizon 4 (see Chapter 10). It is unclear (and remains unresolved) whether Horizons 5 and 6 represent different ploughing regimes or post-depositional effects.

The majority of Prehistoric features, and most graves, were defined against the subsoil (i.e. Horizon 2 between mounds or Horizon 7 beneath them). Features showed as symmetrical patches, and were defined by their upper fills, which were often dished (or sunken) from the ploughsoil above and which provided the colour contrast with the yellow sand subsoil. Within a few seasons we had learnt to recognise most artificial features, and to distinguish certain natural features also. Among the most prominent of the latter were the so-called 'tree pits'. These were D-shaped in plan, and were thought to be caused by trees uprooted in gales. This interpretation received considerable endorsement from the devastation of the 1987 storm at Sutton Hoo, when large numbers of trees were uprooted.

Records made at Horizon 0 included topography, vegetational patterns and other kinds of non-invasive survey (see Chapter 2). All other Horizons were recorded by horizon mapping (Plate 12). In Int. 32, when excavators were still learning how to see horizons, the soil was removed at up to four 'definitions' and the exposed surface drawn using planning-frames. The plans were not consistent, and contexts sometimes did not join, because the initial definition was uneven and the surface patterns changed as they dried out, causing some context edges to disappear. In May 1987 a new procedure was introduced that separated the recording of the surface from the definition of contexts within it. Horizons were defined by fine trowelling (at Level D) in areas of 4 × 8 m (a 'module') and then photographed in colour from a tower at about 4 m above (Colour Plate 4). Immediately after the photograph was taken, the edges of contexts were marked using white gardening tags pinned to the ground with 2 inch nails. The positions of the tags were then surveyed (Plate 13).

Plate 12 Quadrants laid out over Mounds 6 and 7 at Horizon 2 in Int. 44 in 1987, looking north. The three wheelbarrows are parked on the balk of one of the trailing quadrants; while the partially excavated Medieval track (Track 1) can be seen crossing two adjacent leading quadrants. The two photographic towers can be seen centre left. In the background, Int. 41 is at Horizon 2/7.

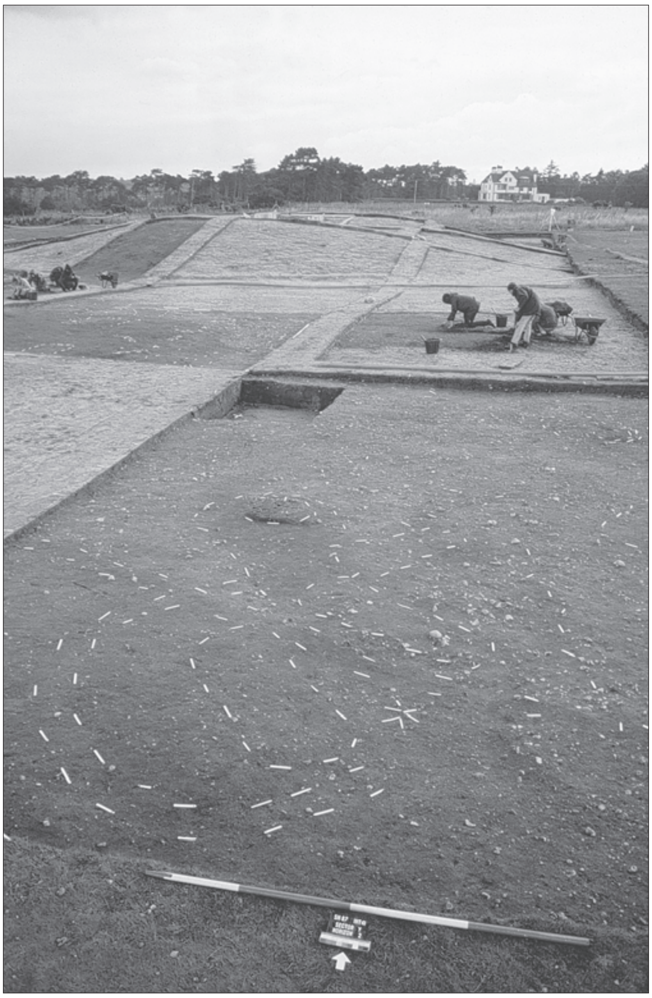


Plate 13 Remote plotting: tagged horizon, S23, and Burial 12.

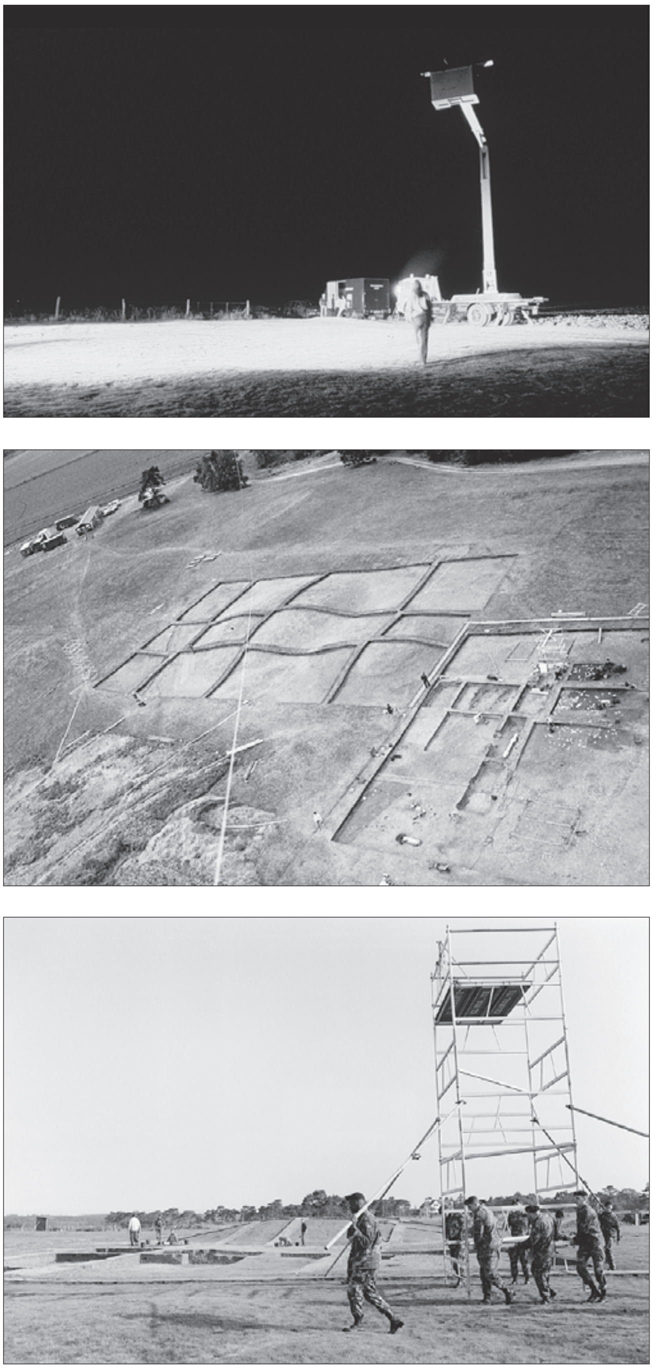


Plate 14 Overhead photography: (a) hi-lift being used to record the surface of the north end of the site at night; (b) kite photograph of Mound 5 under excavation (right). The kite was flown and guided with two strings held by an operator, which are visible in the picture; (c) the larger photographic tower on the move (it could be carried by eight people, in this case some military visitors).

On the flat the new surveying system only required that the tags were located in two dimensions, but the method also needed to be effective on the curved surface of a burial mound. Accordingly (in the days before laser range-finders became available), a method of 'remote-plotting' was devised that used a theodolite and a 4 m aluminium rod, which had a steel millimetric tape fastened to it with glue. The theodolite was set up on a permanent station and aligned to grid north. The base of the rod (known as the 'wand') was placed on a tag and the point measured with cylindrical co-ordinates (two angles and the depth from the horizontal seen on the wand). These were read off and entered into a hand-held computer, a Psion Organiser. A special programme ('PLANET') was written for the Psion, so that it read out the three-dimensional Cartesian co-ordinates, which were used to draw up the plan. Skilled operators could log four points a minute (*Bull.* 5: 21–2). This system served the project until the Total Station Theodolite (TST) came on the market, and we could afford to buy one. The TST did the same job with much greater accuracy, but there was only one on site. Thus PLANET, which ran with three theodolites and three Psion Organisers, stayed in commission for Level D work until the end of the excavation.

The horizon photograph was developed and printed at A4, and the plotted points drawn up on transparent film. The print and the drawing were then compared and the anomalies they depicted were given context numbers; these were recorded on the print on a film overlay and on the drawing by joining the dots. Horizon records were stored in the form of A4 folders containing colour prints of each module at each horizon, and maps generated at 1:50. A horizon plan was captured very quickly (within 15 minutes) of its definition, but it might take twenty-four hours to produce a map checkable on site, by which time the fine detail on the ground had been lost. These problems are now being solved by new hardware, such as the PENMAP

Plate 15 The 'stone-roll': (a) in section on Mound 6, looking east; (b) at the foot of the reconstructed Mound 2.

series, in which plotted points can be fed directly from a TST to a digipad on site, allowing the dots to be joined while the horizon is still fresh.

Photographic procedures (developed by Nigel MacBeth) used the 120 mm colour format for horizon records and 35 mm SLR for records of features, methods and publicity. Finding burials, robber trenches and indeed the edges of the mounds themselves depended on obtaining an oblique view from a vantage point. Various methods were employed for getting aloft – including kite, balloon, helicopter and model aircraft – but the most flexible, controllable and stable for photography was the 4 m tower and its more costly alternative, the 30 m hydraulic hi-lift (Plate 14).

Context definition usually required several trowellings interspersed by systematic spraying. Brushing was advocated by Brian Hope-Taylor, who had used it at Yeavering, and who, on a visit to Sutton Hoo, repeated his famous adage that (used correctly) a brush was the equivalent of 'thousands of tiny trowels'. Brushing was used once in the preparation of Horizon 2 over the whole of Int. 41, but the wind was not strong enough to lift the dust and carry it off site. Given that damp trowelling was generally the most effective method of producing a clean surface, the work was undertaken in 4 × 8 m modules, which could prepared and recorded before they had time to dry out and become opaque.

The most difficult act of definition was that of distinguishing relict buried-soil platforms (Horizon 4) under mounds that had almost vanished, such as Mounds 5, 17 and 18. Under Mound 5, sound and feel were the means by which buried soil that was intact was distinguished from buried soil that had been ploughed. Intact soil made little sound and had a velvet texture; the perturbated version (Context 1147) that covered it announced itself with a tinkle or rattle, due to the presence of fine grits at the base of the old plough-zone. After Context 1147 had been removed, its disturbed status was confirmed by the appearance of the graves it had masked. At Mounds 17 and 18 the buried-soil platforms were only about 100 mm thick, giving rise to the suspicion that we had damaged both through over-machining. However, the depth of buried soil under the lynchet (S31) was of the same order, showing that a major reduction by ploughing had already taken place in, or before, the nineteenth century (see Chapter 10).

Sections were drawn along the quadrant edges and proved particularly valuable in establishing or confirming the location of horizons within and beneath mounds (see below).

Excavating mounds

The principal tasks were to define the mound make-up, the base of the mound, the quarries and the burial pit, and to distinguish these from later trenches and disturbances, particularly by rabbits. The horizon and section system successfully defined the mound platforms, buried soils and quarry ditches. The section was necessary because most layers of mound make-up were not really detectable in plan. The most careful excavator could distinguish very many differences of colour and texture, but was unable to note or remember trends accurately, especially on a curved surface, because the viewpoint was too close and the time taken to remove a layer too long. Kneeling on the ground, an excavator could not resolve the colour- and texture-variables into layers or keep them in mind for the five or six hours it might take to lower the surface of a mound from one horizon to another. In section, however, the eye could see a median line, the height and locus of which could be exactly recorded. Traditional excavators had long known this, but in the British methodological climate of 1987, temporarily taken with recording only contexts and only in plan, it was necessary to rediscover its truth and to insist on its practice.

One example of an anomaly visible for the most part only in section was the 'stone-roll', which proved to be decisive marker. It can be seen in a Mound 6 section (Plate 15:a) as a lens of small pebbles, thickening downwards. It was interpreted as representing the stones that had separated from the last loadings of the mound and had rolled down the slope, coming to rest in the quarry ditch. This hypothesis was later endorsed experimentally (Plate 15:b). The soil above the stone-roll could be interpreted as disturbed mound. In Mound 5, the stone-roll appeared as a ring in plan, marking the true edge of the mound (Colour Plate 5). In Mound 2, the stone-roll put an end to a long struggle to find the inner edge of the quarry ditch, masked by successive swaths of buried soil pulled into it by the plough. The soil below the stone-roll was buried soil or mound make-up, while the soils above the stone-roll were seen as having already been disturbed by ploughing. This reading allowed a short cut in which some 400 mm of disturbed mound was lowered by shovel and wheelbarrow (Level B) against the balks to reveal Horizon 3, the surface of the intact mound.

The excavation procedure failed in two important instances. In Mound 2, the yellow sand upcast was seen in plan but was not mapped, as it was not yet on Horizon 4. It has had to be reconstructed from the sections, where its limits are, however, reasonably clear (see Chapter 6, p. 164). Under Mound 6, part of the north–south section (the upper part of the buried soil) was lost over the winter, through erosion and over-cleaning, so does not appear in the composite drawing (Figure 36).

The problem of defining robbed burial pits had been clear ever since Basil Brown and his colleagues confronted it in their first excavation at Sutton Hoo in a long, drawn out argument for which all parties deserve our sympathy (BBD, 26 July 1938, 'The Controversy'). The robber trenches were sometimes defined in plan (Plate 24:a), but were difficult to follow, being filled with twice re-deposited mound make-up and often having collapsed edges. In practice, the area of the robber trench and the mound were often taken down as one, in spits, and sieved, and the subsequent distribution of cremated fragments (Mound 5) or rivets (Mound 2) was used to infer where the trench had been. A robbed burial mound is very much slower and more difficult to dig than one that is intact. The excavation of robbed burials in Mounds 2, 5, 6, 7, 14 and 18 and the undisturbed burials under Mound 17 followed the stage-by-stage procedure used for graves (below) and is described in Chapters 4, 5 and 6, under the heading 'Description of the investigation'.

Excavating graves

The first intact graves to be contacted were in Int. 32 on the eastern side of the mound cemetery. They appeared at Horizon 2 and were distinguished among the Prehistoric features by their characteristic rectangular shape, which was mapped and photographed before excavation (Plate 16:a). The procedure for excavation and recording (developed by Andrew Copp) adapted standard approaches for skeletons to the sand bodies that these graves usually contained. It was evident from early experience that the bodies lay in unpredictable postures, so no assumptions could be made about how high the body would appear in the grave, or which way up or which way round it was. A *running section* was set along the long axis, and was drawn and sampled at 100 mm vertical intervals. The grave fill was removed in spits of 100 mm (known as 'stages'), each stage being recorded photographically (Plate 16:c) and, when contexts could be discriminated, surveyed. As soon as anomalies from either a body or body-bearer were contacted, the sections were discontinued and the remainder of the grave dug in plan. For this reason, sections through the body-zone are blank or reconstructed (see, especially, graves within quarry pits, Figures 32 and 33). The bodies, together with any primary finds or features, were excavated in their original positions (the 'tableau') and recorded by colour photography and three-dimensional mapping. The body was removed and a final hachure plan made of the empty grave.

Wood appeared as a dark-brown to black sand, which was easily recognizable as such where it ran in a line, as with a plank edge-on (Plate 16:c), but less easily so when it lay next to, or under, a body and had partially eroded. The 'animal joint' in Burial 20 and the 'plough' in Burial 27 are examples of initial interpretations of suggestive shapes probably due to the random rotting of larger wood pieces. Human bodies had generally

Plate 16 Excavation of sand bodies (from top to bottom, left then right): (a) definition of graves at Horizon 2, Int. 32 – note plough-marks; (b) a head appears in Burial 17; (c) a coffin line seen in Burial 20; (d) dismantling the body in numbered samples.

become dark-brown sand, though often less dark than wood in the same grave, and had a crusty feel that distinguished it from wood or the softer grave fill. Thin curved laminae of bone from the skeleton were found inside the sand body jacket, occasionally *in situ* (Plate 17). It was felt important to define the sand body in three dimensions because this was the only sure way of determining its exact posture, which was itself the best evidence for the roles these individuals had played in the Sutton Hoo story. The sand bodies could be kept stable, to a certain extent, with fine spray; but for secure work a weak solution of a proprietary PVA compound was added to the spray. This kept an excavated limb from crumbling while the rest of the body was sought. The compound, known as Vinamul, was made from oil feedstock and was thought not to be invasive or to affect radiocarbon dating – a misplaced confidence (see below). However, Vinamul was successful in allowing the full three-dimensional 'tableau' of the body posture to be recorded photographically.

The creation of permanent three-dimensional records was also attempted using silicone-rubber moulds. These were created by painting hot silicone rubber onto the sand body, which was peeled off when set. The rubber mould took off a millimetre or so of sand with it. It was supported on a fibreglass former and a fibreglass 'positive' was made using the silicone-rubber mould as negative. The results were very true to the original. The fibreglass moulds have proved most useful as a

Plate 17 (a) Sand body, Burial 30; (b) bone beneath the sand body in Burial 30. The brown crust appears to derive from body-matter, within which the skeleton, although thin, was still detectable.

public attraction (Plate 18:a), and one remains on exhibition in the visitor centre.

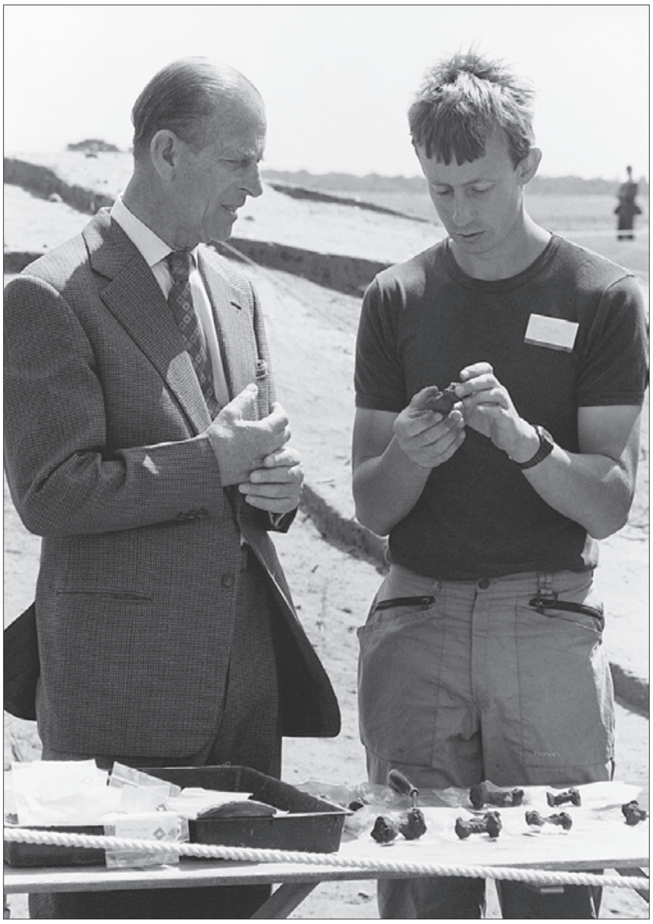
Excavators and their graves were protected from the continuous wind-blown sand by using one stage of an aluminium tower-frame, wrapped around with canvas sheet. When not being worked on, the graves were covered by wooden lids. Excavators used trowels to removed the backfill, and excavated bodies with plasterers' leaves, chemical spatulas, dental picks and pastry brushes. Various aspirators were also tried. However, the battery-powered car cleaner was too feeble, and the generator-driven industrial vacuum cleaner too powerful, for most operations.

Sand bodies were lifted and bagged in the form of numbered samples. The body crust often contained bone; occasionally enough for the body to be aged, sexed and dated (Plate 16; Chapter 9). The formation of the sand body bore on the question of whether there had been a body in Mound 1 (Chapter 1, p. 3), and was of sufficient scientific interest to form the main target of a special project funded by the Leverhulme Trust (see below).

Many of the Group 2 burials were dug into the quarry pits of Mound 5, where the establishment of the stratigraphic relationships was crucial to their interpretation (see Chapter 4, pp. 83–4 and Chapter 9, p. 344). The Mound 5 quarry pits, which contained large quantities of erosion products, were generally cut into quadrants and excavated at Recovery Level C or D, usually before any bodies were suspected or discovered to lie within them. The recovery level employed should have allowed the sighting of any major anomaly in either plan or section. In the event, the height of the grave-cuts, so important for the interpretation of the whole cemetery, proved very elusive, even when the recording was shifted to Recovery Level E. We can be confident that no graves had cut the ultimate quarry pit fill, which was well scrutinised at Horizon 2 and 3. However, very few cuts were seen in the patchy turf layer or the fill beneath it, and in most cases the body was not visible until the quarry pits were nearly empty. At this point, it was sometimes possible to deduce that the grave had been cut from higher up by virtue of a fortuitously placed section. Graves and quarry pits were generally excavated to the apparent limit of their fill. But in some cases (e.g. Burial 49) it was clear that cutting well into the subsoil was the only reliable way of mapping the edge of the feature, which lay behind a mantle in which the subsoil had been slightly re-arranged. This mantle or 'jacket' was only detectable by means of a section cut into the subsoil (a 'box-section'). Recourse to these measures again demonstrated that on sandy sites with poor context definition solely recording contexts in plan was an inadequate prescription, and that sections, whether through mounds or fills, or through fills into subsoil, remain a vital instrument of inquiry.

Finding vanished bodies and investigating taphonomy

The difficulties of defining bodies in graves at Sutton Hoo began with the 1939 excavations, when the Mound 1 ship-burial



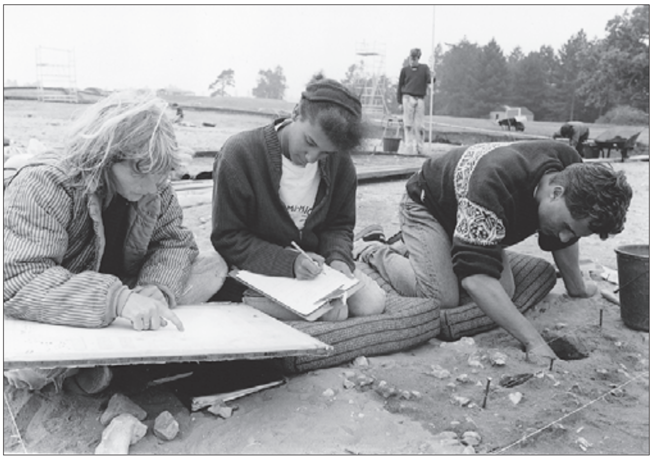


Plate 18 (from top to bottom, left then right) (a) Members of the Sutton Hoo Research Committee viewing the body-moulds on exhibition at the site: left to right, Tom Hassall, Martin Biddle, Birthe Kølbye-Biddle, Rupert Bruce-Mitford, Sir David Wilson; (b) the visit of HRH the Duke of Edinburgh, patron of the Sutton Hoo Society, in 1989, with Andy Copp; (c) a Field School tutorial: Madeleine Hummler, training supervisor, with trainees; (d) children entertaining themselves on site with replica weapons; (e) BBC filming; (f) site tours.

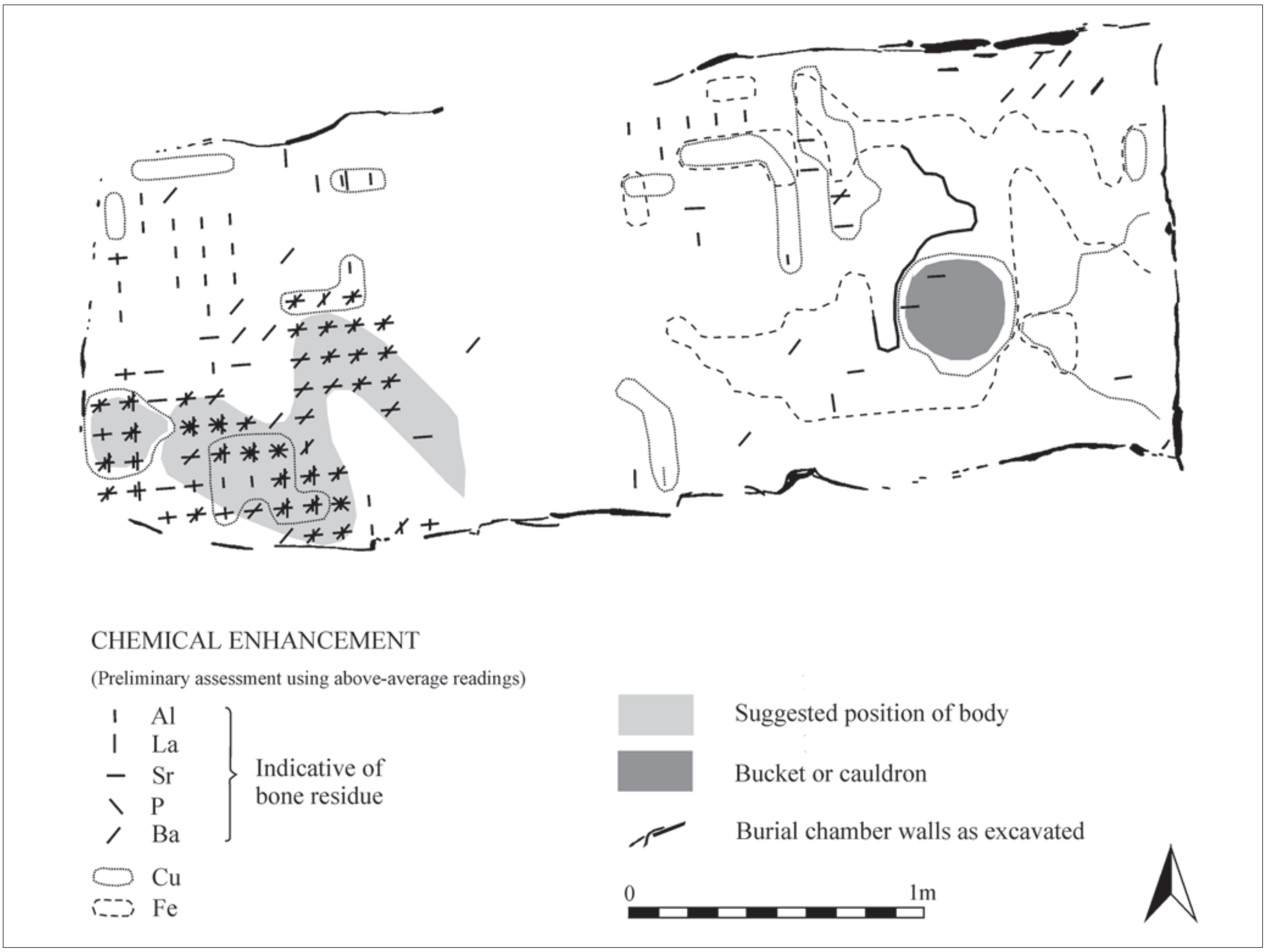


Figure 20 Chemical map of the Mound 2 chamber floor.

famously failed to show traces of the buried man expected to lie there. Rupert Bruce-Mitford commissioned a number of investigations intended to resolve the matter, including the measurement of phosphatic enrichment on grave goods and in sand samples taken from the burial chamber beneath the rivets and/or on a 1 ft grid (SHSB I:529–72, esp. 550–5). The 1983 campaign decided to continue this research, with two aims in view: first, to try to understand the taphonomic process itself, using the sand bodies; and second, to develop methods of chemical mapping that might detect the decay products of a body on the floor of a burial chamber.

Three main projects were begun, supported by a grant from the Leverhulme Trust, in 1986. Within the sand-body graves, samples were taken through the grave fill, body and grave floor to study the migration of organic and inorganic chemicals, and so deduce the way the body had decayed and the sand body had formed. This essentially continued the research undertaken from 1967 onwards by British Museum and Department of the Environment scientists at Mucking, Essex, and described in SHSB I: 564–71. The progress achieved by this first project is described and assessed by Leo Biek at the end of this chapter.

One of the results of the 1986 study of the sand bodies was the discovery of a 'chemical signature' by which a very decayed, even invisible, body could be recognised (at Sutton Hoo). The second project searched for this signature in the base of a robbed burial chamber: the chosen target was Mound 2. In September 1987 the Mound 2 burial chamber was defined beneath a soil mantle that had been left unexcavated by Basil Brown (Chapter 6, p. 161). It was rectangular and lined with traces of timber. Six hundred 30 g samples were taken in a regular array in the chamber floor, and were analysed at the Royal Holloway College by inductively coupled plasma (ICP) spectrometry. This estimated the concentration of elements present in the sample, of which certain cations (for example copper and iron) proved the most diagnostic of vanished artefacts. Concentrations of aluminium, lanthanum, strontium, phosphorus and barium seemed to reflect the former presence of a human body. The picture offered by the analysis is that the body was at the west end of the chamber, while objects of iron and copper were at the east end (Figure 20). The chemical map was combined with other evidence in an attempt to reconstruct the original layout and content of the thrice excavated Mound 2 burial chamber (Chapter 6, p. 164).

The third project was intended to discover how fast the human body and other organic matter buried at Sutton Hoo lost their structure. This was useful for the estimation of the time that elapsed between a burial and any disturbance, and it proved important for the bodies of Group 2 buried around Mound 5. On 13 October 1984 objects made of organic materials were buried in sixteen separate previously excavated features in Int. 22. These features had been cut into subsoil (sand and gravel in that location), excavated and then consolidated with Vinamul (PVA emulsion). The objects were buried in the bottom of the empty features, and the whole trench (Int. 22) back-filled three

Plate 19 Sieving regime: (a) bulk-sieving station, with Mound 2 approaching Horizon 4 in the background. The timber construction in the centre of the mound is the shoring for Int. 26, the exploratory cut into Basil Brown's 1938 trench. The bulk sieves have meshes of 50 mm and 10 mm; (b) (inset) a flotation tank: the two wooden handles belong to the removable 0.5 mm sieve, and a square 0.25 mm sieve to the right catches the flotant; below, the stopcock is for the evacuation of slurry.

weeks later, mainly with humic sand from the spoil heap. The objects lay against sand and gravel subsoil at an average depth of 500 mm from the present ground surface.

The buried objects comprised of a loaf of bread, wood (painted and unpainted), goose feathers, leather, iron nails, raw lamb-meat and red cloth. One set of specimens (except for unpainted wood) was excavated in July 1991, the other being left to continue the experiment. The painted wood (presumed to have been treated with preservative), leather, lamb bone and iron nails were found virtually intact. The meat, feathers, cloth and bread had become completely amorphous, but remained detectable. No staining was noted around the leather or feathers, but a small amount of orange discoloration concentrated under clusters of nails.

The meat was a black, plastic, clayey 'soil' easily separated from the bone. Only a few central 'spine' fragments of the feathers could be recognised, the rest being 10 mm long needle-like pieces in brown clumps. The cloth first appeared as a single, unstained, bright red thread (presumably man-made); the rest (red cotton) having turned into a thin layer resembling fine-grained charcoal. The bread remained as a patch of very dark brown/black humified silt/sand with a high proportion of roots, which made it look more humic than the other organic residues. The loaf's thickness had been reduced from 50 to 5 mm.

It was deduced that a body buried at Sutton Hoo could become a sand body within seven years, but that the bone would then still be rigid. Thus skulls, and other isolated body parts, which were found (as in some Group 1 and 2 burials, see Chapter 9) had probably been disturbed within a few years of burial. The later condition of the body (such as we encountered it) would be less likely to tolerate transport. The experiment proved to be a rough guide only, and a more structured project, with larger specimens buried at a greater range of depths over a longer period, would be needed to produce reliable generalizations about the length of time that body-matter takes to decay to sand.

There were also some attempts to produce a spray that would indicate areas enriched with phosphate. However, the sprayed reagent laid down a rich blue penumbra in which the locus of vanished features was not distinguishable. Experiments were also undertaken with working under ultraviolet and other forms of lighting at night, in the hope of enhancing traces of body or timber in more stable and damper conditions. The method produced no useful results and took its toll on the excavators.

These experiments and investigations delivered some progress in understanding the taphonomy of bodies (see Appendix, p. 58) and produced a chemical map, which was broadly credible. It made less progress in estimating decay times and in developing methods of chemical enhancement for testing blank areas of strata. This remains an important avenue of research.

Sieving and sampling regime

Five separate methods of environmental sampling were applied. All contexts excavated at Level D were sampled and bulk-sieved, in a nest of 10 and 5 mm sieves, for the retrieval of bone and artefact fragments. Certain contexts that contained, for example, traces of visible charcoal, were also sieved by flotation in order to retrieve plant macro-fossils (Plate 19). 'Grab' samples of 30 g were taken from sections at 100 mm intervals in graves, mounds and quarry pits, as well as in major Prehistoric features. Soil columns for pollen and micromorphology were taken from the same places, and from a trench in the valley side beyond Top Hat Wood.

Analyses undertaken

Between 1992 and 2001 the data was analysed at the University of York and in the British Museum. The four main areas of research were on the assemblage, sequences, spatial relationships and radiocarbon dating.

Assemblage

Eighty-five thousand finds were retrieved and indexed. The Early Medieval artefacts (about 300) were studied and conserved in the British Museum under the supervision of Angela Evans of the Department of Medieval and Modern Europe (see Chapter 7). The objects from Mound 17 were conserved in the field in 1991, with the assistance of a British Museum conservation team; the bridle was lifted en bloc, and excavated in the Sturge Basement of the British Museum. The Prehistoric artefacts (about 63,000) were studied by Madeleine Hummler (see Chapter 11). The approach to the Prehistoric material (in accordance with the project design) was selective, and large quantities of pottery and flint have been assessed but not analysed. Cremated and uncremated human and animal bones were studied by Frances Lee, Julie Bond and Terry O'Connor (see Chapters 7 and 9). Soil columns were analysed by Rob Scaife (pollen) and Charlie French (micromorphology). The buried soil was determined to be a podzol from which about 500–700 mm had been removed by quarrying or ploughing – most probably the latter, as the buried soil was under the plough shortly before the mounds were erected (Chapter 10).

Sequence

Stratification diagrams were prepared for burials in which the location of finds or strata were non-random (Mounds 1, 14 and 17). Sections were used to represent examples of the stratification through the mounds and the soil systems beneath them. Context sequence diagrams proved less useful, but for Mound 2 an analysis was devised, using colours and textures, that showed the compositional relationship between all the contexts that made up the mound, the contents of the quarry ditch and the buried soils. This so-called 'tintogram', which purports to show what soil had been used for what purpose, is presented in Chapter 6, p. 170 (see Colour Plate 10). The stratigraphy between mounds was not clearly observed, as they had been ploughed into each other, and could not be used to determine the order of mound-building.

Great difficulties were also experienced in sequencing the deposition of the bodies around Mound 5, the infilling of the quarry pits, the medieval use of the site, the ploughing and robbing of the mounds, and the formation of the tracks and the lynchet. A model was eventually constructed, in which the quarry ditches could be shown to have been back-filled by ploughing between the twelfth century and 1601, when a map showed the track (Figure 206: Track 1) that ran across them. The first robbing had probably also preceded the construction of this track (see Chapter 12).

The minimum original heights of the mounds were computed using the cross-sectional area and volume of the quarry pits. These calculations contributed to the conviction that the mounds had been severely ploughed (see Chapter 10).

Spatial analyses
Spatial analysis was applied to mounds and burials in an effort to deduce an order of building, in default of clear evidence from assemblage, stratigraphy (see above) or radiocarbon dating (see below). The argument is included in a study of the burial rites (see Chapter 8). The spatial analysis of the Prehistoric period was the most productive, mapping Neolithic and Early Bronze Age communities from pit-clusters and pottery scatters (see Chapter 11).

Radiocarbon dating
All bone from Early Medieval contexts was submitted for radiocarbon dating. Two early test dates were undertaken at Harwell (Atomic Energy Authority) and Oxford (Archaeometric Laboratory) and the majority of the other determinations were made by the British Museum Laboratory. Three final datings were done by the University of Belfast. Samples were accepted only where there was sufficient collagen left in the bone. This limited the number that could be examined. Other samples were tested but have been discounted because of the risk of contamination with Vinamul (see comment by Janet Ambers, below). Although this PVA compound was thought to be non-invasive, it could affect the dating: the additional ^{12}C making samples appear older than they are. For this reason the sample from the human burial in Mound 17 appeared older than the horse that lay beside it. Only one radiocarbon determination was made for a Prehistoric context, but other Prehistoric samples are stored in archive.

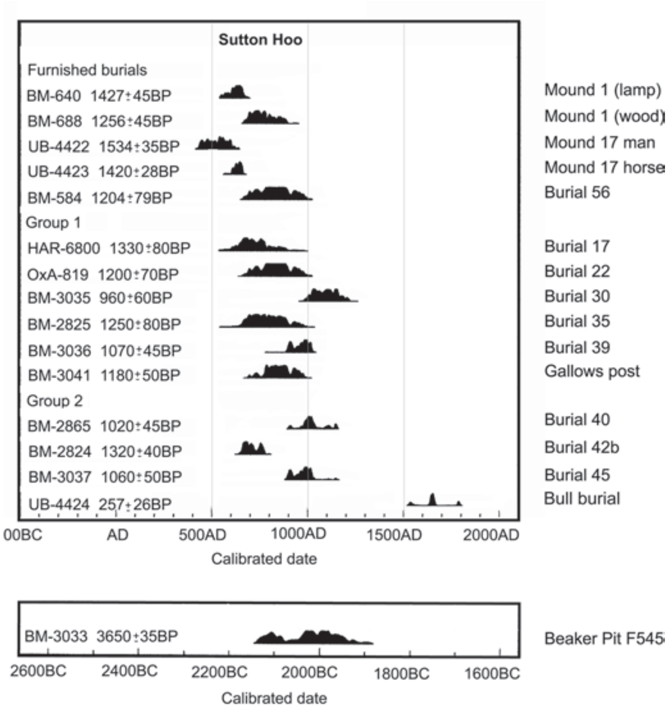


Figure 21 Probability distribution of radiocarbon dates from Sutton Hoo.

Assessment of radiocarbon dates
Janet Ambers

Wherever possible, potential radiocarbon samples were collected from all the burial contexts found at Sutton Hoo, although on laboratory examination many proved not to be viable for reasons discussed below. The samples collected are listed in Table 9, and are displayed here in the form of probability distributions (Figure 21).

Analyses were produced by four laboratories – at the British Museum, Harwell, the University of Belfast (using scintillation counting) and the Oxford Accelerator Unit (using accelerator mass spectrometry) – and the determinations were spread over a period of some years, the earliest being measured in the early 1970s (BM-584, -640 and -688; Barker, Burleigh and Meeks 1971, Burleigh, Hewson and Meeks 1976). Full details of measurement methods used for BM-2824–6, -3033, -3035–7 and -3041 are given in Ambers and Bowman 1999, and for OXA-819 in Gowlett *et al*. 1987. For the laboratory methodology used at Harwell and Belfast, see Walker and Otlet 1988, and McCormac *et al*. 1998, respectively.

Only a limited number of the samples collected from Sutton Hoo could be satisfactorily analysed. One major reason for this, was that the majority of samples were of bone collected from a highly acidic soil. It is well proven that only the protein fraction of bone can be reliably dated (Long *et al*. 1989), and then only if it survives in good condition. If the chemical structure is disrupted, the protein can exchange carbon with the surrounding soil, and so give an incorrect date. At Sutton Hoo protein survival was very poor, and most bone did not yield enough suitable material for radiocarbon measurement.

The nature of the soil occasionally necessitated the use of a consolidator containing carbon, in order to make it possible to lift specimens of bone. This consolidator was manufactured from oil feedstock, and thus contained traces of C_{14} only, but it did introduced small amounts of C_{12} where it penetrated the bone. Two bones so treated, from Burial 9 (the man in Mound 17) and Burial 17 (execution in Group 1), were subsequently submitted for dating, in the belief that the consolidator had not penetrated or could be removed. In retrospect this belief seems optimistic. Penetration by some consolidator is probable, and in this case would have the result of lengthening the measured age by about eighty years for every one per cent of intrusive carbon. The dates for Burial 9 and 17 are thus younger than the results given, by an indeterminate amount, and should be treated with scepticism.

In Burial 9 (Mound 17) a fragment of wood from the coffin was retrieved, but this proved to be of heartwood, and thus considerably older than the date that the wood was used to make a coffin. The sample was therefore rejected for radiocarbon dating.

Caveats should also be applied when interpreting BM-584, -640 and -688, which were all measured some thirty years ago. While there is no particular reason to doubt the broad range of these dates, they should be treated with some caution given the improvements in the scientific methodology for radiocarbon analysis since the time these samples were analysed. The errors quoted are almost certainly underestimates.

Site survey
Initial surveys of the immediate surroundings of the site were carried out as part of the evaluation (see Chapter 2). They included intensive surface collection in Zones D and F, and phosphate and geophysical surveys in Zones A and F. The results allowed the extent of the main Prehistoric settlement area to be mapped and validated (Figure 10). The plotting of features on pre-existing aerial photographs (Chapter 2, p. 21) provided a

Table 9
Radiocarbon dates (J. Ambers, British Museum)

Area	Source	Lab. no.	Material	Radiocarbon result (uncalibrated years BP)*	Calibrated date range (calendar years AD) ** 68% probability	95% probability	date range from probability distribution (see Figure 21)
Mounds							
Mound 1	lamp	BM-640	beeswax	1427 +/– 45	595–660	540–680	early seventh century
	chamber	BM-688	wood	1256 +/– 45	680–810 or 840–860	670–890	centred on eighth century
Mounds 2–7	no viable samples						
Mound 17, Burial 9	human skeleton, F359	UB-4422	bone collagen [possibly contaminated with consolidant]	1534 +/– 35	430–600	430–620	
	Coffin, F356		[only heartwood available]				
Mound 17, Burial 10	horse skeleton, F355	UB-4423	bone collagen	1420 +/– 28	617–656	560–670	early seventh century
Int. 41, Burial 12	child skeleton, F114		insufficient collagen				
Int. 50, Burial 15	inhumation		insufficient collagen				
Int. 50, Burial 16	inhumation		insufficient collagen				
Int. 11, Burial 56	skull	BM-584	bone collagen	1204 +/– 79	690–900 or 920–940	670–990	seventh to ninth century
Group 1							
Int. 48, Burial 17	inhumation, F9	Har-6800	bone collagen [possibly contaminated with consolidant]	1330 +/– 80	620–780	[560–890]	
Burials 18–21			insufficient collagen				
Int. 32, Burial 22	inhumation, F109	OxA-819	bone collagen	1200 +/– 70	720–750 or 770–900 or 920–940	680–980	centred on ninth century
Burials 23–26			insufficient collagen				
Int. 32, Burial 27	'ploughman' inhumation		[contaminated with consolidant]				
Int. 32, Burial 30	inhumation, F173	BM-3035	bone collagen	960 +/– 60	1020–1160	980–1220	centred on eleventh century
Burials 31–34			insufficient collagen				
Int. 52, Burial 35	inhumation, F34	BM-2825	bone collagen	1250 +/– 80	680–880	650–980	eighth to tenth century
Burials 36–38			insufficient collagen				
Int. 52, Burial 39	inhumation, F74	BM-3036	bone collagen	1070 +/– 45	900–920 or 960–1020	880–1040	centred on tenth century
Group 2							
Int. 41, Burial 40	inhumation, F152	BM-2865	bone collagen	1020 +/– 45	900–920 or 970 –1040 or 1100–1120 or 1140–1160	890–1160	centred on late tenth to early eleventh century
Burial 41			insufficient collagen				
Int. 41, Burial 42b	inhumation, F148	BM-2824	bone collagen	1320 +/– 40	660–720 or 740–770	650–780	eighth to ninth century
Burial 44			insufficient collagen				
Int. 41, Burial 45	inhumation, F 55	BM-3037	bone collagen	1060 +/– 50	900–920 or 960–1030	880–1050 or 1090–1120 or 1140–1160	centred on late tenth to early eleventh century
Burials 46–55			insufficient collagen				
Int. 50 cow burial	bull burial, Context 1444, in quarry pit	UB-4424	bone collagen	257 +/– 26	1630–1670 or 1780–1790	1520–1570 or 1620–1680 or 1770–1800 or 1940–1950	centred on 1650
Int. 32 gallows post	post, F165	BM-3041	wood (*Betula* sp.)	1180 +/– 50	770–900 or 920–940	690–980	centred on ninth century
Prehistoric							
Int. 41	Pit, F545	BM-3033	carbonized nuts	3650 +/– 35	2120–2090 BC or 2040–1950 BC	2140–1910 BC	centred on 2000 BC

* Calibrations were generated using version 2.18 of OxCal (Bronk Ramsey 1995), and the INTCAL 98 calibration curve (Stuiver *et al.* 1998).
** Except BM-3033, from the prehistoric period, where the date ranges are calendar BC.

general mapping of the Prehistoric ditch system (*Bull* 6: fig. 8; here Figure 18). The environmental sequence in the valley was studied in a section cut through the valley floor deposits west of Sutton Hoo (Int 53; see Chapter 10, p. 365).

In preparation for the long-term conservation of Sutton Hoo and its presentation to the public, the research team undertook a final programme of recording and management. Zone E, including the area where the National Trust proposed to build a visitor centre, was intensively surveyed (Figure 214, see Chapter 12, p. 475), following up the Early Medieval occupation suspected in 1988. The National Trust commissioned a survey of upstanding antiquities from the Royal Commission (Pattison 2000), and the University of York commissioned a geophysical survey from English Heritage (Linford 2002). The University is grateful to English Heritage and the Sutton Hoo Society for their sponsorship of the geophysical survey.

The Royal Commission survey mapped antiquities that were visible on the surface, on air photographs, or which had been recorded as casual finds. Their findings allowed an appreciation of the tracks and field boundaries in the seventeenth century and later (see also Chapter 12, pp. 460–2). At TM 2882 4886, immediately north of Sutton Hoo, a low semicircular feature was seen which might be the remains of a mound belonging to the mound-cemetery. It lies against a field boundary, and is cut by the track. The purpose of the geophysical survey was to map the extent of the Early Medieval site, as predicted in 1988 (*Bull*. 5: fig. 2), using a caesium magnetometer. This latter instrument was building a reputation for detecting small features (such as post-holes and graves) that had eluded other methods (Doneus, Eder-Hinterleitner and Neubauer 2001: 15–17, 21–23, and 156–158, David *et al*. 2004). Previous surveys at Sutton Hoo had failed to find either the graves to the east of the site, or those suspected north of Tranmer House following the discovery of the Bromeswell bucket (see Chapter 2, p. 20 and Chapter 13, p. 484).

The English Heritage team surveyed an area immediately north of the Sutton Hoo cemetery and immediately west of the Tranmer House cemetery, hoping to map a continuation of the burial grounds in both cases. Both caesium and fluxgate magnetometers were used, and their performances compared. Disappointingly, it was found that, on the particular terrain at Sutton Hoo, little additional detection was achieved by the caesium, as against the fluxgate magnetometer. North of Tranmer House, no ring ditches or likely burial mounds were detected, but the instruments mapped about a hundred anomalies attributable to pits, and these may represent the westwards extension of the Tranmer House cemetery. A group of similar anomalies was found north of the Sutton Hoo mounds, together with a semicircular ditch that might indicate the site of a former barrow.

The surveys thus increased the likelihood that more burial mounds lie immediately north of the Sutton Hoo cemetery. A map of the local Anglo-Saxon geography as so far known (Figure 220, see Chapter 14, p. 495) incorporates the results of these surveys. The site of the new visitor centre was excavated, by Suffolk Archaeological Unit, in the year 2000. It was here that a companion cemetery to Sutton Hoo, at Tranmer House, was brought to light, as reported in Chapter 13. On the Sutton Hoo site itself, now mown and fenced, all mounds were restored to the height they had in 1983, except for Mound 2 which was reconstructed at its calculated height and width in the seventh century (see Chapter 6, p. 171, and Chapter 10, p. 390).

Assessment

The results of the analyses are summarised in Figure 18 and Figure 19, and presented in full in the chapters that follow. A broad Prehistoric sequence was obtained, mainly in the form of evolving land boundaries. However, the economic understanding was limited by a lack of animal bone and plant macro-fossils (see Chapter 11).

The sequencing of the Early Medieval cemetery could be resolved by stratigraphy, and stylistic and radiocarbon dating, into two phases. In the seventh century it was a princely burial ground. Only one of seven excavated mound-burials was intact (Mound 17), but it was still possible to propose the original burial rite practised in the others. The order of mound-building was elusive, though the burials were close to each other in date. The excavation had not offered the anticipated long sequence, but instead indicated a rather short-lived flourish of extravagant ritual, which could be read as a political signal only in the wider context of East Anglia and the countries of the North Sea (see Chapters 13 and 14). Sutton Hoo could now be regarded not as an example of the way that the Anglo-Saxons buried their kings, but as the expression of a particular moment in history.

A second phase of the Early Medieval burial ground was represented by thirty-nine sand-body burials, interpreted as execution burials, which centre on the eighth to tenth centuries. They were disposed in two groups: Group 1 on the eastern periphery and Group 2 around Mound 5. While Group 2 would have been found during any investigation of Mound 5, the discovery of Group 1 was clearly fortuitous. During the design phase, the initial sighting of Group 1 was thought to represent the edge of the main cemetery, which was anticipated to have several hundred such bodies distributed amongst the mounds. In the event, they constituted a small self-contained group of twenty-three executions around a gallows, without any indication of whether other execution sites await discovery elsewhere on the periphery.

Research on the Medieval and later history of the site was in some ways the most taxing as the stratification of the later phases was the most scrambled, through the very ploughing and robbing that were the targets of this part of the investigation. The sequence was eventually resolved, thanks to a combination of stratigraphy, micromorphology and matching the tracks on the ground with those seen on early maps.

The answers to the questions of whether Sutton Hoo is bounded, royal and unique remain equivocal (Carver 1999). The discovery of the Bromeswell Bucket (Chapter 1, p. 12) and the sixth-century cemetery around Tranmer House show that burial, including rich burial, is being practised nearby; but Sutton Hoo, with its concentration of seventh-century mounds and later executions, still retains status as a special burial ground. Although there were probably a number of cemeteries along the left bank of the Deben, present knowledge implies a real change of emphasis in burial practice around 600 AD. The results from Sutton Hoo offer a prominent example of this process (see Chapters 13 and 14).

It is unlikely that the questions which the project failed to resolve could be answered by further conventional excavation. When new research strategies are designed for Sutton Hoo and

Table 10
Costs of fieldwork 1983–92

Item	£ Sterling
Direction and administration (Director contributed gratis by University of York from 1987–2001)	122,720
Excavations: staff and equipment	418,216
Environmental analysis	9,069
Deben Valley Survey	28,390
Archive preparation and preliminary analysis	44,976
Site curation and management	23,962
Total	**639,407**
Grants from Manpower Commission 1986–89 (cash equivalent; dedicated to excavation and site management, including display)	94,785
Total expenditure at the conclusion of fieldwork	734,192

its immediate area, they will need to take into account the fragile and elusive character of what remains and the difficulty of using stratigraphy with any precision. Even at its best, excavation, as presently practised, is likely to destroy more information than it can win in this kind of terrain. Under the executed project design three-quarters of the known cemetery were deliberately left under active curation, to offer a sustainable resource for investigations that use and develop more effective non-invasive methods. New research will also involve a broader template of inquiry, involving other sites in the region that are currently less well known but which form an integral part of the overall social and economic fabric of early East Anglia.

Management

The main fieldwork was completed in May 1992 at a cost of £734,192 (Table 10). The analysis stage that was carried out at the University of York (1992–2001) cost less than £200,000, but this is unrepresentative because the director of the programme (M. Carver) was contributed by the University, and the majority of the cost of artefact analysis and conservation was shouldered by the British Museum. The research report, drafted in 1997, has been reviewed by members the Sutton Hoo Research Trust and others, and now appears as this volume. In 2001 the field records were transferred to the British Museum (see Guide to Records, p. 505).

From 1983 to 1998 the site was maintained by the Sutton Hoo Research Trust. It was mown and kept free of bracken and rabbits by our caretaker Peter Berry, and guarded 24 hours a day. In 1990 a grant from English Heritage enabled the scheduled area to be fenced, which helped to bring the rabbits' tunnelling operations under more permanent control.

In 1992 the site was back-filled and consolidated; the mounds, with the exception of Mound 2, being made up to their 1983 height (see above). With Mound 2, the opportunity was taken to reconstruct to its original seventh-century height (Plate 15) and to observe its rate of erosion. There was very little erosion before the mound and the rest of the site had grassed over naturally, something that had taken place by 1994.

Following negotiations with the landowners, public access was permitted on certain days, and an estimated 75,000 people subsequently visited the site to see the excavations (Plate 18). This was made possible through the good offices of the volunteer guides convened by the Sutton Hoo Society, a charitable organization inaugurated at the Seckford Hall Hotel on 3 June 1984. A further 13.5 million saw the excavations on television thanks to a series of programmes made by the BBC (Plate 18:e).

From April 1983, negotiations were initiated with the landowners (the Tranmer family and their Trustees) with a view to getting Sutton Hoo into public ownership and thereby securing its future (Carver 1998a: ch. 7). Thanks to Mrs Annie Tranmer, her daughter, Valerie Lewis, and her Trustee, John Miller, these discussions resulted in the whole Sutton Hoo estate passing into the hands of the National Trust, who have accepted the responsibility for conserving it and presenting it to the public. Constructed with the aid of a grant from the Heritage Lottery Fund, the National Trust's visitor centre was opened by the poet (and translator of Beowulf) Seamus Heaney on 13 March 2002. It presents a graphic display of the investigations at Sutton Hoo and the discoveries that have been made there between 1938 and 2001, which also form the subject of this book.

Appendix

Scientific investigations on residues recovered from the inhumations

Leo Biek

(edited by Sue Hirst and Martin Carver)

Introduction

The Sutton Hoo ship-burial: 'Was there a body?'

The point of departure for the research project at Sutton Hoo was the Mound 1 burial deposit that was unearthed in 1939. For half a century the fecund minds of Anglo-Saxon scholars have speculated on this question, on which much historical interpretation directly depends.

The most detailed chemical examination of the Sutton Hoo material appeared in Bruce-Mitford's definitive excavation report, under the authorship of Barker *et al*. (1975). The hull area covered by the burial chamber was examined in order to elucidate the pattern of phosphate movement within the chamber. By comparison with controls elsewhere on the hull, it was shown that there was a general concentration of phosphates within the area of the burial chamber. Phosphatic deposits were also traced to some of the grave goods.

In the circumstances, one attractive theory is that the solid wooden hull of the ship would retain water for some time before it decomposed, and would thus create an 'acid-bath' (i.e. 'enclosed reaction vessel') effect for anything lying within the hull. This would give rise to a period of greater ionic/elemental mobility, which may be a useful explanation for some (if not all) of the observed phenomena.

Subsequent excavations at Sutton Hoo by the British Museum during the years 1965 to 1971, and in the later excavations described in this volume, have revealed a vast and complex array of features that have forcefully removed the ship-burial from its splendid isolation. The discovery of two groups of unfurnished, flat graves – one of twenty-three burials on the eastern periphery of the site, and the other, sixteen burials, around Mound 5 (see Chapter 9) – has been of great importance. A characteristic of these graves is the reduction of the body and other organic remains to little more than dark stains in the sand. In some cases bone fragments survive; in others, all skeletal material has disappeared. This does appear to be a phenomenon of acid sandy and gravelly soils. For example, the Early Medieval cemetery at Mucking, Essex, shows a similar level of degradation in its burials (SHSB I: 564–72). The soil at Sutton Hoo is very sandy, with a small colloidal fraction, and is very free-draining. It is also very acidic, with the pH in the central area of the site being about 3.5–5.0. The pH is higher in the surrounding cultivated fields, but this is due to the applications of modern chemical farming.

The physical picture presented by these graves on excavation is as follows: in most cases, the shape of human bones is detectable, and they are generally in the form of dark brown sand, which is distinct from the lighter yellow–brown sand of the soil matrix, and comprise a classic soil silhouette. It could, however, generally be excavated three-dimensionally, so perhaps Biek's term 'pseudomorph' is better, as 'silhouette' implies a more shadowy two-dimensional shape (Biek 1969).

Detailed excavation of these graves showed that four varieties of deposit within the dark stained sand could be distinguished visually: the first is the actual bone, which survives in some cases; the second is a dark brown loam that replaces the bone; and the third is a light brown sand that is intimately associated with the body, but which does not follow the contours of bone (it does sometimes follow the anticipated contours of the body soft tissue, but this may be fortuitous). The fourth deposit type derives from wood, and is quite different from the others, being generally darker in colour and harder, but more powdery, in texture. This is in fact the 'black dust' that enabled the original excavators to trace the outline of the Mound 1 ship-burial in 1939. That this material derived from wood was confirmed by its being located where a coffin stain would be expected. This correspondence has since been used to distinguish quite complex and broken artefacts from the remains of bodies (see, for example, Burial 27, Chapter 9).

Scientific investigations of soil pseudomorphs

Perhaps the earliest work in this area was that done by Bascomb and Biek, who examined a burial silhouette from the barrow excavation at Bishop's Waltham, Hampshire (Biek 1957 and 1963), where the conditions were slightly acidic. It appeared that the darker, stained areas in the body contained about ten times more manganese and phosphorus than the control samples from outside it; the coffin stain contained about a hundred times as much. In a later article (1969), Biek concluded that the most common form of well-developed pseudomorph is caused by manganese (dioxide) deposition within the original site of the skeleton; and that the pseudomorphs are formed during (i.e. as part of) the very process of destruction of the organic structure of the body. It was found that the presence of iron objects in the grave can lead to mineralization of the bone, and confirmed that the presence of copper (alloy) grave goods inhibit microbiological attacks on buried organic material.

A study by Hudson (1974) comprised a quite detailed trace element analysis of a Saxon grave from Mucking, Essex, using emission spectroscopy and atomic absorption spectrophotometry for the quantitative work. The conditions at Mucking consist of (only very slightly) acidic and free-draining sands and gravels (pH 6.6–7.2). Hudson found a relationship between the presence of copper, manganese and phosphorus. Where actual bone remains were present, the phosphorus concentration was naturally higher, but so were those of copper and manganese. In areas of the silhouette with no visible bone, phosphorus, copper and manganese again showed higher concentrations than in the surrounding unstained soil. The manganese measurements from the top to the bottom of the grave were at a minimum directly above the silhouette, indicating that the manganese had been withdrawn into the body area from the immediately overlying soil.

Hudson reported concentrations, particularly in the body silhouette, of elements that show biophile tendencies (i.e. those which are associated with organisms, and so collect in organism-affected horizons): boron, calcium, cadmium, iron, magnesium, manganese, nickel, phosphorus, selenium and zinc. She also felt that organic materials would have an appreciable capacity to fix trace elements by adsorption and/or by chemical complexing in body decay and silhouette formation.

An expanded version of the study (Keeley, Hudson and Evans 1977) listed some data for two other graves from Mucking, previously analysed as pilots, which also shows that manganese concentrations were higher in those silhouettes than in the soil, and also stated that they were much higher than that in living bone (the concentration of copper was lower). Additionally, it quoted from a study (Mishra 1973) that suggested that different forms of phosphate could alter the availability of manganese in the soil. It was felt that the most important characteristic of these soil silhouettes was the manganese enhancement (over the original concentrations in living bone), whereas the levels of copper and phosphorus were not increased by burial, and were more dependent on the concentration of those elements in the surrounding soil.

Yet another study of a Mucking grave was used in the scientific study of material from Sutton Hoo Mound 1 referred to above (Barker *et al*. 1975). The grave's contents were far less acid than those found at Sutton Hoo; nevertheless, the body had almost completely disappeared. The silhouette was analysed for phosphate (P_2O_5), manganese and iron. There was a clear concentration of P_2O_5 in the silhouette, with a 'normal' level above – and a sharp diminution with increasing depth below – the body stain. Manganese was deposited around the lower sides of the grave, and concentrated in the stained area; iron showed no regular pattern of concentration. Barker also found that manganese and P_2O_5 were closely related in their chemical activity within the soil. It was felt that the overall soil conditions (very free drainage, lack of fine-particle fraction, etc.) were responsible for the poor burial preservation, not just the pH.

A final experiment was set up in which 'soil water' at pH 4.5 was percolated through a lysimeter containing Sutton Hoo soil to which phosphate had been added. After some time, all the phosphate was found to have been leached out. Taking this all into account, it was concluded that in the case of the Sutton Hoo ship-burial, the chemical evidence for the original presence of a body had to a large extent disappeared.

The first close examination of material from the flat graves at Sutton Hoo was carried out by Hughes (1980) on two inhumations excavated by the British Museum expedition (here, Group 2, Burials 50 and 51). His aim was to pinpoint reasons for the differential decay of bodies in the flat graves. He analysed samples from bone fragments and the surrounding sand matrix. He found that there was a high concentration of calcium and phosphorus in the bone fragments, but also in the sand at the centre of the body stains which appeared to have no bone remaining. Iron concentration was lower in the bone 'shadow' than in the surrounding sand. Significantly, ten times more manganese was present in the areas of high phosphorus concentration, and Hughes concluded that there was a distinct relationship between manganese and phosphorus in the burials. Hughes also felt that the pH variation he found (6.6–6.8) could not account for the differing states of preservation visible within the same grave.

As regards the organic fraction of the bone, it has been recently shown (R. Burleigh: pers. comm.) that amino acid residues are present in fragments from the Sutton Hoo 'sandmen', but not in sufficient quantities for straightforward measurement. These residues are probably derived from the original bone. The heavily acid conditions at Sutton Hoo would not necessarily be so destructive of the organic, as of the mineral, phase of bone, and these conditions might also serve to inhibit microbiological decay of the organic remains. It is postulated that the mechanism of silhouette formation begins with the liberation and adsorption, to the soil colloids, of phosphorus and collagen breakdown products (peptides and amino acids), and with the formation of organometallic complexes with certain biophile elements present in the soil, particularly manganese. Organic residues from the fleshy parts of the body may also play a part in this process.

The decay products of wood have not been investigated under these conditions. Their darker coloration could be caused by the concentration of carbon in the residue, but this will have to await further analysis.

The Leverhulme Trust project on chemical decay and the detection of organic residues

(Based on Bethell and Miles 1988, Bethell and Smith 1989 and Bethell 1989; for details see FR 9/7, Taphonomy)

This project, managed by P. H. Bethell, was set up in 1987 with the following aims:

1 to characterise and quantify discrimination between grave-fills, body stains and wood stains
2 to detect and enhance such distinctions by chemical means
3 to develop methods of predicting the condition of buried bone on different types of terrain

The analyses undertaken focused on samples taken from the pseudomorph burials of Group 1 (see Chapter 9), which were characterized chemically using Inductively Coupled Plasma Spectrometry (ICPS). The chemical signatures so derived were used to search for the decay products of human bodies on the floor of the Mound 2 burial chamber. Inorganic and organic chemical analyses were conducted by Joanne Smith (née Miles) and Lorraine Stewart at the University of Birmingham, and ICPS determinations were provided by Royal Holloway and Queen Mary Colleges, London. An empirical experiment was also carried out on site, in which various organic materials were buried and re-excavated after an interval (Int. 54, see above).

Inorganic analyses – ICPS Analysis of F235 (Grave 34)

Research by Joanne Smith (née Miles)

A single grave, F235 (grave 34), was sampled exhaustively, so as to have an adequate quantity for statistical analysis. In the event there were twenty-eight samples of body stain, six of coffin stain and one hundred and thirty-one of grave-fill. Eighty-four samples from test pits just outside the cemetery were also

Table 11
Mean concentrations of analysed elements for the body and soil matrix populations and enhancement level in the Royal Holloway ICPS analysis of body samples from F235 (Grave 34)

Element	Background matrix	Body	Enhancement of body over background
% Al_2O_3	1.555	2.400	+
% Fe_2O_3	3.022	2.845	=
% MgO	0.071	0.066	–
% CaO	0.105	0.557	+
% Na_2O	0.089	0.079	–
% K_2O	0.373	0.335	–
% TiO_2	0.100	0.083	–
% P_2O_5	0.078	0.850	+
% MnO	0.028	0.028	=
Ba ppm	127.300	183.500	+
Ce ppm	16.000	29.000	+
Co ppm	5.300	17.400	+
Cr ppm	15.400	23.900	+
Cu ppm	14.300	12.000	–
La ppm	7.000	9.500	+
Li ppm	8.600	8.600	=
Mo ppm	0.900	2.100	+
Nb ppm	2.400	2.100	=
Ni ppm	16.500	17.000	=
Sc ppm	2.000	4.200	+
Sr ppm	21.500	23.700	+
V ppm	26.400	24.300	=
Y ppm	4.200	7.400	+
Zn ppm	46.900	52.000	=
Zr ppm	26.900	27.200	=

+ body enhanced over background
– background enhanced over body
= background and body the same

Table 12
Ordered table of tests of significance for the Royal Holloway ICPS analysis

Element	Probability that the two populations have the same elemental composition	
Aluminium	0.0000	Group A
Cerium	0.0000	
Cobalt	0.0000	
Lanthanum	0.0000	
Molybdenum	0.0000	
Phosphorus	0.0000	
Potassium	0.0000	
Scandium	0.0000	
Titanium	0.0000	
Yttrium	0.0000	
Calcium	0.0003	Group B
Sodium	0.0006	
Copper	0.0012	
Chromium	0.0014	
Barium	0.0140	
Magnesium	0.0210	
Strontium	0.0260	
Niobium	0.0630	Group C
Zinc	0.1200	
Vanadium	0.1500	
Nickel	0.4000	
Iron	0.5800	
Zirconium	0.6900	
Lithium	0.9700	Group D
Manganese	0.9800	

analysed (to reflect a background that was presumably unaffected by human activity relevant to the present study). In each case, samples of *c*.30 g were sent to two laboratories for parallel determinations of the quantities of twenty-five selected elements (for method, see Walsh and Howie 1980).

The results of the ICPS carried out at Royal Holloway College in 1986 indicate that there is a significant enhancement in the elemental compositions of body stain over grave-fill samples for aluminium, calcium and phosphorous (present in quantities greater than 10^{-3} g/g sample, Figure 22a) and barium, cerium, cobalt, chromium, lanthanum, molybdenum, scandium, strontium and yttrium (present in quantities less than 10^{-3} g/g sample, Figure 22b). A significant depletion in body stain with respect to grave-fill samples was observed for magnesium, sodium, potassium and titanium (present in quantities greater than 10^{-3} g/g sample, Figure 22c), and copper (present in quantities less than 10^{-3} g/g sample, Figure 22d). There is no statistically significant difference in the concentrations of niobium, zinc, vanadium, nickel, iron, zirconium, lithium or manganese (Table 11 and Table 12). The similarity of the manganese concentrations of the grave-fill and body samples is in contrast to the results obtained at the higher pH site at Mucking.

Results from the parallel run at Queen Mary College showed a similar lack of difference in manganese composition of grave-fill and body samples (Figure 23, Table 13). However, there is an isolated group (*c.* five per cent of total samples) of the Queen Mary College ICPS results for manganese that shows values higher than the rest by a factor of two. In about half of the samples analysed by Queen Mary College, iron has the largest absolute presence. These are all in grave-fills and 'concretions'. Only in the four 'body' stain samples does aluminium exceed iron.

Al^{3+} is an acidic cation that becomes more evident, with the largest absolute quantities, as the pH falls. One hypothesis for the coincidence of the manganese compositions in the Sutton Hoo grave-fill and body samples is that manganese has been substituted by aluminium in the decomposition processes. Further statistical analysis is required to demonstrate the covariance of the elements.

Comparative ICPS analyses carried out on 490 samples from the very heavily robbed burial chamber in Mound 2, where no visible body traces remained, resulted in similarly enhanced values for aluminium, barium, lanthanum, phosphorus and strontium. These were concentrated in the south-west corner of the chamber, and were interpreted as indicating the probable former presence of a body.

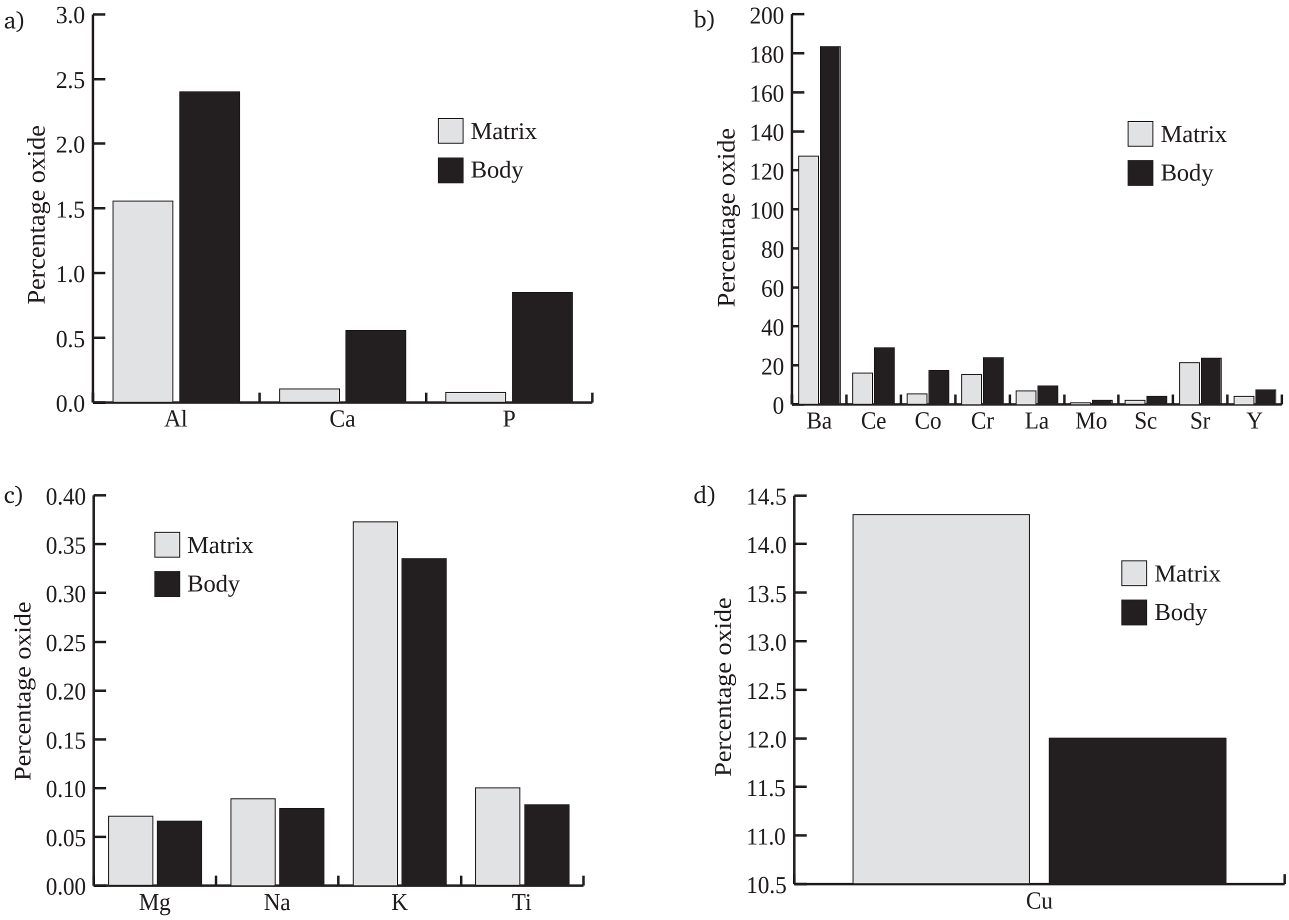


Figure 22 Histograms showing significant differences in the amounts of elements in matrix (grave-fill) and body stains: a and b – significant enhancement in body stain over matrix; c and d – significant depletion in body stain with respect to matrix.

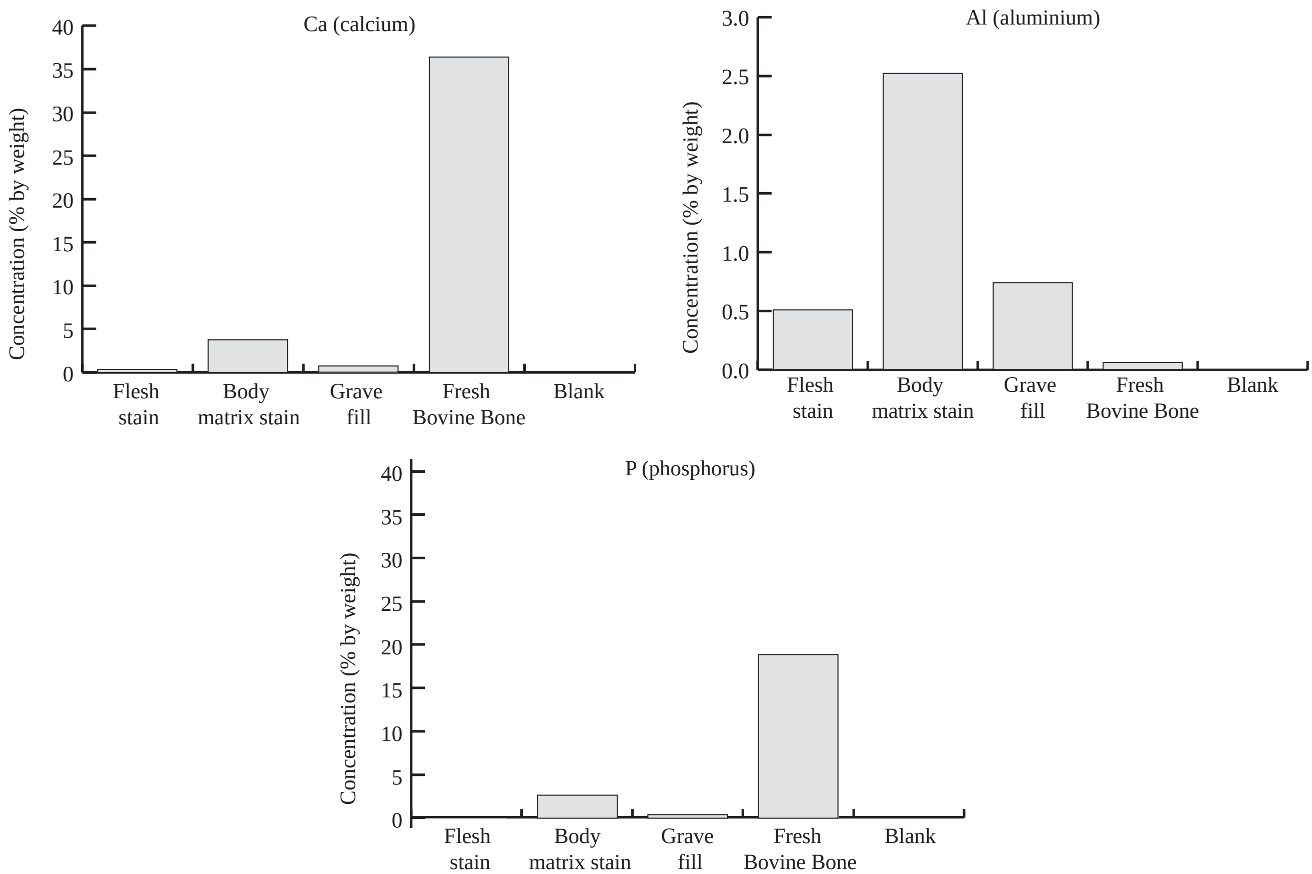


Figure 23 Histograms showing differential concentration of calcium, aluminium and phosphorus between different samples in the Queen Mary College ICPS analyses.

Table 13
QMC ICPS analyses (weight %) of samples from F235 (Grave 34)

Sample identifier		Aluminium	Iron	Magnesium	Calcium	Sodium	Potassium	Titanium	Phosphorus	Manganese
A	Flesh stain	0.51	1.96	0.05	0.33	0.06	0.04	0.01	0.13	0.02
B	Body matrix stain	2.52	1.08	0.06	3.78	0.18	0.03	0.01	2.63	0.02
C	Grave fill	0.74	2.05	0.06	0.72	0.13	0.04	0.01	0.40	0.02
L	Fresh bovine bone	0.06	0.05	0.57	36.42	0.76	0.04	0.01	18.87	0.00
M	Blank	0.00	0.00	0.10	0.10	0.00	0.00	0.00	0.00	0.00

Investigation of methods for enhancing discriminant patterns of aluminium concentration in the field

Research by Lorraine Stewart

Methods of detection and identification proposed for aluminium (e.g. Black 1965) were investigated and adapted for field use, and were also applied to a study of a series of soil samples from F235, in order to determine the proportions of exchangeable (EXCA) and extractable (EXTA) aluminium.

Field use was found to be only moderately successful, though capable of further development. Mean values in F235 for EXCA were *c.*3.2 mg/g of soil sample in the body stain, as against *c.*1.2 mg in the grave-fill; and for EXTA, *c.*3.7 mg as against *c.*1.5 mg.

Organic analyses

An extensive study of the organic properties of soils associated with burials at Sutton Hoo was undertaken at the University of Birmingham by Lorraine Stewart (Stewart 1990). The objectives included methods of extracting and identifying humic substances and using them to discriminate between the body pseudomorph and the grave fills. Analyses included measurement of the content of carbohydrates and amino-acids using NMR and IR. Variations between the body and grave fill in cation exchange capacities and in the degradation of humic components were also studied.

Samples collected during 1987 and 1988 fall into two main categories: those consisting of background material (matrix) filling the graves (grave-fill); and those from the body 'pseudomorph' or silhouette. The work was designed to establish any differences between the organic components of the two categories. Humic substances were successively extracted by sodium hydroxide, dimethyl sulphoxide in hydrochloric acid (DMSO:HCl), and sodium pyrophosphate. Aliquots of these extracts were subjected to sequential degradation: first by sodium amalgam, a mild reductive procedure, next by sodium in liquid ammonia, and finally by alkaline potassium permanganate.

Extensive work was carried out on the reduction of humic substances by the sodium amalgam technique in order to determine the best conditions for this reaction and its mechanism(s). This was necessary to establish whether the extracted humic macromolecules had lignin origins, or whether they were synthesised from the body's residues by soil micro-organisms. Humic substances are classified on the basis of their solubility (see Figure 24).

General conclusions

Although the humic acids extracted with acidified DMSO and sodium hydroxide seem to have basically the same conformation in solution, they appear to have dissimilar functional groups. The sodium hydroxide and sodium pyrophosphate extracts have more similar groups. The latter two also contain more carbohydrates and amino acids than the acidified DMSO extracts. However, the aromaticity (molecular benzene-ring structure content) of the acidified DMSO and sodium hydroxide extracts is greater than that in the sodium pyrophosphate extract.

More humic material is generally extractable from body than from grave fill samples, using the same standard alkali procedure. The body humic acid samples have a greater concentration of carbohydrates (probably microbial in origin), and considerably larger concentrations of amino acids. Above the body, rather than below it, cation exchange capacities were higher, that is more acidic, and thus were possibly richer in aluminium. The component molecules of the humic acids seemed to be more resistant to degradation in the body than in the grave fills.

Most of the soil organic matter was bound to clay particles. This confirms that the clay is the most chemically active of the three fractions of soil particles in relation to humic substances. The clay of both body and grave-fill fractions seems to be composed of three or more clay minerals associated with feldspars.

The organic matter in the grave-fill clay fraction seems to be loosely adsorbed to the surface of the clay. In the body sample it appears to be wedged between the planes of the minerals associated with the clay minerals.

The enrichment of aluminium in the body stain (see above) is likely to be related to the association of humic substances with aluminium in the soil. This may have come to be bound to the humic substances by chelation and strong covalent bondings. These bonds would be difficult to cleave, hence the aluminium (as well as the humic substances) would be stabilised in these regions. However, it is evident that the grave-fill regions do not contain much humic material, hence the aluminium would not be firmly bound in these regions, and could be readily leached from the soil.

From inspection of ICPS results for background samples, taken from test pits just outside the cemetery (Bethell and Smith 1989: 49, 51), it would seem as if the original elemental composition of the soil provides a clear and unequivocal control. It is thus possible to suggest, at this stage, that the concentration of aluminium is due to the interment of the body, rather than being originally present in the soil in great abundance and simply held *in situ* by the organic matter derived from the decomposition of the body. However, this may need to be confirmed in detail in due course.

Despite the lack of any specific correlation between body stains and patterns of phosphorus, it is clear that there is a strong statistical enhancement. It seems, therefore, as if the basis for silhouette formation needs to be sought, after all, in the

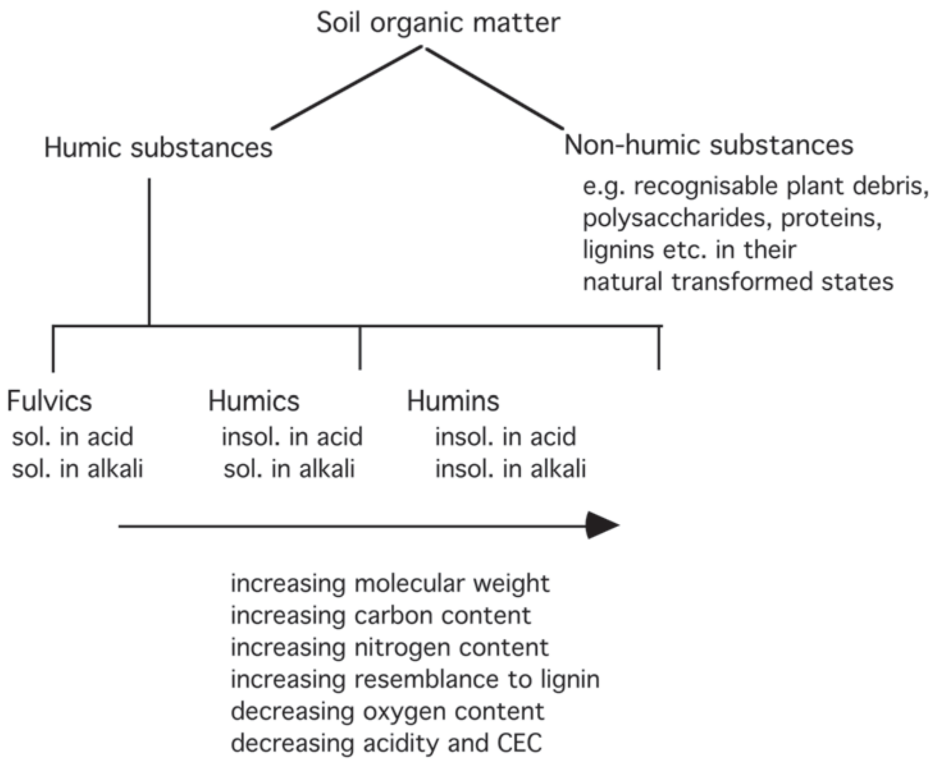


Figure 24 Schematic representation of the classification of soil humic substances; adapted from Stevenson 1982.

burial history of this element. Phosphorus is a major nutrient for the soil microbial population, and so it is likely that factors controlling the decomposition of the bone material centre around the microbial attack on bone phosphate. This is supported by the sharp peak, at a low phosphorus level, of the samples in the grave-fill. This suggests that the microbial population was using all the phosphorus that became available in the soil, and could therefore be considered to be phosphorus limited.

Most phosphorus exists in soil in strongly adsorbed insoluble inorganic forms; the remainder occurs as organic phosphorus, which is the major source of phosphorus for the soil micro-organisms and mesofauna. The phosphate of nucleic acids and nucleotides is rapidly mineralized (i.e. converted to inorganic forms) until the carbon to phosphorus ratio rises above approximately one hundred. Where organic material has a carbon to phosphorus ratio over one hundred, phosphorus is immobilised by the micro-organisms, especially bacteria, which have a relatively high phosphorus requirement (1.5–2.5 per cent phosphorus by dry weight, compared to 0.05–0.5 per cent for plants). Some groups of micro-organisms secrete organic acids, such as a-ketoglucuronic acid, which attack insoluble calcium phosphates, and release the phosphate to the soil solution. Bacterial phosphate residues comprise mainly the insoluble calcium, iron and aluminium salts of inositol hexaphosphate (phytates).

One hypothesis that merits further investigation is that the dark body stain, rich in calcium, aluminium and phosphorus, is composed of these bacterial phytates. The orthophosphatic anions ($H_2PO_4^-$ and HPO_4^{2-}) that are released by mineralization are rapidly adsorbed by soil particles, and their availability steadily declines with time, as they are occluded within clay mineral and discrete sesquioxide particles, or are transformed into insoluble inorganic compounds. Amorphous $AlPO_4$ and $FePO_4$ compounds with aluminium-to-phosphorus or iron-to-phosphorus mole ratios of approximately one, can form in acid soils, especially in the vicinity of a dissolving granule of superphosphate fertiliser. Above pH 6.5, phosphate forms insoluble salts with calcium.

A second hypothesis is that the dark body stain is composed of amorphous $AlPO_4$. The investigations reported above indicate higher levels of humic substances in the body samples than in the grave-fill. The cations Al^{3+} and Ca^{2+} are both strongly bonded to $-COO^-$ groups in humic substances, which coil around the cations, making them unavailable for further reaction.

A third hypothesis is that the dark body stain is composed of alumino-humic complexes. This hypothesis is supported by the loamy texture of the soil, but does not account for the increased phosphorus levels.

Another way of looking at the evidence focuses on the role of calcium under these variable and conflicting conditions. Clearly the effect of a variable pH will be fundamental, as appears from the various points made above: strongly adsorbed insoluble calcium phosphate, attacked by organic acids, releases phosphorus *and* calcium to the soil solution, which returns back to bacterial residues containing insoluble calcium phytates, and is followed by mineralization producing insoluble inorganic calcium phosphate above pH 6.5. Add to this the recrystallization of buried bone; then the organic chemicals, with $-COO^-$ groups coiled round calcium (and other) cations; and finally microbial influences: and the pH will shift and accommodate the changing conditions with alarming speed, so that it is very difficult to 'freeze' it and study the transformations taking place. On the other hand, the exact form and state of the calcium to phosphorus balance at any given stage provides a marker that could enable a reaction map to be produced.

The mechanisms of organic decomposition in soil are extremely complex. Soil pH, clay content, sesquioxide content and exchangeable Al^{3+} all influence the availability of phosphorus. This, in turn, will determine whether phosphorus availability, and the rate at which phosphorus in the bone is initially attacked, limit the microbial population in the soil. The rate of growth of the microbial population is highly dependent on the temperature and moisture content of the soil. All these factors make it impossible to devise a 'rule of thumb' to predict whether ancient remains will be fully or partially decomposed. A fully dynamic, process-based model of phosphorus turnover has the potential to predict the state of ancient remains *before* the soil is disturbed. Future work should develop a predictive decomposition model specifically for archaeological applications.