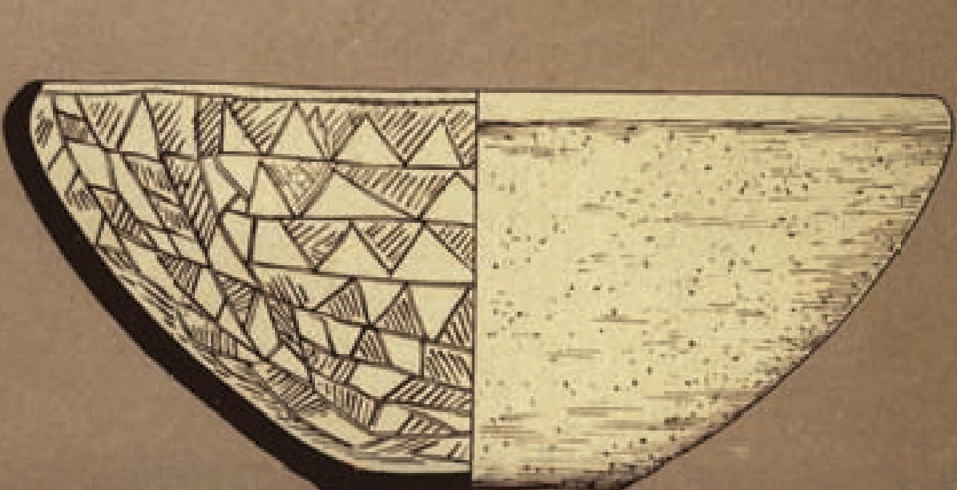
Department of the Environment

Archaeological Reports No 11

GRIMES GRAVES, NORFOLK

Excavations 1971–72: Volume I

by R J MERCER



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Excavations 1971–72: Volume I

R J MERCER MA FSA

WITH CONTRIBUTIONS BY
J G Evans, H Jones, C Keepax, R P Kenward,
A J Legge and I H Longworth

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Note Volume II contains The Flint Assemblage *by A Saville*

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Summary

Excavations conducted in 1971 and 1972 examined a previously undisturbed (1971) flint mine shaft at Grimes Graves, in the parish of Weeting, Norfolk. Examination was also undertaken of a substantial surface area around the shaft yielding information concerning the nature and form of prehistoric overburden tips associated with the mining process and working areas where implements had been manufactured upon the mined flint. Evidence was also retrieved of a secondary phase of occupation of the site during the Middle Bronze Age, a detailed picture of the economy and nature of this occupation being constructed by analysis of a considerable body of midden debris introduced into the top of the second (1972) flint mine shaft. The totally excavated 1971 flint mine shaft yielded evidence of the working practices of the mining process and produced clear chronological and cultural definitions of the mining population. The detailed study of the flint assemblage by Alan Saville will appear in Volume II of this report.

Introduction

Since 1931 the site of Grimes Graves has been within the Guardianship of what is now the Ancient Monuments Branch of the Department of the Environment. During this time an attempt has been made on the recommendation of the Ancient Monuments Board for England to display certain of the shafts to the public in an excavated state. The conditions of access and preservation in these two displayed shafts (Pits 1 and 15) has long been felt to be unsatisfactory by those concerned with the site. Eventually, in 1970, Pit 15 had to be closed to further public access on the grounds of safety. It was then felt that the time was ripe, in view of both the recognised need for public display and in view of the advances made in archaeological technique and our understanding of the later Neolithic period in this country since 1939, for the excavation of a further shaft and its immediate environs to take place. A final decision was reached on this point in the latter part of 1970. A careful programme of research followed in order that a shaft should be chosen that, first, should in its excavation satisfy as many of the archaeological aims of the project as possible and, secondly, should be one *prima facie* adapted to public display. A final choice was made in February 1971 and the excavation took place between April 19th and November 21st of that year (with a five week break during August). A further short season took place between 6th March and April 16th 1972 to complete excavation of the surface area opened in 1971.

Acknowledgments

I owe a great debt of gratitude to the large number of people who at all stages of the project have given so freely of their skills and experience. For invaluable encouragement, advice and help at its inception I owe my thanks to Andrew Saunders, then Principal Inspector of Ancient Monuments for England, Professor Grahame Clark, and the various staff of the Department of the Environment Ancient Monuments Branch in East Anglia whose co-operation and active help made the project—with its considerable material requirements—at all possible. Paul Ashbee with his invaluable experience of shaft excavation and Gale Sieveking with his knowledge of the site and its material have also given valuable advice during and after the excavation.

During the excavation itself I became greatly indebted to Miss Penny English, Miss Frances Healey, Miss Marjorie Robertson, Mr Jeremy Poster, Mr Alan Saville and Dr Stephen Shennan, all of whom assisted me on site for extended periods of time—often under extremely rigorous conditions. My thanks are also due in great measure to the team of workmen I had on site under their foreman Mr Dennis Frost, who worked most willingly in arduous and often difficult circumstances. In their willing treatment of material from the site since the excavation and their submission of specialist reports I am especially indebted to Mrs Robin Kenward, Dr Carole Keepax, Dr Susan Limbrey, Dr John Evans, Mr A J Legge, Dr Ian Longworth and Mr Alan Saville. And for their help in many aspects of the actual preparation of this report I must thank Miss Alison McIntyre and Miss Alison Cook (Ancient Monuments Publication Section).

For the massive and excellent series of drawings that accompany the report on the flintwork for the site I must thank Mr Frank Gardiner and his team of illustrators working in the Ancient Monuments Drawing Office, Fortress House, London.

Lastly I must pay tribute to my wife Susan, who was on site for every day of the excavation, has executed all the drawings of pottery, chalk objects and bone implements in this report and has been of the greatest help in reading through and commenting on the text.

R J Mercer MA, FSA

Lecturer in Prehistory, University of Edinburgh

Chapter I
The Excavation

Location and Description of the Site

The site is 9.6km (6 miles) north west of Thetford and 4.8km (3 miles) north east of Brandon, near the Norfolk/Suffolk border, at grid reference TL 820 900. Itself situated on the low rise from a shallow dry valley, it lies on the reverse slope from the valley of the Little Ouse River. The river itself lies about 1.6km (1 mile) to the south of the site (See Figure 1, Plate I).

The site lies in the heart of the Breckland but towards its eastern edge and is situated directly on the important east–west route formed by the Little Ouse valley. It also lies nearly athwart the chalk ridgeway (the Icknield Way) on the main south west–north east route to Wessex.

The subsoil on the site is a glacial till composed of fine sand with small pebbles and beneath this at a depth of about 1m the irregular surface of the cryoturbated chalk appears. This frost-contorted band of chalk penetrates to a depth of some 2–2.5m and thence the hard natural chalk takes over. The entire area around the site has been developed as a forestry estate in the years since the 1930's, with plantations of conifers. However, the area within the guardianship of the Department of the Environment has not been planted and has seeded back to a natural cover which is periodically cut down and cleared. This cover includes hawthorn, elder, ash, sycamore, oak, hazel and dogrose. Despite the periodic attempts to curb this encroachment, it has persisted and the site is now under a fair cover of saplings as well as grass and bracken. The site covers an area of c. 9 hectares (20–21 acres) and is indicated by a closely juxtaposed series of over 360 saucer-shaped depressions ranging from 6–20m in diameter and from being virtually imperceptible to 6–7m in depth. These depressions mark the sites of filled shafts, and small mounds mark the sites of overburden dumped by the miners. Doubtless many shafts remain to be discovered and some of the shafts run into one another to form conjoined complexes—a feature brought about possibly by the collapse of joining galleries. At the eastern end of the site a mound larger than others on the site stands at the summit of the rise which is known as 'Grimshoe'. Often described as a barrow it appears from surface indications and from previous excavations on the site to be composed of shaft spoil.

The Flint

Embedded in the chalk beneath its surface are three upper seams of flint. These have become known to generations of flint knappers in the area as 'topstone' or 'toppings', 'wallstone' and 'floor stone'. The two uppermost seams (topstone and wallstone) are composed of weathered nodular flint being often inconveniently shaped from the point of view of working and inconsistent in fracture. Beneath these two seams, separated from the wallstone by 2.5m of chalk is the floorstone—a flint occurring in very large tabular nodules approximately 15cm in thickness with a heavy cortex on its base. The fracture of this flint is consistent and highly predictable. These qualities have made this flint much coveted by flint knappers of the recent past at Brandon and were presumably responsible for the attraction it held for prehistoric miners on the site. The even thickness of its tabular form and its predictable fracture would have rendered it extremely suitable for the mass production of fairly heavy edge tools. The angle of plane of the floorstone slopes very gently downwards to the south east so that as the valley slope also rises in this direction the floorstone becomes more and more distant from the surface. In the bottom of the dry valley to the north very shallow pits 2–3m deep were all that were required to locate the floorstone. However, at the top of the slope on the south east extremity of the site the shafts plunge 12–13m below the surface to reach the desired flint seam. The place-name 'Grimes Graves' is presumably of Germanic origin and contains the elements for the Devil (Grim) and Diggings or Hole (Grave).

Previous Work on the Site

This report cannot be the place for a complete synthesis of all work that has taken place over the last century on this much-explored site. However, a brief summary of the results of each season's excavation, with references to the literature, will be attempted.

Apart from surface activities which failed even to establish the nature of the site, carried out in 1852 by the Rev S T Pettigrew and in 1866 by the Rev C R Manning, the first recorded full-scale archaeological investigation of the site was undertaken between 1868 and 1870 under the direction of the Rev Canon Greenwell, assisted in 1870 by Lord Rosehill. Greenwell published his findings in a privately circulated paper printed under the auspices of the Blackmore Museum, Salisbury (Greenwell 1870B) and also in a paper given before the Royal Ethnological Society of London in that year (Greenwell 1870A, 419–439). Lord Rosehill gave a summary paper before the Society of Antiquaries of Scotland also in this year—a paper which was to be included in the Society's Proceedings for 1868–70 (Rosehill 1871, 419–428). The investigation was an auspicious beginning to the long series of excavations on the site.

Greenwell examined one of the saucer-shaped depressions about 1.3m deep and some 8.6m in diameter situated on the easterly extremity of the site. He was not prepared for what he encountered. After three lengthy annual seasons, in which his workmen excavated the shaft by carrying baskets of earth up a series of ladders, he reached the floor (in ⅓ of its area) of a shaft 12m deep and 3.8m in diameter at its base. Galleries opened out from the shaft in all directions where the shaft wall was exposed. When explored (very briefly) large numbers of antler picks

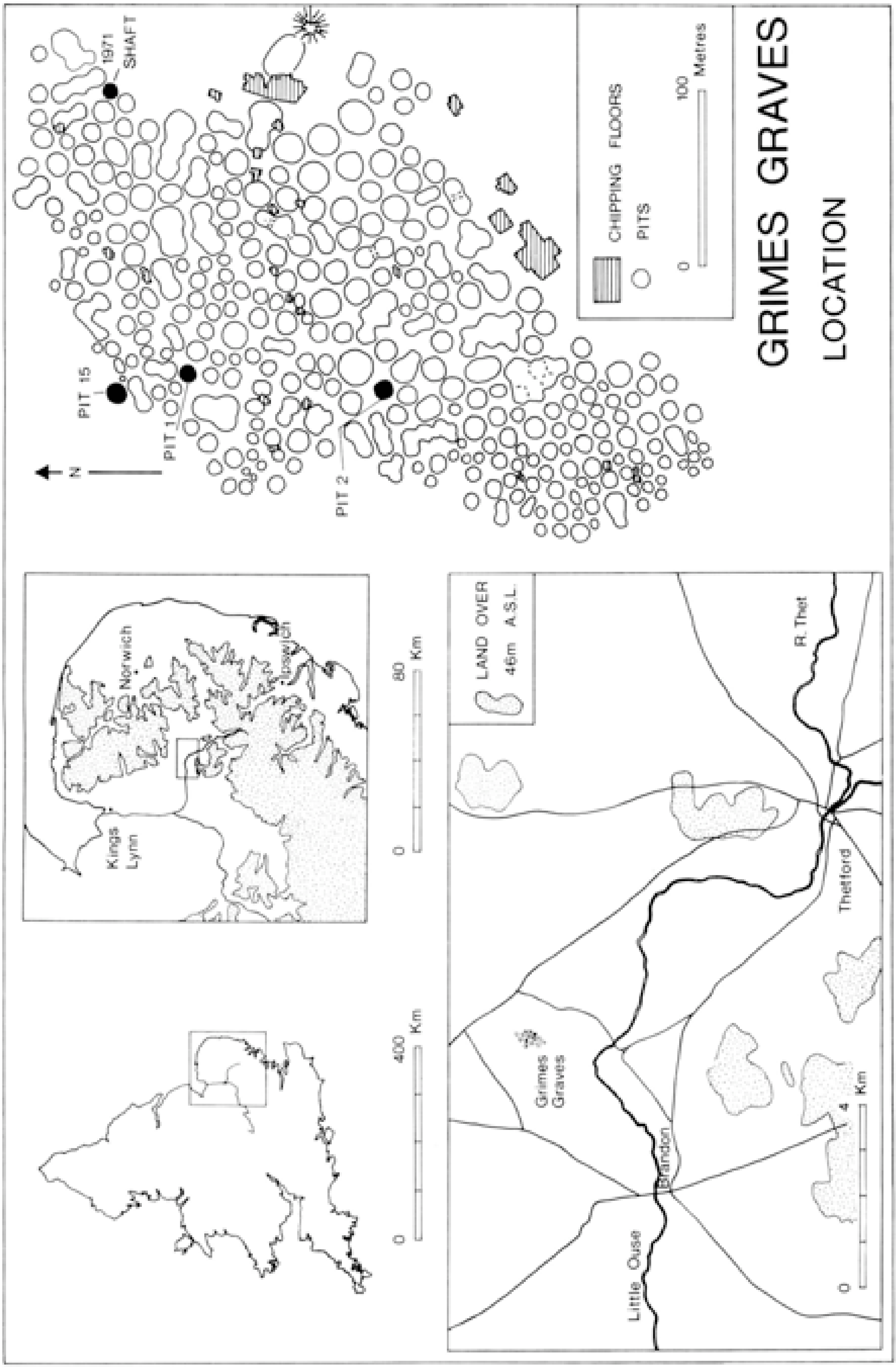


Figure 1 Location map and site plan of Grimes Graves

were revealed, four chalk lamps and a greenstone axe. Marks in the chalk of the walls of one of the galleries showed this axe to have been used in the mining process. The axe has since been studied in thin section and its constituent rock has been identified by Wallis as similar to Group IIIa (Clough and Green 1972) a factory of unknown exact location in Cornwall (this axe is at present in the British Museum (BM 83.7–5.45) and has been allocated a county number N 47).

The purpose of the shaft as a flint mine was, at last, abundantly clear. In the filling of the shaft, disposed amongst much sterile material, was the debris of sporadic 'occupation' which the excavator felt to have been thrown into the shaft from nearby dwelling places. At one point, at a depth of 8.5m, a hearth had been burnt *in situ* in the pit filling. Bone occurred frequently down to this depth but then almost ceased to occur. In order of frequency of occurrence of bone types as identified in Greenwell's Report there were
Bos Longifrons (mostly young calves.)
Ovi-caprids
Equus
Sus
Cervus. Elephas. (very little bone—mostly antler.)
Canis

There was no pottery of any kind recovered from the shaft fill or the galleries. A carved chalk phallus and some rather enigmatic chalk carvings said by Greenwell to resemble a human arm, were located in the shaft fill.

Of the 79 antler picks encountered, mostly in the galleries, only 11 were cut from slaughtered or dead animals, the remainder appeared to be cast. The difficulty of retrieving cast antlers in red deer habitats today was noted and used to argue for the ubiquity of red deer in the locality during the period of mining activity and yet their apparent non-usage as a food source.

Greenwell felt that the filling through which he had dug was the result of the shaft 'being gradually filled by chalk and sand taken out of other pits.' He believed the pits to be largely Neolithic in date although possibly continuing to be exploited into the Bronze Age. He states this quite categorically: 'The Palaeolithic period, when flint was most extensively used in the same district, cannot have been that of the working of these pits, for apart from the fact that nearly all the drift implements have been made from surface flints and those generally not belonging to flint of the quality obtained at Grimes Graves, the greater part of the animal remains found in the pit do not belong to the fauna of the Drift, nor were any bones of the most characteristic animals of that period discovered there'.

Finally, in a prescient paragraph, Greenwell develops a line of thought based on the very great number of shafts on this site and elsewhere, pointing to a very long chronology for the Neolithic period in this country.

In 1870 Rosehill conducted a minor excavation in one of the smaller pits on the Western extremity of the site (Rosehill 1871, 427). He found 'besides quantities of split bones, two very rude adze-shaped tools of very ancient type, almost resembling the flints of the Drift . . . and as in (Pit) No 1 no trace of pottery.' Here, then, at this early date a situation was beginning to develop which was to prove a fertile base for a tissue of what we would now regard as erroneous supposition concerning the date and cultural contexts of the mining complex at Grimes Graves which was to bedevil work on the site for the succeeding half century.

It was thus in 1912 that R A Smith delivered a paper before the Society of Antiquaries of London which was later published in *Archaeologia* of that year (Smith 1912, 109–158). The presence of chalk carvings, the total absence of pottery and the large number of heavy core tools found on the site—amply illustrated from the collections in the British Museum—indicated to Smith a Palaeolithic date for the mines. The presence of domesticated animal bone on the site was recognised but this was not felt at this time to argue the necessity for a New Stone Age date. The almost total lack of polished stone implements was further accepted as evidence for a very early date as was the presence of 'seals' of red sand in the flint mine shafts which were thought to be, not silts, but glacial depositions.

The principal difficulty in the face of which Smith had to work was the axe of polished greenstone found by Greenwell in one of the galleries apertaining to his shaft. By a rather devious argument he established parallels between this axe and examples found on sites of the 'Kjokkenmoedding' cultures of South Scandinavia but failed to establish links between these cultures and those of the Upper Palaeolithic in south west Europe with which he was primarily concerned. Further argument, based on erroneous information from later deposits in French caves was adduced to account for the ceramic found in some of the Cissbury mine shafts also discussed in this article—drawing parallels from the Aurignacian and Magdalenian of north France and Belgium.

This long and well-received paper produced an acceptable, and for a long time accepted, counterpoise for the arguments adduced by Greenwell for a Neolithic date for the shafts; and the first major excavations on the site (since those of Greenwell) were conducted by A E Peake two years later in 1914, largely stimulated by this controversy. The two pits chosen for excavation were Pit No 1 (that now open to the public under Guardianship arrangements) and Pit No 2 (now backfilled) (see Figure 1). They were excavated over a period of about six weeks in stages, half the filling being removed at a time in order that an accurate section might be drawn. Unlike Greenwell who used ladders and baskets for extracting the material from his shaft, Peake removed his spoil by use of a platform, windlass and buckets.

In 1915 appeared the monograph report of the excavation published by the Prehistoric Society of East Anglia (Peake 1914). A useful synopsis of information to that date concerning other flint mine sites in Britain and Europe preceded a complete description of the work undertaken in 1914.

Pit 1
Excavated between 6 March and 24 March 1914. The shaft was 30ft (9.3m) deep, 25ft (7.8m) in diameter on the surface and 13ft (4m) in diameter at the base.

Stratigraphy Beneath two upper layers containing much bone of horse lay an asymmetrical deposit (Layer 3) of loose chalk blocks with its angle of rests rising uniformly to the west. Beneath this layer, Layer 4 (known as the 'Black Band') comprised a layer of chalk rubble and a mass of charcoal, burnt antler, three or four fine axe/adzes as well as a 'discoid' knife. Peake held this deposit to be that of an occupation taking place within the partially filled shaft. Layer 5 comprised another massive and asymmetrical chalk tip from the west into the shaft within which among other finds lay a human skull. Layer 6 seems likely to have been a phase of gradual silting composed in its upper half of sand

and in the lower of rotten chalk wash (Peake called this 'boulder clay'). This layer Peake felt might have been deposited by 'Geological action' and could be argued to lend weight to the idea of a very early date for the shaft. Layers 7 and 8 which formed the greater part of the lower pit fill comprised chalk blocks of various sizes, the smaller material in general being uppermost. Within these two layers a substantial number of deer antlers were located. Some very soft and featureless pottery was found in Layer 8 but was not preserved. Layers 9 and 10 comprised a cone of dumped material in the base of the shaft. They contained some antler but no bone. Three fireplaces were located within the depth of this cone and a rim-sherd of pottery occurred in Layer 10 within the entrance to Gallery 6. The fabric of this sherd is described as 'a thin smooth fabric red on the outside and black on the inside.' The reconstruction of this sherd to form a round based vessel seems to have little to support it. Beneath Layer 10 the chalk floor of the pit was encountered.

The Galleries All the galleries were backfilled with chalk except Gallery 1 which presumably gave rise to the material dumped on the pit floor as the last to be dug. The remaining galleries (up to 13) had to be partially cleared to enable exploration. Antler pick marks were found located on the gallery walls and in Gallery 1 a few fragments of pottery were retrieved (these are not described). Several of the galleries broke into other shafts and others had apsidal ends with the floorstone left *in situ*. In Gallery 10 a chalk lamp was found by the apsidal end of the gallery where working had been abandoned. Peake used the evidence of the filling of the galleries of Pit 1 to argue that two pits, at least, had been in use at any one time and that access was free, for a time, from one to the other.

The Fauna In the upper layers associated with the 'Black Band' the following fauna are evidenced by skeletal remains (in order of bone frequency)

Equus
Bos.
Ovi-caprids
Sus (?) *domesticus*
also *Cervus Elephas*
Cervus. (Roe Deer)?
Small mammals

Down to and including the 'Black Band'

Bos persists into Layers 5 and 6.
Below this point only deer antler occurs with bones of small mammals (largely bats).

Pit 2

The excavation of this shaft was begun on 4 April and continued until 30 April 1914. The shaft was 40ft (12.3m) in diameter at the surface and 14ft (4.3m) at the base. Its depth was 31ft (9.6m).

The Stratigraphy The stratigraphy within the fill of this shaft bore, as recorded, a remarkable resemblance to that of Pit 1.

In the equivalent of Layer 3 in Pit 1 a complete human inhumation was located associated with a hearth ('Fireplace 2.'). Beneath this, a layer corresponding to the 'Black Band' (Layer 4) in Pit 1 revealed two phases of occupation debris containing much bone and charcoal. An antler pick came from the base of this layer.

Underlying this occupation debris was a layer of clean sand with blocks of floorstone in its centre, and beneath this a massive deposit of chalk blocks formed the bulk of the remainder of the pit filling. Several groups of pottery 'all very soft—resembling clay in consistency' were recovered but not preserved from this mass of chalk. Again, a series of hearths occurred just above the pit floor, and near one of these hearths some crumbs of pottery with what may have been cord-decoration were found (Clark and Piggott 1933, Figure 7). No conical dump in the base of the shaft, as in Pit 1, was recorded but Layers 6, 7 and 8 were formed by minor lenses of slipped sand which had run in during and before this massive chalk blocking which rested directly upon the chalk floor of the pit.

The Galleries There were eight main gallery openings from the base of the shaft. Two rough 'engravings' known as the 'tallymarks' and the 'sundial' were noticed by the entrance of the galleries at a height of about 8ft (2.6m) above the pit floor. Marks interpreted as the point where a rope had rubbed against the wall of the shaft were also located.

Three of the galleries were empty—apparently the last to be worked—the remainder were blocked with chalk. Both antler pick marks and the marks of a polished stone axe were noticed on the walls of the galleries.

By studying the final state of the galleries, Peake was able to conclude that to work the galleries left open at the end of the pit's life only three or four miners would be required—plus subsidiary help in evacuating the spoil etc. This he pointed out must have been in sharp contrast to the far larger numbers required for the digging of the shaft itself (see below). This conclusion Peake combined with the very fresh state of the chalk in the base of the shaft pointing to a comparatively brief period of exposure before the chalk blocking began.

In Gallery 7 a rim sherd was found which appears to be part of a saucer-like vessel with cord decoration around the rim (see Clark and Piggott 1933, Figure 7) and in Gallery 5 a flat base sherd was recovered (ibid).

The Fauna Associated with Layer 3 and the inhumation were bones of

Bos
Cervus Elephas
Cervus (Roe Deer?)
Ovi-caprids
Sus domesticus
Canis
Small mammals

At the base of the shaft there occurred only Red Deer antler and small mammal bones (mostly bat).

The 1914 season also saw the excavation of a series of 'floors', or sections across areas where flint working had taken place during prehistoric times. Fourteen floors were excavated during this season and Peake divided them into two predominant types.

A Areas containing massive chipped pieces with primary working only.

B 'Finishing floors'—with, in addition to massive primary working, pockets of minute flakes.

Only one of these floors 'Floor 3' seems to have shown a stratified succession denoting different phases of flint working. The uppermost floor (Floor 3c) rested on the surface of one of the dumps of chalk created by the digging of a nearby pit. Floors 3b and 3a lay beneath the dump. Floor 3c contained material typical of Peake's 'finishing floors'—complete with fourteen hammer stones. To Peake the evidence of Floors 3b + a lying directly beneath a chalk dump and on top of the sand caused him to reject the possibility of a pre-glacial date for the mining complex. The 'Grimshoe' was also explored at this date with little conclusive result.

A series of seventeen 'sections' was also cut at various points on the perimeter which were intended to show the limits of working and mining on the site. These sections did, in fact, seem to indicate how localised the industry was to the area of the pits.

With the outbreak of war in August 1914, Peake's work on the site ceased and the report of the excavation was rapidly completed, to be published in 1915. The report drew all the ready parallels between Greenwell's 1870 Pit and the 1914 examples and *seems* to come down in favour of a Neolithic date for the pits on the grounds of stratigraphy and association as well as on the basis of the specialist report on faunal and particularly molluscan evidence. However, the report on the flintwork from the 1914 excavation was written by Reginald Smith who, understandably, interpreted all the material in the light of his 1912 paper and assigned it to a 'Mousterio-Levalloisian' cultural background. The report seems to leave the matter in balance between the two opposed views.

The first activity of the war years comprised a paper read in 1916 by W G Clarke entitled 'Are Grimes Graves Neolithic?' (Clarke 1917, 339–349) which was primarily intended to act as a counterbalance to the 'Palaeolithic' thesis put forward by Smith in 1912 and reinforced by him in the 1915 report in dealing with flintwork from the site. This paper came down unequivocally, on the grounds of faunal and molluscan remains, parallels with similar sites elsewhere, and on the grounds of stratigraphy at Grimes Graves itself, in favour of a Neolithic date for the whole mining complex.

In 1916 Peake conducted a further season on the site largely concerned with the excavation of a further series of working floors, with the results of his work being published in 1917 (Peake 1917, 409–436). These working floors, Peake felt, had to be directly associated with the period of mining activity which he still saw as being, most acceptably, of Mousterian Palaeolithic date. He nevertheless expressed great caution in dealing with chronology on the site and pressed the need for the excavation of further pit-floors before a final assessment could be made. Two important finds were retrieved during this season; one, from 'Floor 16', was a bronze tanged-spearhead of 'Arreton Down' type (Gerloff 1975, 252, Norwich Museum Catalogue 1966, Figure 3i) which would point to a conventional date of c. 1400 BC for its deposition and the other was the location of a second greenstone axe on 'Floor 15', a find which made the doubts that had been thrown upon Greenwell's find a great deal more difficult to uphold. This axe has also been thin-sectioned and the rock identified by Dr Wallis as originating again in Cornwall and specifically assigned to Group IV rock — a picrite from Balstone Down, Callington, Cornwall. The axe has been assigned the county number N 48 (Clough and Green 1972). Floors 15 and 16 and 19–28 were opened during this season.

In 1917 Peake returned again to the site, publishing his findings in 1919 (Peake 1919, 73–93). In this paper he still pursued a Mousterio-Levalloisian date for the mining. During this year Peake commenced the excavation of a series of very small pits (Pits 3, 4 and 5) on the north-east edge of the site—the pits known later to Armstrong as the 'Primitive Pits'. In this season, however, Peake only continued his sections for a few feet and did not locate the pit floors.

In the same volume of the Proceedings of the Prehistoric Society of East Anglia a paper entitled 'A New Celt Making Floor at Grimes Graves' (Floor 46) was published by another worker on the site during the war, Derek Richardson (Richardson 1920, 243–258). Richardson had supervised the excavation of several of the working floors under Peake's general direction and on Floor 46 had located a mass of flint working debris together with a number of finely worked clearly Neolithic axes discarded *in situ*. In his paper he struck at the root of the problem which had bedevilled flint studies at Grimes Graves, and was to continue to do so for many years. He pointed to the confusion that he saw to exist between 'Neolithic Celts' and 'Northfleet Forms'—confusion between roughouts for Neolithic axe manufacture and heavy core tools of Palaeolithic date.

Another worker on the site under the general direction of Peake during the war years was the Rev H G O Kendall who supervised the excavation of Floors 52–56 and Floor 47. He too published the results of his work separately in a paper which appeared in 1920 (Kendall 1920, 290–305). His findings, which revealed little new material, prompted him to press for a Neolithic date for the whole mining complex and this call was taken up once again, by W G Clarke, in 1921 (Clarke 1921, 431–433). In this paper Clarke compared the fauna at Grimes Graves with that from Spiennes and also with that from a number of Azilian sites of the Upper Palaeolithic. The assemblage studied compared remarkably well with that of Spiennes and hardly at all with the Azilian material. In 1920 began the long series of excavations to take place on the site between the two World Wars financed very largely by the Trustees of the Percy Sladen Memorial fund and with A Leslie Armstrong replacing Peake as director of the Grimes Graves Excavation Committee of the Prehistoric Society of East Anglia. In this year, then, a major advance was sustained by Leslie Armstrong with the excavation of Floor 85 (Armstrong 1921, 434–443, 548). The evidence retrieved here did point to a long life for the mining complex. The floor was one of three phases, the earliest of which produced bones of purely wild fauna—wild horse and red deer. Furthermore, naturalistic engravings of red deer were found on the cortex of pieces of mined floorstone. Armstrong took both of these features to indicate an extremely early date. However three fragments of plain pottery were also retrieved from this level (Clark and Piggott 1933) and although Armstrong took this floor (85a) as an indication of the first exploitation of floorstone during the Upper Palaeolithic this cannot be so. Within Floor 85b a barbed and tanged arrowhead was found amongst the working debris while in 85c, the uppermost floor, 'Bronze Age' pottery was located. In a series of 162 cuttings varying from 4ft to 30ft in length set out over the whole site Armstrong succeeded in demonstrating that the floorstone in some areas was as little as 6in (15cm) below the surface and was therefore to be initially located very easily and probably accidentally by the prehistoric miners. During the 1920 season a re-examination of Pit 1 was also undertaken. It was found that 8ft (2.5m) of silt had dropped back into the shaft in the six and a half years since its abandonment in 1914. A further gallery (Gallery 18) was explored. At the entrance to this gallery a socketed Bronze Axe 'similar to Evans (1881) fig. 116' was uncovered. This type of socketed axe of simple form with a squarish socket mouth and double moulding at the mouth would be quite 'at home' in the East Anglian area—the example quoted in fact was from Reach Fen. It would relate to the Wilburton Fen phase of the Southern British Late Bronze Age conventionally dated to the early years of the first millennium BC (Burgess 1968). The anomalous position and nature of this find may point to mischief-making on the site which may have recurred at a later date.

Between 1920 and 1924 the three small pits opened by Peake in 1917 were completely excavated to their floors along with a further two pits (Pits 6 and 7). A report of the excavation of this group was published in 1923 (Armstrong 1923, 113–125). These pits near the base of the dry valley, were quite shallow—7 to 10ft deep. Their size and their lack of galleries caused Armstrong to describe them as 'Primitive Pits'. He maintained that, in these, he had uncovered the earliest phase of mining on the site and up till now nothing has been found on the site to contradict this basic model.

These shafts were filled with blown sand and overlain by chipping floors. The waste material from these chipping floors and from the pits that precede them was held by Armstrong to be a good deal rougher than in the floors associated with the deeper Pits (1 and 2). These shallow pits also appear to be restricted to the north-east fringe of the site. Furthermore Armstrong noted the almost total absence of antler picks from these pits and the occurrence, instead, of bone hand picks manufactured by artificially hollowing out the distal ends of long bones of *Bos Longifrons* and, in one case, *Homo sapiens*.

The brief interim report of the work up to 1924 was succeeded by Armstrong's Presidential address given to the Prehistoric Society of East Anglia, in London in November 1926 and published in the Proceedings for 1926 (Armstrong 1926, 91–136). This report, as well as describing more fully the excavation of the 'Primitive Pits' mentioned above, dealt also with the excavation of Pit 8 which had taken place in 1922. Pit 8 was a completely buried mine shaft to the south of the Primitive Pits which seems to have had rudimentary galleries cut out at its base. In the filling of the pit and on the floor both antler picks and bone hand picks were found. Armstrong took these features to indicate that this pit could be taken as an example of an 'Intermediate' group of shafts being worked at a period between the Primitive Pits and the fully developed workings as in Pits 1 and 2 and Greenwell's Pit. It was in this 1926 paper that Armstrong set out his chronology for the succession of pit types that he felt that he could see in his excavations of 1921–25. He argued that the wind-borne sand which filled the 'Primitive Pits' was a 'geological' deposit and sealed activity of very early date. He developed this argument by reference to the 'Floors' where only wild fauna had occurred, together with naturalistic engravings (Floor 85c), and refers to the 'Northfleet Forms' that emanate from floors on the site. This misunderstanding of flint typology which we have seen to have been endemic in work carried out on this site ever since the 1870's is now to be seen entering its final phase with the distinction of the three phases of mining and their what we would now regard as spurious dating. As well as relating the Primitive Pits to the Upper Palaeolithic period in the area, the occurrence of axes with 'tranchet' blows which Armstrong called 'modified tranchet axes' in the filling of Pit 9 (excavated in 1927) caused Armstrong to propose a Mesolithic date for the Intermediate pits with an Early Neolithic date being proposed for the fully developed pits.

In 1923 Dr R V Favell, working on the site at the same time as Armstrong located the flint working area known as 'Floor 88'. The site lay quite close to Floor 85—15m west of Greenwell's Pit, and covered an area of 120m². As with Floor 85c, the only faunal remains recovered were wild horse and red deer. Armstrong held the working to be in the Levallois tradition and the site served to reinforce the evidence for 'Upper Palaeolithic' activity on the site provided by the 'Primitive Pits' and Floor 85c.

Situated in a slight hollow on the extreme south-east edge of the site Armstrong also located in 1925 the site of what he was to call 'a huge communal workshop and cooking-place' which came to be known to the excavators as 'The Black Hole'. The site was totally excavated in 1926 and revealed a hollow 10ft (3m) deep and 32ft (c. 10m) in diameter. Armstrong understood the hollow to be natural and the deposits within the hollow were sealed by an extensive sand blow. The deposits themselves consisted of a great mass of organic, charcoaly material containing bone tools, chalk objects and pottery with fingertip and slashed decoration on the rim and on cordons on the upper part of the body. This pottery seemed, and would still seem, to be in the Deverel-Rimbury tradition and as this tradition was then understood the site was dated to a Hallstatt incursion during the earliest phases of the British Iron Age. The site was only dealt with in the 1926 paper in as far as it affected the dating of the flint mine complex and its full publication never took place. Three main aspects emerge from the report—two with reference to the flint and one concerned with the general stratigraphy. The people who had given rise to this occupation deposit had re-used flint debris and actual tools that they had found lying around on the site. Their working was always unpatinated but had always been executed through existing patination. The mining therefore had taken place at some considerable interval before this occupation. At the base of the hollow under the occupation Armstrong described a *talus* of flint mine dump material about 18in. (0.45m) thick—this slip also indicated the time that had elapsed between the mining activity and this occupation. It would seem likely that the *talus* of flint mine waste observed by Armstrong was, in fact, the upper filling of a flint mine shaft in the head of which this later occupation deposit had formed (cf. the '1972 Shaft' below).

The final published project to be undertaken at Grimes Graves in the programme of Percy Sladen Trust Excavations was commenced in 1928 and continued in 1930, 1932 and was completed in 1933. This project was the excavation of five pits of the intermediate phase. An interim report was published in 1932 (Armstrong 1932, 57–61).

Pit 9 was located in 1926, revealed by a trial section, and fully excavated in 1927. This pit, it was found, did not exploit the floorstone 'proper' on the site. Instead, the floor coincided with the top of the solid uncryoturbated chalk where a layer of flint is normally found (the 'toppings'). The toppings in this instance appeared to be a deposit of broken up floorstone at a depth of around 7ft. 'Coves' were dug around the base of the pit to exploit the flint. Deer antler picks (several of them roe deer antler) were found in this pit along with the 'modified tranchet axes' referred to above.

In 1928 two similar 'Intermediate' pits were excavated—Pits 8 and 10. Pit 8 had again been discovered in 1926 and both were without any surface indication whatsoever. Both shafts closely resembled Pit 9, although Pit 8 did have bone hand-picks as well as antler picks and Pit 10 had only one bone hand pick associated with its group of antler picks. Armstrong took this to mean that Pit 8 was earlier than Pit

10. In these pits it was discerned that the antler picks were *all* badly bruised on the backs of the crowns—quite different from the situation in Pits 1 and 2—and this presumably must indicate a difference in usage technique. Stratified in the humus over Pit 10 was a barbed and tanged arrowhead and this evidence was used to push the probable date of the pit back in time.

During the 1928 season exploratory trenching by Dr Favell revealed the presence below a working floor of a large shaft (Pit 12) but it was not until 1930 that work could commence on this shaft owing to Armstrong's absence in Rhodesia in the summer of 1929.

With the coming of the summer of 1930 work commenced on two pits (11 and 12)—both having been formerly invisible on the surface. Pit 11 proved to be 14ft (4.3m) deep and yielded a flint assemblage that Armstrong took to be a typological sequence demonstrating the development from Mesolithic 'tranchet forms' through to the 'Neolithic Celt'. The broken up floorstone at this point where it has come close to the surface was again the object of the miners' attentions as in Pits 8 to 10. Deer antler picks only were present and the 'coves' at the base of the shaft appear to have been somewhat elongated. Both these features were taken as symptomatic of technological advance towards the stage of the deeper pits.

Pit 11 was emptied in this year and work was suspended in the following year 1931. In 1932, however, work on Pit 12 was continued and completed in 1933. In 1934 the results of the excavations were published in the last full scale report to appear on the long sequence of excavations at Grimes Graves (Armstrong 1934, 382–394).

The filling of Pit 12 was interrupted by a sequence of chipping floors (A–G). The first three of these (A–C) Favell had uncovered during his trial trenching of the site. In association with Floor 'C' and sealed by Floor 'B'—in the uppermost filling of the pit fragments of a decorated bowl in the Peterborough pottery style were recovered (op. cit. Plate XII, [illegible]). Armstrong concluded that the period of the filling of the shaft had presumably been very gradual with periods of fairly extended stability in order to enable working to take place in the sheltered hollow.

Five galleries opened out from the base of the shaft and 44 antler picks (mostly of red deer) were recovered along with three bone hand picks.

In a report on the molluscan evidence A S Kennard pointed to the identical nature of the snail fauna with that from Pits 1 and 2, pointing to an immediate environment dominated by damp woodland with open grassy patches.

Fauna
Bos on the pit floor
Lapis Auh.
Ovi-caprids in fill of shaft

In 1933 a paper entitled 'The Age of the British Flint Mines' by Grahame Clark and Stuart Piggott was published in *Antiquity* (Clark and Piggott 1933, 166–183). In this paper the 'Palaeolithic' interpretation of the evidence from Grimes Graves in particular was attacked. The occurrence of pottery in primary contexts in Pits 1 and 2 and in Floor 85a, the evidence of molluscan and animal fauna series, the unreliability of flint typology and the evidence from other flint mine sites were all adduced to bring about the effective abandonment of the controversy. Armstrong nevertheless did criticise the *Antiquity* paper in his 1934 report (supra), but this report was the last he ever published on his work on the site, although he was to continue with the excavation of Pits 13, 14 and finally 15 right up to the outbreak of the Second World War in 1939. Once again the onset of war brought to a halt the excavations on the site, this time finally.

Pit 13 was a mine in Armstrong's 'Primitive' series and agreed in nearly all points with Pits 3, 4, 5, 6 and 7. Pit 14 situated close to the Primitive Pits was, however, of a developed form with galleries similar in type to Pit 12—neither 'Primitive' nor 'Intermediate'.

Pit 15 which until recently has been, along with Pit 1, open to public access, is a shaft of similar depth and type to Pit 1, and being excavated in 1939 ended Armstrong's activities on the site. It is well known that on the floor of this pit a pile of floorstone covered by antler was located, possibly some kind of votive offering and that in the entrance to a gallery, which had proved barren of a floorstone layer, a female figurine in an apparently pregnant state was associated with a chalk phallus and chalk balls.

Thus in 1939 came to an end a programme of research pursued with great tenacity and consistency for over 25 years. The information gained and recorded during these years will be of very great value when considered in the light of excavations carried out, from a different standpoint, both now and in the future. Certainly no work on the site can begin soundly without a full consideration of the results of these previous enquiries. The difficulties, and what we would now regard as errors, which conditioned the enquiry as it was developed by workers like Peake and Armstrong, were brought about largely by the contemporary over-emphasis of the typological significance of the 'Three Age System', or rather the attempt to use a typologically conceived 'Three Age System' to gain other ends—both cultural and chronological. The conclusions drawn by Armstrong from local stratigraphy and association as to the sequence of mining on the site over an extended period of time may well be partially correct. It was in terms of cultural and chronological limits for the development of the mining that we would now see him and others to have erred, largely through an over emphasis on pure (flint) typology as an indicator and a lack of emphasis on the socio-and eco-economic factors which should render for us the act of mining itself and its environment of primary interest.

Table I. Radiocarbon dates from the Armstrong and Greenwell excavations

Feature	Radiocarbon date
Greenwell's Pit (Antler in Gallery III)	1860 bc ± 130 (BM—291)
Armstrong Pit 8 (Antler)	1340 bc ± 150 (BM—109)
Armstrong Pit 10B (Antler)	1920 bc ± 150 (BM—93)
Armstrong Pit 11 (Antler)	1750 bc ± 150 (BM—103)
Armstrong Pit 12 (Antler) galleries	2340 bc ± 150 (BM—97) Fragment of Peterborough Pottery located in the upper fill of this shaft.
Armstrong Pit 12 (Antler) late infill	1600 bc ± 150 (BM—276)
Armstrong Pit 12 Repeat BM—97	2300 bc ± 130 (BM—377)
Armstrong Pit 14 (Antler)	2030 bc ± 150 (BM—99)
Armstrong Pit 15 (Antler)	2100 bc ± 150 (BM—88)
Armstrong Pit 15 (Charcoal)	2320 bc ± 150 (BM—87)

The final contribution to knowledge concerning Grimes Graves comes as the result of a programme of radiocarbon dating carried out by the British Museum Radiocarbon Laboratory on antler and charcoal preserved in the British Museum's collections from the Armstrong and Greenwell excavations. This group of ten dates gives a firm pointer to the absolute chronological context of the site (Table I).

Two important facts emerged from this first series of radiocarbon dates relating to the site.

1. That a time span of probably at least a thousand years is involved in the working of the area.
2. That the dates fall consistently outside and later than the dates for the Sussex mine complexes (which are normally associated with Western Neolithic wares).

Aims of the 1971–72 Project

The basic aims of the excavation were fourfold:

1. To select and open a flint mine shaft for display to the public.
2. To obtain the maximum possible information as to environmental and cultural conditions prevailing during the active use of the shaft and during its total silting and filling.
3. To excavate a substantial surface area around the pit
   (a) to provide archaeological clearance for any public access and amenity provision on the site.
   (b) in order to understand the sequence and nature of the dumping of spoil from the shaft during its excavation by prehistoric miners.
   (c) to locate traces of any occupation or industrial surface which could be related stratigraphically to the shaft itself.
4. To obtain a series of chronological indicators (both absolute and relative) enabling the shaft chosen to be placed within the complete development of mining on the site, to enable the filling to be used as a chronometer of environment and cultural changes, and to link chronologically occupation areas on the surface with the shaft sequence.

These objectives formed the basis upon which the selection of one shaft out of the approximately 350 pits visible on the site took place.

From the point of view of ultimate public display it seemed to the excavator that this did pose three limitations on choice which did not, however, conflict with the archaeological requirements.

1. The shaft should be on the apparent periphery of the complex so that access arrangements should not damage other shafts or their associated dumps of spoil.
2. The shaft should be one that showed the technology of the flint mines at its most advanced i.e. when the miners were sinking their deepest shafts to reach the flint.
3. The shaft should be a single integral example and not one of the 'clusters' where two or more shafts have broken into one another. From the point of view of practicability of display this was essential and it would be greatly advantageous from the point of view of explanation.

The need for a deep shaft immediately required a search on the north-eastern side of the site. The apparent periphery at this point and the preference for a single shaft was also an important consideration.

From the archaeological standpoint the deepest pits on the north-east part of the site were also an obvious choice for the following reasons:—

1. Armstrong had not undertaken any work here.
2. If, as seemed likely, the deepest pits were, as Armstrong had indicated, the latest on the site then the excavation of a deeper shaft would allow us to concentrate on the elucidation of the later phases of activity on the site which had been of little interest to previous workers.
3. This later phase of mining should be seen if possible in association with the Bronze Age occupation that Armstrong also located on this side of the site—'The Black Hole'. It might be possible to encounter another such deposit which could be tied into the stratigraphy of the shaft itself.
4. The cultural context of the shaft could be approached in two ways. Firstly it might be possible to obtain culturally diagnostic material from close to or on the floor of the shaft and secondly by investigating the old land surface sealed by the chalk dump thrown up during the shaft construction. For this reason an area excavation outside the shaft was desirable in an area undisturbed by later mining.
5. The excavation of a deep shaft would also, theoretically, provide through the medium of its filling a more sensitive or simply a longer chronometer of cultural and environmental change as witnessed by artefacts and other material located in its filling.
6. The need for a single integral shaft was also reflected in our archaeological requirements. Only such a shaft could provide the desired seal and isolation for the deposits present within its filling and on its floor.

The 1971 shaft was finally chosen from the group of six or seven which satisfied the above requirements on the grounds of field study. In its case the dump of material thrown out of the shaft by the prehistoric miners was well defined, the pit itself was clearly outlined and yet the hollow over the shaft was very shallow which seemed to promise the greatest depth of filling. No disturbance in recent times was apparent and there were no large tree boles in its centre. The shaft, although on the apparent periphery, was set back slightly between two nearby pits which, it was felt, might indicate that the 1971 shaft was not dug in a barren area which might have caused it to be abandoned before completion.

Methods

The division of the site into the surface area excavation and that of the shaft naturally formed a clear dividing line for the site in terms of the methods of excavation and recording employed. Whereas in the surface area the practical problems of the removal of spoil, the recovery of small finds and the recording of the position of those finds and other material relative to soil layers and features, were fairly orthodox, once into the shaft of the flint mine new techniques had to be introduced to cope with the very considerable problems which had been foreseen.

The dual nature of the site was thrown into relief by the fact that the surface area of the site is not in any way a 'chalk site' as normally understood by archaeologists in Britain, whereas the shaft did involve many features which one has come to expect on the chalk of Southern England. On the surface the natural land surface was a light sand with small much abraded pebbles of flint, ironstone and other rocks. This land surface was extremely fluid and had been very badly mutilated by weathering, root and animal

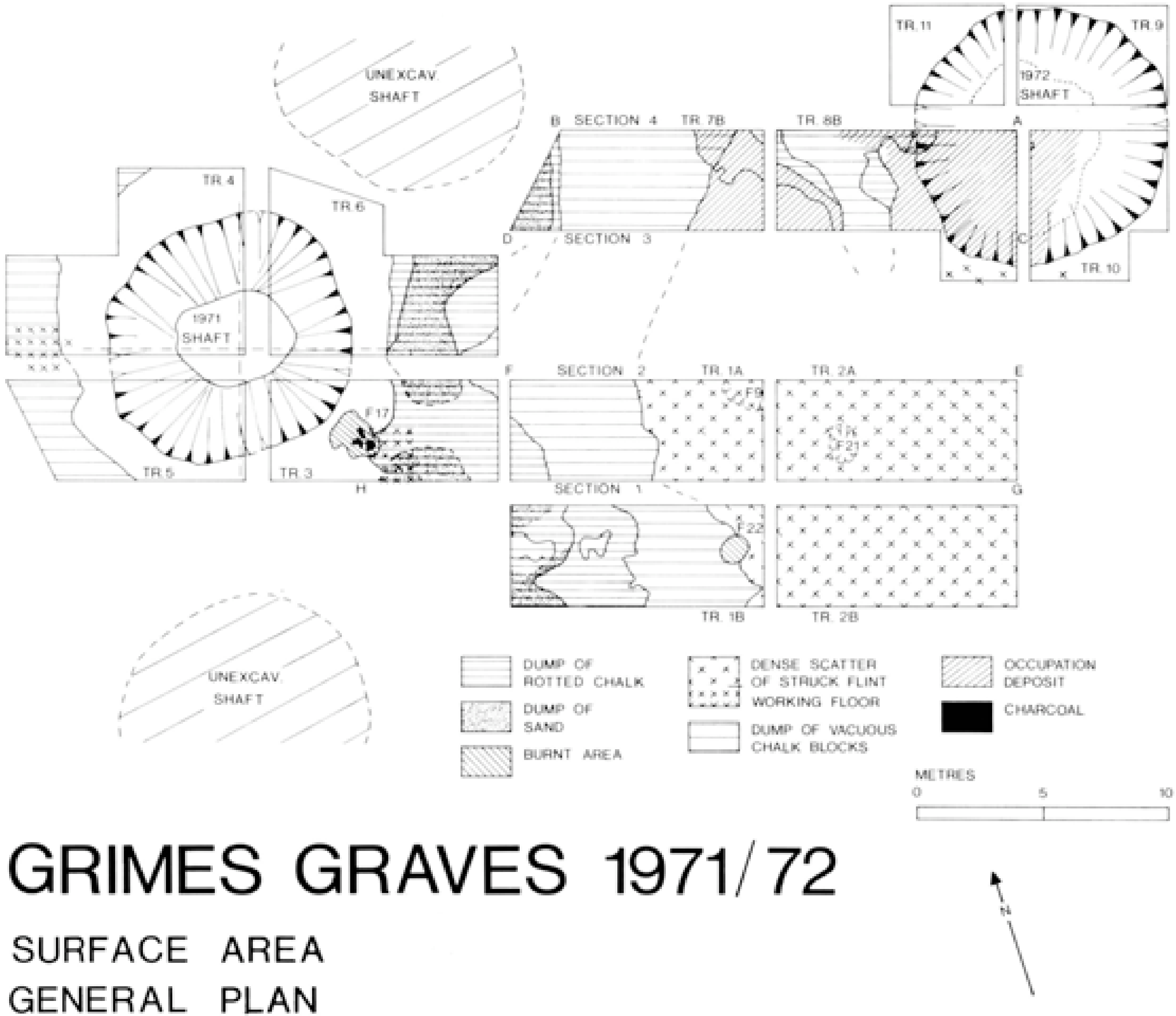


Figure 2 Surface Area excavated 1971–72—General Plan

activity. For these reasons the location and excavation of features cut in its surface was often extremely difficult and there is little doubt that structures which may have existed on this surface may not have been detected in plan.

Initially the whole area was set out as a surface excavation with a series of cuttings based upon a 5m grid (see plan Figure 2). The cuttings were extended to provide four long sections through the dump of shaft-spoil to the east of the pit and to cover the pit itself with its immediately surrounding areas and the dump to its west. The grid base-line, as set out at this stage, (Grid A) bisected in as far as it was possible to judge from surface indications, the depression of the pit. The first section in the pit was recorded from the metre baulks set out on this grid system. Two small extensions to the Grid A cuttings were necessary to locate the full circumference of the lip of the shaft weathering-cone. The shaft was thus revealed as a feature in plan cut through the old land surface as revealed over the site.

At this stage the baulks over the shaft were drawn, photographed and destroyed revealing the entire surface of the filling of the shaft. Two slots were then cut down to the chalk on either side of the shaft to provide a firm basis for the two pylons to be built between which the scaffolding gantry would be slung. The axis of these slots was aligned on the diameter of the shaft and so had to be offset by 75cm from Grid A. A new grid line (Grid B) was then set out to coincide with the now apparent diameter of the shaft and this line was that eventually projected onto the gantry base. From this base line an arbitrary line crossing it at right angles was set out to north and south over the apparent centre of the shaft fill thus providing the basis for the quadrant excavation of the shaft.

On the completion of this survey task the gantry was built on the 'suspension bridge' principle in light alloy tubing covering an unsupported span of 12m. The scaffolding was then decked with 2in timber planks and the pylons weighted with spare timber (Plate II). The decking was wedged firmly to ensure that no lateral movement was possible and the entire gantry checked by theodolite over several days for any vertical or lateral movement.

These checks having been carried out, the Grid B base line was surveyed on to the surface of the gantry decking, each point (at 1m interval) being marked by a 2½in nail hammered vertically through the decking. The nail was picked out on the decking by a red painted cross. One-inch U-staples were then hammered into the under surface of the decking evenly around the ½in protruding nails. These were then picked out on the whitish planking in red paint. A series of plumb bobs were then suspended from these U-staples. The plumb bobs were extendable and could be adjusted to hang at any level in the shaft thereby transmitting the Grid B base line to any depth. The centre of the shaft which formed the axis of the quadrant system was marked with the symbol ∞. The line of the right angle ordinate was indicated on the width of the decking. These lines projected into the shaft formed the basis of the quadrant layout for the entire excavation of the shaft and the plumb bobs acted as 'data' from which all lateral measuring of artefacts and other material and spot drawing was undertaken. The three dimensional fixing of all material was accomplished vertically by tapes suspended from hooks placed on the base of the gantry. These hooks were levelled into the site contour plan.

The gantry provided access to the excavation by means of a ladder suspended into the shaft. Spoil extraction was also based upon the gantry. Two jenny wheels (situated on opposite sides of the gantry to balance the stresses on the structure) were used for hauling the spoil, bucket by bucket, on to the gantry whence it was tipped into a boom conveyor belt (petrol-driven with its engine well off the scaffolding to reduce vibration) and carried to a waiting dumper truck which transported the spoil to a tip well off site. The conveyor belts were essential for the movement of the spoil from the gantry, as wheel barrows being wheeled on and off the decking would have created a hazard to men working below.

All spoil from the shaft was passed through a 1cm mesh sieve. With two quadrants being worked at any one time, one quadrant sieved its spoil at the base of the shaft while the other passed its spoil to be sieved at the head of the conveyor belt. In this way, two quadrants could be excavated simultaneously without any possibility of confusion of the spoil. All finds, where they were not individually measured in (as were all artefacts), were labelled by section, quadrant and layer.

The extraction of the shaft fill took place in seven sections. The first six comprised arbitrary 'spits' of about 2m, this being the maximum height to which sections in the loose fill could be allowed to stand safely. The two diagonally opposite quadrants would be extracted, their sections drawn and photographed and then the two remaining quadrants brought down to the new level. At this point the outline of the wall of the shaft was planned with any *in situ* features in the shaft filling incorporated (see Figures 6, 8, 11, 12). The extraction was done as a rule by labourers using fork and shovel (not picks) working under the direction of their foreman and a supervising archaeologist who was present at all times in the base of the shaft. Any areas of greater archaeological sensitivity were cleared entirely by archaeological staff and supervisors and the main labour force diverted to the second quadrant or to the surface area. In this way all sensitive areas of the filling were excavated with the necessary care while it was possible to maintain the high pressure of work necessary for the completion of the excavation within a reasonable time. In the 'sensitive' areas all finds were planned relative to one another—planning being carried out on the basis of offsets from the main grid line in the normal way.

Somewhere in the region of 10 tons of material were excavated from the shaft each full working day. The dumper ran on a timber roadway built over the site to the gantry so that it could still operate effectively and without creating any undue muddiness on the site even during the wettest conditions.

The sixth section of the shaft was halted at what was calculated to be 30cm above the floor (this calculation was possible because the distance between wallstone and floorstone is consistent over the whole site). The seventh section was then excavated in all four quadrants at once leaving tiny baulks approximately 20cm wide and 30cm high. This change allowed an approach to the floor of the shaft in all four quadrants at once thus ensuring that any features or disposition of artefacts were not misunderstood. It will be appreciated that during the whole process of excavation of the shaft it was impossible to leave finds *in situ* for long periods of time due to the very restricted nature of the working space and the tightness of the working schedule. As the floor of the shaft was revealed it was immediately covered with heavy polythene sheeting in such a way that at no juncture was the Prehistoric floor of the shaft trodden or worked on during the excavation.

The undercuts and galleries, the tops of which had been

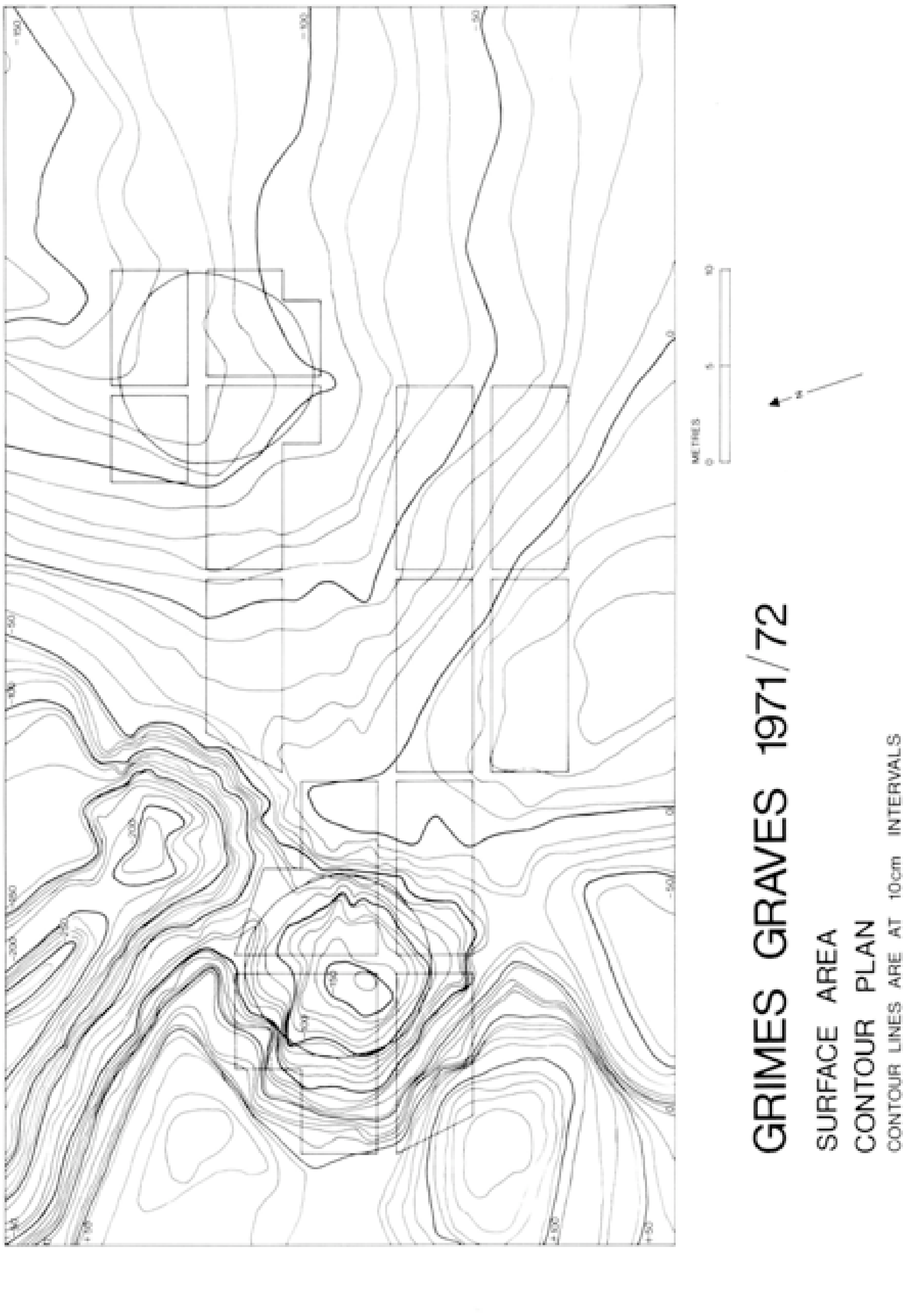


Figure 3 Surface Area excavated 1971–72—Contour Survey

apparent during the excavation of the sixth section, had been left with their blocking in position throughout the clearing of the floor. With the completion of this the blocking was sectioned axially along the line of the gallery or undercut as far as this was possible. With the undercuts, this was invariably as far as the chalk wall. As the chalk floor was revealed so it was covered with polythene in the same way as the floor of the shaft. The standing sections were drawn and photographed and the remaining half of the blocking taken down. Where in the galleries space became too confined to allow sectioning along the length of the gallery transverse sections were drawn at every 0.5m. A series of transverse sections could thus be used to reconstruct the longitudinal section that it was physically impossible to see. All data for the gallery section drawings and spot location of finds were derived by levelling from the depth tapes suspended from the gantry. Lateral measurement was achieved by means of right angle offsets taken from the main grid line extended to the base of the shaft. All surveying on the floor of the shaft and its associated galleries was thus achieved without marking the floor of the shaft in any way—all tapes being secured by weights.

Services to the base of the shaft were twofold—generated electricity for lighting and a field telephone. Electricity was generated by a highly efficient 2 h.p. Honda generator which was quite adequate for all needs. The telephones were absolutely essential to the smooth running of the finds and planning system—more essential than was initially visualised—and also contributed a useful safety factor. The telephone communicated from the base of the shaft to the site office and finds processing office and it was later realised that it would also have been useful to have had a point on the gantry itself. Lightweight plastic telephones used on this occasion were not really adequate for the task and telephones in a steel case would probably have been more satisfactory.

At various stages during the excavation a flotation and sieving process developed within the Faculty of Archaeology, University of Cambridge, was used to extract a near-complete corpus of organic materials from some deposits. Where this process was used manual sieving was not carried out. In order to use this process with maximum economy and efficiency it is often necessary to 'prepare' samples of material for processing,in advance. This can be done in two ways both of which were used. One is the extraction of soil in advance and stockpiling it securely labelled in large plastic bags—or under a heavy plastic tarpaulin. Secondly, it can be more suitable to leave a section through a deposit standing as a baulk and the destruction of the baulk be taken as the seed machine sample. Water needed to be stored on site in 200gal tanks to facilitate this process. Water was transported to the site by bowser.

Lastly, it need hardly be stated that safety was a most important consideration at all times in working on such a site. It is virtually impossible to lay down an effective code of conduct to cover all contingencies, and only constant vigilance to anticipate any dangerous situation developing is really adequate. The wearing of protective headgear is fundamental to safety in such a situation. It might be useful to point out that when working below 2m depth special insurance arrangements are necessary and had to be negotiated.

The excavation report

For the purpose of the description of the excavation results the site can readily be divided into three sectors from the point of view of content. These three sectors are:—

1. The surface area.
2. The totally excavated flint mine shaft—the 1971 shaft.
3. A further shaft which was partially excavated in 1972—the 1972 shaft.

Surface Area (For layer numbers see Figure 4, for general plan see Figure 2)

In planning the excavation of the surface area there were three objectives in view. First, it was sought to establish the extent of the dumps of prehistoric overburden left by the miners. It was hoped that these would be found in association with contemporary working floors where the mined flint had been knapped. Secondly, it was hoped to locate, in some meaningful relationship with the mining phase, an area of the Bronze Age occupation known to exist on the site since Armstrong's excavation of the 'Black Hole' in 1927. Thirdly, it was intended to dismantle the dumps of prehistoric overburden in order to study prehistoric working practices and to examine an area of the old land surface lying protected and sealed beneath.

Immediately the turf was stripped off, very large quantities of flint waste material and some implements began to be recovered, and the prehistoric dumps of overburden became visible either as a surface of chalk blocks or as a surface of the chalk concretion produced by the exposure to weathering of the rotten cryoturbated surface chalk. Behind and beyond the dumps lay a substantial deposit of soil and chalk wash (Layers 4 and 5), resulting from the massive erosion of the prehistoric overburden dumps, sealing the prehistoric surface. This deposit of wash contained very large quantities of flint waste and artefacts and some few fragments of pottery—most of the latter in very abraded condition and varying from Roman to Bronze Age in date. It was much disturbed by tree root and burrowing animal activity.

Beneath lay the sandy old land surface with an ephemeral brownish turfline still extant upon its surface (Layer 11). In the southern part of the excavated surface area (Trenches 1A, 1B, 2A, 2B) there rested upon this surface a dense scatter of flint, mostly in a fairly heavily patinated condition, which must have composed an area of working perhaps at various periods, the waste product of which had become mingled in the very fluid sandy soil. The flints were incorporated well into the surface of the natural sand to a depth of 10 or 15cm possibly by human trampling but equally likely by the activity of earthworms and other fauna, as has been demonstrated by Atkinson (Atkinson 1957, 219–233). Interspersed with this flintwork were sherds of pottery which, where diagnostic, were either Late Neolithic or Middle Bronze Age in date. The accumulation on this prehistoric surface is clearly a product of more than one phase of activity which the nature of the subsoil has rendered inseparable. The sandy surface was a palimpsest of dark and lighter markings brought about by animal and root penetration and in two instances large irregular 'pits' penetrating to a depth of up to 0.75m post-dated the flint debitage. These 'pits' proved to be the remnants of extinct tree root systems.

The absence of any closed surface context was again demonstrated in the northern part of the surface area (Trenches 8B and 7B). Here, the situation was rather different and somewhat easier of interpretation. At this point it was demonstrable (see section 4) that the prehistoric overburden dump had eroded to a certain point and occupation and flint working had taken place against the rear slope of the dump in its partially eroded state and on the sand surface behind. Quantities of Middle Bronze Age pottery, chalk objects such as 'spindle whorls' and fragments of chalk cups, animal bone and evidence of flint working and a single bronze awl were located in this deposit. The ephemeral turfline was stained black by organic material in this area. No structural evidence was retrieved in association with these areas of dark occupation material which in both areas where they occurred were associated with considerable flint working in the area immediately behind the chalk dumps. This occupation debris was clearly associated with the Middle Bronze Age re-occupation of the site which led to the filling of the top of the 1972 shaft with domestic rubbish. One of the major tips of rubbish in this shaft was made from the direction of this occupation and there is no reason to suppose that the two are not contemporary. The fact that no evidence was retrieved of structures in the surface area may reflect more the highly disturbed nature of the sandy subsoil than any real prehistoric absence. The assemblage present on this surface and in the 1972 shaft will be discussed fully under the section dealing with this latter shaft.

The chalk dump (see Figures 2 and 4)

The fact that the main chalk dump across which the excavation was set out related to the shaft which it was proposed to excavate in 1971 is, of course, very difficult to prove conclusively. However, the front of the dump which is proclaimed a unity by its internal stratigraphy does curve round the lip of the 1971 shaft which, it can only be assumed, points to the relationship of one to the other.

The original height of the dump The dump in its present-day state is much eroded but the compression of the old land surface beneath it must point to the very great weight of the dump in its original condition. Indications of the original height of the dump can be obtained by two approaches. Taking the average width of the dump as 15m and its approximate length alongside the shaft as 17m, evaluation of its original height can be based on (a) the angle of tip-lines extant within the dump today and (b) the volume of material known to have been extracted from the 1971 shaft (assuming, as seems likely, that the great majority of this material was assigned to the one dump.)

An average has been taken here for the expansion factors given for chalk in the three 'spits' of the Overton Down experimental earthwork, a factor of 1.44 (Jewell 1963). The shaft excluding the weathering cone has an approximate volume of 368.5m³. This postulates a total volume for the dug chalk of 368.5 × 1.44 = 530.64m³.

In order to calculate the dimensions of the dump:—

(a) Requires the simple formula

$$\tan x^\circ = \frac{2h}{W}$$

where x = angle of tip lines
W = width of the base of the dump

$$\therefore h = \frac{W}{2}(\tan x^\circ)$$

and h = height of the dump

(b) can be expressed

$$\frac{2\ V\ E}{W\ L} = h$$

where V = volume of shaft
E = expansion factor of dumped chalk block
W = width of base of dump
L = length of dump

In (a) ∴ The tip lines within the chalk dump vary between a maximum of 30° and a minimum of 20° over the horizontal. The mean observed angle of rest of block chalk is approximately 35° so that 30° would approximate to a maximum possible (h_1) (Jewell 1963, 24). The 20° tip lines presumably give a minimum possible (h_2)

$$h_1 = \frac{15}{2}(\tan 30^\circ)$$

$$h_2 = \frac{15}{2}(\tan 20^\circ)$$

$$h_1 = 7.5\ (0.5774) = 4.33\text{m}$$

$$h_2 = 7.5\ (0.3640) = 2.73\text{m}$$

In (b) The volume of the shaft projected to exclude the weathering cone = approx. 368.5m³
The expansion factor of dumped chalk as revealed by the Overton Down Earthwork experiment averages at approximately 1.44 (i.e. dug chalk from all parts of the earthwork) (Jewell 1963, 28).

$$h = \frac{2(368.5 \times 1.44)}{15 \times 17} = 4.16\text{m}$$

Both calculations therefore would seem to confirm that a maximum height of the dump would be just over 4m with a minimum possible being just under 3m. The internal composition of the dump provided a first glimpse of the institutionalised skills of the prehistoric miners. At the western end of the dump Layers 13 and 16 comprised the surface sand stripped off the surface of the chalk beneath forming a nucleus for the projected dump. Layer 15 in Section 3 comprised a darker sand which probably represents the pile of turf initially stripped from the pit head. Behind this dump of sand Layers 12 and 18 represent the base of the chalk dump, a rotted surface of chalk which has washed down into a concreted paste either white (12) or a creamy yellow (18) in colour. This rotted chalk had become paste even in the area at the base of the dump where it must have very quickly been covered by the blocks of pure chalk which were dug out next. This may be a feature of the internal drainage of the dump but may also, taken in conjunction with concreted layers of chalk further back within the dump of chalk blocks (Layer 9), be a witness of pauses in the building of the dump when intermediate surfaces had a chance to weather down. If this is so it suggests interesting implications for working practices in the mining process which will be discussed below. Further evidence for mining practices may be seen in the non-selective distribution of chalk blocks within the dump. If the chalk had been thrown on to the dump from the front one would expect a gravitational selection of the blocks to have taken place with smaller falling to the rear and the larger to the front. Where the original make up of the chalk-block dump still exists this does not appear to be the case and a process whereby the blocks were carried onto the dump and deposited in lots would seem on this evidence to be more likely. Very little artefactual material was recovered from within the dump and certainly the 'weathered' surfaces within produced no signs of occupation or vegetational growth. This would tend to indicate that if there were pauses in the construction which allowed weathering to take place these pauses were brief and the site was abandoned during them.

The old land surface

Beneath the chalk dump a flimsy layer of brown sand was all that remained of the old land surface buried beneath the dump and crushed by its weight. Blocks of chalk had been driven down through this layer by the weight of the material above. Upon this comminuted surface were found only 27 struck flint flakes and no other cultural material. This tiny number of flint flakes in a buried area of $116m^2$, when compared with the many hundreds of flakes per m^2, in areas not buried by the dump, must be significant. It is clear that in the area buried by the chalk dump from the 1971 shaft no flint working debris had been left *in situ* by the miners. If we are to assume that it is unlikely that existing debris would have been deliberately cleared away before construction of the dump we must then conclude that no working had ever taken place in this area prior to the digging of the 1971 shaft. As we shall see on radiocarbon grounds and on the *a priori* grounds of the 1971 shaft being one of the deepest so far encountered, it is unlikely that it was one of the first to be dug on the site but rather the reverse. The conclusion would seem to be thrust upon us, then, that working of flint pertaining to each shaft was fairly closely restricted if an open area of $116m^2$ covered by a spoil tip at a secondary stage of working on the site could be absolutely clear of flint working debris. This point is thrown into relief when we come to consider the evidence from the small area of old land surface excavated on the west side of the shaft, again under a prehistoric spoil tip, but this time close to adjoining shafts of the mining complex. Here, very densely packed working debris was found of a type and in a context which makes it clear that it is contemporary with the mining phase. This working floor (see Volume II) is truncated by the actual digging of the 1971 shaft. This violent change in the occurrence of intensive working of flint from one side of the shaft to the other on the surface contemporary with the mining phase may well indicate the close adherence of flint working parties to the area of the shaft whence their raw material was coming and that therefore the winning and working of the flint were very closely related activities.

The old land surface below the very much smaller dump on the west of the shaft set on the narrow platform of ground between the 1971 shaft and the next group of shafts towards the interior of the mining complex was only examined over an area of approximately $4m^2$. Working space in this area was extremely confined and safety demanded that only enough of the prehistoric dump on this west side was removed to allow the insertion of the gantry base.

Beneath the dump, which on this side was composed wholly of chalk, the old land surface was revealed again as a much crushed and comminuted brown sandy layer approximately 10–15cm in depth. Packed closely both on and within this layer was a mass of flint working debitage in fairly fresh and relatively unpatinated condition (see Volume II). Over 7,500 struck flakes and implements were recovered from this deposit which upon analysis have revealed a Late Neolithic complexion to the industry incorporating as it does a *petit tranchet* derivative arrow-head (F 74), a bifacially flaked pick (F 77) and a series of scrapers and points. The whole assemblage can clearly be seen as the result of floorstone working. Incorporated within this old land surface were one, and possibly two, heavily patinated microlithic forms with back blunting which may point to the sub-stratum of Mesolithic activity on the site indicated by the British Museum project since 1971.

Probably also contemporary or nearly so with the digging of the shaft was a further densely packed assemblage of flint debitage sealed beneath wash from the inner face of the prehistoric chalk dump on the east side of the shaft. This working had presumably taken place on the 'berm' separating the 1971 shaft from its spoil tip. This assemblage numbered over 3,500 fragments of struck flint and produced an assemblage of artefacts strictly comparable with the material described above, below the prehistoric spoil tip on the west side of the shaft. Again, a Mesolithic element is present amongst the material in the form of a battered micro-core while points and scrapers again dominated the Late Neolithic assemblage with the use of floorstone being universal. This area of working was associated with a substantial burnt area possibly representing a hearth (see Figures 2 and 5). In addition to these two clearly defined working floors in the area around the edge of the 1971 shaft a whole series of artefacts which in the fluid state of the sand surface can be said only probably to relate to the old land surface were found on analysis to relate closely typologically to the material already described. An axe, a series of scraper types, a discoidal knife and a pick can be related to this group. Further to this analysis of material clearly above the old land surface (Layer 11) in this same area produced an assemblage of essentially similar type with a clear lack of the implements which are diagnostic of later phases of activity on the site. The importance of this assemblage is discussed fully by Alan Saville (Volume II) and suffice it to say here that if these assemblages do relate, as they seem to, to the working of fresh floorstone around the lip of the 1971 shaft then two essential points follow. One is that the working around the lip of the shaft cannot represent a significant element of the total output of flint from the floorstone deposits uncovered (see below). Secondly, whatever the nature of this local working it can hardly be described as 'factory' production and certainly betrays no apparent emphasis upon axe manufacture. Thirdly, while it is impossible to establish at present a detailed chronology and cultural assignation for such an assemblage it is fairly clear that it is of Late Neolithic type and as such represents the prime production of at least part of the flint mining process.

The surface behind the chalk dump

To the east of the chalk dump an intense scatter of struck flint and a number of abraded potsherds lay concentrated at the base of the humic layer (Layer 2). Animal and root disturbance had seriously disturbed the bedding of this material so that no 'cultural layer' as such could be isolated. Within this mixed deposit, flint working debris and other artefacts from at least two phases of occupation on the site were found together. Study of the flint (see Volume II) has produced a general divergence between diagnostic types indicating a division of the material between the two recognised sealed assemblages known on

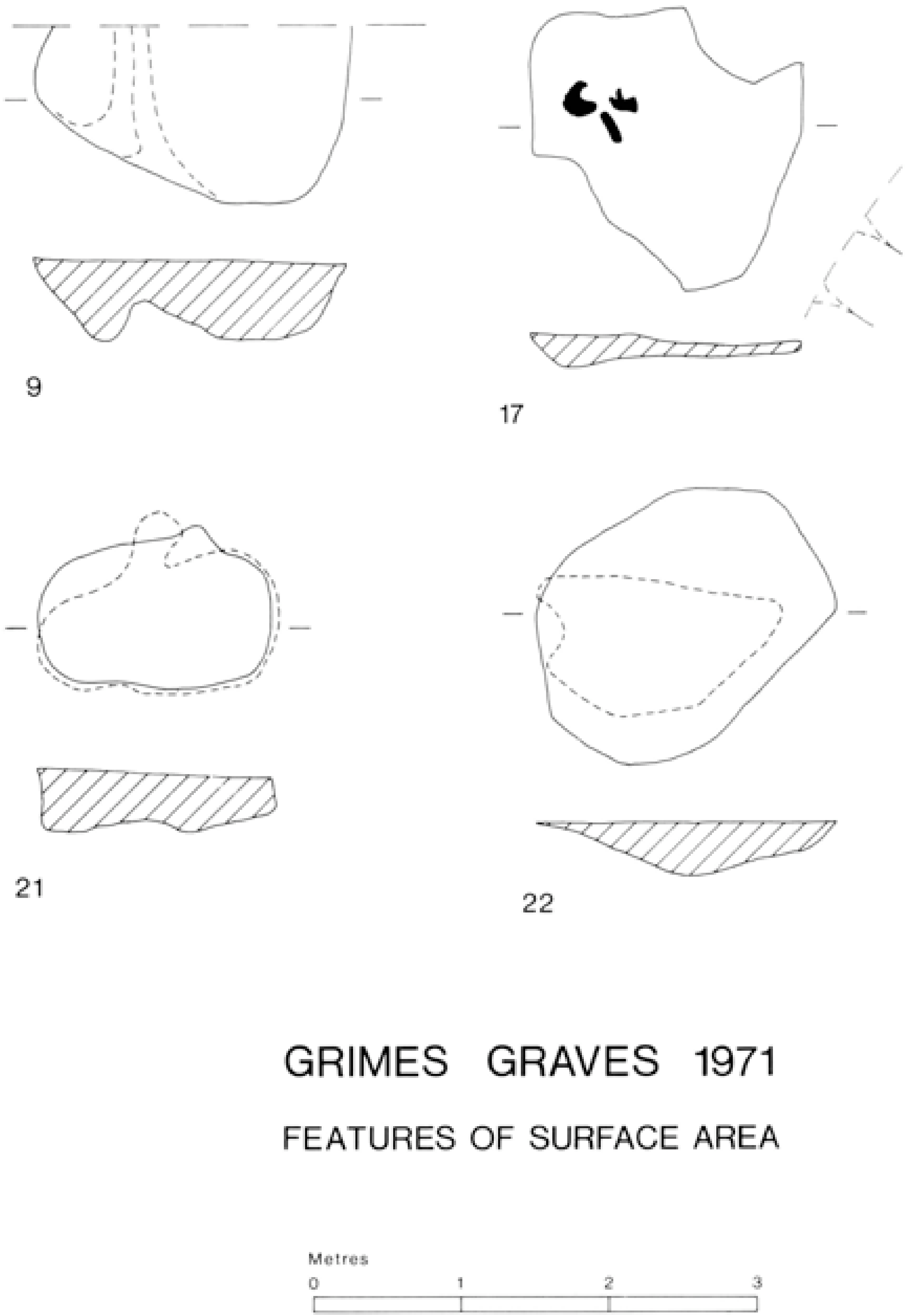


Figure 5 Surface Area excavated 1971–72—Features

the site—the 'Late Neolithic' assemblage and an assemblage relating to later occupation during the Middle Bronze Age (see below). Within the area an average density of c. 1,150 struck flints per m² was encountered and while this density is very high it can be seen to fall far short of densities encountered on the sealed working floor to the west of the 1971 shaft. A subjective impression of the excavator was that this material could certainly not be called an *in situ* working floor but more likely was the accumulation of working debris over a fairly long period—and over more than one phase.

Disturbance of this band of flint material was frequent with one clear pit cutting through the material into the sand subsoil. Examination of this and other more amorphous 'features' led to the conclusion that they were all tree-bole disturbances.

The sheer quantity of flint recovered from this large area enabled a close study of one sample of c. 44,000 struck fragments from Trench 2A (Volume II)—the largest survey of flint waste material from the site—again a Mesolithic sub-stratum is apparent in addition to the two later prehistoric phases apparent on the site.

The 1971 Shaft

The initial clearance by means of Trenches 3, 4, 5 and 6 of the surface of the 1971 shaft revealed the lip of the pit, slightly oval in shape, with a body of dark humic material lying in the depression representing the final and longest period of weathering and humic accumulation. Sherds of Romano-British pottery, abraded sherds of pottery of prehistoric origin and fairly heavily corticated flint fragments occurred frequently within this deposit, together with a substantial deposit of bone including a fairly large number of those of horse. A chalk object (C 11, Figure 34) was located within this deposit in remarkably fresh condition and displaying the 'saw tooth' working which is characteristic of early chalk working on the site. C 10 (Figure 34) found in the basal deposits of the 1971 shaft can perhaps be indicated as the end-product, possibly a chalk lamp, for which this object represents a preparatory stage. Its fresh condition must imply that it lay in a protected context, possibly within the turfline at the edge of the shaft before ultimately silting into the shaft head in relatively recent time. Also within these superficial layers a sherd of East European Neolithic pottery of the fourth millennium BC was recovered, presumably a collector's stray.

At the base of the group of humic layers (Group 1A) a concentration of flint nodules lay in the centre of the deposit, presumably gravitationally selected as the heavier material naturally tended to roll further towards the centre of the depression which marked the position of the shaft. Certainly the nodules were not closely packed but were set within a soil matrix of derived silting which would seem to support the suggestion of a natural origin for the concentration rather than a deliberately built cairn. This consideration was prompted by the deposit found immediately beneath the flint nodule concentration and set in the surface of a thick band of chalky washed deposit (Group 1B). The complexity of this deposit prompted the termination of Section 2 of the digging of the shaft and the removal of the obverse quadrants to enable the whole area of the shaft to be considered at once. Beneath the nodule concentration mentioned above, a deposit of charcoal 90cm in diameter, not burnt *in situ* and containing a great number of sporls of flint presumably from working, was found set in the centre of the shaft (Burnt Area 2). This deposit of unknown function (see Figure 6) was clearly stratified above a dense scatter of animal bone including an entire red deer antler. All this material was set within washed silt making the determination of surfaces with material set upon them most difficult, but apparently associated with this deposit of bone were two inhumations in the crouched position dug into the surface of the 1B chalky wash. Inhumation 2 lying crouched on its back facing south was clearly the earlier of these two burials and had been massively disturbed by the insertion at a later date of Inhumation 1 (see Figures 6 and 7). The greater part of the upper body of Inhumation 2 had been removed entirely from the shaft during this later insertion leaving only a few fragments of the skull and one tooth. A full consideration of the skeletal material will be found in Chapter IV. Suffice it to say here that this primary inhumation would appear to be that of a young adult woman of medium stature. By her hip an etched chalk plaque was found, (see Plate VII), in fresh condition and presumably not exposed for a long period in the washed silting into which the inhumation was dug, and therefore it would seem reasonable to associate this object with the act of burial. The etching is a simple abstract criss-cross design of no readily apparent significance. The feet of this earlier burial rested directly upon an area of *in situ* burning (Burnt Area 1 see Figure 6). Charcoals derived from this deposit (71/19) were submitted for radiocarbon assay within the British Museum radiocarbon laboratory and yielded a determination 2,465 ± 230 bp (515 ± 230 bc) BM—780.

The later burial (Inhumation 1) was cut into a pit in the surface of the Group 1B layers and as has been described destroyed the upper part of Inhumation 2. Presumably some interval of time had passed between the insertion of one burial and the other. This later burial was virtually intact lying in an identical posture to Inhumation 2—supine crouched—but in this instance facing west. The body is that of an adult male of medium stature (see Chapter IV). Abnormalities in the 10th and 11th thoracic vertebrae might indicate *ante-mortem* injury. This individual was furnished with two iron ring beads 8mm in diameter and much corroded (71/1099). One was located just beneath the right mandible of the burial and one behind the base of the skull and they presumably represent a necklace ornament or perhaps earrings.

The cultural and chronological evidence associated with these two inhumations makes it fairly clear that we are dealing with burial rite appertaining to an early formal Iron Age date. That the rite is recurrent is shown in barest outline within the context of the 1971 shaft but at this point we should perhaps recall the excavation by Peake of Pit 2 in April 1914 when in his 'Layer 3' but in an uncertain relationship with his so-called 'black band' a complete inhumation was located although in disarticulated condition (Peake 1914, 79). Very few clearly 'Iron Age' ceramics have ever come from the site and none certainly were found in 1971 so that this activity has to be left somewhat ill-defined. Nevertheless, the retrieval of these two burials is of some importance in the sparsely filled catalogue of Early Iron Age burial in Britain. Whimster (1977) has drawn attention to a relatively sparse and widespread distribution of 'pit burials' throughout southern and eastern England. Such chronological evidence as is available would indicate a 1st–3rd century BC date for most of these. A consistent feature of such burials would appear to be the contracted or flexed position of the body and the secondary use of features, e.g., storage pits and, at Grimes Graves, disused mine shafts. Supine crouched inhumation is, however, only paralleled at Woodcutts and Tollard Royal, Wiltshire and at Worthy Down, Hampshire. Whimster has shown that the preferred orientation for such inhumations is with the head to the north. This is observed in the later of the two burials at Grimes Graves.

The group of layers of chalky wash into which these inhumations were dug are a consistent feature in the upper fill of all the excavated flint mine shafts on the site. It comprises a dense semi-concreted layer of chalk wash with varying degrees of humic discolouration. An immediately apparent characteristic is the very great number of mollus-

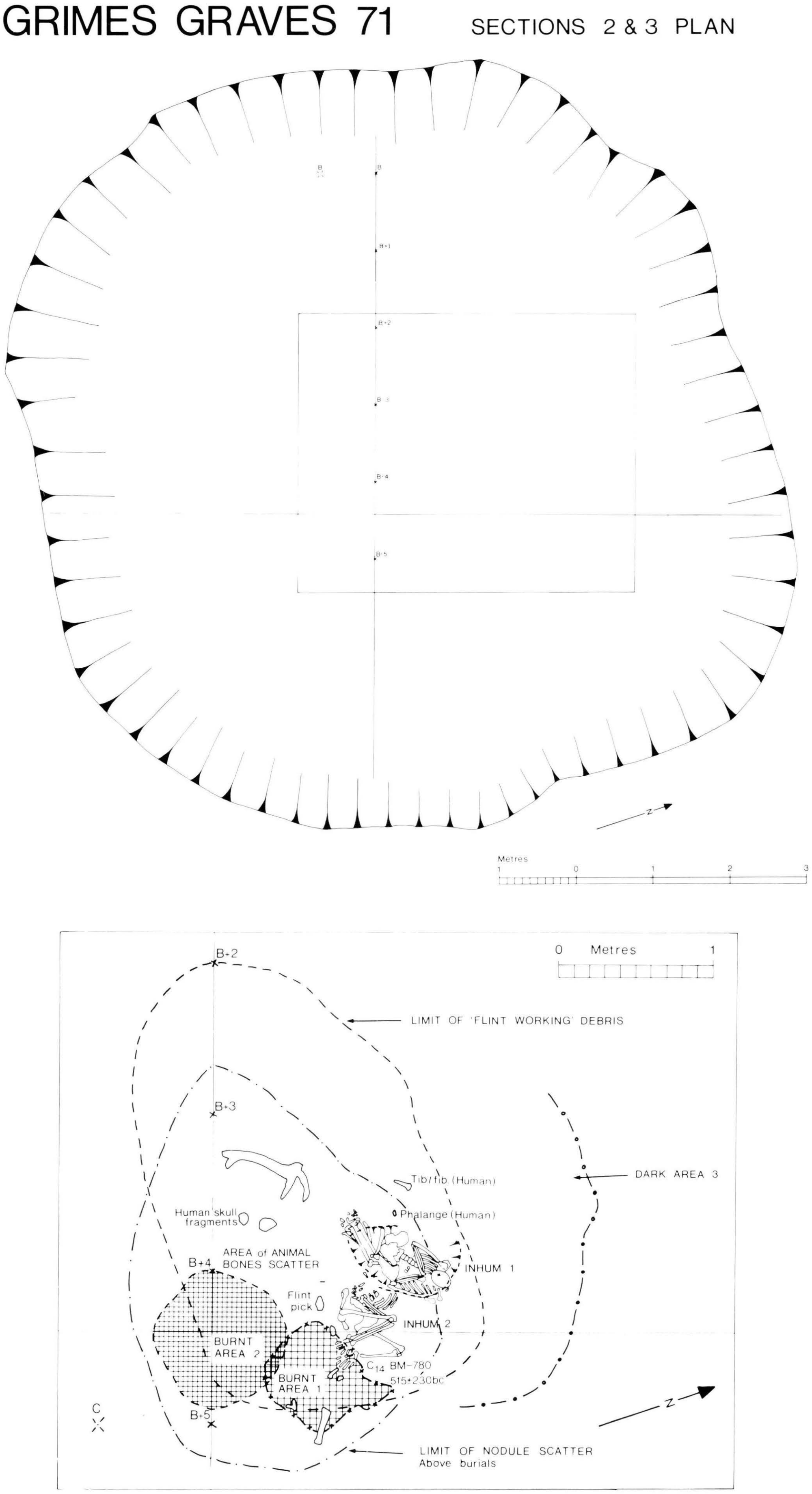


Figure 6 1971 Shaft sections 2–3, plan

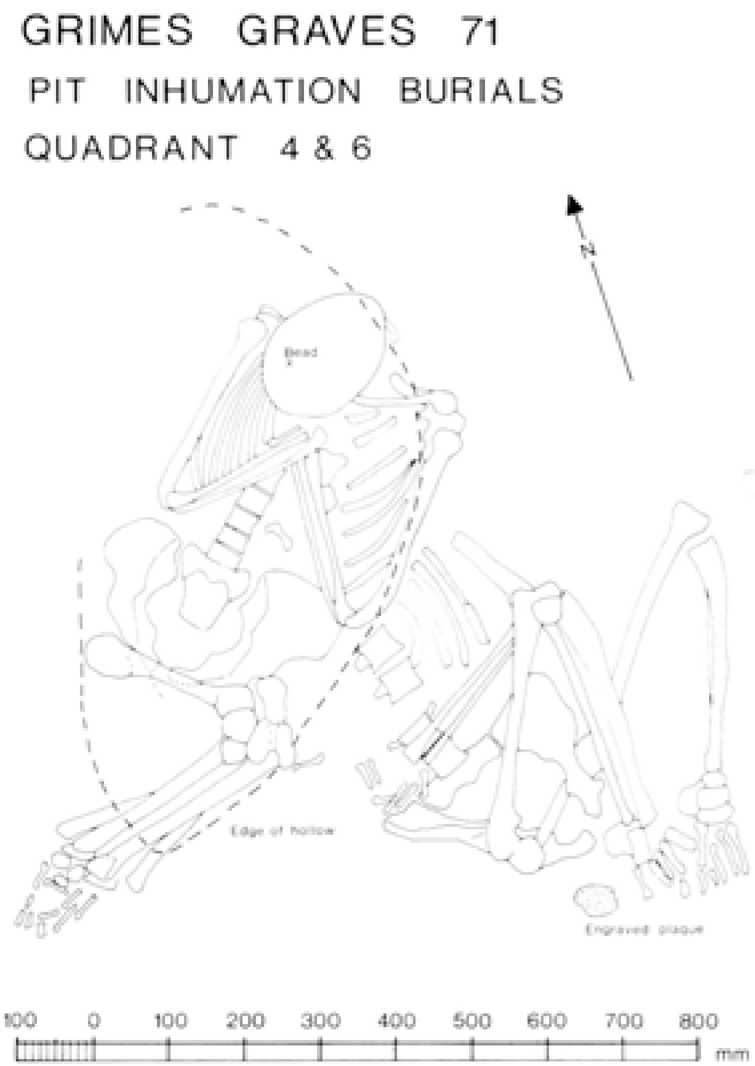


Figure 7 1971 Shaft inhumation burials—detail

can remains present within this material (see Chapter VI). The material itself would seem to be composed of chalk debris, broken down by weathering, and washed into the head of the shaft from the surrounding chalk dumps perhaps during a period of increased precipitation. This process is seen in action on the surface to the north-west of the shaft in Trench 4 where chalk dump material interdigitated with layers of wash and bodies of flint debitage was seen to have stabilised itself on the edge of the weathering cone of the shaft. As the weathering cone slowly expanded giving rise to the lower filling of the shaft, so the edges of the chalk dump were exposed to erosion and at this point the concreted chalk began to form in the shaft head. The molluscan evidence would also indicate that this phase of the shaft filling is occurring at a time when woodland conditions giving rise to substantial leaf litter are also prevailing on the site—presumably representing a re-establishment of woodland after the mining phase although it is difficult to guage how general this cover had become or how restricted it was to the mine shaft depressions themselves. We shall see below further evidence for the composition of woodland in the area during this later period of activity on the site because this 1B group of layers contained within it substantial quantities of pottery and flintwork which are clearly linked to a Middle Bronze Age occupation of the site chiefly evidenced by a series of midden deposits in the head of the 1972 shaft (see below). This link is made even clearer by the occurrence within the 1B layers of a thin (6cm) dark organic lens (Dark Area 3 see Figure 6) representing an incipient deposit of the type noted in 1972 and containing some Middle Bronze Age urn material. To anticipate the study of the 1972 material a radiocarbon determination for this Middle Bronze Age deposit was established at 3084 ± 44 bp (1134 ± 44 bc) BM—1097 and it will be appreciated that drawing in evidence from widely divorced contexts in the later second millennium BC—from the dating of recurrent surfaces in peat bogs in the Lake District (Godwin 1956, 34) to the periods of occurrence of fenland trackways in Somerset (Hibbert and Jones 1975, 9) and with the suggested reason for changing agricultural practice in the Later Bronze Age (Bradley 1971) there is a broad basis of evidence for an increase in precipitation at some time late in the second millennium bc (Piggott 1972, 109–113). It is suggested that this increase in wetness could have brought about the radical change in filling type in the shaft represented by the Group 1B deposits. A very considerable quantity of struck flint debris and implements was recovered from these chalky deposits.

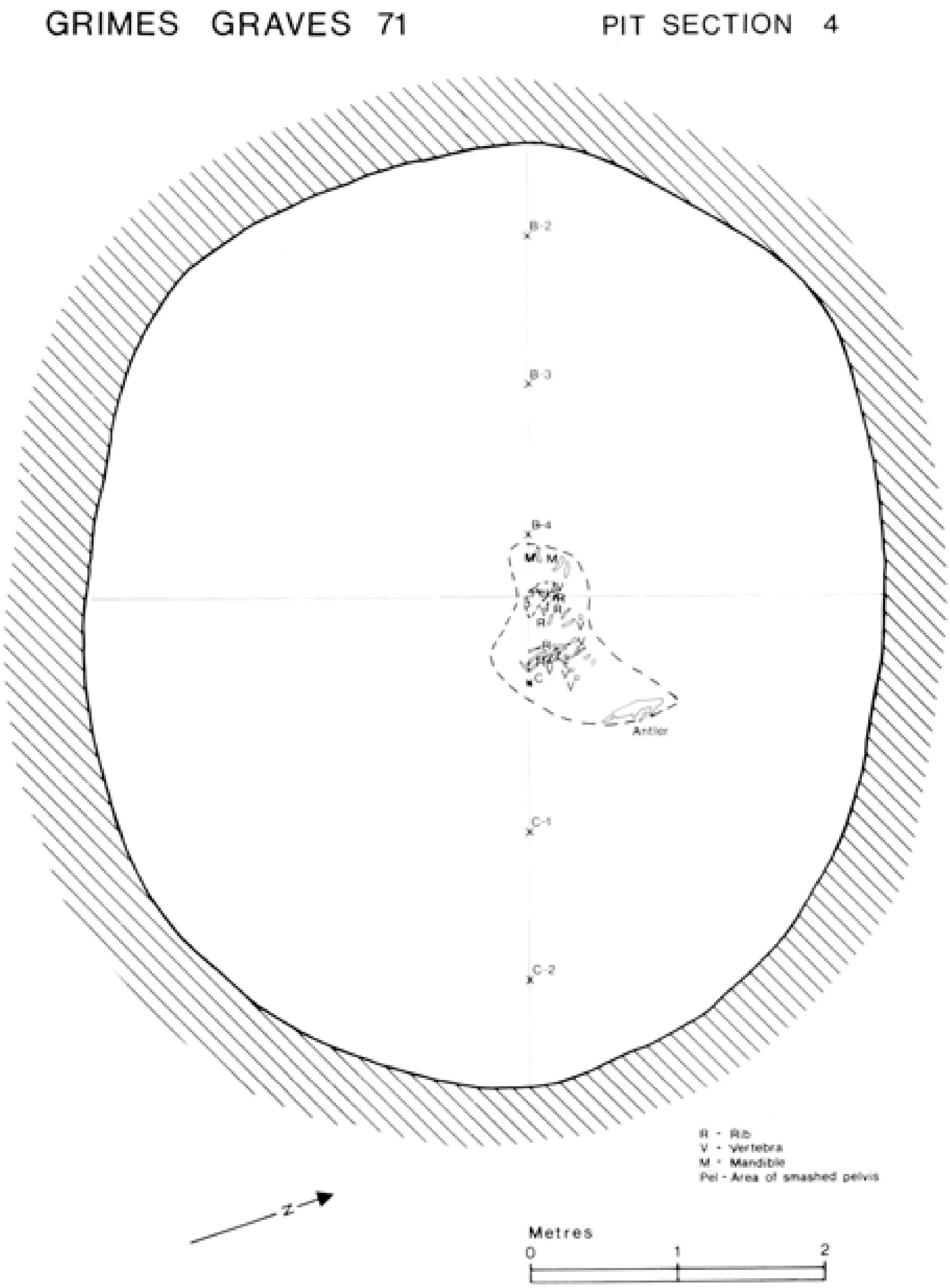


Figure 8 1971 Shaft section 4, plan—showing position of *sus* and antler of *cervus elaphus* in shaft fill

Immediately below the 1B deposits the rapid and largely sterile filling of the shaft begins (Group 1C) comprising interdigitating *laminae* of alternating sand and chalk blending towards the centre of the shaft to a less clearly distinguished mass of gravitationally selected large flint nodules and chalk block material. The symmetry of these deposits clearly visible in the two axial sections drawn through the pit fill ([illegible] and [illegible], is broken only in the uppermost deposits immediately below the 1B series. Here, largely within the north-east quadrant of the shaft a clear asymmetry is to be seen indicating, possibly, the disturbance of these uppermost layers by prehistoric excavation or a phase of asymmetric backfilling, possibly deliberate. The apparent truncation of layers to either side of this depression clearly visible in the north/south section through the pit fill might bring us to favour the former interpretation. Within this steep-sided depression set in the base of the hollow of the partially filled flint mine shaft a massive deposit of flint working debris was located apparently tipped in from the west side, all of it in remarkably fresh condition with its freshly fractured edges completely unpatinated and with fractures still displaying the fine flint dust produced at the moment of striking impact. This mass of debris produced a very large number of flint cores and a very small (by comparison) group of implements including one axe and three so-called 'rods', an implement type which we shall come to see is typical of and unique to the Middle Bronze Age horizon on the site. The whole assemblage is very largely worked upon flint of non-floorstone origin and would appear to be the product of debris picked up on the surface of the site at a post-mining phase rather than in any way reflecting the production of working flint mines. One sherd of Middle Bronze Age urn fabric type was located within this deposit to provide a further indication of its cultural and chronological status.

This deposit represents the last evidence we shall see, as we descend through the filling of the 1971 shaft, for activity on the site during the Middle Bronze Age. The evidence as we have seen it is sketchy and can only fully be appreciated in the light of the excavation of a substantial midden deposit relating to this period in the head of the 1972 shaft. Further discussion will ensue when we come to consider this later work.

The main body of the shaft fill from a depth of c. 4m to c. 5m comprises the laminated natural filling brought about by the gradual erosion of the weathering cone. The generally alternating chalk and sand composition of these *laminae* is presumably brought about by the weathering of the chalk wall of the shaft followed by the infall of exposed sandy turfline. Within many of the sandy *laminae* fresh unweathered flint assemblages were located which we can regard as material of Late Neolithic date lying sealed within the old land surface and being deposited into the shaft along with its matrix. Little molluscan evidence survives in this sandy and coarse textured fill and as elsewhere on the site the calcareous base to the sandy soil precludes the survival of fossil pollens. Little bone material survives from this great block of fill, one of the principal groups being a substantial part of a pig retrieved from a depth of 5.5m associated with an antler of red deer (see Figure 8). The very coarse nature of the central block of this filling led to enormous problems in the recovery of bone material stratified within it, which, in any case, was frequently extremely friable. In the circumstances much bone material may not have survived and ceramic material may have undergone a similar fate. One sherd, identified on the grounds of fabric as of Early Bronze Age type was located in the upper group of *laminae* 35cm below the level of the deposited flint working debris.

What is abundantly clear from this central block of filling is that there can be no question in the instance of the 1971 shaft of deliberate backfilling induced by the proximate digging of later shafts. The vastly greater part of the body of the shaft was left to silt up naturally over a period of time defined by radiocarbon dates in *post quem* and *ante quem* positions beneath and above this body of fill as a period of c. 500 radiocarbon years: 1134 ± 44 bc for the Middle Bronze Age activity directly superimposed, indeed dug into, the top of this central block and a central date of c. 1800 bc for the activity at the shaft base (see below). This long period is apparently, according to the chronometer provided by this one shaft in a complex of over 500, one of virtually no cultural activity in the area. The very small number of molluscs surviving in this block of fill makes it very difficult to assess the environmental circumstances during this long period. However, a period of gradual afforestation would appear to be indicated by the evidence for the wooded environment that appears to have taken over by the time of the Middle Bronze Age occupation. This apparent desertion is readily understandable in that such an unnaturally pock-marked landscape might well have become the subject of awesome respect by neighbouring people and furthermore if many shafts were left by the miners in the open condition that is apparent in the case of the 1971 shaft, considerable physical danger must have attended any penetration of the area particularly in overgrown conditions.

At a depth of 7.5m below the surface, and still 4.6m from the floor of the shaft, a group of six horizontal sockets was located driven into the chalk wall (see Figures 9 and 10 for detailed sections). These sockets contained a compact rusty coloured deposit, quite foreign to any material found in the shaft, which appeared archaeologically to represent the butts of horizontal timber members driven into these sockets. Samples of this material were removed intact and submitted for analysis (see Chapter VI) and it would appear, both on structural grounds and on the basis of flecks of charcoal within this material, that it probably represents posts of oak. All of the sockets in question are very shallow (Figure 10), most being of the order 1–3cm deep—one (no. 3) approaching 5cm in depth, and it is likely that their present condition is the result of much weathering of the wall of the shaft. A corollary of this observation must be that other such sockets may well have totally disappeared, so that probably only a small sample of the remnant of any original structure survives. The directionality of each member, in so far as it can be postulated from such shallow sockets, is indicated on Figure 9 and a discussion of the role of this structure in the working of the shaft is appended below (see p. 30). At this juncture we can point to the possible functions for horizontal members protruding from the wall of the shaft at this height from the floor. A simple shelter built out from the wall to protect the heads of those working below as they enter and leave the galleries is quite conceivable. A platform built out from the wall of the shaft upon which to dump spoil thereby relieving the necessity to carry material right out of the shaft is a second possibility. Thirdly a stage or 'landing' might be constructed to facilitate access to and egress from the shaft by a series of ladders. Combinations of all these reasons should also be expected.

Similar horizontal sockets driven into the chalk walls of flint mine shafts are described by Becker in the Danish neolithic flint mine complex at Aalborg in north Jutland (Becker 1951, 135–52 and Becker 1959, 87–92). Here, Becker has postulated a platform about 2m above the floor of the shaft (and here the depth and frequency of the sockets are such as to make this conclusion a good deal firmer than can possibly be the case at Grimes Graves). Current chronology would place these mines in the latter part of the third millennium BC—a little earlier perhaps than the Grimes Graves complex. Similarities between the two complexes both in the form of the shafts themselves and in the apparent non-concentration on axe manufacture (daggers and sickles appear to have been the principal items produced at Aalborg) are striking. Again as at Grimes

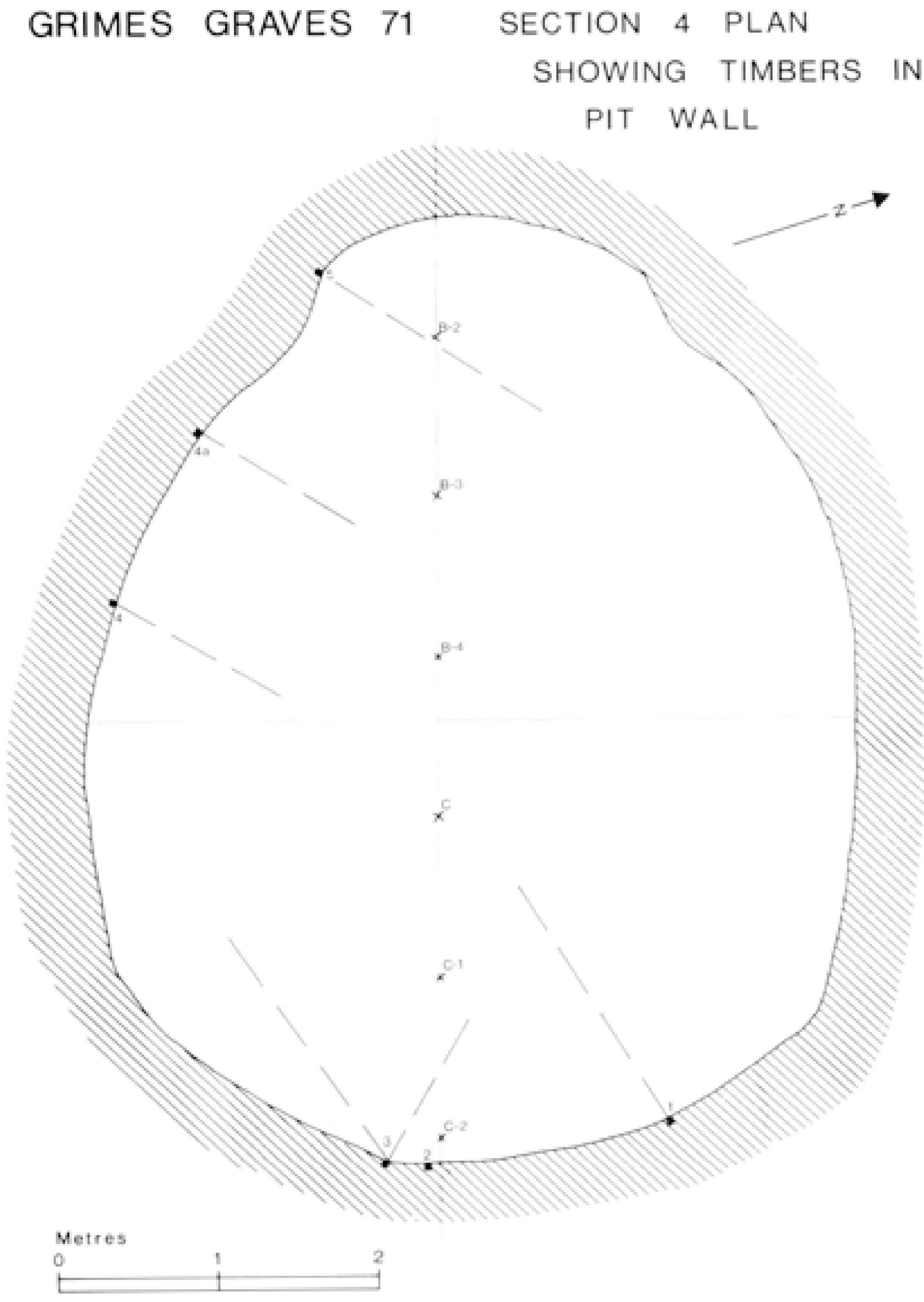


Figure 9 1971 Shaft section 4, showing position of timber in the shaft wall

Graves no occupation debris is found in association with the mining complex and the same scarcity of finished tools is noted.

These very close similarities between the two complexes might tempt us to point to the better preserved evidence for a platform at Aalborg as a direct parallel for the evidence as it exists at Grimes Graves. In the discussion below of working practices on the site we shall see that a platform to assist the excavation of overburden from the shaft would appear on other grounds to be the most likely explanation.

No trace of timber was located within the shaft fill and it would seem that either this evidence has just not survived or that only stumps were left in the sockets upon the abandonment of the shaft. The diameter of the timber as evidenced by these truncated sockets is of the order of 10cm and it would seem likely that such timbers could be carried across the whole diameter of the shaft at this point (minimum 4.8m, maximum 5.9m) and be expected to be load bearing.

It was during the next (5th) section of the shaft's excavation that the angle of laminar silting of the shaft was seen

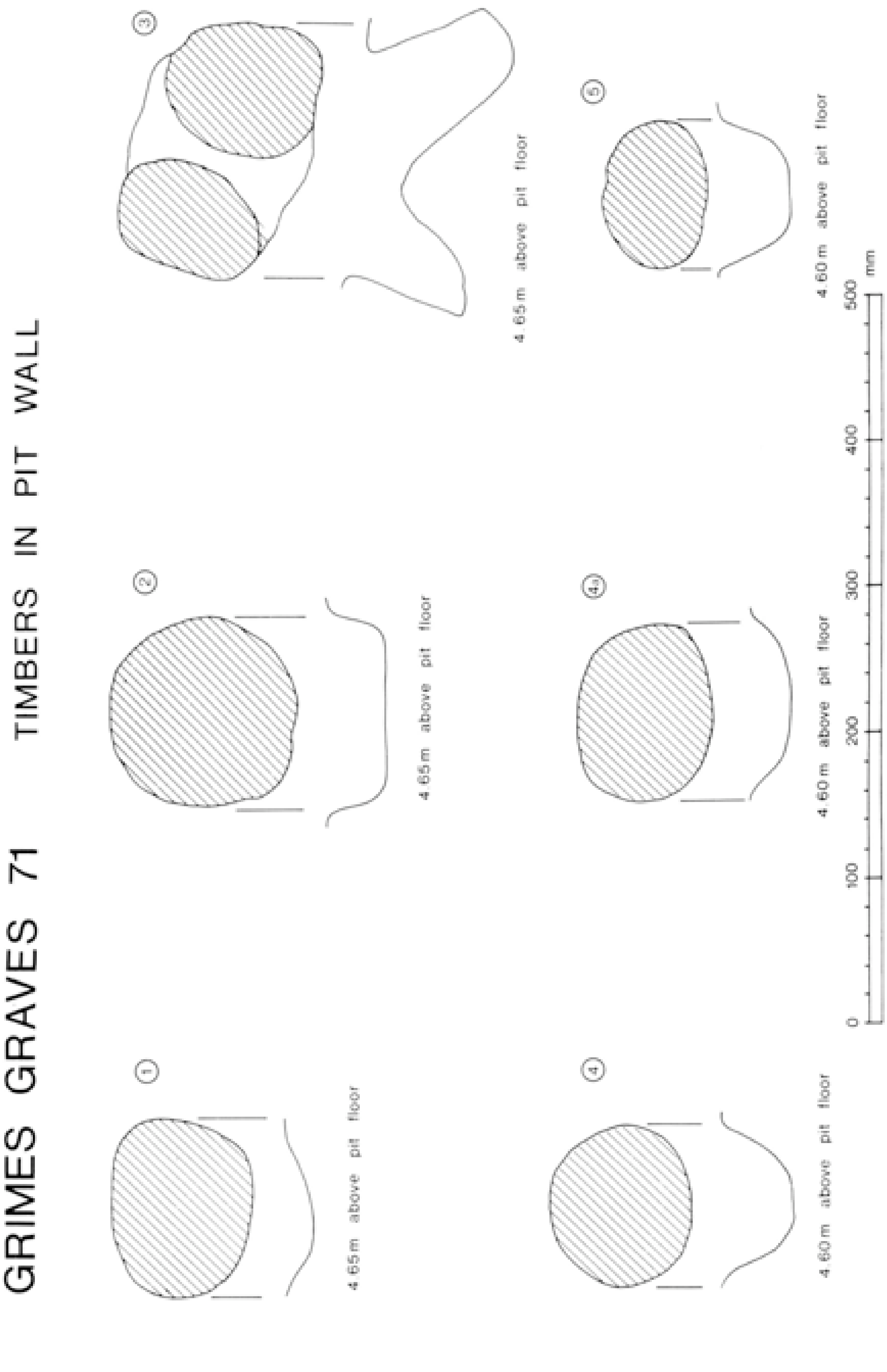


Figure 10 1971 Shaft detail plans and sections of timber sockets in the shaft wall

to level off considerably and it became apparent that this rapid natural silting was resting upon a block of filling which was in no way so even or finely constituted. The configuration of shaft fill experienced up to this time was indeed reversed and a slight dome of chalky blocky fill, well impregnated with sandy detritus was encountered. The surface of this slight dome lay at a depth of c. 11.40m from the surface and about 1.60m from the base of the shaft. The deposit is best interpreted as a dump of block chalk left on the floor of the shaft by the miners to avoid the labour of lifting this overburden out of the shaft. This dump presumably represents the chalk excavated from the last gallery/ies to be dug and must have led to severe congestion on the floor of the shaft. All tip lines within this dump were convex, not concave as elsewhere in the shaft, and yet the outline of the dump was quite symmetrical, displaying none of the asymmetry that would almost certainly characterise partial deliberate backfilling of the shaft from the top—the other possibility. We can thus regard the upper surface of this dump as contemporary with the abandonment of the shaft after the extraction of the floorstone flint. It was therefore peculiarly fortunate that this surface should bear a cultural assemblage of considerable importance. A roughly rectangular area of large nodular flint working debris occupied more or less the whole of the north-east quadrant of the shaft lying on this dump surface. By the wall of the shaft in the declivity at the edge of the dump there was a small patch of burning. The centre of the area of flint working was characterised by a considerable increase in small working debris in an area of granular organic soil which had 'leaked' away through the chalk blocks and the extent of which was quite difficult to define (Dark Area 5). The struck flint set within the loose chalk composition of this basal dump, that on its surface and that immediately above its surface was extremely difficult to separate and for study purposes (see Volume II) has been grouped as material from the 'fifth to seventh sections' (see Figure 11).

A number of very large cores forms the most interesting aspect of this group: all of them were formed on blocks of floorstone and they are accompanied by two or three axe type products, one scraper and a series of utilised and worked flakes. The same generalised, 'domestic' industry appears to be represented here that we have already seen elsewhere where sealed deposits of mining phase flint working occur. Nevertheless perhaps a greater emphasis on axe production is visible in this admittedly tiny sample. Shattered flint sporls occur widely here where floorstone nodules have been initially broken up by massive blows prior to the working up of the material.

Before considering the nature of this final activity in the mine shaft we must consider the most important aspect of this assemblage of material on the surface of this last dump of overburden. Roughly in the centre of the shaft at the southern extremity of the area of flint working a further dark area (Dark Area 4) comprising more of the granular organic material already mentioned was located. This darker area was packed with the unabraded but extremely friable sherds of two vessels assignable on the basis of both fabric and decoration to the Grooved Ware pottery style (see Chapter II). Rim sherds of two other vessels occurred amongst this assemblage. The area of stained soil may well have represented totally decayed sherds or perhaps some organic element associated with the deposition of the pottery. A similar dark deposit of seemingly organic origin was associated with a mass of small flint working debris—the product of smashing floorstone nodules prior to their being lifted. These deposits were set on top of a mass of large flint blocks apparently discarded and not extracted from the mine. Set 60cm to the east of the flint working debris was a small burnt area producing charcoal sufficient for one radiocarbon assay (BM—778 3781 ± 67 bp—1831 ± 67 bc). A further group of twenty-two plain undecorated bowl sherds of Grooved Ware type was found against the west wall of the shaft at this level.

Neither of the principal vessels was complete which might argue against *in situ* breakage. However, the extremely friable mud-like condition of the pottery, necessitating instantaneous conservation on retrieval could well have led to the total decay of substantial elements of each vessel. The two principal vessels are open bowls, profusely decorated on their interior surface with incised and impressed decoration. It is difficult to suggest how these two intricately ornamented vessels should find themselves at the base of the shaft once its productive life had ended associated with a relatively short episode of floorstone flint working. The remainder of the site both on the surface and in the shaft is ill-supplied with pottery at this phase so that the occurrence of this rich deposit is thrown further into relief, and the unusual nature of this deposit may point to the deposition of the pots for some special and irrational purpose. The 'Grooved Ware' context established thereby for the primary activity in the shaft is clearly quite in keeping with the late Neolithic aspect of the flint assemblages found on the old land surface at the shaft head and beneath the chalk dumps in the surface area.

The excavation of the sixth section comprised the removal of the final dump of chalk block material piled up in the bottom of the shaft in the last stages of the mining process. This conical dump had lenses of sand and chalk filling the cavities created at its sides and on the surface of the dump, but down by the wall of the pit near the floor a further group of sherds undecorated, but in similar fabric to that seen in the decorated Grooved Ware bowls described above, was located. The dump of chalk blocks was largely sterile with only a small number of antler picks being located. Beneath the dump, directly, lay a thin layer of trampled chalk covering the chalk floor of the shaft. In the centre of the floor on the surface of the trampled chalk a hearth was located which provided adequate material for radiocarbon assay (BM—776 3789 ± 60 bp—1839 ± 60 bc). This fire could not have burnt for a long period or been very intense as the chalk beneath it was not much scorched, and it may simply have been a dump for torches used at the base of the shaft. Two massive nodules of flint roughly spheroid in shape and weighing in excess of 45kg lay on the floor of the shaft—one had been rolled away into an undercut on the south-east side of the shaft. Clearly attempts had been made without success to break up these nodules and, being too heavy to lift out of the shaft, they had been left and buried by the final dump.

Scattered over the area of the floor of the 1971 shaft and galleries were 65 antler picks and fragments thereof (see Figure 13) all of which were in broken or blunted condition. The nature of the source of this antler will be discussed elsewhere (Chapter V); it remains to discuss at this point however the inference to be drawn from the presence of such a large number of antler fragments on the shaft floor. These picks and a small number of rakes were all presumably broken and discarded during the final phase of shaft working and progress into the galleries. If 74 fragments were broken during this relatively brief period of working

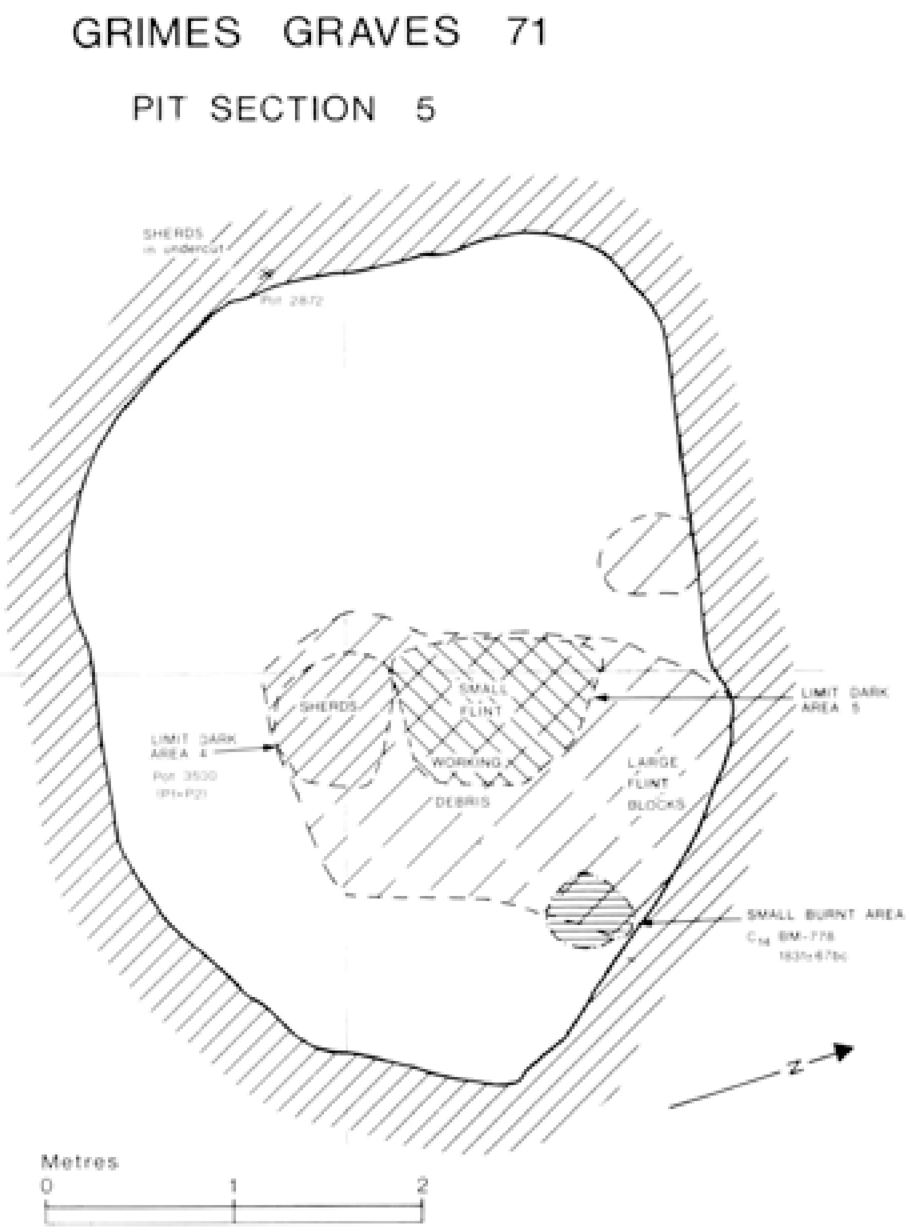


Figure 11 1971 Shaft section 5, plan—showing detail of deposit on top of 'prehistoric dump' on shaft floor

the rate of attrition on these implements during the whole process of working in the shaft and indeed over the much greater scale of the whole mine complex must have been prodigious. Strangely, however, few antler pick fragments and then only a number of tine fragments were located stratified within the chalk dumps where one would expect evidence of the continuing breakage of picks during shaft working to be registered. Perhaps here attention should be drawn to the experience recorded during the digging of the Overton Down Experimental earthwork (Jewell *et al* 1963, 52) where, presumably using a work force with a far less degree of experience than the prehistoric miners at Grimes Graves, no antler pick was broken by levering and even blunting was found to be a relatively rare occurrence. It does seem unlikely that all the large number of picks located in the basal deposits of the 1971 shaft could have been broken in the last stages of the working and it may be that the accumulation of antler fragments in the base of the shaft is the product of some irrational activity associated with the completion of the shaft. If on the other hand one accepts the 65 antler pick fragments and nine rakes as a true reflection of the rate of breakage then the implications for the number of picks used up in the whole mining process are clearly very surprising. Legge (Chapter V) has postulated an average total of 100 – 150 picks per shaft and this estimate may be conservative. The careful selection (to the degree of a 66% preference) of left-hand antlers noted by Legge (see p. 99) may indicate that the picks recovered in the shaft are to be linked to the final phase of working at the shaft floor and in the galleries as the advantages of the 'left hand' pick are clearly to be linked with confined working. That over 90% of the antler used by the prehistoric miners was cast by living animals and not cut from dead ones is a fascinating aspect of economic management considered in some detail by Legge (p. 99). An almost exactly similar percentage of cast to culled antlers was observed by Harcourt at Durrington Walls, Wiltshire (Harcourt *in* Wainwright and Longworth 1971, 345) and

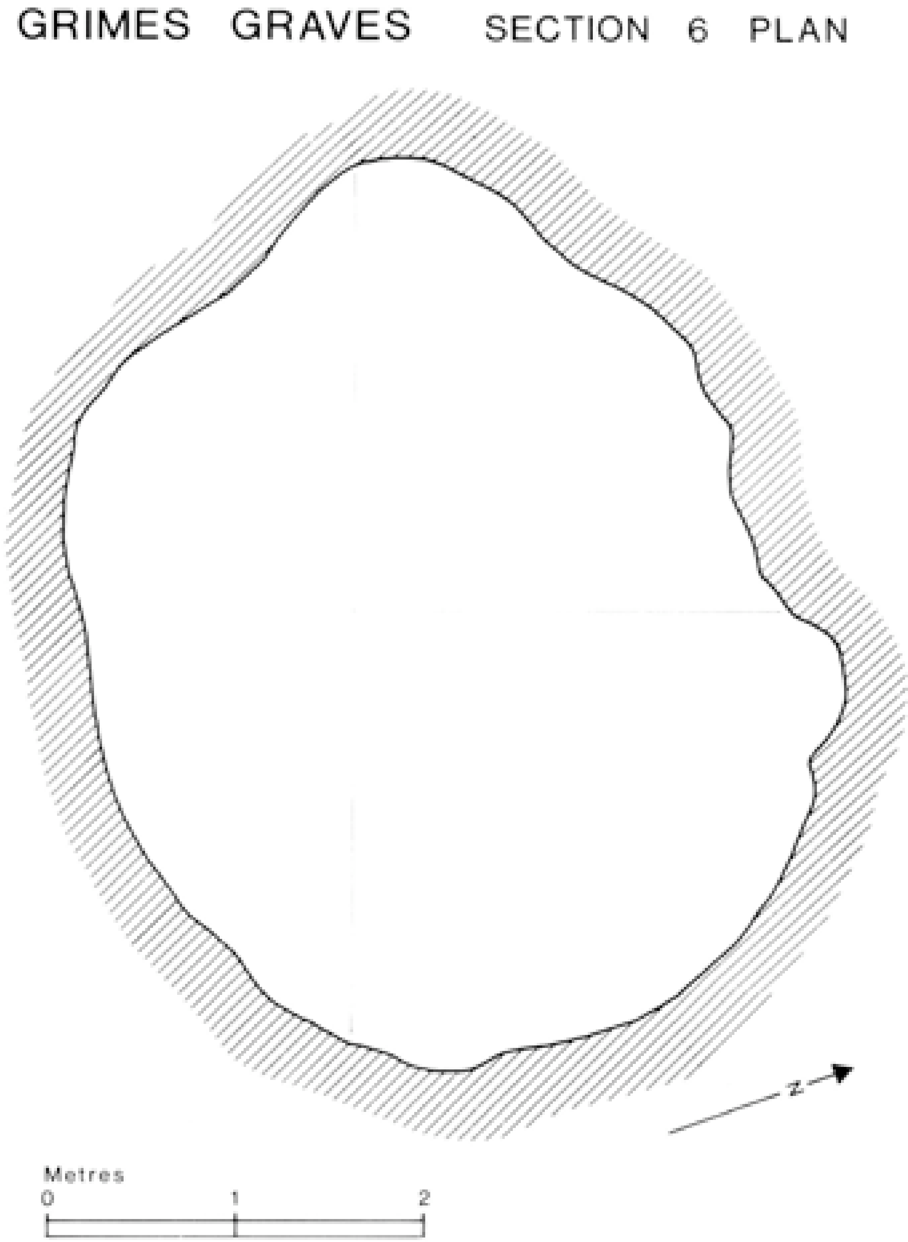


Figure 12 1971 Shaft section 6, plan

Grigson was able to see from 25 red deer antlers with their crowns intact only eight from culled animals at Windmill Hill. At this site the figures for roe deer antlers were more impressive where from 16 antlers only one is cut from a dead animal. Similarly at the flint mine complex of early third millennium BC date at Blackpatch, Sussex 90% of all the antler utilised during the operation was cast (Goodman, 1924).

This wide-ranging preference for cast antler over antler cut from dead animals is probably most elegantly explained in simple utilitarian terms. The natural wish to conserve the source of supply of this all important material would have encouraged this preference; also, the antler of the deer is at its most resilient just before the period of casting i.e. spring (March/April). The collection of the very large quantities of cast antler required, at first sight a task of considerable difficulty, could not have been accomplished without some degree of herd management. Yet this, if modern 'ethnographical parallels' are correct need only be minimal. In Northern Scotland the antler of red deer are a valuable perquisite of the ghillies who manage the shooting on the ground. The writer gathers that it is common practice at the present day at the time of casting to build small high fenced enclosures around which fodder for the deer is scattered. The stags will readily be tempted down by this fodder. At the crucial moment the daily fodder is placed inside the fence and the deer will jump into the enclosure to obtain the food. The shock of landing will frequently dislodge the antlers, which can be collected in large numbers once the deer have fed and retired. The degree of technology and management involved in this ruse cannot be placed beyond the imagination and abilities of the Grimes Graves miners or their dependents.

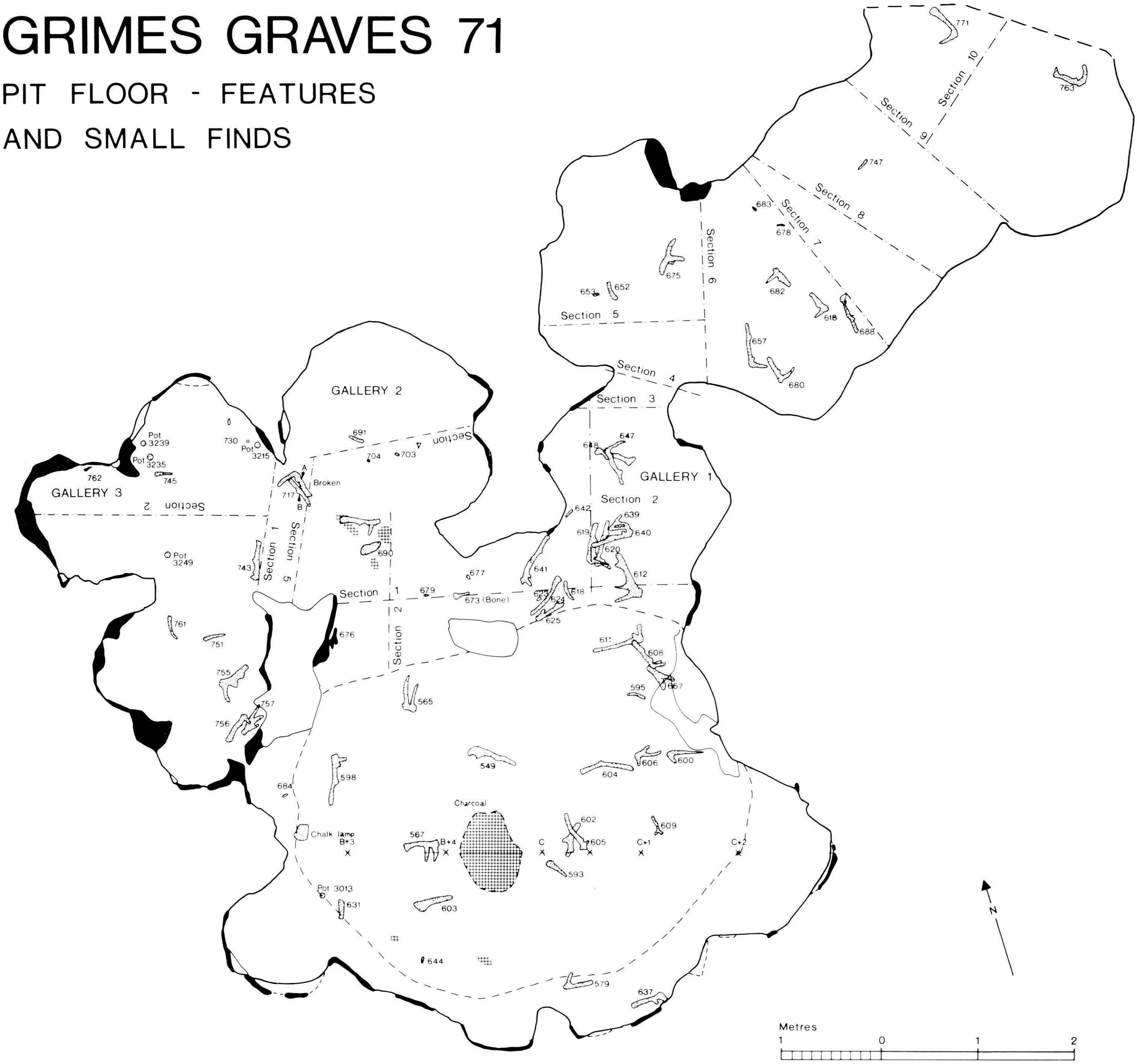


Figure 13 1971 Shaft pit floor. Positions of discarded antlers on and just above the floor and location of central 'hearth' and other small finds

To return, however, to the suggestion of some irrational activity leading to the artificial concentration of antler picks at the base of the shaft; it is perhaps necessary here to recall to our attention the deposit of pottery on the surface of the dump left by the prehistoric miners on the floor of the shaft.

On the pit floor itself 20 antler picks and rakes or fragments thereof were located, seemingly randomly discarded. Against the west wall of the shaft lay a chalk lamp carefully manufactured and unbroken but exhibiting no trace of burning or staining sustained in use. No debris was encountered that could in any way be interpreted as 'domestic'—only one fragment of bone other than the antler was located just within Gallery 2 and one sherd of plain Grooved Ware was located against the shaft wall again in the western sector. Other than these few fragments and the hearth referred to above, the floor was sterile: an indication possibly of the relatively short period for which it was exposed after the floorstone nodules were ripped up and before the dump was built on the pit floor with debris taken from the galleries. Lack of weathering of the lower walls and floor of the shaft would appear to indicate that working on the shaft floor did not last at all long and that silting commenced almost immediately; the experience of Armstrong (see above) may be recalled here when re-excavation of Pit 1 in 1920, six years after its initial investigation, showed that 2.5m of silt had accumulated in the shaft during the interval.

Excavation of the pit floor revealed a surface of consolidated chalk rubble trampled by the original miners. This trampled concreted chalk was extremely hard and on occasion difficult to distinguish from the native chalk. Its careful removal disclosed the uneven chalk floor of the shaft revealed by the original miners when the floorstone nodules were torn up. This surface was studied in considerable detail to record the exact configuration of the floor and to record discolouration by iron staining which appears to be associated with the underside of floorstone nodules *in situ*. By the recording of these two features, in conjunction with the visible remains of floorstone still extant in the walls of the shaft, it was possible to construct a plan of the approximate position of floorstone nodules and of their approximate shape and size (see Figure 14). Such reconstruction, because of the very even thickness of the floorstone layer, has enabled a fairly accurate estimate to be prepared of the weight of flint extracted from the mine during its working life. As will be seen, Gallery 1 rapidly broke through into another gallery complex relating to a mine shaft set to the north-east and calculations of extracted flint weight do not include that taken from this gallery relating as it does to another shaft.

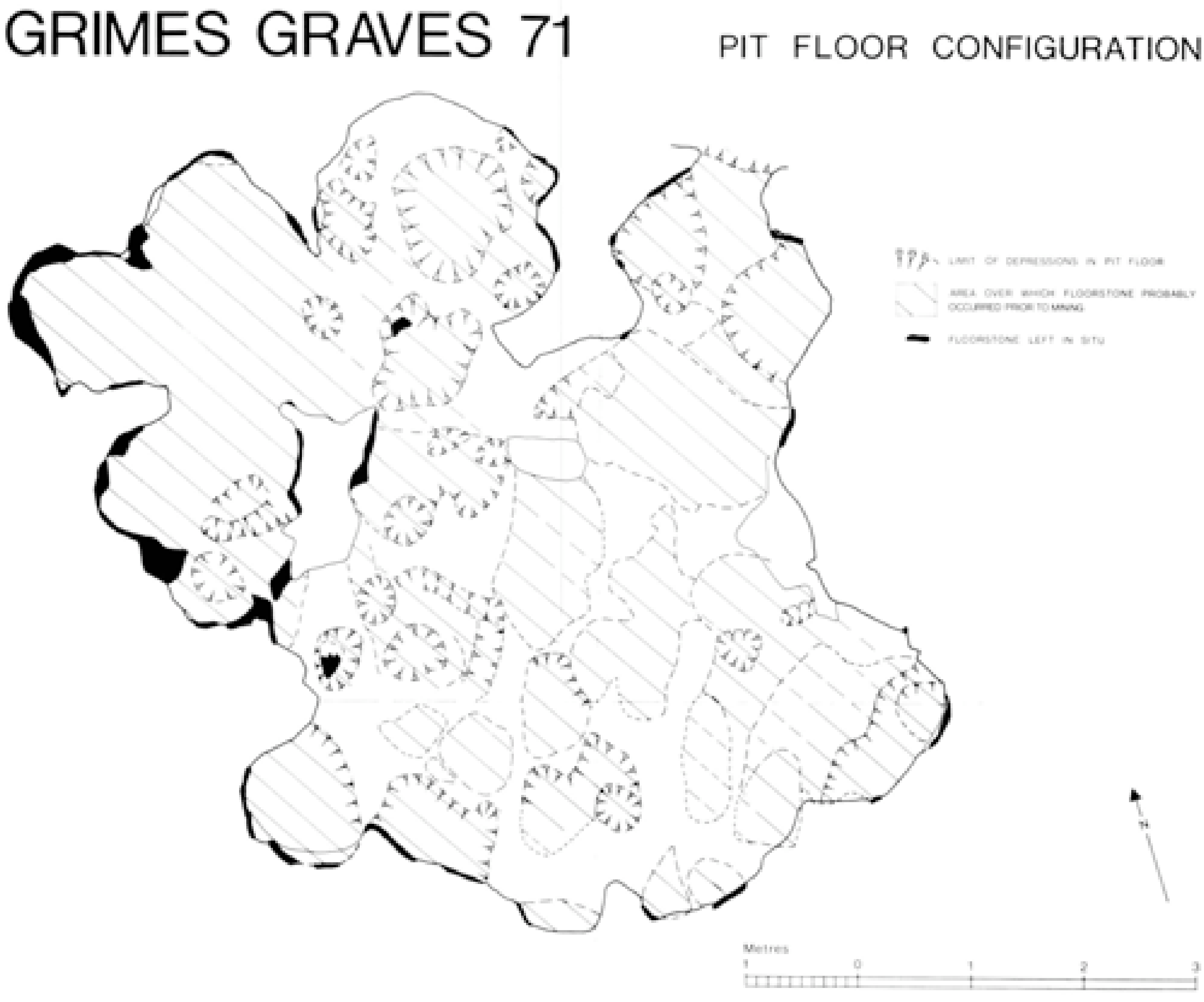


Figure 14 1971 Shaft pit floor. Configuration and location of extracted floor stone nodules

Undercuts into the chalk wall of the shaft at its base were present all around the southern sector of the floor. Apparently all of them proved unrewarding to the miners and contained poor and patchy deposits of floorstone. It was to the north that three galleries were opened revealing a total of 16m² of floor (118% of floor of the shaft itself). Gallery 1 almost immediately broke through into the gallery system of an earlier shaft to the north-east of the 1971 shaft. Galleries 2 and 3 were not well developed, possibly reflecting unsatisfactory floorstone deposits although that remaining in the walls would appear to be of good quality, but more likely reflecting the very broken quality of the chalk at this point leading to the extreme instability of the gallery roofs. The degree of collapse of gallery roofs can be readily appreciated from the gallery section drawings particularly in Gallery 1 (notably sections 7, 8, 9 and 10 see [illegible]). The evidence of the drawn gallery filling section would appear to indicate that Gallery 1 was the first to be dug and was completely finished to the point of break-through before Gallery 2 was commenced. This argument is adduced on the grounds of the axial sections at the entrance to each gallery (Gallery 1 Section 2 Figure 15 and Gallery 2 Section 2 Figure 16). That of Gallery 1 is filled with chalk blocks and contains a very substantial concentration of discarded broken antler picks. This deposit would appear to be directly mined chalk, in all probability derived from Gallery 2 with broken picks discarded amongst it. The deposit at the entrance of Gallery 2 is quite different with a mass of sandy lenses entering the gallery—a situation only possible once the shaft had begun to silt up. The clear implication here is that this gallery was still open when the shaft was deserted indicating that it was the last element to be dug. The relative lack of broken antler within Galleries 2 and 3 is presumably to be linked with this sequence. The putative working of only one gallery at a time has implications for the scale of manpower deployed in the shaft at this late phase in its working life (see below). The galleries also exhibited the layer of trampled concreted chalk on the floor, which had been a feature of the shaft floor itself.

So poor was the quality of the chalk into which the galleries were cut that the roofs and walls had almost totally decayed. No impressions of antler pick or any other implement working were found *in situ* in the walls or roofs. Fallen blocks from the roof did exhibit, occasionally, the traces of soot which would appear to reflect the use of brands and lamps within the galleries and patches of charcoal on the floor in Gallery 2 may well indicate the extinguishing of such sources of illumination prior to leaving the working. Burnt debris in Gallery 2 yielded material sufficient for one radiocarbon date BM—775 3815 ± 60 bp 1865 ± 60 bc while another (BM—777 3764 ± 60 bp 1814 ± 60 bc) was retrieved from carbon located in Gallery 1.

Study of the antler located within the galleries (see below) has shown the strong preference for 'left-hand antlers' which would be more convenient to use 'across the body from the right arm' in the confined space of the galleries. It is unlikely that more than one or at most two digging miners could have worked simultaneously within the galleries of the 1971 shaft with a further two or three personnel to assist with the evacuation of the chalk overburden. The floorstone was torn up leaving a few shattered fragments in the galleries and then apparently dragged whole to the surface of the dump on the shaft floor where it was broken up at least into manageable blocks and thence carried out.

Work and output study relating to the 1971 shaft

The writer must emphasise that what follows is a conjectural analysis of the information available to produce one possible combination of figures which would account for the digging of the shaft. Many observations are based on archaeologically retrieved information which can be subject to more than one interpretation, and some observations are based on the writer's own judgement of the task from experience gained during the archaeological excavation of the shaft. The results which can be arrived at are only intended to give some idea of the *order of magnitude* of the task while giving a picture which will be slightly more realistic than a mere catalogue of man hours involved. The 'man hour' calculations are, however, given in all instances for those who would prefer to study them unembroidered.

The following conclusions are drawn from information supplied in the Work Study chapter of the report on the construction of the Overton Down Experimental Earthwork (Jewell 1963, 50–59). In the Overton Down exercise the labour force used was inevitably inexperienced and, as the authors point out, some allowance must be made when direct comparisons with highly experienced prehistoric labour are undertaken.

The nature of an excavated shaft is one that is most indicative from the point of view of work study. The restricted floor area places an approximate maximum on the number of workers that can be employed at any one time in the digging. For this reason a calculation of man hours involved in the excavation of the shaft can be converted into an actual 'fastest time'. A complication, however, arises with the problem of evacuation of the material won by the miners. To what extent did this act as a brake upon the calculated rate of digging?

Methods used by the Prehistoric Miners

The tools used by the miners in the 1971 shaft seem largely to have been antler picks. Large numbers of these were found on the shaft floor. The method of use of these picks is not clear. Some of those discarded in the shaft show little or no wear at all. Wear on the brow tine itself does not necessarily indicate usage as a pick—this wear can occur prior to casting or cutting from the deer. Very little evidence was located of hammering on the burrs of the antlers although these were damaged in some instances.

Nevertheless, on the dumps of chalk on the surface area around the shaft and in the shaft itself the large fresh blocks of chalk have in many cases obviously been pinned by an antler tine and then broken off from their parent mass. From the little damage exhibited by the burrs, a simple pick swing (which was empirically found to be the best method of usage at Overton Down) seems to have been used to impale a block of chalk and break it free. Also at Overton Down, battering of the burrs was found to inflict remarkably little damage.

Ox scapulae shovels have often been postulated or observed on Neolithic and Bronze Age sites but at Grimes Graves there is absolutely no evidence of their use. Wooden shovels which have left no perceptible record are of course a possibility but the use of a flat bladed tool to shovel blocks of chalk is not particularly successful and a pronged fork or rake is far more effective. The crown tines of the antler (see Figure 57 for antler terminology) seem to have been used for this purpose and the chalk blocks were probably raked up into baskets for despatch from the shaft. The sand in the surface area, however, *must* have been moved by shovel or hoe type implement initially.

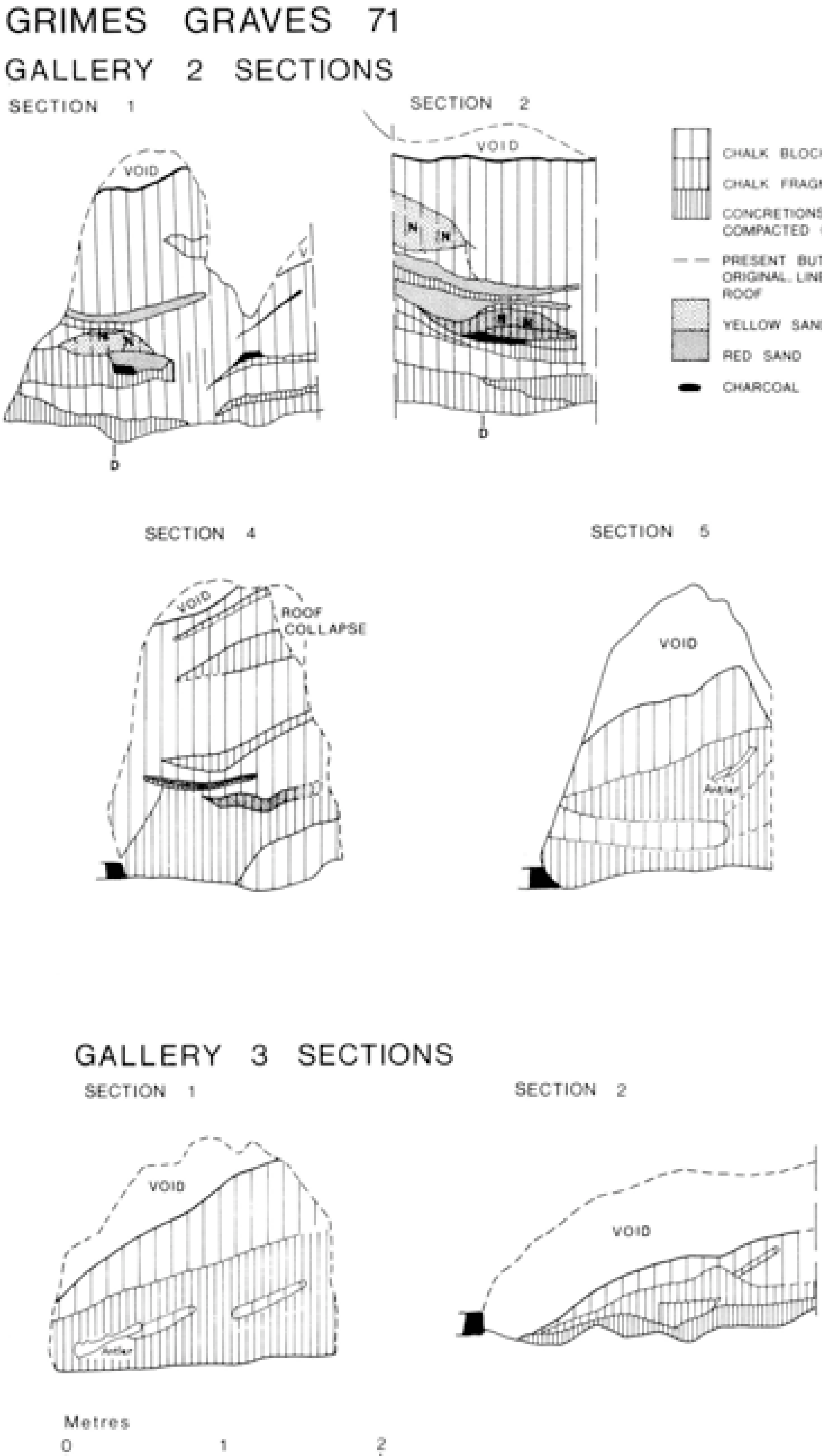


Figure 16 1971 Shaft. Galleries 2 and 3—Sections

The unworn nature of many of the butts of the antlers probably indicates that a leather binding was used to cover the butts or else they became so caked with chalk that the butt did not wear. A leather binding was found to be useful at Overton Down to protect modern hands from blistering.

The method of evacuation of material from the shaft is a subject of conjecture although some indications are available. The rope marks observed by Peake must be noted in this context, but situated as they are at the point where the gallery roof meets the Pit wall it is difficult to see how they occurred in any reasonable method of spoil extraction. Furthermore Pit 2 was much shallower than the 1971 Pit and different techniques might apply. In the wall of the shaft at a height of 4.60m from the floor and approximately 7.50m from the surface as we have seen was a series of timbers set in sockets cut in the chalk wall of the shaft. Some of these sockets were extremely shallow and it is reasonable to assume that weathering has accounted for this. Consequently, it may well be that other sockets have totally weathered out of the wall leaving no archaeologically perceptible trace. The fact that the sockets are apparent over at least half the circumference of the shaft would seem to indicate that the structure to which they related affected the whole diameter of the shaft.

Socket number *2* is composed of two sockets for timber leaving the wall at approximately 45° angles and at right angles to one another, and the angle of these two sockets would militate against these being merely short posts tying, for example, a ladder to the side of the shaft. The diameter of the sockets varies between 10 and 13cm and timbers of this diameter would have been adequate as load bearing joists over the diameter of the shaft (averaging approximately 4.8m at this depth). How the double socket (2) would have been used is not easy to conjecture, a change of plan may be involved or the two timbers could have been braced one against the other. Allowances must be made for a possibly fairly sophisticated timber structure as we know to be possible from other sites with Grooved Ware association.

The most satisfactory explanation for these timbers (although by no means the only one) is that of a timber platform built at this intermediate stage in the shaft as a 'landing' for the terminals of two ladders—or even four ladders—two for people carrying material up and two for people returning. The platform, if such it was, would only have been of value in the extraction of material from the lowest 2 or 3m of the shaft. It is interesting, however, that at this particular height a ladder from the floor to the platform would rest at approximately 45° and the ladder from the platform to the surface would rest at the same angle. This is the critical angle at which a human being can walk up a slope as opposed to climbing using hands as well as feet.

We should bear in mind the observation by Andrews (in Peake 1915) that skeletons of voles were located in the galleries of Pit 1 and indeed several of the discarded antler picks were gnawed by them. He contends that these animals could have only reached the floor of the shaft alive if some ladder or similar mechanism had been available.

Whatever the structure it would have seriously inhibited any hoisting of loads of spoil by rope or its equivalent up the whole depth of the shaft. Furthermore such hoisting would really only be practicable given the use of some form of pulley and a platform built out at the top of the shaft. No evidence of such a platform exists and evidence at present available would suggest that the appearance of the wheel in north-west Europe is occurring at this very period. Radiocarbon dates for the Dutch solid disc wheels are shown in the following table.

Table II. Radiocarbon dates for Dutch solid disc wheels

Site	Radiocarbon date
Dierticnhuizen A	2065 ± 65 bc GrN—2878
B	2120 ± 70 bc GrN—2879
De Eese	2075 ± 75 bc GrN—2368
Exloerveen	1950 ± 60 bc GrN—4155
	(Van der Waals 1964)

Adaptation of this mechanism to use as a pulley would probably not have taken place. Such an improvisation as a rope running over a greased and polished beam is really not practicable. In the case of the 1971 shaft a 'rope' made presumably of hair, vegetable fibre or leather would have had to be over 24m in length without any protruding joins to make this possible. Very little information seems to be available as regards prehistoric rope manufacture (but the retrieval of rope at the base of the Wilsford Shaft may well indicate that lengths of up to and over 38m may have been available). It should be pointed out however that probably up to a metre of the old land surface around the shaft has been lost in the weathering cone and any surface platform only affecting this area would have been lost without archaeological trace. The burnt wood within Feature 7 (see Figure 5) may relate to such a structure but could equally well be a simple hearth by the pit head.

The writer's view is that material was carried out of the shaft by basket or some such rigid container (soft leather bags are a possibility but are extremely awkward to fill) and deposited on the dumps around the shaft at the top. The very even dispersal of the size of material within the dump would tend to indicate direct dumping and not shovelling on to a dump, when some gravitational selection would have occurred with the lighter material falling to the rear of the dump. For this method to work efficiently two means of access would have been necessary to allow those bringing material out of the shaft to be unimpeded by those returning for further loads. Four stages of working can thus be visualised if this interpretation is accepted.

1. The extraction of the chalk by antler picks by breaking away blocks from the solid.
2. The raking of the blocks into rigid containers.
3. The porterage of the spoil out of the shaft.
4. The creation of dumps around the head of the shaft.

Practical experience during the excavation of the filled shaft has shown that at the surface a maximum of c. 12 people could work in the shaft without unduly impeding one another and at the base this maximum would have been reduced to c. 8.

Approximately 10 men working in the shaft at any one time can be accepted as a maximum feasible number. From the excavator's own experience, an average of six men would seem to be as many as could wield picks together in the restricted area available in the shaft. In the very confined area at the base of the shaft, three or four would be the maximum. Each picker, however, would require a team raking together the chalk, filling baskets and carrying the spoil out of the shaft. The experimental work undertaken at Overton Down, Wiltshire (Jewell 1963), indicated that one picker using an antler pick can break up c. 15cwt (762kg) of bedrock chalk per hour (in terms of volume, 762kg = 0.4196m³ of chalk).

We may assume that each load carried by a carrier would average 50lb (22kg) (probably a maximum possible average weight) and also assume an average of five minutes for each round trip taking material out of the shaft. Thus each pick man working at the 'Overton' rate would produce 34 man loads per hour—work for three carriers working continuously at the assumed rate. Six pickers would therefore require 18–20 carriers working continuously plus any workmen raking material together (say a further two men)— a total work force of 26–28 men. This would seem to be a figure involving far too great congestion and a figure of four pickers suggesting 12 carriers and one or two rakers would seem more feasible.

Whatever the concentration of effort, the pickers would require a total of 878 man hours to dig the 368.5m³ of chalk in the 1971 shaft at the rate 762kg (0.4196m³) per man per hour. In support of this activity, 3–4 men per pick man would be necessary for raking and carrying, representing in the shaft body excavation a total of say 3.5 × 878 = 3,073 man hours. Thus a total input of 878 + 3,073 = 3,951 man hours would be necessary for the excavation of the bedrock chalk body of the 1971 shaft.

To this total we have to add estimates for the removal of the sandy material at the head of the shaft, the excavation of the galleries themselves and the lifting of the 8 tonnes of floorstone flint.

The removal of the sandy material would probably have been undertaken by wooden shovel or some such similar tool. There is no reason to suppose that such an instrument would have been markedly less efficient than a modern steel shovel and therefore it is permissible to apply modern working rates to this activity. The volume of sand standing at the head of the shaft would have been approximately 78m³.

A reasonable modern working rate for clearing sand can be reckoned at 0.5m³ per man hour, thus 156 man hours input would be necessary to clear this volume of sand. However, it is apparent that over the diameter of the shaft head simple 'shovelling out' would not have been possible at all points and an element of porterage would also have been necessary here. It is suggested that a notional 1:1 relationship is adopted here of 1 man hour of porterage per 1 man hour digging, in that when porterage was necessary one shovel man could clearly have occupied more than one carrier but at the outer limits of the shaft simple shovelling could have been employed. Thus to 156 man hours shovelling input, a similar figure for porterage has to be added yielding a total of 312 man hours. The working situation in this surface area is altogether more flexible than in the shaft proper and probably up to twelve men could have wielded a shovel effectively with a further 12 or more serving them for porterage.

Some allowance has also to be made for the task of clearance and turf stripping over the area of the shaft head for which a notional 2-day period of uncertain man hour composition can be added to our computation of a total period for the shaft excavation.

For the galleries at the base of the shaft the writer would initially assume a reduced rate of working efficiency (by a factor of 33%) due to working in cramped and awkward conditions. The roofs of the galleries had in all cases collapsed over time but it was clear that their original roof height had generally been between 80cm and 1m. The total volume of chalk dug out of the galleries appertaining to the 1971 shaft was some 19.4m³. Based on the 'Overton Down' rate, the rate of picking would be 0.2538m³/hour × 0.66 = 0.1692m³ per hour. At this rate it would require 115 man hours to dig the requisite volume of chalk. The archaeological evidence at the base of the shaft (see above) would suggest that only one gallery was excavated at a time (in so far as, apparently, overburden from one gallery was deposited in the other) and that little or no gallery overburden was lifted out of the shaft but was left on the floor of the shaft. Only one pick man could work in a gallery at a time, served by one or possibly two men assisting with collection and porterage. Thus it is likely that the 115 hours calculated for pick work would have to be matched, at least by porterage activity producing an estimate of 230 man hours for the excavation of the (relatively minimal) gallery system of the 1971 shaft.

The extraction of the floorstone is a more difficult activity to quantify. The time taken to lever up the floorstone and take it out of the shaft can only be guessed and depends in large measure on whether the material was extracted at a maximum possible rate or was taken as it was required. The weathering of the chalk at the base of this shaft would however indicate that the shaft had not been left open for very long (a conclusion that Peake's findings in 1914 bear out). The floorstone was levered up by jamming the tine of an antler pick beneath the flint and levering upwards either lifting the whole nodule or snapping it off at the chalk face. The impressions of antlers were found in the floor below the flint seam and in one instance a broken tine was located embedded in the chalk where the antler had snapped. The very great strength of shed antler as a lever is demonstrated in the Overton Down report. Ample evidence was found on the floor of the shaft of the breaking up of the floorstone nodules into handleable blocks.

The floorstone is approximately 12–15cm thick at the point where the 1971 shaft encounters it. As we have seen, the imperviousness of the floorstone has led to water being trapped beneath it leading to the deposition of a very thin iron rich stain on the surface of the sub-floorstone chalk. A kind of 'polish' was also imparted to the chalk surface by the presence of the floorstone nodules. Careful plotting of the presence/absence of these traces enabled an approximate reconstruction of the position and size of the extracted floorstone nodules on the floor (see Figure 14). In this way it was possible to arrive at an approximate estimate of the volume of floorstone removed first from the floor of the shaft and then from the galleries.

From the floor of the shaft it is possible to indicate that, in an area of 13.6m², approximately 8.5m² of floorstone had occurred and been extracted. The galleries to the north and the undercuts to the south occupied an area of approximately 21.6m² of which approximately 17.5m² were flint bearing. In total 26m² of floorstone occurred at the base of

Table III. Total working of the shaft in man hours

Task	Man hours
Sandy material at the top of shaft	312
Chalk bedrock body of shaft	3,951
Digging of galleries	230
Lifting of floorstone	44
Total	4,537

Table IV. Optimum working rates and numbers of individuals engaged in shaft excavation

	No. of Men	No. of Hours	No. of 9 Hour Days
Clearance and turfing	?	?	? 2
Sandy material at the top of shaft	? 12 + 12	312	1.5
Chalk bedrock body of shaft	4 + 12 + 2	3,951	24.5
Digging of galleries	2	230	13
Lifting of floorstone	1 + 3	44	1.5
Timberwork etc.	?	?	?2
Totals	2 – 24	?5,000	44.5

the shaft which at 0.12m thickness represents a volume of 3.12m³ of flint weighing approximately 8 tonnes. If we can simply adopt the 'chalk-rate' for the removal of this material, the breaking up of the flint would take 11 man hours and its porterage out of the shaft 33 man hours (at 5 minutes per 50lb (22kg) load)—a total of 44 man hours.

The total working of the shaft is shown in Table III. To this total has to be added more notional figures for turf stripping and clearance at the shaft head and incidental activities like ladder and platform construction during the shaft working, raising the total to approximately 5000 hours.

A further dimension has however been rendered possible by the confined nature of the working environment in the shaft. It is in these circumstances possible, on the grounds of experience and subjective impression, to suggest optimum working rates and numbers of individuals that can be engaged in each phase of the shaft excavation. It is possible to represent this construction in tabular form (Table IV).

The above calculations owe a great deal to the advice and correction of Mr W Startin, Inspector of Ancient Monuments, who as well as reviewing and commenting on the writer's attempts at calculation has given him access to unpublished material relating to other sites.

Discussion

We can see from the calculations above that the digging of the shaft would have probably taken, at a minimum, two months to achieve. The occurrence of delays due to bad weather, rest days, performance of other tasks, ritual activity etc. can only have extended this period. A question that must arise is whether the shaft was dug as a single exercise or was tackled in stages, perhaps seasonally. This point has important implications as to whether the miners were full time 'professionals' or part-time workers with a major interest in some other economic activity. There is very little archaeological evidence to adduce for either possibility. Certain points however may throw some light on the question:

1. There is some sign of intermittent weathering taking place during the formation of the chalk dumps.
2. The shaft in its very highly engineered shape and symmetry would *seem* to be the work of full time miners and would *not* appear by virtue of differential weathering or changing form in the shaft to have been worked in stages.
3. The retrieval of antler at all stages of natural wear might point to an all year round activity.
4. The nature of the industry is one that could seemingly not be carried out for short lengths of time. Peake in 1914 felt that he could indicate the contemporaneity of one other shaft with Pit 1. Presumably during the two months plus which would be necessary for the excavation of the shaft only the last twenty days or so would be directly productive. During that period a vast surplus to the actual needs of the sixteen or so men working in the shaft would be produced. Under primitive conditions the storing of such a quantity of valuable movable wealth might be extremely hazardous and a fairly sophisticated system of links with consumers would be necessary for dispersal on whatever basis this was carried out. Virtually no bone or other occupation materials have been found which relate directly to the mining phase so that little can be reconstructed of the economic subsistence of the miners—the discovery and excavation of their elusive settlement area is a first priority here. We can however indicate that they did not live in close proximity to the shaft during its excavation. Nor had they occupied in any way the old land surface sealed by the dump of material thrown out of the shaft—except one area of flint working to the west of the 1971 shaft.

Two basic possibilities present themselves. Either the enormous surplus of flint was being impounded by an organising or governing minority (whether for the common weal or not) or was being used in exchange for subsistence goods by the miners themselves. There is no evidence as yet to enable us to draw a distinction here. Either way continuity of supply is likely to have been at a premium and therefore it is quite possibly correct to assume that work was carried on on a continuous basis. The discovery of the totally buried and unknown shaft to the east of the 1971 shaft may indicate that a great many more than the 364 shafts visible on the surface are present on the site. Nevertheless, continuous working over 400 years on the site would imply over a thousand shafts which is an unacceptably high number. At the same time anything under a thousand shafts on the site would indicate a working rate of probably less than one shaft a year which also seems unlikely. The answer to this problem is just not known at present.

The number of people involved in the digging of the shafts as postulated above is probably very nearly the maximum feasible. The number (12 to 16) if all-male (and the rigorous nature of the work may well have demanded this), might well point to an extended-family-type unit undertaking each operation. The knapping of the flint would probably have taken place on site to produce the roughout implements. Whether the miners knapped or specialists were employed is not known nor can any information be adduced.

With the perfection of techniques of trace-element analysis of flint the way may lie open for detailed study of the geographical and chronological distribution of artefacts of Grimes Graves origin. The nature of this distribution is not at all understood at present but the position of the site was quite possibly chosen as much for its command of east/west and north/south communications—on to the Valley of the Little Ouse and Icknield Way—as for the flint which lies beneath the surface.

Table V. Analysis of Sussex flint industries (after Pye 1968)

	Knives	Roughouts	Cores	Fine Axes	Serrated Blades	Pick /Axe	Points	Scrapers	Hammerstones
Blackpatch									
Shaft 1	1	33 crude	21	30			1	2 oval 2 steep sided	1 + 5
Floor 3		Several	—	11					
Floor 4		Several							
Shaft 5				A few					
Shaft 7	1			1				1	
Floor 1		Several							
Floor 2						1			
Floor 3				Several					
	2	c. 45	21	c. 50		1	1	5	6
Church Hill									
Shaft 1	1	2	1	4					1
Shaft 4	5?	Part of 1 + 4	4	10	1		3	6	1
Shaft 5a		1		3 + 2					
Shaft 6	1	Part of 1	4	5				1	1
Shaft 7	1 + 2?	1		3	1			1	
Floor 1		Several	Several	4	1			1	
Floor 2		Numerous		4 + Several broken					1
Floor 3		Part of 1 + 1		1 broken					
Floor 4		2 + 1 very large		2	2			31	
Floor 6		1							
Floor 12		2					4		
Floor 14		5		2 (1 broken)				1	
Shaft 3				1					
Shaft 5				1					
Floor 8								4	
Floor 7	2 +						1		
Floor 15					1?				
	12 +	c. 33?	13	c. 47	6?		8	45	4
Cissbury									
Shaft 24	1	7		1					
Shaft 27		9	2	4				3	
Floor 1		12	6	4	5		10	9	1
Floor 2		2	1	1				1	
Surface		2					4	3	
	1	32	9	10	5		14	16	1
Long Down									
Working Floor 1	92	32	12	9	8		9	33	
Shaft 1	39	7	3	4			8	9	
Working Floor 2	147	51	3				4	16	1
	278	90	18	13	8		21	58	1

Table V. (continued)

	Knives	Roughouts	Cores	Fine Axes	Serrated Blades	Pick /Axe	Points	Scrapers	Hammerstones
Easton Down									
Pit B1									
Layer 1		2?		—					
Layer 2		Several +2+?	2	—				1	
Layer 3									
Layer 4		1?		—					
Pit B1a									
Layer 4									
Layer 5									
Layer 6									
Layer 7				4?					
Layer 8		5?		—					

Chronological and cultural context of the 1971 shaft

It has long been recognised that flint mining in Britain approximates, on the basis of present available evidence, to two principal chronological horizons of activity. The earlier horizon is represented by sites among others at Cissbury, Harrow Hill, Church Hill, Findon and Blackpatch all set on the South Downs in Sussex (see Figure 19 for radiocarbon table). These complexes appear to have been in action from the earliest moment of recognisable Neolithic activity in southern Britain and it is assumed that the product of these factories formed the hardware basis of the earlier phases of land clearance witnessed in the environmental record. In support of this assumption is the very high proportion of roughout axes, chisels (and finished products) as well as scrapers and other tools found on the working floors associated with these sites. No real

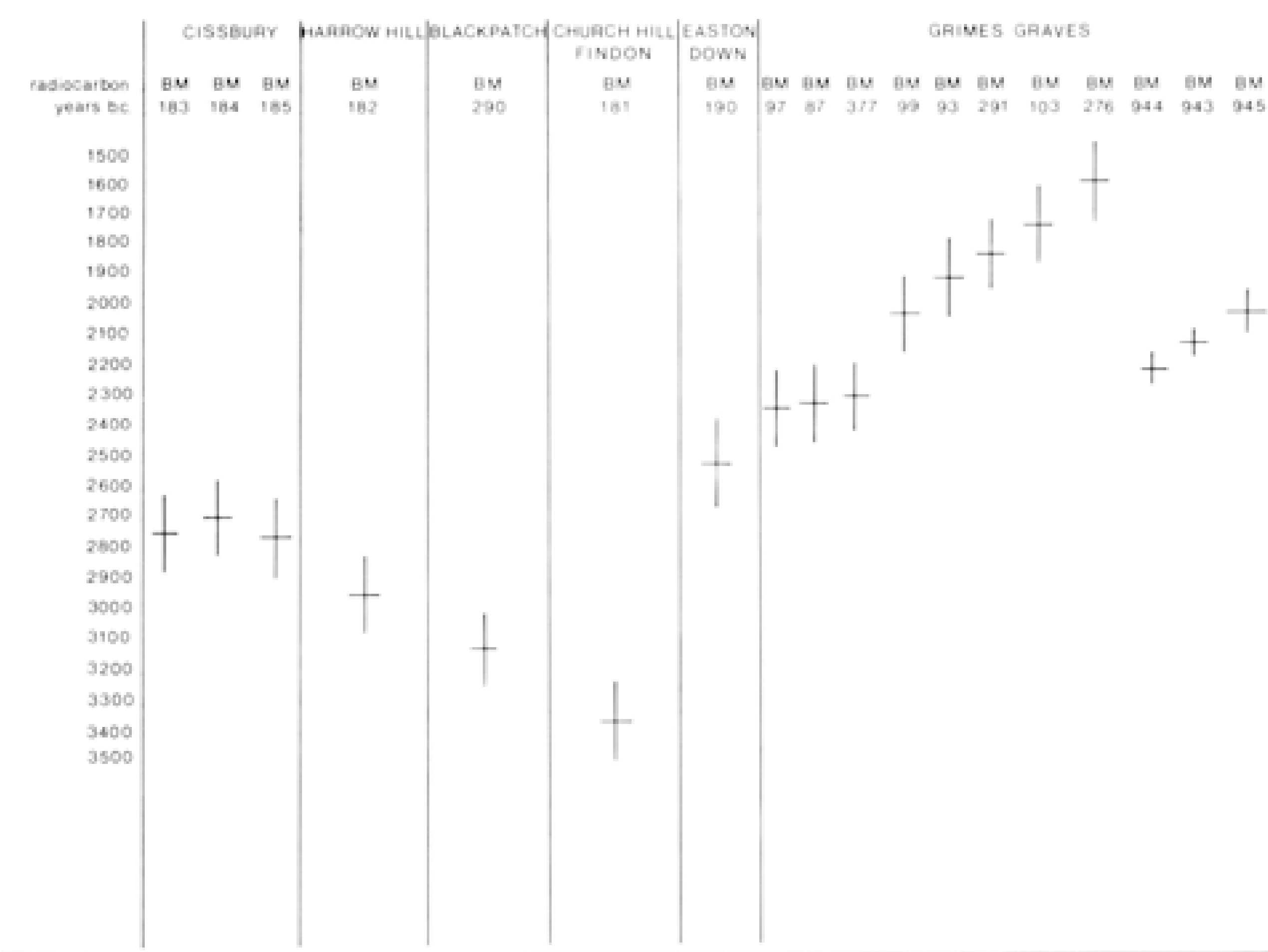


Figure 19 Radiocarbon dates from Cissbury, Harrow Hill, Blackpatch, Church Hill, Easton Down and Grimes Graves

reassessment of the nature of these sites can be attempted at present and indeed it must await the excavation of at least one example to modern standards before any such attempt can be made. All that can be added to Piggott's comments (Piggott 1954) is the clear separation chronologically of these Sussex sites from Grimes Graves (see Figure 19) and the apparently sharply different complexion of flint industries recovered on the site at Grimes Graves from the industries on the Sussex sites. The mode of archaeological recovery on the Sussex sites inevitably renders any direct comparison with recent figures at Grimes Graves open to question. Nevertheless, I am most grateful to Miss Elizabeth Pye, Institute of Archaeology, London for allowing me to use figures she compiled during the completion of an MA thesis within the University of Edinburgh (Pye 1968). The figures (Table V) were compiled during study of the Pull collection in Worthing Museum relating to excavations carried out by J H Pull at flint mines at Blackpatch, Church Hill and Cissbury, Sussex. Other figures have been added by the writer. It will be readily appreciated from these figures that the number of roughout and finished axes as a proportion of the total assemblage recovered from the sites is vastly higher than at Grimes Graves. The writer does not feel that this very marked disproportion is due solely to biased collection and that it must reflect some quite distinct process at work either in mining, production or distribution technique. Either this was the case or the Grimes Graves mine complex was not involved to anything like the extent of the southern sites, in the production of heavy edge tools. The chronology of the site at Grimes Graves on the basis of the recent extensive programme of radiocarbon dating appears to extend between *c*2300 bc and 1600 bc with the majority of dates clustering between 2000 bc and 1800 bc. The only other excavated site to yield a radiocarbon date which approaches the chronological span of Grimes Graves is the complex of mine shafts at Easton Down, near Winterslow, Wiltshire. This complex would appear likely to be rather larger than those at Cissbury, Church Hill, Findon, Harrow Hill and Blackpatch. Church Hill has about 42 shafts visible on the surface, Cissbury c. 117 shafts, Blackpatch c. 118 and Harrow Hill c. 160. Stone in 1931 recorded that ninety shafts were planned at Easton Down and that this number 'represented only a small proportion', the mine area occupying some 40 acres (Stone 1932, 350–351). The mine complex at Grimes Graves occupies an area of at least 40 acres and at least 400 mine shafts are present on the site. The Easton Down complex is of particular interest to us in two other respects. Its cultural context is not clear, yet the existence of a settlement site next to the mine complex which produced typologically late Neolithic ('Peterborough') and Beaker pottery was apparently associated with mine products (Stone 1932, 366–372). The products of the mine were also of considerable interest. The Cissbury/Blackpatch/Harrow Hill/Church Hill group of mines as we have seen, produced under excavation large quantities of complete implements—many of them apparently in highly finished condition. Furthermore, as a proportion of the total recovered assemblage, the number of axes whether roughouts or of the highly finished 'Cissbury' type is very high. While the figures are undoubtedly distorted by collecting bias, in terms of crude totals the figures are still far higher than those which occur at Grimes Graves or in the limited excavations at Easton Down. Finally the type of axes produced at both Easton Down and Grimes Graves are sometimes more massive and apparently less 'finished' than those we encounter in the Sussex mines. While the author feels with Piggott (Piggott 1954) that the direct comparison of mining techniques between complexes is of little value as these necessarily are environmentally rather than culturally determined, it does seem that the comparison of end-products and their distribution will yield results of significance. It would appear that flint mining in Britain can be, in the present state of knowledge, divided into two broad phases on the basis of radiocarbon evidence—one relating to the Early Middle Neolithic stage of development (3400–2700 bc) and one relating to a Late Neolithic stage (2500–1600 bc). Grimes Graves would clearly appear to fall in the latter stage of development. The two later mine complexes that we can perhaps recognise (Easton Down and Grimes Graves) are both very significantly larger in area and number of shafts mined than any of their recognised and excavated early stage counterparts. Furthermore, the later mining complexes would appear to exhibit far fewer (as a proportion of the recovered assemblage) finished axes among the working debris on the mining site, and where such axes do occur they seldom approach the degree of 'finishing' that is common on the earlier sites. The 1971 shaft at Grimes Graves, and there must be many others on the site like it, is furthermore far larger in scale than any mining task attempted in the Sussex group of mines.

Whether the low percentage of axe roughouts at Grimes Graves and at Easton Down reflect low axe output or simply a different organisation of the working of the flint is at present an unanswerable question requiring further investigation. The writer tends towards the view that the act of extraction of fine quality tabular flint at the expense of vast exertion must have been principally for the manufacture of heavy edge tools. The tendency for less finished products to occur at the later sites might also point to differing organisation of the tool working procedure whereby 'ingot' roughouts were removed from the site for fine working elsewhere.

Distributional studies of flint axes are as yet at an early stage of development (Sieveking *et al* 1972, 151–176) and cannot give us any clear idea of the destination of Grimes Graves output. Obviously the establishment of this technique of analysis will be a key factor leading to any appreciation of the economic development and importance of the individual mining sites or groups of sites. It is, at present, only possible to speak of distributional aspects in the most general and tentative manner.

The Grooved Ware associations of the flint mine complex at Grimes Graves (now further clarified by Dr Ian Longworth's work on the site since 1972) and the nodal date bracket of 2000–1800 bc for the complex would place the mining activity in a position of contemporaneity with two principal events that we can discern in the archaeological record of the early second millennium BC. One is the gradual expansion of arable farming land after the contraction that is perhaps apparent in the latter half of the third millennium BC (for example at the site of Broome Heath, Norfolk) (Wainwright 1972). The other is the 'heyday' of vast timber monument construction frequently associated with the Grooved Ware pottery style. Both developments would have required the guaranteed provision of a variety of heavy edge tools for felling, trimming and working timber. It is perhaps of interest that the apparent shift of flint mining activity from the early phase in Sussex to a later phase in East Anglia and Wiltshire may represent a reaction to the distribution of great timber monuments in the Late Neolithic of south Britain and the perceived lack of such monuments in the south east counties (Wainwright 1971, 177–239, Catherall 1976, 1–10).

The 1972 Shaft

The excavation of part of the filling of the 1972 shaft was prompted in some measure by the discovery of the shaft, previously unknown, during the excavation of the surface area in 1971 and the need to prove that it was what it appeared to be, a new completely concealed flint mine shaft. Of greater significance however in prompting further investigation was the occurrence in the upper layers of the shaft filling of massive deposits of occupation debris dated (conventionally to the 'Middle Bronze Age' and identical in type to that located by Armstrong in his 'Black Hole' Armstrong 1926). The circumstances and nature of the material was also, according to Armstrong's description, identical with that he recorded.

It was clear from the excavation of Trenches 7B and 8B on the surface area that intensive activity had taken place on the rear side of the decayed chalk dump of the 1971 flint mine shaft. Here, dark charcoaliferous deposits rested against the tail of the dump and on the sand surface. Associated with this deposit was pottery of a type quite distinct from the Grooved Ware fabrics retrieved at the base of the 1971 shaft. This pottery exhibits cordons ornamented by finger-tip and finger-nail decoration and slashing, with similar ornamentation on the rims (see Chapter II). The forms are predominantly bucket-like and their closest parallels lie with 'Deverel-Rimbury' style pottery further to the south and west. Wares of this kind were located in the upper fill of the 1971 shaft associated with derived deposits of washed chalk material (the 1B group of layers) and also with the mass of flint working debris stratified in the upper part of the filling of the 1971 shaft. This deposit was, however, quite apparently *in situ* occupation debris. The richness of the artefactual assemblage on this site was, however, not matched by any archaeological trace of structures cognate with this occupation. The sand subsoil surface, which was most carefully inspected for such traces had been severely disrupted by root and burrowing animal activity but it would seem unlikely that any substantial structural traces could have been totally eradicated by these means.

A mass of flint working debris accompanied this occupation together with massive concentrations of burnt flint. Two bronze awls and a number of bone piercing implements were also located. The flint working debris may provide a clue to the choice of the Breckland for occupation when it must always have been relatively poor land for subsistence farming. The flint being utilised is only occasionally floorstone left on the site as waste by Late Neolithic mining activity. There is no evidence present in the 1971–72 area of excavation for any mining activity of any kind relating to this re-occupation of the site during the Middle Bronze Age. Yet it is fairly clear that the presence of masses of flint waste of good quality on the site was a feature much utilised by these people and may well have represented to them a major economic benefit from occupation of this area. The nature of the flint industry is fully discussed by Saville (Volume II) and it will suffice to say that a full domestic assemblage with a heavy emphasis on boring and piercing tools is present on the site. This preponderance may indicate concentration upon activities such as leather and woodworking which in the archaeological circumstances of the site must remain intangible to us. The very large quantities of burnt flint may reflect cooking activities but it is extremely likely that the process of deliberate flint calcining was conducted to obtain easily crushed flint grit for pottery manufacture. Certainly calcined flint gritting is the predominant temper in Middle Bronze Age fabrics on the site (see Chapter II). The concentration of the calcined flint material may well indicate with the degree of burning on the sand that the preparation of this material was a specialist activity carried out in this area. The presence of two bronze awls (see Figure 21) may also point to other industrial activities taking place in this area.

Evidence of metalworking itself was retrieved during the 1971–72 investigation on the site in the form of a scrap of what appears to be casting debris and possibly, a saw fragment (see Figure 43). Work on similar deposits since 1972 has produced evidence of smelting and casting (I H Longworth, personal communication). The five fragments found in close proximity within the north-west sector of the 1972 shaft within the Group 3 midden deposit must comprise an associated group of awl fragments, the saw fragment and casting work (The midden deposits in the 1972 shaft were divided into three major groups.These groups are described and discussed below). The juxtaposition of this group within the Group 3 midden may well indicate a source for this material in an area south of the 1972 shaft and possibly may indicate metalworking activity in this area. A number of perforated chalk objects which would be conventionally described as 'spindle whorls' were also located on this surface area which may bear witness to the preparation of woollen yarn, and loom weights retrieved from deposits described below may extend our view of this activity.

The surface activity was bounded on its eastern side by the lip of a shaft hitherto unknown on the site, having been entirely levelled by soil accumulation. This shaft, the 1972 shaft, had been used when it had filled naturally to a point where it was some 2.5m in depth, as a dumping area for midden debris from occupation points around its perimeter. The midden debris is deposited in the shaft in a long sequence of individual tips which clearly divide themselves into three major phases of tipping separated by periods of accumulation of material which is relatively sterile. These major phases of tipping comprising in each case a very large sequence of individual tips, have been treated together under the heading 'Groups' of midden debris. Three major groups have been defined, Groups 1, 2 and 3, with Group 3 being the earliest in the sequence.

As will be clear from the section and plan drawings [illegible] and 21) the Group 3 midden material accumulated in the shaft with a point of origin apparently somewhere to the east of the shaft hollow. Apparently the material composing the midden was shovelled into the pit from the area around the shaft head and in the act of scraping or shovelling up the debris, material of earlier prehistoric date was incorporated within the midden deposits. Grooved Ware pottery was encountered in somewhat abraded condition in all three midden Group deposits. Similarly, joining sherds of Middle Bronze Age date are encountered dispersed between midden Groups as are the joining parts of broken flint implements. Within the Group 3 midden debris, situated on its north-west edge were located the metal fragments described above. A radiocarbon date was derived from charcoal extracted from the Group 3 midden material, BM—1097, 3084 ± 44 bp (1134 ± 44 bc).

After the deposition of the Group 3 midden a layer of

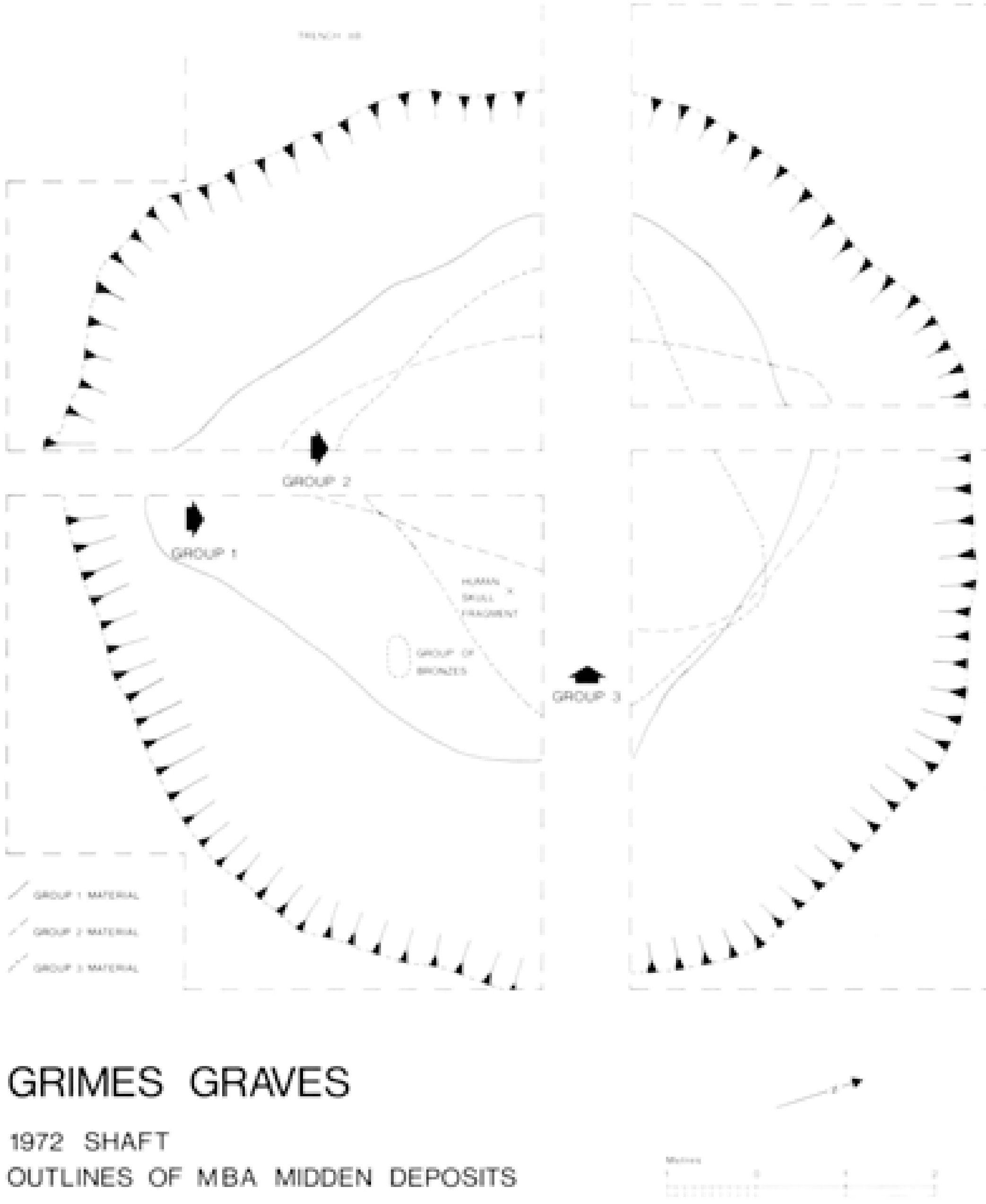


Figure 21 1972 Shaft plan of outlines of Group 1–3 Middle Bronze Age midden deposits

chalky washed material was deposited which contained derived artefactual material but has all the appearance of naturally deposited material accumulated by weathering of the surface around the shaft head. This accumulation would probably have formed in a relatively short period—possibly a year or two years. After it had taken place further material was deposited, the Group 2 of midden debris. This mass of refuse appears to have been deposited from the south side of the shaft head and it is presumably with this phase that we must link the surface occupation encountered in this area. In this material, among the mass of animal bone, pottery, burnt flint and flint working debitage, were retrieved fragments of the skull of a child of about 12 years of age.

Again after this phase of filling a relatively short process of natural accretion of chalky washed filling occurred upon which was laid down a third mass of midden material. A fragment of loom weight (see Figure 32) was retrieved from this Group of material and further fragments were also located on the surface to the west of the shaft head, indicating a link to the west for this Group, and the evidence of section and plan would appear to substantiate this proposed link. Again this series of deposits contained vast quantities of pottery, animal bone, burnt flint and flint work including a few linking pieces with counterparts in the Group 2 and 3 midden material. The Group 1 midden material probably accumulated in two distinct phases with a very substantial deposit of fine washed chalky material to the east of the shaft accruing on top of Group 1 material before a further deposition took place from the east side of the shaft. It is very difficult indeed to conceive of this very substantial body of washed material being deposited in one year and it must presumably represent the accumulation of several years of weathering.

The period over which the midden deposits were laid down must therefore span a number of years. The evidence of sheep slaughter pattern and that for arable cultivation contained within the midden layers (see Chapter V) argues for permanent occupation on the site and it would thus appear that long term occupation on the site used the 1972 shaft head sporadically for the dumping of refuse. The uniformity of the content of the three midden 'Groups' might also argue for one continuum of occupation expressed in the shaft head by interrupted phases of dumping. The dumping activity itself would appear to be a deliberate process involving the scooping up of large bodies of material incorporating earlier residual artefacts and this process may well have only taken place at widely separated points in time. Sadly work on the surface area stripped in 1971–72 revealed no trace of structures which could be linked with this dumping process.

If the occupation linked with the middens is permanent, this would not conflict with the wide ranging number of activities of which evidence is borne in the contents of the midden. Arable farming is clearly evident from the abundant seed remains present within the midden debris (see Chapter V). Six-row hulled barley represented nearly three quarters of all cereal seeds present and seed size might reflect a degree of success in the cultivation of this crop. Emmer wheat is also present and would appear to be the only wheat species cultivated. One specimen of *Pisum* from the Group 1 midden deposits may point to the cultivation of this crop as well. Legge has suggested (see Chapter V) following Dennell (1974) that the content of the midden Groups may well be the product of crop cleaning either after the harvest or before food preparation. That such good quality crops could be generated may point to a further reason for the careful selection of this area of Breckland, and Legge has suggested that the artificial 'fertilisation' of the area by the turning up of vast quantities of chalk during the Late Neolithic phase would have created a 'micro-environment' favourable to arable farming. There is some indication that this *niche* was set in areas of pasture-land, if we can judge from the small quantities of seeds of weeds and grasses of pasture-land found within the midden debris. The site itself is just near enough to the Little Ouse Valley to allow this pasture-land to be used effectively and thus the site was an ideal one for a mixed farming subsistence economy (see Chapter V).

The midden Groups appear to be largely composed of food debris and very large quantities of animal bone both post cranial and cranial were retrieved. Cattle would appear to form about 50% of all the fauna with sheep/goats forming about 30% (see Chapter V). Less important contributions, as witnessed in this group of midden deposits, were made by pig (c. 6%), horse and roe deer (c. 3%) and red deer (c. 4%). Red deer, roe deer and possibly horse appear to have been hunted and the inedible portions discarded at the kill site or elsewhere but not in the homestead midden where only 'edible' elements survive. The heavy preponderance of cranial fragments of cattle and sheep would, Legge suggests, argue for the killing of these animals close by with the discarding of unwanted elements directly on to the midden. Thus slaughtering and grain cleaning appear to be two further activities pursued in the immediate vicinity of the 1972 shaft head.

Legge has convincingly argued that the cattle element on the site at Grimes Graves during the period of Middle Bronze Age occupation was one principally directed to dairy production. The presence of pasture elements within the seed assemblage may be seen as some support for this argument. Within the artefactual assemblage little can be indicated which might offer support. However a number of the vessels exhibited perforations just below the rim and the writer would draw attention to the practice in the outer isles of Scotland in the recent past to use perforated pots as butter churns—the perforations allowing gases formed during the churning to escape without the necessity of removing the leather cover of the pot from its position over the mouth (Mann 1908, 326–329).

The local production of textiles is probably witnessed by the presence of 'loom weight fragments' (see Figure 32), 'spindle whorls' (see p. 60) and the presence of possible dress pins and needles in the bone assemblage (see p. 69). The presence of a number of bone points which may have served as fastening toggles may indicate that leather was also used for garment production. Such production would provide a purpose for the bronze awls present on the site and the high proportion of flint implements apparently designed for boring present in the Middle Bronze Age deposits.

The preponderance of boring tools may also indicate woodworking practice on the site. The rod-like implements are also possibly to be linked with woodworking as chisels, gouges or similar tools. The presence of very substantial quantities of charcoal on the site with oak charcoals principally representing fairly large timbers presumably indicates that felling and working of heavy timber was proceeding in the locality. The almost complete lack of axes and scrapers pertaining to the Bronze Age deposits does, in these circumstances, require explanation, especially in view of the plentiful nature of raw material for their manufacture. The near absence of these classic woodworking tools from the Middle Bronze Age deposits may be because the activity was a specialised one not taking place in the immediate locality. The writer however finds this suggestion unattractive in view of the probable general nature of woodworking within such a community. It is felt to be more likely that the absence of these tool types argues for their presence in another medium—in metal—and that metal tools were not simply discarded upon the midden when worn out or broken but were reserved for melting down.

The picture which emerges from the study of these midden deposits is of a long-lasting occupation of the site by prosperous farming groups utilising the conjunction of water supply, locally enriched land suitable for arable cultivation and a surrounding area of good pasture to pursue a successful cereal and dairying mixed economy and supporting a number of subsidiary industries including textile production and metalworking.

Chapter II
Neolithic and Bronze Age Pottery

by I H Longworth

Neolithic and Early Bronze Age Pottery (Figures 22 and 23)
A small collection was recovered, numbering 144[1] sherds of Neolithic and Early Bronze Age fabric, 126 from the 1971 excavations and 18 from the 1972 shaft.

(a) *Middle Neolithic Bowl*
Four fragments of plain-ware probably attributable to middle Neolithic bowls came from the surface beyond the dump adjoining the 1972 shaft and in the uppermost filling of the 1971 shaft. In both instances the sherds are likely to have been re-deposited.

(b) *Peterborough Ware*
A single sherd P5, from a bowl carrying an incised herring-bone decoration on the rim, was recovered from the top-most filling of the 1971 shaft.

(c) *Beaker*
Four possible sherds of plain Beaker-ware were recovered from the topmost fill of the 1971 shaft.

(d) *Grooved Ware*
126 sherds of Grooved Ware were recovered; 17 from the 1972 shaft, the remainder from the 1971 excavations. In 1971, 21 sherds were recovered from Layer 1, 19 from Layer 1A and 32 from Layer 1B. In addition, three occurred on the surface south of the dump and two were found in association with the chipping floor to the west of the shaft. With the exception of the last named group, the sherds are unlikely to be *in situ* but represent material re-deposited during the filling of the shaft. A number of sherds and larger portions of vessels were, however, recovered *in situ* at the base of the shaft and in Gallery 3, securely dating the working of the mine. These comprise sherds of a plain bowl from Gallery 3 and from Quadrants 4 and 5 at a depth of 10.02m and sherds of two bowls carrying heavy internal decoration recovered from the surface of the dump of spoil derived from the galleries lying on the floor of the shaft.

The small number of Grooved Ware sherds recovered during the 1972 excavations, occurring in midden layer Groups 1, 2 and 3 appear to represent material re-deposited during subsequent deliberate infilling of the top of the mineshaft. The sherd groups correspond with the three major midden groups described on page 36. Sherd Group O consists of material found in superficial deposits above Group 1.

The amount of Grooved Ware recovered from the excavations is not extensive and a large proportion comprises undecorated wall-sherds. The majority of these appear to come from plain bowls of the type already known from the site in the Oppenheimer Collection from Pits 1 and 2 (in the British Museum) and from the extensive working floor recovered during the 1972 British Museum excavations. Similar vessels are now also known from sites like Mount Pleasant, Dorset (Wainwright 1979, P113); Marden, Wiltshire (Wainwright 1971, 214, P57–59); and North Carnaby Temple site 1, Yorkshire (Manby 1974, [illegible] 2, 3 and 5).

Of more particular interest are the two bowls externally plain but with heavy internal decoration. P1 carries a complex incised decoration incorporating filled triangles, lozenges and chevrons alternating with reserved fields of the same shape. P2, of which less survives but employing a similar decorative scheme, utilises dot infilling. Internal decoration of this type is absolutely rare in British Neolithic ceramics and the closest parallels remain sherds recovered during the Durrington Walls excavations (Wainwright and Longworth 1971, P452–461), the as yet unpublished material from Tye Field, Lawford (Colchester Museum), Puddlehill Pits 4 and 5 (information kindly supplied by Dr I F Smith), the Sanctuary (Devizes Museum Reg. No DM 1382) and Wood Henge circle 2 (Cunnington 1929 Plate 48 nos 1 and 2). This trait appears at present confined to the Durrington Walls style of Grooved Ware and of the other fragments of decorated Grooved Ware also recovered from the site, two with vertical applied cordons and the rim, P4, with internal and external twisted cord decoration unmistakably belong to this style. For the first time sufficient remains of these decorated bowls to be able to reconstruct their shape with confidence. One, P2, represents a shallow narrow-based open-mouthed form, the other, P1, a deeper form with inturned rim. The general style of ornamentation using geometric patterns incorporating reserved decoration clearly recalls late southern Beaker usage, though internal decoration is totally alien to that tradition. Dot filling was extensively used in the Clacton style of Grooved Ware where complicated geometric motifs are again in evidence. One might therefore expect the bowls to represent a late aspect of the Grooved Ware tradition and the radiocarbon date of 1800 ± 100 bc adds some confirmation to this expectation.

(e) *Other Sherds of Early Bronze Age Fabric*
Eight sherds of Early Bronze Age fabric were also identified in the sherd collection, including the six illustrated sherds P6–11 (Figure 23). Amongst these can be identified a fragment of decorated shoulder, probably from a Food or Collared Vessel, found in association with the chipping floor under Layer 1B, and sherds again from Food or Collared Vessel occurred in the topmost fill of the 1971 shaft.

Bronze Age Pottery (Figures 24–32)
A total of 2,974 sherds of Bronze Age fabric were recovered

1. Excluding small fragments and the 2 Grooved Ware bowls P1 and P2.

during the excavations, 738 from the 1971 Season and 2,236 from the 1972 shaft, with a total weight of 47.8595kg. Apart from minor contamination of Group 1 in which three sherds of Early Iron Age fabric and one Romano-British sherd could be identified and the occasional occurrence of re-deposited Neolithic pottery in Groups 1, 2 and 3, the four sherd Groups designated 0, 1, 2 and 3 from the 1972 shaft appear to contain only sherds of Bronze Age pottery. The total similarity of this pottery and the presence of joining sherds from Groups 0 and 1, 0 and 3 and 2 and 3 strongly suggests that these deposits are not to be widely separated in time but can be taken as representing individual deposits in a single deliberate infilling. No discernibly significant distinctions can be seen in the pottery recovered during the two seasons and the collection therefore has been treated as a single assemblage.

The assemblage is characterised almost entirely by simple bucket-shaped vessels of coarse fabric, the fillers most frequently used being calcined flint, shell and grog but occasionally other forms of gritting occur and quantities of sand are variable. Only three sherds of fine plain-ware were noted and these probably belong to a vessel of globular form, e.g. P204. Relatively few vessels could be restored to any degree of completeness, the majority being represented by, at most, a handful of sherds. The character of the assemblage, including as it does along with the sherds, fragments of loom weight, suggests essentially domestic refuse but not refuse accumulated *in situ*. Its nature is more likely

Table VI. Characteristics of Middle Bronze Age pottery showing combinations of decorative features

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
RIMS: Plain	1	128															13	9	3	1					2						2	
Finger-tipping on top	2		31														15			1					1	2					1	
Finger-tipping on outer edge	3			3													1															
Finger-tipping below	4				2																										1	
Finger-tipping/finger-nail on top	5					1																										
Finger-nail on top	6						3																1									
Finger-nail on outer edge	7							1																								
Incised herringbone on top	8								2																1							
Incised opposed lines on top	9									2								1					1									
Incised diagonal line on inner edge	10										1																					
Incised diagonal line on outer edge	11											10					1														1	
Incised diagonal line on top	12												27				3	1		2	1						2				1	
Incised vertical line on inner edge	13													1																		
Incised vertical line on outer edge	14														2																	
Other impressions on top	15															15															1	
PERFORATIONS between rim and shoulder	16																38									1						
KNOBS	17																	16					1									
COMB IMPRESSIONS	18																		5													
RUSTICATION	19																			7												1
FINGER-NAIL IMPRESSIONS	20																				1											
LIGHT SCORING	21																					2										
HEAVY SCORING	22																						2									1
FINGER-TIPPING ON SHOULDER	23																							6								
SHOULDER CORDON: with finger-tipping	24																								46							
With other impressions	25																									20						
With incised diagonal lines	26																										5				1	
With incised herringbone	27																											12				
Plain	28																												1			
FINGER-TIPPING ON INSIDE OF BASE	29																													3		
DRILL HOLES	30																														9	
BASE ANGLES	31																															128

to be explained by the hypothesis that the refuse, brought from a living site some distance away, was tipped into the top of a number of weathered mineshafts over a relatively short period of time. During this process the small number of sherds of stray Middle Neolithic, Grooved Ware and Early Bronze Age fabric already noted, were no doubt incorporated.

Main Characteristics of the Assemblages (Tables VI and VII)
Due to the fragmentary nature of the pottery recovered, the proportion of plain to decorated wares is difficult to assess. The presence of a number of vessels with plain rims but carrying decoration on the shoulder, prevents a plain rim being taken as synonymous with plain vessel. A number of small vessels do, however, appear to have been undecorated, e.g. P199.

The main characteristic traits represented can be summarised as follows (Table VII), expressed as a percentage of featured sherds (excluding base-angles) correct to the nearest whole number. The total number of featured sherds is 330:—

Table VII. Main characteristic traits expressed as a percentage of featured sherds

1	Plain rim e.g. P203–236	39%
2	Finger-tipped shoulder cordon e.g. P94–128	14%
3	Perforations between rim and shoulder e.g. P24–36, 89–92, 182–194	12%
4	Finger-tipping on top of rim e.g. P12–39	9%
5	Incised diagonal lines on top of rim e.g. P61–76	8%
6	Impressions other than finger-tipping on shoulder cordon e.g. P133–143	6%
7	Applied knobs e.g. P77, 156, 170–181	5%
8	Impressions other than finger-tipping on top of rim e.g. P43–57	5%
9	Incised herringbone on shoulder cordon e.g. P146–50, 152	4%
10	Incised diagonal lines on outer edge of rim e.g. P77–85	3%
11	Drill holes e.g. P86, 88 195–7	3%
12	Rustication e.g. P161–167	2%
13	Finger-tipping on shoulder e.g. P129–132	2%
14	Comb impressions e.g. P159–60	2%
All other features (individually)	less than	1%

Rims when decorated are usually ornamented with finger-tip or similar impressions or with incised ornament. Impressed decoration is normally applied to the top of the rim on its outer edge or more rarely, below the rim on the external surface. Incised decoration is applied most typically in the form of short diagonal strokes on top of the rim or on its outer edge. Finger-nail impressions e.g. P40–2, P155, opposed incisions P156 and incised herringbone e.g. P93–5, P146–50, are rare and only two instances of decoration placed on the internal edge of the rim were recovered: P60 and P87. Finger-tip impressed rims frequently occur on vessels carrying a row of perforations through the wall between the rim and shoulder, but similar perforations occur almost as frequently with undecorated rims. Decorated shoulder cordons are characteristic, usually carrying finger-tip decoration or similar impressions but more rarely, incised diagonal or herringbone lines were used. A small number of sherds, perhaps all from the same vessel, carry round-toothed comb impressions e.g. P159–60 and sherds from at least four vessels carry scored decoration on the body, either heavily applied in the form of vertical lines, e.g. P155 or more lightly applied P156–8. Rustication appears as a rare component though the sherds are too few and too small to indicate whether ordered patterns as well as 'all over' rustication are present, P161–7. Three base sherds carry the remains of finger-tip impressions on the internal surface, apparently added as internal decoration, P168–9.

The only type of applied decoration other than horizontal shoulder cordons are knobs, which occur on sixteen vessels, small and in rows e.g. P170, isolated or apparently widely spaced. They are set either close to the rim P170–1, P176 or some way down the body P172. The majority of sherds carry no other form of decoration but in at least two instances knobs occur on decorated vessels; P77, with a diagonally incised rim and P156, with incised rim and scored body. Nine sherds preserve drill holes made after the vessel had been fired, presumably for repair.

Discussion
The assemblage is of interest not only for its internal consistency but also in a negative sense for the features which are not represented. The virtual absence of fine wares and globular shapes in particular is striking and only a single sherd of plain shoulder cordon was recovered. This feature, together with the absence of lugs or indeed of any applied decoration other than knobs or shoulder cordons and the use of rustication as only a very minor element in the decorative range is in marked contrast to the Ardleigh Group of urns to the south and east as originally defined. The assemblage stands nearer to elements of Ardleigh III but the correspondence of features is far from total[2]. Outside Grimes Graves, no comparable body of pottery at present exists in the rest of Norfolk but a more complete assessment will be undertaken in connection with two further major collections from the site, comprising the pottery recovered by A L Armstrong, principally from the site which he termed 'the Black Hole' (Armstrong 1924, 192–3) and that recovered during the British Museum research programme during 1975–6 (to be published by British Museum Publications Ltd in forthcoming fascicule).

Catalogue
In the following catalogue, and the subsequent catalogues dealing with chalk, bone and metal objects, the number preceeding each entry is the number used on the figure drawings (Figures 22–43). The number in parenthesis is the site reference number for each find.

P1 Fragments representing approximately half a bowl of fine paste, patchy dark/mid to reddish brown internally, light to dark brown externally.

Decoration: Internally, a complex linear incised pattern incorporating filled and reserved triangles, bar chevrons and chequer board to cover the entire surface. The filling of the pattern is executed in irregular short incised strokes, sometimes roughly parallel, sometimes cross-hatched. (*71.3500*)

2. Colchester Arch. Group Bull (1961) Sept IV.1, 33–55 & IV.4, 60–3; Rep. of Colchester and Essex Mus. 1956–1962 (1962) fig 1–3; Essex Arch and Hist. (1975)7, 14–32.

Figure 22 Decorated Grooved Ware Bowl P1. (Scale 1/3)

P2 Fragments from a bowl of quite well-fired paste, patchy brown both faces.

Decoration: Internally, linear incised pattern incorporating lozenges and triangular spaces filled with impressions made with a blunt instrument. Just below the rim for part of the circumference, horizontal rows of similar impressions. (*71.3500*)

P3 Undecorated rim sherd of fairly compact sandy paste, brown both faces. (*71.3215*)

P4 Rim sherd of compact sandy paste, light brown throughout.

Decoration: Externally and internally, a single horizontal twisted cord line. (*71.2889*)

P5 Rim sherd of coarse soft fabric tempered with a large quantity of shell and other grits, brown externally, grey internally.

Decoration: On the rim, remains of incised herringbone. (*71.2883*)

P6 Shoulder fragment of well-fired compact paste, reddish brown externally, internal surface lost.

Decoration: On the shoulder, diagonal jabbed impressions. (*71.2194*)

P7 Wall sherd tempered with some fine grit and with small pebble inclusions, reddish brown externally, dull grey internally, covered in preservative.

Decoration: One impression made with the articular end of a bone. (*71.2857*).

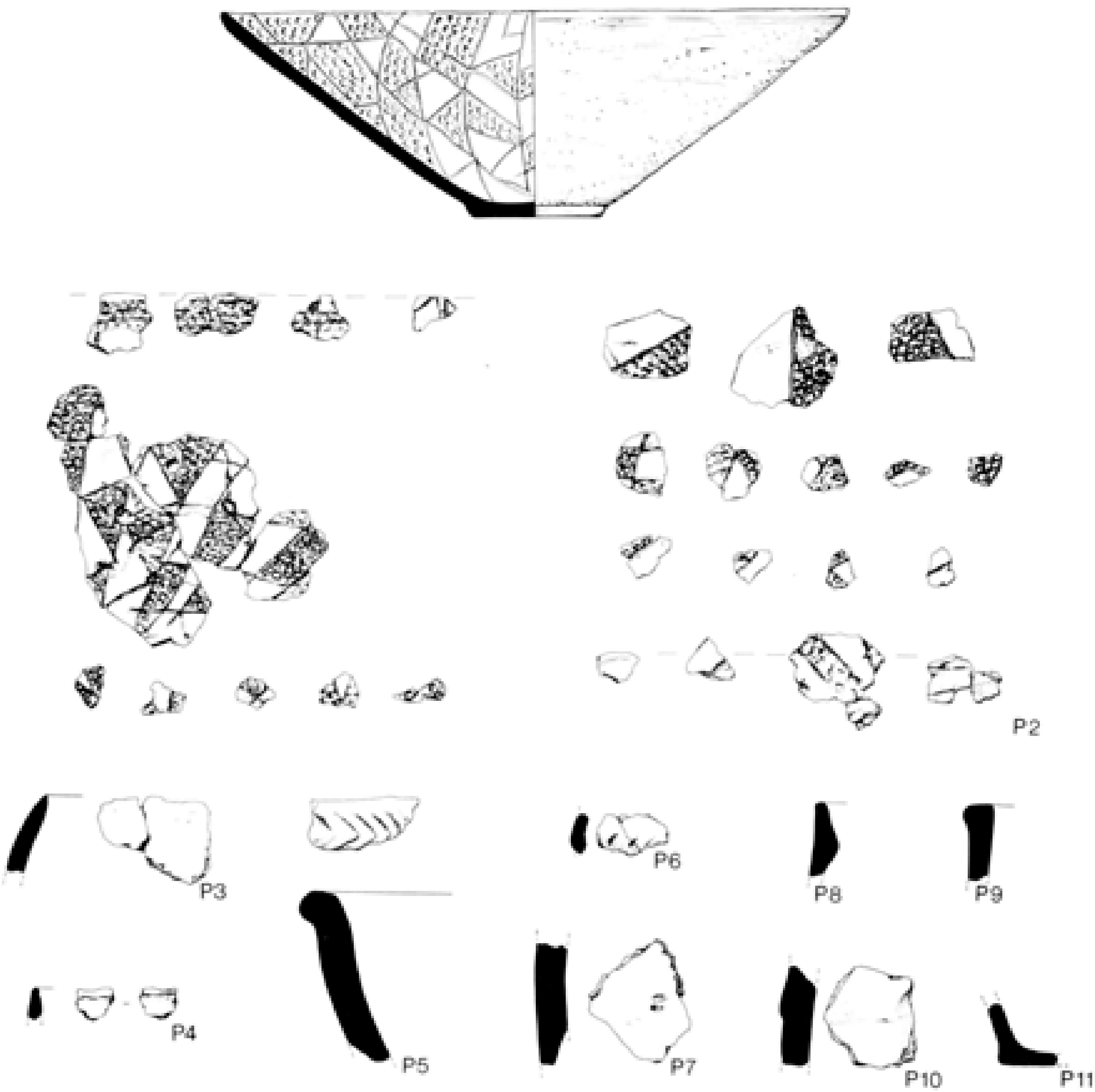


Figure 23 Grooved Ware: decorated bowl P2, plain and decorated rims, P3 & 4. Peterborough Ware: P5, Early Bronze Age: P6–11. (Scale ⅓)

P8 Undecorated rim sherd of quite well-fired paste tempered with a little shell and ? grog, light brown externally, grey to brown internally. (*71.934*)

P9 Two joining undecorated rim sherds of well-fired paste tempered with a little flint, light brown both faces with dark grey core. (*71.3173, 3263*)

P10 Undecorated wall sherd of fairly well-fired, compact sandy paste, light brown both faces with dark grey core. (*71.775*)

P11 Base angle of well-fired paste tempered with large quantity of fine flint grit, brown to grey externally, grey internally. (*71.632*)

P12 Two joining rim sherds of well-fired paste tempered with a large quantity of shell, grey throughout.
Decoration: On the rim, deep finger-tip impressions. (*71.3345, 72.1224*)

P13 Rim sherd of rather soft paste tempered with a large quantity of shell, grey both faces with dark grey core.
Decoration: On the rim, deep finger-tip impressions. (*71.3343*)

P14 Rim sherd of fairly well-fired paste tempered with a large quantity of shell, grey throughout.
Decoration: On the rim, deep finger-tip impressions. Probably same vessel as P12. (*71.3366*)

P15 Rim sherd of well-fired paste tempered with grits, grey externally, greyish brown internally.
Decoration: On the rim, finger-tip impression. (*72.1007*)

P16 Rim sherd of well-fired paste tempered with grits, grey externally, greyish brown internally.
Decoration: On the rim, finger-tip impressions. (*72.911*)

P17 Rim sherd of well-fired paste tempered with some grit, grey externally, light brown internally.
Decoration: On the rim, finger-tip impressions. (*72.821*)

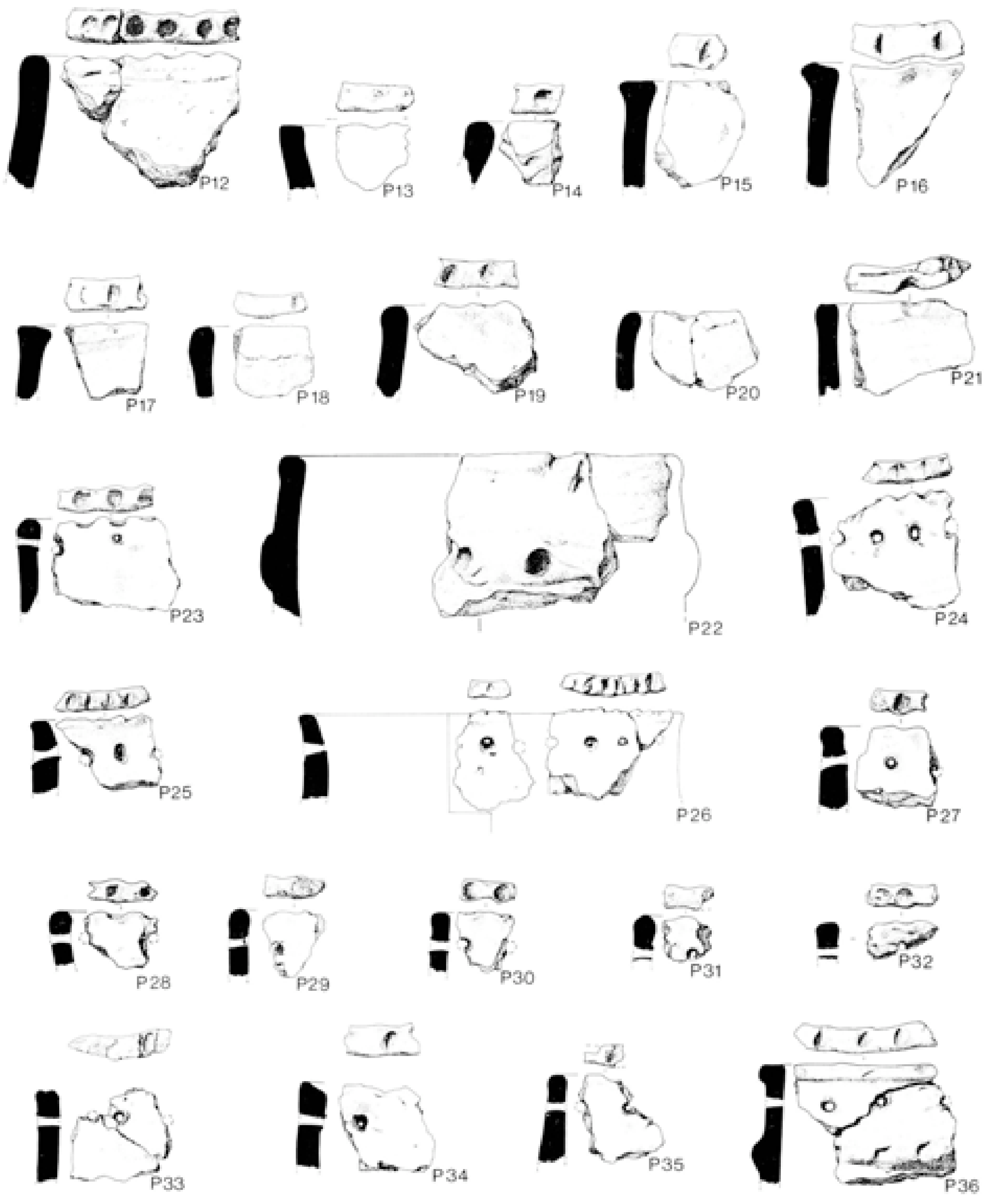


Figure 24 Bronze Age Pottery: P12–36. (Scale ⅓)

P18 Rim sherd of soft paste, grey throughout.
Decoration: On the rim, finger-tip impressions. (*72.858*)

P19 Rim sherd of fairly soft paste tempered with a large amount of shell, grey throughout.
Decoration: On the rim, deep finger-tip impressions. (*72.55*)

P20 Rim sherd of well-fired paste tempered with flint grits, light brown both faces with grey core.
Decoration: On the rim, diagonal impression probably made with a finger-tip. (*72.264*)

P21 Rim sherd of well-fired paste tempered with a large quantity of shell grit, light brown both faces with grey core.
Decoration: On the rim, diagonal impression probably made with a finger-tip and a further finger-tip impression on the rim's outer edge. (*72.1430*)

P22 Two joining rim sherds of well-fired compact paste tempered with some shell, patchy light brown to grey both faces.
Decoration: On the outer edge of the rim ? finger-tip impressions. On the shoulder cordon, remains of deep round-based impressions, probably made with the articular end of a bone. (*72.740*)

P23 Rim sherd of well-fired compact paste tempered with flint grit, grey to light brown externally, grey internally.
Decoration: On the rim, finger-tip impressions.
Remains of two perforations made before firing. (*72.1094*)

P24 Rim sherd of well-fired, coarse paste tempered with grog and a little flint, light brown both faces with grey core.
Decoration: On the rim, deep finger-tip impressions.
A series of perforations made from the external surface before firing. (*71.3258*)

P25 Rim sherd of well-fired, coarse paste, tempered with some grit, light brown externally, grey internally.
Decoration: On the rim, finger-tip impressions.
A series of perforations made from the external surface before firing. (*72.226*)

P26 Two rim sherds of well-fired, coarse paste tempered with flint grit, light brown externally, light brown to grey internally.
Decoration: On the rim, finger-tip impressions.
A series of perforations made from the external surface, before firing. (*71.3322, 72.159*)

P27 Rim sherd of well-fired, compact paste, light brown.
Decoration: On the rim, finger-tip impressions.
Series of perforations made from both surfaces, before firing. (*72.1423*)

P28 Rim sherd of coarse compact paste tempered with much shell, grey.
Decoration: On the rim, finger-tip impressions.
Remains of two perforations made before firing. (*72.1430*)

P29 Rim sherd of well-fired, coarse paste tempered with flint grits, brown to grey both faces.
Decoration: On the rim, finger-tip impressions.
Perforation made before firing. (*72.549*)

P30 Rim sherd of well-fired, fairly compact paste, grey.
Decoration: On the rim, finger-tip impressions.
Remains of two perforations made before firing. (*72.1423*)

P31 Rim sherd of coarse paste tempered with shell, grey.
Decoration: On the rim, finger-tip impressions.
Perforation made from external surface before firing. (*71.2470*)

P32 Rim sherd of well-fired coarse paste tempered with shell, light brown.
Decoration: On the rim, finger-tip impressions.
Remains of a perforation made from the external surface before firing. (*72.205*)

P33 Rim sherd of well-fired, compact paste tempered with flint grit, brown both faces with grey core.
Decoration: On the rim, remains of finger-tip impressions.
A series of perforations made before firing. (*72.541*)

P34 Rim sherd of well-fired, coarse paste tempered with flint grits, grey.
Decoration: On the rim, deep finger-tip impressions.
Perforations made from the external surface before firing. (*72.912*)

P35 Rim sherd of coarse paste tempered with flint grits, dark grey.
Decoration: On the rim, a finger-tip impression.
Perforations made before firing. (*71.2470*)

P36 Rim sherd of well-fired compact sandy paste, grey to brown externally, greyish brown internally.
Decoration: On the rim, transverse finger-tip impressions. On the shoulder cordon, a row of flat-based impressions.
Remains of a row of perforations made through the neck before firing. (*72.43*)

P37 Two joining rim sherds of well-fired coarse paste tempered with a large quantity of coarse calcined flint grit, light brown to brown both faces with dark grey core.
Decoration: Just below the rim, a row of finger-tip impressions. (*72.281, 1409*)

P38 Rim sherd of well-fired coarse paste tempered with a large quantity of coarse calcined flint grit, light brown externally, brown internally with dark grey core.
Decoration: Just below the rim, a row of finger-tip impressions. Perforations through the wall.
Probably same vessel as P37. (*72.1430*)

P39 Rim sherd of well-fired coarse paste tempered with a large quantity of calcined flint grits, grey throughout.
Decoration: On the outer edge of the rim, finger-tip impressions.
Perforation through the wall made before firing. (*72.260*)

P40 Rim sherd of well-fired compact paste, reddish brown to grey externally, brown internally.
Decoration: On the external edge of the rim, finger-nail impressions. (*72.1390*)

P41 Rim sherd of well-fired compact sandy paste tempered with some flint, light brown throughout.
Decoration: On the rim, transverse finger-nail impressions and diagonal slashes. (*72.1430*)

P42 Two joining rim sherds of well-fired compact paste tempered with flint grit, patchy grey both faces with carbon incrustation internally.
Decoration: On the rim, finger-tip and transverse finger-nail impressions. (*72.1141, 1222*)

P43 Rim sherd of well-fired paste tempered with some grit, grey throughout.
Decoration: On the rim, indefinite impressions. On the shoulder cordon, a similar impression. (*72.970*)

P44 Rim sherd of well-fired compact paste tempered with some grit, grey externally, light brown internally with dark grey core.

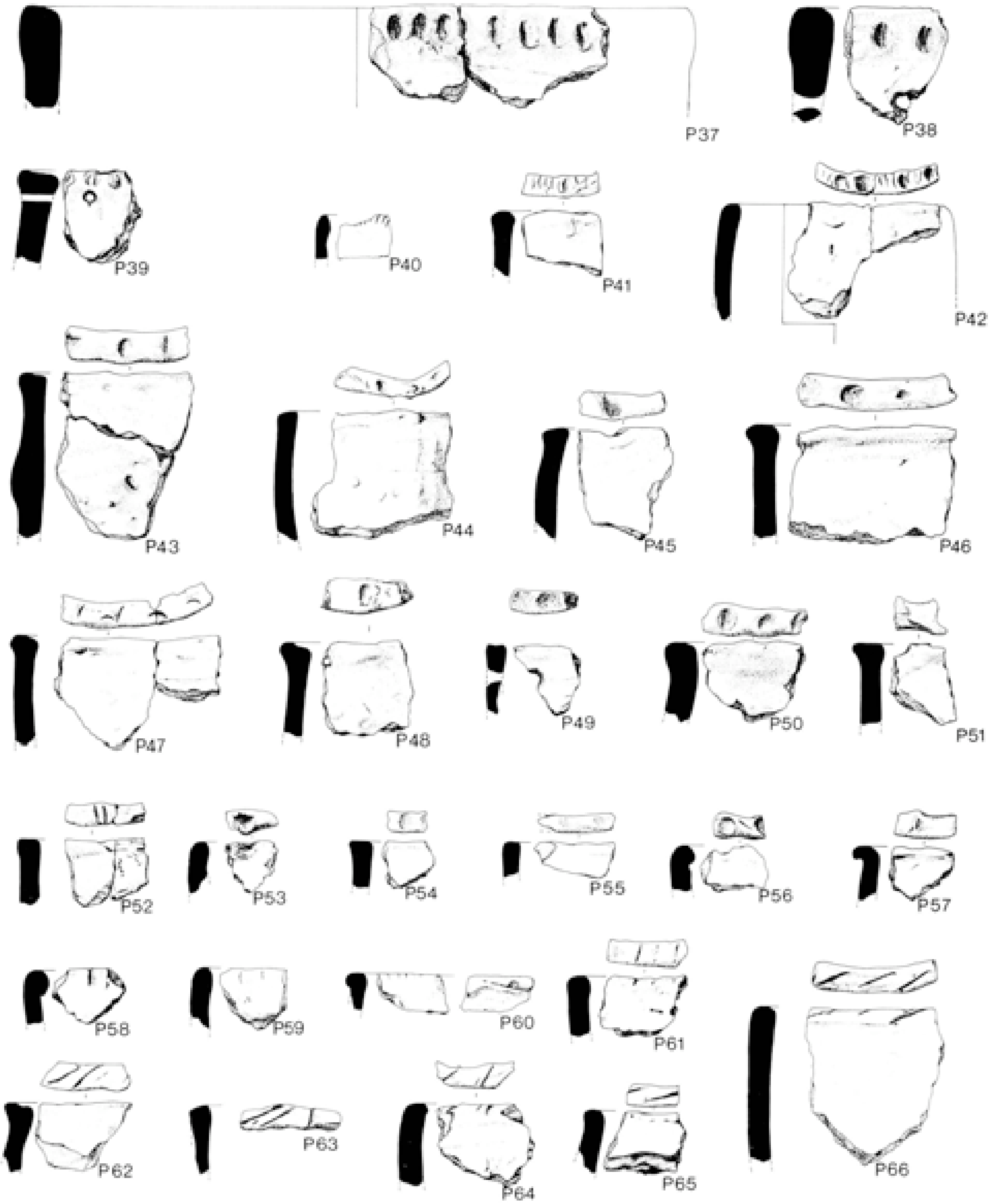


Figure 25 Bronze Age Pottery: P37–66. (Scale ⅓)

Decoration: On the rim, indefinite impressions. (*72.1327*)

P45 Rim sherd of well-fired coarse paste, grey throughout.
Decoration: On the rim, deep round-based impressions. (*72.996*)

P46 Rim sherd of well-fired compact paste tempered with some grit, light brown externally, light brown to grey internally.
Decoration: Remains of indistinct impressions on the rim. (*72.1219*)

P47 Two joining rim sherds of fairly well-fired paste tempered with some fine shell and ? grog, patchy grey both faces with dark grey body.
Decoration: On the rim, concentric impressions made with a ? hollow tube. (*72.654, 712*)

P48 Rim sherd of well-fired paste tempered with some grit including flint, light brown to grey patchy externally, greyish brown internally.
Decoration: On the rim, indefinite impression. (*72.862*)

P49 Rim sherd of well-fired paste, light brown both faces with grey core.
Decoration: On the rim, remains of imprecise impressions.
Repair hole drilled from external surface after firing. (*72.45*)

P50 Rim sherd of coarse paste tempered with massive pieces of shell, brown both faces.
Decoration: On the rim, round/oval impressions. (*72.239*)

P51 Rim sherd of well-fired paste, grey throughout.
Decoration: On the rim, indefinite impressions. (*72.912*)

P52 Two joining rim sherds of well-fired compact sandy paste tempered with a little fine grit, orange both faces with dark grey core.
Decoration: On top of the rim, double diagonal impressed lines. (*72.3025, 3030*)

P53 Rim sherd of well-fired paste tempered with large quantity of shell, grey throughout.
Decoration: On the rim, round-based impression. (*72.549*)

P54 Rim sherd of well-fired compact sandy paste tempered with some shell, grey externally, brown internally.
Decoration: On the rim, a round-based impression. (*71.1183*)

P55 Rim sherd of well-fired compact paste, grey externally, light brown internally, with dark grey core.
Decoration: On the rim, indefinite impressions.
Weathered. (*71.678*)

P56 Rim sherd of well-fired paste tempered with grit, brown externally, grey internally.
Decoration: On the rim, deep round-based impressions. (*72.1205*)

P57 Rim sherd of well-fired paste tempered with a little grit, light brown to grey externally, grey internally.
Decoration: On the rim, impression made with ? bone or tooth. (*71.3200*)

P58 Rim sherd of well-fired paste, grey throughout.
Decoration: On the outer rim edge, deep vertical slashes. (*72.1105*)

P59 Rim sherd of well-fired paste, grey externally, brown internally with dark grey core.
Decoration: On the external edge of the rim, light vertical slashes. (*72.1218*)

P60 Rim sherd of well-fired compact paste, external surface largely lost, grey internally.
Decoration: On the inner edge of the rim, vertical incisions. (*72.100*)

P61 Rim sherd of fairly well-fired paste tempered with some grit, grey throughout.
Decoration: On the rim, deep diagonal slashes, partially obliterated by later smoothing. (*72.595*)

P62 Rim sherd of well-fired paste tempered with a little shell, grey to greyish brown externally, internally covered in preservative.
Decoration: On the rim, irregular deep diagonal slashes. (*72.12*)

P63 Rim sherd of quite well-fired paste tempered with some grit, external surface lost, internally grey.
Decoration: On the rim, deep transverse and diagonal slashes. (*72.648*)

P64 Rim sherd of well-fired paste tempered with grog, reddish brown to grey both faces with dark grey core.
Decoration: On the rim, deep diagonal slashes. (*72.448*)

P65 Rim sherd of well-fired paste tempered with shell, light brown to grey both faces.
Decoration: On the rim, diagonal slashes. (*72.1148*)

P66 Rim sherd of well-fired compact paste tempered with some shell, brown both faces.
Decoration: On the rim, diagonal slashes. (*72.215*)

P67 Rim sherd, tempered with large grits, grey to light brown both faces with grey core.
Decoration: On the rim, diagonal slashes. (*72.239*)

P68 Rim sherd of well-fired compact paste tempered with a little shell, light brown both faces.
Decoration: On the rim, faint traces of diagonal incisions. (*71.3301*)

P69 Four joining sherds from upper part of vessel of well-fired, compact paste tempered with grit, patchy light brown to grey externally, brown to grey internally with dark grey core.
Decoration: On the collar and on the shoulder cordon, diagonal slashing. (*71.701, 3301, 3309, 3312*)

P70 Rim sherd of well-fired paste tempered with some flint, light brown both faces.
Decoration: On the rim, irregular diagonal slashes. (*72.815*)

P71 Rim sherd of well-fired paste tempered with a large quantity of shell, grey throughout.
Decoration: On the rim, diagonal incised lines. (*71.3366*)

P72 Rim sherd of rather soft paste tempered with some shell and chalk, greyish brown to dark grey externally, grey internally, with reddish brown core.
Decoration: On the rim, deep diagonal slashes. (*72.1105*)

P73 Rim sherd of coarse paste tempered with shell, heavily coated with preservative.
Decoration: On the rim, diagonal slashes. (*72.474*)

P74 Rim sherd of rather soft paste, light brown to dark grey externally, light brown to grey internally.
Decoration: On the rim, remains of lightly incised diagonal line. (*72.1108*)

P75 Rim sherd of fine compact paste, light brown to grey externally, light brown internally.
Decoration: On the rim, diagonal slashes. (*71.775*)

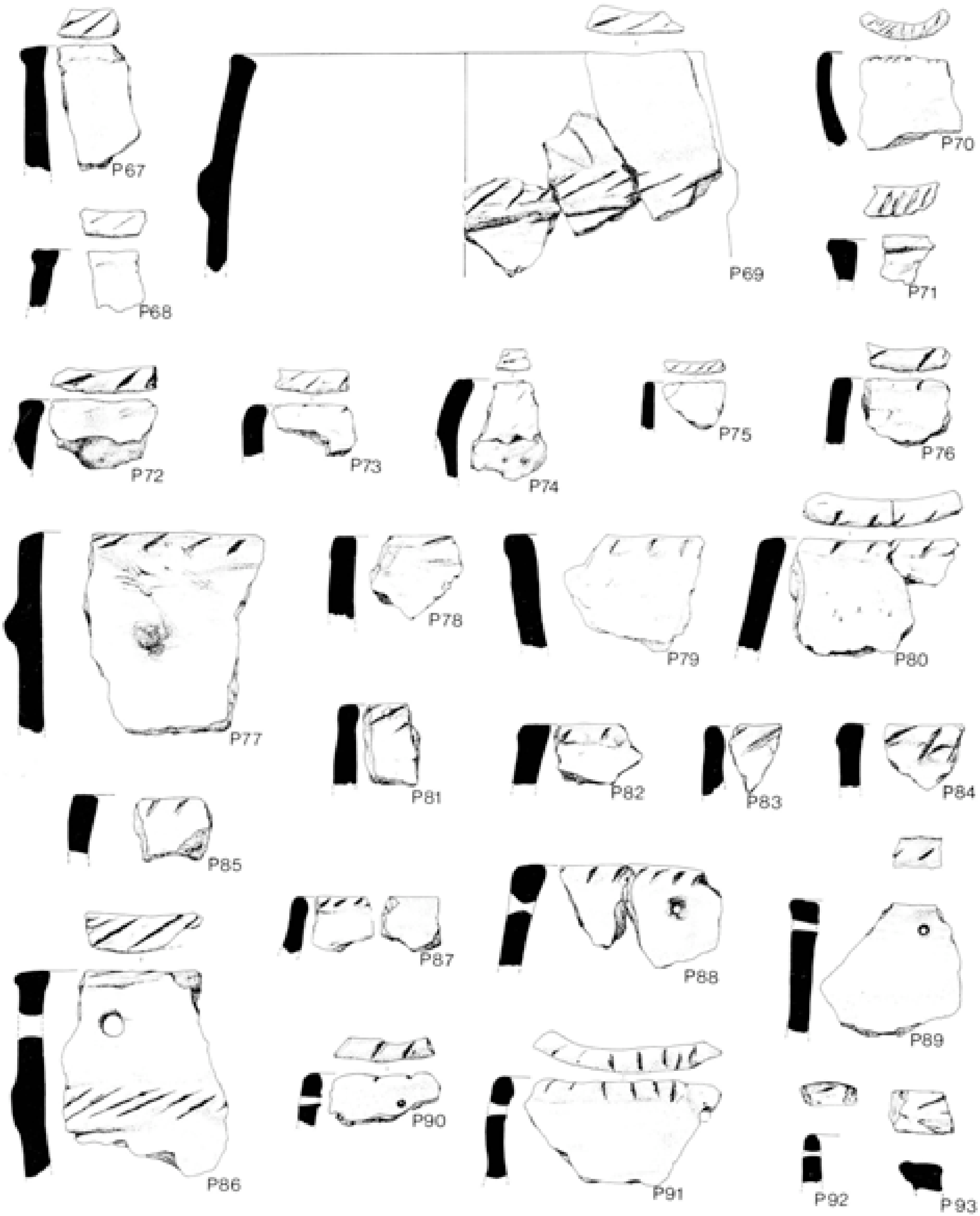


Figure 26 Bronze Age Pottery: P67–93. (Scale ⅓)

P76 Rim sherd of fairly well-fired paste tempered with a little grit including flint, grey throughout.
Decoration: On the rim, deep diagonal slashes. (*72.596*)

P77 Rim sherd of well-fired compact paste tempered with large quantity of flint grit, grey externally (inside surface covered with preservative).
Decoration: On the outer edge of the rim, diagonal slashes.
One applied knob survives. (*72.382*)

P78 Rim sherd of well-fired paste tempered with some flint and grog, light brown both faces.
Decoration: On the outer edge of the rim, deep diagonal impressed line. (*72.154*)

P79 Rim sherd of well-fired paste tempered with grog, grey to brown both faces with dark grey core.
Decoration: On the outer edge of the rim, deep diagonal slashes. (*72.195*)

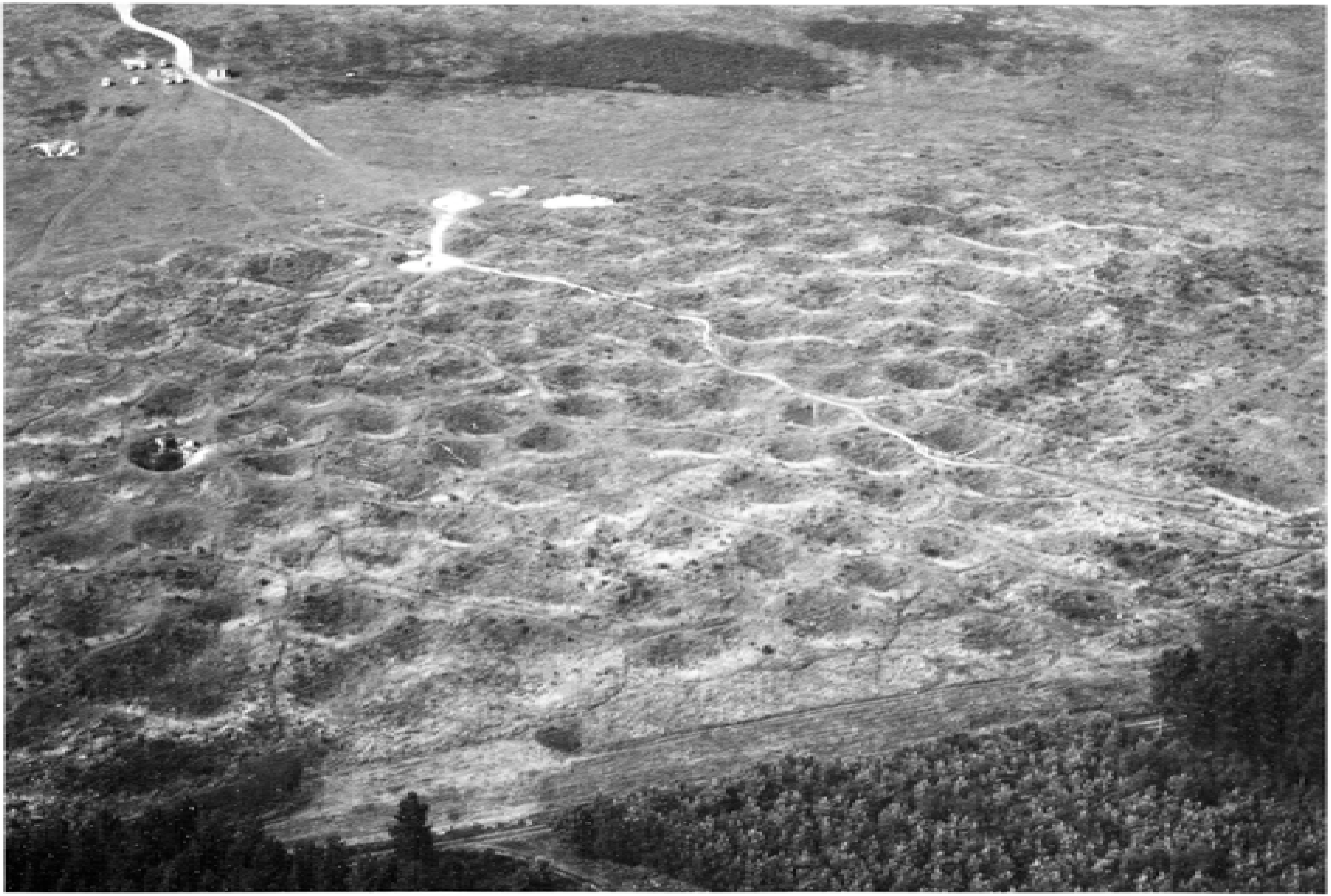


Plate 1. Aerial view of the Grimes Graves flint mine complex from the south

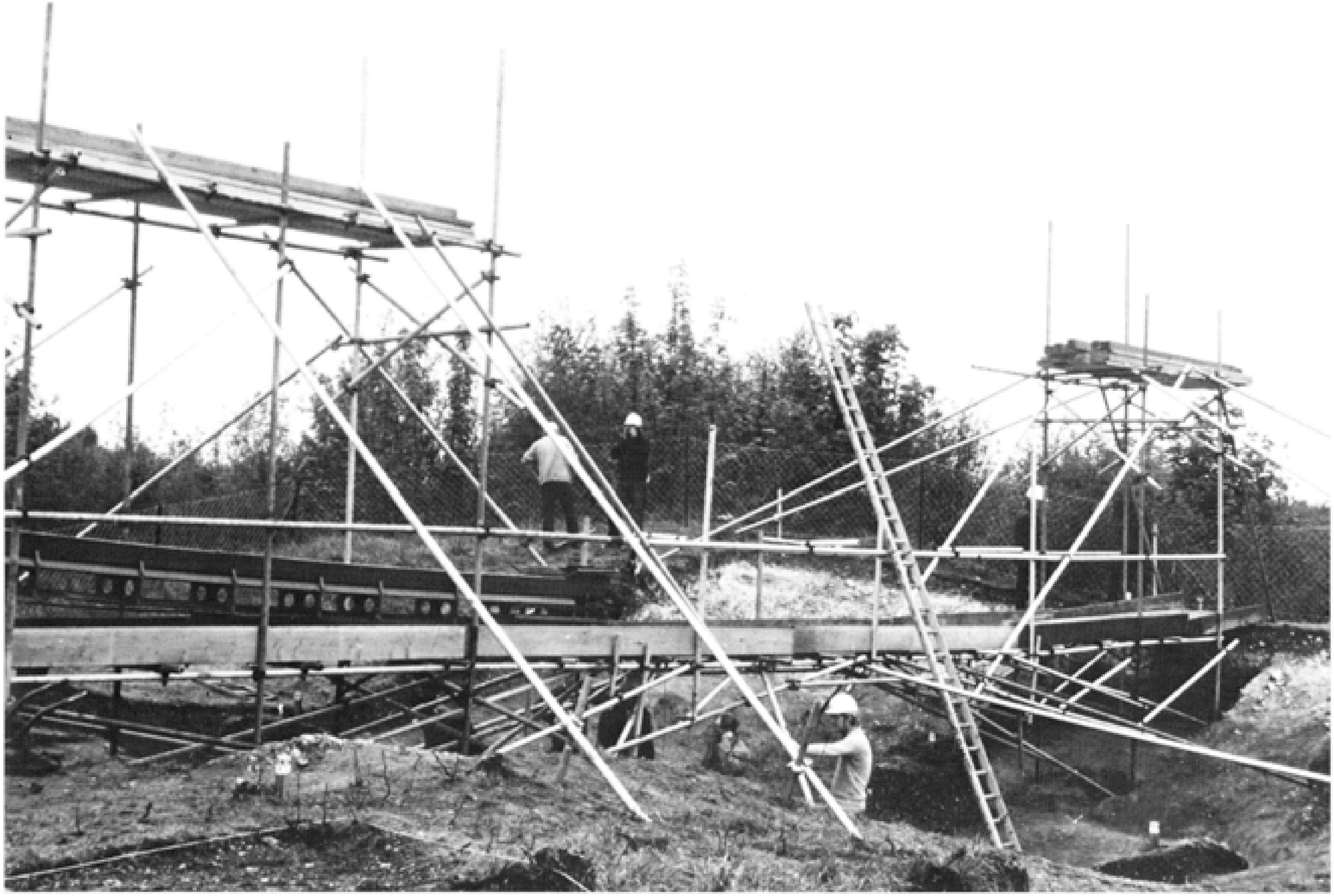


Plate II. The 1971 Shaft. Gantry erected and prepared for commencement of shaft excavation.

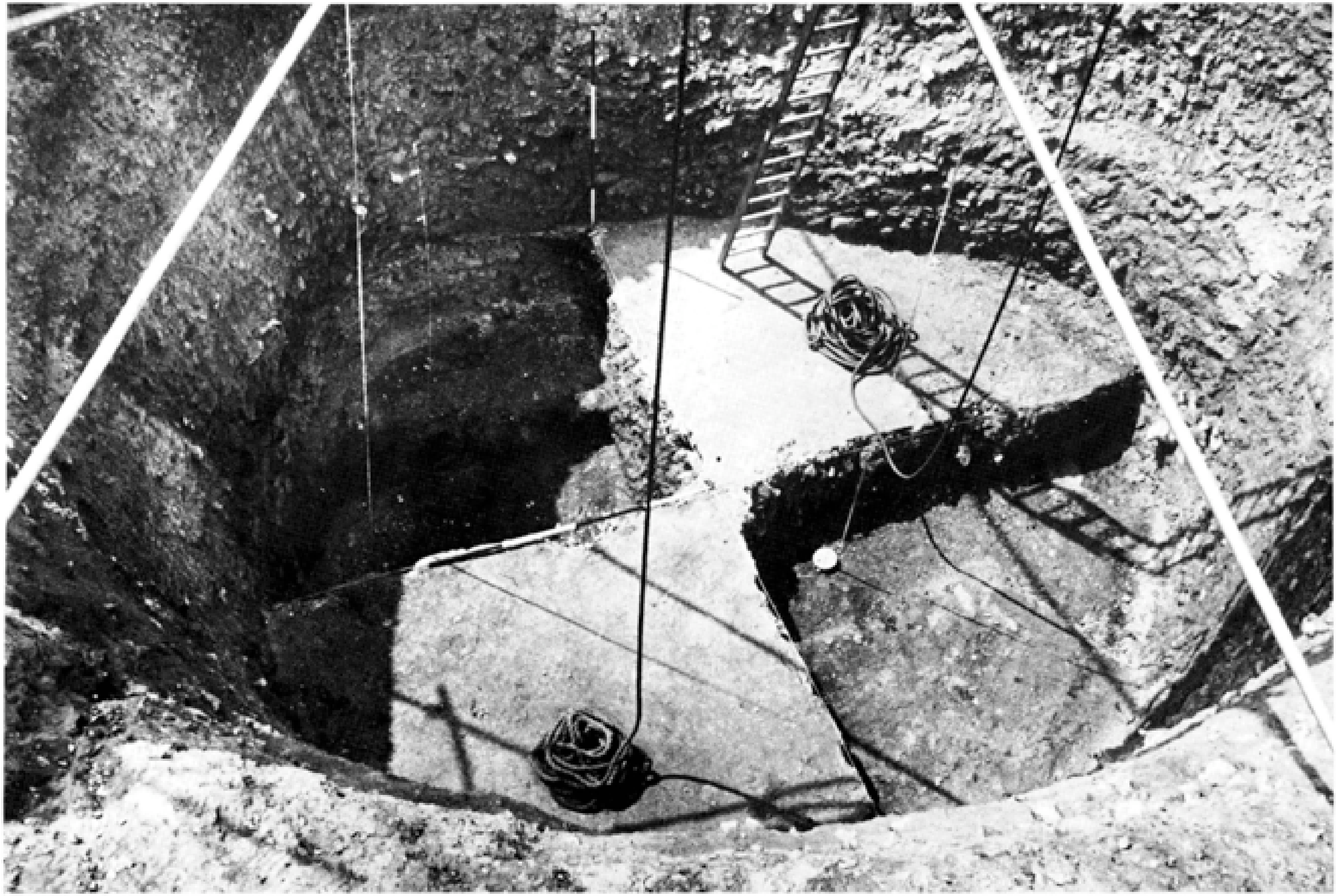


Plate III. Excavation in progress, illustrating excavation method.

Plate IV. The 1971 Shaft. Excavation proceeding to the floor of the flint mine shaft, showing the floor covering of polythene to prevent disturbance.

Plate V. The 1971 Shaft. Gallery 3, showing hollow and staining where a floorstone nodule has been wrenched from position during the mining process.

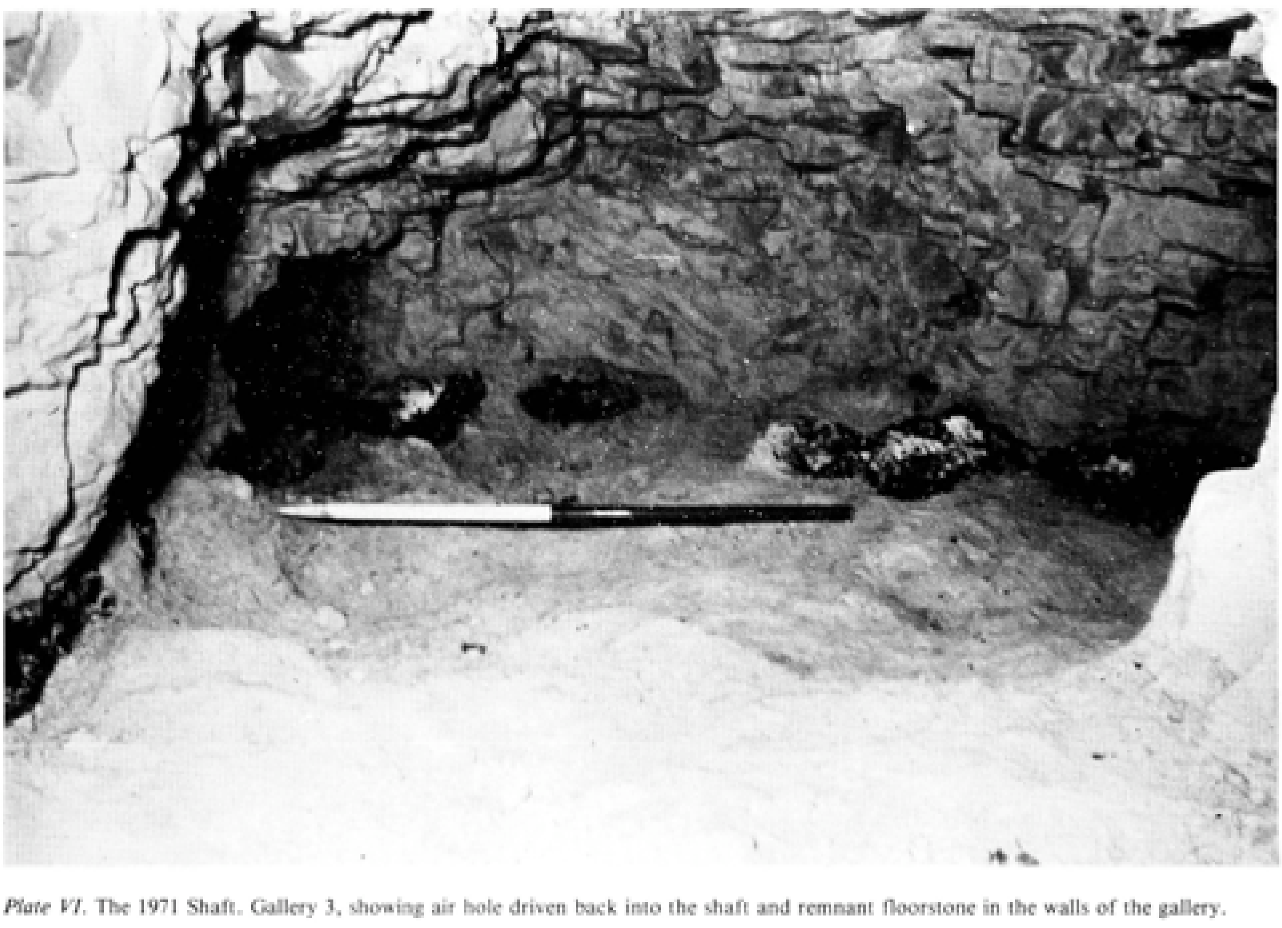


Plate VI. The 1971 Shaft. Gallery 3, showing air hole driven back into the shaft and remnant floorstone in the walls of the gallery.

Plate VII. The 1971 Shaft. Engraved chalk plaque located by hip of Skeleton 2 in upper layers of shaft.

Plate VIII. The 1972 Shaft. View of excavation completed.

Plate IX. The Surface Area: flint working debris *in situ*.

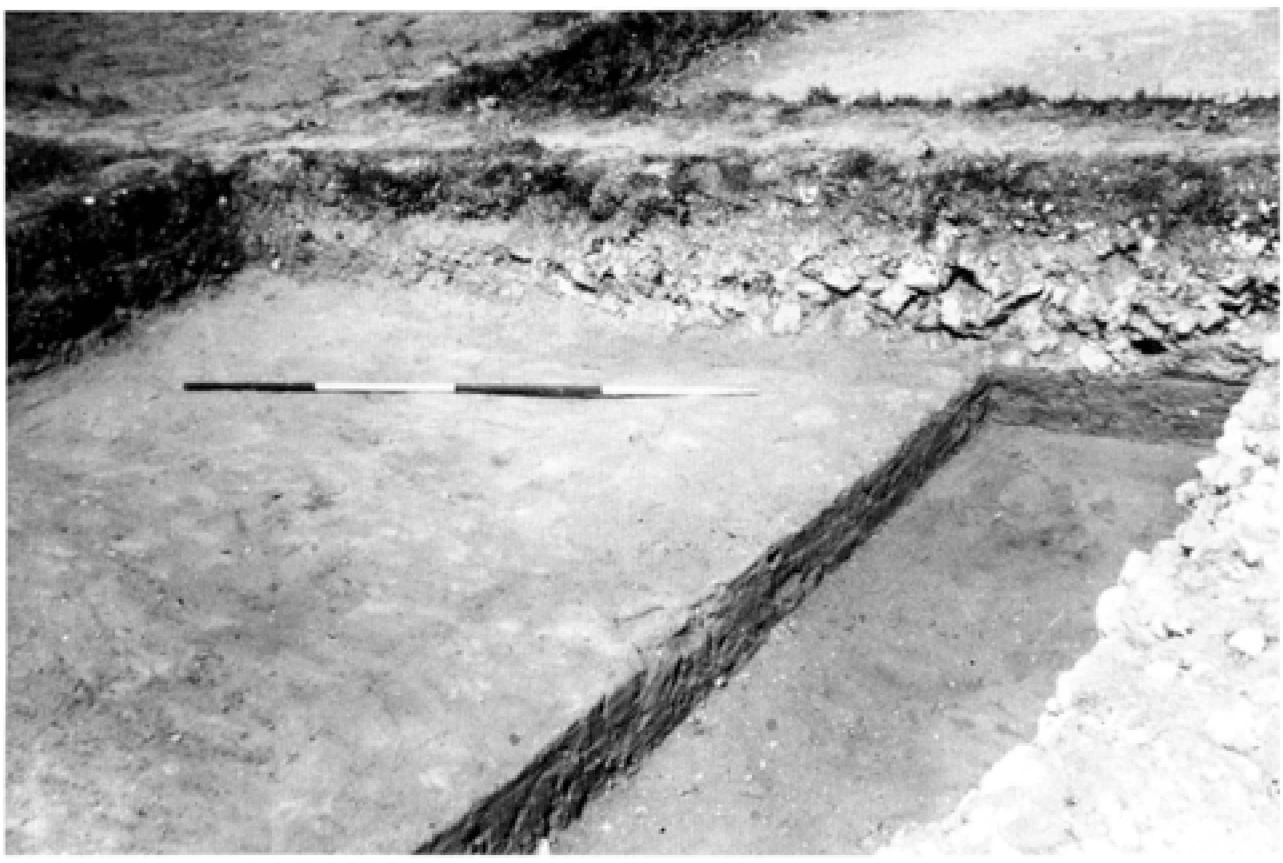


Plate X. The Surface Area: old land surface beneath the chalk dump from the mine shaft showing lack of flint working or other debris.

P80 Two joining rim sherds of well-fired compact paste tempered with some flint grit, reddish brown to grey both faces with dark grey core.
Decoration: On the outer edge of the rim, diagonal slashes. (*72.112, 159*)

P81 Rim sherd of fairly well-fired paste tempered with a little shell, greyish brown both faces with grey core.
Decoration: On the outer edge of the rim, deep diagonal slashes. (*72.525*)

P82 Rim sherd of well-fired compact paste tempered with grit and grog, brown externally, grey internally with dark grey core.
Decoration: On the outer edge of the rim diagonal impressions. (*72.273*)

P83 Rim sherd of well-fired paste, light brown both faces.
Decoration: On the outer edge of the rim diagonally scored lines. (*72.260*)

P84 Rim sherd of well-fired paste tempered with some chalk, light brown both faces.
Decoration: On the external rim edge, deep diagonal slashes. (*72.209*)

P85 Rim sherd of well-fired compact paste tempered with a little flint grit and grog, grey to reddish brown both faces with dark grey core.
Decoration: On the outer edge of the rim, deep diagonal slashes. (*71.3367*)

P86 Rim sherd tempered with large grits, grey to light brown both faces with grey core.
Decoration: On the rim and on the shoulder cordon, diagonal slashes.
One perforation through the neck, drilled after firing probably same vessel as P67. (*72.1209*)

P87 Rim sherd of fairly compact paste tempered with some grit, grey externally, greyish brown internally with carbon incrustation on the rim.
Decoration: On the internal edge of the rim, diagonal slashes. (*72.322*)

P88 Two joining rim sherds of well-fired compact paste tempered with grit including flint, light brown to grey both faces.
Decoration: On the outer edge of the rim diagonal slashes.
One perforation drilled after firing from both faces. (*72.270, 1207*)

P89 Rim sherd of well-fired paste tempered with grits including shell, grey to dark grey stoney with carbon incrustation, brown internally.
Decoration: On the rim, deep diagonal impressions.
Perforation through the wall made before firing. (*72.909*)

P90 Rim sherd of well-fired paste tempered with flint grit, grey to brown both faces.
Decoration: On the rim, deep diagonal coarse slashes.
Two small perforations made through the wall before firing. (*72.1224*)

P91 Rim sherd of well-fired paste, patchy grey to brown externally, greyish brown internally, with dark grey core.
Decoration: On the external edge of the rim, vertical/diagonal coarse slashes.
Remains of one perforation through the wall. (*72.654*)

P92 Rim sherd of well-fired paste, brown to grey externally, internal surface weathered, some carbon incrustation on the rim.
Decoration: On the rim, diagonal slash.
Perforation through the wall. (*72.1010*)

P93 Rim sherd of well-fired compact sandy paste tempered with some shell, light brown externally, with grey core.
Decoration: On the rim, remains of opposed deeply incised lines. (*72.101*)

P94 Rim sherd of coarse paste tempered with a large quantity of shell and some chalk, light brown both faces with grey core.
Decoration: On the rim, deeply incised herringbone. On the cordon, finger-tip impressions. (*72.1430, 1445*)

P95 Rim sherd probably same vessel as P94. (*72.1893*)

P96 Rim sherd of well-fired compact paste tempered with some grit, light brown both faces.
Decoration: On the cordon, finger-tip impressions. (*72.288*)

P97 Wall sherd of rather soft paste tempered with a large quantity of shell, light brown both faces with dark grey core.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.228*)

P98 Wall sherd of rather soft paste tempered with a large quantity of shell, greyish brown both faces.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.954*)

P99 Wall sherd of well-fired paste tempered with some grit including shell, light brown externally, grey internally.
Decoration: On the shoulder cordon, finger-tip impressions. (*72.740*)

P100 Wall sherd of well-fired paste tempered with a large quantity of shell, light greyish brown externally, grey internally.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.1412*)

P101 Rim sherd of well-fired paste tempered with shell, light brown to grey both faces.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.1414, 1416*)

P102 Two joining sherds of cordoned shoulder of fairly well-fired coarse paste tempered with a large quantity of coarse calcined flint, light brown throughout.
Decoration: On the cordon, deep finger-tip impressions. (*72.109*)

P103 Sherd of cordoned shoulder of well-fired coarse paste tempered with calcined flint grits, grey to brown externally, light brown internally.

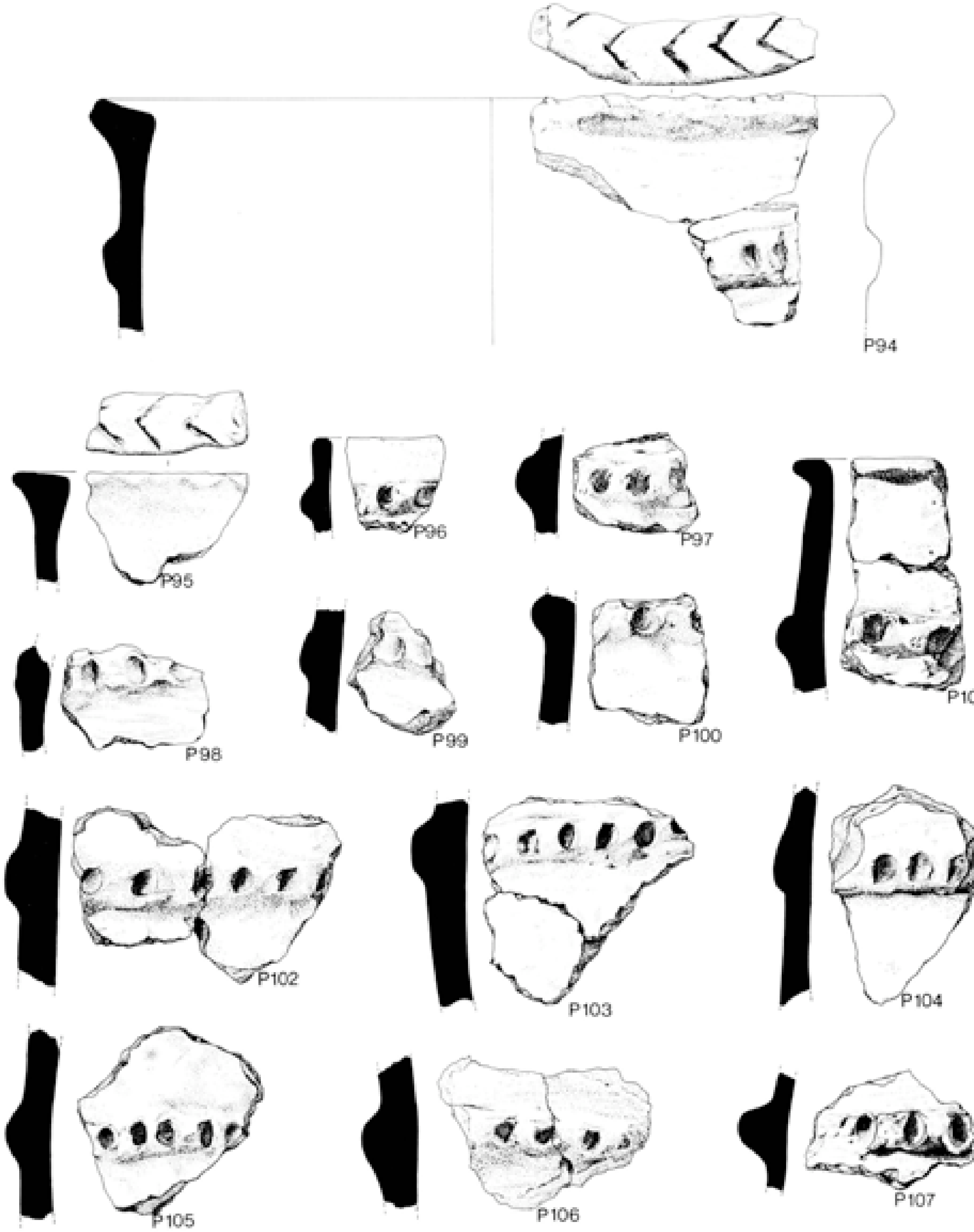


Figure 27 Bronze Age Pottery: P94–107. (Scale ⅓)

Decoration: On the cordon, deep finger-tip impressions. (*72.1304*)

P104 Wall sherd of well-fired paste tempered with a large quantity of shell, grey both faces with dark grey core.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.601*)

P105 Wall sherd of fairly well-fired paste tempered with a large quantity of shell, brown externally, grey internally.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.270*)

P106 Two joining sherds of cordoned shoulder of well-fired coarse paste tempered with a large quantity of calcined flint grits, light brown throughout.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.205*)

P107 Wall sherd of well-fired coarse paste tempered with calcined flint and shell, light brown externally, dark grey with carbon incrustation internally.
Decoration: On the shoulder cordon, deep impressions probably made with the finger-tip. (*71.2107*)

P108 Wall sherd of well-fired paste tempered with a large quantity of shell, light brown externally, grey internally.
Decoration: On the shoulder cordon, finger-tip impressions. (*71.3366*)

P109 Wall sherd of fairly soft paste tempered with grits, grey externally, brown internally, with dark grey core.
Decoration: On the shoulder cordon, light finger-tip impressions. (*72.691*)

P110 Fragment of cordoned shoulder of well-fired coarse paste tempered with coarse calcined flint grits, light brown to grey externally, grey internally, with reddish brown core.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.1445*)

P111 Wall sherd of soft paste tempered with a large quantity of shell, reddish brown throughout.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.188*)

P112 Wall sherd of well-fired but crumbly coarse paste tempered with a large quantity of calcined flint grits.
Decoration: On the shoulder cordon, a deep finger-tip impression. (*72.525*)

P113 Fragment of shoulder cordon, of rather soft paste tempered with grit, including cockle shell, brown externally, light brown internally, with grey core.
Decoration: On the shoulder cordon, a finger-tip impression. (*72.454*)

P114 Wall sherd of well-fired paste tempered with some shell, light brown externally, light brown to grey internally.
Decoration: On the shoulder cordon, finger-tip impression. (*72.1219*)

P115 Wall sherd of quite well-fired paste, brown externally, grey internally.
Decoration: On the shoulder cordon, finger-tip impressions. (*71.3345*)

P116 Wall sherd of well-fired compact paste tempered with a little shell, light greyish brown both faces.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.950*)

P117 Wall sherd of fairly well-fired paste tempered with a little shell, light brown both faces with dark grey core.
Decoration: On the shoulder cordon, finger-tip impressions. (*72.813*)

P118 Wall sherd of well-fired paste tempered with calcined flint, light brown both faces.
Decoration: On the shoulder cordon, finger-tip impressions. (*72.42*)

P119 Wall sherd of well-fired coarse paste tempered with calcined flint grits, red externally, brown internally with dark grey core.
Decoration: On the shoulder cordon, impression probably made with the finger-tip. (*71.3258*)

P120 Fragment of shoulder cordon of well-fired compact paste tempered with a little chalk, light brown throughout.
Decoration: On the shoulder cordon, finger-tip impressions. (*71.3250*)

P121 Two joining fragments of shoulder cordon, of rather soft paste tempered with a little flint and chalk, light brown throughout.
Decoration: On the shoulder cordon, finger-tip impressions. (*71.2462, 2463*)

P122 Fragment of cordoned shoulder of well-fired paste tempered with some grit, light grey throughout.
Decoration: On the shoulder cordon, finger-tip impressions. (*72.209*)

P123 Fragment of cordoned shoulder of quite well-fired paste tempered with grog, brown both faces with dark grey core.
Decoration: On the shoulder cordon, closely set finger-tip impressions. (*72.525*)

P124 Fragment of cordoned shoulder of well-fired paste tempered with coarse flint grits, light brown throughout.
Decoration: On the shoulder cordon, closely set finger-tip impressions. (*72.309*)

P125 Fragment of cordoned shoulder of fairly well-fired paste tempered with grog, brown externally, grey to brown internally, with dark grey core.
Decoration: On the shoulder cordon, closely set finger-tip impressions. (*71.3322*))

P126 Fragment of cordoned shoulder of well-fired paste tempered with calcined flint, light brown throughout.
Decoration: On the shoulder cordon, closely set finger-tip impressions. (*71.3367*)

P127 Wall sherd of well-fired compact paste, light brown externally, grey internally.
Decoration: On the shoulder cordon, diagonal finger-tip impressions. (*72.1126*)

P128 Wall sherd of well-fired paste, light brown both faces.
Decoration: On the shoulder cordon, deep finger-tip impressions. (*72.1209*)

P129 Wall sherd of well-fired compact paste tempered with some grit, light brown externally, grey internally.
Decoration: On the shoulder, remains of finger-tip impressions. (*72.710*)

P130 Wall sherd of well-fired paste tempered with a little flint grit, light brown externally, grey internally.
Decoration: On the shoulder, finger-tip impressions. (*71.3343*)

P131 Fragment of shoulder of well-fired sandy paste tempered with grits including ? chalk and grog, orange both faces with grey core.
Decoration: On the shoulder, finger-tip impressions. (*71.3014*)

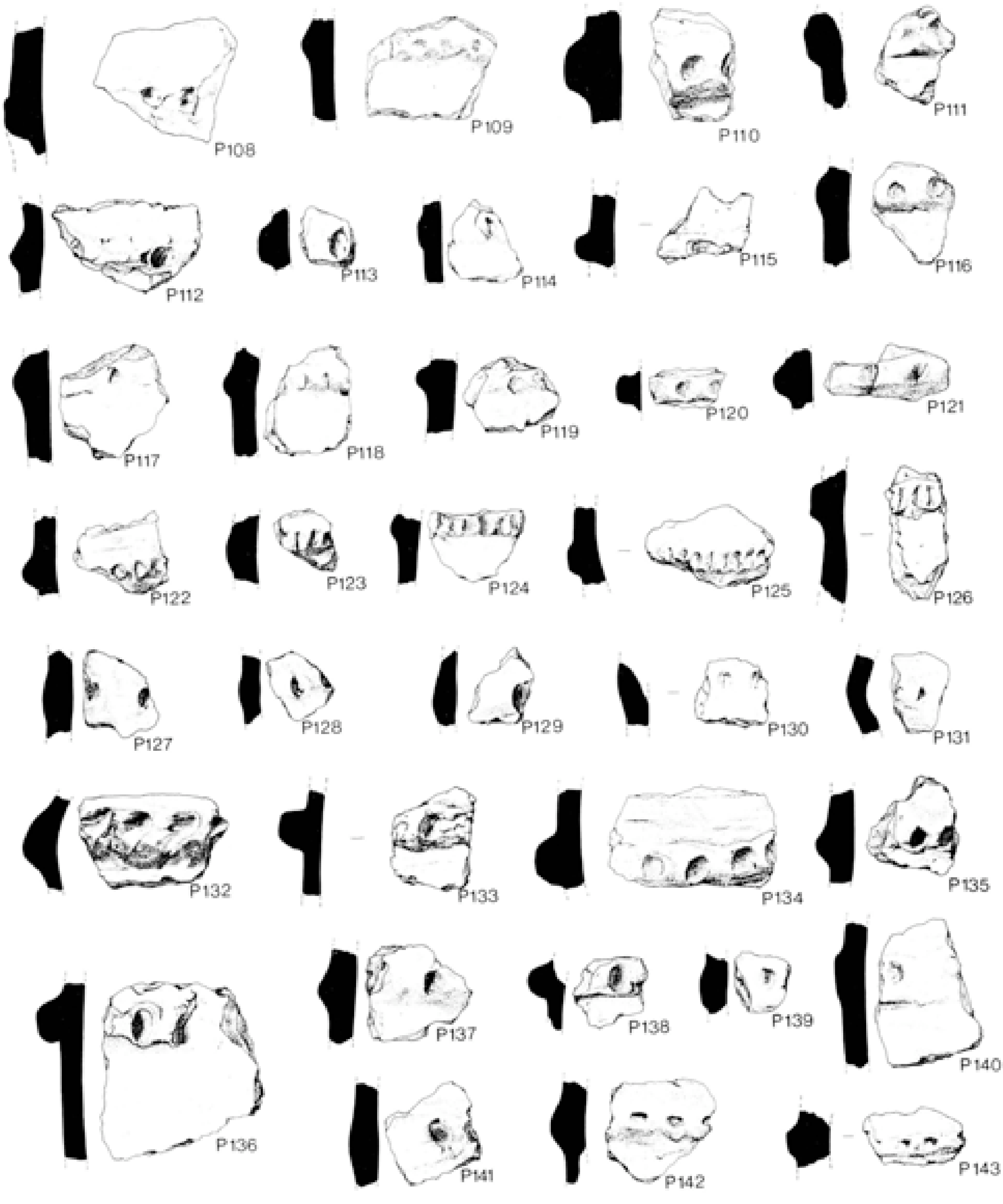


Figure 28 Bronze Age Pottery: P108–143. (Scale ½)

P132 Fragment of shoulder of well-fired, coarse paste tempered with large amount of calcined flint, brown to grey externally, dark grey with carbon incrustation internally.
Decoration: On the shoulder, deep finger-tip impressions dragged down. (*72.1150*)

P133 Wall sherd of well-fired paste tempered with shell, light brown both faces.
Decoration: On the shoulder cordon, deep oval round based impression. (*71.3367*)

P134 Wall sherd of well-fired paste tempered with flint, light greyish brown externally, dark grey with carbon incrustation internally.
Decoration: On the shoulder cordon, deep oval impressions. (*72.205*)

P135 Wall sherd of well-fired coarse paste tempered with grit including shell, grey both faces with dark grey core.
Decoration: On the shoulder cordon, deep irregular impressions. (*72.36*)

P136 Wall sherd of quite well-fired paste tempered with a large quantity of grit including cockle shell, and calcined flint, light brown to grey externally, grey to dark grey internally.
Decoration: On the shoulder cordon, deep oval pebble impressions. (*71.2470*)

P137 Wall sherd of well-fired coarse paste tempered with grit, light brown both faces with grey core.
Decoration: On the shoulder cordon, deep irregular oval impression. (*72.1430*)

P138 Wall sherd of fairly well-fired paste tempered with shell, light brown to grey externally, grey internally, with dark grey core.
Decoration: On the shoulder cordon deep oval impression. (*72.549*)

P139 Wall sherd of well-fired compact paste, light brown externally, brown internally.
Decoration: On the shoulder cordon, oval impression. (*72.995*)

P140 Wall sherd of well-fired paste tempered with some grit, grey throughout.
Decoration: On the shoulder cordon, oval impressions. (*72.972*)

P141 Wall sherd of well-fired paste tempered with some grit, grey throughout.
Decoration: On the shoulder cordon, oval impressions. (*72.961*)

P142 Wall sherd of fairly well-fired paste tempered with a little grit, light brown externally, grey internally.
Decoration: On the shoulder cordon, a row of flat-based oval impressions. (*72.132*)

P143 Fragment of shoulder cordon, of rather soft laminar fabric tempered with a little shell, light brown externally, grey internally.
Decoration: On the shoulder cordon, indefinite impressions. (*71.3366*)

P144 Fragment of cordoned shoulder of well-fired compact paste tempered with flint grits, light greyish brown externally, dark grey internally.
Decoration: On the cordon, diagonal slashes. (*72.1445*)

P145 Fragment of cordoned shoulder of well-fired compact paste tempered with some shell, grey externally, light greyish brown internally with dark grey core.
Decoration: On the cordon, diagonal slashes extending also on to the body beneath. (*72.648*)

P146 Sherd from shoulder of vessel of well-fired, fairly compact paste tempered with a little shell and grog.
Decoration: On the raised shoulder, deeply scored herringbone. (*72.1423*)

P147 Sherd from shoulder of vessel of well-fired, fairly compact paste, tempered with a little shell and grog, light brown both faces.
Decoration: On the raised shoulder, deeply-scored irregular herringbone. (*72.97*)

P148 Sherd from shoulder of vessel of fairly well-fired paste tempered with fine shell, light brown to brown externally, light brown internally.
Decoration: On the raised shoulder, deeply scored herringbone. (*71.735*)

P149 Sherd from shoulder of vessel of quite well-fired paste tempered with a little fine shell, patchy light brown to grey externally, light brown to brown internally.
Decoration: On the raised shoulder, deeply-scored herringbone. (*71.3316*)

P150 Wall sherd of fairly soft fabric tempered with a little grit, brown both faces with dark grey core.
Decoration: Remains of scored herringbone. (*72.821*)

P151 Sherd from shoulder of vessel of fairly well-fired paste tempered with some chalk, light brown externally, brown internally.
Decoration: Remains of diagonal scored line. (*72.762*)

P152 Fragment of applied cordon of well-fired, compact paste, tempered with a little shell, light brown throughout.
Decoration: Deeply scored herringbone. (*72.1098*)

P153 Wall sherd of well-fired coarse paste tempered with shell, light brown externally, grey internally, with dark grey core.
Decoration: Remains of deeply scored lines. (*72.647*)

P154 Base angle of well-fired fairly compact paste tempered with flint grits. Patchy light brown to grey both faces with grey core.
Decoration: Irregular diagonal scored lines. (*72.786*)

P155 Seven sherds including rim of a vessel of well-fired compact paste, tempered with flint grits. Light brown to grey both faces with grey core.
Decoration: On the rim, transverse finger-nail impressions. On the external surface, vertical to diagonal scored lines. (*71.796, 3264; 72.158, 210, 238, 274–5, 372, 450, 1430*)

P156 Rim sherd of fairly compact paste tempered with angular grit. Patchy light brown to grey externally, brown internally.
Decoration: On the rim, short diagonal incised lines, opposed in groups. On the external surface, irregularly-scored diagonal incised lines.
Remains of one applied boss. (*72.753*)

P157 Rim sherd of well-fired compact paste tempered with grit including calcined flint, grey both faces.
Decoration: Remains of lightly applied horizontal strokes. (*72.500*)

P158 Wall sherd of similar paste to P157.
Decoration: Remains of lightly applied strokes. (*72.447*)

P159 Sherds from upper part of vessel of hard compact paste tempered with shell, light brown to grey externally, light brown to dark grey internally.
Decoration: Made with a point-toothed comb. Short diagonal/herringbone lines beneath rim, with a horizontal and diagonal lines on the body. (*72.1141, 1383, 1385, 1392, 1445*)

Figure 29 Bronze Age Pottery: P144–172. (Scale ⅓)

P160 Rim sherd as P159. (*72.1381*)

P161 Rim sherd of well-fired paste tempered with ? chalk, light greyish brown both faces.
Decoration: On the rim, diagonal slashes, externally, finger-tip impressions. (*72.158*)

P162 Rim sherd of well-fired paste tempered with some grog, light grey to brown externally, grey internally.
Decoration: On the rim, transverse slashes. Externally, finger-tip impressions. (*72.273*)

P163 Rim sherd of well-fired coarse pottery, tempered with grits including flint, grey to brown both faces.
Decoration: Horizontal finger-tip impressions.
(Probable grain impression on inner surface.) (*72.1062*)

P164 Rim sherd of soft vesicular paste, light brown both faces with grey core.

Decoration: On the rim, indefinite impressions. Externally, remains of vertical finger-tip impressions. (*72.1229*)

P165 Wall sherd, probably same as P166. (*72.1387*)

P166 Base angle of well-fired coarse paste tempered with a variety of grits, light brown both faces with dark grey core.
Decoration: Horizontal finger-tip impressions set roughly in rows. (*72.1430*)

P167 Wall sherd of well-fired paste tempered with flint, light brown both faces.
Decoration: Remains of finger-tip impressions. (*72.158*)

P168 Fragment of base, of fairly soft paste tempered with a little shell, brown both faces with grey core.
Decoration: Internally, finger-tip impressions. (*72.563*)

P169 Fragment of base of fairly soft paste tempered with a little shell, light brown externally, light brown to grey internally.
Decoration: Internally, finger-tip impressions. (*72.1148*)

P170 Joining rim sherds of compact sandy paste tempered with a little other grit, patchy light brown to grey both faces with grey core. A series of applied blobs beneath the rim. (*72.1209*)

P171 Upper part of well-fired coarse paste tempered with a large quantity of fine flint grit, grey throughout.
One finger pinched knob survives. (*72.462, 464*)

P172 Three rim sherds of vessel of well-fired coarse paste tempered with flint grits, light brown to brown both faces with grey core.
One applied knob survives on one of the sherds. (*72.540, 907, 100*)

P173 Rim sherd of well-fired compact paste tempered with some chalk, light brown to grey both faces.
One applied knob survives. (*72.961, 996*)

P174 Upper part of vessel of well-fired compact paste, light brown to grey both faces with grey core.
Remains of a series of irregularly spaced knobs. (*72.270, 1010, 1423, 1425*)

P175 Wall sherd of compact paste tempered with some flint, light brown externally, brown internally with grey core.
One applied knob survives. (*71.3259*)

P176 Rim sherd of sandy paste tempered with a large quantity of flint grits, patchy light brown to grey externally, grey to brown internally.
Remains of one applied knob. (*71.3367*)

P177 Wall sherd of very coarse paste tempered with a large quantity of flint grit, light brown throughout.
One applied knob survives. (*72.464*)

P178 Rim sherd of fairly compact paste tempered with a considerable quantity of shell, light brown to grey externally, grey internally.
One applied knob survives. (*71.3322*)

P179 Wall sherd of compact paste tempered with some chalk and grog, light brown throughout.
One applied knob survives. (*72.237*)

P180 Wall sherd of compact paste tempered with a little grit, greyish brown both faces.
One applied knob survives. (*72.859*)

P181 Wall sherd of fairly coarse paste, grey both faces.
One applied knob survives. (*72.912*)

P182 Undecorated rim sherd of well-fired paste tempered with some grit including shell and ? grog, brown externally, dark grey internally.
Remains of perforation through the wall. (*71.2886*)

P183 Rim sherd of well-fired paste tempered with calcined flint grits, light brown to grey both faces.
Decoration: Two finger-nail impressions on the external surface.
Remains of perforation through the wall made before firing. (*72.260*)

P184 Rim sherd of well-fired paste, light brown externally, grey internally.
Perforation through the wall, made before firing. (*71.3355*)

P185 Rim sherd of well-fired paste tempered with large fragments of shell and other grit, light brown both faces.
Remains of perforation through the wall made before firing. (*72.1284*)

P186 Rim sherd of well-fired compact paste tempered with some shell, light brown both faces.
Remains of a row of perforations through the wall made before firing. (*72.1025*)

P187 Rim sherd of well-fired paste tempered with a large quantity of calcined flint grit, grey throughout.
Remains of a row of perforations through the wall made before firing. (*72.809*)

P188 Rim sherd of fairly soft flakey paste tempered with some flint grit, grey both faces with dark grey core.
Perforation through the wall made before firing. (*72.1152*)

P189 Rim sherd of well-fired paste tempered with calcined flint grits, brown externally, brown to grey internally, with grey core.
Perforation through the wall made before firing. (*72.1062*)

P190 Rim sherd of well-fired compact paste tempered with some grit including shell, light grey externally, dark grey internally.
Remains of perforation through the wall made before firing. (*71.3362*)

P191 Undecorated rim sherd of well-fired paste tempered with some grit, light brown to grey externally, brown internally with dark grey core.
Remains of perforation through the wall. (*72.570*)

P192 Rim sherd of well-fired paste tempered with some grits, brown externally, grey internally.

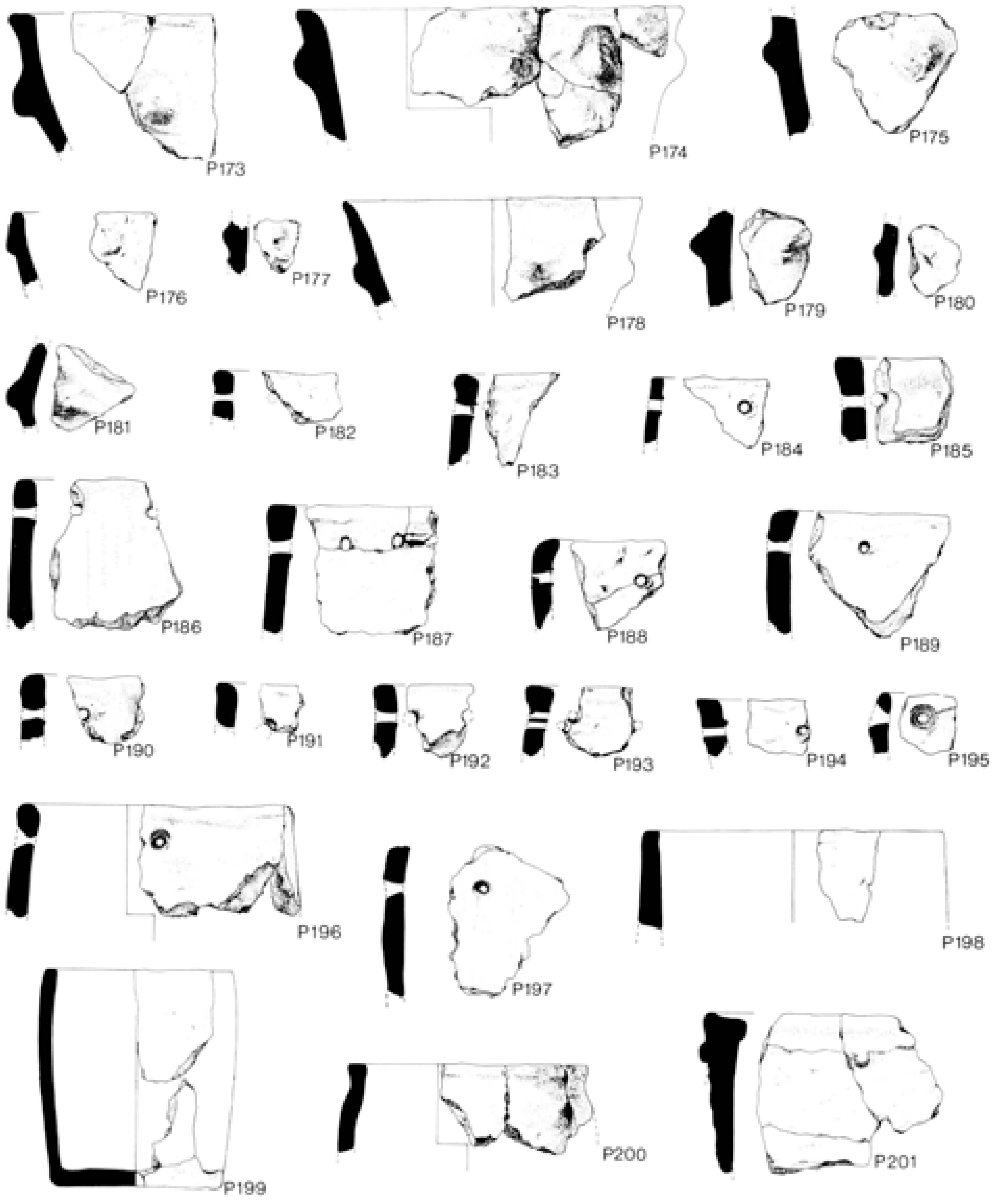


Figure 30 Bronze Age Pottery: P173–201. (Scale ⅓)

Remains of perforations made through the wall before firing. (*72.506*)

P193 Rim sherd of well-fired paste tempered with large calcined flint grits, light brown both faces.
Remains of multiple perforations through the wall, made before firing. (*72.275*)

P194 Well-fired compact paste tempered with large calcined flint grits, reddish brown both faces.
Perforation through the wall made before firing. (*71.3000*)

P195 Rim sherd of well-fired compact paste, light brown both faces with grey core.
Repair-hole drilled after firing from the external surface. (*71.3261*)

P196 Three joining rim sherds of fairly well-fired paste tempered with grits including flint and shell, patchy light brown to grey externally, dark grey internally with carbon incrustation.

Repair-hole drilled from external surface after firing. (*72.253, 654*)

P197 Wall sherd of fairly well-fired paste tempered with grog, light brown externally, grey to dark grey internally with carbon incrustation.

Repair-hole drilled after firing. (*72.562*)

P198 Undecorated rim sherd of well-fired paste tempered with grit including grog and shell, brown externally, light brown to grey internally. (*71.2345*)

P199 Most of the base and part of the rim, of a vessel of quite well-fired compact paste tempered with a little shell and grog, light brown both faces with dark grey core. (*71.2462*)

P200 Three joining undecorated rim sherds of well-fired paste tempered with a large number of grits, light brown throughout. (*72. 1392, 1397*)

P201 Undecorated rim sherd of soft paste tempered with shell, external surface largely lost, internally light brown. (*72.763*)

P202 Two joining undecorated rim sherds of fairly well-fired paste tempered with a large quantity of shell, grey externally, light greyish brown internally, with dark grey core. (*72.39, 1445*)

P203 Undecorated rim sherd of well-fired paste tempered with grits, light brown both faces with grey core. (*72.1388*)

P204 Three undecorated rim sherds of well-fired, fine compact paste tempered with shell, greyish brown throughout, internal surface weathered. (*71.694, 698*)

P205 Undecorated rim sherd of well-fired paste tempered with some flint grit, light brown externally, dark grey with carbon incrustation internally. (*71. 2191*)

P206 Undecorated rim sherd of well-fired paste tempered with some grit, light brown to grey externally, grey internally. (*72.1412*)

P207 Undecorated rim sherd of well-fired paste, grey externally, brown internally. (*72.813*)

P208 Undecorated rim sherd of well-fired compact paste, light brown both faces with dark grey core. (*72.1108*)

P209 Undecorated rim sherd of rather soft paste tempered with some flint grit, greyish brown externally, grey internally. (*72.1108B*)

P210 Undecorated rim sherd of well-fired paste tempered with some grit, grey externally, light brown internally. (*71.3343*)

P211 Undecorated rim sherd of well-fired paste tempered with calcined flint and shell, grey externally, light brown internally, with dark grey core. (*72.1423*)

P212 Undecorated rim sherd of well-fired paste tempered with shell, light brown externally, grey internally. (*72.1415*)

P213 Undecorated rim sherd of well-fired paste tempered with grit, brown to grey externally, brown internally. (*72.1425*)

P214 Undecorated rim sherd of quite well-fired paste tempered with some grit, brown externally, grey internally with dark grey core. (*72.785*)

P215 Undecorated rim sherd of fairly well-fired paste tempered with some grit, light brown both faces. (*72.843*)

P216 Undecorated rim sherd of well-fired paste tempered with some grit, light brown both faces. (*72.1392*)

P217 Undecorated rim sherd of rather soft paste, brown to grey externally, brown internally. (*72.198*)

P218 Undecorated rim sherd of well-fired paste tempered with a little grit, patchy light brown to grey both faces. (*72.821*)

P219 Two joining undecorated rim sherds of fairly well-fired paste tempered with some grit, grey externally, greyish brown internally. (*72.42, 1007*)

P220 Undecorated rim sherd of well-fired compact paste, light brown throughout. (*72.1423*)

P221 Undecorated rim sherd of well-fired paste, greyish brown both faces with dark grey core. (*72.1425*)

P222 Undecorated rim sherd of well-fired paste tempered with shell, patchy light brown to grey externally, dark grey internally. (*72.1445*)

P223 Undecorated rim sherd, probably same as P202. (*72.1392*)

P224 Undecorated rim sherd of well-fired paste tempered with shell, light brown both faces, with dark grey core. (*72.1108*)

P225 Undecorated rim sherd of fairly well-fired paste tempered with shell, brown externally, light brown internally. (*72.398*)

P226 Undecorated rim sherd of rather soft paste tempered with shell, brown both faces. (*72.1242*)

P227 Undecorated rim sherd of well-fired paste tempered with a large quantity of shell, light brown externally, grey internally. (*72.1411*)

P228 Undecorated rim sherd of soft laminar paste tempered with a large quantity of shell, reddish brown both faces with dark grey core. (*71.2456*)

P229 Undecorated rim sherd of fairly well-fired paste, brown both faces. (*72.691*)

P230 Undecorated rim sherd of well-fired paste tempered with a large number of grits, light brown both faces with dark grey core. (*72.572*)

P231 Undecorated rim sherd of well-fired paste tempered with a large quantity of grit including flint, brown to grey externally, reddish brown to grey internally. (*71.694*)

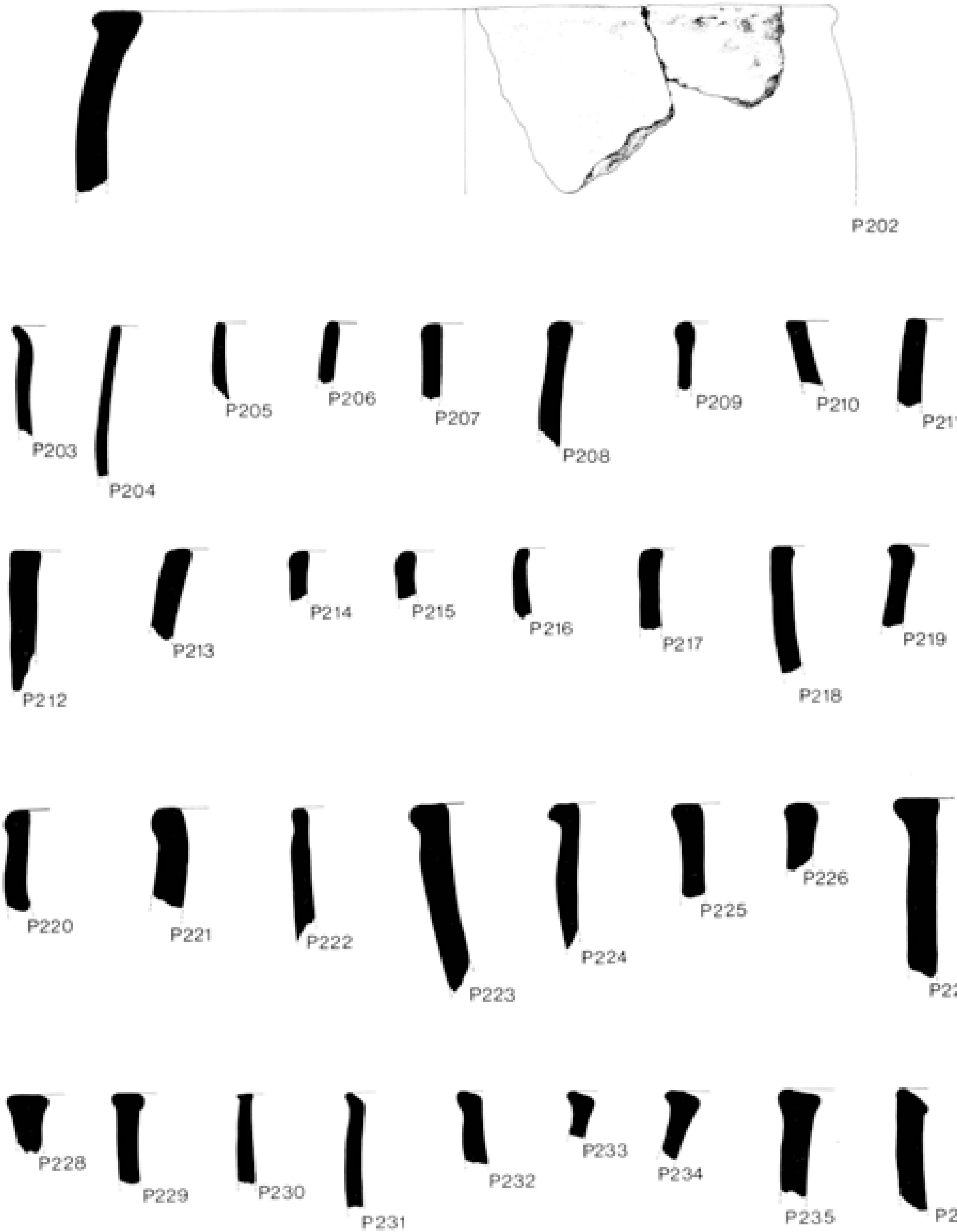


Figure 31 Bronze Age Pottery: P202–236. (Scale ⅓)

P232 Undecorated rim sherd of well-fired paste tempered with some shell, light brown both faces with grey core. (*72.1223*)

P233 Undecorated rim sherd of rather soft paste tempered with a little shell, grey externally, greyish brown internally. (*72.880*)

P234 Undecorated rim sherd of well-fired paste tempered with some shell, brown throughout. (*72.816*)

P235 Undecorated rim sherd of well-fired paste tempered with a large quantity of shell, brown externally, grey internally, with dark grey core. (*72.864*)

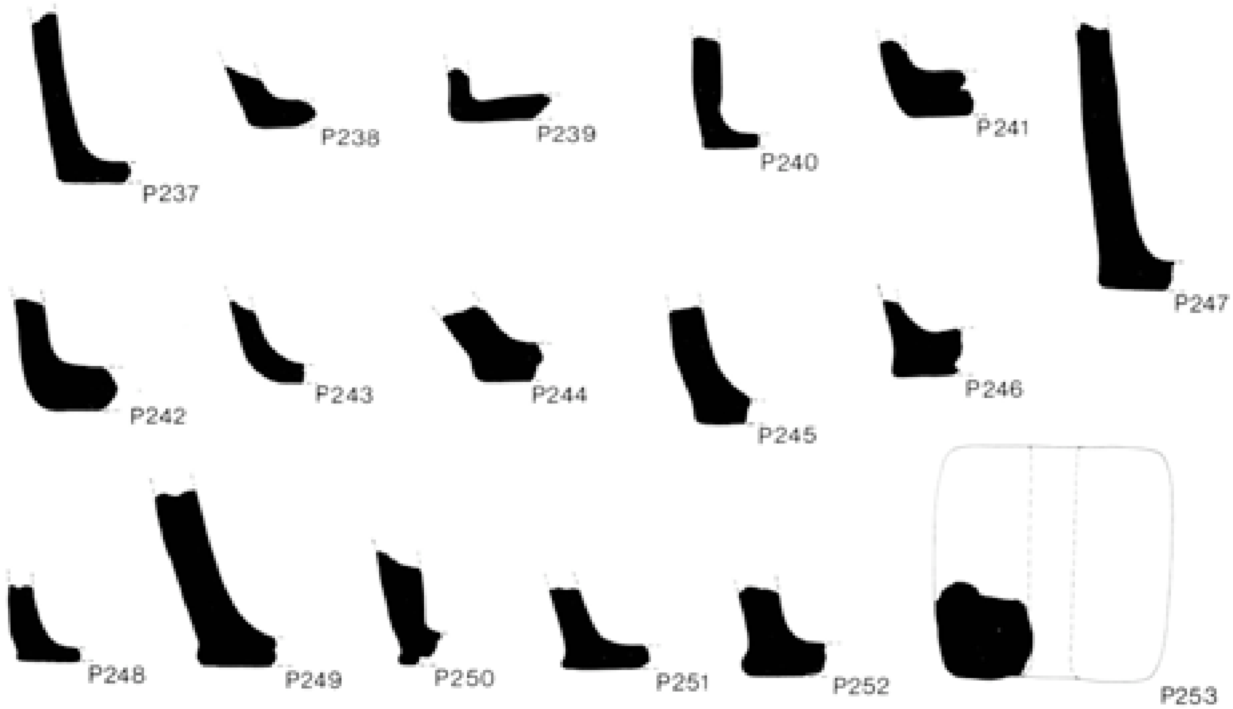


Figure 32 Bronze Age Pottery: P237–252 & loom weight P253. (Scale ⅓)

P236 Undecorated rim sherd of well-fired paste tempered with a little grit including shell, light brown to grey both faces. (*72.650*)

P237 Base angle of fabric similar to *P236* and possibly from same vessel. (*72.1246*)

P238 Base angle of well-fired paste tempered with some flint grit, light brown externally, brown to grey internally with some carbon incrustation. (*72.1423*)

P239 Base angle of fairly well-fired paste tempered with shell, light greyish brown externally, grey internally, with some carbon incrustation. (*72.1235*)

P240 Base angle of well-fired compact paste tempered with grog, brown externally, dark grey internally. (*71.528*)

P241 Base angle of well-fired paste tempered with a little shell and grog, light brown externally, grey internally with dark grey core. (*72.54*)

P242 Base angle of fairly well-fired paste tempered with grit including shell, light brown externally, grey internally. (*72.114*)

P243 Base angle of fairly well-fired paste tempered with shell, greyish brown externally, dark grey internally. (*72.464*)

P244 Base angle of fairly soft paste tempered with a little fine shell, light brown externally, grey internally with grey core. (*72.1097*)

P245 Base angle of well-fired compact paste tempered with grit, light grey externally, dark grey internally with carbon incrustation internally. (*72.237*)

P246 Base angle of fairly soft paste tempered with grog, light brown throughout. (*72.1445*)

P247 Base angle of fairly well-fired, coarse paste tempered with some shell and grog, light brown externally, brown with carbon incrustation internally. (*72.887*)

P248 Base angle of well-fired compact paste tempered with calcined flint, brown both faces with grey core. (*71.3250*)

P249 Base angle of fairly soft, coarse paste, tempered with a large quantity of calcined flint grit, light brown throughout. (*72.109*)

P250 Base angle of fairly well-fired coarse paste tempered with a large quantity of shell, light brown throughout. (*72.1415*)

P251 Base angle of well-fired, fairly coarse paste, light brown externally, grey internally. (*72.1425*)

P252 Base angle of well-fired coarse paste, tempered with calcined flint grits, light brown throughout. (*72.572*)

Chapter III Other Finds

by R J Mercer

1 Chalk Objects (Figures 33–39)
Located on the activity surface of Middle Bronze Age date and within the midden deposits within the 1972 shaft were a large number of carved chalk objects of uncertain function. These are listed below with numbers applying to Figures 33–39. Discussion of function is interspersed within the schedule dealing with the objects group by group. Two chalk objects (C10 and C11) emanated from the 1971 shaft one of which would appear *prima facie* to be a chalk lamp for use in the mining process. The term 'upper surface' used in the descriptions applies only with reference to the attitude in which the object is depicted in the figures and is not intended to imply any known correct attitude for the object when in use.

Catalogue
C1 Small cylindrical vertically perforated block 2cm in diameter. The perforation is of 'hourglass' type (*72.609*). Located within Group 2 midden material.

C2 Cylindrical vertically perforated block 3cm in diameter. The perforation is of 'hourglass' type (*71.758*). Located within a deposit associated with the mass of flint working debris in the upper layers of the 1971 shaft.

C3 Cylindrical vertically perforated block 4cm in diameter. The perforation is of 'hourglass' type (*72.242*). Located within Group 1 midden material.

These three objects would appear to fall within the generalised category of 'spindle whorl' although the C1 example is so light that it is difficult to accept that it could have fulfilled this specific function and may simply be a bead or pendant of some kind. C2 also presents problems of interpretation in that the perforation would not appear to be of sufficient diameter to have allowed a spindle of adequate robustness to pass through and the function here too may be more as a pendant.

C4 Small block of chalk with opposed borings—apparently incomplete hourglass perforation (*72.257*). Located within Group 1 midden material.

C5 Small block of chalk with opposed borings—apparently incomplete hourglass perforation (*72.423*). Located within Group 2 midden material.

C6 Small block of chalk with opposed borings—apparently incomplete hourglass perforation (*72.416*). Located within Group 2 midden material.

These objects would appear of C1–C3 type in an incomplete state of manufacture. From the nature of the impressions of working on the chalk it would appear that a flint borer was used to carry out the perforation.

C7 Fragment of chalk cup (*72.1442*). Located in Group 3 midden material.

C8 Fragment of chalk cup (*72.947*). Located in deposit stratified between Group 2 and Group 3 midden material.

C9 Fragment of chalk cup (*72.1276*). Located in Group 2 midden material.

C7–C9 These chalk cup fragments occur only in the Middle Bronze Age occupation debris. They may perhaps be regarded as parallel in type to the small fired clay cups found at Shearplace Hill, Dorset (Rahtz 1962) and again of unknown function but apparently not associated with metalworking.

C10 Handled chalk cup (handle slightly broken) (*71.2998*). Located in the North East quadrant of the 1971 shaft in the entrance to Gallery 1 within the top 40cm of the entrance blocking. Although no traces of burning or other staining were encountered it would appear reasonable to apply the term lamp to this small container in view of the circumstances of its discovery.

C11 Handled chalk block shaped to cup like form but with no hollowed out cup element within the body (*71.180*). Located within the 1B deposits within the head of the 1971 shaft. An incomplete chalk lamp?

C10 and *C11* These two objects would appear to represent, from the 1971–72 programme of work on the site, the production of chalk lamps on the site during the Late Neolithic mining phase. One lamp is complete and one incomplete. Presumably animal fats would have burnt in the cup of the lamp although no trace of such burning survives today.

C12 Rough plaque of chalk with crudely etched lines upon the surface (*71.2875*). Located in the South West quadrant of the 1971 shaft in the fifth section of filling just above the grooved ware deposit on the dump placed on the floor of the shaft. Etched plaques occur commonly in many flint mine contexts and have been suggested as possibly evidence of 'tally' keeping. While this must be a possibility, idle scratching at a block of chalk during a break from work would appear to be just as likely a source of this kind of evidence.

C13 Rough plaque of chalk with crudely etched lines upon the surface (*72.1319*). Located in the Group 2 midden deposit.

C12 and *C13* It should be borne in mind that light scratching of abstract designs on blocks of chalk are difficult to see and the two examples shown above may be rep-

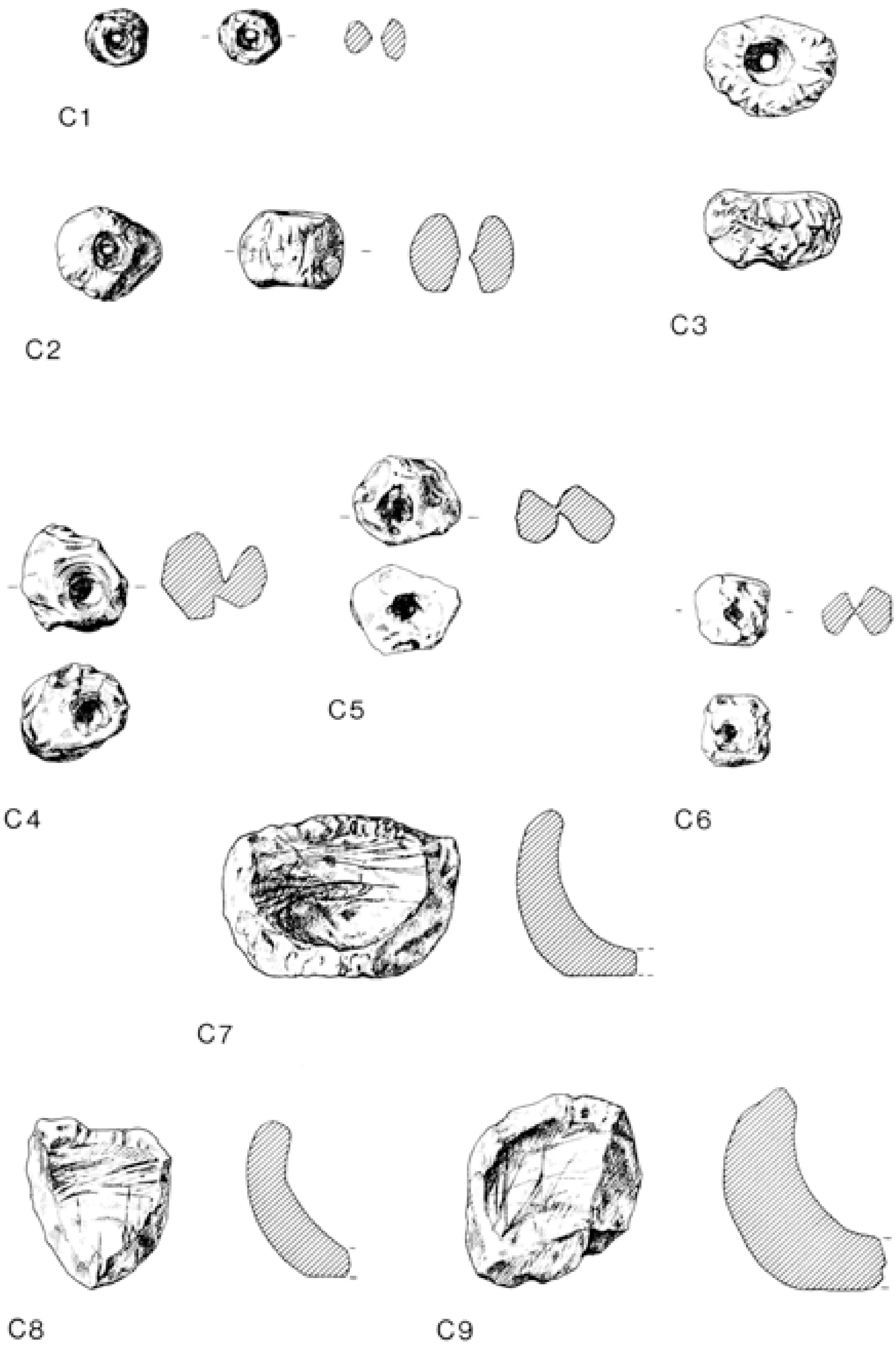


Figure 33 Chalk artefacts: C1–9. (Scale ½)

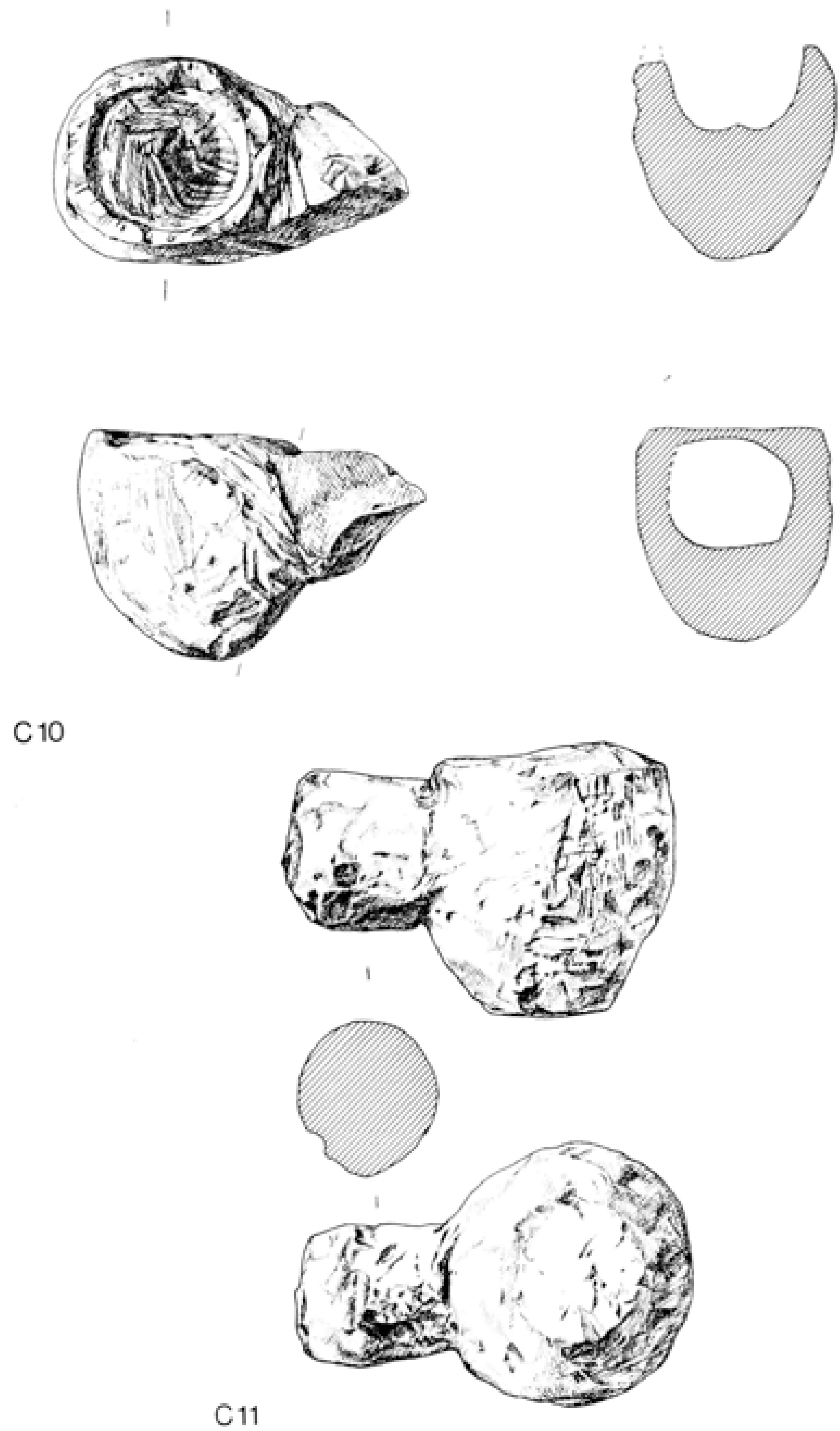


Figure 34 Chalk artefacts: C10–11. (Scale ½)

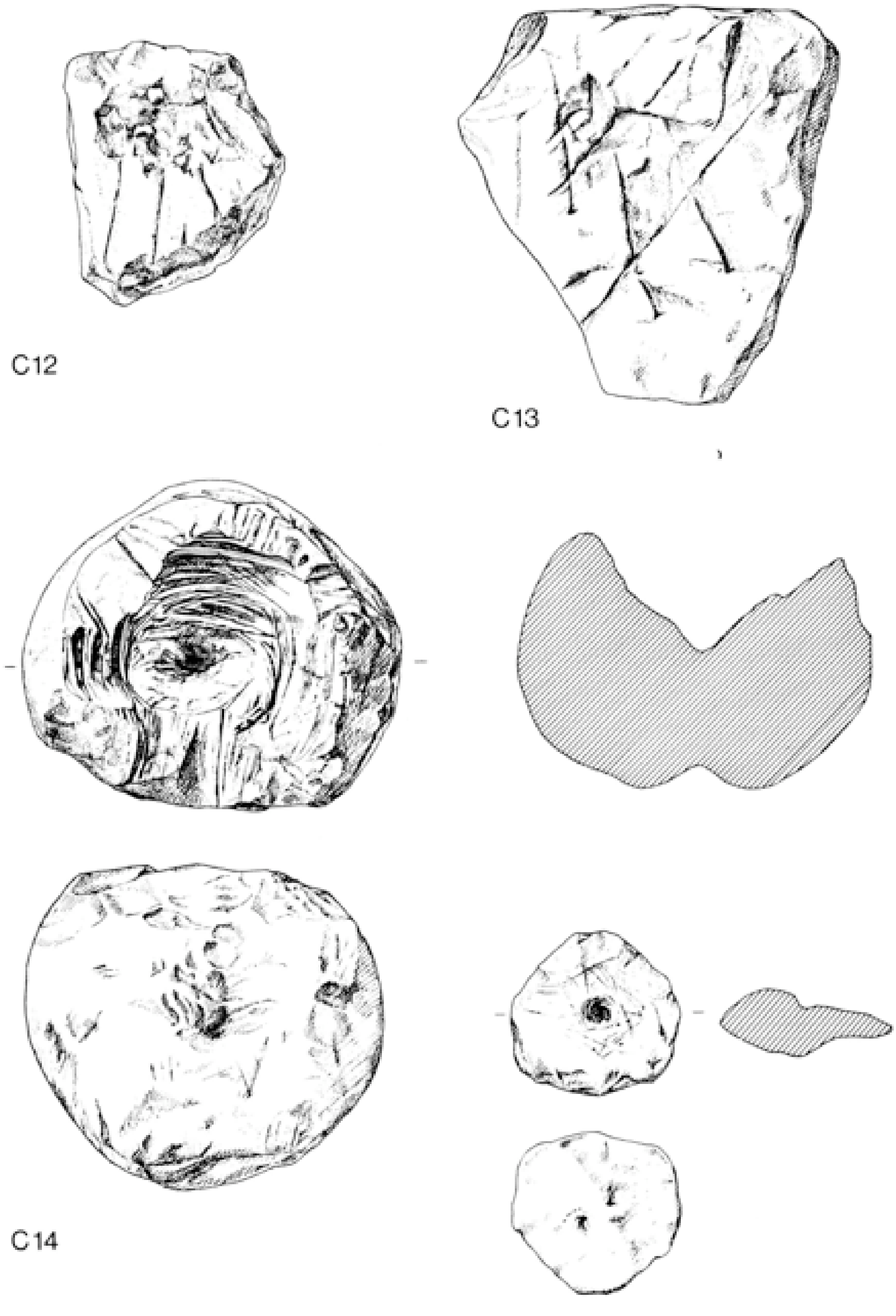


Figure 35 Chalk artefacts: C12–15. (Scale ½)

resentative of an altogether larger group not retrieved during excavation.

C14 Large block with massive boring on upper surface and minimal boring on the lower. Unsuccessful or unfinished attempt at 'hourglass' perforation? Possibly abandoned chalk cup in early stage of production (*72.988*). Located in Group 1 midden material.

C15 Flat chalk plaque with borings on upper and lower faces. The piece possibly represents another unsuccessful or unfinished attempt at 'hourglass' perforation (*71.3390*). Located on the Middle Bronze Age activity surface within Trench 8B to the west of the 1972 shaft head.

C16 Large chalk block with a substantial boring in the upper surface and with a minimal boring in the lower surface. Again this may be an unfinished or unsuccessful attempt at hourglass perforation (*72.1317*). Located in Group 2 midden material.

C17 Chalk block with borings in both upper and lower surfaces possibly in an attempt to produce an hourglass perforation (*72.521*). Located within Group 2 midden material.

The group of objects described above appears to be distinguished by attempts at hourglass perforation which have not been completed. It is however conceivable that the borings that are a recurrent feature of these blocks were intended not to produce shaped chalk objects but to assist in the sharpening of, for example, bone points.

C18 Chalk block with a groove cut round the entire outer surface (*72.1154*). Located in Group 3 midden material. Use as a pendant weight (a thatch weight?) would seem to be the most likely interpretation of this piece.

C19 Chalk block shaped on its outer surface with a massive hollow cut in its upper surface (*72.886*). Located on the surface of Group 1 midden material.

C20 Chalk block shaped on its outer surface with a small hollow cut in its upper surface (*72.339*). Located within Group 2 midden material.

C21 Small chalk block shaped on its outer surface with a small hollow bored in its upper surface (*72.554*). Located on Middle Bronze Age activity surface to the south of the 1972 shaft.

C22 Small chalk block shaped on its outer surface with a small hollow cut in its upper surface (*72.1125*). Located with Group 3 midden material.

C23 Large chalk block with a hollow cut in its upper surface (*71.3251*). Located on Middle Bronze Age activity surface within Trench 8B to the west of the 1972 shaft.

C24 Large chalk block shaped on its outer surface with a large hollow cut in its upper surface (*72.1238*). Located in Group 3 midden material.

C25 Large chalk block shaped on its outer surface with a small hollow cut in its upper surface (*72.932*). Located within Group 1 midden material.

C26 Chalk block with small hollow cut in its upper surface (*72.1276*). Located within Group 3 midden material.

C27 Small chalk block shaped on its outer surface with a small hollow bored in its upper surface (*72.1154*). Located within Group 1 midden deposit.

C28 Chalk block with small hollow cut in its upper surface (*72.1313*). Located within Group 1 midden deposit.

C29 Large chalk block shaped on its outer surface and with a hollow cut in its upper surface (*72.1238*). Found together with C24 in Group 3 midden deposit.

C30 Fragment of worked chalk hollowed on upper surface (*72.1155*). Located within Group 3 midden deposit.

C31 Small chalk block with a deep bored hollow on its upper surface (*72.1370*). Located within Group 3 midden deposit.

C32 Chalk block with a shallow bored hollow in its upper surface (*72.295*). Located within Group 1 midden deposit.

C33 Large chalk block with a hollow cut in its upper surface (*72.1277*). Located within Group 3 midden deposit.

C34 Small chalk block with cut hollow on its upper surface (*72.403*). Located within Group 1 midden deposit.

This large group (C19–C34) of chalk blocks sometimes dressed on their outer surface (C19–22, C24–25, C27, C29) with hollows cut or bored in their upper surfaces may represent a variety of function. The larger examples may well be lamps although such small cups could, of course, perform a very wide variety of functions. This group is clearly distinct, however, from the cups of much finer type represented by the fragments C7–C9. One or two may represent early stages in the manufacture of these finer examples (C18, C23) but most seem to be quite casual indentations. It is conceivable that a number of the lesser examples are the by-product of bone point sharpening.

II Bone Implements (Figures 40–42)

A number of bone implements were located during excavation of the Middle Bronze Age levels on the site and these are discussed below. The numbers beside each schedule entry relate to Figures 40–42 and discussion of each class of object is interspersed within the schedule. Implements of antler located in the Late Neolithic phases of mine working on the site are studied in Chapter V section 7.

Catalogue

B1 Flat sectioned point (*Ovis* right distal metacarpal) (*72.316*). Broken in antiquity at two points and located in superficial deposits in 1972 shaft.

B2 Flat sectioned point (*Ovis* right distal metacarpal) (*72.163*). Broken in antiquity at one point. Located in Group 2 midden deposit.

B3 Flat sectioned point (*Ovis* right distal metacarpal) (*72.805*). Broken point missing. Located within Group 3 midden deposit.

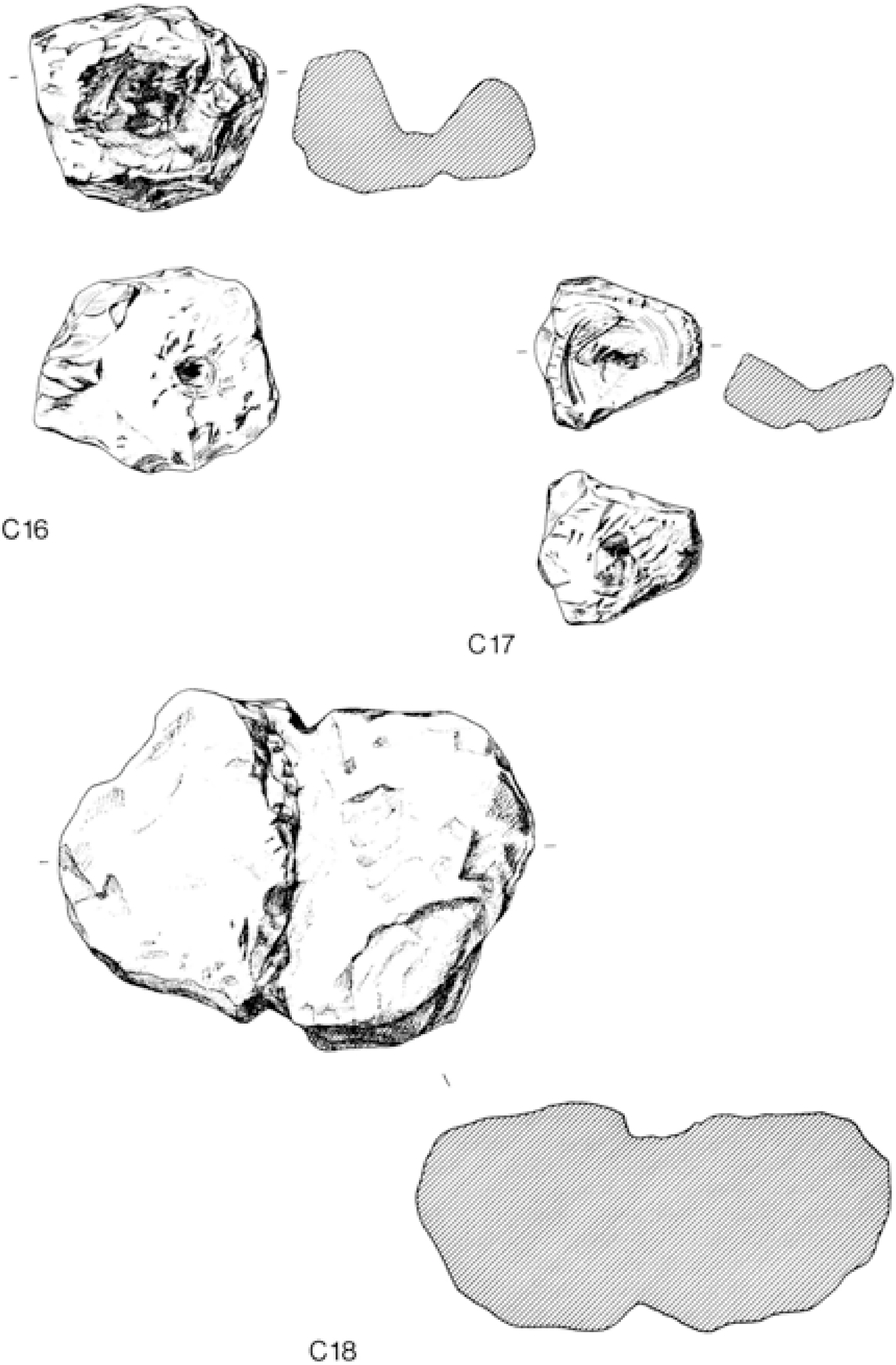
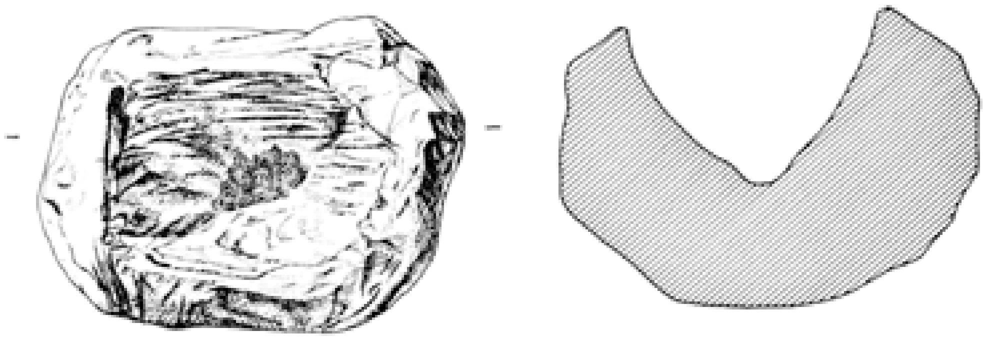
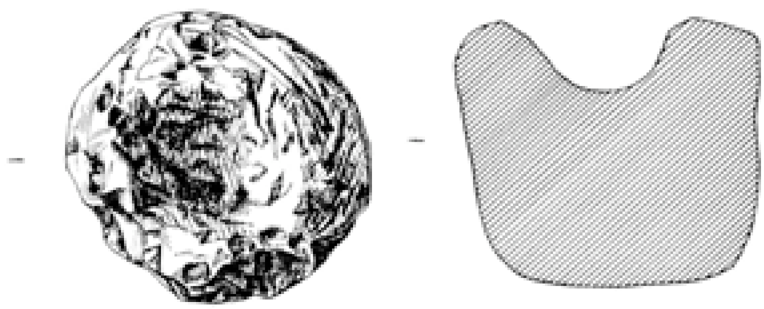


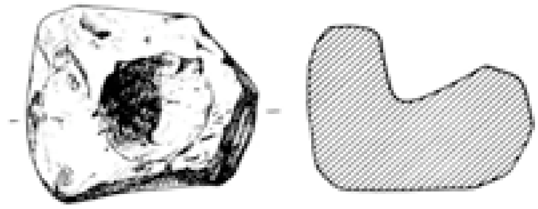
Figure 36 Chalk artefacts: C16–18. (Scale ½)



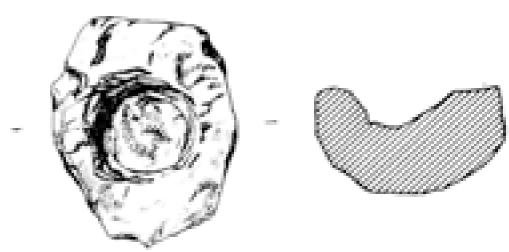
C19



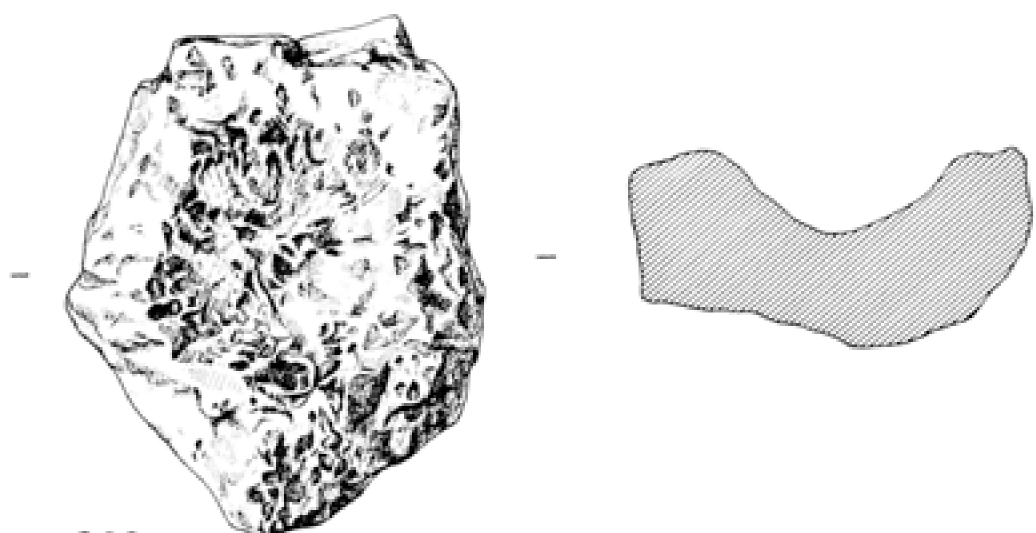
C20



C21



C22



C23

Figure 37 Chalk artefacts: C19–23. (Scale ½)

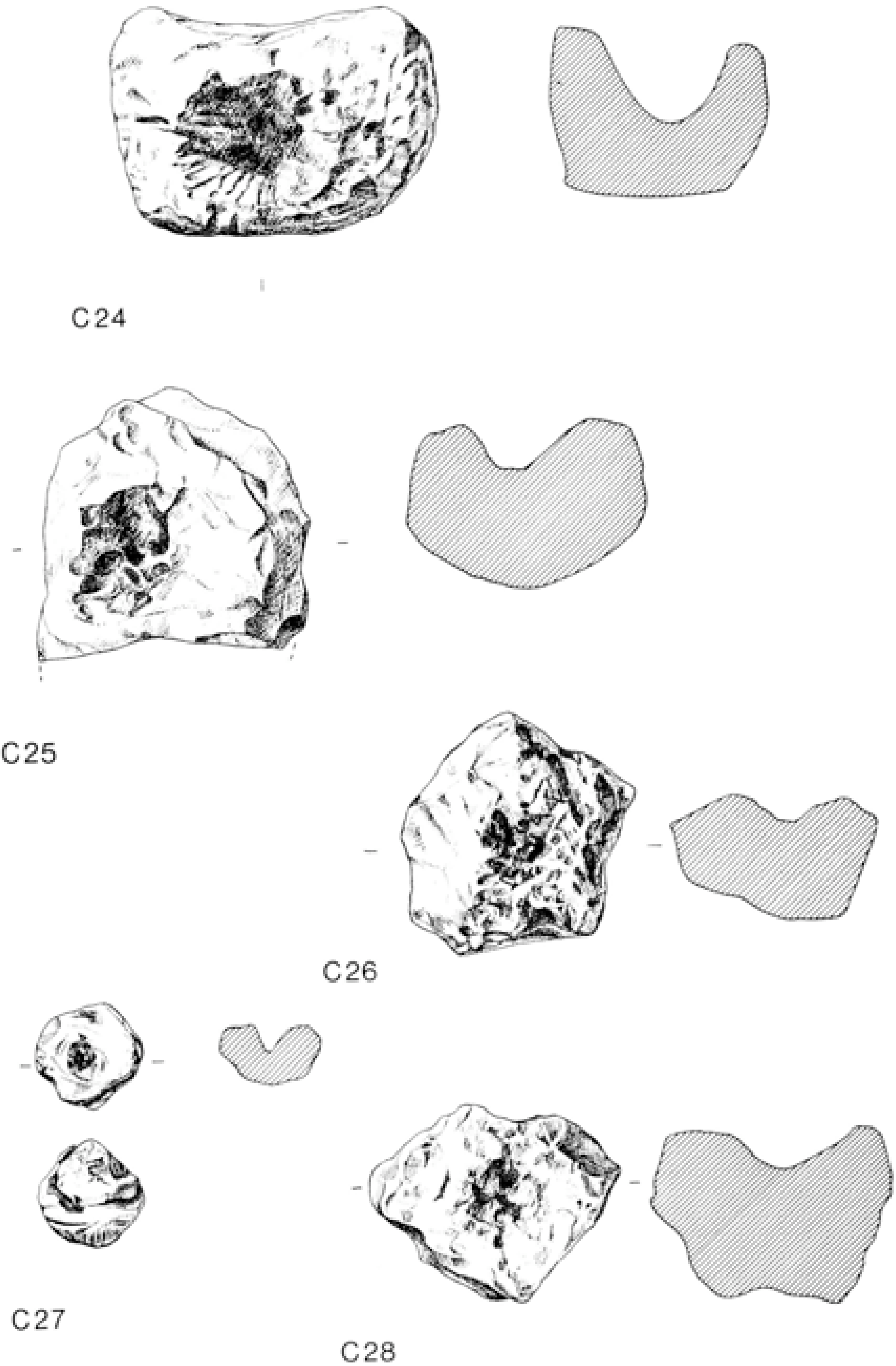


Figure 38 Chalk artefacts: C24–28. (Scale ½)

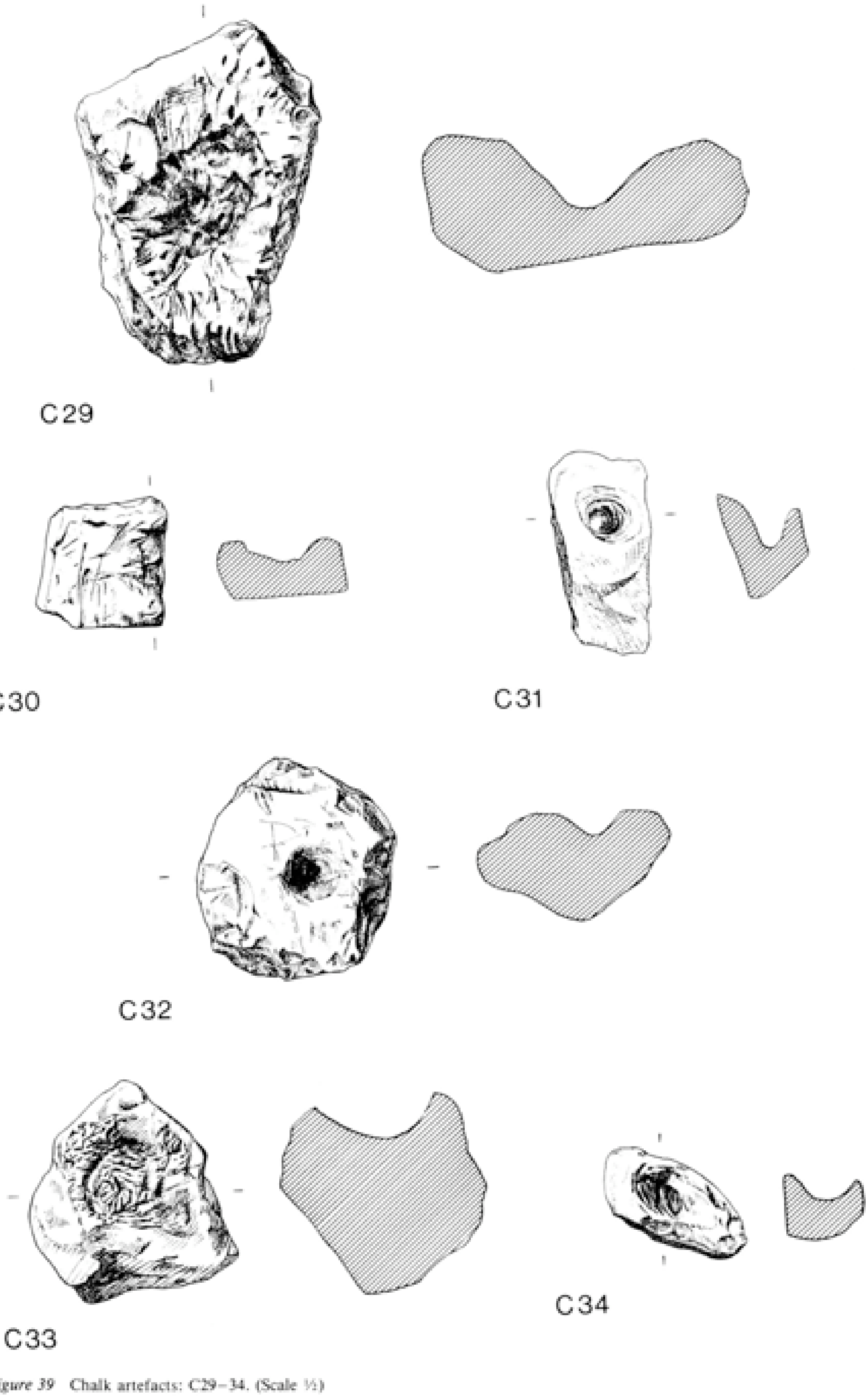


Figure 39 Chalk artefacts: C29–34. (Scale ½)

B4 Flat sectioned point with perforated head (*Ovis/Capra* metacarpal splinter) (*72.342*). Broken in antiquity at the head. Located in surface of Group 1 midden.

B5 Flat sectioned narrow point with perforated head (*Ovis* metacarpal) (*72.520*). Broken at point. Located within Group 2 midden.

B6 Flat sectioned point with perforated head (*Ovis/Capra* right metatarsal shaft) (*71.3318*). Located in Trench 8B on the Middle Bronze Age activity surface to the west of the 1972 shaft.

B1/B2/B3 Produced by splitting the metacarpal bone longitudinally and working the shaft of the bone to a carefully produced point. Little indication can be seen of wear marks accumulated during use and so generalised is the form that a multiplicity of functions may apply. It may be suggested that the retention of the thickened bone terminal may indicate that these points were not intended to be passed through any material and were used for 'prodding' or 'pushing'—possibly for decorating pottery or pushing up the weft in weaving activities. The careful selection of one specific bone type for the production of these tools may however indicate a clearly defined specialist function. The frequency of breakage presumably simply reflects the comparative delicacy of these long thin sectioned bone points.

B4/B5/B6 Similar to the above implements but with a clearly manufactured perforation in the head. Their function may relate to that of a modern bodkin. It is equally likely that B1–B6 are dress pins, the perforations being for retention in a manner familiar from bronze parallels. The occurrence of metal dress pins within the British prehistoric record from the latter part of the Early Bronze Age onwards would argue for the existence of parallel less luxurious items in bone and the lack of clear traces of use-wear would fit with this interpretation. This observation should be examined in conjunction with observations relating to B34.

B7 Thick-shafted chisel or gouge (*Ovis/Capra* right tibia shaft) (*72.846*). Smashed in antiquity at distal end. Very clear traces of wear and extensive damage at the proximal (blade) end. Located in Group 1 midden deposit.

B8 Thick-shafted chisel or gouge (*Ovis/Capra* Right proximal metatarsal) (*72.849*). Broken in antiquity. Located with Group 1 midden deposit.

B9 Thick-shafted awl (*Ovis/Capra* right proximal metatarsal) (*72.1437*). Located below Group 3 midden deposit. The proximal end of this tool is worked to produce a point rather than a blade edge. This point appears to have been fire-hardened.

B10 Thick-shafted chisel or gouge (*Ovis/Capra* left proximal metatarsal) (*72.84*). Located within Group 1 midden deposit. The proximal end of the tool is extremely abraded by use. At a point presumably secondary to the tool's original use a cut has been made on the side of the shaft, probably by a flint blade.

B11 Thick-shafted awl with perforated butt (*Capreolus capreolus* left proximal metatarsal) (*71.985*). Located in North West sector of 1971 shaft 90cm north-west of Burnt Area 2 at the junction of the 1A and 1B group of layers. The proximal end of the tool is worked to a point and the butt end is perforated with little trace of damage to the upper surface.

B12 Thick-shafted awl with perforated butt (*Ovis/Capra* right proximal metatarsal) (*72.97*). Located in superficial deposits in the 1972 shaft. The proximal end has been worked to a point with little apparent trace of damage in use. The butt is perforated with no trace of damage to the upper surface.

B13 Thick-shafted awl (*Ovis/Capra* left proximal metacarpal) (*72.853*). Located below Midden Group 2. Some attempt has been made to perforate the head of this implement, in the manner achieved in B11 and B12, by rotary boring. The tool appears to have been abandoned incomplete as there is very little trace of wear of any kind on the point.

B14 Thick-shafted awl with perforated butt (*Ovis/Capra* distal metacarpal) (*72.727*). Located with Group 1 midden material. This point is badly broken at its distal end with traces of two perforations set opposite one another both now broken out.

B15 Thick-shafted chisel or gouge with perforated butt (*Ovis/Capra* left proximal metacarpal) (*72.255*). Located in Group 1 midden material. Chisel proximal end with traces of wear with the butt perforated at one point and with a possible further broken out perforation.

B16 Butt of perforated shaft (*Capra* distal right metacarpal) (*72.284*). Located in superficial deposits in 1972 shaft (Layer 2). Perforation performed with considerable skill.

B17 Thick-shafted point with perforation (*Ovis/Capra* proximal right metatarsal) (*72.267*). Located in superficial deposits in 1972 shaft (Layer 2). The point of this tool has been severely damaged by use. The butt is also badly damaged with evidence of one perforation now largely broken out.

B18 Thick-shafted point with perforation (*Ovis/Capra* proximal left metatarsal) (*72.694*). Located in Group 1 midden material. The point is somewhat abraded by usage. The butt is largely undamaged although the upper limit of the perforation has split out.

B19 Thick-shafted chisel or gouge(?) with perforation (*Ovis/Capra* proximal left metatarsal) (*72.731*). Located in Group 2 midden material. An apparently 'chisel' edge is severely abraded by use damage. The butt is broken out but the perforation survives.

B7–B19 This large point/chisel/gouge group with thick hollow shafts (except B16) form the dominant type within the Middle Bronze Age bone implement assemblage at Grimes Graves. Their thick shafts would presumably render them unsuitable for use as bodkins or for any other purpose involving a process of passing *through* material. The 'chisel' forms frequently show a degree of wear quite consistent with the use suggested by the name. With one (rather doubtful) exception (B19) none of these lateral bladed chisel forms have a perforation at the butt. In no

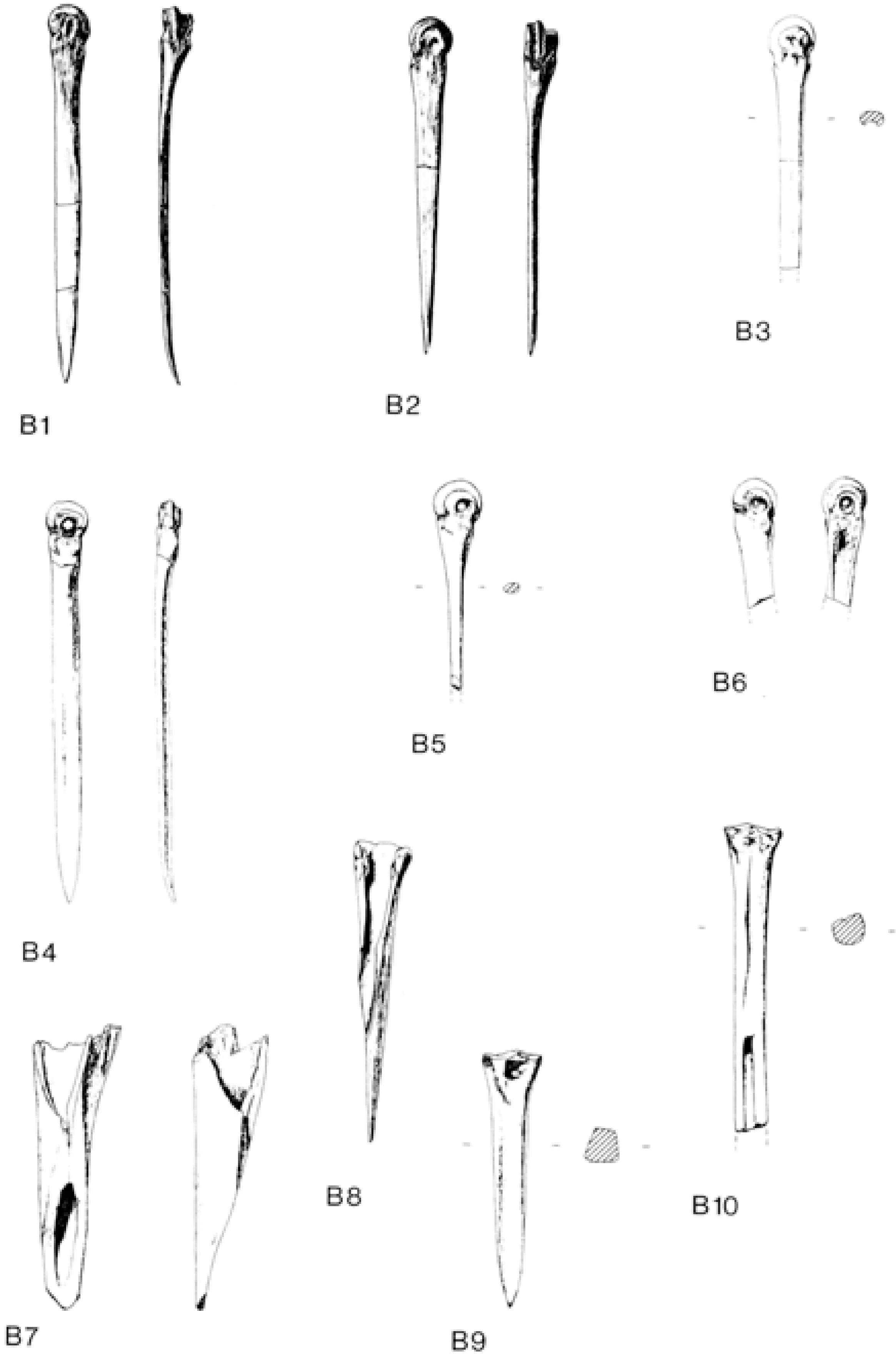


Figure 40 Bone artefacts: B1–10. (Scale ½)

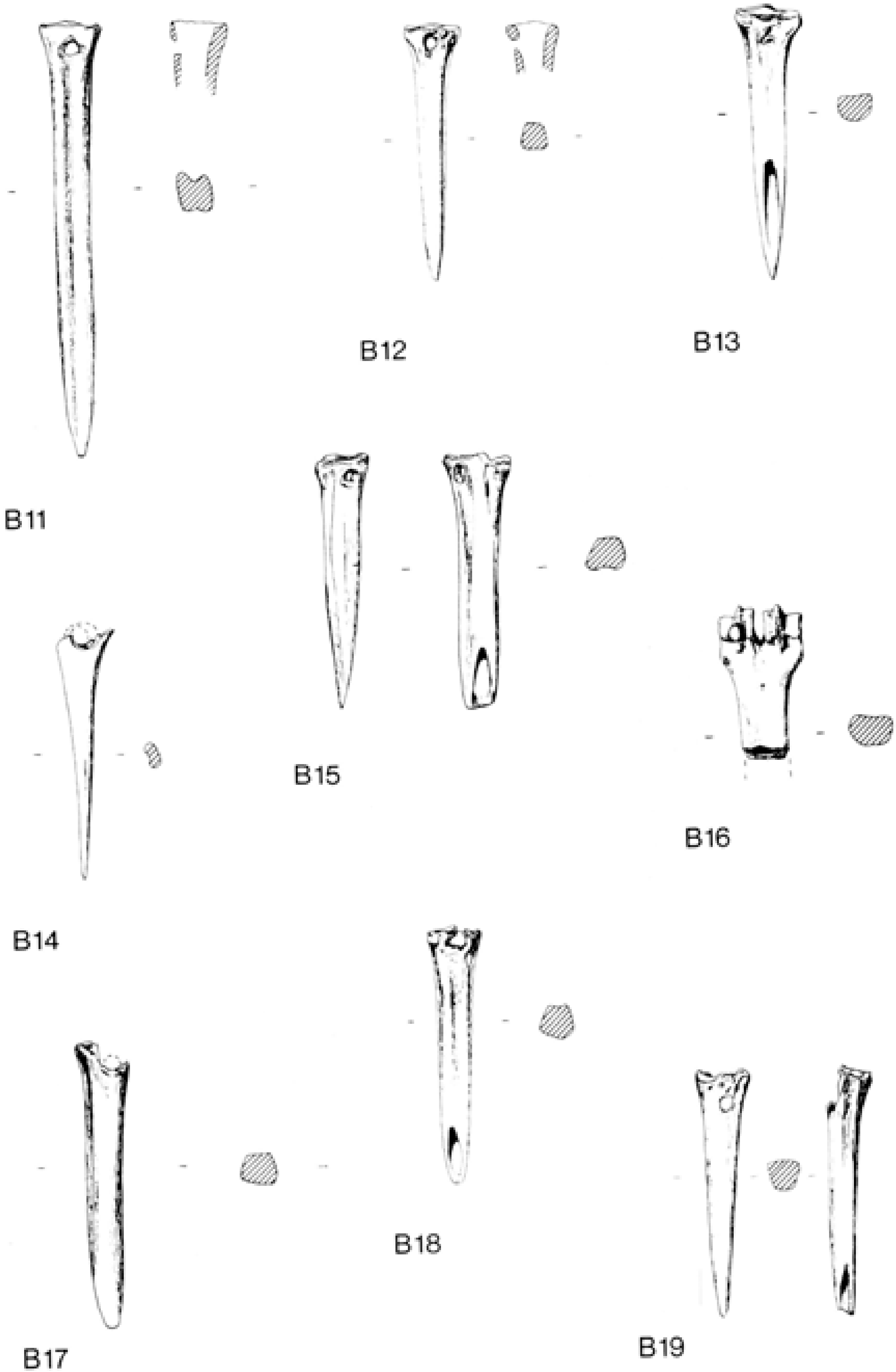


Figure 41 Bone artefacts: B11–19. (Scale ½)

instance however is there any evidence of the hammering on the butt that one would expect. This can be accounted for if a wooden peg was inserted in the 'socket' formed by the hollow butt of the tool and this peg 'took the punishment'. The breaking out of the socket visible in B7 and B8 might well occur if this mode of use was practised. Certainly the interiors of some of the hollow butts seem to show traces of wear. The 'point' series are almost all (except B9) perforated at the butt. Their use as awls seems unlikely in view of the lack of wear traces which would appear inseparable from such use (except with B17). Furthermore no satisfactory function for the perforation can be suggested.

The suggestion has been made (Gibson 1979) that this type provides the archery armatures so conspicuous by their absence from the British Bronze and Iron Ages and that the perforation was to receive a peg which held armature and shaft together. To the writer such a suggestion is attractive but possibly falls down at two points. First, the peg arrangement required to account for the perforation would appear to be superfluous and secondly the unevenness of many of the points would make them unsuitable for use as arrow armatures, the unevenness leading inexorably to inaccurate shooting.

For a further interpretation of function we can refer to the report of J R Mortimer (Mortimer 1905, 150) of four burials found in a chalk quarry about ¼ mile north east of Grimthorpe House, Grimthorpe, Yorkshire and treated by Stead (Stead 1968).

Bone points with distal perforations identical in form and size with those under discussion at Grimes Graves were found in a grave containing an iron sword, an iron spear-head and shield remains. 'Six or eight bone implements measuring three and a half to four inches long were found distributed on the top of the interment the whole length, and others, making sixteen in all, were found below and around the remains. These Dr Wilson (of Pocklington) thinks had been used to secure some covering or wrapper round the doubled up body when it was placed in the grave'. This covering was 'seemingly in some kind of skin, as evident trace of hair is observable through the whole length of one side of the sword sheath'.

Here would appear to be clear evidence of the use of such pins as 'toggles' for use in conjunction with thongs to secure a heavy garment (very like the modern duffle-coat toggles). There can be no possibility of these thick points being used to penetrate any fabric as the damage created would be too great. The point was tied to the garment (viz. the perforation at the butt) and was fed through a thong loop. Mortimer (Mortimer 1905, 75) makes reference to a grave of an elderly woman within a barrow (No. 113) within the Aldro Group in the East Riding of Yorkshire. Here in a grave apparently of the Early Bronze Age six pins of a form very close to those under discussion, but unperforated, were found around the head of the burial and these had apparently performed a retaining function in the coiffure of the lady in question.

It will be clear that this suggested use of such points is one possibility out of several and that anyway B11 is apparently altogether too large for use in this way and must have performed some other function. A range of functions is thus certain and the possible breadth of that range has been indicated.

B20 Perforated length of hollow shaft (*Capreolus* capreolus left proximal metatarsal) (*71.3318*). Located on activity surface in Trench 8B to the west of the 1972 shaft. Shown in drawing as broken at the lower end and this is fairly clearly so. Yet after breakage wear has taken place on the broken edge indicating presumably continued use in broken condition. The function of this piece is not at all clear.

B21 Curved bone point (Unspecified bone splinter) (*72.794*). Located within Group 3 midden deposit. Function not apparently specific. No clear wear traces.

B22 Pin fragment (Unspecified bone splinter *Ovi Caprid* size) (*72.814*). Located in Group 3 midden material.

B23 Pin fragment (*Ovi Caprid* size distal metatarsal—unfused) (*72.528*). Located in Group 1 midden material.

B24 Pin fragment (Unspecified metapodial shaft splinter) (*71.3317*). Located on activity surface in Trench 8B to west of 1972 shaft.

B25 Pin fragment (*Ovi Caprid* size metapodial splinter) (*72.770*). Located in Group 2 midden material.

B26 Pin (Unspecified metapodial shaft splinter) (*72.259*). Located in Group 1 midden material.

B27 Cylindrical bone shaft (Unspecified bone splinter) (*71.2451*). Located within the 1B group of layers in the head of the 1971 shaft.

B28 Needle (Unspecified bone splinter) (*72.390*). Located within Group 1 midden debris.

B29 Needle (Unspecified bone splinter) (*71.3262*). Located on the activity surface within Trench 8B to the west of the 1972 shaft.

B30 Needle fragment (Unspecified bone splinter) (*71.298*). Located on the Middle Bronze Age surface behind the chalk dump within Trench 1A.

B31 Needle fragment (Unspecified bone splinter) (*72.821*). Located within Group 3 midden material.

B32 Peg (Unspecified bone splinter) (*72.814*). Located within Group 3 midden material. This bone peg is not broken and is neatly finished at each end.

B33 Plaque polished by use (*Bos* size splinter) (*72.108*). Located in Group 1 midden material.

B34 Perforated disc (Unspecified scapula fragment?) (*72.463*). Located in Group 2 midden material. This perforated disc may have had a simply decorative function. It might be suggested however that the disc could have formed a protective plate around the hole through which the pin fastening penetrated the fabric of the fastened garment. This interpretation might be supported by the scratches on the surface of the disc as though by a clumsy hand endeavouring to insert a sharp point through the central perforation.

B35 Sub-rectangular plaque (Unspecified scapula fragment?) (*72.27*). Located on the activity surface within Trench 8B to the west of the 1972 shaft.

B36 Worked fragment (*Ovi Caprid* tibia shaft) (*72.853*). Located within Group 3 midden material. This fragment of

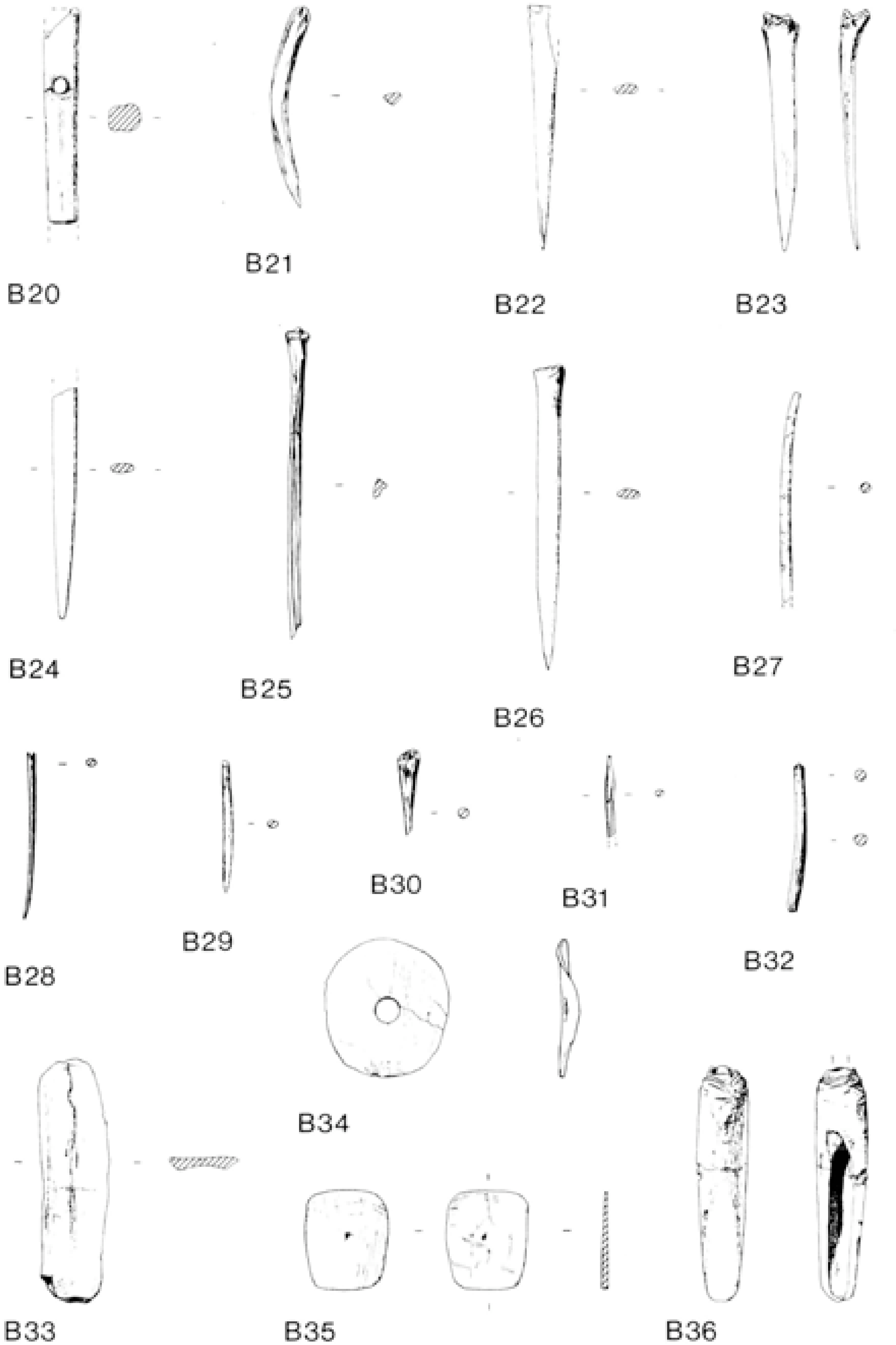


Figure 42 Bone artefacts: B20–36. (Scale ½)

tibia shaft has been split at the lower end and polished to produce a chisel-like edge. The upper terminal has been whittled down by a flint or metal blade.

The bone assemblage retrieved during 1971–72 from the Middle Bronze Age occupation debris at Grimes Graves shows an apparent concentration in areas of activity related to the manufacture of textile fabrics and their conversion into garments. The pins, needles and flat section points would all appear most likely to be associated with these activities. The flat sectioned points may furthermore be dress pins for the fastening of garments and this role may have applied to the thick shafted points with perforations which possibly performed some toggle fastening function. Bone chisels presumably bear witness to wood or leather working.

III Bronze Metalwork (Figure 43)

The Awls Awls of rectangular/oval section are long-lived and widely distributed types in the British Early and Middle Bronze Age. At Latch Farm Barrow (Piggott 1938) Pit 3 containing one of the primary burials beneath the barrow exhibited a cremation apparently enclosed within a bag which in turn was apparently set within an oak coffin. A rectangular/oval section awl was located with but not in amongst the cremated bone. Pit 2, which would appear to be contemporary, contained a Primary collared urn. Other Early Bronze Age associations of the type do occur e.g. in the Upton Lovell G2 (e) burial where an amber spacer plate necklace, grape cup, Primary collared urn and a sheet gold ornament were located (Annable and Simpson 1964) associated with an awl of similar type. It seems quite possible that the primary phase at Latch Farm could be contemporary with the latter grave and a start for the square/round section awl series well within the Southern British Early Bronze Age seems likely.

At Monkswood, near Bath, Somerset a similar awl was located with a side-looped spearhead of Rowlands' Group 2 (Rowlands 1976) (leaf or flame shaped blade flat or slightly concave in section with rounded midrib with loops semi-circular in shape). The presence of torcs, spiral arm-rings, rhomboid section arm-ring, coiled finger-ring and a double looped bracelet prompted Smith (Smith 1959) to include Monkswood in the group of hoards that distinguished her 'Ornament Horizon', conventionally dated c.1100 BC, contemporary with Coles's Glentrool Phase and Eogan's Bishopsland Phase (Coles 1966; Eogan 1964). Group 2 spearheads associated with the awl in this hoard also occur in direct association with Deverel-Rimbury settlement contexts—at Thorny Down, Wiltshire (Stone 1941), at New Barn Down near Worthing, Sussex (Curwen 1934) and at South Lodge Camp where a spearhead of this type was located high up in the filling of the ditch (Pitt-Rivers 1898). At the upper chronological limit Coles (Coles 1966) has pointed to awls of essentially similar form occurring within the Glentrool hoard from South West Scotland (which he would conventionally date to c.1100 BC onwards). Such awls also occur at a parallel date within the Bishopsland Hoard from County Kildare (Eogan 1964, 268–351). A conventional time bracket stretching between the middle of the Southern British Early Bronze Age (conventional date c.1500 BC) until the final stages of the Middle Bronze Age (conventional date c.1100 BC) would appear to be established for this type.

Within Early Bronze Age grave assemblages awls would appear to be an item of female accompaniment and as such it might be seen as a leather piercing tool to be associated with repair and manufacture of clothing. Coles (Coles 1966, 117) has however interpreted these tools as small punches to produce pointillé and line engraved ornament with pointed and blade ends respectively.

The only example in complete condition at Grimes Graves located during 1971–72 shows absolutely no traces of wear on the square sectioned tapering end while quite extensive wear is visible on the point. Such a wear pattern would be more in keeping with the square sectioned end being retained within a wooden or bone haft. An example found in the Middle Bronze Age settlement at Chalton, Hampshire (Cunliffe 1970), although of identical type exhibits evidence of wear at both ends. Three other tiny fragments occur within the 1971–72 assemblage.

1. A curved fragment less than 0.5cm in length, oval in section and possibly representing a fragment of a torc or bracelet.
2. *The Saw* A tiny fragment of beaten bronze occurs with clearly visible denticulation on its thinner edge. This fragment presumably represents a portion of a saw blade. Rowlands (1976) records a single find of a saw fragment in Southern Britain also at Grimes Graves. The occurrence of bronze saws again leads us back to the Bishopsland Hoard and to the hoard from Monkton, Pembrokeshire (Grimes 1939, 222). At Monkton, the saw was associated with a torc fragment, a palstave fragment and a chisel.

The tendency of these rare fragments to occur in hoards prompts Rowlands to suggest that the saws should be seen as 'a likely component of the Middle Bronze Age smith's tool range'.

One other tiny fragment occurs in the material recorded during the 1971–72 investigation and it would seem from its fused and porous appearance to be a fragment of casting debris. If this identification is correct this fragment is the only evidence retrieved during the 1971–72 work on the site which might clearly represent the practice of metalworking in the vicinity. However, it would seem unlikely that this scrap of evidence would indicate a smith's workshop at any close proximity.

Catalogue

M1 Awl (*72.389*). Located in Group 1 midden in North West sector of 1972 shaft. Complete with rectangular tapering end and pointed cylindrical end. No trace of wear on rectangular section. Clear wear traces on the cylindrical section.

M2 Awl fragment (*72.1311*). Located in Group 3 midden in the North West sector of 1972 shaft. This awl is broken at the junction of square and round sections which fracture might argue further for the hafting of the square section element of these tools.

M3 Awl fragment? (*72.1310*). Located 10cm from 2 in Group 3 midden material. Possibly part of the same implement yet no join apparent.

M4 Curved fragment of oval sectioned rod (Bracelet fragment?) (*72.1191*). This fragment would appear to be cast in a bivalve mould with an improperly cleaned casting seam on one side. This fragment may also indicate, in its unfinished condition, the proximity of metalworking activity. Located also within the North West sector of the 1972 shaft in Group 2 midden deposit.

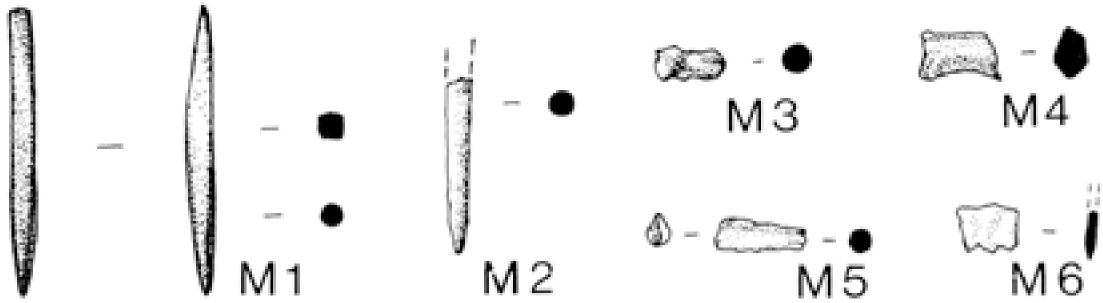


Figure 43 Metalwork: M1–6. (Scale 1:1)

M5 Fragment of bronze rod—oval in section (*72.1360*). Located 1m from M2 and M3 in Group 3 midden material.

M6 Small denticulated fragment of blade (Saw?) (*72.1312*). c.0.9cm in length. Located within 40cm of M2 and M3 within Group 3 midden material.

M7 Casting waste fragment (*72.1230*). Again located within 60cm of M2, M3 and M6 within Group 3 midden material. (Not illustrated).

Chapter IV
Human Skeletal Material
by R P Kenward[3]

Two skeletons were located in the uppermost layers (1A) of the 1971 shaft. The bones of the two individuals, one male, one female, were in a very good state of preservation. The damage to the upper part of Skeleton 2 suggests interference in antiquity due to the disturbance of an earlier grave for the burial of the virtually complete Skeleton 1.

The standard biometric measurements have been taken on the skull of Skeleton 1 and all long bones wherever possible, according to the techniques of Buxton and Morant (1933), Morant (1933), and Mukherjee, Rao and Trevor (1955). The stature of the individuals was calculated by using the regression formulae of Trotter and Gleser for whites (Trotter and Gleser 1952 and 1958) and is based on the maximum length measurements of the complete long bones.

Skeleton 1

Complete except for some bones of the wrists, hands and feet, namely: R pisiform, L trapezoid, L trapezium, L triquetral, L lunate, L scaphoid; L lateral cuneiform; and some phalanges of hands and feet.

Sex Male. Diagnosed from anatomical features of skull, pelvis, sacrum, and prominent muscular attachments and stoutness of the bones in general.

Age at death 25 – 30 years suggested by wear on teeth; the non-fusion of coccyx 1 and 2; the epiphyseal union being visible at the sternal end of the clavicles, and (JC) the state of fusion of the epiphyses of the centra of the lumbar vertebrae. Using Stewart and McKern's set of aged pubic symphyseal models (McKern and Stewart 1957), the pubic symphysis gave an age range of 23 – 39 years with a mean estimate of 29. The skull demonstrates well the great variation in the age at which obliteration of the sutures can begin. External obliteration has occurred in the lower part of the coronal sutures and in the whole of the lamboid suture except for the 2cm nearest the bregma—a condition that taken alone might suggest an age of 40 – 50 years (Powers 1962, 52 – 54).

Stature Approximately 168cm.

General pathology

There are no traces of osteo-phytic growth.

The 1st lumbar vertebra has, in the inferior aspect of the body nearer to the posterior than the anterior margin, a hole 1cm in transverse diameter and 7mm in anterior-posterior diameter, and 7mm deep at greatest depth. This is typical of a Schmorl's Node and means a central perforation into the body of the vertebra of the nucleus pulposus of the intervertebral disc between the first and second lumbar vertebrae (JC).

The 10th and 11th thoracic vertebrae are narrower in body than normal, and X-ray suggests a compression fracture, perhaps due to trauma.

The sacrum is incomplete, but fusion is not complete between S 1 and S 2 and between S 3 and S 4. The facets of the superior articular processes face in different directions; the R facing inwards, and the L straight backwards.

The R femur has an abnormality of the anterior surface of the femoral neck near the head. This is in the form of a pitted elliptical area 10 × 15mm (DB). Parietal foramina are absent from the skull, and no mastoid foramen is present on the R side.

Skull (JC) The skull has been well reconstructed after post-mortem damage to both parietal and both temporal bones, Cephalic Index 71.5 (dolichocephalic).

Norma frontalis The supraciliary ridges are rounded and well-developed, the forehead sloping back from them at an angle of about 30° from the vertical. Supra-orbital notch—two together on R side; supra-orbital foramen on L side. There is a remnant of the metopic suture 1cm long, fused immediately above the nasal bones. Orbital cavities—lachrymal region of L orbit is damaged, otherwise these appear within normal limits. Infra-orbital foramina are normal. Nasal fossa—septal deviation marked to R; turbinates degenerate.

Norma lateralis The zygomatic arch is well-formed, and the anterior and posterior roots are suggestive of male sex, as are mastoids. Parietal eminences are well-marked.

Norma occipitalis Wormian bones—none at the lambda, but probably four on the lambdoidal suture (not certain owing to damage). The Inion is not a protruberance, but a crest 3cm long on the superior curved lines. The Toracular Herophali feels normal and suggests the S.L. sinus turns to the R and the I.L. sinus turns to the L. The basisphenoid and basioccipital synchondrosis appears to have ossified and then been broken.

3. Incorporating reports (as indicated in the text) by Mr Judson Chesterman (abbreviated to JC in the text) and Mr J S Hogg. I am very grateful to Miss Rosemary Powers and Dr D R Brothwell (abbreviated to DB) of the British Museum (Natural History) for measuring the bones and to Dr D R Brothwell for discussing the bones and the report as a whole.

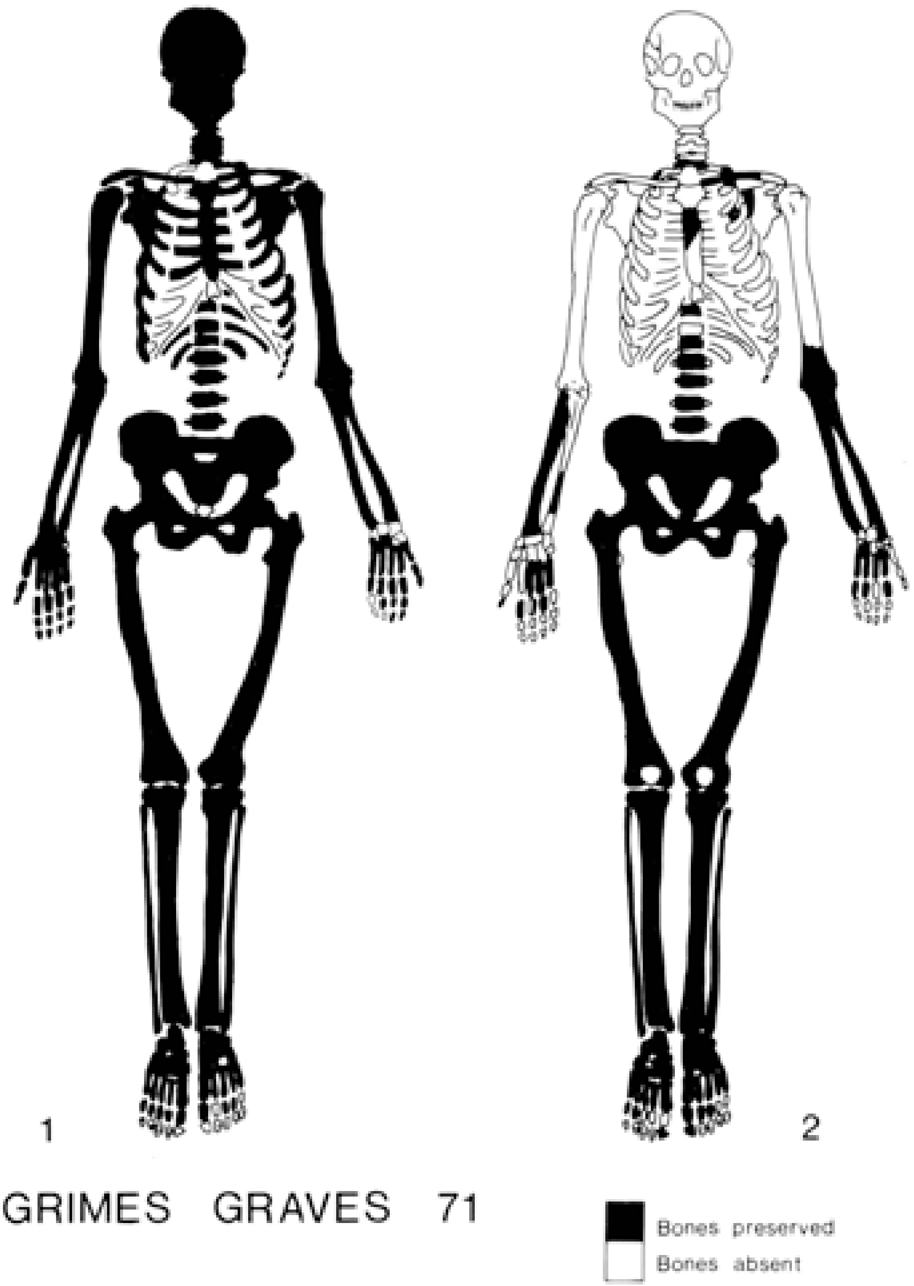


Figure 44 Inhumation burials: bone survival diagrams

Dental pathology
(symbols discussed fully in Brothwell 1963)

	R8	R7	R6	R5	R4	R3	R2	R1	L1	L2	L3	L4	L5	L6	L7	L8	
			A												X	X	
	c	c	c									c	c		A	A	
(right)	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	(left)
	8	7	6	5	4	3	2	1	1	2	3	4	5	6	7	8	
	c	c	c	c									A	c	c	c	
			A	A									X	A		A	

c—caries A—tooth with abscess at root X—tooth lost ante-mortem

The following teeth have lost the entire crown due to caries: upper R 7; lower R 5 and 6, L 6

The root of Lower R 5 shows hypercementosis. An abscess has inflamed the bone from 5 to the back of 8 (osteitis present on the outer surface of the mandible) (DB).

Mr J Hogg, a dental surgeon, points out pericoronitis in the area of upper L 7 and 8. Due possibly to food impaction, an abscess formed on 7 and spread to 8, involving the bone around 8, the gap between 8 and the alveolus being caused by pus tracking out.

Skeleton 2

The pelvic girdle and legs are complete except for the patellae and some phalanges. The following bones of the upper part of the body are present: skull: part of the occipital; fragments of maxillae; fragments of temporal, parietal and sphenoid bones. One lateral upper incisor tooth. Mandible: Two fragments, including one head. One pre-molar tooth. Vertebrae: one cervical (3–6); parts of four thoracic; five lumbar. Upper part of sternum; parts of clavicles and of L scapula. Distal end of L humerus; L radius and ulna; L scaphoid, hamate and pisiform; four metacarpals and three proximal phalanges. R radius; part of shaft of R ulna; three metacarpals, three proximal phalanges (possibly 2nd, 4th and 5th) and 1st distal.

Sex Female. Diagnosed from anatomical features of pelvis and sacrum, which were well-preserved, with a well-defined sulcus. The bones in general were smaller and lighter than those of Skeleton 1.

Age at death 20–25 years suggested by wear on teeth and by non-fusion of sacrum 1 and 2. No signs of fusion on sutures of occipital bones. M 8 was possibly not erupted.

Stature Approximately 150cm.

General pathology

Both tibiae show posterior ridging of the medial malleolus. On the L fibula is a bony outgrowth at the base of the head. Some osteoporosis is present.

Table VIII. Measurement of post-cranial bones (in mm)

	Skeleton 1		*Skeleton 2*	
	L	R	L	R
Humerus	302	312		
max. br.	21	22		
min. br.	16	18		
Radius	240	236	220	
Ulna		(253)	241	
Femur				
max.	444	440	382	384
'standing'	442	439	382	382.5
troch.	429	425	371	365
a/p br.	28	26	24	22.4
lat. br.	35	34	32	30.5
d'm head	43	43	42	42.3
Tibia	361	364	319	319
a/p	35.8	36.2	30	30.5
lat. br.	23.6	24.4	21	21
Fibula	353	348.5	305	306

A human skull fragment found in the top of the 1972 shaft (see Figure 21) has been identified as part of the skull (occipital) of a child of about 12 years of age. It was not possible to ascertain the sex.

Chapter V
The Agricultural Economy
by A J Legge

During the excavations at Grimes Graves, animal bones and seeds were recovered in sufficient quantity to reconstruct some aspects of the agricultural economy at the site. To avoid sampling bias from the areas excavated, the animal bones were recovered with the use of a sieve of 1cm mesh, and carbonised seeds by the use of the froth flotation technique (Jarman, Legge and Charles 1972). In addition to the analysis of these materials, the soil types within 3km of the site are described in relation to their likely agricultural potential at the time of settlement, and the food values represented by the midden debris are calculated in order to predict the population size.

1. Animal Bone

The preservation of animal bones at the site is generally good, though some bones tend to be brittle, especially where buried in chalk rubble. Consequently the fragmentation of the bone is partly due to the conditions of burial and not only to the activities of the prehistoric inhabitants of the site. The identifications of bones given below, and their percentages, are therefore based upon the articulations of limb bones, and jaws.

The numerical data derived from the identification of bones are expressed according to the following excavation units:

Table IX.

Stratigraphic designation	*Date*
1971 Shaft fill: layer I	Topsoil
1971 Shaft fill: layer IA	Iron Age
1971 Shaft fill: layer IB	Middle Bronze Age
1971 Shaft fill: chalk rubble	Late Neolithic/Middle Bronze Age
Base of 1971 shaft	Late Neolithic
Trenches IA, IB, 7A, 7B	Late Neolithic/Middle Bronze Age
1972 Shaft: excavated in three main units as Groups 1, 2, 3	Middle Bronze Age
Upper levels, Trenches 9, 10, 11, 12	'Post' Middle Bronze Age

The results of the faunal analysis, and the percentages of particular species, are based upon these data. Calculations are also made on a combination of the fauna from all Middle Bronze Age deposits.

The animals represented and percentages

The species identified are cattle, pig, sheep, goat, dog, horse, red deer and roe deer. Different methods of calculating the percentages of each give rather different answers, though without changing the apparent emphasis within the animal economy. For example, the excavation unit designated as midden layer Group 1 in the 1972 shaft contains the limb bones which represent about 12 cattle, while the mandibles of that species from the same layer could not represent less than 22 animals. Percentages within the fauna are therefore calculated in a number of different ways: –

Table X.

1. Late Neolithic—Old land surfaces below mining dumps, percentages of identified bones and jaws

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep/ Goat*	
2.3	4.7	2.3	9.3	54.7	26.7	Sample = 86

2. Middle Bronze Age—midden deposits only, percentage of identified bones and jaws

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep/ Goat*	
1.1	4.5	1.6	4.0	62.8	26.0	Sample = 1,284

3. Minimum Nos. individuals from jaws only; Middle Bronze Age Midden deposits. Percentages in parenthesis

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep/ Goat*	
1	6	2	1	64	39	
(0.9%)	(5.3%)	(1.8%)	(0.9%)	(56.5%)	(34.5%)	No. of individuals = 113

4. Minimum Nos. individuals from Post-Cranial bones: Middle Bronze Age Midden deposits. Percentages in parenthesis

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep/ Goat*	
4	7	3	5	30	17	
(6.0%)	(10.6%)	(4.6%)	(7.6%)	(45.5%)	(25.7%)	No. of individuals = 66

The total identified sample on which the analysis is based consists of 1,447 bones and jaws; loose teeth are not included in the totals, as these need represent no more than teeth lost from the identified jaws with partially complete tooth rows. Most of the material is derived from the Middle Bronze Age midden (1,284 identified bones and jaws) with a small sample from the Late Neolithic old land surface which is sealed below the spoil heaps associated with the sinking of the flint mine shafts (86 identified bones and jaws). A further 77 bones come from archaeological contexts which are superficial, and therefore undated or disturbed. The calculations derived from the Middle Bronze Age midden (columns 2, 3 and 4 above) each indicate a fauna largely dominated by cattle and sheep or goat. As noted above, the three methods of calculation give rather different answers. This can be explained in terms of the representation of the less common animals, especially horse, roe deer and red deer, where the percentages show that these animals are less well represented by jaws, and more by limb bones, while for cattle and sheep, which make together some three-quarters of the fauna, jaws represent a greater number of individuals than do the post-cranial bones. Pigs are about equally represented by mandibles and post-cranial bones. The numbers of animals indicated are shown in Table XI.

Table XI.

Mandibles: given as numbers of right and left mandibles

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep*
loose teeth only	6R 5L	1R 2L	0R 1L	63R 64L	29R 39L

Post-Cranial bones (minimum number of individuals)

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep*
4	7	3	5	30	17

The under-representation of horse, and red and roe deer by the mandibles is clear from the above figures. It seems likely, at least in the case of the deer, that the heads may have been often discarded at the point of killing, away from the midden, while the abundance of jaws from cattle and sheep does argue that killing took place close to the midden so that the less valued parts of the animals (mainly heads and feet) were being discarded fairly directly. The position of the horse is less clear. It is often assumed that the occurrence of the horse in the Bronze Age is in itself an indication of domestication; on the other hand, the absence of tooth rows places the horse rather closer, in its bone representation, to the deer, and it may have been a hunted animal. Certainly domestic horses readily reverted to a wild state in Australia and America, and their occurrence at Grimes Graves in feral herds cannot be overlooked. The figures given above suggest a fauna composed of: –

Horse	*Pig*	*Roe Deer*	*Red Deer*	*Cattle*	*Sheep/ Goat*	
4	7	3	5	64	39	
(3.3%)	(5.7%)	(2.5%)	(4.1%)	(52.5%)	(31.9%)	= 122 individuals

However, each method of calculation gives broadly similar percentages, and the importance of cattle and ovicaprines is confirmed within the animal economy.

The species represented and their body size

All measurements given are in millimeters, to 0.1mm. Smaller bones were measured with the use of vernier callipers; larger bones with a bone measuring board. The measurement points that were utilised on the individual bones are illustrated in Figure 58.

Horse: Equus caballus

The horse is represented by isolated teeth or limb bones in all the excavated units with the exception of the main rubble infill of the 1971 shaft and the galleries. The total number of horse bones is only 21, plus 14 loose teeth. Grigson (1966) provides a detailed list of finds of horse bones from Neolithic sites, and regards the presence of that animal as 'virtually certain' during that period. From this, there is no reason to doubt the presence of horse in the Middle Bronze Age at Grimes Graves as a contemporary part of the fauna. Harcourt (in Wainwright and Longworth 1971) identified horse from the Neolithic site of Durrington Walls (the second such identification from that site; see Stone et al. 1954) and considers them to be wild. Harcourt also suggests that the horses at Durrington Walls were larger (2 specimens) than those from 'Last Glaciation' sites in Britain; however, a comparison of the small number of measurements available from the sites in question suggests that the horses from the late Glacial site of Flixton 2 (Moore 1954) are rather larger than those from Durrington. A single specimen from Durrington Walls (1st phalanx) equals the largest Flixton specimen in length, and this may indicate that Neolithic horses were already highly variable in stature; the alternative possibility, of sexual dimorphism, must always be remembered when comparing the size of animals between sites, especially when the available bones are few.

Table XII. Horse bones—Grimes Graves

	Length	*W. Prox. Epiphysis*	*W. Dist. Articulation*	*Date*
Humerus	259.0	—	73.4	Middle Bronze
Metacarpal	—	46.4	—	Middle Bronze
	227.2	44.2	—	Middle Bronze
	—	—	43.8	Middle Bronze
Metatarsal	249.2	41.7	36.3	Middle Bronze
	244.4	41.0	40.4	Middle Bronze
Tibia	319.0	77.0	—	Middle Bronze
*Flixton site 2**				
Metacarpal	212	48	55	Late Glacial
Metatarsal	265	54	55	Late Glacial
	258	49	50	Late Glacial
Tibia	—	80	—	Late Glacial
	345	75	94	Late Glacial

*Flixton measurements given to nearest mm.

Comparison of samples of this size cannot be expected to indicate much about the horse populations at the sites in question, especially as impressions vary with the particular bone considered. For example, the intact Grimes Graves metacarpal is longer than that from Flixton, while the metatarsals from Flixton are longer than those from Grimes Graves, as is the tibia. However, the horses from Flixton appear to be much more robustly built, as the width measurements mostly exceed those from Grimes Graves. Comparison with Durrington can only be oblique, as the same bones of the body are not available for comparison from each site. In general, the Grimes Graves horses appear to be rather larger than those from Durrington, and, for a Bronze Age context, the presence of a domestic population is usually accepted. Arguments for or against domestication of the horse on the basis of body size are unlikely to resolve the question. Bone samples are usually small as a proportion of a site fauna, and the horse is an animal which has shown perhaps the highest degree of variability under domestication, along with the dog. At present, data are not available that can resolve the question of the status of the Grimes Graves horses.

Pig: Sus scrofa

The pig is present in all the excavation units, but again at a low frequency. The animals concerned are mostly juvenile, showing unerupted molars and unfused epiphyses from the limb bones. Few adult specimens were present that could be measured; the dimensions fall at the very lowest end of the size ranges given by Harcourt (in Wainwright and Longworth 1971) for the Neolithic pigs from Durrington

Walls. The small size of the animals leaves little doubt that the animals represented were drawn from a domestic herd.

The articulated skeleton of a pig was found in the shaft fill, at a depth of some 6m below the modern land surface. The skeleton rested at a point where the shaft was filled with chalk blocks, presumably representing a time of rapid filling. It is doubtful that the animal was alive when it fell, or was placed, into the shaft. Much of the bone shows recent breaks, indicating that the skeleton was damaged in excavation. Skull fragments, vertebrae, limbs and ribs are represented, but while the ribs are from both the right and left sides of the body, only right side limb bones appear to be present. It is possible that the animal was thrown into the shaft when already partly disarticulated.

The animal was almost adult, with upper and lower third molars in the first stage of wear on cusps 1 and 2, with cusp 3 unworn. Upper and lower second molars were heavily worn. The distal ends of the tibia, humerus, femur and metatarsals III and IV were unfused, or in early stages of fusion. The proximal ends of the scapula, femur and a first phalange were fused. Twenty cervical, thoracic and lumbar vertebrae had unfused epiphyses.

Roe Deer: Capreolus capreolus

The roe deer is represented by four mandibles and one maxilla, 22 limb bones and three antlers. All come from the Middle Bronze Age midden deposits. In view of the suitability of this area for the roe deer now, the low values for this animal might indicate rather more open conditions in the past. The large numbers of roe deer now living in the Grimes Graves area are favoured by the existence of thick woodland cover due to commercial forestry work. The antlers from the site had not been utilised, although those recovered by Armstrong (1932) in a similar archaeological context had been worked to chisel-like points on the tines.

Red Deer: Cervus elaphus

Red deer are present in all the Middle Bronze Age levels, but with only one maxilla fragment, three isolated teeth and 69 limb bones. It should be noted that these figures do not include the large numbers of Neolithic mining tools made mainly from shed red deer antler, which are separately described below. Modern red deer in the Thetford region attain a large size, as did those from the Bronze Age.

Cattle: Bos taurus

Cattle from the Middle Bronze Age midden are the most numerous animal by each method of calculating species representation, and probably were about 52% of the fauna. It may be noted that the percentages obtained from the post-cranial bones (column 4, Table X above) under-represents the cattle in relation to the less common animals. The species is represented by 898 post-cranial bones, 321 upper and lower jaws, and 253 isolated teeth. This assemblage contrasts with those found from other archaeological sites, in having the cranial bones so well represented. Even if the isolated teeth are ignored, the total samples of bones, at 1,219, is composed of about 26% complete or fragmentary upper and lower jaws. The problems associated with the differential preservation of animal bones in archaeological sites have been relatively little studied. The assemblage from Grimes Graves indicates that the cattle were killed close to the point where the bones were discarded, with the fragmentary crania thrown directly into the midden deposits. As Table XIII shows, the number of right and left lower jaws show a striking agreement in number, especially for cattle and the sheep/goat. On the other hand, the post-cranial bones are more variable in number, and often appear to indicate quite different numbers of animals according to the particular bone considered. As described above, the post-cranial bones show smaller totals of animals than do the jaws, although in similar proportions. It seems likely that the limb bones were scattered more widely following cooking; the assemblage also contains fewer juvenile bones than would be expected from the representation of age classes by the jaws. Most of the juvenile post-cranial bone, from all species, appears to have been consumed by dogs. It is therefore evident that the bones of juvenile cattle have been less well preserved, which has further contributed to a higher proportion of cranial bones in the total assemblage.

As is usual with archaeological material, the bones are fragmented to a degree that limits the range of measurements that can be taken. However, sufficient data are available to make some comment on the size range of the cattle, and, more usefully, on the selection of sexes in herd composition and in slaughter. Among the cattle bones, the metapodials and distal humerus are sufficiently common to allow comparison with other populations from earlier and later periods. The dimensions show the cattle to be intermediate in size between Neolithic and Iron Age cattle from Southern Britain.

Figure 45 shows the cattle bones from the Middle Bronze Age at Grimes Graves compared with those from the Neolithic sites of Windmill Hill (Grigson 1966) and Durrington Walls (Harcourt in Wainwright and Longworth 1971) and an Iron Age sample from the site of Aldwick, at Barley in Hertfordshire (Cra'ster 1961). In the scatter diagram, none of the Grimes Graves cattle fall near to the larger size of Neolithic and earlier *Bos*, and only the smaller Grimes Graves cattle fall within the small size of the Iron Age population. This indicates that the reduction in size seen in cattle from the Neolithic period was comparatively rapid, and occurred mostly during the late Neolithic and Early Bronze Age. Figures 46 and 47 show the distal metacarpal and metatarsal dimensions. Each of these diagrams shows two distinct groups of animals of different size. These diagrams are based upon the fused (adult) distal articulation, on the measurement of distal thickness plotted against distal width. Each of these sets of dimensions offers a reasonable discrimination between the sexes represented in the slaughter. This has been established by Higham (1967) and Higham and Message (1969), and can be widely observed in other species of Bovidae and Cervidae. It must be noted that the observation of sexual dimorphism in animals such as cattle, sheep and deer renders the comparisons of body size between prehistoric populations open to misinterpretation, as the actual size observed will, to a considerable degree, be a reflection of the numbers of males and females in the assemblage measured. This will be especially so where only mean dimensions are given. In the light of data shown, the two groups observed within the population are interpreted here as representing the two sexes rather than two different breeds. The most significant point that emerges is the representation of a greater number of adult female animals in the cull. The significance of this is discussed in detail below. In the diagram of metacarpal dimensions (Figure 46) a single individual stands between the two groups. Howard (1963) sexed cattle metapodia on the basis of length against distal width, and suggested that intermedial animals would represent castrates, a suggestion also explored by Higham and Message (1969). From this work, it seems likely that this animal was castrated, and may have been retained as a working steer.

Table XIII. Grimes Graves—Representation of species by upper and lower jaws

Excavated		Dog		Horse		Pig		Roe Deer		Red Deer		Cattle		Sheep–Goat	
Unit		right	left	right	left	right	left	right	left	right	left	right	left	right	left
1971 Shaft	*upper*	—	—	—	—	—	1	—	—	—	—	1	—	—	—
Layer I	*lower*	—	1	+	—	—	—	—	—	—	—	1	1	—	—
1971 Shaft	*upper*	+	—	—	—	—	—	—	—	—	+	—	1	—	—
Layer IA	*lower*	—	—	—	—	1	—	—	—	—	—	3	1	1	1
1971 Shaft	*upper*	—	—	—	—	2	1	—	—	—	—	—	—	2	—
Layer IB	*lower*	—	1	—	—	—	1	1	2	+	—	7	7	2	2
Midden	*upper*	—	—	+	—	—	1	—	—	1	—	1	3	—	1
Group O	*lower*	—	—	—	—	—	4	—	—	—	—	6	6	—	3
Midden	*upper*	—	—	—	—	2	1	—	1	—	—	15	17	6	4
Group I	*lower*	—	—	—	—	2	1	—	—	—	—	19	22	17	15
Midden	*upper*	—	—	+	—	—	—	—	—	—	+	4	—	2	—
Group II	*lower*	—	—	—	—	1	—	—	—	—	—	8	3	2	2
Midden	*upper*	—	—	—	+	1	1	—	—	—	—	11	5	2	—
Group III	*lower*	—	—	—	—	3	—	—	—	—	—	15	16	4	14
Midden	*upper*	—	—	+	—	—	—	1	—	—	—	3	3	4	1
Group I/III (mixed)	*lower*	—	—	—	—	—	—	—	—	—	—	8	10	4	3
Totals		—	2	?	?	12	11	2	3	1	+	102	95	46	46
Maxilla Totals		+	—	+	+	5	5	1	1	1	+	35	29	16	6
Mandible Totals		—	2	+	+	7	6	1	2	+	—	67	66	30	40

+ = isolated teeth only

Sheep and Goat: Ovis aries and Capra hircus

These two species are represented by 367 post-cranial bones, and 92 upper and lower jaws. Horn core and skull fragments show that both sheep and goat are present in the collection, but the use of identification criteria published by Boessnek (1969) and Boessnek *et al* (1964) shows that the majority of the animals in this group are sheep. No exact proportions can be given, as the metrical distinction proposed by Payne (1969) can be applied to only five metacarpals and three metatarsals. The scarcity of this bone is probably due to its frequent selection for the manufacture of bone tools at this site. The collections made by Armstrong (1932) in excavating similar deposits, and now housed in the British Museum, show a similar selection. Of all the sheep/goat bones from the site, the goat is certainly represented by only a single horn core. This had been removed from the skull by cutting at its base and snapping, and is very narrow, curving in a single plane with no indication of twisting. It measures 280.0mm along its anterior keel, and 64.2mm × 34.7mm at the base. One goat horn core from Armstrong's excavation, and one from a collection of Middle Bronze Age material from the Mildenhall region, housed in the Museum of Archaeology and Ethnography at Cambridge, are of very similar form. From the observed and measured attributes of the Grimes Graves ovicaprines, it is likely that almost all were sheep. Most of the bones are very fragmentary, with the consequence that available measurements are few. Those available suggest an animal of small stature, similar to the known sheep of the British Iron Age, or to the surviving small Soay sheep of the island of St. Kilda in Scotland.

A partly articulated skeleton of a young sheep was found in the upper part of the midden. All the limb bones were unfused; the deciduous teeth showed light wear, and with the first permanent molar half erupted, and unworn.

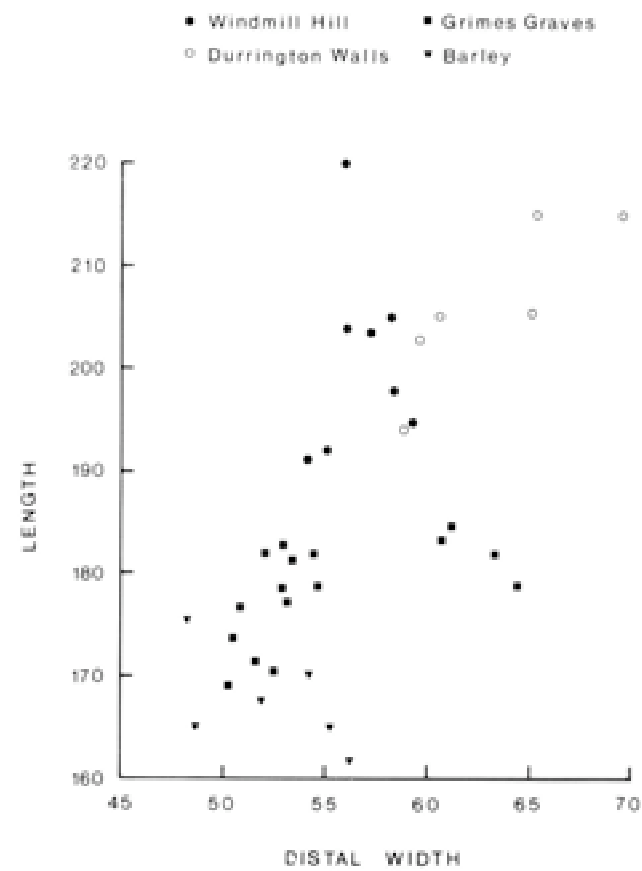
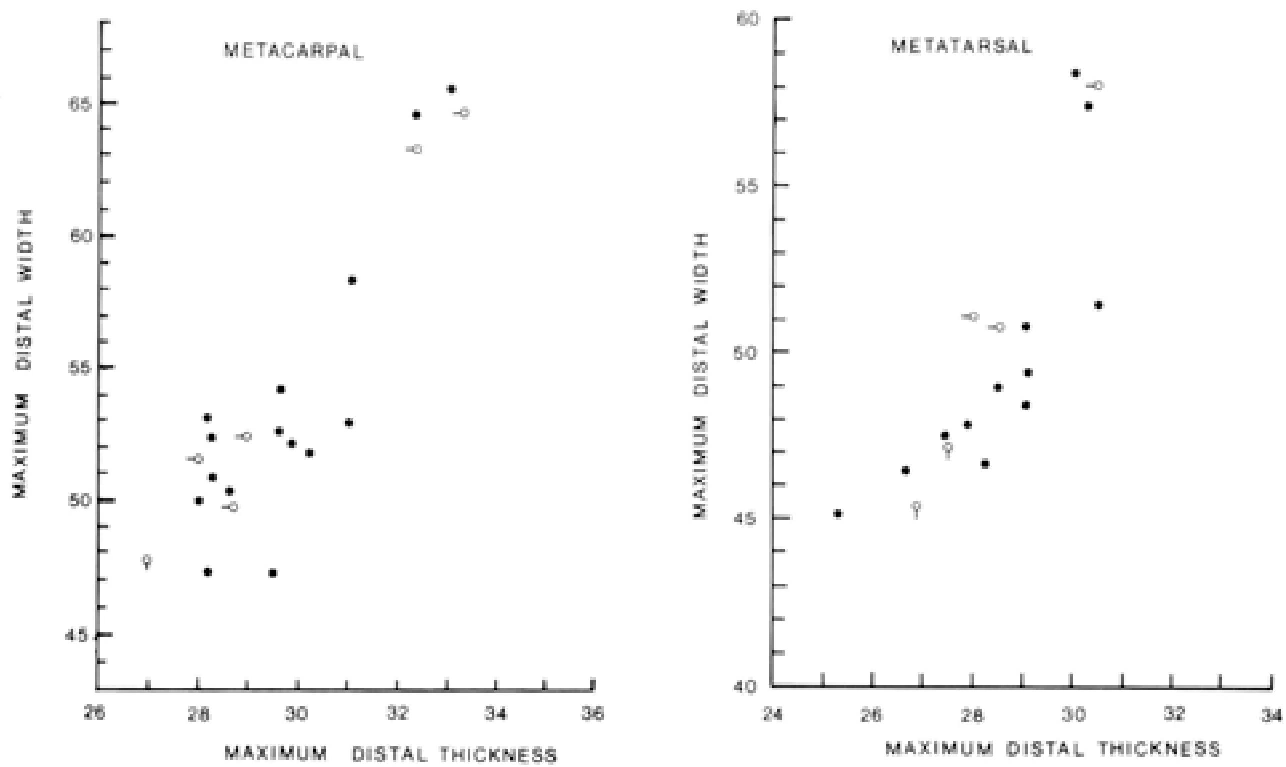


Figure 45 Scatter diagram of metacarpal dimensions for cattle from four prehistoric sites in Britain. Windmill Hill and Durrington Walls are samples from the Neolithic period, Grimes Graves is of Middle Bronze Age date, and Barley is Iron Age. The Grimes Graves sample shows considerable sexual dimorphism, and more numerous adult females in the cull.



Figures 46 and 47 Scatter diagrams of metapodial measurements (in mm) for cattle from the Middle Bronze Age midden. The open circles show specimens in which one measurement is estimated. The known measurement is indicated by the small lines. Each shows two groups of animals differing in size. The more numerous group of smaller size are regarded as females; the larger metapodia on each diagram are regarded as males. See also Figure 45.

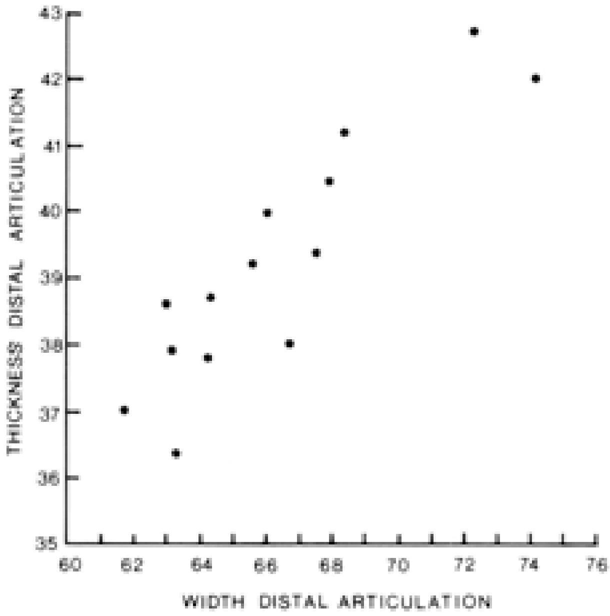


Figure 48 Scatter diagram of distal humerus measurements of cattle from Middle Bronze Age midden. A similar grouping is shown in Figures 46 and 47; the more numerous group of smaller size are regarded as female animals. Although the samples are small, an internal consistency is shown across a range of bones.

The Dog: Canis familiaris

The dog is represented by a single mandible in layer I of the upper shaft fill (Middle Bronze Age or Iron Age) and by three limb bones and a mandible from layer IB of the upper shaft fill. This latter context is regarded as Middle Bronze Age in date though possibly derived. Dog bones do not occur in the Middle Bronze Age midden, although gnawed bones indicate their presence. The few bones are all from adult dogs, and both mandibles are of the size represented by Neolithic dogs from Durrington Walls (Harcourt in Wainwright and Longworth 1971) and Windmill Hill (Grigson 1966). As the provenance of the Grimes Graves dogs is not certain, their bones are not included in the Middle Bronze Age faunal totals.

The Smaller Vertebrates

It is perhaps remarkable that the faunal assemblage at Grimes Graves contains few small mammals or birds, in spite of the use of dry sieving and some sampling with finer meshes and water sieving. Most of the smaller animals found are from relatively superficial deposits, and appear to be of recent origin. The species found were:

Oryctolagus cuniculus—The Rabbit

This was the most common small mammal. Most of the bones are from the upper layer in each trench, though occasionally from sand lenses sealed below old chalk mining dumps. All of the contexts in which rabbit bones were found are within the burrowing capacity of this animal. None therefore need be older than the very recent past.

Talpa europaea—The Mole

Mole bones were found at three separate places, though again all quite superficial. A skull and right and left humeri were identified.

Microtus agrestris—The Field Vole

This species was represented by a small cache of bones (layer 2, Trench IB East) that comprised four right and four left mandibles, two maxilla fragments and some limb bones. This probably represents the burrow of a small carnivore, such as a stoat or weasel. The context is probably recent.

Arvicola terrestris—The Water Vole

Two right mandibles and a right and left maxilla of this species are more darkly stained; they may be again from a predator's burrow, and quite recent.

Vulpes vulpes—The Red Fox

A single third left metatarsal, from the midden deposits, is from an early context.

Anas sp—The Duck Family

Two humeri of a small species of *Anas* probably represent food, and are also from the midden levels.

2. Evidence for permanent occupation

At the majority of archaeological sites the alternative of permanent or seasonal occupation is seldom considered, especially where the economic basis of the community includes domestic animals and plants. However, such investigations may have a profound effect upon the archaeological interpretations made about the site in question. The test for permanence of occupation at sites may be difficult and depends upon the nature of the surviving organic materials in many cases. The antlers of deer, which are subject to seasonal growth and shedding, have been used to indicate occupation in the winter at the site of Star Carr (Clark 1954), a suggestion that is supported by other archaeological indications. Tooth eruption sequences have also been used in this way, to argue for seasonal or permanent occupation at particular sites. However, such data needs to be used with caution, and depends upon a number of assumptions that have often not been clearly stated. Indeed, some such data can be more readily interpreted to show the opposite to the published conclusions; some of the suggestions of permanent (year-round) occupation from Middle and Upper Palaeolithic caves in France lack conviction (Bouchud 1966; see also Binford 1973 for a reconsideration of Bouchud's view). The use of a tooth eruption sequence for this purpose in archaeological data requires the following conditions:–

1. A marked season of birth in the species under consideration, and with a strong probability that most animals surviving come from a single birth season.
2. A constant for growth conditions in the young animals; this might, for example, be disturbed by different husbandry practices being applied to sections of the juvenile population.
3. The animals should represent a food supply that is likely to be utilised throughout the year, and is not only seasonably available. In such a case the consumption of an animal species in one season might represent no more than the passage of that animal through the territory of a human group, and may not be related to the mobility of that group.

The area around Grimes Graves now shows some limitations in agricultural potential, and it seemed possible that, were this also true for the Bronze Age, a pastoral or herding economy with a degree of mobility might be predicted. Such suggestions are popular in the literature concerning British Neolithic and Bronze Age animal economies, though not yet demonstrated from any site data. This view may well be true for certain parts of Britain in prehistory, but seems to be more a reflection of a better knowledge of standing monuments than of settlement sites, which are comparatively scarce in the archaeological record for these periods.

Ewbank (1964) used the tooth eruption sequence for the sheep mandibles from the site of Barley to argue against the familiar hypothesis of 'autumn slaughter', where the suggestion has been made that difficulties in providing winter feed for stock would be reflected in peaks of autumn killing. Such a pattern of flock management might be expected to show a peak of slaughter at the 18—21 month age, as the young animals were entering their second winter. Neither Ewbank's study of the sheep at Barley, nor Higham's work (1967 and 1968) on European cattle husbandry is argued as showing a high rate of killing at one season.

The tooth eruption sequence used in calculating the slaughter pattern in sheep at Grimes Graves is based upon the work of Ewbank (1964) concerned with the Iron Age site at Barley, near Royston, so that both samples may be directly compared. Hafez (1968) has shown the degree to which latitude, and consequently different day lengths, modifies the oestrus cycle of sheep. Among his data is the Suffolk sheep breed from a Cambridgeshire flock which is shown to have a markedly seasonal oestrus cycle in the late autumn and early winter, and that the lambing rate is significantly higher from October matings than those of an earlier or later time. Ewbank *et al* (Ewbank 1964) assumed a February/March lambing season which corresponds to the data given above. It must be remembered, however, that not all young animals erupt their teeth and grow at the same rate, and, by the age of one year, a group of lambs might show a variance of several weeks in their dental ages, even if of the same calendar age. If the variance in birth date is added to this, it is evident that an even larger degree of variability in dental age will be encountered. It is clear that the graphs presented need to be interpreted with caution; for example, a site occupied for only a few months in the spring and autumn might be expected to show an indication of human presence throughout the year. However, in such a case a histogram of the tooth eruption stages observed would show peaks corresponding to the season of occupation, with troughs representing periods of absence.

The slaughter pattern from the two sites is shown in Figure 49 and again in the form of a histogram in Figure 50. For the latter diagram, the animals are grouped in 3-month age classes, which broadly correspond to the seasons of the north European year. Both the graph and the histogram show that the Grimes Graves and Barley sheep were managed in different ways; the Barley animals were showing a high rate of slaughter during the first year of life, while those at Grimes Graves were killed mainly during the second year. The economic implications of this are discussed below, but both methods of representing the pattern of slaughter at each site give no indication that the settlement was seasonal. However, it must be remembered that such data cannot show short periods of absence, even if these are quite frequent, although the indications of an arable economy which are also present at Grimes Graves makes such a pattern of occupation less likely.

The test for seasonal or permanent occupation at the mining site might be thought relevant to our understanding of the nature of the flint mining activity. This point has been noted in earlier discussion of this site. Greenwell (1871) considered the possibility of full-time miners who bartered flint for foodstuffs, and Clark (1952) observed that the problem might be resolved if '. . . a sufficiently large body of organic fossils were collected and studied from this point of view.' However attractive this prospect may be, it is not a problem that can be resolved in this study. Indeed, Armstrong (1927) was quite familiar with the Bronze Age deposits at Grimes Graves, and observed that these deposits have '. . . no bearing whatever upon the age of the mines'; equally, the apparently permanent occupation shown by the tooth eruption data has little bearing on the way in which the mines were worked in an earlier time.

3. Animal Husbandry

The cattle form the largest group of animal remains from the Middle Bronze Age midden, and an analysis of the slaughter pattern and the metrical distinction between the sexes offers the possibility of understanding their position in the food-producing economy. Greenwell (1871) described his examination of similar midden deposits from which the fauna was identified by W Boyd Dawkins, who observed that cattle were the most common animal and that many of these were juvenile. Boyd Dawkins' observation led Greenwell to suggest that a milk-producing economy might be reflected in the midden deposits. The present analysis confirms, in rather more detail, Greenwell's inference and it is argued here that an important emphasis in the economy was on dairying. Both earlier and more recent work confirms that this aspect of the economy is common to a number of the midden deposits; Manning in 1866 (see Clarke 1915, 13–14) observed 'numerous bones of oxen' and noted that most were young, and the recent excavations conducted by the British Museum also have a fauna (partly

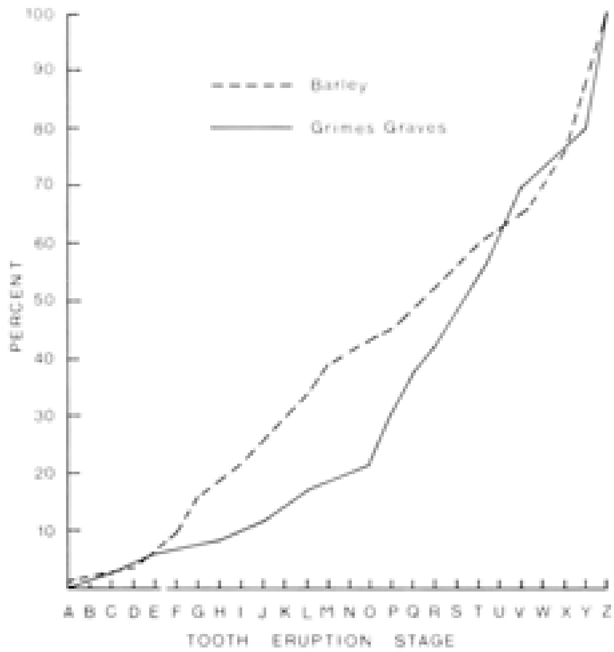


Figure 49 The slaughter pattern shown by the sheep mandibles from Grimes Graves compared with the Iron Age site of Aldwick, Barley (Ewbank et al 1964). Neither site shows the culling rate to rise in steps, which would indicate a seasonal occupation, or slaughter.

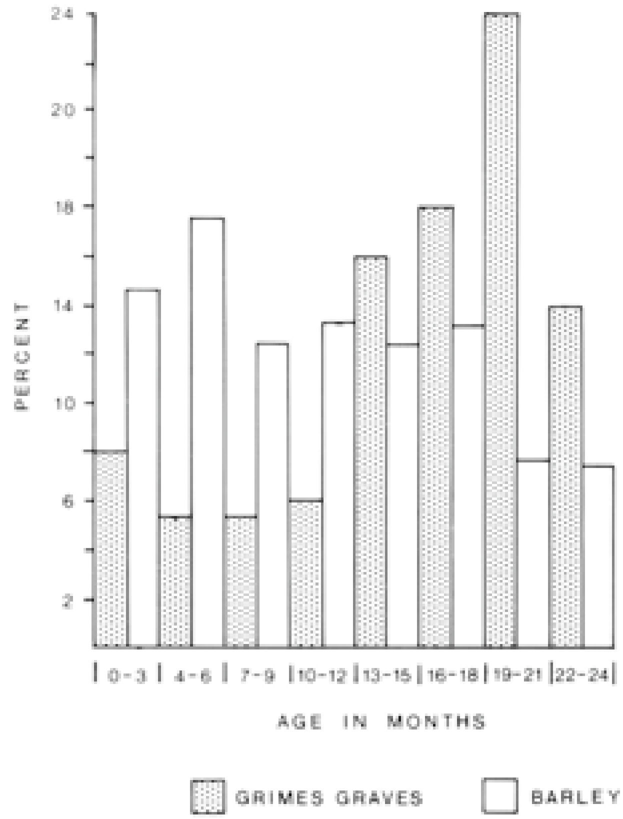


Figure 50 Slaughter pattern in sheep from two sites, as an indication of year-round occupation. The three month age classes are approximate, but neither site shows the low frequencies at one season that would be associated with a seasonal occupation. Grimes Graves shows a concentration on yearling sheep, while those at Barley are killed more equally during their first and second years of life.

examined by the writer) containing mostly cattle, with a high proportion of juveniles.

As noted above, the midden contains a large number of intact, and partially intact, cattle mandibles, and these were analysed according to the system used by Higham (1967) in his study of European cattle husbandry. This system employs 23 stages beginning with the unerupted deciduous teeth of the neonatal calf and extending to full wear on both premolars and molars of the adult dentition.

The pattern of slaughter at Grimes Graves is shown in Figure 51. From this it emerges that half the cattle in the assemblage were killed by stage five, which represents about 6 months of age. Needless to say, this would represent a remarkable waste of food in an economy based upon the production of meat, yet it is unlikely that this represents other than a deliberate pattern of killing decided by the husbandman. The nature of the slaughter pattern can be better understood in relation to modern and historic patterns of cattle management in dairy husbandry. The particular advantages of the dairy economy, and the conditions under which it is managed, are related more to the physiology of the cow than to the level of technology of the society which exploits it. Cows do, after all, produce milk for their calves, and not for man; in exploiting this particular food man competes directly with the needs of the calf. In modern dairy husbandry this conflict is avoided by the early transfer of the calf to a substitute food which is usually a prepared commercial brand, or, as in the prehistoric economy, by killing the calf. The production of calves is, of course, an essential precursor to the establishment of lactation in the cow as this is initiated only by the period of gestation and the birth of the calf. In modern specialised dairy economics the calf seldom remains more than 48 hours with its mother which is again mated at about 10 weeks after the birth of the calf, so that another period of gestation begins. This pattern is regarded as ideal in modern husbandry (M.A.F.F. 1971) and results in the birth of one calf each year to each cow in the dairy herd. It is clear that the number of calves produced each year is greatly in excess of the need to maintain herd numbers by the replacement of old animals, especially with regard to the male calves. In modern British agriculture much of the beef produced is from these surplus animals, and the high cost of such meat is a reflection of the high cost of its production, largely due to the cost of the fossil energy used in intensive husbandry systems. Even so, large numbers of calves produced in this way are not raised beyond an early age, in spite of government intervention in an attempt to maintain meat supplies. It is apparent that the harsh facts of Bronze Age economics are no less relevant now.

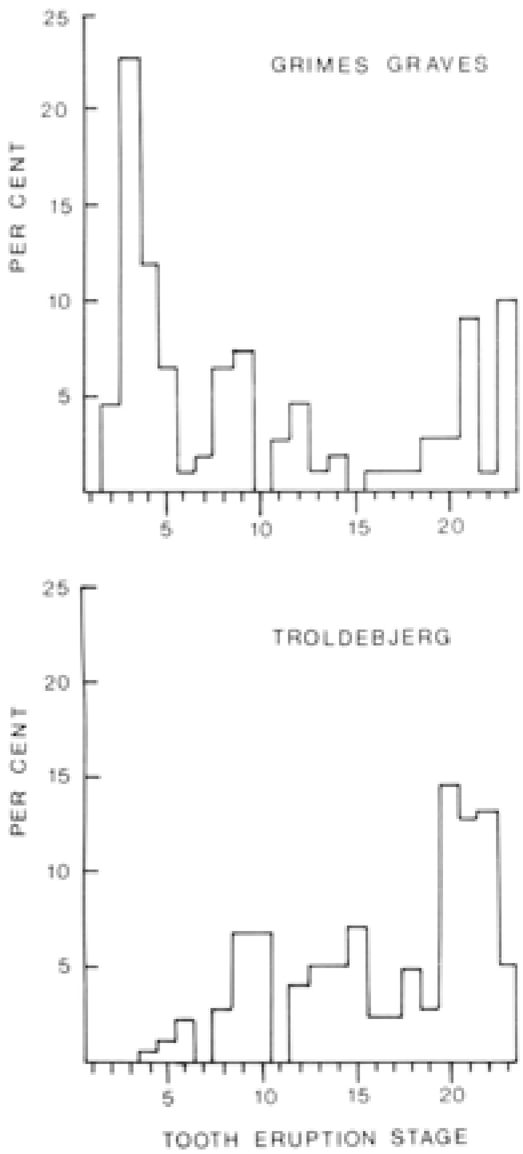


Figure 51 Slaughter pattern for cattle from the site of Grimes Graves, compared with the site of Troldebjerg (Danish Neolithic; Higham 1967). Each column shows the percent of animals killed at each stage of tooth eruption. Both faunas were analysed by the same method (Higham op cit); note the high mortality in juveniles at Grimes Graves, and the reverse at Troldebjerg.

It may be felt that the modern practices are a reflection of modern technology and that the earlier systems could not attain equal efficiency. While this must be true to a certain extent, it is of interest, and some relevance, to compare this pattern with earlier written instructions in animal husbandry. An early instruction manual was published by Fitzherbert (1524), and includes some information on cattle husbandry. Fitzherbert's instructions are most relevant to a mixed economy of a sixteenth century household, but includes some discussion of the dilemma faced in reconciling human demands with those of the calf. Fitzherbert wrote 'Yet it is better for the husband(man) to sell those calves than to rear them because of the cost, and also for the profit of the milk to his house, and the rather the cow shall take the bull'. It is possible to see that the system of management in the sixteenth century faced the same problems and limitations as does the system now; those of equating the calf's need for milk with those of its owner, and with the cost of calf raising. It is likely that most male calves, and all females not earmarked for herd replacements, would be culled in a dairy economy, and it must be remembered that the 'cost' of raising a calf for meat in a prehistoric economy would be that each animal grown on will consume much of the food that could support a dairy cow, and the milk or meat emphasis will be decided according to a complex set of pressures and possibilities acting on the human group.

The advice provided by Fitzherbert for the farmer of the sixteenth century in Britain is close in principle to patterns observed in recent cattle herding economies of Africa. Accounts given by a number of travellers confirm a similar pattern of culling in young animals observed in a range of societies where cattle provide, in milk, much of the human diet. Roscoe (1923A) notes that, among the Bunyoro of Uganda, 'A bull calf borne by a good cow might at times be kept in the herd, but more often they were exchanged for cow-calves or killed.' Roscoe (1923B) also describes a similar motivation among the Banyankole '. . . . their aims were to increase their numbers (the cattle) and to have as large a population as possible of cow-calves.' Rigby (1969) observed, in the Gogo herders 'Most livestock killed on ritual occasions, apart from sheep and goats, are young oxen'. Rigby (op. cit.) gives the proportions for the average herd in Tanzania as:

Uncastrated males	7.5%
Castrated males	4.0%
Adult females	54.6%
Calves less than 2 years old	33.9%

He also further notes that 'The low proportion of adult oxen (males) in the herd is indication of the rate at which they are reduced by killing.' This is, of course, self evident, as the animals of over two years of age and comprising some 66% of the herd show a ratio of almost five females to each surviving adult male. Barth (1961) observed a very similar pattern of husbandry among the Basseri nomads of Iran. Here, flocks are made up of sheep and goats, but the basic problem of reconciling herd numbers and composition and milk production leads equally to a rapid slaughter of most young males and the surplus females. Barth (op. cit.) noted a 5:1 ratio of females to males among the adult stock, and recorded that 'Most male and many female lambs and kids are slaughtered for meat' and also that 'milk and its products are the most important'. This might be compared, as an example in practice, of Payne's (1973) 'model B' for a hypothetical slaughter pattern in a milk economy with sheep and goat herds; this pattern, though predicted, is very similar to the actual pattern seen in the cattle from Grimes Graves. Faunal assemblages studied by Higham (1968 and 1969) show very similar patterns, and, I would argue, have the same economy; Egolzwil shows rather over three females to each adult male, while for the smaller collection of metapodia from Grimes Graves the ratio is some six to one. Zurich Alpenquai, on the other hand, shows more than two adult males for each adult female. Higham (1968) interpreted this high frequency of males as the retention of these animals for draught purposes within the greater area of open land available by the later Bronze Age of Switzerland; however, this interpretation is arguably less likely than the alternative view that the animals were being retained for meat production. This is especially likely in that Higham's (1968) analysis the sites of Zurich Alpenquai, Arbon Bleiche and Troldebjerg (Figure 52) show an increased rate of culling at stages 12 to 17, which represents that period in which the killing of animals for meat would be the most productive. It would appear that lactating animals gained preference at Grimes Graves, which may be related to other factors in the economy which are discussed below.

Some further support for this interpretation can be gained by reference again to the proportions of males and females represented in the cull of adult animals (Figures 46 – 48) where it is argued that most of the animals (the more numerous group of smaller size) are female. This again may be understood in relation to the demands of dairy economics, where the majority of the adult animals killed will be females in which milk yields are uneconomically low or those which have failed to establish lactation. Such animals are now regarded as immediately surplus to the herd, their places being filled by a cow grown on from the young animals and in her first lactation. The age structure and culling pattern from the herd of cattle represented in the Grimes Graves bone assemblage may be compared again with Higham's data from Troldebjerg in Denmark and sites of the Swiss Neolithic and Bronze Ages. At Troldebjerg, the killing of juvenile animals was very rare; indeed, the proportions given are lower than might be expected in natural post-natal mortality. Only 4% of the animals were killed by stage 6 of the tooth eruption sequence, and for the sites of Zurich Alpenquai (Late Bronze Age) and Arbon Bleiche (Early Bronze Age) the figures are 8.6% and 6.5% respectively. The adult metapodial bones from these sites also show a very different selection of sexes in the cull to that found at Grimes Graves, and in the Swiss Neolithic (Cortaillod) sites of Egolzwil and St Aubin. At Troldebjerg and the Swiss Bronze Age sites, the scatter of bovine metapodial bones is interpreted as showing the size grouping of two sexes. These sites show large groups of both males and females in which the two sexes are culled in equal numbers, or with the males outnumbering females. At Grimes Graves and the Swiss Neolithic sites, females greatly outnumber males, with the latter being almost absent in the adult animals.

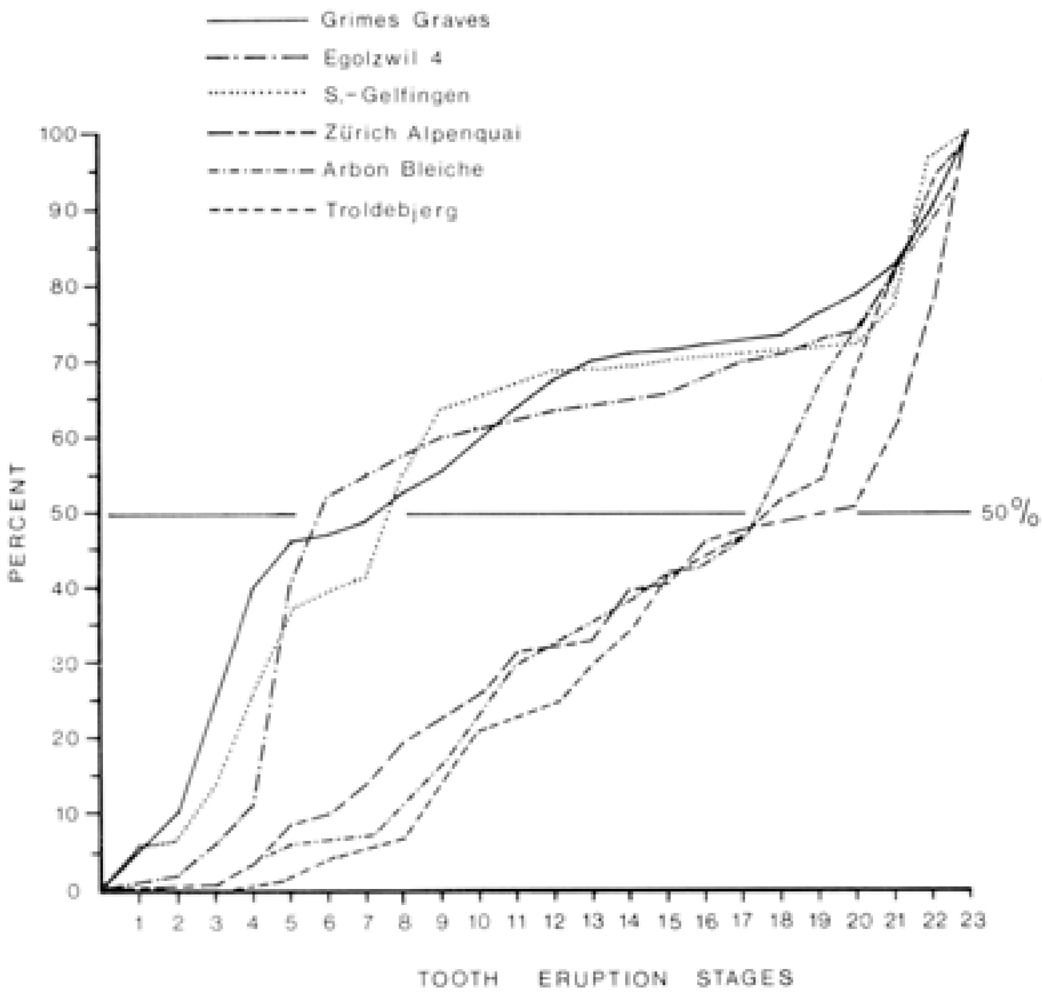


Figure 52 Slaughter patterns in cattle from five European sites compared with Grimes Graves. The clear division between the two groups of sites is interpreted as a dairying basis to the economy at those sites with a high juvenile mortality, and an emphasis on meat production in the group with a low juvenile mortality.

Table XIV.

	Grimes Graves	Egolzwil 2	St Aubin	Troldebjerg	Zurich Alpenquai
Culling	High juvenile	High juvenile	High juvenile	Few juvenile	Few juvenile
Proportion of Males/ females in adult cull	Mostly female	Mostly female	Mostly female	Equal male/ female	Males exceed females
Economic interpretation	Milk emphasis	Milk emphasis	Milk emphasis	Meat emphasis	Meat emphasis

It may be emphasised that the complimentary tests of age and sex distribution, when applied to the cattle bones from these sites show that very different patterns can be observed with the animal economies. The data are summarised in Table XIV above.

Milk production as an important food resource has often been suggested, but not demonstrated, from archaeological data, yet as an aspect of prehistoric subsistence it may have been extensive. It is obvious that any economy which includes cattle will have access to both milk and meat, but either system can only function to its greatest efficiency if developed in a specialised way. To argue that both systems run side-by-side in modern husbandry is to ignore the massive energy subsidies involved, which include manufactured substitute feeds. The efficiency of milk production compared with meat production depends not simply on energy outputs from a herd of a given size but also on the energy outputs possible from the available space. It seems very probable that in most prehistoric economies this latter consideration was vital. In modern husbandry these two animal based systems may be compared with the outputs from cereal cultivation (Holmes 1970):

Table XV. (Holmes 1970)

	Energy yield Mcal/Hectare	Protein yield Kg/Hectare
Dairy cattle	2,500	115
Beef cattle	750	27
Wheat	14,000	350

These figures give the gross yields of a common unit of land utilised under three systems of food production. The relative efficiency of milk production over that of beef is clear, as is the inefficiency of each compared with the cereal crop. It must be remembered that the prehistoric farming economy, like modern farming economies, would not be planned on the basis of a single factor, but is the response to a complex set of interacting pressures, which include soil type and fertility, climate and many other economic and social factors. Higham, in his discussion of the economies of Swiss prehistoric sites, considers the reasons for high percentage cull of juvenile animals at Egolzwil 2 and 4, Seematte-Gelfingen and St Aubin. He concludes that the economy is biased in this way by '.... sound economic reasoning', a conclusion that is not disputed here. It seems less likely, however, that the production of meat from very young cattle can be described in this way. It seems more likely that economic reasoning placed milk before growing calves at the earlier of the sites in Higham's study. In fact, in the group of sites considered by Higham that show a high juvenile mortality, the average cull is 45% by stage 6, which is to represent less than the first *six months* of the animals' lives, while in the other group of sites, mortality by this stage is less than 10%. It may be argued from this that the cattle slaughter patterns at the sites in question show grouping not through different types of meat production, but rather through profoundly different emphasis within the economy. Higham (1968), citing the work of Welten (1954), Troels-Smith (1954) and Lüdi (1954), gives an account of the changes postulated for agricultural systems in Switzerland in the Neolithic and Bronze Ages. The Neolithic farmers '.... created small cereal fields. They did not, however, create open pasture land. The early and late Bronze Age cultures, on the other hand, not only cleared an increased area of forest, but also established progressively greater area of pasture. The varying intensity of forest clearance is basic to a consideration of the seven societies under consideration, for the forest imposes serious limiting factors on the amount of stock which may be maintained.' It is also shown that, for the Neolithic settlement, 'Plants characteristic of open pasture land are rarely represented in the relevant pollen spectra' (Higham 1968), while for the Bronze Age 'The occupation phase at Arbon Bleich is marked by a decrease in arboreal pollen.... and by a marked increase in non-arboreal pollen.' This account provides a reasonable model of environmental change for an area in its early stages of agricultural colonisation, and such changes may well be related to the types of economies practised. The sites argued here to have milk based economies belong to the Swiss Neolithic (Older/Younger Cortaillod and Horgen cultures) while those with largely meat based economies are of the Bronze Age. From these data it appears that dairy husbandry was practised at those sites of the Neolithic period where pasture was of limited extent, while increased clearance in the Bronze Age is marked by a shift to meat economies.

This argument is relevant to the site of Grimes Graves. Although there are insufficient data to argue in terms of economic shifts within the British Neolithic and Bronze Ages (and hardly sufficient data to discuss economy at all), the apparent high emphasis on milk production at Grimes Graves may well be related to the rather low fertility and carrying capacities of some soils in that area, which is discussed further below. However, on the basis of these data, it is argued here that cattle husbandry can only be understood in relation to the broader aspects of the settlement economy, which will include, besides the other animal species, a consideration of the agricultural potential. As an hypothesis, I suggest that milk production may be important in the prehistoric economy where the animal husbandry potential is limited; better established systems, in more fertile areas or with more extensive pastures, may well be able to afford a greater indulgence in the more extravagant economics of beef production.

Sheep

Bearing in mind the specialised manner in which the cattle population was exploited at Grimes Graves, it may be noted that the sheep were managed in a quite different way. The data given above, in which the sheep mandibles are used to show that the site was occupied on a year-round basis, also indicate that the maximum level of slaughter was during the second year of life; in fact, only about 17% of the sheep were killed before this, but with a figure of 38% for Ewbank's Iron Age population from Barley.

By stage W, about 24 months of age, each flock shows a mortality of about 70%. It seems most likely that the sheep at Grimes Graves were being exploited for meat. Higgs (1963) and Payne (1973) show that sheep herds may contain larger numbers of old animals where wool production is important as old sheep and wethers (castrated males) produce larger fleeces. There is no evidence for this as a primary factor in the exploitation of the sheep at Grimes Graves.

There has also been speculation in the archaeological literature that sheep might have been important milk animals in prehistoric times. This is indeed likely, and it may be noted that sheep are now as important as the goat in dairying economies on a worldwide basis (Laben 1974). However, modern exploitation of sheep for milk in Europe is found mostly in the Mediterranean area, and generally in those places where the cattle potential is low. Breeds exploited for milk are also of large body size, and Mason (1969) gives weights of from 45 to 65kg. Yet the sheep from Grimes Graves are of small body size, and hardly larger than the small sheep of the Iron Age in Britain. As Fitzherbert noted in 1524 'How be it in some places they used to milk their ewes, and will cause them, that they will not take the ram at the time of the year for poverty, but go barren'. We do not know if the Bronze Age husbandry shared this view, but there is no evidence of intensive management for milk output in the flock.

From the slaughter pattern of the sheep at Grimes Graves it appears that the flock was managed in a way that was complementary to the cattle. The higher rate of cull during the second year of life reflects an effective use of the animal in meat production.

The Pig

Pigs are the least common domestic animal at Grimes Graves, apart from the few dogs. The pig forms a special part of many agricultural economies due to its rapid growth and short generation cycle, as even a pig of modest reproductive performance can produce twelve offspring in one year. The pig has a dual purpose as a supply of both meat and fat, and in peasant economies has the added advantage of a very wide dietary tolerance. The few mandibles and other fragments show that mostly young animals were killed. The species was not important in the economy, and even its normally valued fat would not be significant in a dairy economy.

4. Carbonised seeds

Carbonised seeds were recovered by the use of froth flotation (Jarman, Legge and Charles 1972) during both seasons of excavation. Samples were taken with the aim of testing each stratigraphic unit that was recognised. During 1971 sampling was mostly from the horizontal distribution of area excavation, while those taken during 1972 consisted of a sample column through the Middle Bronze Age midden deposits. The abundance of seeds in these two series of deposits show a striking variance; the earlier deposits associated with mining activity required an average of 553 litres of excavated soil to be processed for each seed recovered (two seeds per m^3), while those from the richer occupation deposits from the midden contained an average of two seeds in each processed litre of soil (2,000 seeds per m^3—see Table XVI).

Soil was taken directly as freshly excavated, and then passed through a sieve of 1cm mesh to remove stones, bones, flints and sherds as a preliminary to flotation. The volumes of processed soil given in Table XVI describe this sieved deposit. A total of 5,168 litres of sieved soil is represented from the full range of archaeological contexts. The distribution of carbonised seeds within the deposits thus reinforces the other archaeological indications that the late Neolithic/Early Bronze Age settlement was of a different character from that represented by the Middle Bronze Age midden.

The seed samples were allowed to air-dry slowly after flotation, and were sorted dry using X10 and X20 magnifications with a binocular dissecting microscope. Higher magnifications were employed when required for specific identifications. The sample for sorting was spread onto a

Table XVI. Grimes Graves: Soil volumes processed by flotation

	Volume of Soil (L)	Seeds	Charcoal	Ratio of seeds to litres of soil
Late Neolithic				
Occupation below chalk dumps	2,763	5	present	1:553
Middle Bronze Age				
1971 Shaft, derived deposits at surface	288	0	traces	—
1971 Shaft, layer 1B	352	0	traces	—
1972 Shaft, Group 1	70	399	abundant	5.7:1
Group 1/2	49	17	present	1:2.9
Group 2	62	21	present	1:3
Group 3	30	4	present	1:7.5
Trench 1A and 1B (not dated)	1,554	5	traces	1:311
Total of Middle Bronze Age midden	211	441	present all levels	2:1

shallow plastic tray on which a sequentially numbered grid of 15 × 15cm squares was drawn. Each square was searched in sequence, with the whole area of the tray being scanned twice. Seeds were removed into sample tubes, and with the larger samples sorted in several batches to avoid the overloading of the sample tray.

The species represented

Six-row hulled Barley (*Hordeum vulgare L. amend Lam.*)
Barley is the most common seed found in all samples, and accounts for nearly 65% of the seeds identified, and 74% of the *Cerealia*. Many of the grains recovered show signs of heavy carbonisation, with the characteristic porous structure. Many of these could be assigned to no more than the genus *Hordeum*, but the apparent absence from the samples of barley other than *H. vulgare* makes it likely that this species is represented throughout. Measurements were taken from the better preserved part of the sample, consisting of those grains which showed an intact surface with little or no distortion evident. The characteristic twisted profile seen in the lateral grains of *H. vulgare* was evident in about ⅓ of the intact barley grains.

Although uncertainties remain concerning the effects of carbonisation on grain shape in cereals, it appears that grain size measurement in carbonised samples is of value in determining the quality of crops. As yet, few samples from sites in Britain have been systematically recovered, and have had measurements published, and consequently little comparative material is available. Van Zeist (1970) has published a description of numerous samples of cereals from both prehistoric and historic sites in Holland; however, the nature of the sites and the single archaeological context for most of the samples reduces the value of direct comparison. For the purpose of indicating the status of the Grimes Graves crops, mean values for the seed dimensions are shown in Figure 53. These are compared with data from Van Zeist (1970). Dennell (1972) has commented upon the difficulty of relating the mean size of a cereal sample directly to agricultural efficiency, as processing methods used to prepare cereals for storage or consumption will introduce a size bias into the carbonised fraction. Besides such filters of cultural practice, the soils of the Grimes Graves area are freely drained, prone to drought, and also present a complex mosaic of soil types within a small area (see below). From this, it is evident that both physical and human factors could influence the nature of the seed assemblage, both in terms of grain size and the actual numerical composition, from year to year. Thus the common assumption that the proportions of species within a seed assemblage is directly related to their abundance within the economy is probably false in the majority of cases. Dennell (1972 and 1974) has also described the association within seed samples of grain size and the presence or absence of chaff fragments and weed seeds. The samples are then classified, each group representing one of several stages in the preparation of grain from its initial harvesting to final storage and consumption. Dennell (1974) observed that grains of small mean size may be associated with large numbers of 'weeds of cultivation', and represent the residue of grain cleaning and threshing or food preparation. At such a time, small grains might be

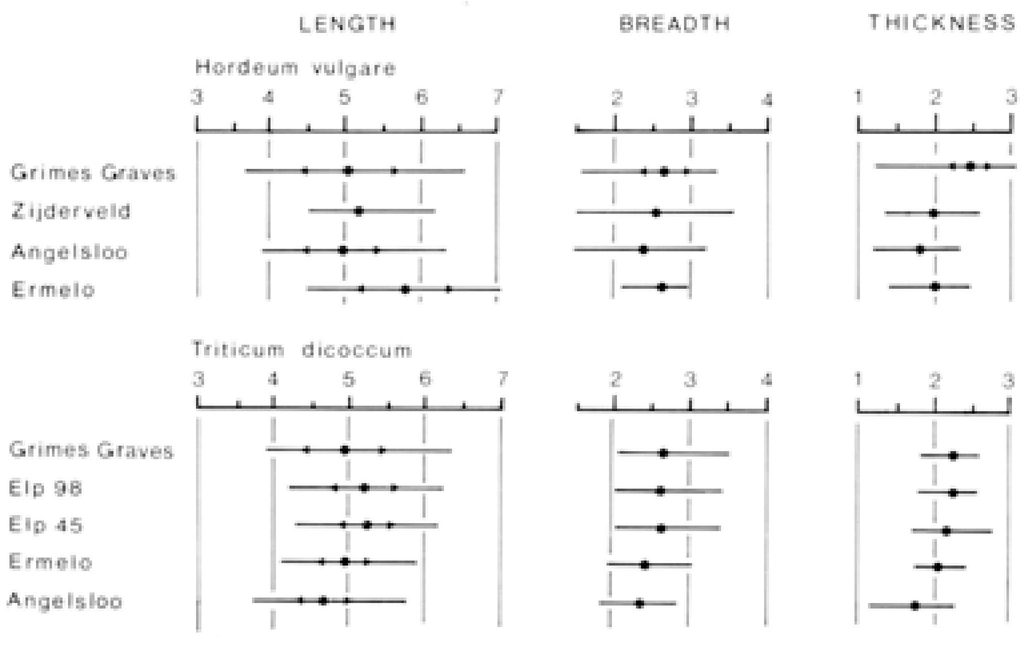


Figure 53 Hulled six-row barley (*Hordeum vulgare*) and emmer wheat (*Triticum dicoccum*) from Grimes Graves compared with the same species from sites in Holland (van Zeist 1970). The sites are: Zijderveld (Bronze Age, 1420 ± 80 BC) Elp (Bronze Age and Iron Age; Elp 98, 1155 ± 65 BC, Elp 45, 805 ± 65 BC) Angelsloo (Iron Age, 620 ± 55 BC) and Ermelo (Iron Age, 510 ± 65 BC). The sites are described as located on sandy soils and coversands. On the diagram, the spots depict mean values, the horizontal bar delimits the range of measurements within the sample, and the small arrows indicate the standard deviation where possible. From the sites in Holland (van Zeist op cit) the standard deviations are calculated from the histograms of seed sizes given.

removed with dirt, stones and the weed seeds by the use of sieves. The use of such grain-cleaning sieves is well-known in recent subsistence economies. In the case of the midden deposits recovered at Grimes Graves, it is probable that such selection was responsible for the assemblage, and the quantity of animal bones found in the same midden confirms that food refuse comprises a substantial part of its volume. However, the mean size of the barley grains in the sample is not so small that this can be confirmed, and no significant samples are available from other contexts at the same site, between which comparisons might be made. Certainly many of the weed seeds commonly show an association with barley crops at the present (Gill and Vear 1969) and the mean size of the grains suggests a level of success in cultivation that rather contradicts the low estimate that the soils of this area were given by past writers (Clarke 1937). Although the soils of the Grimes Graves area suffer from some limitations of fertility and free drainage, the good average size shown by the barley samples suggests that a satisfactory agricultural economy could be maintained.

Emmer wheat (*Triticum dicoccum Schub.*)
With the wheat, it is also clear that only a single species is represented. The emmer grains generally show less damage in carbonisation than does the barley, and it was also possible to take measurements from a larger proportion of the sample. In general, the size of the grains falls at the middle of the range for British and North European samples, though with the presence of many terminal grains apparent, the mean size may be somewhat depressed. The range of measurements varies from 4.5 to 6.9mm, a range of some ±18% of the mean value.

However, the seed samples from Grimes Graves come from only one archaeological context within the Bronze Age, and the samples from elsewhere on the site are too small for a comparison to be made. It is therefore difficult to assess which part of the crop may be represented, assuming some selection to have taken place during the processing of the crops.

Field Pea (*Pisum sativum*)
The presence of the pea is attested by only a single specimen from 'Group 1' of the midden. Although this is an early specimen of *Pisum* from British sites little can be said of the importance of this species in the economy. It seems likely that peas would have less heat-treatment before storage, and may thus be less often carbonised than is the case for the *Cerealia*.

Oak (*Quercus Sp*)
Seven acorn fragments were recovered from the old ground surface sealed below spoil dumps from the mining of an adjacent shaft, and are thus dated to the earlier phase of activity at the site. Only three or four nuts are represented, and of a type which is comparatively long in relation to its breadth, and which may be referred to *Quercus robor*. Acorns have long been used for food by man and other animals, and their occurrence in this context is scarcely surprising. Other samples of acorns had been recovered in other parts of the excavation, and were submitted for identification. These examples were not carbonised, and showed varying states of decay. The presence of oak trees on the site now suggests that these represent the recent food caches of squirrels. However, the carbonisation of the prehistoric samples indicates a human agency in their deposition.

Weeds of Cultivation
Fat Hen (*Chenopodium album*) (seeds July—October; annual weed of arable land)
Chenopodium is a common 'weed of cultivation', preferring nitrogen-rich soils. It may be excessively abundant on cultivated land today, and, growing to a height of up to 3ft, is prone to incorporation in cereal samples during harvesting. It has been suggested that this species was cultivated in the past and its recent exploitation as an oil seed and leaf vegetable may be noted.

Cleavers, Goose Grass (*Galium aparine*) (seeds June—August; annual weed, arable and waste land)
Cleavers represents the commonest impurity of modern cereal crops. The straggling growth of this plant can be a serious impediment to crop growth, and the prickly seed capsule ensures a wide dispersal on the clothing and coats of man and animals. The species is present in all samples analysed here, and occurs widely in archaeological samples, including those from the Mesolithic period (writer, unpublished).

Sheep's sorrel (*Rumex acetosella*) (seeds May—August; perennial, weed of arable and grassland)
This species is present in the two larger midden samples. Under cultivation, poor, lime deficient soils favour the prolific growth of the species; certainly a habitat could be found close to Grimes Graves that could satisfy such needs. Heathland and acid grassland also contain *R. acetosella*.

Black Bindweed (*Polygonum convolvulus*) (seeds July—September; annual weed of arable land)
This and other species of Polygonum are the most abundant weed seeds in the total assemblage from the site. Black bindweed is a common impurity of agricultural cereal samples, as it grows to a height of about 3ft and may therefore be harvested with the crop.

Knotgrass (*Polygonum aviculare*) (seeds July—October; an annual weed)
P. aviculare is a common weed of arable land.

Small nettle (*Urtica cf. urens*) (seeds July—September; a wide tolerance of habitat)
This is referred to *urens* on morphological grounds, and this is also the species associated with the lighter soils of the types found around Grimes Graves.

Ribwort plantain (*Plantago lanceolata*) (seeds April onwards; a grassland weed).
This species is associated with grassland and can be a useful herbage species, as it is readily eaten by grazing animals.

Curled dock (*Rumex crispus*) (seeds August—September; a perennial weed of grassland and arable)
A common weed of arable land, found as a contaminant in modern seed samples. This weed may be difficult to control by cultivation, as the broken fragments of taproot may themselves sprout and give rise to new plants. This renders eradication difficult by means of cultivation. *R. crispus* is classified as an 'injurious weed' in modern British agriculture.

Barberry (*Berberis vulgaris*)
A widespread species with edible berries.

Fescue grasses (Festuca sp)
A single specimen. The Fescue grasses are a common and generally valued pasture species.

Crataegus cf. monogyna
This single specimen is probably the hawthorn, which is common in the area now.

Medicago sp
This specimen may be *M. falcata*, as this species is most tolerant of the Breckland soils.

Unidentified
11 seeds of three or so species remain to be identified.

Discussion
The assemblage of carbonised seeds is dominated by two species of cereal; 6-row barley and emmer wheat. A single pea seed provides an indication that this species was also cultivated. This rather narrow range of crop plants may well have been influenced by the limitations of the available soils, which, while light and easily worked, are prone to drought and relatively infertile. However, the infertility of the Breckland soils may well have been overstated in the past, and it is clear from the concentration and distribution of sites in the area that the light but more calcareous slope soils have been favoured for cultivation from the earliest times (see below). The association of these food species with both weeds of arable and pasture land supports an interpretation that an established mixed farming economy is represented, in which both plants and animals were important. Indeed, the mean size of the cereal grains, when compared with the only other available data from North Europe, does not suggest that the site was especially marginal in arable crop production.

Of the weed seeds associated with the cereal samples, some such as *Galium aparine, Polygonum convolvulus* and *Rumex crispus* are tall plants, producing ripe seeds through the period in which cereals would be harvested. Their association with cereals is therefore to be expected. On the other hand, species such as *Plantago lanceolata, Medicago cf. falcata* and *Festuca sp.* are of low growth habit, and more likely to be found in pasture or on waste ground. Their presence may be indicative of the collection of hay or fodder for use at the site; again, interpretation is limited by the lack of comparative samples from British archaeological sites. Acorns are present in the small Late Neolithic samples, and their use as food for animals and man is well known. It may be noted that while pigs and sheep are not harmed by eating acorns, young cattle may be poisoned. Cattle would need to be segregated from woodland containing *Quercus* during the autumn.

Table XV shows the quantities of seeds recovered from the excavated units in relation to the quantities of soil processed. The contrast between the midden and other samples is striking; the former yielded many seeds, while the latter had few seeds even though much larger samples were processed from a wide range of contexts. The surfaces sealed below the piles of chalk spoil derived from the digging of the mine shafts are almost entirely sterile where seeds are concerned, although the samples tested were adequately sealed and contained fragments of charcoal. It is tempting to infer from this that the late Neolithic activity was not concerned with a cereal economy at the site. However, even if this can be argued as likely, it should be noted that the Middle Bronze Age layer IB, from the upper level of the 1971 shaft, contained no seeds of any sort. Indeed, had it not been possible to examine the midden deposits, evidence for the cultivation of cereals at the site would have been almost wholly lacking.

Dennell (1972 and 1974) has shown that carbonised seeds from archaeological sites occur in different assemblages according to their stratigraphical context. Seeds may be found in 'pure' samples (i.e. a clean single species sample) or with several food species mixed with various weed seeds. The range of associations described are interpreted as stages in the processing and preparation of food seeds from threshing to consumption, with samples being accidentally or deliberately burnt during these processes. Although this has obvious relevance to the interpretations that may be made about a seed sample, those recovered from Grimes Graves come from only a single midden context and with no knowledge of the associated settlement. The association of three familiar species of cultigen with at least eight species of weeds is most like those samples described by Dennell (1974) from floors and middens, and would appear to be derived from some stage of crop cleaning, either after harvest or before food preparation. However, no case can be argued from a single context and it is sufficient to observe that both the range and size observed in the cereals, and the importance of the various species is at best a reflection of the prehistoric economy.

5. Soils and land-use potential

The site of Grimes Graves lies roughly at the centre of the Breckland, a large area of sandy heathland covering an area of about 1,036km^2. Of this about one quarter is used for forestry and other non-agricultural purposes, while the remaining three quarters are mostly arable land. The soils in this area have recently been described by Corbett (1973), and are mostly formed on sands and gravels deposited and re-sorted under glacial and periglacial activity. Consequently, the soils are subject to very free drainage over most of the area and this fact, combined with the relatively low annual rainfall (584–635mm average per annum—23–25in) places restrictions on plant growth during the summer in the more superficially rooted species. Drought may be experienced from June to October, in which time the water demand of the plant cover, combined with evaporation from the soil, can exceed the available reserves of soil water. The amount of summer rainfall is thus the main factor in determining the profitability of agriculture in this area.

Detailed studies of the soils and plant cover in the nearby Lakenheath Warren have been published by Watt (1940 and 1966) in which seven main vegetation types have been recognised. These types correspond to soils of increasing depth and falling chalk content, with consequently lowered fertility. Watt (1940) designated his vegetation types into the stages A to G. Types A and B are simple A/C profiles, of a soil with chalk stones overlying chalky boulder clay. Watt's type C vegetation is on an A/B/C profile, but with chalk only in the B horizon at 13–28cm depth. The remaining types D to G show increasing degrees of podsolisation, acidity and infertility with types E, F and G showing, according to Watt, 'floristic poverty'. The soil profiles described by Watt (1940) correspond with the soil series of Corbett (1973) for the areas of forest that now surround the site of Grimes Graves. Under the heading of 'Slope Soils' Corbett describes the 'Newmarket, Methwold and Worlington (shallow phase)' soil series, the soil profiles of which correspond with those given by Watt for his grassland types

Table XVII. Grimes Graves: distribution of seeds by archaeological context

Late Neolithic deposits	GG 71 3/6 Baulk, layer 4 OLS below chalk dump. 7 Cotyledon fragments of *Quercus robor*
	GG 71 4/5 Red sand below chalk dump 1 *Berberis* sp.
	GG 71 Trench 6 OLS below chalk dump 1 *Galium aparine*
Late Neolithic/Early Bronze Age	2 *Galium aparine* 1 *Chenopodium album* 1 *Crataegus* sp. 1 *Leguminosae*
Middle Bronze Age	GG 72 8B/11 Layer 4A1 216 *Hordeum vulgare* 42 *Hordeum* cf. *vulgare* 92 *Triticum dicoccum* 1 *Pisum sativum* 9 *Galium aparine* 4 *Polygonum aviculare* 2 *Polygonum convolvulus* 5 *Polygonaceae* sp. indet. 2 *Rumex acetosella* 1 *Plantago lanceolata* 2 *Urtica* cf. *urens* 2 *Medicago* sp. 9 *Cruciferae* sp. indet. 1 *Graminae* sp. 11 Varia (species undetermined)
	GG 72 8B/11 Light grey below 4A1 7 *Hordeum vulgare* 4 *Hordeum* cf. *vulgare* 2 *Triticum dicoccum* 3 *Galium aparine* 1 *Rumex crispus*
	GG 72 8B/11 Layer 4B 12 *Hordeum vulgare* 4 *Hordeum* cf. *vulgare* 2 *Triticum dicoccum* 1 *Galium aparine* 1 *Polygonum convolvulus* 1 *Festuca* sp. indet.
	GG 72 4 BV Sand 2 *Hordeum vulgare* 1 *Hordeum* cf. *vulgare* 1 *Triticum dicoccum*

Total of Middle Bronze Age samples

Number		*% of cultigens*	*% of total*
Hordeum	288	74.4	65.1
Triticum	98	25.3	22.2
Pisum	1	0.25	0.2
Others	55	—	12.4

A, B and C. It is this group of calcareous soils which would have provided the best grazing and arable soils to the prehistoric communities of Breckland.

The main agricultural crops in this area are now barley and sugar-beet, with wheat and other root crops of secondary importance. Barley yields are in the order of 22–30cwt/acre (2,750–3,750kg/ha) but can be more than halved in a dry year (Corbett 1973). Soil humus is maintained by break crops of grass or lucerne, and this, combined with the winter feeding of some cereals, maintains some livestock in the area. These factors, which bear upon the modern agriculture of Breckland, are also relevant to the patterns of prehistoric land use. The soils, though subject to limitations of fertility and dryness, offer some compensation in the ease with which they may be worked; as Corbett (op. cit.) notes, Breckland soils are suited to systems of minimal

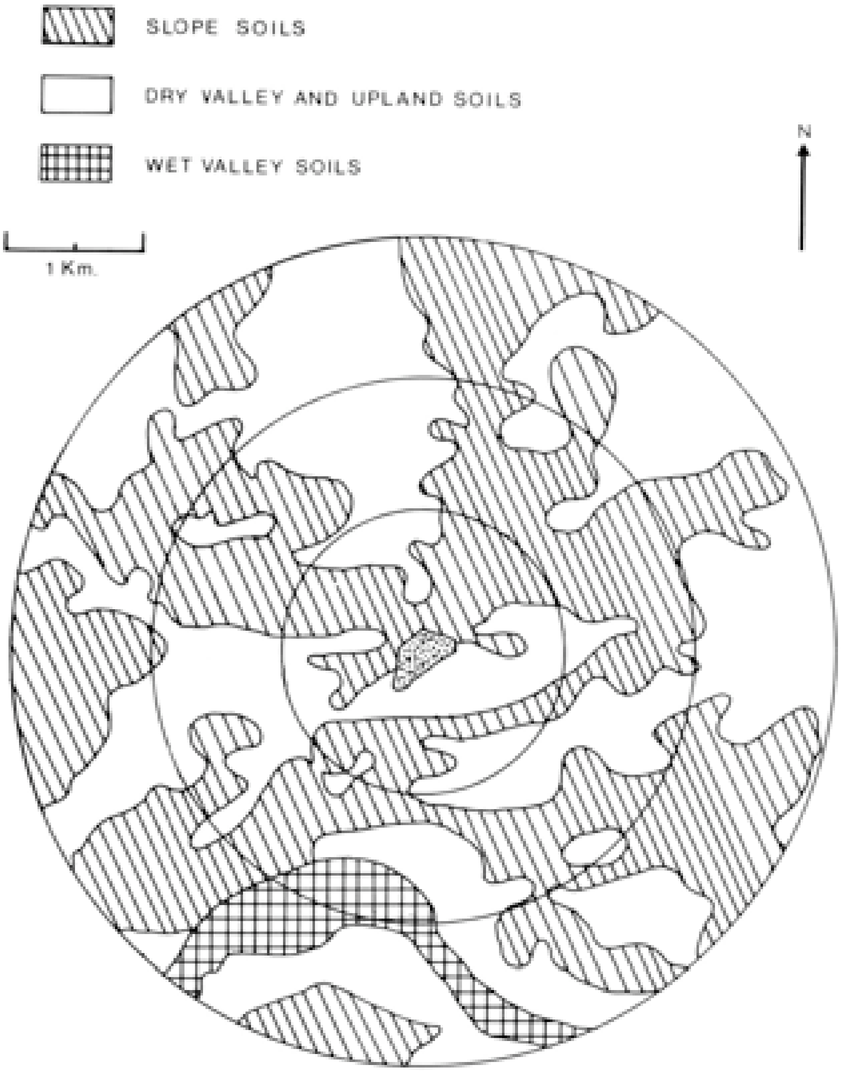


Figure 54 Soils of the Grimes Graves area (redrawn and simplified after Corbett 1974). The slope soils are now more favoured in agriculture, with generally shallow and calcareous profiles. The dry valley and upland soils are drawn as a single unit, and generally have deeper and acid profiles, not suited to agriculture. The Little Ouse river is marked by wet valley soils, now used for summer grazing. The better soils are likely to be represented at a minimal value, due to leaching since the Middle Bronze Age.

cultivation in modern agriculture, a fact that would be of direct importance to earlier farmers with a simple technology. Cultivation of these soils also requires the use of break crops to maintain fertility and soil humus, an aim which is more easily realised in an agricultural economy that combines plant and animal husbandry. Indeed, the more recent history of the Breckland confirms repeatedly the essential association of livestock with arable cultivation in order to maintain the fertility of these light soils (Crompton and Sheail 1975).

Corbett's mapping of the Breckland soils shows a complex mosaic of 18 types. Most of the soils around Grimes Graves belong to the calcareous 'Slope Soil' or more acid and dry 'Upland Soils' series. About 1.5km south of Grimes Graves the valley of the Little Ouse river contains wetland soils consisting of gleyed sands, or peat over sand. Figure 54 shows those soils mapped according to their modern agricultural potential. Of Corbett's 18 soil types, fourteen are present within a 3km radius of the site. Of these many soil classes, five main groups are described, which consist of:—

1. Upland soils
   Deep, acid soils with excessive drainage over chalky boulder clay. Unsuited for agriculture.

2. Slope soils
   Shallow, or relatively shallow soils, well drained; calcareous A horizon in the Newmarket and Methwold series.

3. Terrace/Upland gravels
   Stony acid soils, well drained. Their coarse texture renders them unsuitable for agriculture.

4. Dry valley soils
   Deep coarse textured soils, well drained, and unsuited for agriculture. This is a small soil group, of local distribution.

5. Valley floor soils
   A complex group of soils, but sharing in common a water table within the soil profile. All are now commonly under wet pasture.

Table XVIII. Grimes Graves: Soil types around the site expressed as percentages within concentric zones. The area of each in hectares is given in brackets. (1 ha = 2.47 acres).

Distance from site	Upland soils	Calcareous Slope soils	Terrace/Upland gravels	Dry valley soils	Wet valley soils
0 to 1km	41.0 (128.7)	51.0 (160.2)	0.5 (1.6)	3.7 (11.7)	3.7 (11.7)
1 to 2km	40.1 (377.7)	45.8 (431.4)	6.3 (59.3)	4.7 (44.3)	3.1 (29.2)
2 to 3km	29.2 (458.4)	43.4 (681.4)	15.3 (240.2)	6.3 (98.9)	5.8 (91.0)
Total area (Hectares)	964.8	1,273.0	301.1	154.9	131.9

The proportions of each of these soil types around Grimes Graves has been calculated, and is given in terms of zones around the site at distances of up to 1km, from between 1–2km, and 2–3km. (Table XVIII) There is little doubt that most of the food produced at the site by both plant and animal husbandry would have come from within this area, with the expectation that arable husbandry would occupy the more adjacent soils, with animal husbandry using the areas at rather greater distance. This, of course, corresponds to the classic Thünian model of land use (Hall 1966, Chisholm 1968) and can also be paralleled with the infield-outfield system described by Postgate for the Breckland in later medieval times (Postgate 1973).

The site is situated at the junction of an area of the upland (Worlington) and calcareous slope soils (Newmarket, Methwold and Worlington shallow phase), and giving access to a larger area of the latter (Figure 53). Though it seems likely that the site was originally located for easy access to the flint seams, it is evident that the underlying chalk on the valley slope was equally suited to the needs of the later subsistence economy of the Middle Bronze Age. The area within 1km shows a high proportion of the more valued calcareous slope soils, which also form a substantial part of the outer zones around the site. In fact, it is probable that the modern map places a minimal value on the areas of better calcareous soils available; as Corbett (op. cit.) notes, there is much evidence of long-term soil cultivation and liming of the more acid soils, and equally the probability that the calcareous content of some soils has been lowered by leaching, even to the point of such modification that the unit into which the soil might be placed in modern mapping has been changed. Indeed, Perrin (1964) has shown that Breckland podsols were developed by c. 3,000 BC, and the degree of decalcification observed in some soil units can only have been accelerated by the greater leaching associated with cultivation.

Another important factor in the location of the Bronze Age settlement would be the access to water. This is especially so in an economy where animal husbandry appears to have played so central a role, and here water lies at a distance of about 1.6km in the Little Ouse valley. This distance corresponds well with that recommended by the Ministry of Agriculture as the maximum that should be travelled by lactating cows (Walker-Love and Day 1971) and placing the site at this distance from water allows maximum exploitation of both grazing and arable land on the northern bank of the Little Ouse river. Indeed, it is likely that the river would have been a boundary between different human groups at that time, just as it now divides the parishes of this area. In the dry Breckland such water rights are crucial, and records from the later Medieval period show that competition among herders for access to water by grazing animals has been occasionally bloody. Again, the parish boundaries reflect these pressures, where at the small lake of Rymer (grid reference TL 867 757) no less than eight parishes join, with a ninth having access to the water supply.

The site is therefore situated at such a point that the favourable arable soils, extensive grazing and access to water are balanced according to the needs of the human community. This does, of course, leave open the question of why the Middle Bronze Age settlements at Grimes Graves were located within the area of abandoned mine shafts. The history of excavation at Grimes Graves shows that several middens from the later occupation have been found infilling the upper shafts. It is possible that the availability of the waste from earlier flint working was one factor in attracting human settlement; equally, it seems likely that the large area of disturbed ground was itself of value. Visits to the area during the recent dry summers showed the extent to which the disturbance associated with the earlier mining has modified the vegetation of the area. Grasses and other herbaceous plants were seen growing more freely in the damper soils of the old shaft infills, and the chalk dumps have also created an area of good pasture. Watt (1940) showed the influence of soil pH and depth in the growth of plants in the Breckland; the chalky upcast from the mineshafts has created an area of 15ha, consisting of Watt's grassland types A and B. These rather shallow, highly chalky soil types have a better water balance and higher fertility than the deeply leached and acid gravels. The history of land use in the Breckland includes heavy liming of agricultural land, and local chalk pits for this purpose are a feature of the landscape. It would seem that a large area of artificially improved pasture was an attraction at this point, to a site that is also bordered by a large area of the better arable soils.

6. Food supply and population numbers

The levels of milk output for cattle within subsistence economies in Europe are unavailable, and earlier writers, such as Fitzherbert (1524), seldom give figures for yields or other details of the expected performance of animals. Some data are available from other regions, and Brown (1971) gives information concerning the diet and husbandry practices of cattle herders in the semi-arid regions of East Africa in more detail than is usual in studies of these peoples. Brown gives a theoretical calculation for dietary allowances, in which the average family in East African cattle herding groups contains 6.5 'adult equivalents', and needs 15,000 kcal/day for its support. These estimates are based upon the observed situation. This dietary need could be obtained from 21 litres of milk, or 10.5 litres of milk and 4.8kg of meat each day. The proportions of each food will vary according to the season, and hence the particular economic circumstances of the herders. Under such a regime, Brown finds that 2.0–3.0 'Standard Stock Units' (1 SSU = 1,000lb of stock; for example, one large or two small cattle, or ten goats) must be maintained for each person. With a relatively short season of lactation in a semi-arid region (usually less than six months) the average family group will need to maintain a herd of about 15 cows to provide their daily needs. Brown's figures show a 70% calving rate annually in all adult cows, about 10% annual losses, and four years to the production of the first calf by heifers. Most female calves must be retained in the herd as replacement animals for the adult cows, adding an average of 15–18 young stock to the herd. With one or two young and adult bulls, the herd is raised to 35–40 animals (in this case about 17 SSU) to serve the needs of 6–7 'Adult equivalent' people.

The example given by Brown (op. cit.) is considered with others in a detailed review by Dahl and Hjort (1976), who suggest that rather higher numbers of cattle would need to be maintained. The uncertainties in such statements reflect the seasonal variance within the environments from which these examples are taken, with marked wet and dry seasons, and periodic drought, combining to ensure that an 'average' figure can refer only to the exception. It must also be remembered that the groups considered usually employ agriculture as only a small part of their annual subsistence activities. The probability remains that, for Grimes Graves, agriculture was a central part of the economic activity at the site in the Middle Bronze Age.

The East African environment is one in which cattle husbandry involves a higher degree of risk than might be found in the temperate and wetter latitude of Southern Britain, and the cattle management practices reflect this fact, in the endeavour to provide the maximum degree of security. While the figures given by Brown (op. cit.) provide an understanding of the numbers of stock required to maintain a human family in a mobile system of husbandry, and at low animal yields, a number of reasons prevent direct extrapolation of these values to Grimes Graves. This site does not experience such a degree of summer aridity and, although the soils of this area possess very free drainage, and drought is not uncommon, the site of Grimes Graves has access to wetland soils in the valley of the nearby Little Ouse river which would have a higher productivity in the summer months. Thus the grazing resources, combined with a sedentary life and the opportunity to collect and store adequate hay, can be expected to provide a longer season of lactation and a faster growth rate in the cattle. It may be remembered that barley and legume straw, especially if cut before full ripeness, have feeding values little below that of average hay and the extent to which cereals may have been used as a feeding supplement to animals at that time cannot yet be known. In all there can be little doubt that adequate food could be provided to maintain the animals in good health and productivity, especially as the alternative of meat production requires no less a food input to each animal; the *total inputs* greatly exceed those for dairy cattle for similar *outputs*, and thus represent a less efficient conversion of grazing into human food. 'Autumn slaughter', so often suggested as a means of avoiding winter fodder shortage, has not been seen in any assemblage of animal bones studied to test that hypothesis (Higgs and White 1963; Ewbank 1964). The Grimes Graves animal remains also provide indications of year-round occupation, and the flotation samples show that cereal-based agriculture was also part of the site economy. It appears that the use of cultivable soils plus the possibility of collecting and storing adequate hay outweighed any advantage that a more mobile economic system might have in terms of grazing potential, even assuming that adequate land was available and free of other competing human groups.

The practice of calculating food values from the bones at archaeological sites, in terms of calories, and hence the number of man-days represented, is well established since the work of Clark (1954) in reporting the site of Star Carr. In his monograph, Clark used the quantity of bone, corrected both for the number of individuals identified from the excavation, and those predicted in the unexcavated part of the site, to calculate the supply of food available from animal protein. A group of four families was postulated from the area of the site as the consumers, and at this figure, some 6¼ years of occupation were suggested on a sedentary basis, or two or three times this number of years when the indications of seasonal occupation were taken into account. As Clark (op. cit.) says 'Although no positive assessment can thus be made, the figures at least give some indication of the maximum aggregate occupation of the site, one which it is to be presumed was made up of visits at certain seasons over a period of years'. In his later reconsideration of the Star Carr data (Clark 1972) a different approach is taken, by calculating the likely productivity of a given territory around the site in terms of red deer, and this calculation is compared with the original estimate. A reasonable match with the original figures is found, especially at the upper limits in size allowed for the territory. Such calculations are, of course, open to revision, which any reader is able to do from the figures given. The value of the calculation lies in providing a reference point in terms of the likely duration of settlement, or the size of the human population, which may not be available from other sources. Although Clark's original (1954) calculation contained errors of procedure, even the correction of these does not significantly alter the *magnitude* of the settlement at the site.

More recently, similar calculations have been applied to other sites (Shawcross 1967 and 1973; Bailey 1975) applying methods derived from the work of Clark (1954), Cook and Treganza (1947) and others. Each of these approaches uses some of the following factors in making these estimates—

1. *The number of years of settlement likely to be represented*
   In the case of Star Carr, the archaeological indications were for a small and short-lived settlement. On the other hand, Bailey (1975) was able to utilize radiocarbon dating to give an occupation of some 1650 years to a deeply stratified shell midden on the Richmond River in Australia. The indications from Grimes Graves are for an extensive Middle Bronze Age occupation, but with the particular midden in question being quite rapidly accumulated.
2. *The number of people resident at the site*
   Here, Clark (op. cit.) was able to use the physical limits of the site to predict a population size, while Shawcross (1967 and 1973) and Bailey (op. cit.) were able to use ethnographic accounts as an additional source of information. In the case of Grimes Graves, the prediction of a population size, on a site with widespread occupation traces, would be the best result of such a calculation.
3. *The proportion of plant and animal foods in the diet*
   As yet, the only method available in archaeology for the calculation of this proportion is an evaluation of the agricultural potential of the territory which would have supplied most of the food needs of a group, supported

where relevant by ethnographic accounts. Most anthropological surveys of herding peoples give but scant information concerning diet, and other aspects of the dietary economy; we do not yet have sources of the quality available for hunter-gatherers e.g. Lee (1968) and Meehan (1977). Figures for the importance of plants and animals in the diet at Grimes Graves can at best be estimated by the availability of the better agricultural and other soils, and in data for the carrying capacity of animals.

4. *The proportions of milk and meat in the diet*
   An estimate of this relationship is possible from the animal bones at Grimes Graves.

The interest in calculating the food supply for man at Grimes Graves lies in allowing an estimate of population size. While this is possible, and I believe useful, it depends upon making certain allowances and rests upon certain assumptions. I hope that sufficient data are given to allow the reader to recalculate any variable which is treated in a manner here to which objections may be raised.

The point from which the calculation begins is the assemblage of animal bones, and the stratigraphic provenance from which it was recovered. The several phases within which the midden was deposited suggest several years of deposition with a changing regime of sedimentation winter and summer. The movement of animals and man around the chalky upcast at the lip of the old shaft could well result in the lenses of wash which occur between the more darkly organic layers of sediment. The calculation is first made on the total bone assemblage, in terms of the number of animals represented and their size, and, where relevant, their possible milk yields. The predicted human population may then be modified to allow for various amounts of plant foods.

The animal bones, corrected to a minimum number of individuals, suggest the presence of:

64 cattle
39 sheep and goat
7 pigs
3 roe deer
1 red deer
1 horse
2 dogs

The horse and dog bones are scattered within the different excavation units and show little trace of cutting, breaking or burning. In view of this, and the small quantities involved, they are discounted in the calculations that follow.

The cattle from Grimes Graves are intermediate in size between those of the Neolithic and Iron Age (Figure 45) and also rather smaller than recent samples of the Danish Red breed used by Higham (1968 and 1969) in his study of prehistoric European cattle husbandry. Rouse (1970) gives a weight of about 1,200lb (545kg) for females of this breed. The cattle from Grimes Graves may be compared with the Danish Red in order to estimate body weight. It can be seen (Figures 45–47) that the measurement of metapodial *length* is a poor indication of the degree of sexual dimorphism within the Grimes Graves cattle, while the *width* of the distal epiphysis provides good discrimination. The sample of Red Danish cattle used by Higham contains only a single adult male, which again falls *within* the female range on the length measurement, but outside this group on the width of the distal articulation. A similar pattern emerges from the figures given by Higham, and taken from Zalkin's study (1962) of the Kalmyk breed of cattle. The following mean dimensions have been calculated:—

Grimes Graves

Metacarpal length	females	(11)	177.0mm
	males	(4)	182.95mm
Metacarpal width	females	(11)	52.0mm
	males	(4)	62.35mm

From these dimensions, it is evident that the metacarpal bones of the Grimes Graves cows are 96.7% of the length of the male metacarpals, but only 83.0% of the width of the distal articulation. For females of the Red Danish breed, the mean dimensions of the metacarpal bones are given by Higham (op. cit.) as:

Metacarpal length (10)	215.7mm
Metacarpal distal width (10)	72.6mm

When the cows from Grimes Graves are compared with the modern females in the Danish Red sample, the former group have a metacarpal length which is 82.0% of that from the Red Danish, and 80.0% of the distal articular width. Taking this as a guide to the relative body mass of the two groups (and it is likely to be more reliable than the customary calculations based upon metapodial length alone) it is possible to estimate a weight of about 960lb (436kg) for the Grimes Graves cattle.

The animals killed at less than one year of age are likely to be mostly male, but including some of the poorer females, and with the possibility of a natural mortality of around 10% in the young animals. Carrying the maximum number of females into their second year would also provide an additional security in the case of disaster causing mortality in the adult herd. A four or five year milking period is also likely in the cows, requiring a 20% annual replacement. It is possible, from the data, to observe the following pattern of culling and to predict the herd structure represented. (The calculation assumes, in the first instance, that a single year is represented by the faunal assemblage.)

Cull observed from midden deposits

31 animals of less than 1 year of age
13 animals of between 1 and 2 years of age
20 animals carried on to the herd, and killed at different stages of adult life.

This pattern of killing can be used to predict a herd of some 58 breeding cows.

58 cows = 29 m and 29 f calves per annum
cull 26 m and 5 f calves = 27 carried on

Of a similar number of yearlings from the previous season:

13 culled, comprising 1 m and 12 f
Carried on to herd: 12 f and 1 m

This suggests that some 60 births may be estimated for the population within the site, from at least 60 cows. As 10–15% will fail to produce a calf in a given year, the number of cows would be nearer to 70. Add to this perhaps five bulls, plus five juvenile bulls and a maximum herd of some 140 animals could be predicted, perhaps averaging 120 according to the season of the year. The fact that about 15 of the cattle were killed at calf-bearing ages agrees with a predicted average milking life for the cows of four or five years.

From such a herd, the following food outputs may be calculated:

Culled below 1 year of age:	
31 calves at an average 100kg body wt	3,100kg
Culled at 1 year of age:	
13 yearlings at an average 250kg body wt	3,250kg
Culled from adult herd:	
20 cattle of an average 450kg body wt.	9,000kg
Total cull weight	15,350kg

Observations within subsistence economies show that a relatively high proportion of the body weight of animals is consumed; the proportion of 60% that is commonly taken in such calculations is used here. To the cull weight of the cattle must be added the other animals present in the midden.

The bones show a minimum of 39 sheep, most of which were killed at relatively early ages, as yearlings. By this time, they would be about 70% of the adult weight. The small Bronze Age sheep are a little larger than the living Soay sheep of St Kilda and are given an average weight of 25kg.

The pigs were killed at early ages also, and few bones can be measured in consequence. As the animals themselves were comparatively small at the time of death, 40kg live-weight is estimated. Only 7 pigs were found to be present in the midden bones. The 3 roe deer are taken at the modern equivalent for this species in the Thetford region, at 20kg, and the 5 red deer at 90kg.

This gives the following total cull weights (Table XIX):

Table XIX. Total cull weights

Species	Total dead wt (kg)	Total meat wt (kg)	kcal/kg	Total kcal
Cattle	15,350	9,210	2,000	18,420,000
Sheep	975	585	2,300	1,345,500
Pig	280	168	2,900	487,200
Roe Deer	60	36	1,340	48,240
Red Deer	450	270	1,340	361,800
			Total kcalories	20,662,740

This figure may readily be converted into Standard Nutritional Units (1 SNU = 1,000,000kcal) and would thus allow about 21 'adult equivalents' to live at Grimes Graves for one year, calculating food intakes at the levels normally associated with European populations in the present.

However, to this the likely output for milk must be added. The calculation above allows for the milking herd of some 58 or so cows. Brown (1971) suggests an average yield of 600 litres (132gal) for cattle of the semi-arid zone in East Africa; Dahl and Hjort (1976) give similar figures for a range of African herding economies. Outputs in non-arid regions under intensive systems are, of course, much higher. It must be remembered that the Grimes Graves area (and especially the site itself) has a well balanced range of grazing resources, obviously the capacity to provide hay, as well as 'maintenance' fodder from arable crops (see above). There seems little reason to postulate animals of low performance simply because the site is prehistoric, especially as the provision of adequate fodder requires little technology. Figures for the small Dexter cow (Dexter Cattle Society, not dated) suggest a lactation of 600–700gal (2,730–3,185 litres) per annum with a grass and hay diet and very limited supplementary feeding, and Russell (1974) states that a yield of 2gal per day (9 litres) can be achieved from small cattle by the feeding of good quality hay to appetite.

For the purposes of calculation, an average milk yield of half the amount given by small modern cattle in Britain, under non-intensive systems of management, is taken here. 300gal per annum is a yield which even simple technology could maintain without requiring a high input of human effort. The 58 or so cows would thus produce 18,000gal of milk per annum (81,900 litres) from an average 300 day lactation. About one quarter of the milk would be lost to those calves being maintained for herd replacements; the remaining three-quarters, with a food value of 670Kcal per litre, represent some 41.15 SNU. The midden thus represents foods from animals sufficient for 62 people to subsist on a diet wholly of animal products.

At this point, it might be remembered that the midden probably represents several years for its accumulation; there is some stratigraphic evidence that this was about four separate years. Therefore, the figures which have been derived above are divided by four, and a population of 16 people may be suggested.

An allowance may now be made for the dietary input from cereals and legumes. The site has adequate resources of arable land, in which the fertility could readily be maintained by fallowing, and manured by grazing and direct application. Equally, large resources of land of lower productivity, but of light texture and showing early plant growth would extend the grazing season. Wet pasture provided an important summer resource, and the site itself is composed of high yielding grassland, probably too undulating for extensive cultivation. The necessity for a system of long fallow on this land, combined with the grazing resources this allows, might provide as much as 30% of the diet to be from animal sources; in this case a further 37 SNU would be needed from cereal cultivation. 1,000kg of cereals provides 3.3 SNU, so some 11,200kg (220cwt: 11 tons) of cereal would be needed. The present yields of barley in the Grimes Graves area is some 20–30cwt per acre, depending on the quality of the growing season; at reasonable fertility, at least half this yield could come from land without the use of manufactured fertiliser. At an average 10cwt per acre (1,250kg per ha) the amount needed could be obtained from rather less than 22 acres (8–9ha). This effectively represents some 6.2% of the area of better arable land lying within 1km of the site.

The calculations made above suggest that, taking a four-year deposition for the midden, and at the values given for the plant and animal components of the diet, some 53 people would be present *at the site of that midden.* It should also be noted that 10% of the midden deposits were not excavated, and to assume that the fill was relatively uniform would increase the population to 58; this figure is also given in 'adult equivalents', and to allow for a proportion to be infants and young people would raise the total to 75 or so.

The largest of the several difficulties involved in making such a calculation lies in the problem of providing any objective estimate of the proportion of cereals that were included in the diet. The quantity of animal-derived food is fixed by the number of individuals represented by the bones, and from an estimate of milk output from the surviving herd. If, for example, animal foods made up only

10% of the diet, the 'adult equivalent' population might be as high as 160; on the other hand, a 50% animal-derived diet would give a population of only 32. The calculation is perhaps at its weakest if a very high plant food intake is postulated; at around 99%, the human population by the same prediction rises to 1,600. Practical considerations argue against extremes, however. The production of plant foods is relatively energy intensive, though high-yielding. On the other hand, animal foods are low in the energy need for production, but also with a lower yield. The availability of much land with a low cultivation potential leads me to favour the lower population estimates, with a relatively high animal-derived part of the diet in this instance.

The possibility remains that many more years were represented in the accumulation of the midden; in this case, the suggested human population of 75 adults and young people would need to be reduced by an appropriate amount. For example, a 10 year duration would reduce the population from 75 to 30 or so.

This calculation is not presented as an exact guide to the population of the Middle Bronze Age at Grimes Graves, but simply to provide an indication of its possible magnitude. I have assumed that the food-producing system was organised on efficient lines by skilled practitioners in the arts of plant and animal husbandry, and that the maximum output possible with the minimum input of human labour was their objective, combined with the greatest security that could be achieved.

The food outputs suggested here could, I believe, be attained with a simple technology and sustained in the long-term. Such calculations have seldom been possible from the data recovered at archaeological sites in Britain, for a variety of reasons, yet the customary archaeological data could perhaps be more readily understood in this way.

Allen (1965) shows the relationship in numbers between the human population and stock units carried for a range of economic systems in Africa. His figures are as follows (Table XIX).

Table XIX

	cattle per individual	SSU per individual (includes small stock)
Pastoralist economies (little or no cultivation)	10.2–16.3	12.5–19.6
Mixed economies (some cultivation)	3.6– 6.0	4.4– 6.2
Mainly cultivation (some stock)	0.8– 2.0	0.9– 2.4

Although these figures do not bear direct comparison with Grimes Graves, it is probable that the Middle Bronze Age economy was most like the last group in the table shown above. Stock numbers might roughly equal the human population, and the data from Grimes Graves indicate a permanently settled, mixed farming economy. The possible constraint on stock numbers, of limited summer grazing in a dry season, may well be the cause underlying a particular concentration on dairy husbandry. Under such a system, the food value of milk output is about twice that of meat (even at the low values taken here) when calculated in terms of calories; the apparent protein contribution to the diet is more nearly equal, although the protein value of the milk exceeds that of all stock killed at the site. The assumption of a 4-year midden life and a human population of about 50 people would be supported by agriculture, and a milking herd of about 16 cattle. Young cattle, sheep and pigs taken together with the milking herd raise the Stock Units to about 0.7 per 'adult equivalent' of the proposed human population.

7. Antlers and implements of antler

74 implements of red deer antler (*Cervus elaphus*) were recovered from the areas excavated, and five antlers of roe deer (*Capreolus capreolus*). The majority of the red deer antlers had been formed into 'picks' and were mostly found at the base of the mine shaft. As well as the picks, nine of the branched crowns cut from the top of the antler had been utilised. These implements were called 'rakes' in an earlier work by Sandars (1910). The red deer antlers show evidence of a high degree of selection, partly based upon gross size, but also on the form of the individual antlers. About ⅔ of the antlers are from the left side of the head, and it appears that this represented a form more suited to mining in the restricted conditions of the small galleries. The total of antler tools used could have been made from a minimum of 65 individual antlers, which would include the crowns used as rakes.

The most obvious feature of this sample is the selection of 'shed' antlers, which amount to about 90% of the total. red deer antler grows and is shed according to a highly seasonal cycle. The new antler grows from March to July, and is fully developed from then to the following February. Shedding of the antler takes place within a few weeks at the end of February and in early March. Consequently, it can be seen that fully developed antler is available from killed animals during about half the year, with shedding during a short period in the late winter. Shed antler is vulnerable to destruction from a number of causes, the chief of which is by being eaten either by the deer themselves, or by several species of rodents. Shed antler, even in areas with a high deer population, is seldom found. This makes the frequency of shed antler in this and other assemblages from the site (Clark 1915) even more striking, and suggests that this material was recovered by very close observation of the herds at the very least; deliberate decoying and enclosure of the animals might also be possible. Only seven of the antlers showed the attached pedicle and skull fragment that would be characteristic of an animal either killed or dying during the period from September to February.

It is, of course, difficult to calculate the area from which the antlers might be obtained. The frequency of such antler picks at sites which would have involved the excavation of major features by the prehistoric inhabitants (for example, Windmill Hill, Durrington Walls, Stonehenge) suggests that this was a prized commodity, and, as such, may well have been gathered from a larger area than that exploited in the food economy of the site. At each of these sites, the amount of antler indicates a deer population higher than would be expected from the small amounts of red deer bones in the faunal assemblages. From this it may be argued that the red deer population, which must have been reduced by this time by agricultural encroachment on its territory, was seen as of more value in supplying this raw material than as a meat supply. It may be expected that some form of prohibition against the killing of red deer would exist in these prehistoric societies.

A minimum of 350 mineshafts is known at Grimes Graves, and Clark (1915) observed that the two shafts excavated at that time contained 244 antler picks. Clark felt that a further 100 might be in the unexcavated galleries of each of those shafts, and suggested a total of 57,346 antlers of red deer for the whole site. The shaft with which this work is concerned produced a lower total, and an average of 100–150 picks per shaft might be a more reasonable estimate. It is also known that many more shafts exist that can be observed as some are filled to be level with the modern ground surface. For the purpose of calculating the number of red deer needed to supply these antlers, 400 shafts are assumed to have been dug, with each containing 100 antler picks. If the results from the 1971 shaft are typical of the whole site, about 66 of this 100 would be left hand antlers, and 34 right hand antlers. (This degree of selection is not observed in the recent excavations conducted by the British Museum. Juliet Clutton-Brock, pers. comm.) The 40,000 antlers likely to be present must therefore be taken from some 26,400 sets of left and right antlers. Of the antlers from the 1971 shaft, 43 could be classed into stages given by Schmidt (1972) which shows six stages in the growth of antlers during the maturation of the animal (Figure 55). The data show that none were utilised from stages A or B, 1 from stage C, 7 from stage D, and 43 from stage E or above. Most of the crowns are from stage F. All the antlers from stages C and D are from animals that would grow on to stage E or F; according to the age-structure of the herds, and allowing for discarded right antlers, some 20–40 deer could supply those found in the shaft. About one third of the antler sample could not be assigned to a stage, and may partly be smaller antlers from younger animals. However, it places the likely number of deer near to the upper end of the range suggested. Therefore, if 67 beams may represent about 40 animals, it seems that a figure of 60% or so of the antler total for the whole site could be near to the number of deer required. For 40,000 antlers, this would be 24,000 deer. It must be remembered that only male red deer carry antlers, which effectively doubles the number of adult animals to 48,000. Before such vast herds are imagined, allowance must be made for the duration of the mining work. If one shaft was dug each year, for about 400 years, a standing population of only 120 deer would in fact be required, assuming all antler was recovered, and that all suitable antler was utilised. This number could well be found in a few square miles of country, and does reduce the seemingly huge numbers to a more familiar scale.

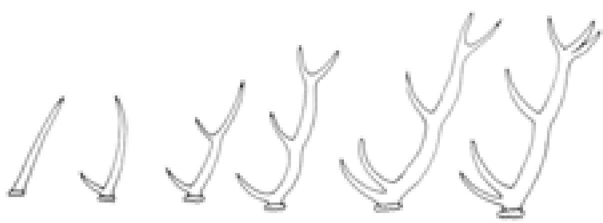


Figure 55 Stages of antler growth in Red Deer (*C. elaphus*) redrawn from Schmidt (1972).

The preference for antlers from the left of the skull has been outlined above. The actual numbers observed are:

Left antler		Right antler	
shed	unshed	shed	unshed
40	3	18	4

The reason for this probably lies in the form of the antler, and the manner of its use in mining. It has been suggested that the antlers were used by being held in one hand, while the brow tine was forced into the fissures within the chalk by hammering on the back of the antler beam. The heavy battering shown on most of the antler beams supports this interpretation. The brow tine of the red deer antler normally curves upwards and inwards, and points forwards over the animal's muzzle. In the mining of flint in small galleries, this form of antler favours the left hand antler in a human population that is commonly right-handed. The left antler, held in the user's left hand, can be driven into the chalk by striking downwards on the back of the beam; the right hand antler used in the same way would require an upward blow, which would be difficult in such restricted conditions. This, of course, applies to right-handed persons; in the left-handed, the opposite advantage would prevail.

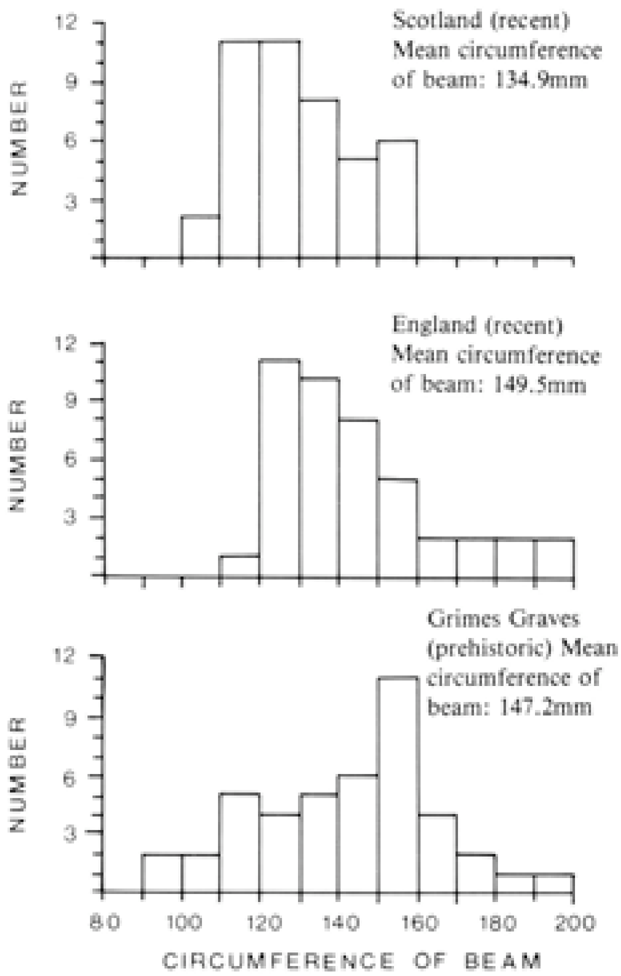


Figure 56 Dimensions of antler picks from Grimes Graves, compared with recent English and Scottish 'trophy' heads. The Grimes Graves antlers show a wider distribution of size than do the highly selected trophy heads; the mean size of the Grimes Graves assemblage is close to the recent parkland deer from England, and larger than those from Scotland.

The picks were manufactured to a regular pattern, and mostly made on antlers of large size. This may represent no more than the age distribution within the red deer herd, or reflect the good nutritional status. The size of the antlers is shown in Figure 56. This shows the distribution of the antlers in size classes, based upon the measurement of the circumference of the beam above the brow or bez tines. These data from Grimes Graves are compared with those given by Rowland Ward (1929) from trophy heads handled

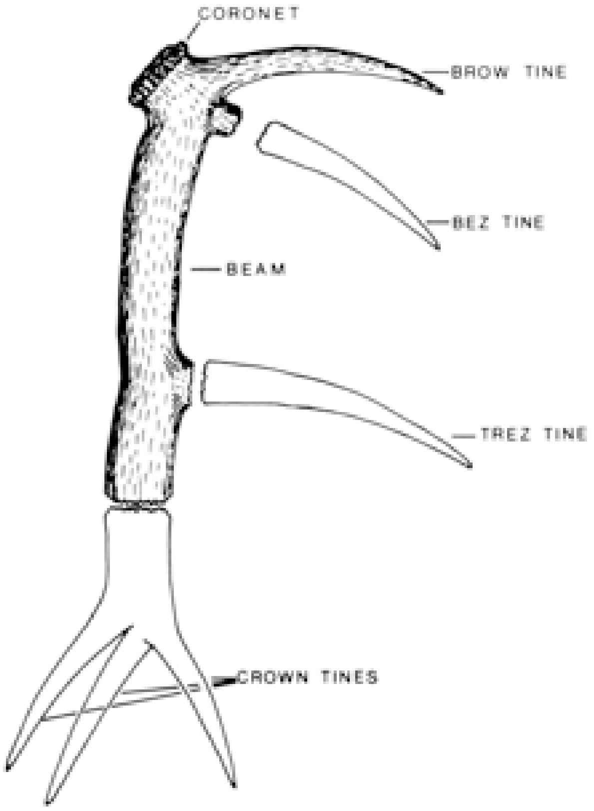


Figure 57 Method of manufacture of antler picks (*Cervus elaphus*) from Grimes Graves. The bez, trez and crown tines were removed in the places shown.

in his taxidermy workshop. These populations are selected from recent red deer populations in Scotland and England, the choice being determined by the size and form of the antlers as sporting trophies. As such, the largest and best heads will be represented in the two recent populations. Figure 56 shows that the Grimes Graves antlers are drawn from a wider range of age-classes within the prehistoric population than is the case with recent rifle hunting. The sample from Southern England is from animals in favoured parkland environments, yet the mean size of antler, in spite of the degree of selection involved, is closely similar to the Grimes Graves animals. The Scottish deer, in environments with poorer grazing and lime deficient soils, produces rather smaller heads. The mean circumference is: Scotland 134.9mm, Southern England 149.5mm, Grimes Graves 147.2mm. The largest antler measured by Clarke (1915) had a circumference of 228mm (given as 9in) and is larger than any seen from the excavation described here, or in recent trophy heads. The preferred length of the mining pick was 30–60cm in the beam, and each was prepared by cutting off the bez and trez tines, if both were present, and then breaking the beam above the point of attachment of the trez tine (Figure 57). Breaking was accomplished by scoring the hard outer surface of the antler and then breaking at this point. Smoothing of the broken surfaces was often done by charring with fire and most of the antler picks show signs of this treatment.

Whitehead (1964) refers to the living red deer of Thetford Chase as 'possibly the best in England'. The modern population are there largely as the result of introduction in recent times, though their stature does suggest that the area is highly suited to the species now, and appears to have been no less so in the past. The greater range of beam circumference in the prehistoric sample contrasts with those derived from trophy heads, which presumably represents a selection of the best animals to be found within the areas in question. In the absence of much skeletal material of the red deer the larger antlers do suggest a prehistoric population of very large stature. The range of beam circumferences indicate the use of all suitable antlers as tools, but that a large standing population of deer would not be needed to supply the raw material. The comparable absence of skeletal material, at this and other British Prehistoric sites, and the preference for shed antler combine to show that the killing of this species was generally avoided.

The distribution of antlers utilised as tools in the archaeological deposits may have some bearing on the nature of the Middle Bronze Age settlement and its relationship to possible mining activity. It has been shown that the deposits at the base of the shaft fill and galleries are of an earlier

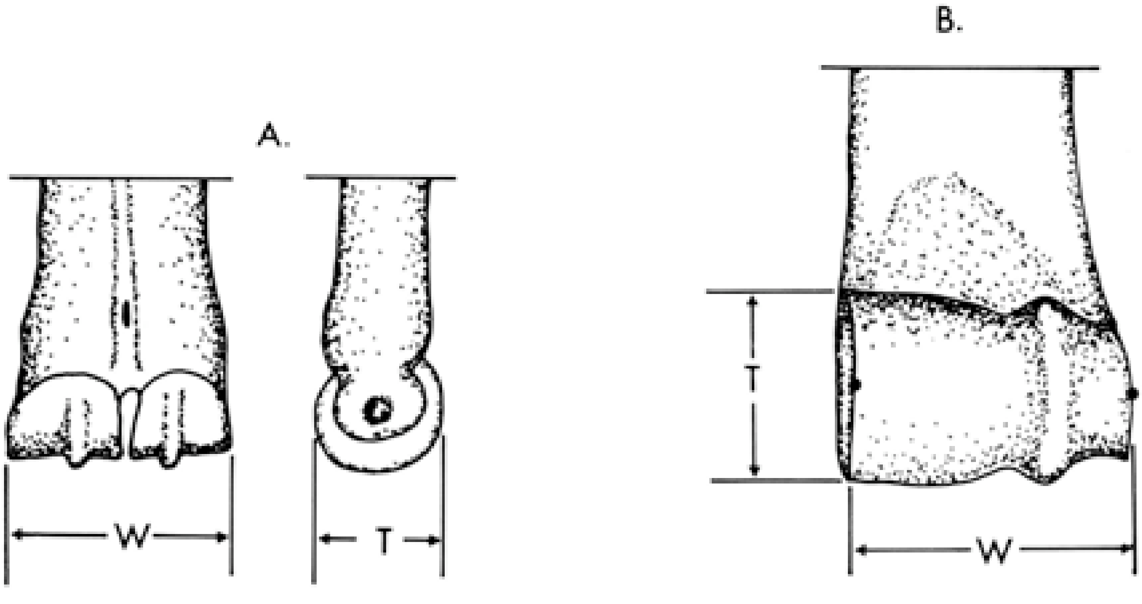


Figure 58 Measurements taken of distal metapodials (A) and distal humerus (B). For the latter, the exact measurement points for the width of the articulation are shown on the drawing by dots. Figure 45 employs the width measurement of the metacarpal plotted against maximum length.

date, than the Middle Bronze Age midden, and that the uppermost layers of the shaft fill (layers 1A and 1B) are possibly of Bronze Age date. The distribution of antlers utilised as picks, and the frequency of heavy battering on the beams of these, is shown below (Table XX).

Table XX.

Lower Pit Fill and Galleries		Layers 1A and 1B		M.B.A. Midden	
Battered	Not Battered	Battered	Not Battered	Battered	Not Battered
38	3	4	4	1	3

It can be seen from this that 12 antlers formed and some apparently used as picks are associated with the Middle Bronze Age, and even later deposits, only five of which show the characteristic battering on the rear of the beam while seven do not. The presence of these tools does not demonstrate that mining was being undertaken, as the same type of tool is known from other prehistoric sites where holes and ditches were being dug for other purposes. Thus the presence of these tools in the Middle Bronze Age does not argue for flint mining at that time.

Acknowledgements
I wish to thank Richard Hubbard of the North-East London Polytechnic for helpful discussion on the plant remains. The manuscript was read by Dr C Vita-Finzi of the Department of Geography, University College London, whose observations are gratefully incorporated.

Chapter VI
Subfossil land-snail faunas from Grimes Graves and other Neolithic flint mines

by J G Evans and Hilary Jones with comments on the charcoal by Carole Keepax.

Some of the earliest work in which land snails were used as indicators of the past environment of archaeological sites was on the faunas from Neolithic flint mines. It is just over a century ago that E H Willett (1872) remarked on the shell layers in the shafts at Cissbury, Sussex, and he was followed shortly after by A H Lane-Fox (General Pitt-Rivers) (1875), the first to suggest the potential of land snails as environmental indicators. In the early decades of the 20th century, the principal champion of molluscan analysis was A S Kennard. One of his first major studies of an archaeological site was Grimes Graves where the faunas were used not only as environmental and climatic indicators, but as evidence for the Holocene age of the mines which was then in dispute (e.g. Clarke 1917).

In this report, the subfossil land-snail faunas from the infill of the flint mine shaft excavated by the Department of the Environment in 1971 and 1972 at Grimes Graves are described and their environmental implications discussed. The opportunity is taken to record previously unpublished lists of mollusca from three Sussex flint mines—Blackpatch, Church Hill and Cissbury. The identifications of charcoal samples from Grimes Graves are listed and discussed.

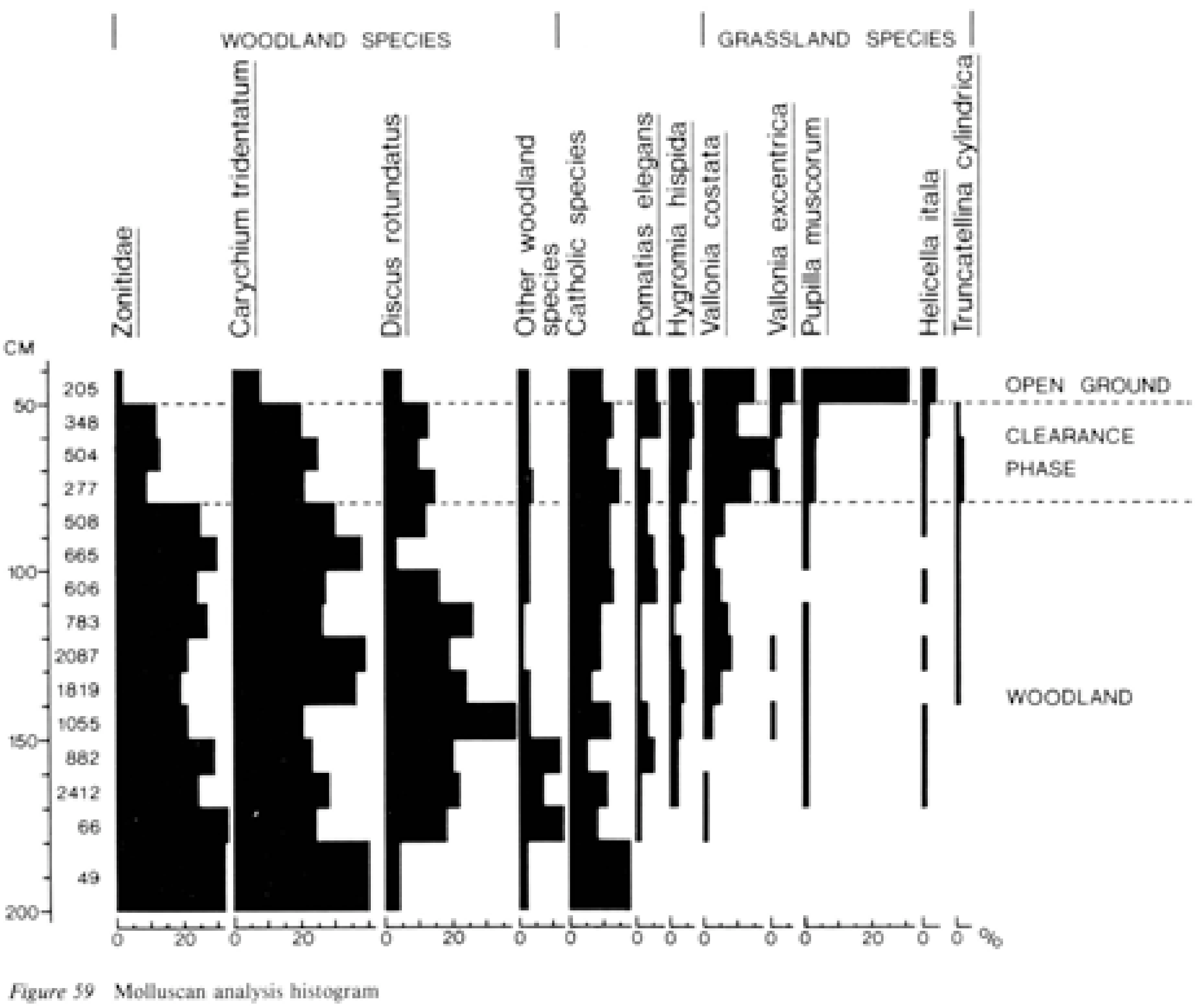


Figure 59 Molluscan analysis histogram

Table XXI. Grimes Graves. Land mollusca.

cm . . .	180–200	170–180	160–170	150–160	140–150	130–140	120–130	110–120	100–110	90–100	80–90	70–80	60–70	50–60	40–50
Pomatias elegans (Müller)	—	—	26	46	27	28	14	7	35	34	15	10	7	26	12
Acicula fusca (Montagu)	—	7	72	84	11	11	3	—	—	—	—	—	—	—	—
Carychium tridentatum (Risso)	20	16	703	214	202	157	787	198	167	252	161	60	134	74	16
Cochlicopa lubrica (Müller)	—	—	35	8	33	18	15	9	8	10	10	3	3	8	—
Cochlicopa lubricella (Porro)	—	—	22	11	13	12	7	30	6	2	—	—	2	12	2
Cochlicopa spp.	1	2	72	—	25	48	88	15	17	11	20	10	15	8	8
Truncatellina cylindrica (Férussac)	—	—	—	—	—	2	5	2	2	2	1	5	12	5	—
Vertigo pusilla Müller	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—
Pupilla muscorum (Linné)	—	—	4	1	5	5	5	3	—	1	+	17	14	14	66
Lauria cylindracea (da Costa)	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Acanthinula aculeata (Müller)	—	—	65	17	12	21	8	2	8	9	13	5	9	5	3
Vallonia costata (Müller)	—	1	29	—	19	91	162	58	30	23	34	40	100	39	32
Vallonia excentrica Sterki	—	—	—	—	6	—	2	—	—	—	—	5	2	11	14
Ena obscura (Müller)	—	—	7	4	1	8	6	—	—	3	—	—	1	2	—
Marpessa laminata (Montagu)	—	—	13	1	6	1	2	1	1	1	3	3	3	—	—
Clausilia bidentata (Ström)	1	2	19	6	8	11	8	4	6	11	1	3	1	3	4
Cecilioides acicula (Müller)	—	—	—	1	—	—	1	—	—	—	—	—	—	—	—
Helicigona lapicida (Linné)	—	—	2	—	1	—	2	—	2	—	—	—	1	1	—
Cepaea hortensis (Müller)	—	+	+	—	+	+	—	—	+	+	—	1	—	—	+
Cepaea nemoralis (Linné)	—	—	—	—	—	—	—	+	+	+	—	—	—	—	+
Cepaea spp.	—	+	36	9	16	3	17	5	22	20	8	2	8	4	3
Hygromia hispida (Linné)	—	—	54	15	28	65	71	10	21	25	16	14	30	25	12
Helicella itala (Linné)	—	—	1	2	3	—	4	—	2	—	2	2	1	7	9
Punctum pygmaeum (Draparnaud)	6	2	22	2	10	15	5	—	1	1	4	7	5	1	—
Discus rotundatus (Müller)	2	12	550	178	394	435	386	208	101	18	67	43	55	46	11
Euconulus fulvus (Müller)	—	1	13	5	4	2	—	—	—	—	1	—	—	—	—
Vitrea crystallina (Müller)	—	—	58	35	29	32	28	—	—	2	—	—	—	—	—
Vitrea contracta (Westerlund)	6	—	59	58	17	39	41	—	—	—	—	4	20	19	—
Vitrea spp.	3	11	164	42	52	98	112	92	63	88	66	10	21	—	1
Oxychilus cellarius (Müller)	2	5	35	39	29	32	43	24	12	19	8	3	7	3	—
Retinella radiatula (Alder)	1	—	1	—	—	—	—	—	—	—	—	—	1	—	—
Retinella pura (Alder)	1	4	196	66	62	112	161	45	26	32	24	4	5	9	1
Retinella nitidula (Draparnaud)	4	2	80	29	22	44	50	52	50	58	27	6	22	13	2
Vitrina pellucida (Müller)	1	—	46	4	9	14	39	11	12	28	17	6	21	10	5
Limacidae	1	—	28	5	11	14	16	7	14	15	10	14	4	3	4

+ = non-apical fragment only. Weight of each sample, 1.0kg (air-dry). 0cm = 2.17m below C + 1.

Grimes Graves: Excavations 1971–1972

A series of 15 samples was analysed for land mollusca using the method described by Evans (1972). The samples came from the upper, relatively fine fill of the shaft (Layers 1 to 1B) of mainly Bronze Age date. Below this level the deposits were virtually devoid of snails due to the rapidity of infilling and the coarse nature of the fill. The results of analysis have been presented in tabular form (Table XXI) and as a histogram of relative abundance (Figure 59).

Between 170 and 200cm, shells are sparse. Nevertheless, the fauna is clearly dominated by shade-loving species. This material is the upper part of the rapid fill.

Above 170cm, shells become extraordinarily abundant, in two samples there being over 2000 shells. Conditions were evidently extremely congenial for molluscan life. Woodland species predominate, the main elements being the Zonitidae (in particular *Retinella pura* and *Vitrea*), *Carychium* and *Discus*. Of the open-country species, only *Vallonia costata* is at all well represented, and this is known to occur in woodland on occasion. It certainly seems to have been more flexible in its habitat preferences in prehistoric times than it is today.

What kind of environment is to be envisaged in the lower levels of the fill? The interpretation of molluscan assemblages from ditch or pit situations is always made difficult by the local conditions of shelter and dampness which they engender. Open-country forms are inhibited by tall, rank grass and scrub as much as by an arboreal cover. Nevertheless, the almost total absence of any grassland or open-country species throughout the deposits up to about 80cm at Grimes Graves almost certainly indicates tree growth. Moreover, the detailed composition of the assemblage indicates a certain amount of leaf litter. Vast numbers of *Carychium* and *Vitrea*, and, relatively, of *Acicula*, would not occur in rank grass habitats. Catholic species such as *Retinella radiatula*, *Vitrina*, *Euconulus* and *Cochlicopa* are sparse, and this too suggests a woodland vegetation with dense leaf litter. A further indication is provided by the low percentages of *Pomatias elegans*, a species which prefers broken ground such as obtains in scrub. Altogether there is strong evidence for woodland between 170 and 80cm.

Above 80cm, open-country species increase in numbers, but it is not until 50cm that they become important. *Vallonia costata* is the main component of the open-country (grassland) group in the 'Clearance Phase' (Figure 59, 80–50cm). *Pupilla* shows a marked rise above 50cm. Woodland species decline, reaching insignificant proportions by 50cm. It is interesting that the rare xerophile, *Truncatellina*, which occurs in low numbers from 140cm upwards, although initially increasing in the clearance phase, actually shows a decline towards the surface, and fails to appear at all in the top sample. These changes in fauna reflect deforestation and a trend to the more open conditions which today prevail on the site.

Previous lists of land mollusca from Grimes Graves are published by Clarke (1915), Peake (1919) and Armstrong (1934). They do not differ significantly from the faunas described above, although Kennard records *Balea perversa*, a tree snail, which has not turned up in the present study.

The buried soil beneath the dumps from the mine shaft was non-calcareous and devoid of snails. The rich molluscan fauna in the fill of the shaft is due to the activities of man in breaking through the sandy drift and bringing up chalky material thereby upgrading the lime content of the environment.

Numerous (262) samples of charcoal from Grimes Graves were identified, providing evidence for 14 types of woody plant. These are listed in Table XXII. Many of the samples were from the upper layers of the shaft, but some were also available from lower levels. The pattern of results from different layers was similar, providing no evidence for a change in the actual composition of woodland during the period of infill. An environmental interpretation of these results is complicated by a number of factors. First, it must be assumed that the wood was of local origin, and not imported by man. In this case, the types represented (with the possible exception of a single pine fragment) would be expected on the local soils. Secondly, the charcoal may not reflect the local abundance of various tree types because of preferential human selection of the timber before it was burnt. Finally, as charcoal is resistant to decay, some older charcoal may have been incorporated into the deposits filling the shaft. This could partly explain the lack of variation in charcoal composition throughout the layers. The taxa identified, therefore, probably represent locally available material contemporary with, or earlier than, the shaft deposits.

The overall results resemble those obtained from many other lowland sites of various periods (Keepax 1977). The only apparent differences are the absence of ash, alder, and willow at Grimes Graves. These are often present on other sites. The lack of alder and willow could be tentatively linked to an absence of suitably damp habitats in the immediate vicinity of the site. Without supplementary evidence, however, it is not possible to distinguish variations caused by environmental factors from those caused by human selectivity.

Table XXII. Grimes Graves. Charcoal identifications.

Quercus sp. (oak)	+ + + + +
Rosaceae, subfamily Pomoideae (e.g. hawthorn)	+ + + +
Corylus sp. (hazel)	+ + + +
Prunus sp. (e.g. blackthorn)	+ + +
Taxus sp. (yew)	+ + +
Rhamnus sp. (buckthorn)	+ +
Ilex sp. (holly)	+ +
Tilia sp. (lime)	+ +
Hedera sp. (ivy)	+
Betula sp. (birch)	+
Acer sp. (e.g. field maple)?	few samples
Sorbus sp. (e.g. rowan)?	one sample
Pinus sp. (pine)	one sample
Sambucus sp. (elder)?	one sample

The frequency of occurrence within the samples is roughly assessed on a scale from + (occasional) to + + + + + (very common).

Cissbury, Sussex

One of the earliest excavations of the flint mines at Cissbury was by E H Willett (1872) who commented on the abundance of *Pomatias elegans* in the upper levels of the fill; the presence of *Cepaea nemoralis* and the rare species, *Helicodonta obvoluta*, was also noted. In later excavations, A H Lane-Fox (1876) remarked on the 'very numerous' *Pomatias elegans* and listed, in addition to the species recorded by Willett, *Helicella itala*, *Helicigona lapicida*, *Discus rotundatus*, *Arianta arbustorum* and *Oxychilus cellarius*.

The excavations by J H Pull in the early 1950's were not published. Only one shaft, number 27, was thoroughly excavated. The mollusca from this shaft were never analysed and remained in the Pull Collection in the Worthing

Museum. They were made available for study through the kindness of the Curator, Mr L M Bickerton, and were sent to me by Miss Elizabeth Pye. All the samples were of large shells collected during excavation. Fortunately, however, they had not been washed and it was possible to extract many smaller species from the earth inside the larger shells.

The loci of the various shell collections are as follows:

1. Surface soil.
2. Base of surface soil.
3. 90cm. Rainwash in shaft.
4. 90–105cm. Fill of shaft. Very chalky; many of the shells heavily encrusted with calcium carbonate.
5. 90–120cm.
6. 180–240cm.
7. 240cm.
8. 420cm.
9. 450cm.
10. 450–480cm.
11. 540cm.
12. 600cm. Shells with skeleton at base of shaft.

The results of analysis are presented in tabular form (Table XXIII), but because of the over-representation of the larger species—*Pomatias elegans, Helicigona, Arianta* and *Cepaea*—it has not been possible to construct a meaningful histogram.

The fauna from the fill of the shaft (3 to 12) is totally dominated by woodland species. All open-country species are absent. Woodland conditions are indicated. There are certain differences with the fauna from Grimes Graves which are worthy of mention although their meaning is obscure. Thus *Arianta* and *Hygromia striolata* are abundant at Cissbury while totally absent from Grimes Graves. Of the zonitids, *Oxychilus* and *Retinella nitidula* are the predominant forms, which is in striking contrast to the profusion of *Vitrea* and *Retinella pura* at Grimes Graves.

It is interesting that mollusca should be prolific to the base of the shaft. This is in contrast to the situation at Grimes Graves where the coarse rubble was poor in shells. However, this may be a reflection of the shallower and broader nature of the shafts at Cissbury, making for less coarse fill and greater stability at a relatively lower level. Thus Willett (1872, Plate 26, Figure 3) shows a section through one of the shafts in which a layer of fine rainwash occurs less than 120cm from the base.

The fauna from the surface soil (1 and 2) is of mixed character, with shade-loving and open-country species present. Woodland clearance, as at Grimes Graves, is implied by these faunal changes.

Church Hill, Sussex

The mollusca from the various excavations at Church Hill have never been published. Identifications were made by A S Kennard (Shafts 1, 2 and 3) and A G Davis (Shafts 4, 5, 6 and 7). The lists were kindly made available from the Pull Collection by Mr L M Bickerton and were sent to me by Miss Pye; they are reproduced in Table XXIV.

The larger species are clearly over-represented due to hand-picking during excavation. As at Grimes Graves and Cissbury, the faunas fell essentially into two groups, those from the galleries and shafts in which woodland species predominate, and those from the upper fill and top-soil in which open-country species are prominent. Again, as at Cissbury, mollusca are prolific in the galleries.

Blackpatch, Sussex

The mollusca from this site were examined by Kennard and Woodward but not published. J H Pull in 'The Flint Miners of Blackpatch' (1932), discusses the assemblages and suggests that they imply damper climatic conditions than exist on the Downs today. M P Kerney (1957) re-examined the shells from the Neolithic levels (Rainwash 2, Table XXV) which are now in the British Museum, and re-identified one of the examples of *Lauria cylindracea* as the rare species, *Lauria sempronii*, now extinct in Britain.

The lists given here are from three levels: Topsoil, Rainwash 1 and Rainwash 2 (Table XXV). Rainwash 2 is almost certainly of Neolithic age, but the age of Rainwash 1 is unknown. The lists from the Topsoil and Rainwash 1 are from the manuscripts of A S Kennard in the Pull Collection. That from Rainwash 2 has already been published (Kerney 1957) and is reproduced here for comparison with those from the upper levels. (Six levels are given by Kennard, but the snails from the three lowest comprise examples of only five species—*Pomatias elegans, Cepaea hortensis, C. nemoralis, Hygromia hispida* and *Oxychilus cellarius*—all listed as common.)

Here again we are dealing with an initially woodland fauna (Rainwash 2) which is succeeded by two increasingly open-country assemblages. It has been suggested that the presence of species such as *Acicula, Lauria* and *Helicodonta* attests to '. . . a climate damper than that of the South Downs today . . .' (Kerney 1957). This is seemingly supported by the presence of a very large (giant) race of *Arianta arbustorum*. Rainwash 1 and the Topsoil are characterised by a more open and impoverished fauna, a change which reflects a drying out of the environment, but which does not *necessarily* imply a *climatic* shift to drier conditions.

Other Neolithic flint mines

Snail assemblages from Harrow Hill, Sussex, are listed by Curwen *et al.* (1926) and Holleyman (1937). In both cases they are scanty in species and numbers, and the over-representation of the larger forms apparent. Open-country species predominate but this is probably a reflection of the fact that the samples came from close to the surface. The presence of *Helix aspersa* is certainly not in keeping with a prehistoric age, for this species was introduced into Britain in Roman times.

Mollusca from Shaft 3 at Stoke Down, Sussex are listed by Wade (Wade 1923), all from the silting down to 75cm. The list is short but includes the rare *Helicodonta obvoluta*, and the tree snail, *Balea perversa*. The mollusca from Long Down, Sussex, (Salisbury 1961) include only those hand-picked during excavation and are of little value.

In Wiltshire, extensive lists of mollusca are recorded from Easton Down (Stone 1931 and 1933). The faunas are rich in species and similar to those from the lower levels at Grimes Graves and the Sussex mines—Blackpatch, Church Hill and Cissbury—although differing in the presence of a small, open-country component. *Helicodonta* and *Clausilia rolphi*, species with a restricted distribution today, are present. So too is *Ena montana*, unrecorded from other flint mine sites.

There is a short and uninformative list of species from Peppard Common, Oxfordshire (Peake 1913), and an equally short list from the medieval flint mine at East Horsley, Surrey, which includes *Helix aspersa* (Wood 1950).

Table XXIII. Cissbury, Shaft 27. Land mollusca.

Samples. .	12	11	10	9	8	7	6	5	4	3	2	1
Pomatias elegans (Müller)	229	53	—	580	6	+	57	—	162	—	112	22
Acicula fusca (Montagu)	—	—	—	1	—	3	2	—	3	—	—	1
Carychium tridentatum (Risso)	—	—	—	—	—	11	—	—	14	—	3	3
Cochlicopa lubrica (Müller)	1	—	—	1	—	—	1	—	2	—	—	—
Cochlicopa lubricella (Porro)	—	—	—	—	—	2	—	—	—	—	+	2
Cochlicopa spp.	—	—	—	—	—	—	2	—	4	—	—	—
Vertigo pygmaea (Draparnaud)	—	—	—	—	—	—	—	—	—	—	—	1
Pupilla muscorum (Linnè)	—	—	—	—	—	—	—	—	—	—	1	4
Acanthinula aculeata (Müller)	—	—	—	—	—	—	—	—	3	—	—	4
Vallonia costata (Müller)	—	—	—	—	—	—	—	—	—	—	—	1
Vallonia excentrica Sterki	—	—	—	—	—	—	—	—	—	—	—	2
Ena obscura (Müller)	—	—	—	—	—	—	—	—	1	—	—	—
Marpessa laminata (Montagu)	4	27	—	1	—	—	—	—	—	—	1	2
Clausilia bidentata (Ström)	—	1	—	—	—	—	—	—	1	—	1	1
Helicodonta obvoluta (Müller)	—	—	—	—	—	—	—	—	2	2	—	—
Helicigona lapicida (Linnè)	12	5	52	1	—	1	—	—	1	—	—	—
Arianta arbustorum (Linnè)	9	5	41	1	1	2	1	6	5	—	—	—
Cepaea hortensis (Müller)	24	39	—	42	1	—	8	—	17	—	—	20
Cepaea nemoralis (Linnè)	80	160	—	134	—	—	23	1	33	—	—	68
Cepaea spp.	7	29	—	17	—	3	—	—	14	—	1	5
Helix aspersa (Müller)	—	—	—	—	—	—	—	—	—	—	—	4
Hygromia striolata (C. Pfeiffer)	5	14	—	—	5	16	—	—	9	—	—	—
Hygromia hispida (Linnè)	11	9	—	1	2	—	—	—	—	—	3	8
Helicella gigaxi (L. Pfeiffer)	—	—	—	—	—	—	—	—	—	—	1	—
Helicella virgata (da Costa)	—	—	—	—	—	—	—	—	—	—	1	—
Helicella itala (Linnè)	—	—	—	—	—	—	—	—	—	—	1	1
Discus rotundatus (Müller)	25	30	—	—	—	4	2	—	24	—	—	5
Euconulus fulvus (Müller)	—	—	—	—	—	1	1	—	—	—	—	—
Vitrea crystallina (Müller)	—	—	—	—	—	—	—	—	2	—	—	—
Vitrea contracta (Westerlund)	1	—	—	—	—	1	1	—	10	—	1	3
Oxychilus cellarius (Müller)	20	23	—	—	3	—	2	—	8	—	—	1
Retinella radiatula (Alder)	—	—	—	—	—	—	—	—	—	—	—	1
Retinella pura (Alder)	—	—	—	—	—	—	—	—	4	—	1	2
Retinella nitidula (Draparnaud)	14	11	—	—	5	7	2	—	17	—	—	6
Vitrina pellucida (Müller)	—	—	—	—	—	—	—	—	3	—	—	2
Limacidae	—	—	—	—	—	—	—	—	3	—	—	9

+ = non-apical fragment only.

Table XXIV. Church Hill. Land mollusca.

	Shaft 1				Shaft 2			Shaft 3			Shaft 4			Shaft 5	Shafts 6 & 7	
	4	3	2	1	3	2	1	3	2	1	3	2	1	1	2	1
Pomatias elegans (Müller)	x	x	x	x	6	10	3	14	2	4	36	36	20	13	59	3
Acicula fusca (Montagu)	—	—	—	—	—	2	—	—	3	—	—	—	—	—	—	—
Carychium tridentatum (Risso)	—	—	x	—	—	—	—	—	—	—	12	—	—	—	8	—
Cochlicopa lubrica (Müller)	—	—	x	x	—	2	6	1	1	4	4	1	20	—	5	29
Vertigo pygmaea (Draparnaud)	—	—	x	x	—	—	—	—	—	x	—	—	6	—	—	2
Pupilla muscorum (Linné)	—	—	x	x	—	2	9	—	1	7	—	—	79	—	4	26
Acanthinula aculeata (Müller)	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
Vallonia costata (Müller)	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—
Vallonia excentrica Sterki	—	—	—	x	—	—	2	—	4	1	—	—	4	—	—	3
Ena obscura (Müller)	—	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—
Marpessa laminata (Montagu)	—	—	x	—	—	—	—	1	—	—	—	—	—	—	—	1
Clausilia bidentata (Ström)	—	—	x	—	—	—	—	—	—	—	—	—	—	—	—	1
Clausilia rolphi (Turton)	—	—	—	—	1	2	—	—	—	—	2	—	—	—	1	5
Helicodonta obvoluta (Müller)	x	—	x	—	—	—	—	—	—	—	8	2	—	—	2	—
Helicigona lapicida (Linné)	—	—	x	—	—	—	—	—	—	—	—	3	—	—	4	1
Arianta arbustorum (Linné)	x	x	x	x	2	11	—	1	5	—	4	10	2	1	22	—
Cepaea hortensis (Müller)	x	x	x	x	8	2	—	7	1	—	9	10	14	—	29	19
Cepaea nemoralis (Linné)	x	x	x	x	4	8	10	8	8	9	25	48	76	2	51	72
Helix aspersa (Müller)	—	—	—	x	—	—	—	—	—	x	—	—	5	—	—	6
Hygromia striolata (C. Pfeiffer)	—	—	x	x	—	—	—	2	2	—	4	—	—	—	10	3
Hygromia hispida (Linné)	—	—	x	x	1	1	6	1	—	7	—	—	16	—	2	49
Monacha cantiana (Montagu)	—	—	—	—	—	—	—	—	—	x	—	—	—	—	—	—
Helicella caperata (Montagu)	—	—	—	x	—	—	—	—	—	x	—	—	1	—	—	6
Helicella gigaxi (L. Pfeiffer)	—	—	—	x	—	—	—	—	—	—	—	—	5	—	—	8
Helicella virgata (da Costa)	—	—	—	x	—	—	—	—	—	x	—	—	2	—	—	76
Helicella itala (Linné)	—	—	—	x	—	—	—	—	—	x	—	—	30	—	—	22
Punctum pygmaeum (Draparnaud)	—	—	—	—	—	—	—	—	—	—	—	—	7	—	—	—
Discus rotundatus (Müller)	x	x	x	—	8	20	2	6	27	—	79	17	9	5	20	16
Vitrea crystallina (Müller) (agg.)	—	—	—	—	—	—	—	—	—	—	2	2	1	—	—	2
Oxychilus cellarius (Müller)	x	x	x	x	—	—	—	1	1	1	25	1	2	3	3	2
Retinella pura (Alder)	—	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—
Retinella nitidula (Draparnaud)	—	x	x	—	—	4	1	1	3	1	—	—	—	—	3	4
Limacidae	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10	5

x = presence; numbers not recorded.
Shaft 1: 4 = base of shaft and galleries; 3 = rainwash 2; 2 = rainwash 1; 1 = top soil.
Shafts 2 and 3: 1, 2 and 3 = layers 1–3; no other data.
Shaft 4: 3 = base of shaft and galleries; 2 = silt; 1 = top soil.
Shaft 5: 1 = base of shaft.
Shafts 6 and 7: 2 = rainwash; 1 = top soil.

Table XXV. Blackpatch. Land mollusca.

	Rain-wash 2	Rain-wash 1	Top-soil
Pomatias elegans (Müller)	C	C	C
Acicula fusca (Montagu)	R	—	—
Carychium tridentatum (Risso)	C	R	R
Cochlicopa lubrica (Müller)	8	—	—
Cochlicopa lubricella (Porro)	4	—	—
Cochlicopa spp.	—	—	C
Vertigo pygmaea (Draparnaud)	—	—	R
Pupilla muscorum (Linné)	—	C	C
Lauria cylindracea (da Costa)	2	—	—
Lauria sempronii (Charpentier)	1	—	—
Acanthinula aculeata (Müller)	C	—	—
Vallonia costata (Müller)	—	—	C
Vallonia excentrica Sterki	—	—	C
Ena obscura (Müller)	R	—	—
Marpessa laminata (Montagu)	C	R	—
Clausilia bidentata (Ström)	C	—	—
Cecilioides acicula (Müller)	R	R	R
Helicodonta obvoluta (Müller)	C	—	—
Helicigona lapicida (Linné)	R	R	—
Arianta arbustorum (Linné)	C	—	R
Cepaea hortensis (Müller)	C	—	—
Cepaea nemoralis (Linné)	C	C	C
Helix aspersa Müller	—	—	R
Hygromia striolata (C. Pfeiffer)	R	—	—
Hygromia hispida (Linné)	C	—	C
Helicella itala (Linné)	—	C	C
Punctum pygmaeum (Draparnaud)	R	—	—
Discus rotundatus (Müller)	C	C	C
Euconulus fulvus (Müller)	R	—	—
Vitrea crystallina (Müller)	7	—	—
Vitrea contracta (Westerlund)	45	—	—
Vitrea spp.	—	R	—
Oxychilus cellarius (Müller)	C	—	—
Retinella pura (Alder)	C	R	—
Retinella nitidula (Draparnaud)	C	R	R
Vitrina pellucida (Müller)	R	—	—
Limacidae	R	—	R

C = 10 or more;
R = less than 10.

Discussion

There is little doubt that the rich faunas from Grimes Graves, Easton Down and the Sussex mines indicate the presence of former woodland which grew up after the abandonment and partial infilling of the shafts. We have already discussed the evidence for this in the case of Grimes Graves. The type of woodland is difficult to assess, however, for mollusca do not reflect the composition of the vegetation in terms of plant species. The charcoal identifications may give some indication of the taxa present, but not their relative abundance.

It has been suggested on a number of occasions that species such as *Helicodonta* and *Helicigona* are indicative of beech woodland. This is not so, however, the present day predeliction of these species for beech woods simply being a reflection of the fact that such habitats are widespread in the area of distribution of these two species. In Neolithic and Bronze Age times, beech, although present, was rare and did not form extensive stands of woodland as it does today. Perhaps the most likely species are birch and ash, and certainly the latter is recorded as charcoal from a number of sites—Harrow Hill (Curwen *et al.* 1926; Holleyman 1937), Blackpatch (Pull 1932) and Church Hill (Pull Collection manuscript). Regeneration of an area of chalk downland, after Neolithic forest clearance, by ash, yew and birch, has been attested at Brook, Kent from the joint evidence of charcoals and snails (Kerney *et al.* 1965). In the Lewes area in Sussex, the importance of ash in regenerating vegetation close to or on the Chalk has been demonstrated by pollen analysis (Thorley 1971). At Grimes Graves it is perhaps more reasonable to see birch as the main component of the regenerating vegetation (as it is today in the area—with the exception of the conifer plantations of the Forestry Commission) due to the cover of non-calcareous, sandy drift. Beech charcoal is recorded as being abundant at Grimes Graves (Clarke 1917). It was absent, however, from the 1971–2 material, and the identification should perhaps be considered with reservation in view of the confusion sometimes arising between beech and hazel charcoal at low magnifications. The 1971–2 samples did not produce ash charcoal, but a small quantity of birch was present. Even if some of this represents pre-abandonment vegetation, its presence in the area would mean that it could quickly colonise clearings.

The extent of the woodland cover—whether spread over the entire area of the sites and beyond or whether confined to individual mine shafts—is difficult to ascertain. This problem arises frequently on prehistoric sites of the pit or ditch type, there being several faunas from southern England which indicate woodland regeneration in such a context. Many of these are of Late Neolithic or Early Bronze Age date and follow a phase of open country. It is possible to see these as a stage in the ecological succession of vegetational change accompanying the infilling of a rock-cut hollow, but the degree of woodland regeneration must also relate to broader aspects of the environment such as the extent of woodland in the area, grazing pressure by wild and domesticated animals, and the degree of human interference. I (J G E) have recently suggested that woodland regeneration in Late Neolithic and Early Bronze Age times may have been a general trend in various parts of Britain as a whole (Burleigh *et al.* 1973) but this is not a theory for which there is strong evidence.

The woodland phase was followed by clearance, but neither the age, origin nor mechanism for this at the various sites is clear. Almost certainly, however, we can see man or his domestic animals as being responsible, not climate. There is no reason why woodland should not occur on any of the sites discussed, as indeed it does on high chalkland areas today when anthropogenic controls are relaxed.

In his interpretation of the land-snail faunas from flint mines, Kennard was inclined to see climate—and in particular, conditions of high rainfall—as the prime cause of their richness. 'The whole assemblage denotes much damper conditions than now exist. This . . . confirms the view . . . that Grimes Graves were excavated in the damp period immediately succeeding the warm Holocene period . . .' (Kennard and Woodward in Peake 1919). 'The conditions indicated are a damp woodland with open grassy patches certainly much damper than it is today with a greater rainfall' (Kennard in Armstrong 1934). The theory, which in essence suggests that the climate during the Neolithic period in southern England was wetter than that of today, is based on the fact that certain species of snail which are now locally extinct on the Downs, or at least greatly restricted, were once more common, sometimes thriving in abundance. The main species are *Pomatias elegans*, *Acicula fusca*, *Clausilia rolphi*, *Helicodonta obvoluta* and *Arianta arbustorum*. Other evidence for a damper climate is the presence of giant forms of some species, notably *Arianta*, and of charcoal of plants such as willow.

Taking the latter two points first, H S Toms (1928), in an interesting article in the *Sussex County Herald*, has pointed out that '... the presence of burnt willow wood in the mines seems ... unreliable as an indication of changed climatic conditions, when one remembers that even now willows are very largely used in basket-making'. Certainly, in view of the problems in charcoal interpretation discussed briefly above, it would seem unwise to base any environmental conclusions on this evidence alone. In any case, willow and alder were not identified in the 1971–72 Grimes Graves samples, providing no evidence to support this theory. Concerning *Arianta*, Toms points out that it is '... an edible snail, and that, taken by itself, the occurrence of its shells with the flint miners' debris affords no proof of wetter conditions ...'

With regard to the restriction in the distribution of the snail species mentioned above, Kerney (1968) has shown that the decline of temperature in the second half of the Post-glacial may have been a contributory cause, rather than any change in moisture regime. This applies particularly to *Pomatias elegans* which is affected by severe winter frosts. The species shows a westerly shift in its distribution in Britain to more oceanic areas from the mid Post-glacial to the present day, and locally it has become confined to sheltered habitats where temperature extremes are less marked.

A final point, and one which has often been made by archaeologists, is that all the woodland faunas come from hollows where conditions were naturally suitable for vigorous molluscan life. The kind of habitat created by the excavation of these mine shafts was alien to the chalk, and its extreme suitability for snails was almost bound to lead to extreme faunas—vast numbers of animals, many species, and giant races. Certain levels of the shafts at Cissbury were so rich in *Pomatias* (= *Cyclostoma*) *elegans* that the term '*Cyclostoma elegans* rainwash zone' was coined for them. An ecological imbalance may have been created by man, with the result that snail faunas were atypical. If this is so one is not justified in using them as indicators of climate.

This account is not intended to deny the possibility of a period of wet climate in the Neolithic. It is simply to point out that the molluscan evidence is not unequivocable. There is, for example, evidence in the Somerset Levels for an increase in rainfall in the third millennium BC (Godwin 1960), during which a series of trackways was built. This was followed by a period of apparently drier climate until the Middle Bronze Age when trackway construction ceased. Likewise in the flint mine shafts we see a substantial drying out of the environment as reflected in the changing molluscan faunas. But this may be related as much to deforestation and other processes of human origin as to climate.

Chapter VII
Summary and Conclusions
by R J Mercer

The restricted investigations carried out at Grimes Graves during 1971–72, under the direction of the writer for the Department of the Environment, demonstrated a cultural and chronological sequence for this part of the site and provided an interpretative outline for a number of phases of activity. After some evidence of Mesolithic activity and for an Early/Middle Neolithic presence in the area, the mining phase with the excavation of deep shafts on the eastern side of the site would appear to take place at some point shortly after the turn of the second millennium bc. This aspect of the mining activity is closely related, in the 1971 shaft, to the presence on the site of Late Neolithic 'Grooved Ware' users, evidenced both by the presence of Grooved Ware pottery in a primary context within the shaft and by the presence of a generalised and characteristic flint assemblage. While some evidence exists for periodic pauses in the prehistoric excavation of the shaft, the overwhelming impression gained from the site is one implying the work of a highly institutionalised and 'professional' mining community. Whether other economic activities were pursued during these pauses in mining activity (if such they be) is not known and cannot be known until occupation evidence related to the mining communities is located. This was not in evidence on site within areas excavated in 1971–72. Whatever the case, ergonomic studies indicate that the 1971 shaft *could* have been excavated, the nodules removed from the shaft floor and the galleries worked within a period of 2–3 months by a work team never exceeding 15–16 men. Calculations based upon the negative impressions of the floorstone nodules remaining on the trampled chalk floor of the mine shaft indicate that after the removal of some 1000 tons of overburden, 8 tons of tabular flint were obtained. The nodules were broken to manageable proportions at the base of the shaft and removed, it is suggested, like the chalk overburden, by ladder and baskets or leather containers to the surface area. The evidence of the 1971–72 excavation would tend to suggest that the preliminary working of the flint to form implements took place generally in very close proximity to the shaft head. Among the debris of working located in this position the industry would appear to be a non-specialist one reflecting all aspects of a normal domestic flint assemblage—very few complete or fragmentary heavy edge tools being found. The writer suggests that so strikingly does this situation contrast with that prevalent on Middle Neolithic flint mining sites in Sussex and so unlikely is it that the enormous labour input involved in shaft excavation would have been expended simply to produce a normal domestic flint assemblage, that the contrast indicates some fundamental difference in working or distributional method on the late Neolithic site at Grimes Graves. It is noted that the site at Easton Down, Wiltshire, exhibits the same contrast and may also be late Neolithic in date. This fundamental difference, which can only be guessed at without further evidence, may have resulted in very few roughouts or completed edge tools being left on the site. Immediate export of axes away from the extraction site to distribution centres or final working centres may have been one mode whereby this changed pattern was created. It is, of course, a matter of considerable urgency in British prehistoric studies that an excavation to modern standards is conducted of a Middle Neolithic flint mine shaft so that these fascinating contrasts can be properly evaluated.

The tools used in the prehistoric excavation of the shaft, it is suggested, would be wooden shovels to remove the sandy glacial till which comprises the first metre of overburden and antler picks and rakes to excavate the chalk bedrock within which the desired seam of flint lies. More than 90 such implements were recovered during the working process. The vast majority of the implements are formed from antler cast from living beasts, not cut from dead animals. It is clear that the industry at Grimes Graves must have supported an industrial sub-structure, one important aspect of which was the provision of the vast quantities of antler which would have been required. The provision of cut timber for staging and ladders within the shafts would form another aspect of this sub-structure. The working up of implements and their dispersal from the site on whatever basis would involve further specialist activities.

It is extremely difficult to suggest a likely yield in axes for the output of flint from the 1971 shaft at Grimes Graves without large-scale experimental work. In limited experimental attempts to reproduce the manufacture of a hand axe of Lower Palaeolithic type by both hard and soft hammer technique, Newcomer produced one axe of 230g weight from a nodule of 2948g weight (Newcomer 1971). In very crude terms this would indicate an 8% degree of efficiency in terms of raw material usage. This is likely to have been much enhanced by the use of the tabular floorstone and presumably was partly responsible for the very considerable efforts of the miners at Grimes Graves to obtain this material. (Other stimuli were probably the predictability of fracture and the very beautiful black lustre of the flint.) If one could assume an increase of efficiency to between 15 and 25%, then the 8 tons of flint estimated as a yield from the 1971 shaft at Grimes Graves would have produced between 1.12 and 2 tons of axes. Saville (forthcoming) has indicated a massive range between 760 and 50g for the seventeen implements classified as axes located on the site during the 1971/72 seasons. Again in very crude terms these figures (based upon a very small and possibly atypical sample) would suggest an average axe-weight of c. 200g. At these suggested rates of efficiency in raw material usage, the number of axes produced would range from c. 6150 (15% efficiency) to c. 10250 (25% efficiency). Even at Newcomer's 'single nodule' rate the figure would stand at c. 3275 axes. These figures, to a large extent notional, give some possible indication of the order of magnitude of the industry at Grimes Graves; between 5,000 and 10,000 axes may have been produced from one shaft (assuming all the time, that axes were the principal product). Comparison of the gallery plan of the 1971 shaft with those, for example, of Pits 1 and 15 would indicate (although nothing is known of the distribution of floorstone nodules in these localities) that yields may have been much higher for less labour, in that the shafts are considerably shallower. In conclusion, using these figures, the c. 500 shafts at Grimes Graves would have yielded, over a very extended period of time, between 2½ and 5 million axes (again figures which seek only to provide a concept of the order of magnitude and which assume that axes were the principal product of the mine complex).

As well as these industrial specialisms, it should not be forgotten that the ergonomic calculation carried out regarding the time and effort required for the prehistoric evacuation of the 1971 shaft has indicated that about 16 men would be required for approximately three months of working days. Whether worked continuously or not, this labour input would require (and the writer uses, for comparison, the figures used by Legge (in Chapter V) the consumption of approximately 4 SNU (standard nutritional units). In terms of cereal produce this consumption represents approximately 1212kg of cereal which, again using Legge's figures of 10cwt per acre (the Butser Iron Age Experimental Farm has produced a comparable figure, with Emmer Wheat, of 1.4ton per hectare (Reynolds 1979, 59)) suggests that one hectare of land would have had to be cultivated to satisfy this consumption. These figures may hint at a food/flint 'value' in that we can suggest with some degree of certainty that about 8 tons of flint was the product of the 1971 shaft. This last tentative suggestion must of course be tempered by a whole series of unknown factors—whether the shaft was 'disappointing' in its yield not being the least of them. A host of other specialisms (house construction and maintenance, protective clothing manufacture (a *sine qua non*), rope production, basketry production, etc.) must be built into the economic sub-structure visualised as necessary for the flint production process. It may well be that the termination of mining at the eastern edge of the complex with the 1971 shaft being one of the deepest shafts known on the site may represent the 'break even' point where the degree of exertion to obtain floorstone flint had reached a point where its yielded value could no longer be justified in terms of the very substantial diversion of material and labour from other areas of the local economy.

If such a 'catastrophic' end can be seen on economic grounds this would concur with the evidence for the total desertion of the site as reflected in the 1C group of laminar deposits within the 1971 flint mine shaft which are clearly almost sterile of any human interference. Against this proposition must, however, be placed the tendency suggested by evidence retrieved from the old land surface on both the eastern and western sides of the 1971 shaft for the strict localisation of activity to the near vicinity of any one working shaft. In these terms, work could have continued on the site with little apparent trace of its existence occurring in the 1971 shaft fill. Radiocarbon evidence would suggest that this apparent desertion of the site continued for up to 600–700 radiocarbon years before further occupation occurred of a radically different kind.

Before turning to this later occupation, something should be said of the cultural picture recorded on the site. Work since 1971 by the British Museum research project has confirmed the close association of flint mine working, at least on the southern and eastern fringes of the site, with the users of Grooved Ware pottery. While this pottery style is in itself clearly defined and well studied (Longworth *in* Wainwright and Longworth 1971) little has emerged of a cultural unit (in the Childean sense) which can be placed alongside this distinctive ceramic. Whatever the prehistoric realities that lie behind this ceramic style it can, at Grimes Graves, presumably be tied to a community of people (with specialist interests), a community who, on present evidence, would appear to exclude from the site the users and producers of other styles of pottery in use, on the basis of radiocarbon evidence, contemporarily. Notably Beaker pottery is almost totally absent from the site and this segregation might be held to argue that control of the mining complex at least at one stage of its development lay in the hands of one group who processed the flint both on and off site with no evidence being present for interaction with other groups. This suggestion would dovetail neatly with evidence for off-site processing and distribution which it has been suggested is implicit in the apparent lack of large edge tool debris on the site.

That Grooved Ware users were in need of the products of flint mine exploitation cannot be in doubt if one considers the massive architecture associated with similar ceramics at Durrington Walls, Wiltshire, Mount Pleasant, Dorset (Wainwright 1979) and Marden, Wiltshire (Wainwright 1971) and the shift in flint mine distribution to reflect the distribution of henge monuments in southern Britian during the Late Neolithic may add some weight to this suggestion. Yet the possible yield of axes from the mine complex cannot be accounted for in terms of the erection of these impressive but rare monuments. The more mundane requirements of renewed and expanded agricultural clearance apparently evidenced at the beginning of the second millennium bc associated with an apparent expansion of population may well be the major stimuli behind this demand. It is presumably these same stimuli which saw the commencement of manufacture of axes in the Group III, XIII, XVIII and XX volcanic rock axe factories at about the same date (Smith 1979).

If these estimates for axe output are even within several factors of the suggested total it is difficult to understand how this output was matched once the production of the stone axe factories ceased. There is little evidence for stone or flint axe production or even the specialised production of battle axes after c. 1200bc, and after this date we must either assume that the need for axes had substantially diminished—but there is little reason to suppose this to be the case even if forest clearance had to some extent ceased—or we must assume that production of a similar order had been taken over and achieved by metal workers by this date—at a point during the Middle Bronze Age. Even bearing in mind the greater resilience and recyclability of the metal axe this must have represented a massive achievement.

At Grimes Graves it would appear that the main phase of flint production on the site, on the basis of available radiocarbon evidence, had ceased by c. 1600 bc. After this, on the evidence present in the 1971 shaft, the site would appear to have been deserted.

Re-occupation took place, on the basis of radiocarbon evidence, at a date during the 13th century bc by farming communities moving into the area. Legge (Chapter V) would maintain that the Breckland can only be regarded as marginal land from the point of view of subsistence farming communities and it is the industrial exploitation of the site at Grimes Graves, with its consequent massive soil disturbance, that had rendered this particular niche a hospitable location. Nevertheless, it might appear that occupation of the site implies a substantial element of pressure on good farming land. The economy and subsistence of this community have been discussed at length in Chapter V. It would appear that the midden deposits set in three major horizons within the upper filling of the 1972 shaft represent the debris of a number of industrial and subsistence activities. From material within the midden a whole range of domestic and industrial pursuits are witnessed—weaving, spinning, piercing activities possibly associated with leatherworking, the processing of cereals and the slaughter of sheep and cattle. An argument has been advanced for animal husbandry on the site at this time being directed towards milk production from cattle. At Rams Hill (Bradley and Ellison 1975, 118) on the basis of a relatively small bone assemblage on a site of similar date, the suggestion is made of milk production as a possibly important element in the economy. There the situation is perhaps complicated by the uncertain function of the site. This complication would not appear to be present at Grimes Graves.

The exploitation of sheep for meat production has been suggested by Legge with the second year killing of the majority of sheep being held to militate against exploitation for wool production. It is however quite likely that meat and wool could be taken from the same animals with diminished quality and quantity being accepted in one product or the other. Certainly the artefactual assemblage from the site, including needles and bodkins, loomweights and spindle whorls, would appear to argue that textile production was of considerable importance in the settlement which produced the midden debris in the top of the 1972 shaft.

The evidence of animal bone study would appear to indicate that the Middle Bronze Age settlement at Grimes Graves was a stable one occupying the site all year round. The disposal of midden debris into the 1972 shaft was certainly periodic with fairly long periods between each phase and this may indicate shifting occupation within the immediate area or periodic clearance of debris into the shaft head when accumulation had become obstructive (or perhaps noxious). Whatever the case, the occupation at Grimes Graves would appear to have persisted for a considerable period and Legge indicates one possible combination of nutritive factors which might indicate a population *giving rise to the one midden excavated* of the order of 75 people. If one extends the midden life to 10 years the population suggested would be nearer 30.

It would appear fairly certain that cognate with the 1972 midden was a population unit substantially larger than a single nuclear family and possibly representing between five and ten such units. It is difficult to proceed any further with such figures in view of the very restricted sample of Middle Bronze Age occupation debris on the site present within the confines of 1971–72 excavation. We can however indicate that at other Deverel Rimbury sites where settlement and structures survive there would appear to be 'units' enclosed by earthworks containing timber built circular huts—at least two at New Barn Down, Sussex (Curwen 1934), two or possibly three at Shearplace Hill, Dorset (Rahtz and Apsimon 1962), two to four in the individual earthwork 'units' at Itford Hill, Sussex (Burstow and Holleyman 1957) and two or three in the 'units' at Plumpton Plain, Sussex (Holleyman and Curwen 1935). Such structural evidence might indicate that at these each unit of settlement supports 15–25 people—figures fairly close to Legge's order of magnitude calculation for a 'time span' of 10 years for the midden deposits. At Chalton, Hampshire (Cunliffe 1970) a unit of similar size to those listed above produced a series of storage pits which on the basis of calculations as exploratory as those discussed here pointed to a single family unit cultivating an area in the region of 16 acres (6.5 hectares) in extent—a figure certainly close to the c. 20 acres postulated by Legge as the requirement for the population at Grimes Graves. These figures, of course, only apply for one population unit (extended family?) of 25. In view of evidence from former excavations and work on the site since 1972 is seems likely that multiples of such units were present. Sites like Itford Hill, Sussex provide structural confirmation of the possible co-existence of several such units on one site. Radiocarbon evidence would indicate that Shearplace Hill (1180 ± 180 bc NPL-19), Itford Hill (1000 ± 35 bc GN-6167) and Chalton (1243 ± 69 bc BM-583) are very close to Grimes Graves chronologically if indeed they were not functioning contemporarily.

It is possible that the degree of intensity of exploitation indicated by Legge and the possibilities of climatic decline suggested by Evans combined to bring this stage of utilisation of the site to a close. The two burials of Early Iron Age date sealing the top of the 1971 shaft *may* be linked with the latest phase of this occupation. Equally they may represent a separate and individual casual use of the site at this later date. With their deposition, apart from intermittent visitation during the Roman period giving rise to a few sherds scattered in the hollow of the 1971 shaft, the archaeological record and chronometer of the shaft filling ceases.

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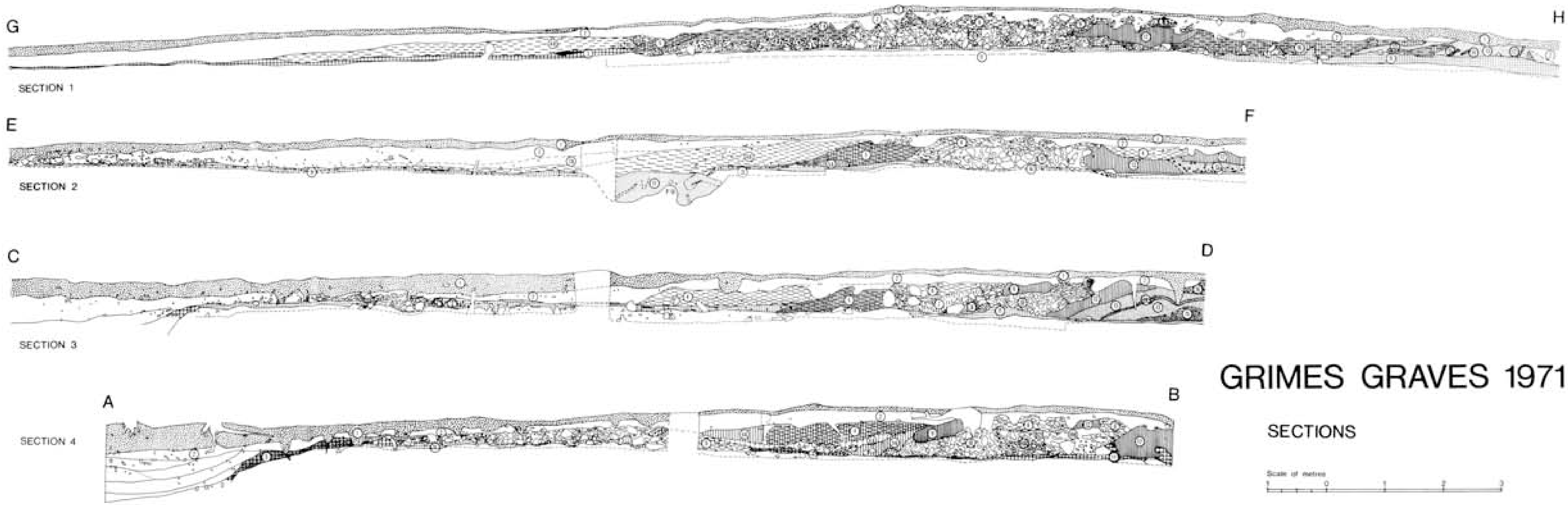

Figure 4 Surface Area excavated 1971–72—Sections

1. Humus.
2. Humic light brown soil—possibly a plough soil.

2A. Similar to 2 but with a greater quantity of chalk flecks.

3. MBA activity surface with *in situ* flint working—a brownish sand.
4. Post-MBA secondary chalky wash from the tail of the LN chalk dump.

4A. Similar to 4 with larger chalk fragments.

4B. Similar to 4 with more concreted chalk wash.

5. Pre-MBA primary chalky wash from the tail of the LN chalk dump.

5A. Similar to 5 with more concreted chalk wash.

6. Root disturbed body of LN chalk dump.

6A. Similar to 6 but with a higher proportion of chalk blocks.

7. Dump material—pure concreted chalk weathered "surface" within chalk dump.
8. Dump material—sand with large chalk blocks.
9. Dump material—chalk blocks set in dense chalk concretion.
10. Dump material—various chalk blocks.

10A. Dump material—apparent tip lines visible within 10, matched with smaller chalk blocks.

10B. Dump material—apparent tip lines visible within 10 marked by tiny chalk blocks.

10C. Dump material—vacuous chalk blocks relating to dump apparently from shaft to NE of 1971 shaft.

11. Brown sand—crushed old land surface lying beneath chalk dump.
12. Dump material—pure concreted chalk.
13. Dump material—yellow sand with few chalk fragments.
14. Dump material—yellow sand with flecks of chalky concretion.
15. Dump material—darker brown sand—apparently stripped turf.
16. Dump material—yellow sand with tiny chalk inclusions.
17. Depression in natural sand filled with uniform brown sandy soil—probable tree-hole.
18. Dump material—yellowish rotted chalk concretions—probably dug from weathered surface of natural chalk.

Figure 15 1971 Shaft. Galley 1—Sections

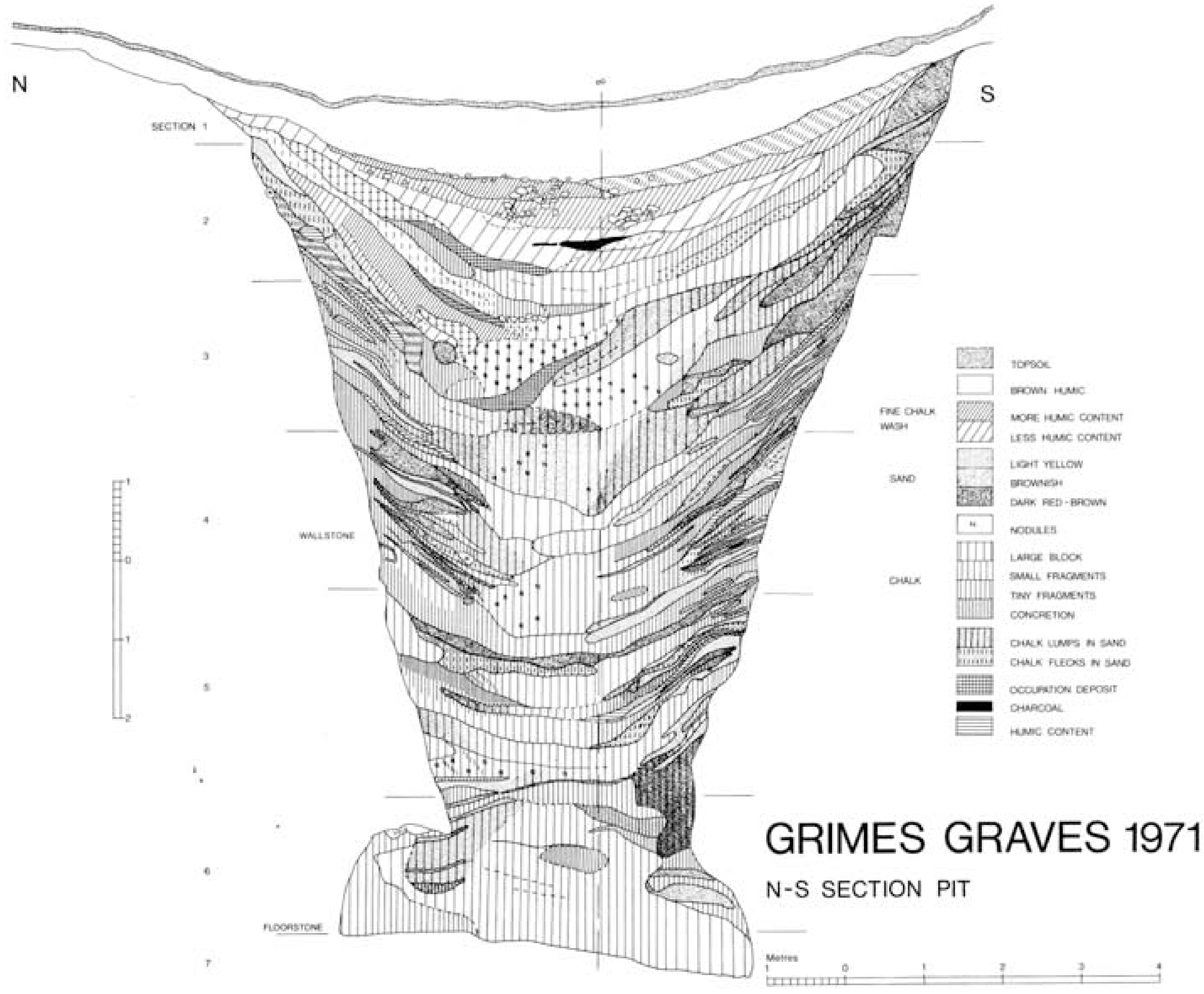

Figure 17 1971 Shaft north/south section

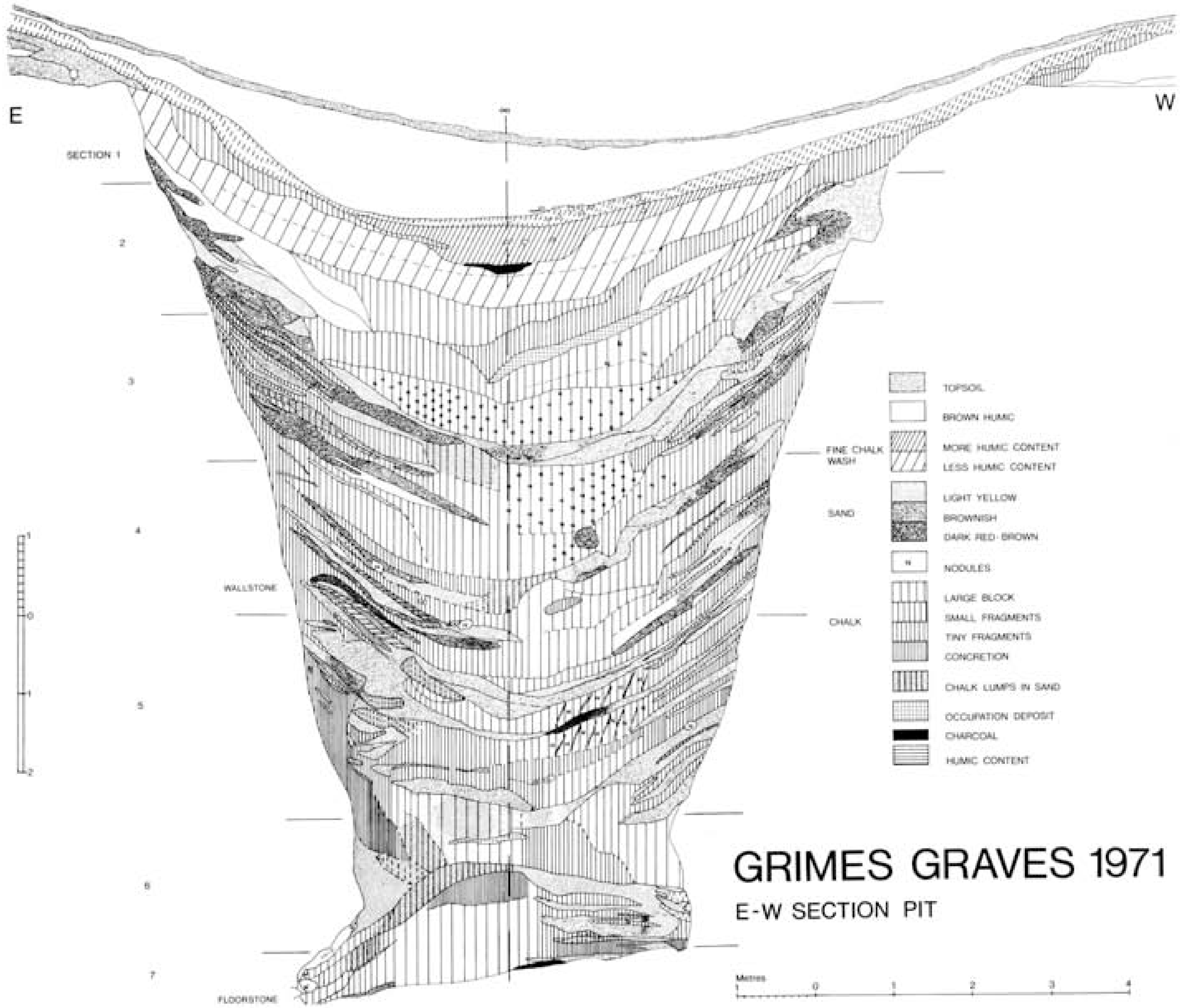

Figure 18 1971 Shaft east/west section

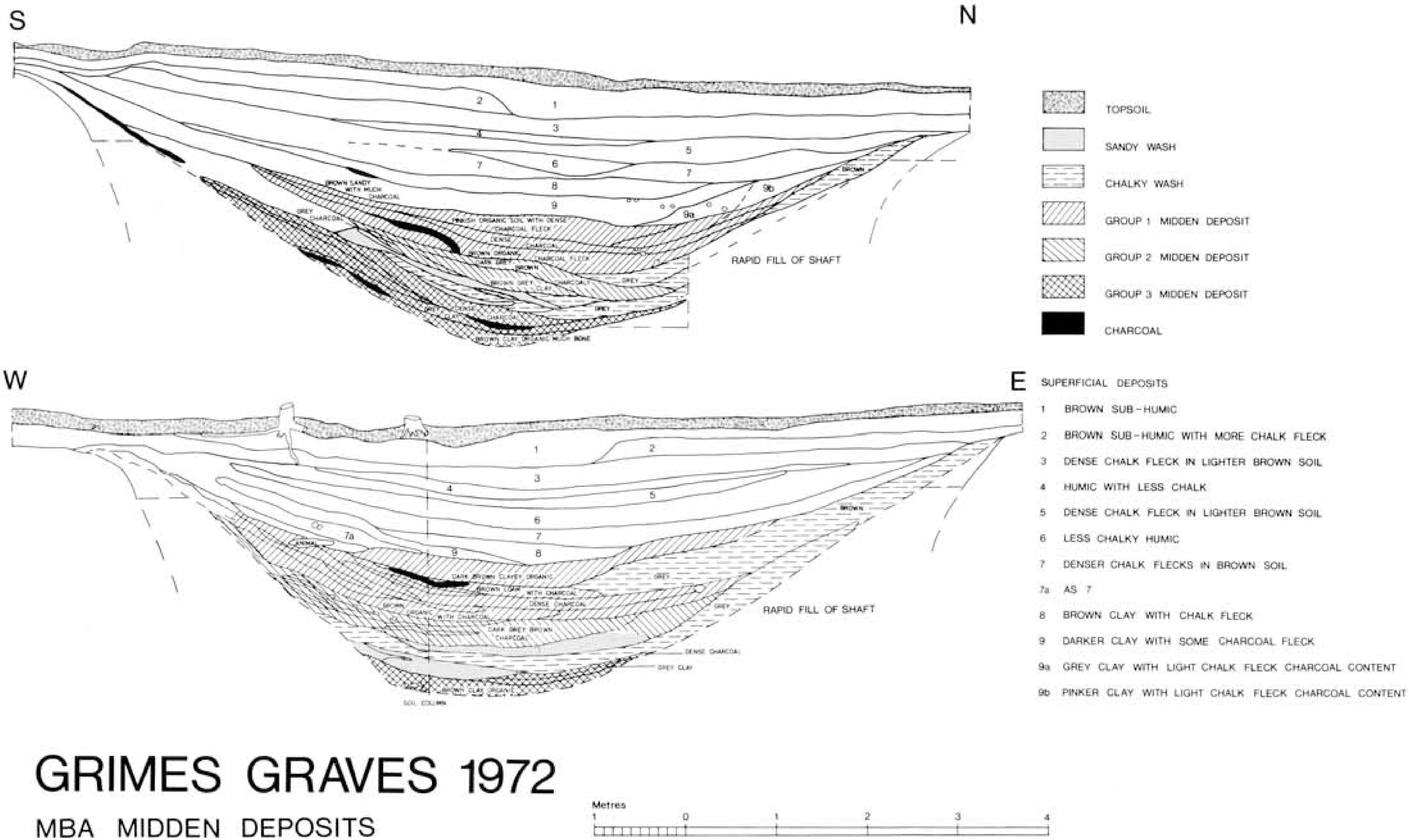

Figure 20 1972 Shaft north/south and east/west sections. Middle Bronze Age midden deposits

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