Neolithic flint mining in Britain

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There are over twenty Neolithic flint-mining sites in Britain. The location of these sites is examined in relation to the distribution of geological flint deposits. This is followed by a review of investigations that have taken place at these sites. The nature and significance of flint mines in Britain is then discussed.

KEY-WORDS: flint mining, axes, discoidal knives, mines, flint

INTRODUCTION

Over twenty Neolithic flint-mining sites are known in Britain. Mining for flint is one of the traits associated with the start of the Neolithic period in Britain, along with pottery vessels, ground and polished stone (including flint) axes, leaf-shaped arrowheads, domesticated animals, cultivated cereals and various monuments which comprise chambered tombs, earthen long barrows and causewayed enclosures. The earliest mines, those on the South Downs in Sussex, were related to the production of ground flint axes. Apart from radiocarbon dates obtained on antler picks and charcoal, the site at Cissbury can also be linked to the earlier Neolithic period by the presence of carinated bowl sherds from the fill of one of the mine shafts, the earliest type of pottery known in Britain that dates from 3100 to 2800 bc (Herne 1988). Flint-mining sites were abandoned at the end of the Neolithic period, with the latest known phase of mining at the later Neolithic site of Grimes Graves in Norfolk being associated with the deposition of Grooved Ware pottery vessels.

The purpose of this article is to look at where flint mines were located, to review investigations that have taken place at known flint-mining sites and to discuss the nature and significance of flint mines in Britain.

THE LOCATION OF FLINT MINES

Flint-mining sites occur on the Chalk of southern and eastern England (Fig. 1). The Chalk of southern England is part of the Southern or Anglo-Paris Basin

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Fig. 1. Map showing the location of known flint-mining sites in Britain: 1 — Massingham GB 14; 2 — Grimes Graves GB 13; 3 — Pitstone Hill; 4 — Peppard Common GB 11; 5 — Durrington GB 18; 6 — Easton Down GB 9; 7 — Martin’s Clump GB 10; 8 — East Horsley GB 16; 9 — West Stoke GB 8; 10 — Long Down GB 6; 11 — Harrow Hill GB 4; 12 — Blackpatch GB 1; 13 — Church Hill, Findon GB 2; 14 — Cissbury GB 3; 15 — Windover Hill GB 12; 16 — Hambledon Hill; 17 — Liddington; 18 — Beer Head GB 17; 19 — Ballygalley Hill (Ireland); 20 — Buchan (Scotland) GB 19, 20. The stippling indicates the main areas of chalk with in situ flint.
Province, mostly characterised by soft, massive chalks (Mortimore and Wood 1986). Discrete marl-seams are particularly well developed in the Turonian and lower Campanian successions and flints, where present, are typically black. The greatest concentration of mining sites in the Southern Province is on the South Downs in Sussex. Here, the main group of four sites, Blackpatch, Harrow Hill, Cissbury and Church Hill, Findon, is situated on the Secondary Escarpment between the rivers Arun and Adur. A second group of sites, Long Down and West Stoke, lies on the southern edge of the Downs in West Sussex, whilst the other known group, Windover Hill, is on the Primary Escarpment in East Sussex. Elsewhere in Sussex, single shafts have been discovered at Slonk Hill, near Shoreham, and Nore Down, near West Marden. Archaeological investigations have shown that mining took place at five of these sites during the earlier Neolithic period.

In Sussex, flint distribution varies laterally in both type and quantity due to a series of small anticlines and synclines that occurred during the Upper Cretaceous Stage (Mortimore 1986, forthcoming). Well-developed courses of flint are found along the crest of the Primary Escarpment, corresponding to the lower part of the Lewes Chalk at or close to the high Turonian flint maximum, a stratigraphic position comparable with Grimes Graves in Norfolk (see below). Although these courses of flint are known to occur at several sites along the Primary Escarpment, for example at Newtimber Hill and Chanctonbury Ring, the only known flint-mining site where this flint was extracted is at Windover Hill. However, recent excavations at Pyecombe have revealed probable flint quarry pits in an area where large quantities of Mesolithic, Neolithic and earlier Bronze Age flints, including axe roughouts and relateddebitage, have been recovered (Chris Butler pers. comm.). Further fieldwork might lead to the discovery of further mining or quarrying sites on the Primary Escarpment. The four major flint-mining sites associated with the Secondary Escarpment of the South Downs west of the Adur valley and the site at West Stoke occur in the Old Nore and Peacehaven Beds of the Newhaven Chalk. At Harrow Hill and Blackpatch seams of sheet flint and occasional large nodular flints were encountered, whilst large nodular flints were exploited at Cissbury and Church Hill, Findon. The Long Down site probably occurs in the geologically youngest chalk within the Sompting Beds of the Culver Chalk Member.

Whilst large quantities of flint were extracted at the various mining sites in Sussex, a study of flintwork from domestic and other Neolithic sites shows that mined flint accounts for a very small proportion of the flint in general circulation. In most cases, flint from local beach, river gravel, drift, Clay-with-flints or downland sources was exploited for making the range of implements and weapons in everyday use. The flint-mining sites served as sources of flint for specific purposes, mainly for producing axes. However, it is clear that axes were made at some domestic sites using flint

The Chalk in Yorkshire, Lincolnshire, Humberside and north Norfolk constitutes the Northern Province, which is characterised by hard, well-bedded chalks. As in the south, discrete marl-seams occur in both the Turonian and Lower Campanian successions. Flints, where present, are typically pale grey and, in the greater part, are tabular flints of a type not normally encountered in the Southern Province. In marked contrast to the south, flint is absent from the greater part of the visible outcrops, for example Flamborough Head in Yorkshire, of the Northern Province succession. Although there is no in situ flint at Flamborough, large flint nodules occur on the beach and these were exploited during the Neolithic period (Manby 1988:42–3). Between the two main provinces, in the central part of East Anglia and in the area stretching from the Chiltern Hills through Berkshire and Wiltshire into Dorset, is the Transitional Province. Here, the Chalk is soft but at one level, high in the Turonian, massive tabular flints of Northern Province type, known as the “Brandon Flint Series”, are present. This is the flint series exploited at Grimes Graves, in the Norfolk Breckland, the most extensive flint-mining site in Britain. One of the flint layers encountered at Grimes Graves, the wallstone, correlates with flint seams exposed where the North Downs meet the east Kent coast. A second site in Norfolk occurs at Massingham, to the north of the Breckland on the west Norfolk chalk ridge. In Wessex two sites, Easton Down and Martin’s Clump, occur on the Wiltshire-Hampshire border, whilst another is situated at Durrington on the Salisbury Plain. A quarry site is situated on the western side of Hambledon Hill, Dorset, between two earlier Neolithic causewayed enclosures. Another possible site, Liddington, Wiltshire, is situated on the scarp slope of the Marlborough Downs.

In south-west Britain lies a further discrete area of flinty Chalk, around Beer in east Devon. Another outlying area of Chalk in the British Isles occurs at County Antrim in Northern Ireland. This Chalk contains flint but is much harder than the English Chalk. Neither area has produced evidence for Neolithic flint mines, although two quarry sites are known from County Antrim (see below).

HISTORY OF RESEARCH

The flint mines at Grimes Graves, Norfolk, and Cissbury, Sussex, were amongst the earliest archaeological sites in north-west Europe to be excavated (Smolla 1987:127; Lech 1992). Superficial work was undertaken in the 1850s at both sites, examining the upper fills of some of the mine shafts. Work also took place at this time at Massingham, to the north of Grimes Graves. In the late 1860s, further excavations took place at both Grimes Graves and Cissbury. In 1867–8 General Pitt Rivers and
Canon Greenwell dug into about 30 pits at Cissbury (Lane Fox 1869:59, 1876). Although only excavating to a metre’s depth, they discovered large numbers of humanly-worked flints and thus inferred that the pits were flint mines.

The first full-scale investigation of a flint mine then followed in 1868–70 at Grimes Graves (Figs 2, 4, 5, 7 and 8). Canon Greenwell, assisted in 1870 by Lord Rosehill, excavated one of the mines on the eastern side of the site. The floor of the shaft was 12 metres below the surface, cutting through six flint seams and with galleries radiating out in all directions. In addition to worked flints, the excavations produced antler picks, chalk cups, some enigmatic chalk carvings, animal bones and a polished greenstone axe (Figs 11 and 13). Marks on the chalk walls of one of the galleries showed that this type of axe had been used during mining. Greenwell (1870) concluded that the mines at Grimes Graves dated to the Neolithic period, largely on account of the domesticated animal bones found in the fill of the shaft.

Following Canon Greenwell’s discoveries at Grimes Graves, in 1873–4 Ernest H. Willett and Plumpton Tindall each excavated completely one of the Cissbury shafts (Fig. 3): Tindall’s shaft was over 12 metres deep, whilst Willett’s was 6.5 metres deep (Willett 1880). Pitt Rivers returned to the site in 1875 and investigated a further nine shafts. The fill of one shaft produced part of a carinated plain pottery vessel. In another shaft, over one of the gallery entrances, criss-cross markings in the chalk were found. The most intriguing discovery was the skeleton of a young woman, buried head downwards near the bottom of a shaft. She had either fallen in or her body had been placed head-first in what was an unusually narrow shaft, being only 1.5 metres wide.

Pitt Rivers’ colleague, J. Park Harrison (1878), continued working at Cissbury for the next two years, opening up the three mines immediately surrounding Willett’s shaft, and exploring the gallery system interconnecting them (Figs 3 and 4). He also discovered a human skeleton, that of a young man buried half way down the shaft, lying on his side in a crouched position and surrounded by a single row of chalk blocks, as well as what are described as “refuse heaps” of domestic animal bones (Willett 1880:347–8).

After the decade in the late nineteenth century of excavating shafts at Cissbury and Grimes Graves, there was a lull of over 30 years before flint mines received further attention. In 1910–13, Major A.G. Wade (1922) excavated three of the shafts at West Stoke, Sussex, recovering, amongst other material, a saddle quernstone (Fig. 2). The shafts were 3 to 5 metres deep. No galleries were found but two of the shafts were undercut at the base, giving them a boot-shaped profile. On the Chilterns in 1912–13, Dr A.E. Peake (1913) excavated two shallow shafts at Peppard Common. In 1913, Reginald A. Smith re-opened the first shaft, which proved to be an open-cast pit with no signs of galleries in the sides of the pit (Peake 1914:404). Discoidal knives, axe
Fig. 2. Plans of flint-mining sites in Norfolk, Wiltshire and West Sussex.
Fig. 5. Plans of flint-mining sites in East and West Sussex.
preforms and roughouts are the main implements recovered from the site (Holgate 1988:336–7).

Although Canon Greenwell’s excavations at Grimes Graves had provided evidence that the site dated to the Neolithic period, this apparent fact was refuted by Reginald Smith (1912), who suggested a Palaeolithic date for the mines. The large numbers of rough-shaped core tools from Grimes Graves were likened by Smith to Palaeolithic implements, whilst the presence of domesticated animal bone was not considered as evidence for a Neolithic date. Ingeniously, the greenstone axe found in one of the galleries excavated by Greenwell was equated with similar axes found in southern Scandinavia on shell midden sites which were then interpreted as pre-Neolithic in date; since then, however, these sites have been dated to the 4th millennium bc. Smith’s views were received favourably and his arguments for dating flint mines to the Palaeolithic period became accepted.

Largely stimulated by this controversy, Dr A.E. Peake excavated at Grimes Graves in 1914–17 (Clarke 1915; Peake 1917). He excavated two shafts in 1914, both of which were about 9.5 metres deep and had galleries. The filling of the shafts and galleries produced flint-mining tools, flint-working debris and Neolithic pottery fragments. Also investigated in 1914 was a series of surface “floors” or flint-working areas. In all, fourteen working areas were excavated, which Peake classified into two types: areas containing massive chipped pieces and “finishing floors” with both massive pieces and minute flakes. On this evidence, Peake (1914) seems to favour a Neolithic date for the flint mines. However, the report on the flintwork, written by Reginald Smith, assigns a Palaeolithic date to the flints. In 1916 Peake excavated twelve more flint-working areas, recovering a second greenstone axe from one of them, and in 1917 he began the excavation of three small pits on the north-eastern edge of the site (Peake 1917); these were later termed “primitive pits” by Armstrong.

Following Peake’s work, a 19 year programme of excavations commenced in 1920 at Grimes Graves under the direction of A. Leslie Armstrong. At first, he excavated a further flint-working area where, in addition to flint-working debris, he recovered pieces of mined flint with engravings of red deer on the cortex and Neolithic pottery fragments. He also dug a series of trenches over the whole site and demonstrated that, in some areas, the floorstone was as little as 15 cm below the ground surface, suggesting that the site could have initially been located relatively easily, and probably accidentally, by the prehistoric miners.

Over the next four years, Armstrong excavated totally the three small pits opened by Peake in 1917, along with two further pits. These pits, situated on the valley side to the north-east of the visible mines, were up to 3 metres deep and without galleries. Armstrong (1923) described them as “primitive pits”, inferring that they represented the earliest phase of mining on the site. Furthermore, a mine shaft excavated in 1922 to
the south of the primitive pits appeared to have rudimentary galleries at its base. Armstrong considered this shaft to be an example of an "intermediate" group of pits, which were worked at a period between the primitive pits and the fully developed workings situated immediately to the south. Thus Armstrong (1926) proposed a three-phase chronology for the site, with the primitive pits assigned to the Upper Palaeolithic period, the intermediate pits to the Mesolithic period and the fully developed pits to the Early Neolithic period. The final published excavation programme undertaken by Armstrong (1934) at Grimes Graves began in 1928 and continued in 1930 and 1932–3, involving the excavation of five pits of the intermediate phase.

In 1922–32 John Pull (1932) investigated seven shafts and four working areas at Blackpatch, Sussex, along with twelve Bronze Age round barrows which overlay the site (Figs 3 and 4). The first shaft was over 3 metres deep with seven short galleries at its base, whilst the others varied in depth from 1 to 3 metres, all exploiting a single seam of nodular flint. One of the Bronze Age burials, a cremation accompanied by Beaker pottery, was found underneath one of the flint-working areas, showing that flint on the site continued to be worked into the early Bronze Age. Axe preforms and roughouts predominate amongst the implements recovered from the working areas. A single radiocarbon date of \(3140 \pm 150\) bc (BM-290) has been obtained on an antler pick from one of the galleries excavated on the site.

In 1924, Drs Cecil and Eliot Curwen (1926) excavated one of the shafts on the northern edge of Harrow Hill (Fig. 3), situated on the hill immediately west of Blackpatch. It was 7 metres deep and some of the galleries on the north side of the shaft were interlinked with open-cast mining of flint seams at the point where they outcropped on the side of the hill. They recovered a variety of antler and bone tools, including picks, rakes and ox shoulder-blade shovels. In 1936 George Holleyman (1937) excavated a further three shafts on the summit of Harrow Hill.

From 1929–34 Dr J.F.S. Stone (1931; 1933a) investigated a cluster of flint mines adjacent to an early Bronze Age settlement on Easton Down, Wiltshire (Figs 2 and 5), and discovered a second flint-mining site, 3 km to the north-east on the same downland ridge at Martin's Clump, Hampshire (Stone 1933b). At Easton Down, he excavated six shafts and six flint-working areas, recovering flint-working debris, antler picks and Neolithic pottery fragments. The shafts were 3 to 4 metres deep, dug to exploit the one seam of nodular flint outcropping on the hill. Whilst the base of these shafts was undercut to extract flint, there were no galleries probably due to the weak nature of the chalk which would have made the creation of galleries a hazardous task. Axe and chisel preforms and roughouts predominate amongst the implements recovered from the flint-working areas. A single radiocarbon date of \(2330 \pm 150\) bc (BM-190) was obtained from an antler pick excavated from shaft 1.
Fig. 4. Plans of three excavated flint mines.
Fig. 5. Sections of three excavated flint mines.
The work at Easton Down prompted a fresh appraisal of the age of the British flint mines. Grahame Clark and Stuart Piggott (1933), in reviewing the accumulated evidence of 60 years’ excavation work, demonstrated that the stratigraphic association of Neolithic pottery in Peake’s 1914 shafts and Armstrong’s 1920 flint-working area at Grimes Graves gave clear evidence for a Neolithic date for all three of Armstrong’s mining “phases”. Furthermore, excavations at West Stoke and Easton Down, in addition to those at Grimes Graves, suggested that the different forms of pit reflected safety in working and economy in extracting flint. They concluded that all the evidence pointed to a Neolithic date for prehistoric flint-mining sites in Britain.

The article by Clark and Piggott was published before Armstrong (1932) produced his final publication on his 1928–33 excavations at Grimes Graves. Nevertheless, Armstrong criticised the article and continued, until 1939, to excavate three further shafts, although he never reported on his final seasons’ work.

In 1932–52, Pull excavated six shafts, eight flint-working areas and eight Bronze Age round barrows at Church Hill, Findon in Sussex (Pye 1968; Figs 3 and 5). The shafts were 3 to 6 metres deep, the deepest cutting through six nodular flint seams. The galleries radiating out from the base of the other excavated shafts, mostly exploiting the fourth deepest flint seam. A series of pictograms had been cut into the roof of certain galleries in one of the shafts, whilst the upper fill of shaft 1 produced later Neolithic Grooved Ware pottery and a human cremation burial in a Beaker vessel, overlain by a flint-working area. Implements recovered from the working areas included axes, chisels, miniature axes and discoidal knives. An antler pick from one of the galleries produced a radiocarbon date of 3390 ± 150 bc (BM-181). In 1952–5, Pull transferred his operations to the flint mines on the south-western side of Cissbury (Fig. 3) excavating three shafts and three flint-working areas where axe preforms and roughouts formed the largest proportion of the implements recovered (Pye 1968). A skeleton of a young woman buried on her side in a crouched position was found on the floor at the entrance to one of the galleries in shaft 27. Three radiocarbon dates of 2780 ± 150 bc (BM-185), 2770 ± 150 bc (BM-183) and 2700 ± 150 bc (BM-184) have been produced on antler from the site.

Sample excavation of a cluster of surface depressions at Windover Hill was undertaken in 1953 by E.W. Holden (1974), confirming that the site was a small group of Neolithic flint mines. After Cissbury one of Pull’s assistants, E.F. Salisbury, spent two seasons in 1956 and 1958 excavating part of a shaft and two flint-working areas at Long Down (Fig. 2), a small group of flint mines east of the site at West Stoke (Salisbury 1961).

In Wessex, a third group of flint mines was discovered in 1952 at Durrington in the side of a pipetrench. The site, investigated by A.St.J. Booth and J.F.S. Stone (1952), consisted of three open-cast pits and two 1.5 metres’ deep shafts with undercut
bases, dug to extract a seam of poor quality flint. The fill of one shaft produced a later Neolithic flint arrowhead.

On the North Downs, the only known Neolithic flint-mining site is at East Horsley, Surrey. In 1949 excavations by K.R.U. Todd showed that a shaft and two flint-working areas on the site were Neolithic in date (Wood 1952).

In 1957 A.E.P. Collins, whilst excavating a late prehistoric enclosure, found an open-cast mining site associated with a flint-working area and earlier Neolithic pottery at Balleygalley Hill, County Antrim (Collins 1978). Only one other “quarry” site, at Black Mountain near Belfast, is presently known in Ireland (Woodman 1992) although flint nodules were later obtained from the coast in Co. Antrim, either freshly eroded from the cliffs or washed up on the adjacent beaches (Woodman 1992).

Subterranean flint mines are unknown in Scotland. However, gravel deposits composed predominantly of flint occur on the Buchan Ridge, near the coast north of Aberdeen. Over 450 shallow pits are known in one isolated patch at the Den of Boddam. A small group of these pits was excavated by Alan Saville in 1991–3, producing considerable quantities of debitage (Saville 1994).

In the early 1970s the British Museum Research Laboratory radiocarbon-dated antler and charcoal from flint-mining sites preserved in the British Museum and other museum collections. The Sussex mines generally proved to be dated to 3300–2700 BC, whilst Grimes Graves was dated to 2300–1300 BC (Burleigh 1975). At the same time, a programme of trace element analysis of a sample of flint axes from southern Britain was undertaken by the British Museum Research Laboratory. The results were matched with those obtained by analysing flint obtained from the mining sites, suggesting that the majority of these axes were manufactured using flint from the Sussex flint-mining sites. However, as some flint axes are not produced on flint extracted from the mining sites, the trace element composition of flint from sources throughout southern Britain should have been analysed, casting some doubt on the validity of the results from this programme of analysis. These scientific analyses, though, paved the way for further investigations at both Grimes Graves and the Sussex sites.

In 1971–2 Roger Mercer excavated one of the deepest shafts on the north-eastern side of Grimes Graves, finding later Neolithic Grooved Ware pottery on the floor of the shaft (Fig. 6). This was followed in 1972–6 by geophysical prospection and excavations by Gale de G. Sieveking and Ian Longworth on behalf of the British Museum (Sieveking et al. 1973; Sieveking 1979). In 1974–6 they were assisted by P.J. Felder of Werkgroep Prehistorische Vuursteenmijnbouw from the Netherlands Geological Society. This work included the investigation of several open-cast pits 2 to 3 metres in depth on the north and west side of the site, alongside which were numerous flint-working areas; the re-excavation of Greenwell’s shaft in 1974–6; and the investigation of two of the “primitive pits”, including the
re-excavation of one of the pits excavated by Peake in 1917, on the north side of the site in 1976 (Figs 7–9).

The excavations at Grimes Graves indicate that the mines were 4 to 8 metres in diameter at the surface and up to 14 metres deep, with galleries radiating out from their bases (Figs 7–8). At the tops of shafts and in the western and northern part of the site were scattered over 100 flint-working areas. At these working areas, implements were manufactured from mined flint amongst which axes, some of which were produced on large flakes, and discoidal knives appear to have been the main products (Saville 1981; Herne 1991). Neolithic pottery, notably Grooved Ware, and discarded antler picks have been recovered from the bottom of the deeper shafts. Seventeen radiocarbon dates obtained from a selection of these picks and charcoal range in date from $2320 \pm 150$ bc (BM-87) to $1340 \pm 150$ bc (BM-109). Five dates produced on antler and charcoal from the shafts excavated by Canon Greenwell and Mercer range from $1865 \pm 60$ bc (BM-775) to $1814 \pm 60$ bc (BM-777). Some of the earliest work on the use of land snails as indicators of the past environment of archaeological sites was undertaken on samples obtained from Neolithic flint mines. In the early 20th century, A.S. Kennard examined the snail shells from Grimes Graves, recording species that
Fig. 7. GB 13 Grimes Graves. Re-excavation of Greenwell's shaft in 1974-75, carried out by the British Museum. Photo: J. Lech.
Fig. 8. GB 13 Grimes Graves. A gallery at the floor of the Greenwell’s shaft excavated in 1975, showing the remnant floorstone that was being mined and two red-deer antler picks. Scale 20 cm. Photo: J. Lech.

Fig. 9. GB 13 Grimes Graves. Open-cast pit on the west side of the site during excavation carried out by the British Museum in 1976. Photo: J. Lech.
favoured woodland habitats. Work by J.G. Evans on the snails from the fill of the shaft excavated by Mercer suggests that when the shaft was abandoned and partially infilled, it was surrounded by woodland vegetation with dense leaf litter (Evans and Jones 1981). It is likely that this woodland cover spread over the entire site and beyond during the Neolithic period.

In 1982 Sieveking, with assistance from P.J. Felder, excavated the shaft at Harrow Hill immediately north-west of the one opened by Curwen in 1924–5 (Fig. 10). He also investigated the area in the vicinity of this shaft in 1984, in search of a flint-working area. In 1986 the author excavated a flint-working area and a series of open-cast pits on the south side of Harrow Hill and excavated a sample of a flint-working area and three flint mines at Long Down in 1984. Analysis of the snail shells from the fills of the shaft excavated by Sieveking (Kerney 1983) and the open-cast mines on the southern side of Harrow Hill (James Hart and Ken Thomas pers. comm.) suggests that the mines were being dug through forest. Five radiocarbon dates produced on charcoal from the shaft excavated by Sieveking range from $3400 \pm 150$ bc (BM-2098R) to $2950 \pm 120$ bc (BM-2071R). The date of $3090 \pm 120$ bc (BM-2099R) was also produced on a piece of antler that was found 5 centimetres above the floor of one of the galleries (Burleigh, Ambers and
Matthews 1984:62–3; Ian Kinnes pers. comm.), correlating favourably with the date of 2980 ± 150 bc (BM-182) produced from antler excavated by Curwen (Burleigh 1975).

At Long Down, excavation of the flint-working area indicated that axes, some of which were made on large flakes, sickles and discoidal knives were produced. Two radiocarbon dates around 3000 bc were produced on an antler pick and an ox shoulder-blade from the upper fill of a shaft partially excavated in 1983, whilst snail shells from the same deposits suggest that the flint mines were surrounded by woodland at the time when they were abandoned (James Hart and Ken Thomas pers. comm.).

In recent years, excavation of Neolithic monuments on the Chalk of southern England has indicated that ditches dug to produce material for banks and mounds sometimes yielded nodules of flint that were subsequently worked, for example at Maiden Castle, Wiltshire (Edmonds and Bellamy 1991:218), and Offham, East Sussex (James 1977). Roger Mercer’s investigations at the earlier Neolithic causewayed enclosure complex at Hambledon Hill, Dorset, in 1981 uncovered an area of flint quarrying (Mercer 1987). This area of quarrying consisted of about ten pits dug to extract a thin seam of poor quality flint. Galleries interlinked some of these pits, the fills of which produced fragments of antler mining tools and earlier Neolithic pottery. This previously unsuspected discovery shows that an unknown number of small-scale quarry sites, which leave insignificant surface undulations, could exist throughout southern and eastern England.

THE NATURE AND SIGNIFICANCE OF FLINT MINES IN BRITAIN

In Britain, flint was extracted in one of two main ways. Where it was close to the surface, it could be quarried by digging shallow pits or working horizontally in the direction of the flint by open-cast or drift mining. In places where seams of flint occurred some way below the surface, deep mine shafts were sunk (Figs 7 and 8).

When flint outcropped at the surface, chalk could be quarried horizontally, following a flint seam until a vertical working face was created. From this face galleries large enough for one person to crawl along were dug in further pursuit of the flint seam. This method of quarrying was probably practised at several sites, one example being at the northern and southern perimeter of Harrow Hill (Curwen and Curwen 1926; Holgate 1991). The maximum length of these galleries is about two metres: the approximate limit beyond which it became too dark and unsafe to work without artificial light and some form of gallery support.

An alternative method of open-cast mining, as practised on the western edge of Grimes Graves (Sieveking 1979), was undertaken by digging small pits in honeycomb fashion over the area where the main flint seam on the site reached the surface (Fig. 9).
Most galleries and pits appear to have been backfilled fairly rapidly after they were created, preserving both marks on the walls resulting from their original excavation and tools that were abandoned after use. The main mining tools used were red deer antler picks (Figs 8 and 11). Most picks were made from shed antlers, which would have been gathered in late winter. All the tines, except the brow tine, were trimmed off using a flint knife; the pick was then used to prise out the chalk. At Grimes Graves, perforated bone points, made from ox leg-bones (Fig. 11), were found in the shallow pit fills on the north-western part of the site (Sieveking 1979). These were mounted on the brow tines of antler picks whose points had previously been worn or broken off. Marks on the chalk walls of some of the galleries at Grimes Graves show that stone or flint axes, mounted in wooden handles, were also used. The chalk rubble loosened by picks or axes was then scooped up into leather bags or baskets either by hand or by using an ox shoulder-blade shovel and antler rake, the latter apparently being used at some of the Sussex sites as exemplified by Harrow Hill (Holleyman 1937); wooden shovels may have been used as well.

In the areas where the flint seams were over a metre below the surface, vertical shafts were dug. Most shafts were between 4 and 8 metres wide and up to 14 metres deep (Fig. 7). These shafts were generally dug through two or more layers of nodular flint before reaching the preferred flint seam just above floor level. At Grimes Graves, the uppermost nodular flint layers are known as “topstone” and “wallstone”, whilst the seam which was mined at the bottom of the shafts is known as “floorstone” (Sieveking 1979). This seam was extracted by cutting down to the base and then levering up the flint in blocks. Galleries were then dug, radiating in all directions from the shaft at the level of the flint seam. These galleries were up to about 3 metres in length, joining up in some instances with galleries from neighbouring shafts (Fig. 8).

Chalk rubble and blocks of flint could have been removed from the shafts in various ways but it is considered probable that chalk waste was carried in baskets or leather bags up a wooden ladder. One of the flint mines excavated at Church Hill, Findon produced evidence for a wooden ladder (Pye 1968), whilst excavations at Grimes Graves in 1971 discovered post holes associated with a probable platform a quarter of the way up the shaft (Mercer 1981). This could have been used as a stage for a ladder system to carry material out of the shaft; it would also have served as a means of protecting miners working beneath from falling debris.

The chalk from each mine was either piled up around the lip of the mine or dumped in an abandoned shaft. The unweathered walls on most shafts suggests that they were backfilled fairly rapidly after they had been dug. It is likely, then, that as a new shaft was opened up old shafts were used as receptacles in which to dump spoil, both to fill up a dangerous hole and to avoid heaping up spoil on ground required to sink adjacent shafts. Similarly, loose chalk quarried from a gallery was used to backfill
Fig. 11. Flint-mining and flint-working implements: 1 — red deer antler pick; 2 — perforated ox leg-bone point; 3 — ox shoulder-blade shovel; 4 — red deer antler rake; 5 — chalk cup; 6 — flint hammerstone; 7 — antler hammer. 1, 2, 5 and 6 are from Grimes Graves; 3, 4 and 7 are from Harrow Hill.

recently excavated galleries in order to avoid the unnecessary removal of spoil from the shaft.

Mining was largely carried out using natural light. Carved chalk cups have been found which could have been filled with animal fat and used as lamps when working
in dark recesses. There is no evidence for the use of pit props and ceiling rafter to support the roof of galleries. Careful examination at Grimes Graves showed that flint mines were designed with a series of narrow galleries and load-bearing walls, as opposed to straight galleries extending for some distance from the shaft (Sieveking 1979). Thus a series of large shafts close together with numerous short galleries between them is not only a relatively safe system to operate without roof supports, but also an efficient and effective way of extracting a large percentage of the flint seam in the immediate vicinity of the shafts (Sieveking 1979:23–4).

The flint obtained by mining, once it had been brought to the surface, was initially dressed near the mine. This process mainly involved trimming off any irregular lumps with a flint hammerstone. In some cases clusters of debitage, often referred to as “nests” of flakes, resulting from either the initial trimming of nodules or the production of one or two core tools occur in the backfill of flint mines, for example at Harrow Hill (Curwen and Curwen 1926). The roughly shaped blocks of flint were then taken to an area where they could be worked into axes and other implements. These flint-working areas were sometimes situated close to the mines themselves, as at Grimes Graves and Easton Down, and sometimes located on the edge of the mining area, as appears to have been the case at Harrow Hill and Long Down (Holgate 1991). A thick layer of flint flakes, shattered pieces of flint and fragments of axes and other implements, for example discoidal knives, sickles and chisels, which broke in the course of manufacture usually make up the remains of these working areas.

There is no evidence that the grinding and polishing of axes took place at flint-mining sites. It is thus likely that implements which required finishing other than by flaking using hammerstones were prepared as roughouts and taken off site for further treatment. Most of these roughouts appear to have been flaked symmetrically at the flint-mining sites into preforms that only required grinding and polishing to produce the finished artefact.

A study of the snail shells extracted from many of the Sussex flint mines and Grimes Graves suggests that flint-mining sites were situated in small forest clearings at some distance from agricultural land. In addition, the sides of most mines are unweathered and there is little evidence for the accumulation of sediments that have been washed in by rainwater. This suggests that mining was a seasonal activity undertaken during the drier summer and early autumn months. Furthermore, Canon Greenwell’s pit at Grimes Graves was abandoned before all the galleries had been exploited, indicating that mines could have been in operation for a limited period. Clearly, shafts and their network of galleries were not left open for flint to be extracted intermittently over a number of months; each mine was more or less fully excavated and most were at least partially backfilled before being abandoned.
Evidence for contemporary domestic activity has not been found at any of the flint-mining sites. The miners either travelled from where they lived to the mine each day, or camped nearby for the period when mining took place. The results of recent fieldwork and analysis of flint collections in museums throughout much of southern and eastern Britain show that the first farmers lived mainly on the chalk and limestone upland areas, for example the South Downs, Salisbury Plain, Marlborough Downs and the Cotswolds (Gardiner 1984; Richards 1990; Holgate 1988a). By the end of the Neolithic period, settlement was widespread, taking in most of the previously settled upland areas and also the major river valleys (Holgate 1988a). The flint-mining sites, if not immediately alongside settlements, would therefore have been situated relatively close to the places where people lived at the time when they were in use.

The recent archaeological investigations at Grimes Graves indicate that a carefully planned system was pursued of excavating large shafts close together with narrow galleries and strategically positioned load-bearing walls (Sieveking 1979). This reflects the high degree of ingenuity, skill and organisation of the miners who undertook this work. Concerning the amount of work and length of time involved in flint mining, radiocarbon dating suggests that Grimes Graves and the Sussex sites were probably worked over an average of three hundred years. If mines were opened at a constant rate, then no more than one or two shafts a year at the most would have been dug, implying that this would have been sufficient to supply Neolithic communities for one or two years. At Grimes Graves, it has been calculated that a team of up to twenty able-bodied workers could excavate and extract flint from a mine with radiating galleries in a minimum of two months (Mercer 1981:112). Fewer people, though, would have worked more efficiently and effectively in the confined space at the bottom of each shaft. Open-cast mining would have been a much smaller scale operation, involving two or three people less than one or two days at the most to open up and exploit an open-air quarry. Given that shafts were not left open for long, and the safety risks inherent in mining, it is probable that a specialist or experienced team of workers was responsible for excavating each shaft.

A team of flint miners would have to be supported by the Neolithic communities living in the area. One example of the resources needed for each mining operation is the use of antler tools. Discarded antler picks are encountered in the fill of most flint mines. The four shafts excavated by Canon Greenwell in 1868–70, Peake in 1914 and Mercer in 1971 at Grimes Graves yielded over 570 picks, most of which were made from shed antlers (Legge 1981). It has been calculated that 20 to 40 deer could supply the antlers for picks found in one shaft and, with an average of 100 to 150 picks per shaft, the total number of antlers represented at Grimes Graves as a whole would be 40,000 antlers from 24,000 male deer (Legge 1981:101). Assuming that all antler was recovered and that all suitable antler was used, this would mean the existence or maintenance of a standing population of 120 deer to supply the miners excavating
each shaft. Given this and the other resources needed to support a team of full-time workers it is likely that, assuming mining was an annual event, no more than one team would be released to excavate one or two shafts per site a year.

Estimates have been calculated for both the amount of flint mined and the number of flint implements manufactured at Grimes Graves (Sieveking 1979:35; Mercer 1981:112). Each galleried shaft produced about 40 tonnes of floorstone, giving a figure in excess of 14,000 tonnes for the entire site. If exploited to its full potential, this would enable in excess of 50,000 implements per shaft to be produced, or something in the region of 25 to 30 million implements from the site as a whole. Experiments to replicate axes carried out at Grimes Graves showed that it takes about 10 to 20 minutes to produce the rough outline of an axe, generating up to 4,000 flakes in the process (Newcomer and Sieveking 1980). In addition, the experiments indicated that the scatter patterns of the flakes from the Neolithic working areas resulted from the manufacture of numerous roughouts, rather than merely one or two. In some cases, the position of the flint worker’s “seat” could be recognised by the occurrence of a blank area in the scatter pattern. It would thus have been possible for one or two flint workers to produce substantial quantities of implements in a semi-finished form at the same time that flint was being mined. However, the large quantity of rough trimmings, shattered pieces and flakes amongst the flintwork making up the working areas at Grimes Graves shows that flint was not worked as economically as it could have been (Mark Newcomer pers. comm.). Furthermore, it is unknown whether or not flint was taken from the site in any quantity for working elsewhere. This, in addition to the fact that a range of implements was produced at Grimes Graves, makes it difficult to estimate the number of axes, discoidal knives and other implements manufactured here.

Apart from industrial activity, rituals and ceremonial activities associated with life at the time also took place at flint-mining sites. The pottery vessels found at Cissbury and Grimes Graves and Church Hill, Findon were deliberately deposited at these sites. Human burials were also intentionally placed in the flint mines. Flint-mining sites, particularly the Sussex sites, were usually false crested, a similar setting to that of most causewayed enclosures and long barrows in existence at this time. The flint mines can thus be seen as one of a series of short-term activity sites in seasonal use, either annually or when there was the demand for further flint from these sites.

Whilst flint at the mining sites was flaked into core tools, there is a significant difference between the types of implement produced at the Sussex sites and at both Grimes Graves and Peppard Common. At the Sussex sites, and possibly Easton Down as well, mining appears to have taken place during the earlier Neolithic period with the intention of producing axes (Fig. 12). During the later Neolithic period flint continued to be exploited at some of these sites, for example Church Hill, Findon, although there is no definite evidence for mining itself taking place (Holgate 1991).
Fig. 12. Flint implements from flint-mining sites: 1 — axe roughout from Harrow Hill; 2 — axe roughout from Long Down; 3 and 4 — axe preforms from Church Hill, Findon; 5 — axe preform from Cissbury; 6 and 7 — axe preforms from Blackpatch; 8 — axe preform produced on a flake from Long Down; 9 — axe preform produced on a flake from Grimes Graves; 10 — polished flint axe from Cissbury.
However, whilst relatively small quantities of thin-butted axes were manufactured, emphasis at the Grimes Graves and Peppard Common later Neolithic sites was placed on the production of discoidal knives (Fig. 13).

![Flint and stone implements](image)

Fig. 13. Flint and stone implements from flint-mining sites: 1, 2 and 3 — discoidal knives from Grimes Graves; 4 — sickle roughout fragment from Long Down; 5 — discoidal knife from Long Down; 6 — polished greenstone axe from Canon Greenwell’s pit at Grimes Graves.

It is also significant that, during the later Neolithic period, a distinctive and novel range of thin-butted, edge-ground axes and chisels was manufactured. It has previously been assumed that axes in Britain were only produced at flint-mining sites and that the flint-mining sites were associated with the long-distance exchange of semi-finished axes (Sieveking 1979; Bush and Sieveking 1986). This is not the case (Edmonds 1993; Holgate 1991; Gardiner 1990). Axe-thinning flakes and axe fragments manufactured using flint from Clay-with-flints deposits, beach deposits and flint obtained from coastal cliff slumps often occur in domestic flint assemblages, for example at Pyecombe (Chris Butler pers. comm.) and Bullock Down (Holgate 1988b), both in Sussex, and also occur amongst the flint debitage recovered from the ditch fills of Neolithic enclosures, for example Maiden Castle (Edmonds and Bellamy 1991:218). Clearly, axes for use on or near domestic sites in regions where flint is readily available were produced at these sites. Most of the domestic sites in Sussex where axes were produced using local sources, though, date to the later Neolithic period (Gardiner 1990:131).

At this time, there were also changes taking place at the Great Langdale stone axe quarry site in Cumbria (Edmonds 1993:81). Small groups continued exploiting the
source but started creating and maintaining formal quarries, often placed in highly inaccessible locations. In addition, massive debitage assemblages are found on these sites, indicating an increasing concern with the production of preforms that required relatively little grinding and polishing to achieve the final form. Edmonds (1993:81–2) interprets this as reflecting greater emphasis than before on local production for exchange with groups outside the region. There are thus numerous changes in flint axe production taking place in the mid-3rd millennium bc: not only are they different, often localised, sources of flint being used for making axes but also new axe forms were being produced. This coincides with an expansion of settlement into previously unoccupied areas, the construction of new forms of monument and the development of new pottery styles (Holgate 1988a). Before considering these developments further, it is necessary to examine the function of axes.

Gardiner (1990) has also demonstrated that most flint axes in central southern England are found on the Chalk Downs, precisely the area where evidence for settlement is concentrated. Furthermore, whilst a large number of broken and reworked axes occur on the Downs, a larger proportion of polished axes recovered from the coastal plain south of the Downs and from the Weald to the north-east are complete and often in pristine condition. In the Thames basin, the large number of complete axes retrieved from the River Thames and other watery contexts is striking, as is the number of axe hoards, including both preforms and edge-ground axes of later Neolithic date, that have been recovered (Holgate 1988). An example of a carefully excavated watery context where complete axes were found, showing that they result from deliberate deposition, is the Sweet Track in the Somerset Levels (Coles and Orme 1976). This wooden catwalk structure, radiocarbon dated to 3200 bc (Coles and Coles 1975) and running from the Quantock Hills to a sandy island across a peaty quagmire, had broken carinated pottery bowls and stone objects placed at intervals along its length. Amongst the stone objects were a polished jadeite axe and a flint axe preform. Both were unhafted and in pristine condition, undoubtedly positioned intentionally by the track. Clearly, these particular axes were not intended for mundane use in any way. They were prized as "symbols of wealth": objects to be treasured and used in specific transactions, for example as votive offerings.

It is apparent that, throughout the Neolithic period, axes were used for both mundane tasks and in a variety of ways as prized objects. Trace element analysis of a sample of flint axes from southern Britain suggests that most of these axes were produced from flint obtained from the Sussex Downs (Craddock et al. 1983). This is borne out, to a certain extent, by macroscopic examination (Holgate 1988a:70). Mining appears to cease at the Sussex sites at the end of the earlier Neolithic period; relatively few axes were produced at later Neolithic flint-mining sites but a variety of local sources of flint were exploited for making both axes and the range of flake tools in everyday use. Edmonds (1993:82) believes this is due to the difficulties encountered
in controlling access to the raw materials that were used to produce important markers or symbols of social identity, reflecting a greater concern with controlling access to objects through established exchange networks, rather than control over production per se. This is one way of explaining why mining appears to have ceased in Sussex and the difference in character between flint-working areas at the Sussex sites and Grimes Graves coupled with the use of localised sources of flint for axe and other flint tool production in Sussex. It is of interest that most flint axe hoards in southern and eastern England consist of later Neolithic thin-butted axe forms which appear, through trace element analysis, to have been made using South Downs flint. These hoards, as with bronze hoards deposited in the late Bronze Age and 4th century Roman coin hoards, might have been linked with the decline in the use of flint axes in exchange networks. Similarly, mining and implement production at Grimes Graves and any other sites still in use ceased at about the time that hard-edged metal tools were introduced to Britain. A new range of prized objects, for example copper flat axes, came into circulation, although it is uncertain whether or not it was the technological change from stone to bronze or other changes in economy and society that led to the abandonment of the last prehistoric flint mines.

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