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Early Neolithic flint mining at Södra Sallerup, Scania, Sweden

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The area around the villages of Kvarnby and Södra Sallerup in south-west Scania is the only known flint-mining site in Sweden. Radiocarbon dates show that the flint was mined mainly during the earliest phase of the Early Neolithic, between *c.* 4000 and 3600 BC, thus coinciding with the earliest evidence of the Funnel Beaker Culture in the region. The type of flint, the size of the flint nodules, production debris in the mining area and the concentration of point-butted axes to south-west Scania all suggest that the mining was related to the extraction of flint for the production of point-butted axes. However, considering the abundance of easily available flint elsewhere in the region, it seems clear that the mining was not motivated purely by economic reasons. We suggest that the very extraction of flint from pits and shafts in the chalk was socially and symbolically significant in itself.

KEY-WORDS: Early Neolithic, flint mining, southern Sweden, point-butted axes

INTRODUCTION AND HISTORY OF RESEARCH

The area around the villages of Kvarnby and Södra Sallerup, located two kilometres apart and about ten kilometres east of the city of Malmö in south-west Scania (Fig. 1a), is the only known location of prehistoric flint-mining in Sweden (Olausson *et al.*, 1980). It was in connection with chalk quarrying that the flint mines were first discovered in 1904 (Holst 1906). This led to a limited number of excavations during the first part of the 20th century (Schnittger 1910; Althin 1951). During the latter part of the 20th century the area experienced escalating rescue archaeological activity and systematic documentation and

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excavation of prehistoric mining areas was initiated in the late 1960s (Salomonsson 1971: 127–129). Archaeological excavations took place almost every year between 1977 and 1998 in the Södra Sallerup area (Fig. 1b), instigated by threats from chalk quarrying (Olausson *et al.*, 1980; Rudebeck 1986, 1987, 1994, 1998; Nielsen and Rudebeck 1991), excavations for gas pipelines, the building of local roads (Rosberg and Sarnäs 1996), and highway construction for the Öresund Fixed Link (*e.g.* Nilsson and Onsten-Molander 2004; Kishonti 2006). In addition to the flint mines, substantial settlement remains from all periods from the Early Neolithic to the Medieval Period have been documented, indicating continuous human settlement in the area. Chalk quarrying operations ceased in 1998 but the city of Malmö continues to grow and the most recent excavation was performed in 2014, due to a building project on the estate Pilbladet (marked with **P** in Fig. 1b; Berggren, in prep.).

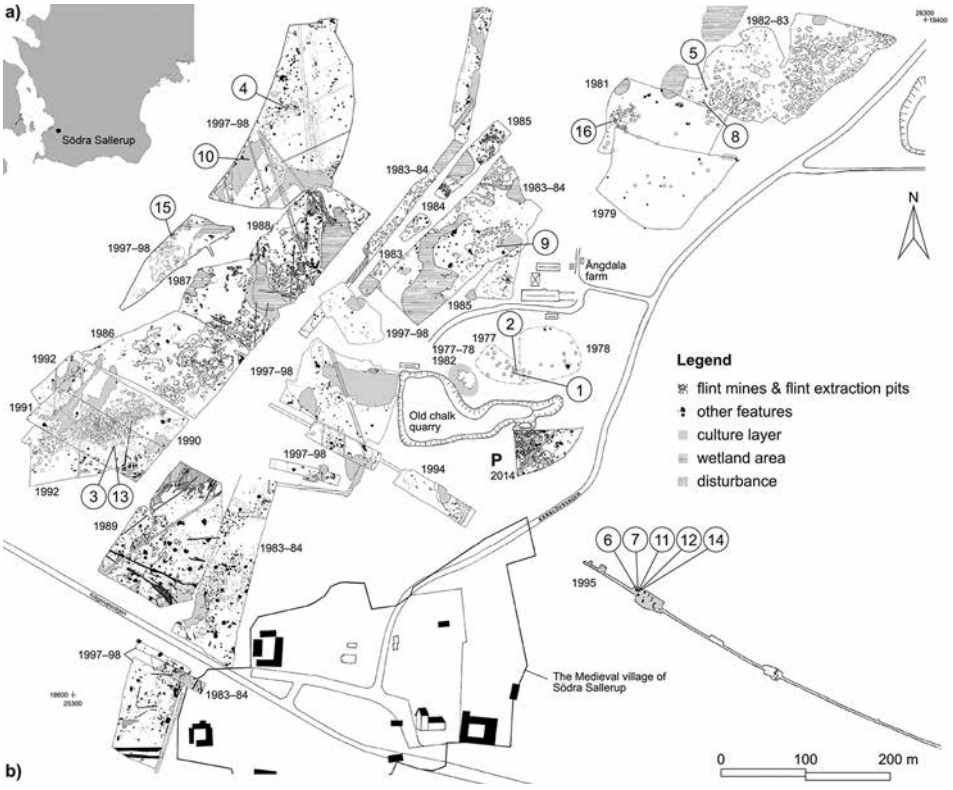


Fig. 1. (a) The location of the flint mine area of Södra Sallerup in Scania in Southern Sweden. (b) The archaeologically excavated areas are marked with the year of excavation. The most recent area excavated, Pilbladet, is marked with **P**. The numbers 1–16 indicate dated flint mines and other features from excavated areas around Pilbladet, corresponding to the dates with the same numbers in Fig. 6. Illustration: Map by Elisabeth Rudebeck, revised by Anders Gutehall and Joakim Frejd, Sydsvensk Arkeologi.

No synthesis on the Early Neolithic flint mining in the area is presently available. However Rudebeck will commence work with a comprehensive synthesis of evidence from all excavations in the Södra Sallerup area in 2016.

Rough estimates show that the flint mining areas documented since 1977 in the Södra Sallerup area covered *c.* 215,000 sq m (shown in Fig. 1b), with an additional *c.* 200,000 sq m removed by chalk quarrying in the whole Kvarnby – Södra Sallerup area prior to 1977 without previous archaeological investigation (Rudebeck 1994). This destruction was the reason for the Swedish National Heritage Board's decision in the early 1980s to protect an area with about 400 flint mines from future land development. As the area had been stripped of topsoil, it was possible to document the mines by aerial photography and mapping and to excavate a few mines and flint knapping floors (the north-eastern mining area in Fig. 1b; cf. Fig. 2a; Rudebeck 1987, 1994; Högberg *et al.*, 2001). The methods used for documentation of the flint mining areas have changed profoundly between the 1970s and the present; the most recent ones are illustrated in Fig. 2b.[1]

[1] In order to evaluate these methods, a research project will be conducted in 2015–2016 (by Åsa Berggren and Anders Gutehall, Sydsvensk Arkeologi).

Fig. 2a. Aerial photo of uncovered flint mines in the north-eastern part of Södra Sallerup, 1982. These mines were documented, but not excavated and are now protected by the Swedish National Heritage Board. Photo: Lena Wilhelmsson, Malmö museer.

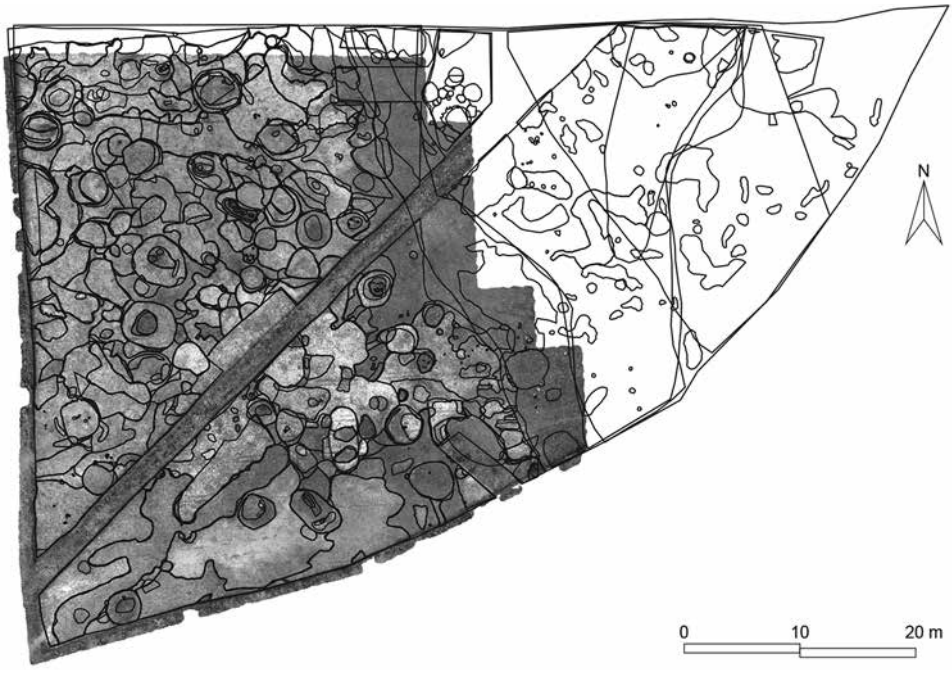


Fig. 2b. During the most recent excavation in 2014 at Pilbladet, a combination of methods was used to document the flint mines in plan, such as hand drawing, digital planning with GPS and orthophotography. The combined result of these documentation methods is shown here. The flint mines were confined to the western part of the excavated area, while the eastern part contained other types of features. Figure: Åsa Berggren and Anders Gutehall, Sydsvensk Arkeologi.

GEOLOGY AND ITS EFFECT ON MINING ACTIVITIES

Visual and geochemical provenience analyses show that flint from the chalk at Södra Sallerup is comparable to Senonian flint of Maastrichtian age from geological deposits in eastern Denmark and northern Jutland (Högberg and Olausson 2007; Hughes *et al.*, 2012). However, the geology of Södra Sallerup is different compared to other north European flint mining sites (e.g. Allard *et al.*, 2008). The chalk is not *in situ*; rather, the enormous chalk slabs were transported by glacial movement, deposited at the site as the ice melted, and subsequently covered by glacial till (Ringberg 1980). This affected prehistoric flint mining in three main ways: 1) the chalk is not solid and therefore it was not possible to dig horizontal galleries, but only minor extensions into the chalk (Fig. 3); 2) the flint nodules are unevenly distributed in the chalk, making it difficult to predict the yield; 3) the glacial till is rich in secondary flint (especially from Maastrichtian and Danian periods) which also was exploited by prehistoric people.

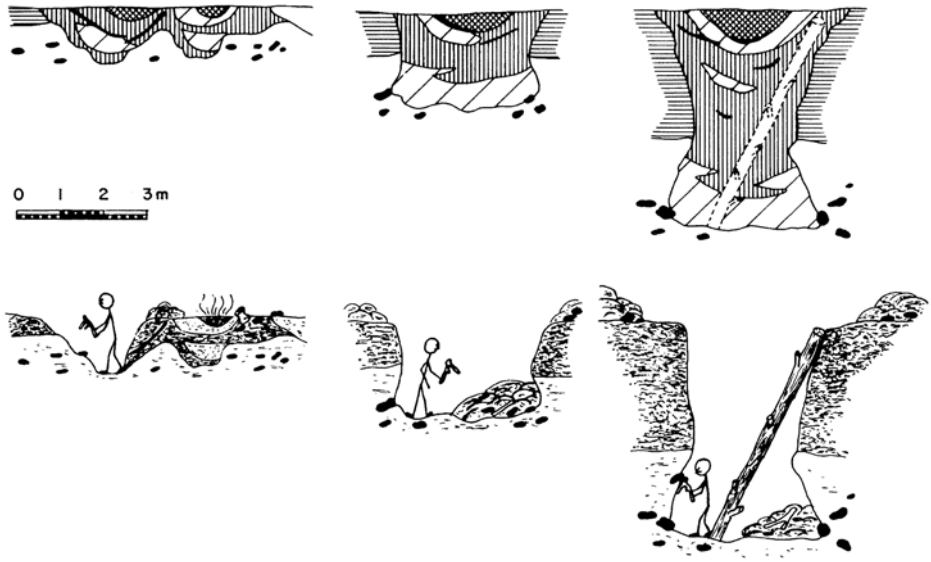


Fig. 3. A generalised sketch of the various types of flint mines at Södra Sallerup. The shallow open-cast pit type is shown to the left, the medium-sized type in the middle and the deeper mine shaft type to the right. Illustration: Elisabeth Rudebeck, Sydsvensk Arkeologi.

MINING METHODS AND TOOLS

The depth of flint extraction pits varies from one meter to about seven metres, depending on the thickness of the overlying clayey till and the occurrence of occasional intermixing layers of sand and gravel (Fig. 3 and 4). Pit diameter varies from one and a half to six metres. The shallow pits were often dug in direct proximity to each other, allowing deposition of the clay and chalk in the neighbouring exhausted pits. This open-cast mining created large areas, typically where the chalk was close to the surface, where the surface was entirely excavated. The deeper pits – often located at the periphery of open-cast areas where the chalk was more deeply buried – were probably also refilled soon after flint extraction was completed (Rudebeck 1987: 153). This is indicated by the fact that the fill in the lower parts of the deeper pits usually consists of almost pure chalk, indicating that each pit was refilled with the extracted material and not with material from adjacent pits. However, substantial volumes of clay and chalk must have been left on the surface because of the inevitable 'expansion' of the material removed. Therefore, the mines would have been surrounded by spoil heaps that subsequently became overgrown by vegetation and the landscape would have been characterised by a very uneven surface long after flint extraction had been discontinued.

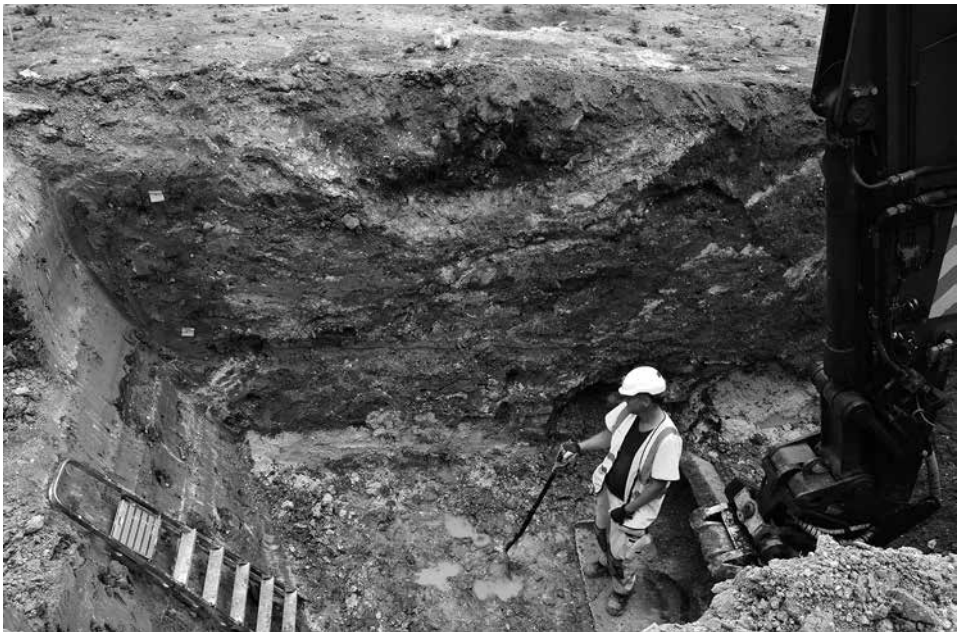


Fig. 4. A flint mine during excavation in 2014. The large pit is half-sectioned using a mechanical excavator. Photo: Åsa Berggren, Sydsvensk Arkeologi.

The tools associated with the flint extraction are roughly-shaped flint picks, red deer antler picks (Fig. 5), wooden wedges and composite tools made from wooden handles, antler sockets, and pointed flint picks (Rudebeck 1986; Nielsen and Rudebeck 1991). Scapulae of red deer and cattle were used as shovels. Holes in the chalk walls of mines have been interpreted as the remains of structures of wood, such as ladders and platforms (Olausson *et al.*, 1980: 193; Rudebeck 1986: 8).

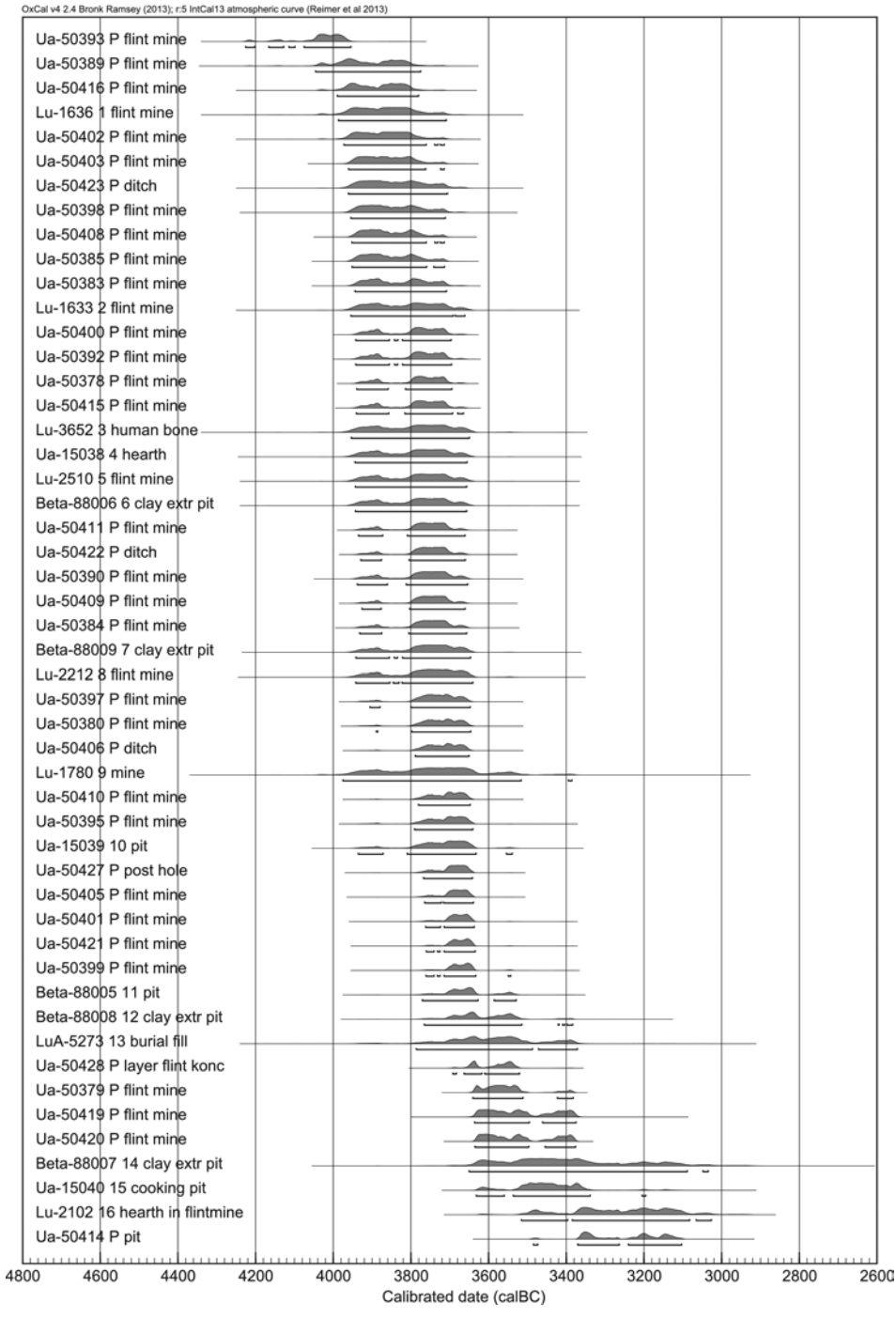
THE CHRONOLOGY AND STRUCTURE OF MINING ACTIVITIES

The dating of the flint mining activity was a matter of debate until the first radiocarbon dates of charcoal from pit contents excavated in the late 1960s and the 1970s showed mainly Early Neolithic dates, coinciding with the appearance of the Funnel Beaker Culture in the region (*c.* 4000–3600 BC), but also dates to the Middle Neolithic (Nielsen and Rudebeck 1991). In addition, a few tools and some flint knapping debris interpreted as dating to the Late Mesolithic indicate that flint extraction may have occurred prior to the Early Neolithic (Nilsson and Onsten-Molander 2004: 48f, 70ff). However, subsequent radiocarbon dating, in particular extensive sampling

Fig. 5. A red deer antler pick *in situ* in a flint mine excavated in 1978.
Photo: Ulf Säfvestad, Malmö museer.

from the recent excavation at Pilbladet (indicated by **P** in Fig. 1b and 6), confirmed that the main period of flint extraction occurred during the earliest Early Neolithic.

The samples dated to the Early Neolithic were taken both from the lower fill in flint mines, from open-cast pits and from other features such as hearths and pits, thus dating the flint extraction itself as well as other contemporary activities (Fig. 1b and 6). The dated material is mainly charcoal and hazelnuts, but also human bone from a burial in one mine (Lu-3652) and emmer wheat from a pit (Ua-50414). Equally early radiocarbon dates have been obtained from a flint mine in the Kvarnby area, one kilometre south-west of Södra Sallerup, indicating that flint extraction was taking place simultaneously over a larger area (Rudebeck 1994: 12).


OxCal v4 2.4 Bronk Ramsey (2013); r:5 IntCal13 atmospheric curve (Reimer et al 2013)
Ua-50393 P flint mine
Ua-50389 P flint mine
Ua-50416 P flint mine
Lu-1636 1 flint mine
Ua-50402 P flint mine
Ua-50403 P flint mine
Ua-50423 P ditch
Ua-50398 P flint mine
Ua-50408 P flint mine
Ua-50385 P flint mine
Ua-50383 P flint mine
Lu-1633 2 flint mine
Ua-50400 P flint mine
Ua-50392 P flint mine
Ua-50378 P flint mine
Ua-50415 P flint mine
Lu-3652 3 human bone
Ua-15038 4 hearth
Lu-2510 5 flint mine
Beta-88006 6 clay extr pit
Ua-50411 P flint mine
Ua-50422 P ditch
Ua-50390 P flint mine
Ua-50409 P flint mine
Ua-50384 P flint mine
Beta-88009 7 clay extr pit
Lu-2212 8 flint mine
Ua-50397 P flint mine
Ua-50380 P flint mine
Ua-50406 P ditch
Lu-1780 9 mine
Ua-50410 P flint mine
Ua-50395 P flint mine
Ua-15039 10 pit
Ua-50427 P post hole
Ua-50405 P flint mine
Ua-50401 P flint mine
Ua-50421 P flint mine
Ua-50399 P flint mine
Beta-88005 11 pit
Beta-88008 12 clay extr pit
LuA-5273 13 burial fill
Ua-50428 P layer flint konc
Ua-50379 P flint mine
Ua-50419 P flint mine
Ua-50420 P flint mine
Beta-88007 14 clay extr pit
Ua-15040 15 cooking pit
Lu-2102 16 hearth in flintmine
Ua-50414 P pit
4800
4600
4400
4200
4000
3800
3600
3400
3200
3000
2800
2600
Calibrated date (calBC)

Based on calculations of the density of mines in the archaeologically documented areas and the extent of old chalk quarries, it has been estimated that there may originally have been thousands of mining pits in the Södra Sallerup area, probably 7000 or more (Nielsen and Rudebeck 1991: 67). Assuming that most mines were dug during the main phase of mining activity, a rough calculation is that 17–18 mines may have been dug every year (7000/400=17.5). However, it is likely that the intensity of mining varied within the time span of the 400 years of the Early Neolithic.

The interpretation of the spatio-temporal patterns in the mining area is inevitably biased by the fact that 68 % of the dates are from the most recent excavation at Pilbladet (Fig. 1b and 6), which constitutes a mere two percent of the documented area in Södra Sallerup. Taking this into account, the dates obtained from other mines in the area still indicate that the earliest extraction activities were simultaneously in progress at several places, or at close time intervals. Hence, it seems likely that flint mining activity was not initiated in just one place and fanned out from there over time, but rather that it was going on simultaneously over the entire area. The fact that the dates from adjacent pits may be separated by a couple of hundred years suggests that the flint miners probably returned to, or kept working in, certain areas. The dates also indicate that open-cast mining in shallow pits and mining in deep shafts occurred simultaneously from the very beginning. The patterning indicates that the mining operations were not subsumed under a central authority.

PRODUCTION

The flint in the chalk at Södra Sallerup was attractive for the knapper because it is glassy and easily worked (Högberg and Olausson 2007: 88–91). The majority of the flakes bear cortex, signalling that early manufacturing stages were carried out in the mining area (Fig. 7). However, as would be expected at a production site, few blanks or completed pieces are present (Rudebeck 1986: 29–35; Nielsen and Rudebeck 1991: 77). It is significant that the nodules available were not particularly large. Rudebeck (1998: 323–324) determined that only 10–15 % of the nodules from four test pits dug into the chalk were suitable in shape and size for the production of axe blades.

Per Jansson's analysis of debitage from two knapping floors in the preserved mining area revealed few flakes that were diagnostic of either of the two production schemes most common in the Neolithic: quadrifacial axehead production on the

Fig. 6. Radiocarbon dates showing the main period of flint mining in the Södra Sallerup area. The radiocarbon dates numbered 1–16 are from mines and other features in various excavated areas at Södra Sallerup, corresponding to the same numbers in Fig. 1b. The majority of radiocarbon dates, marked with **P**, are taken from mines and other features at Pilbladet, marked with **P** in figure 1b.

Fig. 7. A selection of flint debris from a mine at Södra Sallerup is being sorted.
Photo: Åsa Berggren, Sydsvensk Arkeologi.

one hand, and bifacial production leading to sickles or daggers on the other. Instead, he proposed that point-butted flint axes were the production target (Jansson 1999). This is supported by the concentration of point-butted axes, particularly the earliest type (type 1), in southwestern Scania (Sørensen 2014: 162–175). However, the mined flint was also used in the mining area for the production of tools such as flake axes, borers, scrapers and transverse arrowheads (Olausson *et al.*, 1980; Rudebeck 1986; Nielsen and Rudebeck 1991).

Högberg showed that flint in the area was also used in the Late Bronze Age for the production of large blade knives. However, it has not been proven that the flint used for these knives was actually mined during the Late Bronze Age, rather than the alternative possibility of being acquired from Neolithic waste dumps (Högberg 2009: 201–205).

MINERS' CAMPS AND SETTLEMENTS

Traces of Early Neolithic huts and tents as well as hearths, pits and cultural layers in and around the flint mining area have been interpreted as settlements connected to the mining operations. The find material is rich and, in addition to flint tools of various types, Funnel Beaker Culture pottery occurs, mainly of the Oxie-type (Rudebeck 1986). There is also a sizeable collection of animal bones, revealing the presence of cattle, domestic pig, sheep, goat, and dog, but also wild species, notably red deer, and fish, mainly cod (Nilsson 1991). It is not clear whether these settlements were short term and perhaps seasonal camps or whether they were more permanently inhabited.

However, there is one site in the vicinity from which there is substantial evidence to indicate a direct link to the flint mining area. This is the contemporary gathering site of Almhov, located *c.* 11 kms south-west of Södra Sallerup, which was excavated in 2001–2003. From this site we have some of the earliest dates of cereals in southern Scandinavia (Gidlöf *et al.*, 2006; Rudebeck 2010; Sørensen 2014: 74), and recent isotope analyses on cattle teeth from animals that have been indirectly dated to the same period indicate Early Neolithic dairying (Gron *et al.*, 2015).

Of the roughly 320 Early and Middle Neolithic features on the Almhov site, the majority were dated to the earliest phase of the Early Neolithic. Among these were long barrows and dolmens. The earliest features were *c.* 200 pits, many of which occurred in pairs, indicating specific norms for dwelling, pit use and waste deposition. Scattered cranial bones suggest that animal heads or crania were on display adjacent to the pits (Rudebeck and Macheridis 2015).

The Early Neolithic features at Almhov contained 700 kg of worked flint, mainly Scandinavian Senonian flint, including point-butted axes, drills, scrapers, flake axes,

transverse arrowheads, blades and debitage from the manufacture of bifacial and quadrifacial objects. Forty point-butted axes, more or less fragmentary, were found, making this the largest known assemblage of this axe type at any one site in southern Scandinavia (Gidlöf *et al.*, 2006; Rudebeck 2010). Many axes retain small patches of cortex, which could have been a means of demonstrating that the flint originated from mines rather than from till or beach deposits (cf. Rudebeck 1998). In conclusion, the dates as well as the many similarities in the material suggests that the same people who extracted flint at Södra Sallerup also brought it to Almhov for the production of point-butted axes and other tools to be used and exchanged during seasonal gatherings (Rudebeck 2010).

THE SOCIAL AND CULTURAL CONTEXT OF THE EARLY NEOLITHIC FLINT MINING AT SÖDRA SALLERUP

Members of Early Neolithic society had access to a vast variety of high quality flint types in the glacial till, on beaches and at stream banks in southern Sweden and eastern Denmark (Högberg and Olausson 2007: 54–62). In fact, there is evidence for extensive flint extraction and axe preform production at beach-ridges along the south-western coast of Sweden, and one of these sites is within an hours' walk from Södra Sallerup (Högberg 2002). Hence, a shortage of high-quality flint was not the reason for digging through the till and chalk at Södra Sallerup (Högberg *et al.*, 2001). It is more likely that motivations for the mining of flint in the early Funnel Beaker Culture context were social and symbolic as well as practical and economic. This is indicated by the links between the flint mines and the gathering site of Almhov as well as by the fact that the deposition of point-butted Senonian flint axes in wetland areas appears to have been particularly concentrated in southwestern Scania (Karsten 1994: 54; Rudebeck 1998; Sørensen 2014: 162–175). Based on the overall similarities in the flint mining techniques within the Michelsberg Culture and the early Funnel Beaker Culture of southern Scandinavia, Lasse Sørensen has suggested that the practice of deep flint mining was introduced to Scandinavia in connection with the immigration of farmers from the Michelsberg Culture (Sørensen 2014: 174). Apart from flint mining techniques, further similarities between the earliest Funnel Beaker Culture (the Oxie-group) and the Michelsberg Culture include cereal types, domestic animal species, point-butted flint axes, pottery styles, the practice of displaying animal heads or crania on settlements and the building of long-barrows. However, there also are differences: e.g. bifacial arrowheads dominate in the Michelsberg Culture (although transverse arrowheads do occur), while transverse arrowheads (usually made from flakes) are characteristic of the Funnel Beaker Culture. This suggests that traditions from the Ertebølle Culture were an integral part of the early Funnel Beaker Culture in

southern Scandinavia. Whether this was due to cultural choices among immigrants, a result of the mixing of populations, or a continued tradition among local populations that otherwise adopted new customs, is an issue that remains to be explored.

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