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PATTERN IN DIVERSITY – KRZEMIONKI AND GRIME'S GRAVES. UNDERSTANDING COMMONALITY IN FLINT MINING ACROSS EUROPE

ABSTRACT

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Across Europe, in the late 19th century, deep-flint mines dating to the Neolithic period were discovered. Since their discovery, it has been noted that the mines, located many kilometres apart, share common traits. Despite these connections, little research has compared the pan-European mining phenomenon. It is beyond this paper to review the numerous European mines, rather, two sites will be detailed: Krzemionki, southeast Poland, and Grime's Grave, eastern England. The comparison of these two prehistoric mines, located c. 1500km apart, expands knowledge of a mining methodology likely to have started in the mid-5th millennium BCE and spread across Europe, becoming associated with large and enduring complexes.

Keywords: Neolithic, Early Bronze Age, Flint mining, Axeheads, Britain, Poland
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INTRODUCTION

Extracting knappable rocks for producing implements was undertaken throughout European prehistory, from Neolithic quarrying for jadeite in the Italian Alps (Pétrequin *et al.* 2006) to Late Bronze Age flint mining in Poland (Lech *et al.* 2011). Of numerous rocks sought, the most extracted was flint, with mines located in the British Isles (Barber *et al.* 1999), Denmark (Becker 1959), France (Ghesquiere *et al.* 2021; Bostyn 2023), Belgium (Bostyn *et al.* 2018), the Netherlands (Felder *et al.* 1998; de Grooth *et al.* 2023), Germany (Fisher *et al.* 2023; Schyle and Weiner 2023), Poland (Lech 2023; Lech and Werra 2023; Schild 2023), Belarus (Gurina 2000), the Iberian Peninsula (Terradas and Ortega 2017; Díaz-del-Río *et al.* 2023; Tarriño *et al.* 2022a, 2022b), Italy (Galiberti and Tarantini 2023) and Ukraine (Kolesnik 2020; see Fig. 1). Most Neolithic flint mines are composed of pits and quarries. One method, shaft-galleried mining, resulted in amongst the most extensive Prehistoric mines in the world.

Shaft-galleried mining appears to start simultaneously across Europe at the end of the 5th millennium BCE (Edinborough *et al.* 2019). At present, Spiennes is perhaps the earliest shaft-galleried mine with extraction beginning around 4200 cal. BCE, although some caution is expressed with the earlier radiocarbon dates from the mines (Collet and Collin 2023, 112). Because shaft-galleried mining is a method that would have taken years to develop, being passed to new generations through the learned experience of mining, it is considered unlikely that it began independently across Europe at contemporary mines. Therefore, the knowledge of shaft-galleried must have travelled with communities well-practised in its intricacies (Wheeler 2011; Bączkowski 2014).

Nevertheless, the start of shaft-galleried mining is still a matter of dispute. The oldest dated shaft-galleried mines are known to date back to the 5th millennium BCE, when in the Dutch Limburg region, Michelsberg culture communities mined flint from shaft-galleried mines and produced flint long blades, and flint axeheads, which played an important economic role (Spiennes mine, Belgium; 4350-2300 cal. BCE; Rijckholt-St. Geertruid mine, the Netherlands; 4300-3400/2650 cal. BCE; Bostyn *et al.* 2018; Collet *et al.* 2016; Collet and Collin 2023; de Grooth 2023). However, the flint technologies of the Funnel-Beaker culture (FBC) communities from the Ćmielów site, southeastern Poland, the striped flint miners' settlement from the Krzemionki mining complex and the Świeciechów-Lasek mine have analogies in the lithic inventories of the Trypillia culture (Budziszewski 2006; Pellegrin 2012; Kadrow 2016). It has been suggested that the tradition of making exceptionally long flint blades and flint axeheads spread, along with shaft-galleried flint mining, from the East through the Trypillia region and the FBC communities areas in Poland and into Scandinavia (hoards with long blades: Nielsen 2017, 2021; see Immel *et al.* 2020).

Pellegrin suggests that if it is confirmed that the complete debitage at Spiennes was achieved using lever pressure with deer antlers, then its origin could be traced back to the Polish centre at the Ćmielów site (Pellegrin 2012, 26).

A comparison between Krzemionki and Grime's Graves, two seemingly unconnected mines, is significant because both adopted the shaft-galleried method early in their mining chronology. They also represent the western and easternmost extents of shaft-galleried mining. Finally, the comparison of these mines helps illuminate many unresolved questions about shaft-galleried mining, especially regarding how knowledge of the method spread with communities.

EUROPEAN MINING

Mining for flint dates to the Final Palaeolithic, c. 10,500 cal. BC, including mines at Orońsko (Werra and Kerneder-Gubała 2021) and Wołowice (Bańdo *et al.* 1992), both in

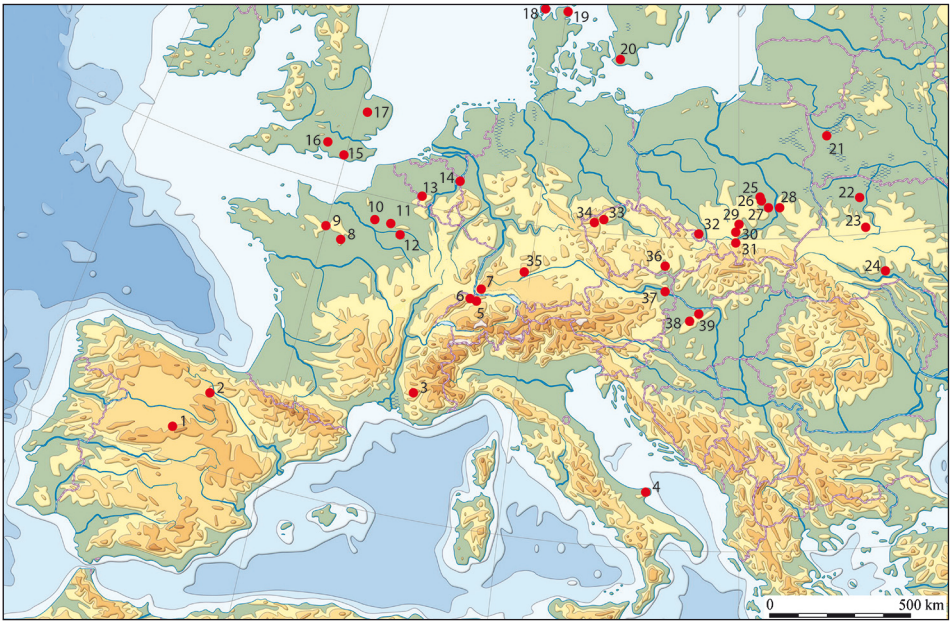

Fig. 1. Distribution of the main European prehistoric siliceous rock mines:
1 – Casa Montero (Spain); 2 – Pozarrate (Spain); 3 – Malaucčne (France); 4 – La Defensola (Italy); 5 – Olten (Switzerland); 6 – Löwenburg (Switzerland); 7 – Asch-Borgerhau (Germany); 8 – Ri (France); 9 – Espins (France); 10 – Jablines (France); 11 – Marais de Saint-Gond flint mine region (France); 12 – Villemaur-sur-Vanne (France); 13 – Spiennes (Belgium); 14 – Rijckholt-St. Gerrtruid (The Netherlands); 15 – Worthing Group (Blackpatch; Cissbury; Church Hill; Harrow Hill; UK); 16 – Wessex Group (Easton Down; Martin's Clump; UK); 17 – Grimes Graves (UK); 18 – Hov (Denmark); 19 – Aalborg (Denmark); 20 – Södra-Sallerup (Sweden); 21 – Krasne Selo (Belarus); 22 – Polovla (Ukraine); 23 – Gorodok, Višnevaya Gora (Ukraina); 24 – Studenica, Belaya Gora (Ukraina); 25 – Orońsko – Tomaszów (Poland); 26 – Wierzbica 'Zele' – Polany (Poland); 27 – Krzemionki – Borownia (Poland); 28 – Świeciechów-Lasek (Poland); 29 – Udorka (Poland); 30 – Sąspów (Poland); 31 – Wołowice (Poland); 32 – Maków (Poland); 33 – Tušimice (Czechia); 34 – Bečov (Czechia); 35 – Lengfeld (Germany); 36 – Krumlovský Les (Moravia, Czechia); 37 – Vienna-Mauer (Austria); 38 – Nagytevel (Hungary); 39 – Tata-Kalvariadomb (Hungary). After Lech 1981: fig. 2; Werra and Woźny 2018; Bostyn *et al.* 2023

Poland. Mesolithic mines are rare but include the Polish mines of Udorka (Sudoł-Procyk *et al.* 2021) and Tomaszów (5600-5400 cal. BCE; Schild 1995, 464).

Fint mining appears to have become more widespread across the 6th millennium BCE to early 5th millennium BCE (Kerig *et al.* 2015). Mines dated to the period include Defensola A, southeast Italy (the beginning 6010-5720 cal. BCE; Galiberti and Tarantini 2023, 42), Casa Montero (Díaz-del-Río 2023) and Pozarrate, central Spain (Tarriño *et al.* 2022a, 2022b), Krumlovský les, Moravia (Oliva 2022, 39), and Tomaszów, Central Poland (5000-4800 cal. BCE; Schild 1995, 462; Schild 2023, 204). Overall, these mines produce radiocarbon dates to the mid 6th millennium BCE, and earlier dates should be treated with caution, as the 'old wood' effect is often a problem for charcoal collected from mines (Díaz-del-Río *et al.* 2023), alongside samples that are poorly contexed (Consuegra and Díaz-del-Río 2018).

The oldest flint mining, before the late 5th millennium BCE, was from pits, in some cases up to 10m in depth, as found at Casa Montero (Díaz-del-Río *et al.* 2023), or occasionally niched mineshafts. The only galleries and chambers known from this period exist at Defensola A. These early mines are associated with the production of blades.

Shaft-galleried mining began in the late 5th-4th millennium BCE, with mine and appears to have quickly become widespread and associated with large mine complexes, such as, Spiennes, southern Belgium (Collet and Collin 2023), Rijckholt, the Netherlands (Felder *et al.* 1998; de Grooth *et al.* 2023), Jablines, the Paris Basin, France (Bostyn and Lanchon 1992), Krzemionki, Poland (Bąbel 2014), Södra-Sallerup, Sweden (Berggren *et al.* 2016; Högberg *et al.* 2023) and Krasne Siolo, Belarus (Gurina 2000). These complexes are predominantly connected with axehead production. Whilst extraction finished at most mines by the late 4th millennium BCE, mining continued at Spiennes and Krzemionki into the 3rd millennium BCE. The opening of new mines is rare, except for Grime's Graves, which is late in the shaft-galleried tradition.

Few mines postdate the 3rd millennium BCE, when flint industries are often based on the recycling of earlier mine waste or open quarries. One mine, Wierzbica, Poland, dates to 1800-800 cal. BCE and is associated with 'Zele' knives (Lech and Werra 2023).

COMPARISON BETWEEN KRZEMIONKI AND GRIME'S GRAVES

The excavation histories of both mines are covered elsewhere (Bąbel 2014; Bishop 2012; *Krzemionki* 2018; Healy *et al.* 2023). The 4000+ mineshafts at Krzemionki were discovered in the early 20th century (Fig. 2; Bąbel 2014; *Krzemionki* 2018, 154) and initially excavated in 1925. Excavations by Stefan Krukowski followed (Krukowski 1939; Borkowski 1995; Piotrowska 2014). More recent excavations were undertaken 1969-1970 (Balcer 1975), 1979-1984 (Bąbel 2015), and 2006-2008 (Jedynak and Wroniecki 2022).

Altogether, several shafts and chipping floors (workshops) were partly excavated (Bąbel 2015, 30-41).

Less than 30 of the 450+ known mineshafts at Grime's Graves (Fig. 3) have been excavated, with work periodically carried out from the late-19th century (Greenwell 1870) to the mid-20th century (Armstrong 1923). The last excavation of Grime's Graves was undertaken in 1971-1972 (Mercer 1981).

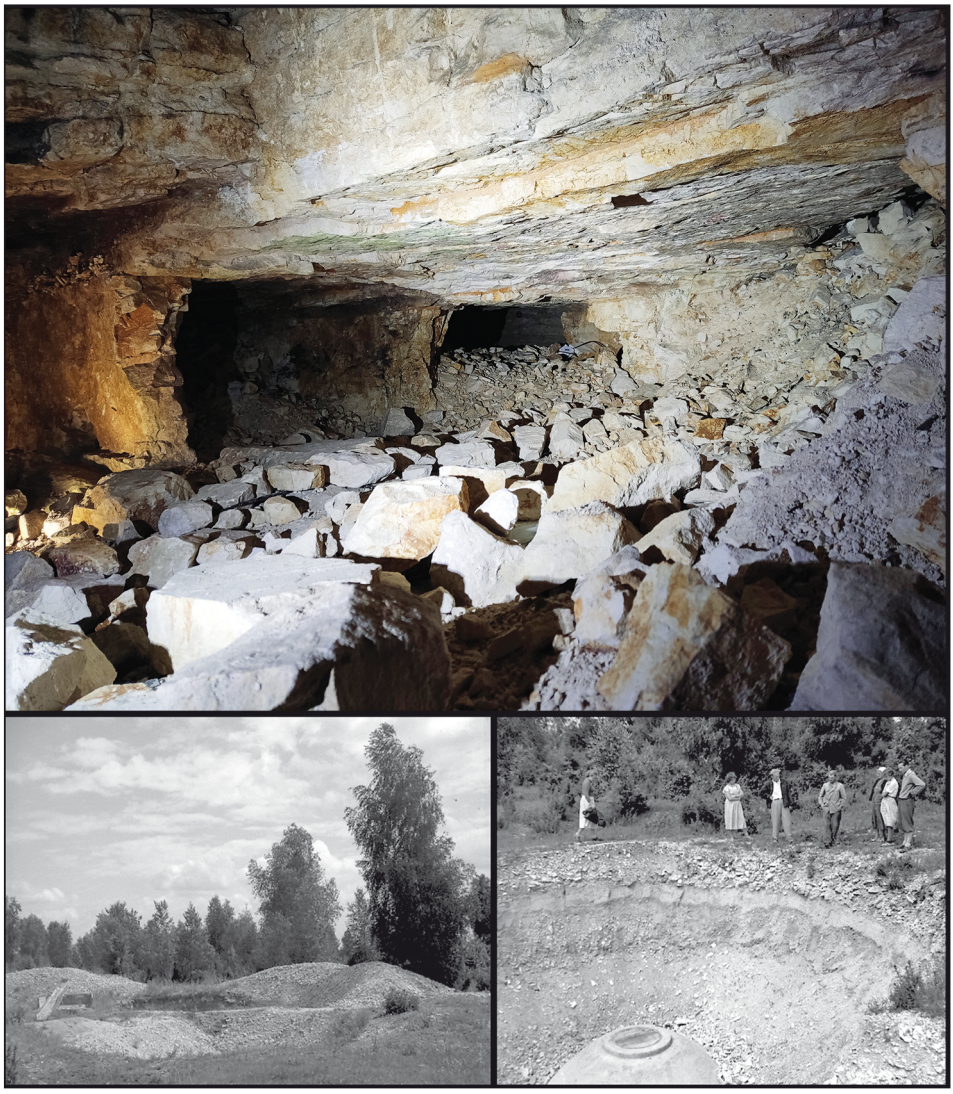

Fig. 2. Photographs of Krzemionki. Top, a pillar-chamber mine. Photo: D. H. Werra; bottom left, the mine field in 1957; bottom right, mineshaft protection in 1957. The photo was taken by S. Biniewski, IAE PAN Archive in Warsaw

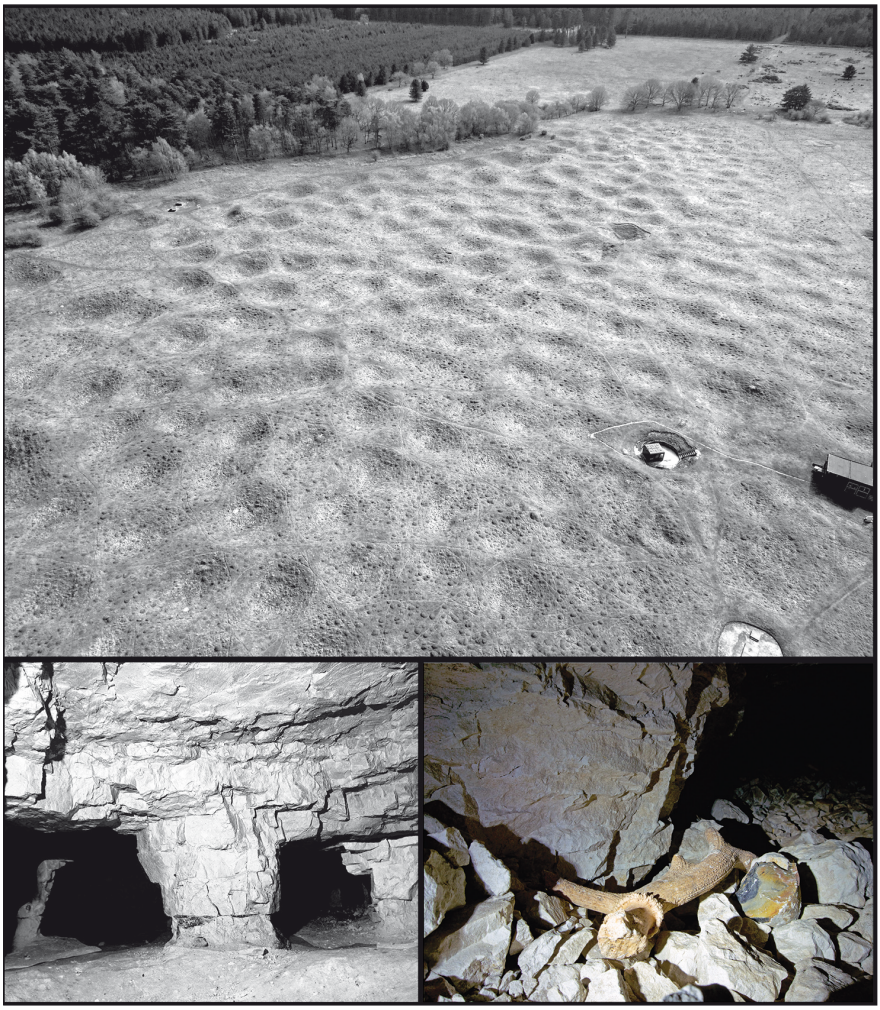

Fig. 3. Photographs of Grime's Graves. Top, the mining field; bottom left, gallery with pillars. Credit: English Heritage Trust; bottom right, abandoned antler pick in gallery. Photo: J. Bączkowski

THE EXTRACTION CHRONOLOGY

Krzemionki

Extraction at Krzemionki began in the early 5th millennium BCE and lasted until the mid-2nd millennium BCE (Fig. 4; Bąbel *et al.* 2005). Although no pre-36th century BC dates are known from the mines, striped flint axeheads were being produced at FBC settlements in the region surrounding Krzemionki from c. 3650 cal. BCE (Jedynak and Kaptur

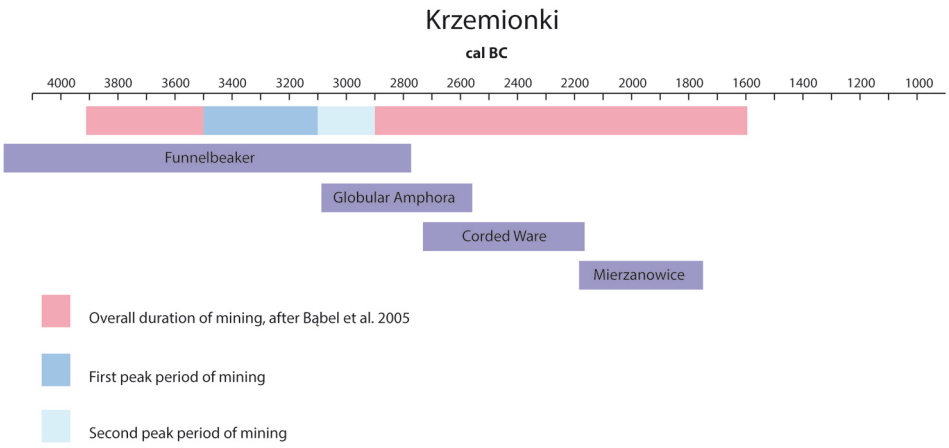

Fig. 4. Chronology of cultural periods at Krzemionki

2017; Sałacińska and Sałaciński 2022). Mining must have therefore been underway by the early 4th millennium BC (*Krzemionki* 2018, 136). Funnel-Beaker pottery dating to the 4th millennium BCE has been recovered from both pit and niche mines at Krzemionki (Sałacińska and Sałaciński 2022), and from the surface of the mine complex and surrounding fields (Bąbel 2015, 183-199). Although Globular Amphora culture (GAC) material was also found in the pit and niche-mines, confusing their chronology (Balcer and Kowalski 1978).

The earliest of 33 radiocarbon dates obtained from Krzemionki are from shaft 795 (Bąbel *et al.* 2005), dating to 3368-3100 cal. BCE (68.3% probability), and associated with GAC communities mining. Other pillar-chamber and chamber-mines, shafts 805 and 815, fall between 3100-2500 cal. BCE (Bąbel *et al.* 2005), when mining and axehead production at Krzemionki peaked (Jedynak and Kaptur 2017).

Deep mining concluded in the mid-3rd millennium BCE at Krzemionki, and although striped flint is still used by Corded Ware and Złota culture communities, the character of extraction in this period is unknown (Borkowski and Budziszewski 1995; Witkowska and Włodarczak 2021; Sałacińska and Sałaciński 2022). In the 2nd millennium BCE Mierzanowice culture communities recycled the spoil heaps of earlier mines (Balcer and Kowalski 1978; Budziszewski and Włodarczak 2010, 138, 139; Jedynak and Kaptur 2017).

Grime's Graves

A chronology for Grime's Graves results from 310 radiocarbon dates (Fig. 5; Healy *et al.* 2018). The earliest extraction is between the 27th century cal. BCE – early 24th century cal. BCE, associated with the most complex structures, shaft-galleried mines. Simple pits, located in the West Field, date to the late-27th century cal. BCE – 21st century cal. BCE

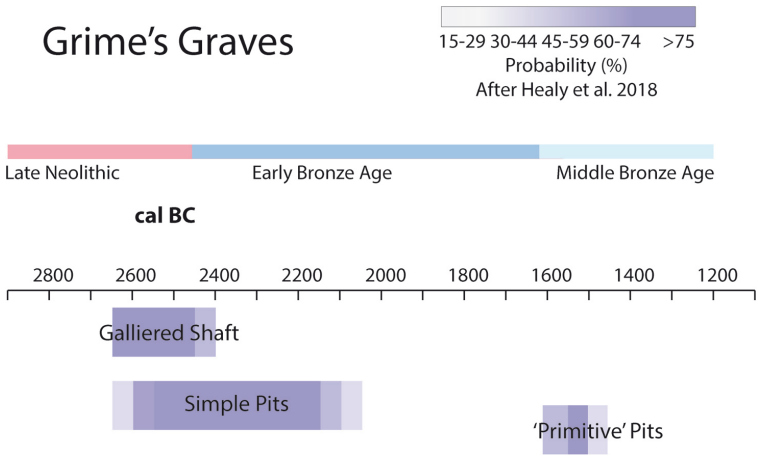

Fig. 5. Chronology of mining and cultural periods at Grime's Graves

(Healy *et al.* 2018, 287), overlapping with shaft-galleried mining but in use for a longer period.

After an extraction hiatus, 'primitive' pits (terminology originating from the original authors of Grimes Grave's research) were opened in the Early Bronze Age, c. 17th century cal. BCE, and worked until the 15th century cal. BCE. Midden deposits in the tops of mine-shafts (Mercer 1981, 13) date to the late 15th – early 13th centuries cal. BCE, the Middle Bronze Age (Healy *et al.* 2018, 288). There is no evidence of contemporary mining with midden formation; instead, flintworking focused on the recycling of earlier mine waste (Healy *et al.* 2018).

MINING METHODOLOGY

Krzemionki

Krzemionki is located at the north-east edge of the Świętokrzyskie (Holy Cross) Mountains and the north-west end of the Magonie-Folwarczysko Jurassic basin on Upper Oxfordian limestone (159.4-154.1 Mya) that faulted in Younger Kimmeridgian orogenic movements (Gutkowski 1998). Krzemionki is parabolic in plan, located on a syncline that dips between 3° and 20° along an 11km-long limestone outcrop (Fig. 6). Above the limestone are deposits of glacial sands and weathered clay. Within the limestone are three stripped flint seams that, due to tectonic movements, are unevenly distributed, vary in size, and are often cracked. The upper two seams comprise good-quality flint nodules. The low-quality bottom seam was rarely exploited (*Krzemionki* 2018, 100, 108-11).

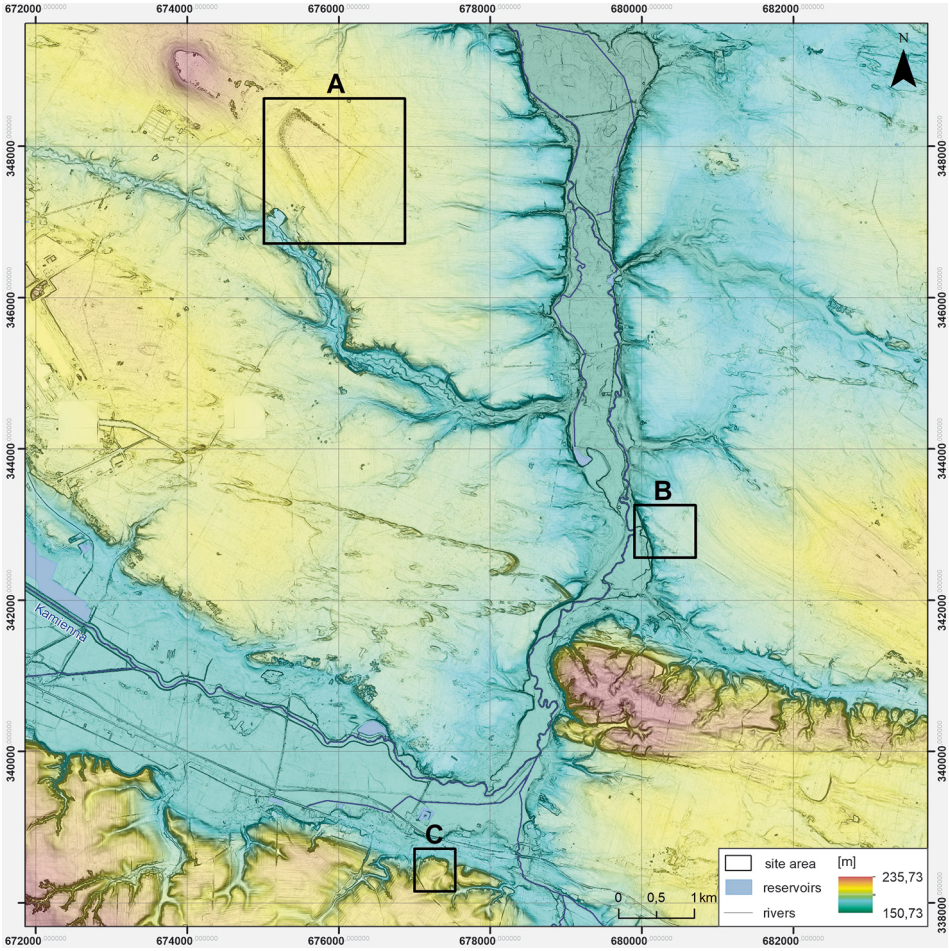

Fig. 6. Wider landscape of Krzemionki with Lidar map:
A – Krzemionki mining field; B – Borownia mining field; C – Gawroniec hill in Ćmielów – Funnel-Beaker culture settlement. Author: M. Skrzatek

Flint seams are not naturally exposed on the surface of Krzemionki, so it is unknown how miners discovered their existence. It is possible that flint fragments on the surface alerted the miners to the underlying seams, or it is possible that characteristic limestone flora (*Berberis vulgaris* L., *Padus avium Mill.*) forewarned miners to the presence of flint-bearing limestone bedrock (Borkowski and Budziszewski 1995, 72, 73; Bąbel 2015, 86; Barga-Więcławska 2016; *Krzemionki* 2018, 112-117).

There are four mine types at Krzemionki: 1) pit and shaft-niche-gallery, 2) shaft and gallery, 3) shaft, galleried and pillar-chamber, and 4) shaft, galleried and chamber (Table 1 and Fig. 7).

Table 1. Krzemionki mine types (after Bąbel 2015; Krzemionki... 2018)

	Mineshaft Dimensions	Gallery Dimensions	Mine Features	Mining tools
Pit	5m< diameter 2.5m< depth		Sometimes undercut/ niches.	
Shaft-niche-gallery	4m< diameter 4.5m< depth	1m< high 5m< long	Short galleries opened in multiple directions	Stone wedges Flint picks Antler levers and chisels
Shaft and gallery	3m< diameter 7m< deep	7m< long	Pillars	
Shaft, galleried and pillar-chamber	3m< diameter 7m< deep	1m< high 8m< long	Radial galleries Pillars	Flint picks Antler levers and chisels
Shaft-galleried and chamber	3m< diameter 9m< deep	1.2m< high 20m< long	3-4 radial galleries Timber props Slab supporting walls	Flint pickaxe

Pit and shaft-niche-gallery

Open pits are located on the outer edge of the complex, where shallow flint seams are weathered and of poor quality due to the syncline. These pits take on two forms: pits and shaft-niche-gallery. The pits were kept small and shallow, probably because of weak bedrock wall structure, although small undercuts were often developed in their bases (Fig. 7: 1).

Shaft-niche-gallery mines were opened to exploit deeper, better quality flint seams, extracted from the shaft bottom and by the opening of short galleries. They were worked with a variety of stone, flint, and antler implements (*Krzemionki* 2018, 123).

Shaft and gallery

Few shaft and gallery mines are recorded at Krzemionki, probably because the well-bedded limestone allowed large and stable workings, such as chamber mines (Fig. 7:2). One mine, no. 8/669 (excavated in 1985) is an example of a shaft and gallery mine which connected the gallery (*Krzemionki* 2018, 124).

Shaft, galleried and pillar-chamber

Shaft, galleried and pillar-chamber are amongst the deepest mines at Krzemionki (Fig. 7: 3). Their defining features are in situ bedrock pillars formed at the base of mineshafts and within galleries. Mineshaft spoil was often deposited into redundant shafts previously excavated shafts. Within the basal system, spoil was backfilled into exhausted galleries. To extract flint nodules from the bedrock, niches were cut above the nodule, which was then levered free with wooden wedges. Pine (Latin: *Pinus)* torches or firebrands were used to provide working light; these were maintained by scraping their charred tips against the mine wall, leaving distinctive charcoal 'cleaning' marks (*Krzemionki* 2018, 124, 125).

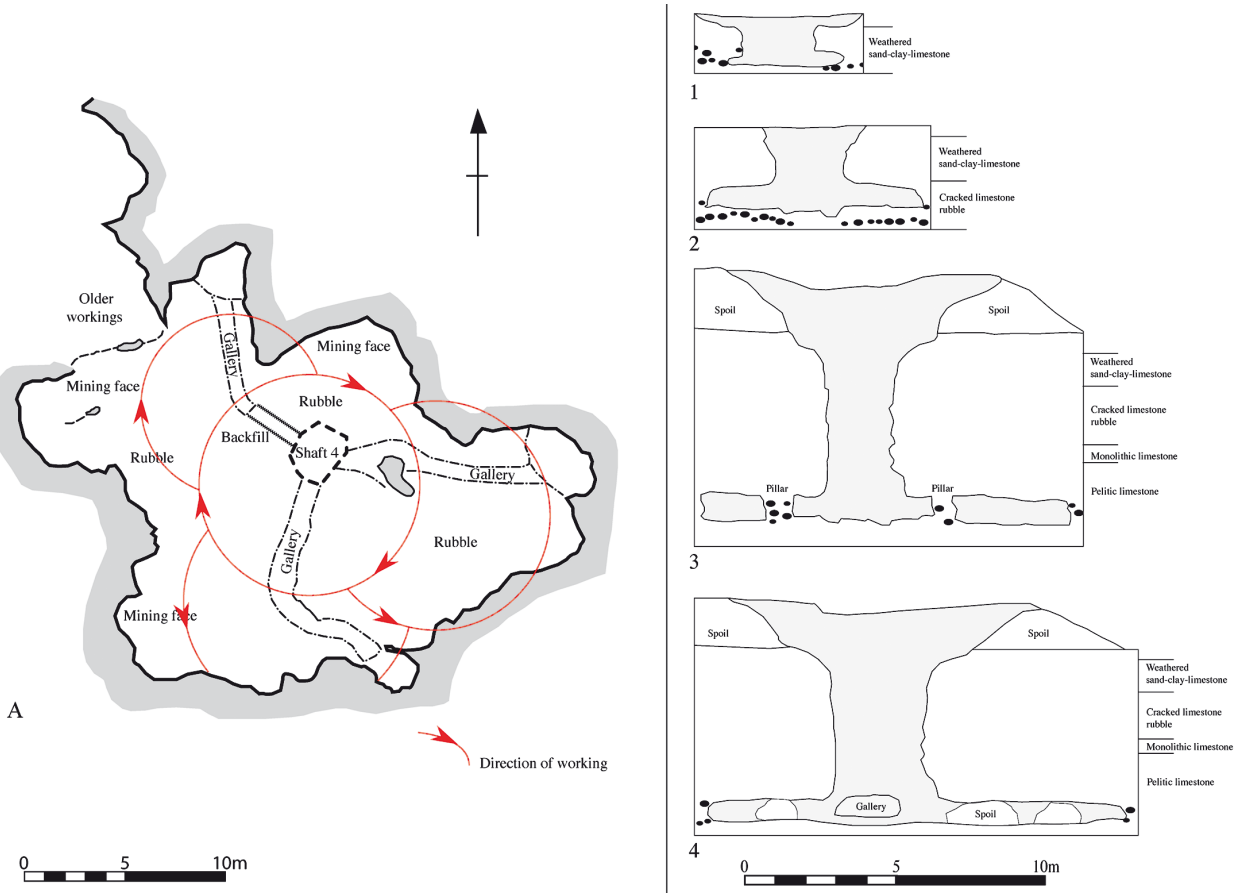

Fig. 7. Krzemionki; plans of mineshafts and galleries. After Bąbel 2015.
A – plan of working in a chamber mine with marked directions of mining work (fan-shaped working); 1 – Pit and shaft-niche-gallery; 2 – Shaft and gallery; 3 – Shaft, galleried and pillar-chamber; 4 – Shaft-galleried and chamber

Shaft-galleried and chamber

Shaft-galleried and chamber mines, the apex of mining at Krzemionki, comprise mineshafts which join radial galleries (Fig. 7: 4). In the chamber mines, galleries were dug radially in three directions, extending approximately 4 to 6 or 7 meters. This method allowed miners to determine the extent of the area to be worked. The next stage involved longwall mining on one or both sidewalls. Once the area was opened, flint was extracted from the gallery walls in a fan-like pattern, with extraction progressing from the 'longwall' working faces by removing flint nodules (see Fig. 7: A). Mine spoil was stacked within empty galleries to support the roof. Once the galleries reached a certain length, the chamber perimeter was extended in the same manner, sometimes a second or even a third time, progressively moving away from the shaft. The old galleries then became access routes, and as extraction continued, new chambers were opened. Additional access galleries were created from the mine spoil, which was supported by limestone blocks and wooden prop-like structures (Bąbel 2014, 25; *Krzemionki* 2018, 126).

A distinctive flint pickaxe, cigar-shaped, thick, and cylindrical with a sharp point and blunted hammerhead, was developed to work the shaft-galleried and chamber mines. Chamber-mines reached up to 500m^{2,} and it is estimated that enough flint to produce up to 7000 axeheads could be extracted from a single working (Borkowski *et al.* 1991, 616, 617; Borkowski 1995, 511-518; *Krzemionki* 2018, 122-126).

At the top of shaft 7/610, an arc of 16 postholes surrounded its entrance, interpreted as a cone-shaped shelter that covered the mineshaft to protect the workings and miners from the elements (Bąbel 2014, 97).

Grime's Graves

The Grime's Graves mine complex is located on Upper Cretaceous Late Turonian White Chalk (93.9-89.8 Mya) that contains nodular and tabular flint of the Brandon Flint Series (Mortimore and Wood 1986). The landscape is typified by undulating sandy heathland, the Breckland (Fig. 8). The upper chalk was subjected to Pleistocene glacial erosion and cryoturbation, and is covered by gravels, sands and tills, up to 2.5 m in depth.

Mine features at Grime's Graves are broadly divided into three forms: 1) galleried mines, 2) simple pits and 3) primitive-pits (Fig. 9).

Galleried-mines

The mineshafts of galleried mines were generally opened individually, although on occasion they were excavated in groups (Bishop 2012, 44). Floorstone flint was initially removed from the mineshafts' base, after which flint seams were followed by radiating galleries, eventually forming a basal system.

In the galleries, chalk pillars and walls were left in situ to support the roof. Empty galleries were backfilled with spoil from newly opened ones, negating their transfer to the

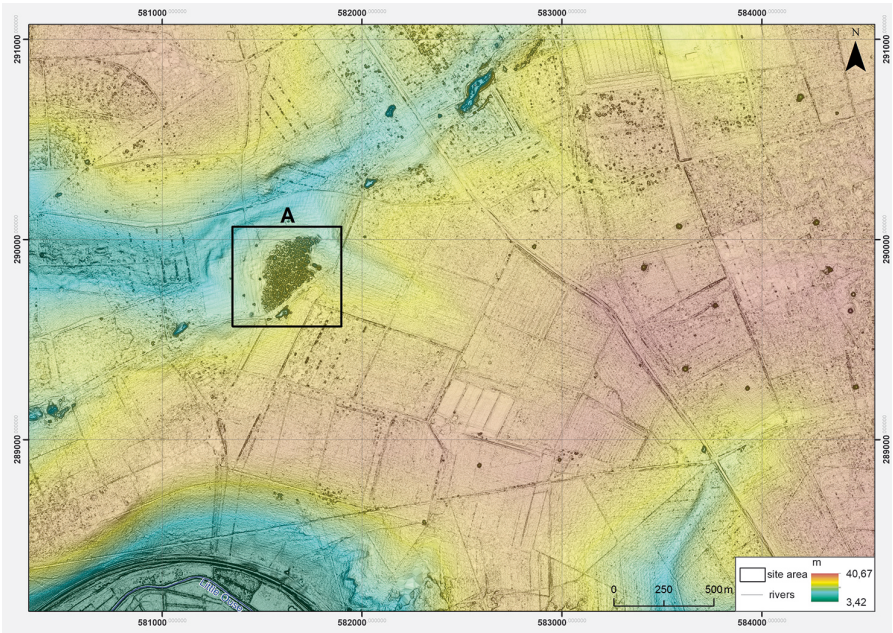

Fig. 8. Wider landscape of Grime's Graves with Lidar map. Author: M. Skrzatek

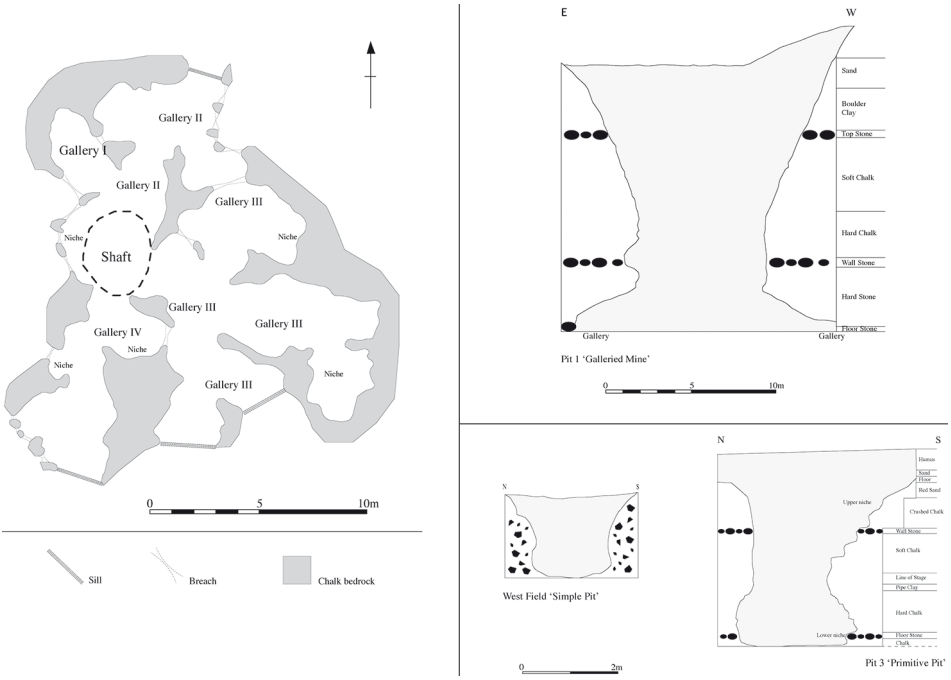

Fig. 9. Grime's Graves; plans of mineshafts and galleries

surface and helping to prop them up. Floorstone nodules were levered from the floor using red deer antler picks, large amounts of which were found abandoned.

Simple pits/primitive pits

Simple pits and primitive pits are in the north and West Field area of the complex, where the upper chalk flint seams are close to the surface but are glaciated and of low quality. In the simple pits, flint was extracted from superficial chalk geology, although floorstone was occasionally exploited (Healy *et al.* 2023).

The primitive pits are not named by chronology, but rather because they are technologically less advanced than the galleried mines. Flint was exploited in the Primitive-pits via undercuts from both the glacial deposits and floorstone. Unlike simple pits, working in the primitive pits was undertaken with animal bone picks, rather than antler.

Table 2. Grime's Graves mine types (after Bishop 2012; Healy *et al.* 2018; 2023)

Mine Type	Mineshaft Dimensions	Gallery Dimensions	Mine Features	Mining tools
Galleried-mines	12m< diameter 13m< deep	Radial galleries 1.5m< height 3.5m< wide >15m long	Pillars. Walls between galleries. Windows and doorways between galleries	Red deer antler picks Occasional flint and stone picks/axes
Simple-pits	4m< diameter 4m< deep			Red deer antler picks
'Primitive' pits	4m< diameter 5m< deep		Niches cut at mid-shaft and base of pit	Bone picks

WORKSHOPS AND PRODUCTS

Krzemionki

In Krzemionki, the primary processing of flint, mainly flint axeheads, was carried out at the tops of mineshafts (Bąbel 2015, 99-112). In the workshops, raw flint was sorted, with large nodules reduced on stone anvils before the shaping of axehead roughouts. Flint nodules were processed into blocks for transportation to settlements or for long-distance trade (Sałacinska and Sałacinski 2022).

The processing of flint was organised differently by the Funnel-Beaker and Globular Amphora cultures at Krzemionki (Borkowski *et al.* 1991; Borkowski 1995; see Fig. 10). Funnel-Beaker workshops are located both within and outside the mine complex. Their axeheads were tetrahedral, square, or wedge-shaped, and often polished across entire surfaces or just at their cutting end (see Fig. 10: 1; Borkowski *et al.* 1991, 622; Jedynak and Kaptur 2017). It is argued that axeheads were mass-produced by FBC communities for

Fig. 10. Striped flint axes, a typical Krzemionki mine product, by cultural period: 1 – Funnel-Beaker culture ('Gawroniec hill' at Ćmielów); 2 – Globular Amphora culture (Krzemionki mining site); 3 – Mierzanowice culture (Kichary Nowe, site 2, Sandomierz district). Photo: D. H. Werra

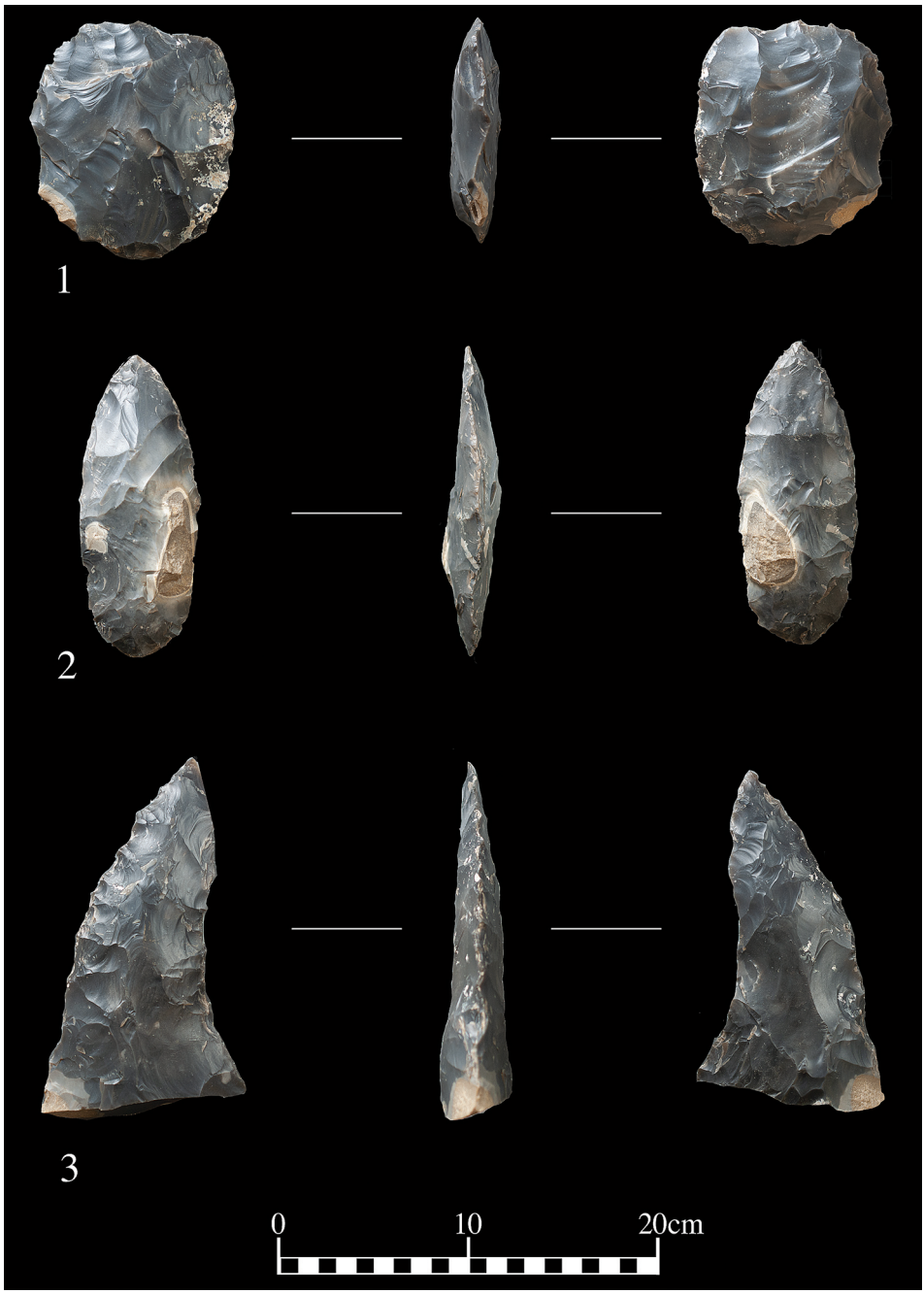

Fig. 11. Selection of typical Grimes Graves mine products. 1 – Discoidal knife roughout; 2 – Bifacial axehead; 3 – Irregular biface, a possible pick. Credit: English Heritage Trust. Photo: J. Bączkowski

woodland clearance (Bąbel 2015). Other FBC communities lithics included chisel blades, dihedral forms, and, occasionally, long blades, manufactured in workshops at the mine and at settlements in the wider region (Sałacińska and Sałaciński 2022).

During GAC communities mining, workshops are found mainly on the mine and are often accompanied by camps. At workshops, the entire technological cycle of axehead and chisel production is evidenced. The number of workshops and accumulation of production waste reflect the vast scale of exploitation.

Globular Amphora culture axeheads were flat, wedge-shaped, and often completely polished (Fig. 10: 2). They are recovered from a variety of archaeological contexts, including pits at settlements and human graves, leading to the proposal that they became symbolic objects, before or after use (Borkowski 1991, 622; Bąbel 2014, 14). During the Early Bronze Age, the Mierzanowice culture produced bi-facial polished axeheads from Krzemionki flint (Fig. 10: 3).

Grime's Graves

At Grime's Graves, primary dense flintworking floors were located close to mineshafts (Mercer 1981, 32). Working floors are also recorded 600m from the complex with smaller densities, although it is uncertain if they are associated with any mineshafts (Bishop 2012).

The full range of forms manufactured at Grime's Graves is not clear. Known products include flake axeheads and discoidal knives, as well as bifaces, including picks, points, waisted tools, and oblique arrowheads (Saville 1981; Bishop 2012; Lech 2012; see Fig. 11). A Levallois method was developed to produce discoidal forms (Saville 1981, 6, 7). There is often a lack of cortical flakes, large flakes, and cores in the working floors, indicating that primary working was carried out elsewhere and prepared cores were removed (Lech 2012; Healy *et al.* 2023). The production of these forms was continuous across the span of the galleried mines and simple pits, despite the differences in the quality of raw material (Lech 2012).

Little is known about flintworking in the 2nd millennium BCE. Limited production of multi-platform flake cores was carried out using recycled waste from earlier deep mines. Also, floorstone may have been used to produce quern stones as suitably abrasive rock is not locally available (Healy 1996, 96).

MINING AND SETTLEMENT

There is little evidence of settlement directly on both mines, possibly due to a paucity of immediate sources of fresh water. It is also likely that occupation evidence may have been buried or destroyed by continuous mining. The nearest year-round water sources are rivers, the Little Ouse at Grime's Graves and the Kamienna at Krzemionki, located 1.2 km and 3.7km from the complexes, respectively (Bąbel 2014; Healy *et al.* 2023).

Krzemionki

Located in the wider landscape of Krzemionki are karst sinkholes that provided seasonal water. One excavated sinkhole contained flint debitage from all stages of both FBC and GAC communities' axehead production (Zalewski 1996). The sinkholes are likely to have been the location of seasonal mining camps. Occupation evidence, including hearths, pottery, and animal bone, was also recovered from working floors surrounding the mineshafts. The structures capping the mineshafts presumably functioned as shelters. To date, no evidence of houses is recorded (Bąbel 2015, 112, 113).

Grime's Graves

Settlement evidence at Grime's Graves is lacking, although there is limited domestic evidence documented in the galleries in the form of hearths and Late Neolithic Grooved Ware pottery. The pottery is exclusively bowl-forms, suitable for cooking and eating rather than storage. It is reasoned they relate to short-term occupation (Longworth *et al.* 1988, 14), although this seems incompatible with the timescale of mining (Healy *et al.* 2023).

WIDER LANDSCAPE AND DISTRIBUTION

Krzemionki

There is good knowledge on the movement of stripped flint from Krzemionki, due to the distinctive character of the flint and its limited geological distribution. The only other source of striped flint, "Kraków-Częstochowa striped flint", is from the Holy Cross Mountains, and there is no evidence of it being mined (Sudoł-Procyk *et al.* 2021)

It has been calculated that Krzemionki flint accounts for over 90% of striped flint in assemblages (Borkowski and Budziszewski 1995). In the wider region of Krzemionki FBC communities settlements, including 'Gawroniec hill' at Ćmielów and Stryczowice, are located along river valleys below the Sandomierz Uplands. Both settlements contained large assemblages of striped flint, including axeheads (Sałacińska and Sałaciński 2022). It is considered that both settlements were the 'home' of miners who carried large quantities of flint from Krzemionki for mass processing (Kowalewska-Marszałek 2019). It seems that 'Gawroniec hill' (Balcer 2002, 161) was the central settlement in this raw material economy, as its inhabitants processed striped flint on a scale exceeding their needs. Other river valley settlements were smaller and lacked traces of intense flint processing. Likely, these communities did not have access to flint deposits (Krukowski 1939, 73; Balcer 1975, 180, 1995; Borkowski *et al.* 1991; Uzarowicz-Chmielewska and Sałacińska 2013).

The Sandomierz Uplands are also where GAC settlements associated with Krzemionki (Kowalewska-Marszałek 2019) were located, including Mierzanowice and Krzczonowice (Jedynak and Kaptur 2008; Sałacińska and Sałaciński 2022). These settlements differ in character and range from those of the FBC communities (Kowalewska-Marszałek 2019), because GAC communities are associated with increased mobility and a lifestyle centred on short-lived camps (Szmyt 2017). There is scant evidence of striped flint being worked at GAC communities settlements beyond those directly located at Krzemionki, indicating that the mine complex was the focal point for production during this period (Borkowski *et al.* 1991; Borkowski 1995, 522, 523; Jedynak and Kaptur 2008; Szmyt 2017; Kowalewska; Marszałek 2019; Sałacińska and Sałaciński 2022).

Grime's Graves

Settlement evidence in the Breckland area surrounding Grime's Graves is mostly presented by flint scatters (Healy 1998; Healy *et al.* 2023) and occasional pit groups along river valleys (Bishop 2012, 325). Analysis of lithic assemblages from settlements indicates flint was generally locally sourced rather than imported (Bishop 2012). Therefore, Grime's Graves flint is thought to have only supplemented local supplies (Bishop 2012, 330).

In the wider region, analysis of lithic scatters from eastern England is dominated by locally sourced flint from river gravels, till and beach deposits, with only a fraction possibly from Grime's Graves (Healy 1996, 52; Bishop 2012).

Evidence of Grime's Graves flint travelling long distances is rare but may include high-quality chalk flint found in assemblages in Mid-Wales and the East Midlands (Healy *et al.* 2023, 146). There are also four oversized 'keeled cores', weighing 15kg-26kg (Harding and Lord 2017). Three of the cores were recovered from within 40km of Grime's Graves. However, a fourth was recovered from West Kennett, close to Avebury henge, Wiltshire, located c. 200 km from the mines. Negative flake scars on the cores are for discoidal knives blanks (Harding and Lord 2017), a product associated with Grime's Graves. Finally, two Cornish axeheads found at Grime's Graves hint at long-distance connections, as their source is 500km away.

DISCUSSION

There are notable differences between the chronology of both mines. At Krzemionki, striped flint sourced from the mines was worked at FBC communities settlements in the early 4th millennium BCE (Sałacińska and Sałaciński 2022), contemporary with the start of shaft-galleried mining across Europe, including England (Edinborough *et al.* 2019). In contrast, Grime's Graves dates to the final centuries of the shaft-galleried mining tradition in the mid-3rd millennium BCE.

Comparable chronologies occur in later phases at both mines with shaft-galleried mining finishing before the 2nd millennium BCE, after which simpler extraction methods were employed. Flint industries at both mines in the 2nd millennium BCE were based on the recycling of older mine waste. Recycling of mine waste is also documented at other mines across the 3rd-2nd millennium BCE, including in southern England (Bączkowski 2022) and Sweden (Berggren *et al.* 2016; Högberg *et al.* 2023).

It is notable that recycling activity occurs after bronze had started to transform societies in Britain and Poland, a process impacting on flint reliant communities (Bradley *et al.* 2016; Kadrow 2017; Parker *et al.* 2019; see Lech *et al.* 2015; Oliva 2022, 67ff) who may have wanted to retain a connection to a deep-rooted tradition, shaft-galleried mining.

Methodology and origin

Similarities exist in shaft-galleried mining, which requires a sophisticated knowledge of bedrock conditions. At both mines, this knowledge is expressed in the careful placement of pillars and walls in galleries to support bedrock stresses.

Although, as found at all flint mines, geology governs extraction at Krzemionki and Grime's Graves, with shaft-galleried mines targeting deep flint seams and pits exploiting shallow ones, the difference in structures is not evolutionary. The chronology is not clear at Krzemionki, although shaft-galleried mines were most probably opened in the early 4th millennium BCE, as evidenced by the presence of striped flint at FBC settlements connected to the mines. However, there is still a lack of radiocarbon dates, which will evidently connect different types of mining features with the activities of particular prehistoric communities. However, there is no evidence of evolutionary development of extraction features. The simple workings also post-date subterranean workings at Krzemionki, as at Grime's Graves.

Mining at Krzemionki started in the 4th millennium BCE when FBC communities were expanding into areas beyond those previously settled by Linear Pottery Culture communities, including the opening of land along river valleys below the Sandomierz Uplands (Bąbel 1980, 592; Borkowski and Budziszewski 1995, 75; Nowak 2017; Krzemionki 2018, 977). Axeheads from Krzemionki were in demand for woodland clearance, and grey-white spotted flint from the Świeciechów mines was also used to produce axeheads and long blades for the processing of crops. Both Świeciechów grey-white spotted flint and Krzemionki striped flint are recorded at the 'Gawroniec hill' settlement at Ćmielów (Balcer 1995; 2002; Budziszewski 2006), showing the importance of mining to pioneer communities for providing material needed for woodland clearance and agriculture.

At Grime's Graves, the shaft-galleried mines are the earliest mining features chronologically. This strongly suggests that shaft-galleried mining was introduced specifically to Grime's Graves by communities already familiar with the method (Healy *et al.* 2018, 290), especially since no British shaft-galleried mines are chronologically close to the mid-3rd

millennium BCE. Although it is worth noting that shaft-galleried mining at the southern British mines began around 3900/3800 cal. BCE, it had all but ceased by 3400/3300 cal. BCE (Edinburgh *et al.* 2019), which meant an almost 800-year gap before it began at Grime's Graves. This infers that at that shaft-galleried mining is not an insular innovation, as it is unlikely that the knowledge, or memory, of shaft-galleried mining would have been retained for such a long break (Healey et al 2018, 290). It is further notable that when shaft-galleried mining started at Grimes Grave's the recycling of mine spoil, and possibly even the opening of new mines, also commenced at the earlier and long abandoned southern English flint mines in the mid-3rd millennium BCE (Bączkowski 2022), indicating a renewal of interest in lithic sources and production in the final centuries of the Neolithic.

Understanding the origins of Grime's Graves is difficult, with no contemporary mining in Britain and no obvious connection with any Continental mines, although shaft-galleried mining was underway at Spiennes (Belgium, 4350-2300 cal. BCE; Collet *et al.* 2008; Collet and Collin 2023), and mines in the Paris Basin (Bostyn *et al.* 2018), as well as Skovbakken (Denmark, Late Neolithic, 2300-2100/2000 cal. BCE; Sørensen 2015, 6, 25).

The proposed continental origin of Grime's Graves challenges the idea of insularity in the British Late Neolithic period (Allen *et al.* 2012). It is possible that the entire community, or some of the skilled miners, were incomers, possibly from the Continent, but this phenomenon has not been thoroughly examined. To understand how miners spread their knowledge, a comprehensive analysis of their work procedures is essential. This analysis should include a review of the technical aspects of underground exploration, as well as research into long-distance contacts and exchanges. The location of Grime's Graves is also significant for understanding this phenomenon, as the mines are situated less than 15 km from the modern coastline, within a vast area of wetland and estuary known as the Fens. Mining groups may have accessed the area through this coastline, which has a rich history of prehistoric activity (Healy 1996).

Other concentrations of finely worked Late Neolithic flintwork around the British Isles, including discoidal knives, indicate that coastal locales were important for the exchange of material culture (Bradley 2022). If Grime's Graves was connected to coastal trade, it might explain the scarcity of mined flint from local settlements if it was exported via maritime routes (Bradley 2022, 30), although it is acknowledged that direct knowledge on the wider distribution of Grime's Graves flint is lacking.

The origins of this cultural phenomenon, shaft-galleried flint mining, remain under investigation. In both presented sites, this extraction method appears as a fully developed technique. At the Krzemionki mining complex, this method was introduced alongside the emergence of FBC communities. Similarly, for the Grime's Graves mine, it seems that the innovation was not locally developed but rather introduced by incoming communities. The question remains: where did the impulses for this excitation method originate?

Products

At Krzemionki axeheads were produced throughout the entire working life of the mine, although the use of axeheads may have altered over time.

Initially, mining at Krzemionki appears to have been driven by necessity, as no striped flint can be surface sourced. However, it is difficult to interpret axehead production as driven solely by demand. Axeheads are not exclusively quotidian. They contain symbolism, signified by their deposition into pits, graves and other contexts across Europe throughout the Neolithic and Early Bronze Age periods (Davis and Edmonds 2011). Excessively polished Krzemionki axeheads were often deposited unused into pits, inferring that they were meant for deposition and not use. For example, later in the chronology of Krzemionki, the Globular Amorpha Culture deposited highly polished axeheads into graves and pits (Szmyt 2010; Przybyła *et al.* 2013; Bąbel 2014, 41ff). Also, it cannot be ruled out that the aesthetic value of striped flint may have increased the demand for polished axeheads in the history of Krzemionki mining (see Nobis 2018).

At Grime's Graves, axeheads were only a small component of the lithics being produced from mined flint. This is unlike the Early Neolithic southern British mines, which were associated with bi-facial axeheads produced for woodland clearance by incoming farming communities (Brace *et al.* 2019). The demand for axeheads had waned by the Late Neolithic, and extraction in mining areas had shifted to surface sources (Gardiner 1990). This makes Grime's Graves an oddity because there is no obvious need for large-scale flint procurement in the Late Neolithic. Mining at Grime's Graves may have therefore fulfilled a less prosaic role, and it is argued that the mines were a place for community gatherings associated with the production of 'special objects' (Bishop 2012). These 'special objects', such as discoidal knives, were often symbolically deposited into pits alongside Grooved Ware pottery (Healy 2012). Similar pieces were also produced on waste flakes from Early Neolithic mines, including the southern English mines (Bączkowski 2022) and Södra Sallerup, Sweden (Berggren *et al.* 2016; Högberg *et al.* 2023).

Cultural importance of mining

It has long been acknowledged that Krzemionki and Grime's Graves were production centres from which lithics were distributed, but this is only part of their narrative because mining has demands beyond the extraction face requiring complex social organisation. Entire communities must have been engaged in mining or related activities because miners needed support with sustenance and materials, including wood for structures, antlers for picks and stone for hammers. The scale and duration of mining at both mines indicate that extraction episodes lasted for many months. This infers that occupation was directly upon, or close to the mines. It is unlikely that miners settled far from the mines.

Water could be sourced within a practical distance from both mines, including from seasonal sinkholes and rivers, the Kamienna at Krzemionki and the Little Ouse at Grime's Graves. Settlements were probably located close to these water sources, with miners travelling short distances or supported by communities at these camps. The temporal character of evidence, including hearths, occasional animal bones and a paucity of large storage vessels, may support this model.

That both mines were close to rivers is further helpful for trading and exchanging mine products. Mined flint may have been traded along these watercourses between riverside settlements, forming long reaching distribution networks. Because Krzemionki striped flint is easily provenanced, research has shown that it was widely distributed from the mines. Material from GAC communities mining in the 3rd millennium BCE has been found up to 660km from the mine (Balcer and Kowaski 1978; Bąbel 1980, 595; 2015, 128).

Of the limited evidence of Grime's Graves flint being exported from the mines, the four oversized cores are most notable. If the oversized cores originate from Grime's Graves, they may represent similar export pieces only surviving because they were venerated (Harding and Lord 2017), or simply because they were a forgotten reserve waiting for reduction. Future analysis of these cores to provenance their source would help attribute them to Grime's Graves and possibly increase knowledge of the movement, and use, of mined flint.

During extraction episodes, the mines and wider environs would have been busy with community activities. In this respect, mines operated like large-scale community monuments (Edmonds 1999; Bishop 2012), increasing their significance. The experience of mining and the performance of lithic production would have enhanced the cultural and symbolic value of mines (Whittle 1995; Oliva 2018; Topping 2021).

Mines endured as meaningful locales for successive generations, and seasonal mining may have brought together disconnected communities, maintaining cultural links, knowledge transfer and social relationships (Bąbel 1997; 2015; Topping 1997; Berggren *et al.* 2016; Castańeda 2018; 2021; Bostyn 2023, 363; Díaz-del-Río *et al.* 2023; Högberg *et al.* 2023). After mining waned, non-mining communities continued to visit the mines to recycle mine waste, either because the spoil heaps of abandoned mines were an easily exploitable resource or because communities still held cultural links to the mines (Lech *et al.* 2015; Oliva 2022).

Wider significance of mining

Both mines reflect wider cultural narratives and transformations. At Krzemionki, mining arrives with incoming FBC communities who may have originated from a merger of farming communities with hunter and gathering groups in southern Scandinavia, northern Germany and Poland (Nowak 2017; Gron and Sørensen 2018). Although the origins of the

FBC communities are debated, with DNA analysis showing a complex mixing of FBC and post-FBC Neolithic communities (Fernandes *et al.* 2018; Gron and Sørensen 2018).

The cultural meaning of mining at Krzemionki shifted with the arrival of GAC communities, coinciding with a migration of groups from the Pontic steppe (Tassi *et al.* 2017). Although the lifestyles of GAC communities were based on mobility and pastoralism (Szmyt 2010), and mining at Krzemionki became more complex with the development of chamber mines. During this period, the distribution of striped flint axeheads from Krzemionki increased, and they were now deposited alongside human burials.

After mining finished at Krzemionki, the mines were visited by incoming Bell-Beaker communities, whose recycling of mine waste is documented by striped flint found at their Sandomierz Upland settlements (Budziszewski and Włodarczak 2010, 69). The same recycling is observed at Grime's Graves. Even after shaft-galleried mining ceased both mines therefore retained an importance in supplying flint, regardless of whether this recycling was for cultural or practical reasons.

At Grime's Grave, the arrival of Bell-Beaker communities into the British Isles in the second half of the 3rd millennium BCE marked a period of change when the cultural landscape shifted from an insular Late Neolithic (Parker Pearson *et al.* 2019). It may be no coincidence that in this period shaft-galleried mining was abandoned, and simple pit extraction began (Healy *et al.* 2018).

It is notable that, although galleried mining lost its importance, the production of 'special' lithics continued even after all forms of mining ceased, and only waste recycling remained. Throughout this cultural transformation, the same fine lithic forms are produced at Grime's Graves. This may show a community at odds with a world being transformed by bronze, preferring to continue previous traditions (Healy *et al.* 2018).

Analysis of DNA in this period shows both the eventual replacement of British Neolithic populations (Olalde *et al.* 2018) and the nuances of social relationships with incoming Bell-Beaker communities (Booth *et al.* 2021). The waxing and waning of mining links Grime's Graves to wider cultural shifts within a changing world, when old customs were being lost or renegotiated. It is possible that mining at Grime's Graves was founded by an incoming community because they decided to continue a mining and lithic tradition that was an important part of their cultural identity.

CONCLUSION

It is recognised that Grime's Graves and Krzemionki are located hundreds of kilometres apart, making any direct connection impossible. However, this paper has shown that both mines share an extraction methodology that originated in the late 5th millennium BCE, which by the early 4th millennium BCE had become associated with many mines across Europe.

Shaft-galleried mining presumably originated at a yet to be identified location in the late-5th millennium BCE, becoming the method associated with large, persistent mines. Grime's Graves, established in the mid-3rd millennium BCE, represents one of the last cultural expressions of a tradition that had its origins over a millennium earlier and underpinned extraction at Krzemionki.

Overall, both mines reflect wider narratives of cultural transition and were locales for lithic production and gatherings. They were manifestly more than just extraction sites.

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References

Allen M. J., Gardiner J. and Sheridan A. 2012. *Is there a British Chalcolithic? People, place and polity in the later 3rd millennium* (= *Prehistoric Society Research Paper* 4). Oxford: Oxbow Books.

Armstrong A. L. 1923. Discovery of a New Phase of Early Mining at Grime's Graves, Norfolk. Percy Sladen Fund Excavations: Preliminary Report. *Proceedings of the Prehistoric Society of East Anglia* 4/1, 113-125.

Bąbel J. T. 1980. PL 6 Krzemionki, Gemeinde Bodzechów, Wojw. Kielce und Gemeinde Boria, Wojw. Tarnobrzeg. In G. Weisgerber, R. Slota and J. Weiner (eds), *5000 Jahre Feuersteinbergbau. Die Suche nach dem Stahl der Steinzeit*. Bochum: Deutsche Bergbau-Museum, 586-596.

Bąbel J. T. 1997. Technical flint knapping skills in Neolithic mining societies. In R. Schild and Z. Sulgostowska (eds), *Man and Flint: Proceedings of the VIIth International Flint Symposium, Warsaw-Ostrowiec Świętokrzyski, September 1995*. Warszawa: Institute of Archaeology and Ethnology PAS, 167-169.

Bąbel J. T. 2014. *Krzemionki. Historical Monument Reserve, Museum. Prehistoric mines of striped flint*. Warszawa: ENETEIA Publishing House.

Bąbel J. T. 2015. *Krzemionki Opatowskie. Monument prahistorii Europy. Kopalnie krzemienia pasiastego*. Ostrowiec Świętokrzyski: Muzeum Historyczno-Archeologiczne w Ostrowcu Świętokrzyskim.

Bąbel J., Braziewicz J., Jaskóła M., Kretchmer W., Pajek M., Semaniak J., Scharf A. and Uhl T. 2005. The radiocarbon dating of the Neolithic flint mines at Krzemionki in central Poland. *Nuclear Instruments and Methods in Physics Research* 240, 539-543.

Bączkowski J. 2014. Learning by Experience: The Flint Mines of Southern England and Their Continental Origins. *Oxford Journal of Archaeology* 33/2, 135-153.

Bączkowski J. 2022. Re-working the Past: Evidence for Late Neolithic and Early Bronze Age Flint Extraction at the Early Neolithic Mines of Sussex. *Archaeologia Polona* 60, 61-86.

Bańdo C., Dagnan-Ginter A., Hole S. K., Kozłowski J. K., Montet-White A., Pawlikowski M. and Sobczyk K. 1992. Wołowice, province of Kraków (Flint extraction and processing site). In J. K. Kozlowski and J. Śliwa (eds), *Recherches archéologiques de 1990*. Kraków: L'Institut d'Archéologie de l'Université de Cracovie, 5-24.

Balcer B. 1975. *Krzemień świeciechowski w kulturze pucharów lejkowatych. Eksploatacja, obróbka i rozprzestrzenienie*. Wrocław, Warszawa, Kraków, Gdańsk: Zakład Narodowy im. Ossolińskich.

Balcer B. 1995. The relationship between a settlement and flint mines. A preliminary study of the Eneolithic workshop assemblages from Ćmielów (Southern Poland). *Archaeologia Polona* 33, 209-221.

Balcer B. 2002. *Ćmielów, Krzemionki, Świeciechów. Związki osady neolitycznej z kopalniami krzemienia*. Warszawa: Instytut Archeologii i Etnologii PAN.

Balcer B. and Kowalski K. 1978. Z Badań nad Krzemieniem Pasiastym w Pradziejach. *Wiadomości Archeologiczne* 43/3, 127-146.

Barber M., Field D. and Topping P. 1999. *The Neolithic Flint Mines of England*. London: English Heritage.

Barga-Więcławska J. 2016. Krzemionki „przyrodniczym archiwum" neolitycznego górnictwa krzemienia. In B. Furmanik, K. Piotrowska-Nosek and A. Wawrzyńczuk (eds), *Historyczne kopalnie. Dzieło przyrody sztuka człowieka*. Warszawa: Narodowy Instytut Dziedzictwa, 28-35.

Becker C. J. 1959. Flint Mining in Neolithic Denmark. *Antiquity* 33(130), 87-92.

Berggren A., Högberg A. Olausson D. and Rudebeck E. 2016. Early Neolithic flint mining at Södra Sallerup, Scania, Sweden. *Archaeologia Polona* 54, 167-180.

Bishop B. J. 2012. *The Grime's Graves Environs Survey; Exploring the Social Landscapes of a Flint Source*. Unpublished PhD thesis. University of York.

Booth T., Brück J., Braace S. and Barnes J. 2021. Tales from the Supplementary Information: Ancestry Change in Chalcolithic-Early Bronze Age Britain Was Gradual with Varied Kinship Organisation. *Cambridge Archaeological Journal* 31, 379-400.

Borkowski W. 1995. Prehistoric flint mines complex in Krzemionki. *Archaeologia Polona* 33, 506-524.

Borkowski W., Migal W., Sałaciński S. and Zalewski M. 1991. Possibilities of investigating Neolithic flint economies, as exemplified by the banded flint economy. *Antiquity* 65(248), 607-627.

Borkowski W. and Budziszewski J. 1995. The use of striped flint in prehistory. *Archaeologia Polona* 33, 71-87.

Bostyn F. 2023. The Neolithic flint mine at Jablines, 'le Haut-Château' (Seine-et-Marne, France). In F. Bostyn, J. Lech, A. Saville and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 355-365.

Bostyn F. and Lanchon Y. 1992. *Jablines Le Haut-Château (Seine-et-Marne): Une minière de silex au Néolithique (= Sciences de l'Homme. B. Documents d'Archéologie Française 35*). Paris: Éditions de la Maison des sciences de l'homme.

Bostyn F., Collet H., Collin J-P. and Giligny F. 2018. Flint Mining in Northern France and Belgium: a Review. In D. H. Werra and M. Woźny (eds), *Between History and Archaeology*. Oxford: Archaeopress Archaeology, 25-35.

Bostyn F., Saville A., Lech J. and Werra D. H. eds 2023. *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology.

Bradley R. 2022. *Maritime Archaeology on Dry Land; Special Sites along the Coast of Britain and Ireland from the First Farmers to the Atlantic Bronze Age*. Oxford and Philadelphia: Oxbow Books.

Bradley R., Haselgrove C., Vander Linden M. and Webley L. 2016. *The Later Prehistory of Northwest Europe: The evidence of development-led fieldwork*. Oxford: Oxford University Press.

Brace S., Diekmann Y., Booth T. J., van Dorp L., Faltyskova Z., Rohland N. *et al.* 2019. Population replacement in Early Neolithic Britain. *Nature and Evolution* 3, 765-771.

Budziszewski J. 2006. Flint Economy in Chalcolithic Societies of East-Central Europe. In G. Körlin and G. Weisgerber (eds), *Stone Age – Mining Age. Montanhistorische Zeitschrift DER ANSCHNITT Beiheft 19* (= Veröffentlichungen aus dem Deutschen Bergbau-Museum Bochum 148). Bochum: Deutsches Bergbau-Museum, 315-327.

Budziszewski J. and Włodarczak P. 2010. *Kultura pucharów dzwonowatych na Wyżynie Małopolskiej*. Kraków: Instytut Archeologii i Etnologii PAN.

Capote M., Castańeda N., Consuegra S., Criado C and Díaz-del-Río P. 2008. Flint mining in early Neolithic Iberia: a preliminary report on 'Casa Montero' (Madrid, Spain). In P. Allard, F. Bostyn, F. Giligny and J. Lech (eds), *Flint Mining in Prehistoric Europe: Interpreting the Archaeological Records: European Association of Archaeologists, 12th Annual Meeting Cracow, Poland 19th-24th September 2006* (= *BAR International Series* 1891). Oxford: Archaeopress, 123-138.

Castańeda N. 2021 An Operative Sequences Network: The Technical Organization at Casa Montero Early Neolithic Flint Mine (Madrid, Spain). *Open Archaeology* 7, 986-999.

Castańeda N. 2018. Apprenticeship in early Neolithic societies. The transmission of technical knowledge at the flint mine of Casa Montero (Madrid, Spain), c. 5300-5200 cal. BC. *Current Anthropology* 59/6, 716-740.

Charraud F. 2019. Flint mining and blade management in the Blicquy/Villeneuve-Saint-Germain culture through the earliest mines of Normandy and Northwest France settlements. In H. Collet and A. Hauzer (eds), *Mining and Quarrying. Geological Characterisation, Knapping Processes and Distribution Networks during Pre- and Protohistoric Times, Proceedings of the 7th International Conference of the USIPP Commission on flint mining in Pre- and Protohistoric Times.*

Mons and Spiennes, 28th Sept – 1st Oct 2016 (= *Anthropologica et Praehistorica* 128/2017). Brussels: Royal Belgian Institute of Natural Sciences, 119-123.

Collet H., Hauzeur A. and Lech J. 2008. The Prehistoric Flint Mining Complex at Spiennes (Belgium) on the Occasion of its Discovery 140 Years Ago. In P. Allard, F. Bostyn, F. Giligny and J. Lech (eds), *Flint Mining in Prehistoric Europe: Interpreting the Archaeological Records: European Association of Archaeologists, 12th Annual Meeting Cracow, Poland 19th-24th September 2006* (= *BAR International Series* 1891). Oxford: Archaeopress, 41-77.

Collet H. and Collin J.-P. 2023. The Neolithic flint mines of Spiennes (Belgium). In F. Bostyn, J. Lech, A. Saville and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 101-128.

Collin J.-P. 2016. Mining for a week or for centuries: Variable aims of flint extraction sites in the Mons Basin (Province of Hainaut, Belgium) within the lithic economy of the Neolithic. *Journal of Lithic Studies* 3/2, 1-17.

Consuegra S. and Díaz-del-Río P. 2018. Early Prehistoric Flint Mining in Europe: a Critical Review of the Radiocarbon Evidence. In D. H. Werra and M. Woźny (eds), *Between History and Archaeology: Papers in honour of Jacek Lech*. Oxford: Archaeopress, 1-8.

Davis V. and Edmonds M. 2011. *Stone Axes Studies III*. Oxford: Oxbow Books.

Díaz-del-Río P., Consuegra S., Castañeda N., Capdevila E., Capote M., Criado C., Casas C. and Nieto A. 2023. The Flint Mine of Casa Montero (Madrid, Spain): Making Society in Early Neolithic Europe. In F. Bostyn, J. Lech, A. Saville, and D. H. Werra, *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 165-184.

Edinborough K., Shennan S., Teather A., Baczkowski J., Bevan A., Bradley R. and Schauer P. 2019. New Radiocarbon Dates Show Early Neolithic Date of Flint-Mining and Stone Quarrying in Britain. *Radiocarbon* 62/1, 75-105.

Edmonds M. 1999. *Ancestral Geographies of the Neolithic: Landscapes, Monuments and Memory*. London and New York: Routledge.

Fernandes D. M., Strapagiel D., Borówka P., Marciniak B., Żądzińska E., Sirak K., Siska V., Grygiel R., Carlsson J., Manica A., Lorkiewicz W. and Pinhasi R. 2018. A genomic Neolithic time transect of hunter-farmer admixture in central Poland. *Scientific Reports* 8. https://doi.org/10.1038/s41598-018-33067-w

Felder P. J., Cor P., Rademakers M., Marjorie E. and de Grooth M. 1998. *Excavations of Prehistoric Flint Mines at Rijckholt-St. Geertruid (Limburg, The Netherlands) by the 'Prehistoric Flint Mines Working Group' of the Dutch Geological Society, Limburg Section* (= *Archäologische Berichte* 12). Bonn: Dr. Rudolf Habelt GmbH.

Fisher L. E., Knipper C., Harris S. K. and Schreg R. 2023. Neolithic Chert Extraction and Processing on the Southeastern Swabian Alb (Asch-Borgerhau, Germany). In F. Bostyn, J. Lech, A. Saville, and D.H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 267-282.

Gardiner J. 1990. Flint Procurement and Neolithic axe production on the South Downs: a re-assessment. *Oxford Journal of Archaeology* 9, 119-140.

Ghesquiere E., Marcigny C. and Charraud F. 2021. *La minič̆re de Ri (Orne): Extraction de silex et production de haches au Néolithique moyen* (= *Recherches archéologiques* 20). Paris: INRAP, CNRS Éditions.

Greenwell W. 1870. On the Opening of Grime's Graves in Norfolk. *Journal of the Ethnological Society of London* 2, 419-439.

de Grooth M. E. Th., Deeben J., Willem de Kort J. and Schreurs J. 2023. The mining complex at Rijckholt-St Geertruid (Eijsden-Margraten, Limburg NL). In F. Bostyn, J. Lech, A. Saville, and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 57-99.

Gron K. J. and Sørensen L. 2018. Cultural and economic negotiation: a new perspective on the Neolithic Transition of Southern Scandinavia. *Antiquity* 92(364), 958-974.

Gurina N. N. 2000. *Prähistorische Feuersteinbergwerke in der ehemaligen UdSSR* (= *Der Anschnitt Beiheft* 12). Bochum: Verlag Marie Leidorf GmbH.

Gutkowski J. 1998. Oxfordian and Kimmeridgian of the northeastern margin of the Holy Cross Mountains, Central Poland. *Geological Quarter*ly 42/1, 59-72.

Harding P. and Lord J. 2017. Thoughts on massive flint cores from Wiltshire and East Anglia, the movement of flint and its role in Late Neolithic Britain. *The Antiquaries Journal* 97, 49-63.

Healy F. 1996. *The Fenland Project Number 11: The Wissey Embayment: Evidence for Pre-Iron Age settlement accumulated prior to the Fenland Project* (= *East Anglian Archaeology* 78). Dereham: Field Archaeology Division, Norfolk Museums Service, Union House, Gressenhall.

Healy F. 1998. The Surface of the Breckland. In N. Ashton, F. Healy and P. Pettit (eds), *Stone Age Archaeology: essays in honour of John Wymer* (= *Lithics Studies Society Occasional Paper* 6 *Oxbow Monograph* 102). Oxford: Oxbow Books, 225-235.

Healy F. 2012. Chronology, Corpses Ceramics, Copper and Lithics. In M. J. Allen, J. Gardiner and A. Sheridan (eds), *Is there a British Chalcolithic? People, place and polity in the late 3rd millennium* (= *Prehistoric Society Research Paper* 4). Oxford: Oxbow Books, 144-164.

Healy F., Marshall P., Bayliss A., Cook G., Bronk Ramsey C., van der Plicht J. and Dunbar E. 2018. When and Why? The Chronology and Context of Flint Mining at Grime's Graves, Norfolk, England. *Proceedings of the Prehistoric Society* 84, 277-301

Healy F., Topping P. and Varndell G. 2023. Grime's Graves (England). In F. Bostyn, A. Saville, J. Lech and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 131-164.

Högberg A., Berggren Å. and Brink K. 2023. Early Neolithic flint extraction in south-western Sweden: Transregional practices on a local scale. *Antiquity* 97(392), 331-347.

Immel A., Ţerna S., Simalcsik A., Susat J., Šarov O., Sîrbu G. *et al*. 2020. Gene-flow from steppe individuals into Cucuteni-Trypillia associated populations indicates long-standing contacts and gradual admixture. *Scientific Reports* 10, 4253. https://doi.org/10.1038/s41598-020-61190-0

Jedynak A. and Kaptur K. 2008. Sprawozdanie z badan osady kultury amfor kulistych na stanowisku 63 w Krzczonowicach, pow. Ostrowiecki w roku 2006. *Ostrowieckie Zeszyty Naukowe* 1, 19-26.

Jedynak A. and Kaptur K. 2017. *Krzemionki Prehistoric Flint Mines Folder*. Ostrowiec Świętokrzyski: Muzeum Historyczno-Archeologiczne w Ostrowcu Świętokrzyskim.

Jedynak A. and Wroniecki P. 2022. Non-invasive Investigation of Segment C of the Krzemionki Exploitation Field. Initial Research Results. *Archaeologia Polona* 60, 39-59.

Kadrow S. 2016. Exchange of People, Ideas and Things between Cucuteni-Trypillian Complex and Areas of South-Eastern Poland. In C. Preoteasa and C. D. Nicola (eds), *Cucuteni Culture within The European Neo-Eneolithic Context* (= *Bibliotheca Memoriae Antiquitatis* 37). Piatra Neamț: Editura 'Constantin Matasă', 649-677.

Kadrow S. 2017. The Bronze Age. In U. Bugaj (ed.), *The Past Societies 2000-500 BC, Vol. 3*. Warszawa: Institute of Archaeology and Ethnography of Sciences, 10-385.

Kerig T., Edinborough K., Downey S. S. and Shennan S. 2015. A radiocarbon chronology of European flint mines suggests a link to population patterns. In T. Kerig and S. Shennan (eds), *Connecting Networks: Characterising Contact by Measuring Lithic Exchange in the European Neolithic*. Oxford: Archaeopress, 116-164.

Kowalewska-Marszałek H. 2019. The Funnel Beaker and Globular Amphora Cultures in the Sandomierz Upland in the Light of Settlement Research. *Archaeologia Polona* 57, 119-134.

Krukowski S. 1939. *Krzemionki opatowskie*. Warszawa: Muzeum Techniki i Przemysłu.

Krzemionki... 2018. *Krzemionki Prehistoric Striped Flint Mining Region. World Heritage Nomination. Poland. January 2018*. Ostrowiec Świętokrzyski: Muzeum Historyczno-Archeologiczne w Ostrowcu Świętokrzyskim.

Kolesnik A. 2020. Dobycha i obrabotka kremnia na Donbasse v neoliticheskuyu epokhu. *Eminak: Scientific Quarterly Journal* 1(29), 211-224.

Lech J. 1981. Flint Mining among the Early Farming Communities of Central Europe. *Przegląd Archeologiczny* 28: 5-55.

Lech J. 2012. The Late Neolithic flint and stone industries. In I. Longworth., G. Varndell and J. Lech, *Excavations at Grimes Graves, Norfolk, 1972-1976* (= *Fascicule 6: Exploration and Excavation Beyond the Deep Mines*). London: British Museum Press, 90-144.

Lech J. 2023. Sąspów near Cracow (Poland). A Neolithic flint mine of the Danubian communities. In F. Bostyn, J. Lech, A. Saville, and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 223-265.

Lech J. and H., Adamczak K. and Werra D. 2011. Extraction methods in the Bronze Age at the Wierzbica "Zele" flint mine site (Central Poland): a model. In M. Capote, S. Consuegra, P. Díaz-del-Río and X. Terradas (eds), *Proceedings of the 2th International Conference of the UISPP Commission on Flint Mining in Pre- and Protohistoric Times (Madrid, 14-17 October 2009)* (= *BAR International Series* 2260). Oxford: Archaeopress, 109-116.

Lech J., Piotrowska D. and Werra D. H. 2015. Between economy and symbol: flint in the Bronze Age in eastern Central Europe. In P. Suchowska-Ducke, S. Scott Reiter and H. Vandkilde (eds), *Forging Identities. The Mobility of Culture in Bronze Age Europe, Vol. 1* (= *British Archaeological Reports, International Series* 1891). Oxford: Archaeopress, 221-229.

Lech J. and Werra D. H. 2023. Wierzbica 'Zele' (Poland). A flint mine from the Bronze Age. In F. Bostyn, J. Lech, A. Saville and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 453-483.

Longworth I., Ellison A. and Rigby V. 1988. *Excavations at Grimes Graves Norfolk 1972-1976* (= *Fascicule 2: The Neolithic, Bronze Age and Later Pottery*). London: British Museum Press.

Mercer R. J. 1981. *Grime's Graves, Norfolk Excavations 1971-72: Volume 1* (= *Department of the Environment Archaeological Reports* 11). London: Department of the Environment.

Mortimore R. N. and Wood C. J. 1986. The Distribution of Flint in the English Chalk, with Particular Reference to the 'Brandon Flint Series' and the High Turonian Flint Maximum. In G. de G. Sieveking and M. B. Hart (eds), *The Scientific Study of Chert and Flint*. Cambridge: Cambridge University Press, 7-42.

Nielsen S. V. 2017. Long blades and phantom cores: A case of long-distance stone tool refitting (Southern Norway). *Lithic Technology* 42, 1-12.

Nielsen S. V. 2021. From Foragers to Fisher-Farmers: How the Neolithisation Process Affected Coastal Fisheries in Scandinavia. *Open Archaeology* 8, 956-986.

Nobis A. 2018. Powrót krzemienia pasiastego. In B. Gediga, A. Grossman and W. Piotrowski (eds), *Inspiracje i funkcje sztuki pradziejowej i wczesnośredniowiecznej*. Biskupin, Wrocław: Muzeum Archeologiczne w Biskupinie, 151-166.

Nowak M. 2017. Ubiquitous settlers, consequent farmers, and monument builders. In P. Włodarczak (ed.), *The Past Societies 5500-2000 BC, Vol. 2*. Warszawa: Institute of Archaeology and Ethnology PAS, 125-170.

Olalde I. S., Brace S., Allentoft M. E., Armit I., Kristiansen K., Booth T. *et al*. 2018. The Beaker phenomenon and the genomic transformation of northwest Europe. *Nature* 555, 190-196.

Oliva M. 2018. Women´s Work? Findings from the Neolithic Chert Mines in the 'Krumlovský les', South Moravia. In D. H. Werra and M. Woźny (eds), *Between History and Archaeology Papers in honour of Jacek Lech*. Oxford: Archaeopress Archaeology, 43-48.

Oliva M. 2022. *Těžební krajinou předků. O tajmném podzemí Krumlovského lesa* (*Mining landscape of Our ancestors. On the mysterious underground of "Krumlowský les"*). Brno: Moravské zemské museum.

Parker-Pearson M., Sheridan A., Jay M., Chamberlain A., Richards M. and Evans J. 2019. *The Beaker People: Isotopes, Mobility and Diet in Prehistoric Britain*. Oxford: Oxbow Books.

Pellegrin J. 2012. Conférence inaugurale: grandes lames de l'Europe néolithique et alentour / Large blades from Neolithic Europe and abroad. In J.-C. Marquet and C. Verjux (eds), *L'Europe, déjà, à la fin des temps préhistoriques. Des grandes lames en silex dans toute l'Europe. Actes de la table-ronde internationale, Tours, Septembre 2007* (= *Supplément à la Revue archéologique du centre de la France* 38). Tours: Fédération pour l'édition de la Revue archéologique du Centre de la France, 15-43.

Pétrequin P., Errera M., Pétrequin A-M. and Allard P. 2006. The Neolithic quarries of Mont Viso (Piedmont, Italy). Initial radiocarbon dates. *European Journal of Archaeology* 9/1, 7-30.

Piotrowska D. 2014. Krzemień pasiasty i początki badań prehistorycznego górnictwa w Polsce. In D. Piotrowska, W. Piotrowski, A. Jedynak and K. Kaptur (eds), *Górnictwo z epoki kamienia: Krzemionki – Polska – Europa. W 90. rocznicę odkrycia kopalni w Krzemionkach* (= *Silex et Ferrum* 1). Ostrowiec Świętokrzyski: Muzeum Historyczno-Archeologiczne, 21-51.

Przybyła M. M., Szczepanek A. and Włodarczak P. (eds) 2013. *Koszyce, stanowisko 3. Przemoc i rytuał u schyłku neolitu* (= *Ocalone Dziedzictwo Archeologiczne* 4). Kraków, Pękowice: Wydawnictwo Profil-Archeo.

Sałacińska B. and Sałaciński S. 2022. Settlement base of the Neolithic banded flint mines in Krzemionki Opatowskie – an outline of the issues. *Sprawozdania Archeologiczne* 74/1, 67-104.

Saville A. 1981. *Grime's Graves, Norfolk Excavations 1971-72: Volume 2, The Flint Assemblage* (= *Department of the Environment Archaeological Reports* 11). London: Department of the Environment.

Schild R. 1995. Tomaszów, Radon Province. *Archaeologia Polona* 33, 455-465.

Schild R. 2023. The Chocolate Flint Mine of Tomaszów (Poland). In F. Bostyn, A. Saville, J. Lech and D. H. Werra (eds), *Prehistoric Flint Mines in Europe.* Oxford: Archaeopress Archaeology, 185-221.

Schyle D. and Weiner J. 2023. The Late Neolithic opencast flint mining and axehead blank production on the Lousberg in Aachen (Germany). In F. Bostyn, J. Lech, A. Saville, and D. H. Werra (eds), *Prehistoric Flint Mines in Europe*. Oxford: Archaeopress Archaeology, 283-311.

Sørensen L. 2015. *From hunter to farmer in Northern Europe: Migration and adaptation during the Neolithic and Bronze Age* (= *Acta Archaeologica* 85/1-3). København: Det Humanistiske Fakultet, Københavns Universitet.

Sudoł-Procyk M., Brandl M., Krajcarz M. T., Malak M., Skrzatek M., Stefański D., Trela-Kieferling E. and Werra D. H. 2021. Chocolate flint: new perspectives on its deposits, mining, use and distribution by prehistoric communities in Central Europe. *Antiquity* 95(383), e25. doi:10.15184/aqy.2021.48.

Szmyt M. 2010. Between West and East: People of the Globular Amphora Culture in Eastern Europe: 2950-2350 BC. *Baltic-Pontic Studies* 8.

Szmyt M. 2017. Collective graves, flint axes, and cows. The people of Globular Amphora culture on the Vistula and Odra. In P. Włodarczak (ed.), *The Past Societies 5500-2000 BC, Vol. 2*. Warszawa: Institute of Archaeology and Ethnology PAS, 211-264.

Terradas X. and Ortega D. 2017. Flint quarrying in north-eastern Iberia: quarry sites and the initial transformation of raw material. *Antiquity* 91(359), e5. doi:10.15184/aqy.2017.167

Tarriño A., López Tascón A., Hernández H., Hernandez H. H., Elorrieta I., Herrero-Alonso D., Aguirre M., Larreina D., Castaneda N. and Mahjuika A. 2022a. The Neolithic Flint Quarry of Pozarrate (Treviño, Northern Spain). *Open Archaeology* 8, 273-86.

Tarriño A., Elorrieta I., Alonso-Herrero D., López-Tascón C., Hernández-Hernández H., Castañeda N., Larreina D., Aguirre M. and Mujika J. A. 2022b. The Flint Quarry of Pozarrate (Treviño, Spain) in the Context of Iberian and Early European Neolithic Mining. *Archaeologia Polona* 60, 127-147.

Tarantini M., Giacomo E., Monno A. M. and Italo M. M. 2016. Gargano Promontory Flint: mining practices and archaeometric characterisation. In A. Tomasssi, D. Binder, G. Martino, G. Porraz, P. Simon and N. Naudinot (eds), *Ressources Lithiques, Productions et Transferts Entre Aples et Méditerranée, Actes de la Journée de la Société Française Nice 28-29 Mars 2013*. Paris: Société Préhistorique Française, 257-275.

Tassi F., Vai S., Silvia G., Lari M., Modi A., Pilli E., Brunell A., Susca R. R., Budnik A., Labuda D., Alberti F., Lalueza-Fox C., Reich D., Caramelli D. and Barbujani G. 2017. Genome diversity in the Neolithic Globular Amphorae culture and the spread of Indo-European languages. *Proceedings of the Royal Society B* 284, 1-9.

Topping P. 1997. Structured deposition, symbolism and the English flint mines. In R. Schild and Z. Sulgostowska (eds), *Man and Flint: Proceedings of the VIIth International Flint Symposium, Warszawa – Ostrowiec Świętokrzyski, September 1995*. Warszawa: Institute of Archaeology and Ethnology PAS, 127-132.

Topping P. 2021. *Neolithic Stone Extraction in Britain and Europe: An Ethnoarchaeological Perspective*. Oxford: Oxbow Books.

Uzarowicz-Chmielewska A. and Sałacińska B. 2013. Osady neolityczne w Stryczowicach, woj. świętokrzyskie. *Materiały Starożytne i Wczesnośredniowieczne* 10, 5-250.

Werra D. H. and Kerneder-Gubała K. 2021. 'Chocolate' flint mining from Final Palaeolithic up to Early Iron Age – a review. In F. Bostyn, F. Giligny and P. Topping (eds), *From Mine to User: Production and Procurement Systems of Siliceous Rocks in the European Neolithic and Bronze Age Proceedings of the XVIII UISPP World Congress (4-9 June 2018, Paris, France) Volume 10 Session XXXIII-1&2*. Oxford: Archaeopress, 42-56.

Werra D. H. and Woźny M. eds 2018. *Between History and Archaeology*. Oxford: Archaeopress Archaeology.

Wheeler P. 2011. Ideology and context within the European flint-mining tradition. In A. Saville (ed.), *Flint and Stone in the Neolithic Period* (= *Neolithic Studies Groups Seminar Papers* 11). Oxford: Oxbow Books, 304-315.

Whittle A. 1995. Gifts from the earth: symbolic dimensions of the use and production of Neolithic flint and stone axes. *Archaeologia Polona* 33, 247-256.

Witkowska B. and Włodarczak P. 2021. Relationships between Globular Amphora and Corded Ware occupation phases in Złota-Nad Wawrem site, Sandomierz Upland. Chronometric and stratigraphic evidence. *Baltic-Pontic Studies* 25, 117-158.

Zalewski M. 1996. Badania nad bezpośrednim zapleczem osadniczym kopalni krzemieni pasiastych w Krzemionkach (wyniki prac archeologicznych w rejonie tzw. 'Kału Cebuli'). In W. Brzeziński, W. Borkowski and W. Migal (eds), *Z badanì nad wykorzystaniem krzemienia pasiastego* (= *Studia nad Gospodarką i Surowcami Krzemiennymi w Pradziejach* 3). Warszawa: Państwowe Muzeum Archeologiczne w Warszawie, 9-23.