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At the Turn: Flint Mining as an Element of Social Changes in the Second Half of the Fifth Millennium BC in Western Lesser Poland

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In the second half of the fifth millennium BC, a new model of supply and processing of siliceous rocks appeared in western Lesser Poland (Małopolska). The existing methods of production of blades and flakes from small cores obtained at a short distance from the settlement were supplemented by those enabling the production of much longer blades from cores made from raw material obtained by mining. The significant increase in the size of lithics meant that this moment was referred to as "the metric change" (Polish: *przełom metryczny*). It was assumed that this was due to internal technological development within the early Neolithic communities of the Lengyel-Polgár cycle. This paper introduces a different explanation for this phenomenon. It is argued that the new model of supply appeared as an already developed model that was implemented by experienced outsiders. A thesis that the indicated technological caesura is not categorical and new patterns in a relatively small area could co-exist with previous ones.

KEY-WORDS: flint mining, lithic technology, Neolithic, Eneolithic, radiocarbon chronology, Lesser Poland

THE PROBLEM OF FLINT MINING IN WESTERN LESSER POLAND (MAŁOPOLSKA)

This paper discusses the problem of flint mining origins in western Lesser Poland (Fig. 1), which is locally perceived as a feature of the early Eneolithic (Kadrow 2017: 83). Due to the change in the length of the flint blades being the first

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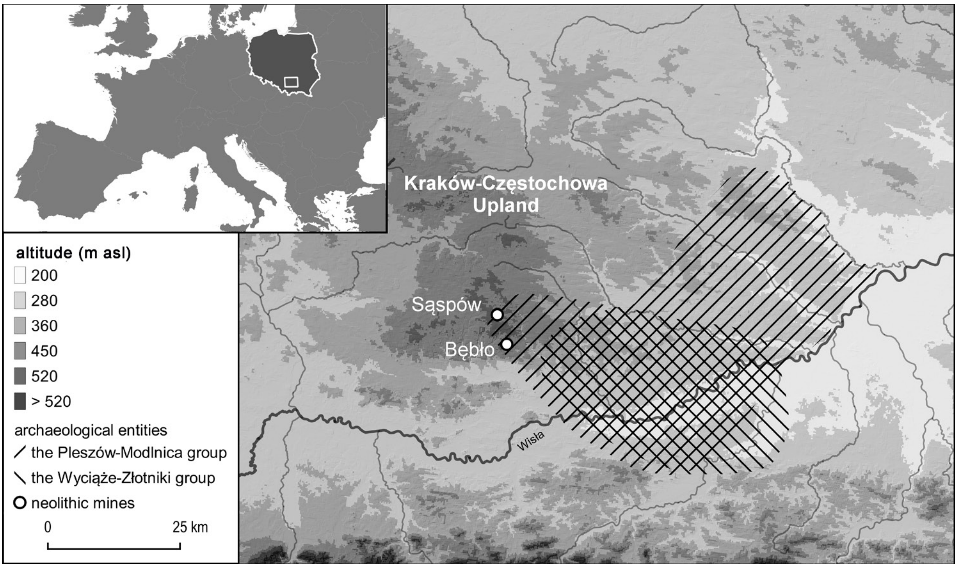

Fig. 1. Range of the Modlnica and Wyciąże-Złotniki groups of the Lengyel-Polgár cycle.

recognized feature, the emergence of this new, much more advanced production and supplying system is described by the term "metric change" (Budziszewski 1999: 256). It was defined by Witold Migal (2006: 387) who wrote: "The Polish literature on the subject stresses the metric change that occurred when Neolithic peoples began producing blades up to 34 cm long, with an average length of about 22–25 cm". Nevertheless, the situation was much more complex and it marked succession broader change in the lithic strategy. The Early and Middle Neolithic concept (Kozłowski 1969: 138; Balcer 1983: 94; Kaczanowska 2006: 30) was replaced with the Early Eneolithic one (Table 1). That profound technological transformation has usually been linked in Lesser Poland with the Modlnica phase of the Lengyel-Polgár cycle (Dzieduszycka-Machnikowa 1970: 462; Dzieduszycka-Machnikowa and Lech 1976: 136; Kaczanowska and Lech 1977: 15; Lech 1981: 124; 1987: 112; 2006: 414; Balcer 1983: 115). Migal (2006: 387) also considers "large-sized blades" to be of key importance within the Neolithic communities of the Lengyel-Polgár cycle, and associates them with the Wyciąże-Złotniki group and the influence of the Tiszapolgár and Lublin-Volynian culture communities. The beginning of the production of long blades is therefore closely related to other changes that together make up the Eneolithic phenomenon (Kadrow 2015: 248; Wilk 2018: 485).

Table. 1. The metric change in the technology of flint working in the Lengyel-Polgár cycle.

	technology BEFORE the metric change	technology AFTER the metric change
cores	– making use of natural forms and surfaces – narrow flaking surface – poor initial preparation: cortical flaking surface, no crests – flaking surface repaired with lateral crests – platform resharpened with a large flake – platform edge trimming	– platform formed with a single large removal – denticulated platform edge – lateral crests – maintaining the standard shape and size – deposits of cores
core processing	– soft punch – technique of the primary blade in the initial stage of exploitation	– pressure, punch – no platform edge trimming – strong reduction of the platform after each blow – great skill resulting from specialisation
blades	– unparallel edges – thick items because the flaking surface was distinctly rounded – triangular cross section – marked bending of blades made in the initial stages of core processing – flat butt – negatives of platform edge trimming	– regular blades (parallel sides and interior ridges) – significant length – uniform thickness – flat butt – en éperon (angular) butt obtained with a hard punch – small bulb – lip under the bulb – weak ripples (more dense where a punch was used)

The metric change can hardly be viewed there as resulting from technological evolution, and examples from the areas south of the Carpathians indicate that the diverse techniques of reduction could not have developed without profound social changes. In Bulgaria, small numbers of medium and macro blades have been dated to a relatively early period (the Slatina site associated with the Karanovo I culture; Gurova 2012: 8); therefore, the crucial question is when the production of long blades began in western Lesser Poland and what gave the impulse to introduce flint mining on a large scale. Manolakakis (2017: 275) states: "All available evidence – rare extraction sites, specialised knapping workshops, high level of technicity – points to specialised production limited to a small number of workshops", and: "The relatively small quantity of long blades produced raises questions regarding the mechanisms of apprenticeship, transmission and maintenance of know-how throughout the entire Chalcolithic".

Additionally, flint mining should not be interpreted solely in economic terms. Prehistoric communities saw the mines as a source of flint nodules, but they valued their ritualistic function as well (Barber 2006; Weeler 2011; Lech *et al.*, 2015; Topping 2017; Oliva 2019). The mines may have been landmarks that served as monuments in the Neolithic (Barber 2006: 174; Kerig *et al.*, 2015: 116) and the Early Bronze Age (Lech *et al.*, 2015: 222; Oliva 2019: 189). In his detailed discussion of flint mines in England, Topping (2017: 212ff) compares archaeological findings with ethnographical data and states that rituals covered the whole mining *chaîne opératoire*, starting from the activities preceding the extraction itself (hearths used in ceremonial purification). Research into the mines in Rijckholt, Spiennes and most of Sussex has shown that the observances may have determined the choice of flint seems to be mined, impelling the workers to pass over the first flint-bearing layers, easier to extract (Weeler 2011: 309). In Cissbury, Blackpatch, Easton Down and Grime's Graves, ceramic or stone deposits and human or animal bones have been recorded in contexts suggesting their sacrificial character. In the mines of Rudna Glava and Krumlovský Les, offerings were made during the mining as well, the gifts being placed on the bottom of the galleries or in special recesses (Barber *et al.*, 1999: 61; Borić 2009: 201; Oliva 2019: 111). The abandonment of the mine shafts required another set of observances that included multi-stage backfilling (Topping 2017: 212; Oliva 2019: 188) or making human sacrifices (Barber 2006: 175). The rituals accompanying flint mining and the changes resulting from social specialisation: the gradual formation of the group of miners and knappers, constitute a subject in its own right, separate from the economic role of flint mines in the Middle Neolithic.

Long blades were primarily treated as prestige objects embedded in the network of social and symbolic relations (e.g., Libera and Zakościelna 2013: 290; Kadrow 2016: 656; Manolakakis 2017: 277). Budziszewski (2006: 324) notes that in Central Europe "the first metallurgic centres developed parallel with the centres of flint knapping, resulting probably from the same socioeconomic processes". The earliest indication of the new era in western Lesser Poland may be traced to the Modlnica group and the Wyciąże-Złotniki group (Wilk 2018: 486). So, the essential question concerns the state of the relationship between both cultural units and the Lublin-Volhynian culture, which is indicated as the first to adopt the Eneolithic mode, which according to Stanisław Wilk (2018: 485) consists of components such as "the metallurgy of copper and gold, and its far-reaching trade; the beginnings of societal stratification observed in the elitism of some burials and their clear diversification in terms of sex; changes in beliefs seen in creating separate cemeteries and situating them away from settlements; changes in settlement structure – the disappearance of tells, use of draft animals". Accordingly, research into the origin of long blade production should focus on the time when long blades made of Volhynian flint started to be present in assemblages dated to the Lengyel-Polgár cycle. At that time, they circulated via Lublin-Volhynian communities in the form of finished products (Kozłowski 2006: 54; Libera and Zakościelna 2011: 89). Zakościelna (2006: 90) emphasises a link between the Lublin-Volhynian culture and "the huge demand for high-quality flint". She points out, too, that the Lublin-Volhynian culture had access to "external models", e.g., those from the south, and used them gladly. Since the turn of phases II and III, outcrops of Volhynian flint were not readily available. This forced Lublin-Volhynian communities to use chocolate or Jurassic flint (Zakościelna 2006: 90) but Volhynian flint continued to be imported. However, the crucial question is who was the consumer?

At present, we have no irrefutable evidence that Volhynian flint was brought to the Modlnica group, and Volhynian flint artefacts mentioned in the literature should probably be associated with the Wyciąże-Złotniki group (Libera and Zakościelna 2011: 88, Fig. 1). Items made of Volhynian flint have been recorded in Kraków-Nowa Huta Pleszów, Dziekanowice and Wężerów, but a detailed analysis of their contexts shows that none of the features containing them was a closed assemblage. Sites 17–20 in Kraków-Nowa Huta Pleszów form a vast multicultural complex with settlement features and graves within crest II of the Pleszów terrace. Due to the construction of a metallurgical conglomerate plant in that area, archaeologists responsible for the salvage excavation in 1953–1981 were pressed for time, and the contexts of many items seem unreliable (Kaczanowska and Tunia 2009: 268). Features associated with the Lengyel culture have been dated both to the "early and the middle phase of that culture" (Kaczanowska and Tunia 2009: 269), but some burials documented there may come from the younger phase, the Wyciąże-Złotniki group (Grave XVI in Feature 818; Kaczanowska and Tunia 2009: 76). A similar multi-stage settlement has been identified at Site 1 in Dziekanowice. The outline of the burial pit of Feature/Grave 24 was practically indiscernible during the excavation; moreover, the original arrangement of the bones was found to have been disturbed (Jaśkowiak and Milisauskas 2001: 124). Feature 15 in the immediate vicinity contained ceramics of the Funnel Beaker culture (Jaśkowiak and Milisauskas 2001: Plates 15, 18), while the cultural layer contained a quadrilateral axe, flakes with traces of polishing and retouched tools made from large blades, including a blade with a tang. Kozłowski (2006: 54) relates artefacts from a settlement pit in Wężerów, including items made of Volhynian flint with "the existence of a settlement of the Tiszapolgár population".

When characterizing the raw material background for the discussed processes, it should be noted that in Lesser Poland, good quality flint suitable for the production of larger blades and axes could only be obtained by mining. However, according to Alicja Kochman, Jacek Matyszkiewicz and Michał Wasilewski (2020: 4) who presented an extensive description of local Jurassic raw materials, and Michael Brandl (2013: 172), flint concretions obtained by the mining method from bedded limestones have average dimensions of 10 cm to 15 cm, less often 20 cm, which limited the size of the finished products. Therefore in the case of blades, we have to speak of mediololithic instead of macrolithic production. The Olkusz Upland within the southern Kraków-Częstochowa Upland covers two Neolithic sites interpreted as mining areas: Site 4 in Bębło, Wielka Wieś district, formerly referred to as Bębło-Zachruście or Bębło, Site I (Trela-Kieferling 2021a), and Site 18 in Sąspów, formerly referred to as Sąspów I (Dzieduszycka-Machnikowa and Lech 1976). At Site 4 in Bębło, small irregular flint concretions were formed in weathered clays within karst karren covered by a layer of humus and clayey loess (Przybyła *et al.*, 2021: 25). The site was excavated to a small extent by Albin Jura, Stanisław Kowalski, Janusz Krzysztof Kozłowski and Jacek Lech; most artefacts at the Archaeological Museum in Cracow come from Jura's surface surveys carried out in the 1930s (Kowalski and Kozłowski 1958: 350; Lech and Leligdowicz 1973; Lech 1981: 65; Trela-Kieferling 2018: 421). The items in the Bębło collection were shaped by uniform techniques of core preparation and reduction and by consistent methods of debitage production. Although they have provided no material for radiocarbon dating, their typological and comparative analysis has shown that the techniques of core preparation and reduction used in Bębło and at the nearby mine in Sąspów were very similar (Trela-Kieferling 2021b: 49ff). It may therefore be assumed that both areas of flint mining and knapping were linked to groups of the Lengyel culture in the period following the metric change.

CHRONOLOGY

While constructing the chronological framework for the phenomena discussed here, several elements have to be considered (Fig. 2). First of all, it should be emphasized that there are obvious obstacles that severely limit the possibility of creating an indisputable and precise time frame. This is mainly due to the small amount and insufficient quality of the radiocarbon dates, which are often derived from older investigations. Additionally, because of specific mining activity, like at the Sąspów site, the context from which they were obtained is hard to unequivocally define.

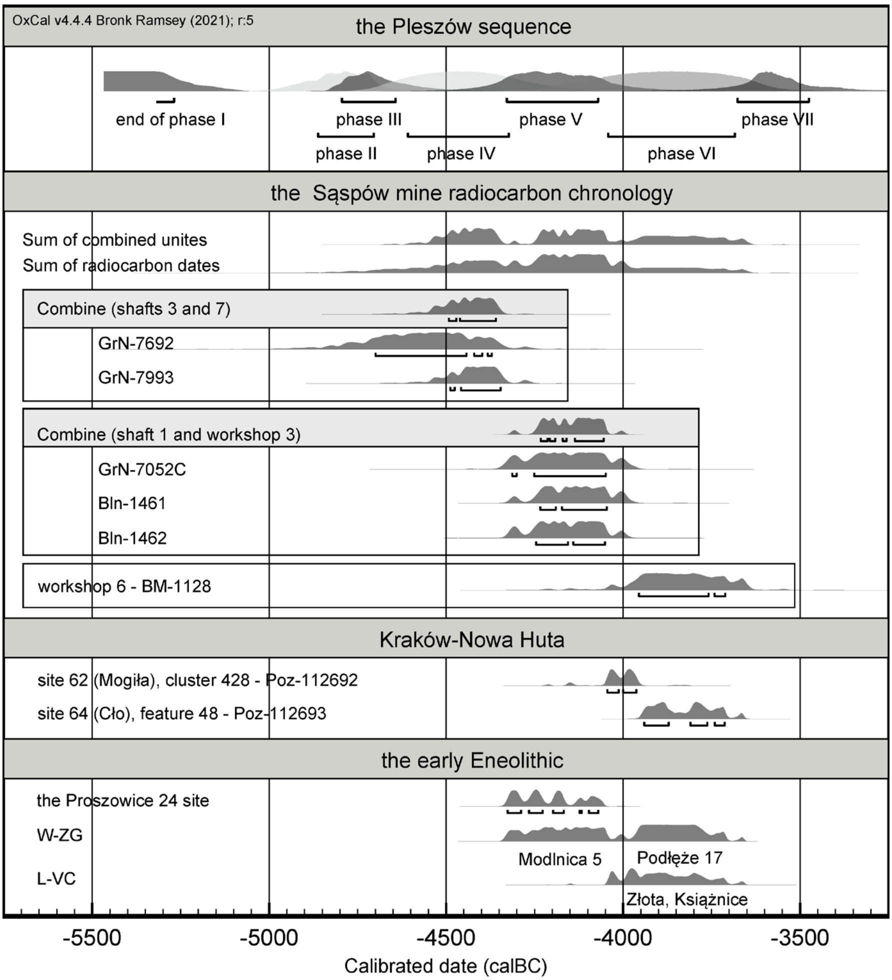

Fig. 2. The radiocarbon chronology of individual phenomena of the Early Eneolithic against the background of the Pleszów sequence. The Pleszów sequence. Linear Pottery culture (LBK): I – music note phase, II – Želiezovce phase; Lengyel-Polgár cycle (LPC): III – Samborzec-Opatów group, IV – Pleszów group (PG), V – Modlnica group (MG), VI – Lengyel-Polgár cycle (LPC)/Funnel Beaker culture (FBC?); Funnel Beaker culture (FBC) – VII.

Other factors are the materials sampled, which include charcoal, organic sediments and bones. Another issue is that precise calibration of the entire obtained probability distribution of radiocarbon dates is currently impossible. The list of the most important

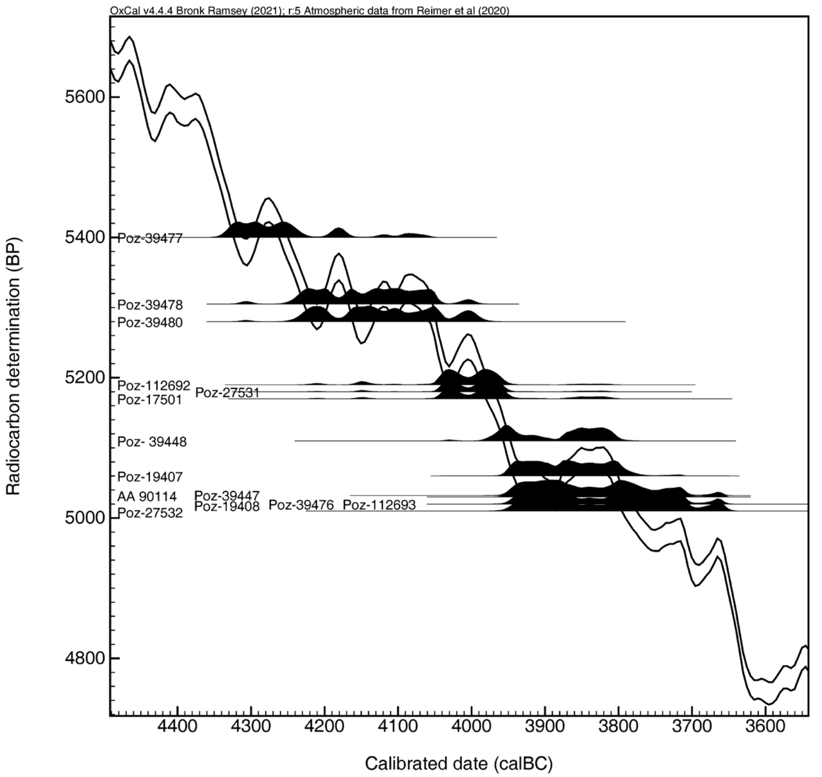

Fig. 3. Radiocarbon dates discussed in the text against the calibration curve (IntCal20).

ones shows that the flattening in the calibration curve between 4300–4000 BC (phase Pleszów IV), even with high precision of dates, does not allow for an accurate determination of a sequence of cultural facts (Fig. 3). The dates (Table 2) were calibrated with the OxCal software v4.4 (Bronk Ramsey 2009) working with the IntCal20 atmospheric curve (Reimer *et al.*, 2013).

The first element in this study involved a sequence model for cultural facts documented within the stratified organic sediments from the oxbow lake at the foot of the loess terrace close to the agglomeration of sites 17–20 at Kraków-Pleszów (Mook 1985; Godłowska *et al.*, 1987). Palynological analysis revealed intense Neolithic settlements, the chronology of which covers almost the entire Early and Middle Neolithic, as well as the Eneolithic, making it a key local chronological benchmark (Wasylikowa *et al.*, 1985).

Table. 2. A list of radiocarbon dates used in the analysis.

Site	Context	Lab code	14C Age	SD	Sampled material	Reference
Sąspów 18 (I)	shaft 3	GrN-7693	5700	135	-	Lech 1981
Sąspów 18 (I)	shaft 7 (?)	GrN-7993	5575	75	-	Lech 1981
Sąspów 18 (I)	shaft 1	GrN-7052C	5325	90	charcoal	Lech 1975; 1981
Sąspów 18 (I)	shaft 1	Bln-1461	5295	60	charcoal	Lech 1981
Sąspów 18 (I)	workshop 3/1970	Bln-1462	5325	60	charcoal (hearth)	Lech 1981
Sąspów 18 (I)	shaft 6 workshop 2/1970	BM-1128	5046	102	charcoal (hearth)	Burleigh 1975; Lech 1981
Książnice 2	grave 7	Poz-27531	5180	35	human bone (rib)	Wilk 2016
Książnice 2	grave 8	Poz-27532	5010	50	human bone (rib)	Wilk 2014
Złota „Grodzisko I”	grave 390	Poz-17501	5170	40	human/ animal bone	Sałacińska and Zakościelna 2007
Złota „Grodzisko II”	grave 101	Poz-19407	5060	30	human/ animal bone	Sałacińska and Zakościelna 2007
Złota „Grodzisko II”	grave 122	Poz-19408	5020	40	human/ animal bone	Sałacińska and Zakościelna 2007
Bronocice	grave VI	AA 90114	5032	41	human bone; AMS	Milisauskas *et al.*, 2016
Podłęże 17	feature 1674A; thin ditch with W-ZG pottery	Poz-39448	5110	35	charcoal; AMS	Nowak 2017 (Supplementary Data)
Podłęże 17	feature 2051; thin ditch of the La Tène culture with admixture of the W-ZG pottery	Poz-39447	5030	40	charcoal; AMS	Nowak 2017 (Supplementary Data)
Podłęże 17	feature 1827D; ditch with W-ZG pottery	Poz-39476	5020	40	charcoal; AMS	Nowak 2017 (Supplementary Data)
Modlnica 5	feature 4071; bottom part	Poz-39477	5400	40	charcoal, Fraxinus excelsior; AMS	Grabowska and Zastawny 2011

Site	Context	Lab code	14C Age	SD	Sampled material	Reference
Modlnica 5	feature 4071; ceiling part	Poz-39478	5305	35	charcoal, Fraxinus excelsior; AMS	Grabowska and Zastawny 2011
Modlnica 5	feature 54 (burial within a settlement pit)	Poz-39480	5280	40	charcoal, Fraxinus excelsior; AMS	Grabowska and Zastawny 2011
Proszowice 24	grave	Poz-34765	5370	40	human bone	Nowak 2017 (Supplementary Data)
Kraków-Nowa Huta Mogiła 62	cluster 428 (grave)	Poz-112692	5190	40	human bone	unpublished
Kraków-Nowa Huta Cło 65	feature 48 (grave III)	Poz-112693	5020	40	human bone	unpublished
Pleszów	core ID, layer PL-7a, b, phase VI	GrN-9267	4755	35	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core ID, layer PL-6, phase V	GrN-9182	5380	60	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core I bis, layer PL-3/PL-4a, phase III-1	GrN-9268	5830	45	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core I bis, layer PL-2c, phase II	GrN-9270	5905	40	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core I bis, layer PL-2c, phase II	GrN-9269	5910	40	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987

Site	Context	Lab code	14C Age	SD	Sampled material	Reference
Pleszów	core I, layer PL-2c, phase II	GrN-9184	5958	50	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core I bis, layer PL-2b, hiatus between phase I and II	GrN-9183	6050	40	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core I, layer PL-2b, hiatus between phase I and II	GrN-9272	6075	40	wood+ peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987
Pleszów	core I bis, layer PL-2b, hiatus between phase I and II	GrN-9271	6255	40	peat	Mook 1985; Wasylikowa *et al.*, 1985; Godłowska *et al.*, 1987

As shown above, the technological change was linked with the Modlnica group. However, according to the authors of this paper, archaeological material associated with this unit does not corroborate that. Additionally, there are hardly any chronological markers that would unambiguously define its chronology. Until now, it was based on the Pleszów stratigraphy, as well as a series of contradicting radiocarbon dates from Feature 416 at site 62 in Kraków-Mogiła (Godłowska and Gluza 1989). Therefore it was decided to date two finds, considered as burials – Kraków-Nowa Huta Cło, Site 64, Grave III (Feature 48) and Kraków-Nowa Huta Mogiła, Site 62, Cluster (Grave) 428. The association with the Modlnica group was based on the analysis of ceramics carried out by the authors of the research. Both features contained a selection of flint products, which provided important arguments concerning the methods of flint-making at that time.

Kraków-Nowa Huta Cło, Site 64, Grave III (Feature 48)

The feature was identified during an excavation carried out in 1997 (Kaczanowska and Tunia 2009: 266). The oval pit became visible at a depth of 80 cm; the burial was uncovered at 90–100 cm. The body, probably of a young man (20–30 years old), had been deposited on the right side with the arms and legs pulled up. The bones were very poorly preserved (Wróbel 2002: 11). The burial was accompanied by two flint artefacts: a burin and a blade, placed in its immediate vicinity. Although Kaczanowska does not consider those items as burial goods, she links all the finds: those from the bottom of the pit and those from the fill, "solely with the Lengyel culture". The burial in Feature 48 is associated with the period of the Pleszów-Modlnica group (Kaczanowska 2006: 51). Samples of the human bones were radiocarbon dated at the Poznan Radiocarbon Laboratory in 2019. The date for Feature 48 at Site 65 in Kraków-Nowa Huta Cło (Poz-112693) has been estimated at 5020 ± 40 BP (Fig. 4).

Feature 48 contained 19 flint items, three of them considerably burnt, made of brown Jurassic flint from around Cracow, including a distinctive spall: a partly cortical flake formed perhaps during the repair of the striking platform (preserved fragments of two blade negatives); two burins: a strongly burnt single blow (length 45 mm, width 14 mm, thickness 7 mm) made from a partly cortical blade with the burin removal noticeable on its distal end (Fig. 5:1); an angle burin on a break (length 35 mm, width 26 mm, thickness 11 mm) with a single burin negative, made from a thick wide blade (preserved central part of the blade; Fig. 5:2); a fragmentarily preserved endscraper (Fig. 5:3) made from a partly cortical large flake, with a fragmentarily preserved crest and an abrupt narrow arched front, its crumbled edge forming a serrated line due to the secondary burning of the item; a blade and nine fragments of blades (five butt parts, two central parts, two distal parts; Fig. 5:4–13) and four flakes.

Most flint artefacts seem to have undergone the same technological procedure. The stylistic and metric properties of the blades suggest that the items were produced before the metric change. The blades and the blade burin have narrow arched butts with a distinct lip and a small bulb. The artefacts are relatively slender, thin (the maximum thickness is 7 mm) and not very long (the maximum length is 55 mm), with parallel lateral edges. The large flake from which the endscraper was formed had been produced in the preliminary phase of core reduction; there are remnants of a crest and cortical surface in its distal part. The blade from which the angle burin was shaped differs somewhat from the other items as its Jurassic flint is grey and opaque. The artefact was recovered from a depth of 70–80 cm, e.g., slightly above the outline of the pit. It has survived fragmentarily, which precludes its precise description.

Kraków-Nowa Huta Mogiła, Site 62, Cluster (Grave) 428

The salvage excavation occasioned by a planned motorway was carried out in 1969 (Kaczanowska and Tunia 2009: 274). It uncovered a human skeleton considered by the researchers, despite some doubts, to be a burial. The bones of a 30- or 40-year-old

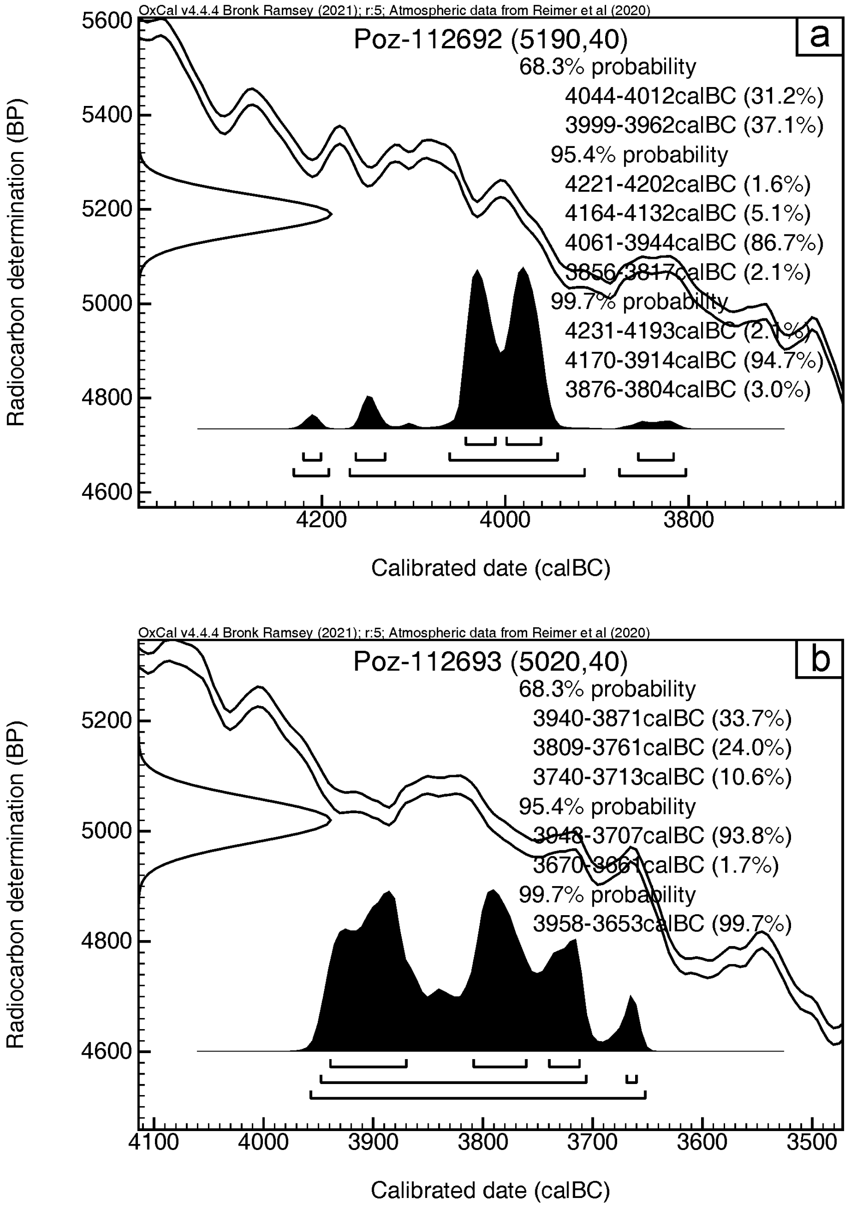

Fig. 4. Calibration of radiocarbon dates: a – Kraków-Nowa Huta Mogiła, Site 62, Cluster (Grave) 428; b – Kraków-Nowa Huta Cło, Site 64, Grave III (Feature 48).

man were found at a depth of 190–200 cm at the bottom of a settlement pit. Artefacts came from a cone-shaped deposit (150 cm deep) covering the bones. Samples of the human bones from Feature 428 at Site 62 in Kraków-Nowa Huta Mogiła (Poz-112692) have been radiocarbon dated to 5190 ± 40 BP (Fig. 5).

All recovered artefacts (8 items) were made of light or dark brown Jurassic flint from around Cracow: a residual flake core (Fig. 5:14): a small boat-shaped item used also as a hammer; its striking platform, divided into passive and active parts with a markedly serrated edge, was repaired with removals of small core tablets starting at the flaking surface; the last flaking surface was formed on the broader face; two butt parts of relatively big blades (length 36 and 44 mm, width 21 mm, thickness 6 mm): a partly cortical item with a relatively broad butt and a convex bulb bearing distinct scars, trapezoidal in cross-section (Fig. 5:15); an item with a narrow arched butt characterised by a distinct lip and a small bulb, polygonal in cross-section (Fig. 5:16); three fragments of flakes and two chunks with single removals.

Another element of the chronological framework is a visualisation and comparison of radiocarbon dates from the Sąspów mine, which, despite multiple doubts, is the only available argument in the discussed issues. Sąspów was chronologically ascribed to the successive phases of the Lengyel-Polgár cycle in the 1970s and the 1980s, when radiocarbon dating was obtained for four sites of the Pleszów-Modlnica group and the Wyciąże-Złotniki group: Kraków-Mogiła 62, Kraków-Pleszów, Sąspów, and Złotniki (Dzieduszycka-Machnikowa and Lech 1976: 151; Lech 1981: 63, 181; Godłowska *et al.*, 1987: 37). Shaft 3 in Sąspów, the earliest one, was then considered to have been related to Samborzec-Opatów settlement or with Malice settlement (Lech 1981: 179). Shaft 7 was linked to Malice settlement (Nowak 2009: 109), Workshop 3/1970 came presumably from "the Modlnica phase or possibly the Pleszów phase", while Shaft 6 and Workshop 2/1970, viewed as the youngest features, were dated to the final phase of the mine, contemporaneous with the Wyciąże-Złotniki group (Lech 1981: 185ff). The long consistent exploitation of the Sąspów shafts should be corroborated by artefacts formed according to diverse Middle Neolithic technological models within various groups of the middle and late Lengyel culture. Although one can argue for the "continuation and uninterrupted gradual development" of the flint industry at that time (Kaczanowska 2006: 49), flint knapping in those Lengyel groups differed considerably in the choice of core types, the character of debitage, and the metric properties of the products (Balcer 1983: 81, 95, 115; Nowak 2009: 150). With so many obscurities, the explanation may be sought in various areas, e.g., in the social function of the mines, the access to know-how or the quality of raw material. However, this text focuses on the verification and reinterpretation of chronometric evidence. A new approach to the radiocarbon dating of the Sąspów shafts

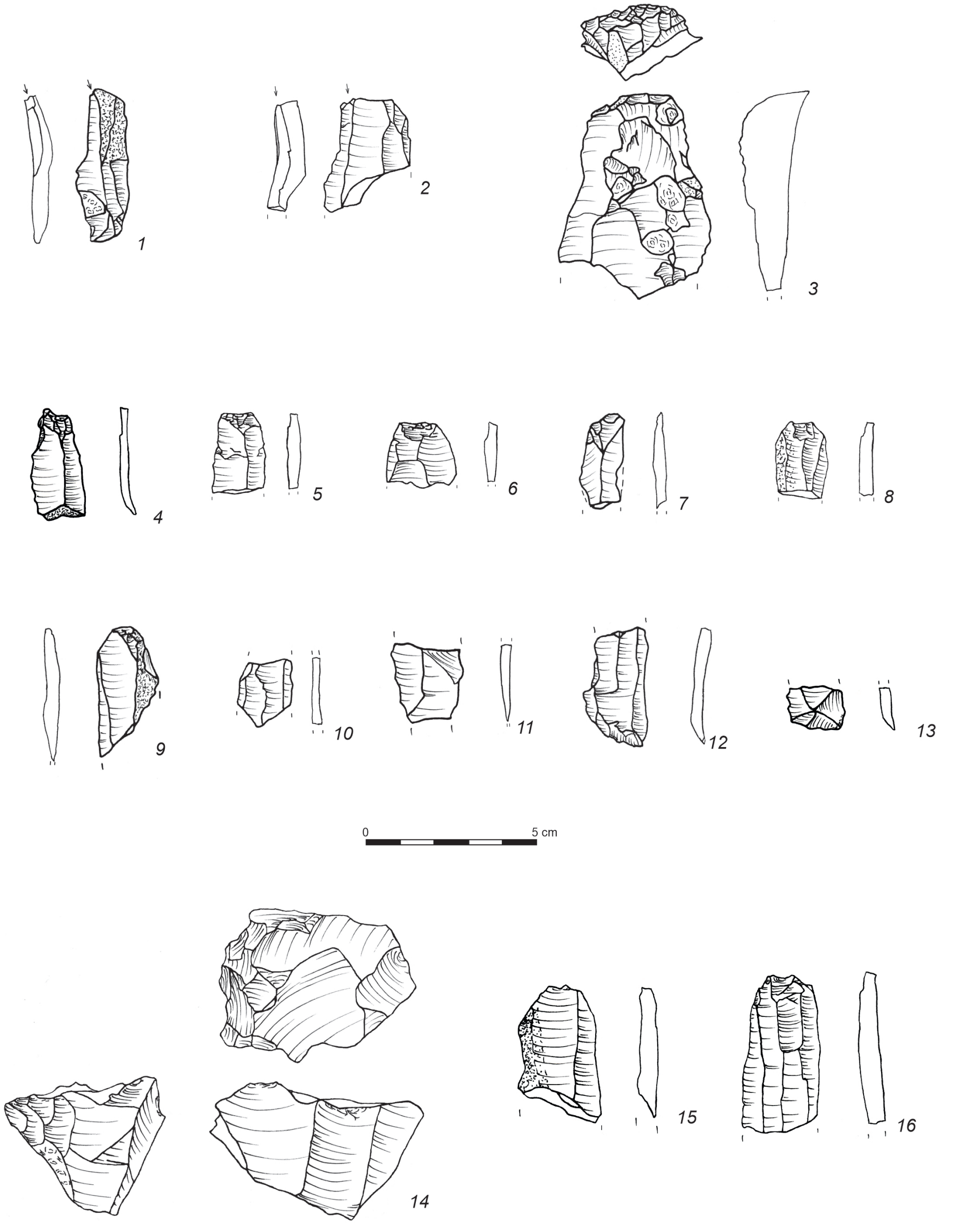

Fig. 5. Lithics: 1-14 – Kraków-Nowa Huta Cło, Site 64, Grave III (Feature 48); 15-17 – Kraków-Nowa Huta Mogiła, Site 62, Cluster (Grave) 428.

(Lech 1981: 81) would be particularly helpful here. Naturally, flint mine shafts are difficult to date due to several factors that can distort (reduce) their age, such as re-exploitation of old shafts; subsequent use of raw material abandoned in earthworks at the shafts; a limited range and usually a small amount of substances suitable for the dating (charcoal from fires or torches, mining tools made of bone or antler); few fragments of pottery. All those factors may have affected the dating of the Sąspów mine. With no dates for the Bębło shafts and with some doubts about the presumably long operation of the mine in Sąspów, an absolute chronology of the mine shafts in Lesser Poland may not be possible without new radiocarbon dates. In total, six radiocarbon dates were obtained from shafts and workshops (Lech 1981: 185). Their visualisation was presented in the form of a probability distribution and the sum of these probabilities (Fig. 2). This chart indicates that the site area could have been used even by Linear Pottery cultures (the II phase), as well as the earliest communities of the Lengyel-Polgár cycle, both of which can be correlated with III phase of the Pleszów sequence. However, it must be noted that the date from shaft 3, which supports such chronology, is characterized by a relatively large standard error, which covers three successive phases of the sequence from Pleszów (II–IV) resulting in its value for establishing the chronology being limited. In this article, based solely on radiocarbon dates, the existence of three chronological phases of the Sąspów mine is assumed. The phases are determined by combinations of radiocarbon dates from shaft 3 and the hypothetical shaft 7; combinations of relatively consistent radiocarbon dates from shaft 1 and workshop 3; and the radiocarbon date from workshop 6 respectively. They indicate subsequent chronological intervals: 4550–4300 BC (second half of the Pleszów IV phase); 4300–4000 BC (Pleszów phase V) and 4000–3650 BC (Pleszów phase VI). Phases established in such ways are the basis for further considerations. As mentioned above, production wastes recorded at the site point to unchanging technology, which suggests a relatively narrow chronology. Almost all cores produced in the workshops located by the mines show the implementation of the same flint processing strategy. They are similar in terms of the preparation and exploitation techniques which allowed the production of fairly standardized blades with a length of 8 cm to 10 cm (Trela-Kieferling 2021b: 196).

Another piece of argumentation is the assumption that the commencement of mining in western Lesser Poland was not the result of the internal development of the methods of flint-production of the Linear Pottery cultures, but was the outcome of the implementation of a new cultural pattern, which should be associated with the emergence of the Eneolithic in southern Poland. Therefore, it should be linked with the crystallization of archaeological units of the Wyciąże-Złotniki group and the Lublin-Volhynian culture. Initially, their chronology was established between 4000–3800, which matches the chronology of the youngest phase proposed for the mine. However, the first determinants of the early Eneolithic appeared much earlier (Nowak 2014: 250). The first of such is the settlement at site 5 in Modlnica, which can be considered an early stage of the Wyciąże-Złotniki group (Grabowska and Zastawny 2011; Nowak 2016; 2017). The feature 4071, which provided charcoal for radiocarbon dating, and yielded several lithics with average dimensions of over 7 cm (the longest being 11.8 cm; Wilczyński 2011: 519). The second indicator is the burial discovered recently at site 24 in Proszowice which was richly equipped with copper products (Marcin M. Przybyła personal communication; Wilk 2016; Nowak 2017).

Based on the above assumptions, it should be expected that the mining activity in Sąspów took place during the second chronological phase and probably continued in the third phase. The first chronological phase is undoubtedly the most difficult to interpret. Currently, it should be assumed that this is a trace of indefinite penetration of the site by the Lengyel-Polgár cycle communities, which is misleading due to the complicated archaeological context and should be excluded. However, if the mine exploitation limit was to be extended to the period from approx. 4500 BC, it then would be one of the first archaeologically tangible elements of the early Eneolithic. Such a long sequence could be confirmed by the observations of other mining centres. For instance, in Great Britain and Ireland, when Neolithic populations increased in the mid-fifth millennium BC, flint mining accelerated due to the rising need for the production of axes (Shennan *et al.*, 2017: 78). The research team of the NEOMINE project points out that the extent of flint mining decreased only in the mid-third millennium BC when copper metallurgy gained great popularity (Shennan *et al.*, 2017: 78). Analysis of the dates proposed for mining sites in Western Europe (Bretteville-le-Rabet Jablines, Seine-et-Marne, Jandrain-Jandrenouille, Petit-Spiennes, and Camp-a-Cayaux, Rijckholt-St. Geertruid) has shown that the mines were all used between 4500 and 3000 cal BC, with the shared period of their exploitation *c*. 3800 cal BC (Wheeler 2011: 306).

The above considerations are backed by the chronological outline of new impulses in western Lesser Poland marking the period of the early Eneolithic which are locally identified with the Lublin-Volhynian culture and the Wyciąże-Złotniki group settlements (Wilk 2016; Nowak 2014; 2017).

CONCLUSIONS

Neolithic flint mining in western Lesser Poland ought to be seen in the context of the social order evolving under the impact of new cultural patterns that emerged at the turn of the middle Neolithic and the early Eneolithic (Kadrow 2017). These changes are clearly visible in the lithic production (Table 1). The chronology of that period remains an interesting subject of study (e.g., Kaczanowska 2006: 52; Kozłowski 2006: 60; Nowak *et al.*, 2007: 463; Nowak 2010: 83; 2014: 250; 2017: 260; Grabowska and Zastawny 2011: 129ff; Wilk 2016: 22). New research concerning the Carpathian Basin shifts the beginning of the Eneolithic in the region towards the middle of the 5th millennium. It was also pointing out the non-linear development of these communities (Raczky and Siklosi 2013: 570). This new framework may also be applied to refine the chronology of the Eneolithic phenomena in Lesser Poland which was in a sphere of influence radiating from that centre.

The chronological framework proposed by the authors, if accepted, would require a re-evaluation of the premises for associating the technological transformation of flint knapping with the Modlnica group which has to be viewed as contemporaneous with the Wyciąże-Złotniki group (Nowak 2014: 276). So, the question is whether that change might not have taken place in the Wyciąże-Złotniki group and whether both mines and their workshops should not be ascribed to that cultural unit? There are no arguments supporting the opinion that flint knapping in the Wyciąże--Złotniki group resulted directly from the technological development of stylistic achievements of the older cultural units (Kozłowski 2006: 54), contrary to the Modlnica group. Moreover, the relatively late chronology of the Modlnica group, as well as the suggested continuation of older technological threads, which could be confirmed by the new radiocarbon dates presented, indicate a more complex picture of flint--making during this period. Therefore, the "metric change" term could potentially apply to only a fraction of the overall picture. If dating the Wyciąże-Złotniki group to 4300–3600 BC is correct (Nowak 2010: 82; 2017; Grabowska and Zastawny 2011; Wilk 2018: 492), flint mining in Bębło and Sąspów may be viewed as a response to the new demands of the latest of the Lengyel-Polgár cycle communities. This response may also be considered to run parallel to the Lublin-Volhynian culture. The metric change can thus be seen as another trace of local social transformation that was triggered by a Tiszapolgár impulse.

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