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EXAMINING THE ASSOCIATION BETWEEN PIGMENT RESIDUES AND POTLID-LIKE CRACKING: A CASE STUDY FROM ZASKELNA V

The article examines flint artefacts with traces of pigment discovered in 1993 in layer II of the Zaskelna V site (Crimea), focusing on one specimen with rare incomplete potlid-like cracking and associated ochre-rich residues. An initial hypothesis that the cracking was caused by heated pigment-containing adhesive was not supported experimentally. Instead, the scar likely resulted from localised sudden cooling, while the pigment adhered later to the surface damage, though their precise relationship remains unclear.

K e y w o r d s: Eastern Europe, Crimea, Middle Palaeolithic, potlid-like cracking, pigment residue.

The year 2024 marks the centenary of Yurii Heorhiiovych Kolosov, a famous archaeologist who significantly advanced the study of Ukraine’s prehistoric period in the late 20th century (Степанчук 2024). In the 1970s and 1980s, Yu. H. Kolosov, who led the Crimean Palaeolithic Expedition of the Institute of Archaeology, Academy of Sciences of Ukraine, discovered and studied many multi-layered Neanderthal sites, recovering thousands of artefacts. Since the early 2000s, partial and unsystematic examinations of these collections reveal many fragments of natural pigments and artefacts showing signs of pigment use. Early examples, such as ochre pencils with scraping and abrasion traces, were published (Степанчук 2006). Recently, a comprehensive collection of ochres from all layers of Prolom II (Степанчук, Нездолій, Вєтров 2018) and a selection of pebbles with pigment residues from various Middle Palaeolithic sites in the Crimea have been documented (Stepanchuk 2022). Preliminary studies of micro-residues on artefacts from older sites, including the Late Acheulean site of Zaskelna IX, also indicate pigment utilisation (Ryzhov et al. 2022; Рижов, Тислюк 2024). The widespread evidence of pigment use at Middle Palaeolithic sites in the Crimea highlights the active application of pigments by local Neanderthals. Besides, a few stone artefacts with pigment residues have been published from the layers III and IIIa of the Zaskelna VI (Kolosov) site (Степанчук, Васильев 2018).

A few years ago, the first author of the current paper identified a flake in the collection of stone artefacts from the layer II of Zaskelna V that displayed possible pigment residues within a cracked area of the artefact. This article explores a potential relationship between two features observed on this object: internal cracking of the flint and the presence of adhered pigment in the same zone. As a working hypothesis, it is proposed that the fracturing of the flint resulted from short-term thermal stress, possibly caused by the application of a hot pigment-based compound to a cooler flint surface. This compound was likely used as an adhesive — a possibility supported by numerous studies. Adhesive mixtures, including ochre-based compounds, are widely known to have been used for hafting stone tools in the Middle Palaeolithic con-

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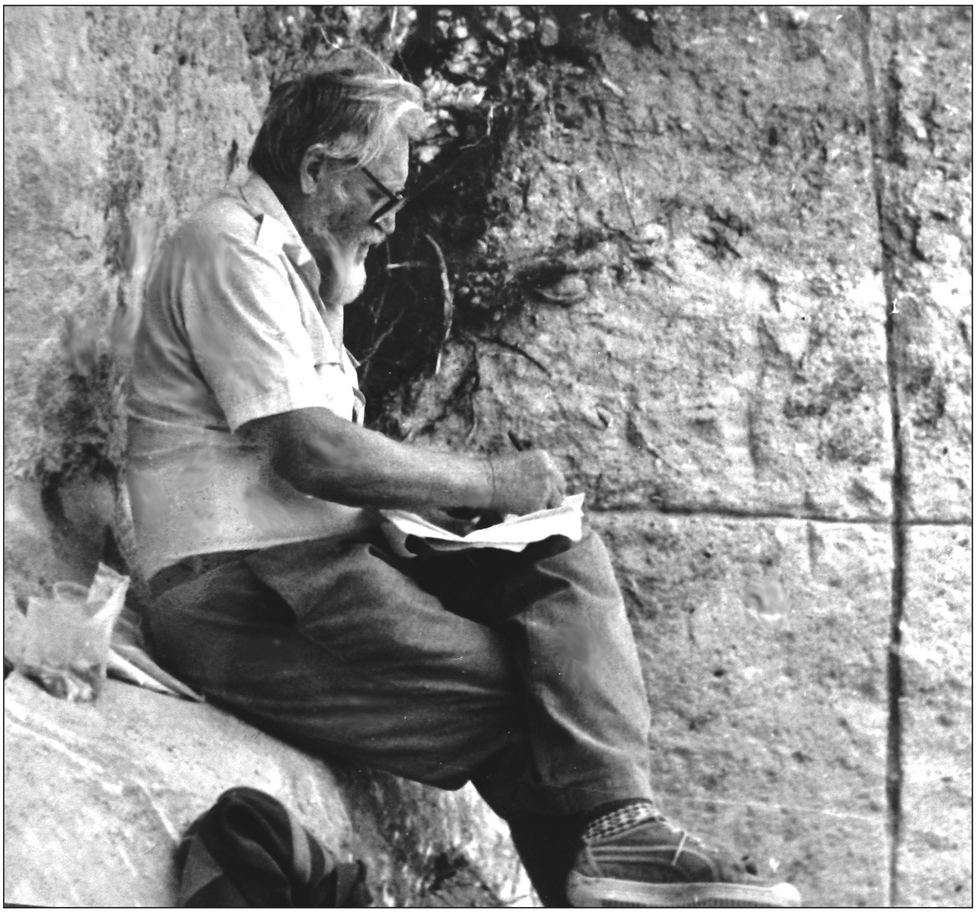

Fig. 1. Yu. H. Kolosov at the excavation of Zaskelna V in 1993, photo by Yu. V. Kukharchuk

texts, with evidence extending back nearly 200,000 years (Mazza et al. 2006; Cârciumaru et al. 2012; Degano et al. 2019; Niekus et al. 2019; Doronicheva et al. 2022; Schmidt et al. 2024). To test this hypothesis, we conducted a series of experiments. In parallel, we carried out a targeted re-examination of related materials from the layer II, focusing on finds from the specific area where the artefact in question was discovered during the 1993 excavations (Колосов, Кухарчук, Рыжов 1994a). This revision yielded several artefacts that offer new evidence and relevant insights for interpreting the originally identified flake with pigment residue and potlid-like cracking. This term refers to a particular type of internal fracture that may — but does not necessarily — result in the detachment of so-called potlid flake, which may occur with a delay over time (Stepanchuk, Naumenko 2022, 2024).

Materials and methods

Materials.

Brief characterisation of the site and layer II industry. The multilayered cave site Zaskelna V is located in the eastern part of the Crimean Peninsula, near the village of Bila Skelia in the Bilohirsk district. It is positioned on the right slope of the Chervona gully, on the right bank of the Biiuk-Karasu River, within the remnants of the limestone massif of the second mountain ridge. Facing south, the site is at coordinates: 45°6'58.42"N, 34°36'37.03"E (Google Earth 2024), about 60 m above the river level. Surface materials from the area later associated with Zaskelna V were first identified by V. F. Petrun in 1964. The stratified nature of the site was subsequently revealed by Yu. H. Kolosov (1983). The site was intensely studied by Yu. H. Kolosov during various periods: 1969–1972, 1974–1975, 1977–1978, 1981, 1986, and 1993–1994 (fig. 1). Further investigations were carried out by Yu. H. Kolosov and V. M. Stepanchuk in 1997, and by V. P. Chabai in 2012–2013. The materials from the 1960s and 1970s were published in a monograph (Колосов 1983) and papers. Excavations between the 1960s and 1990s involved studies of geological, geomorphological, palaeogeographical, palaeontological, palynological, and other aspects of the site, with contributions from specialists such as V. P Dushevskyi, P. D. Podhorodetskyi, O. A. Kliukin, A. O. Velychko, Ye. I. Danylova, K. V. Kapelist, and Z. P. Hubonina.

Yu. H. Kolosov identified eight cultural layers within a ~4 m sediment profile, each varying in thickness and extent. Recent studies have distinguished nearly 90 habitation episodes at the site (Chabai, Uthmeier 2017). The radiocarbon age of the layer II is estimated to be between 45,000 and 36,000 calibrated years ago (table 1), consistent with the ESR date of 41.8 ± 3.1 kyr (Колосов 2003). Layer II has been studied over an area of about 41.5 m^2, including 4 m^2 excavated in 2012–2013. The artefacts discussed in this article originate from the 1993 excavations in sector 17АБВГ, where less than three-quarters of 1 m^2 of the layer II was explored. The primary aim of the 1993 excavations was to prepare sections for installing ESR and TL dosimeters in the upper and lower parts of the layer II. Notably, by 1985, most of the layer II in sector 16–17АБВГ had been nearly fully explored, although some areas were previously inaccessible due to a collapsed rock roof. In 1993, part of this obstruction was removed, allowing access to the deposits of the layer II in unit 17Г. The eastern wall of the excavation was also cleaned, and the material was extracted in layers rather than a grid of squares. Consequently, despite the small area of the layer II investigated in 1993, the exact 3D location of the artefacts discussed cannot be determined.

Table 1. **Conventional and calibrated radiometric dates from Zaskelna V layer II (Степанчук, Ковалюх, Ван дер Плихт 2004; Chabai, Uthmeier 2017); calibration with OxCal v4.4.4 (Bronk Ramsey, 2021); (r:5; Atmospheric data from Reimer et al. (2020)**

Zaskelna V	Material	Lab no.	14C age, yrs BP	Calibrated Age calBP 95.4% probability (OxCal 4.4.4)	Reference
Layer II	Bone	Ki-10743	31,600 ± 350	35,944 ± 357	Степанчук, Ковалюх, Ван дер Плихт 2004
Layer II	Bone	OxA-35786	41,600 ± 1,400	44,878 ± 1398	Chabai, Uthmeier 2017
Layer II	Char-coal	OxA-35253	37,350 ± 500	41,927 ± 281	Chabai, Uthmeier 2017

The second cultural layer is greyish-brown in colour, likely due to the use of fire, 30–35 cm thick, and sub-horizontal with a slight slope to the northwest, located at a depth of 2.90–3.20 m. The containing light pale sediment, genetically associated with rock shelter erosion, comprises loam with a silt fraction of up to 15 %, including nummulitic limestone sand and poorly rounded gravel (1–5 mm in size). Ore minerals, including magnetite (Fe_2O_3), are sparse within this layer. Iron-based oxides constitute approximately 4 % of the total chemical composition (Колосов 1983), which roughly corresponds to the typical dispersed content in nummulitic limestones. The cultural layer does not represent a single living floor, but rather a series of successive visits occurring close in time. Under such conditions, remains of a later occupation may sometimes directly overlie and become mixed with those of an earlier one. In 1993, a wall up to 3 m long was revealed in sector 17А — В and partially in unit 17Г, where a sample was collected. Approximately 0.5 m^2 of the layer was excavated in half of unit 17Г. Since the excavation into the eastern wall was about 5 cm deep, the total volume of excavated sediments was around 1/4 m^3. This revealed a high density of stone artefacts, with over 8.500 items per m^3, indicating intense activity at the site.

Palynological data reconstructs a steppe landscape during the period of remains accumulation, with pine being the most common tree species (Губонина 1985). The megafauna, listed by abundance, includes mammoth, horse, saiga, cave bear, wolf, corsac, and marten (Колосов 1983). Among the bone remains, saiga (including other indeterminate ungulates) and mammoth are predominant. The cultural horizon reaches 30 cm in thickness and frequently contains sooty stains and occasional hearth lenses. Frequent discoveries of burnt bone further underscore the active use of fire.

The stone inventory comprises over 30,000 items, most made from local, fine-grained, high-quality Turonian-Cenomanian flint. It is predominantly grey of various shades, with less frequent occurrences of black and brown. Nearby flint deposits, 1–3 km south of the site in the southern part of the Ak-Kaia rock massif and on adjacent terraced surfaces along the Bilohirsk-Feodosiia road, as well as 2–3 km west in the Sary-Kaia tract, were used. The layer contains many nodule fragments, serving as a raw material reserve, confirming the use of local flint (Chabai, Uthmeier 2017). The Ak-Kaia sites are characterised by a preference

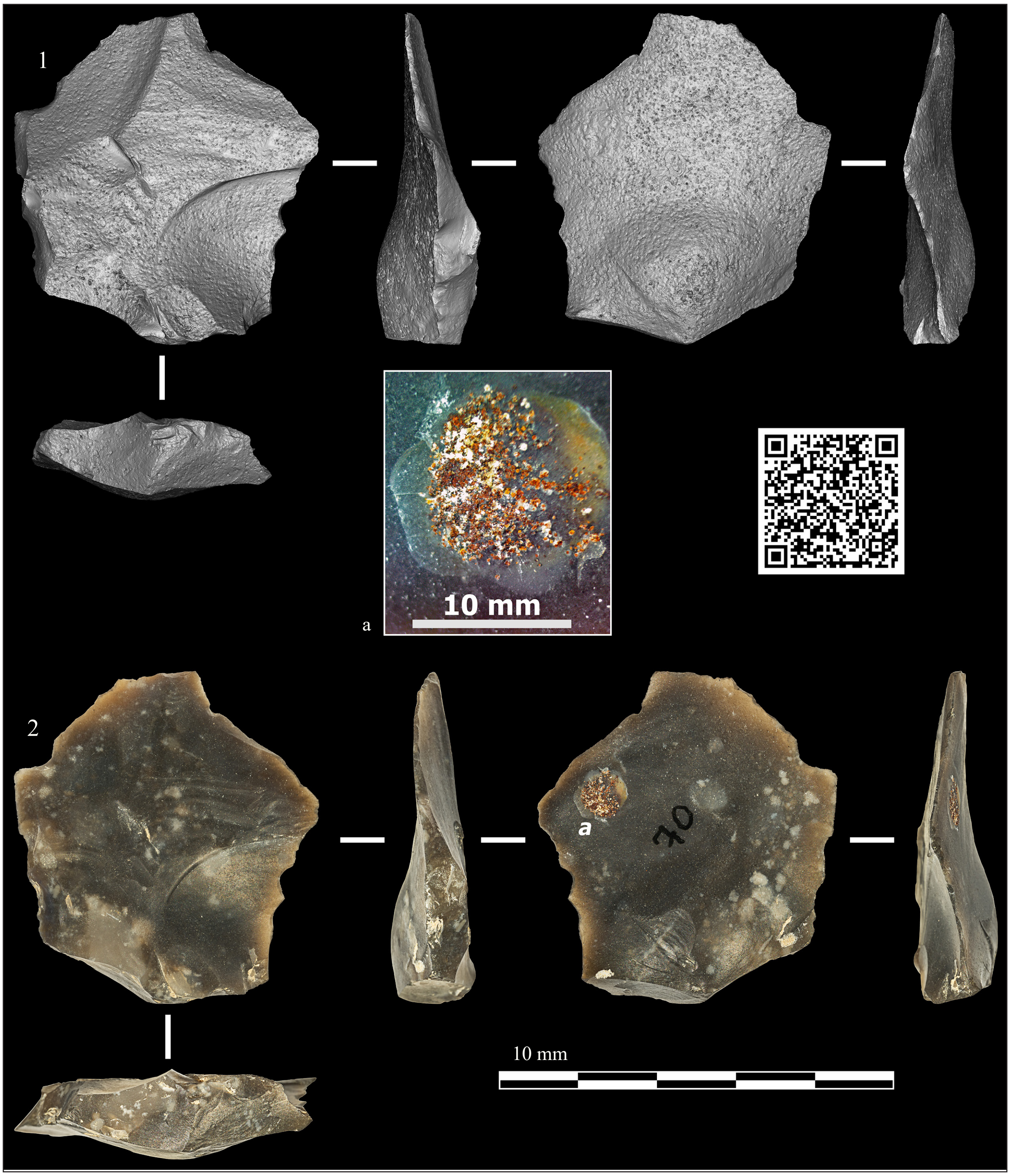

Fig. 2. Zaskelna V, layer II. Flint flake (db 271) with incomplete potlid-like cracking in the area contains microremains of ochre-rich material (a). The 3D model (1) and photos (2) of the artefact. Scan the QR code to view the 3D model

for tabular nodules (Колосов 2003; Ryzhov, Stepanchuk, Sapozhnikov 2005). According to Kolosov (2003) and Kolosov, Kukharchuk and Ryzhov (1994b), the flint assemblage from the layer II studied in 1993 includes 1,677 items: 117 tools, 23 cores, 765 flakes, 117 blades, 75 fragments, and 577 pieces of debris. The industry is macrolithic, with bifacial forms constituting 41.4 % of all tools. The typological set of tools is detailed in table 2. The industry is defined as Micoquian or Mousterian bifacial according to Yu. H. Kolosov's terminology (Колосов 1983; Колосов, Степанчук, Чабай 1993; Kolosov, Stepanchuk 2000).

Presentation of the artefacts discussed. Flake ZskV:1993:17A/G:II:300/330:db271 (further on db 271) (fig. 2). This flake, which shows remains of probable pigment associated with the cracking zone of the artefact, is made from translucent Turonian flint, grey with light spots. The flint is homogeneous and fine-grained, with no inclusions. The surfaces are slightly smoothed and have an oily sheen. The flake is suboval in plan and slightly curved in profile, measuring 4.3 × 3.8 × 9.4 cm and weighing 13.6 g. Its dorsal surface displays a centripetal flaking pattern, and the dihedral striking platform shows signs of preparation through faceting. The point of impact is clearly at the edge of the platform. The flake's basal portion is relatively thick due to the platform and a prominent bulb (1.5 cm thick), while the distal section is thinner (0.4–0.6 cm). The termination and laterals are feather-like, and a bulbar scar and fissures are visible on the bulb.

Several other flint artefacts with possible pigment residues or unusual cracking were identified in the materials from the layer II during the 1993 excavations (table 3). These artefacts are similar in both raw material and state of preservation, made from translucent grey Turonian flint, occasionally with a brownish hue. One artefact has dark inclusions, up to black, arranged in a banded pattern. Another artefact shows unfinished potlid-like damage on its ventral surface. Additionally, three artefacts show possible pigment residues.

Methods.

General approach. We use a multimethod approach that includes a comprehensive description of the site, the context of the artefact's discovery, its detailed characteristics, and specific features. It covers essential geostratigraphic, chronological, and spatial data, as well as information about the associated material. Our approach combines standard technical-typological analysis with diacritical analysis. Experimental replication is also employed to reconstruct the likely conditions responsible for the observed features on the artefact. Additionally, the study provides a preliminary description of the micro-remains, without relying on complex analytical methods or equipment.

Table 2. **The typological set of tools from the layer II of the Zaskelna V site, based on the 1993 excavations, according to Kolosov Kukharchuk and Ryzhov (Колосов, Кухарчук, Рыжов 1994b).**

Bifacial forms		Flake tools	
Knives	13	Knives	10
Sidescrapers	7	Sidescrapers	13
Points	4	Points	2
Triangles	2	Retouched flakes	15
Fragments	20	Fragments	31
Subtotal	46	**Subtotal**	71
Total			**117**

The research and illustrations were prepared using the Biwyily USB500xDM electron microscope, MBS-9 and Bresser Advance ICD binocular microscopes, and the Levenhuk M10.P Series digital camera with Levenhuk Lite software. Additionally, a Nikon Coolpix AW130 camera was employed. For detailed surface analysis of the artefact, a 3D model was created with Structure from Motion (SfM) photogrammetry, using the Sony a7RIII camera with a Sigma 105 mm F2.8 DG macro lens and RealityCapture software.

Working Hypothesis and Experimental Research Procedure. Our investigation focused on determining the potential causes for the simultaneous occurrence of two distinct features: flint cracking and the presence of suspected pigment residues in the affected area. The crack on the artefact is an unfinished potlid-like damage, usually caused by temperature-induced effects on the near-surface layer of stone (Patterson 1995; Fiers et al. 2021; Abdolahzadeh et al. 2023). Potlid-like fractures have been observed on the surfaces of heated flint artefacts from various periods (Moore et al. 2009; Yegorov et al. 2020, fig. 8; Науменко, Радієвська 2022, fig. 4: 10, 15), including Middle Palaeolithic examples (Agam et al. 2023).

Our working hypothesis suggests that the cracking on the db 271 artefact may have been caused by a short-term, localised temperature effect. We propose the involvement of two interacting agents: a hot, pigment-containing substance and flint that was either at moderate temperature (20–22°C) or possibly cooled to below freezing.

To test the working hypothesis, we aimed to simulate localised cracking in a fine-grained, isotropic material when exposed to a high-temperature, pigment-containing substance. We replicated various temperature interaction regimes, including: a) room temperature (20–22°C), b) room temperature followed by cooling, c) applying the hot composition to a pre-cooled base, and d) placing a pre-heated base with a hot composition into cold water for rapid cooling. The cooling was done using a household freezer, reaching −15°C with a minimum cooling time of four hours. The progress and results of the experiments were photographed and recorded.

The experiments involved two types of interactive agents: passive ("base") and active ("adhesive"). The passive elements were objects onto which pigment-bearing substances were applied. These included experimental flakes made from fine-grained flint resembling the artefact under study, specifically Cenomanian flint from the Dnister region and Turonian flint from the Volyn region. The flakes were small, thin, and had feather-shaped edges, typically without a cortex on the dorsal surface. We also used modern untempered glass (4 mm and 10 mm thick) due to its homogeneous and isotropic properties, which made it ideal for studying potlid-like cracking, even though it's not fully similar to experimental model material. The active components included sealing wax, chosen for its resemblance to traditional adhesives made from natural resins and pigments. In several experiments, pine resin and organosilicon polymer glue were added to the sealing wax to enhance its adhesive properties.

Results

Techno-morphological characteristics of flake db 271.

All edges of the artefact show evidence of wear or intentional modification. Due to relatively sharp changes in angle, ranging from 95° to 115°, the working edge can be divided into five sections: a short, oblique transverse edge, two adjoining edges on the left, and two on the right.

The left lower edge, adjacent to the striking platform, is slightly curved and 2.3 cm long. It has intentional dorsal retouching in 1–2 rows at a steep angle of 80–90°. The transition to the adjacent left edge is approximately 115°. This slightly curved edge, 2 cm in length, shows multiple micro-fractures, mainly on the dorsal surface, including a tongue-shaped fracture extending onto the back of the flake. The transition to the next edge maintains a similar angle of around 115°.

The straight, transversely oblique edge is 1 cm long and shows small breaks and blunt micro-retouch at a 70–80° angle. The transition angle forms an angle of about 110°. The adjacent curved edge on the right, 2.3 cm long, has minimal wear signs on both surfaces, characterised by individual and clustered micro-retouch scars. The joint angle to the next edge is approximately 95°.

The last edge, measuring 2.7 cm is next to the striking platform on the right, has a denticulated-concave shape. Both surfaces show many retouched and non-retouched micro-notches along the edge. The protruding part at the contact area between the right edges is more polished than the other areas. The nearby 1.1 cm long inter-scar area on the dorsal surface has unusual damage, with several small flat scars, likely caused by strong pressure applied parallel to the surface (Thiébaut, Claud, Costamagno 2019).

On the ventral surface of the flake, near the protrusion of the right edge, there is rounded potlid-like damage in the form of an incomplete circular crack measuring 6.8 × 6.1 mm, along with small dents and scratches, each measuring less than a millimetre (fig. 2: a). The flake's thickness at this location is 3.3 mm. More than 10 tiny micropotlids, about 0.2 mm, are detectable inside the potlid area, along with a few larger ones that are up to 1 mm. Despite this damage, there are no other signs of fire exposure on the flake.

Table 3. **Flint artefacts mentioned in the text, main features**

Data-based code	Box code (+code on the artefact)	Raw: FG – fine-grained; WS – white spots	Pigment (?) residue	Unfinished potlid-like cracking	Typology	Completeness	Use-wear/ retouching
db 271	Zsk-V-93 unit 17А-Г II 3.00–3.30 (70)	FG grey with WS	yes	yes	retouched flake	complete	yes/ yes
db 291	Zsk-V-93 unit 17А-Г II 3.00–3.30 (z/ch)	FG grey with WS	yes	no	flake	broken	yes/ no
db 292	Zsk-V-93 unit 17А-Г II 3.00–3.30	FG grey with WS	yes	no	micro-flake	broken	yes/ no
db 293	Zsk-V-93 unit 17А-Г II 3.00–3.30 (27)	FG grey-brownish with WS	yes	no	partial biface	broken	yes/yes
N/A	Zsk-V-93 unit 17А-Г II 3.00–3.30 (z/ch)	FG grey-brownish with WS and dark-coloured stripes	no	yes	blade flake	complete	yes/yes

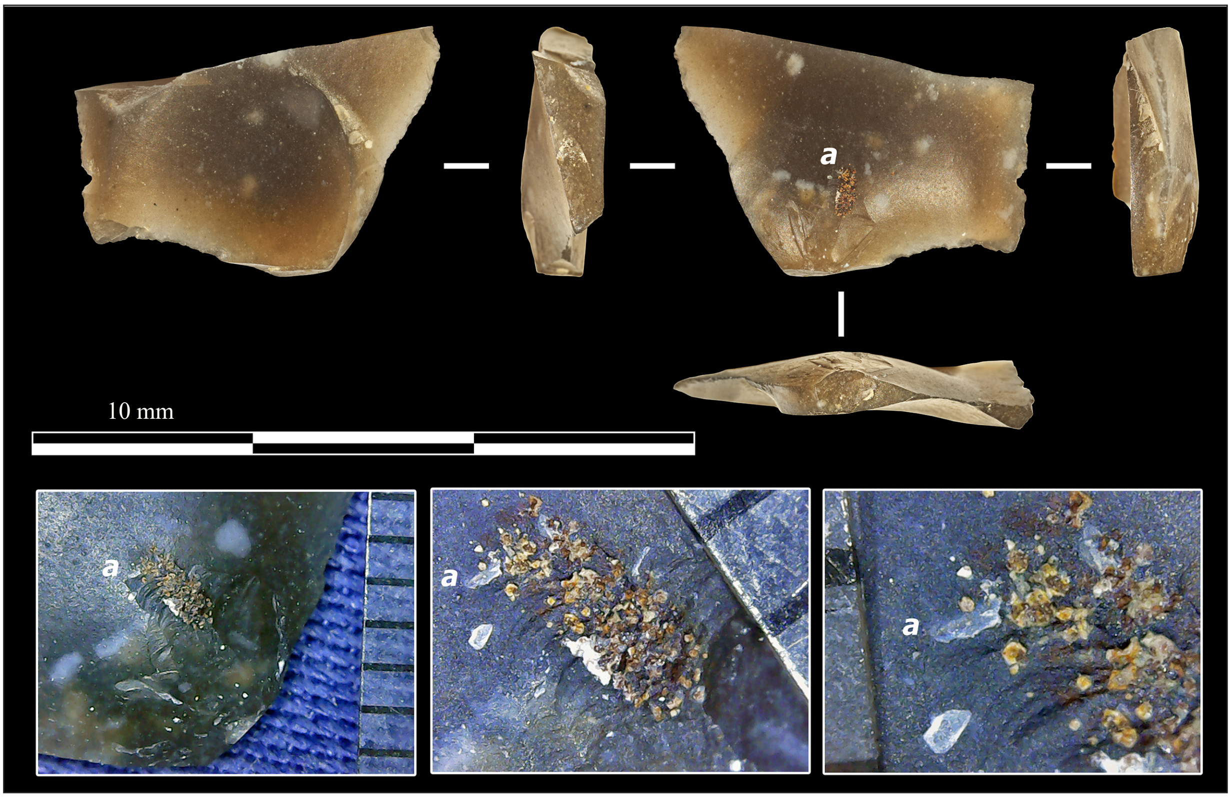

Fig. 3. Zaskelna V, layer II. The proximal fragment of flint flake (db 292) with adhered particles of ochre-coloured material on the percussion bulb (a). This material is similar to that observed on the flake db 271 (see: fig. 2). However, there are no potlid-like cracks

There is a suboval area (4.3 × 5.7 mm) with ochre-coloured particles inside the rounded potlid-like damage. The colour varies, displaying areas of dark reddish-brown, light reddish-brown, dark reddish-grey, and pinkish-grey, according to the Munsell chart. Although these residues probably contain ochre, we cannot be sure of their exact nature, because we have not done chemical or elemental analyses to confirm this.

The space between the ochre-coloured particles is somewhat filled with loamy sediment. The boundaries and surface of the ochre-coloured accumulation are irregular, and it slightly protrudes above the flake's surface by fractions of a millimetre. The pigment particles are associated with micropotlids, while the areas of flint surface between them are often free of residues. Some pigment grains are also found outside the main zone of the large unfinished potlid-like crack, but still on the flake's ventral surface. The area with adhered microremains does not appear to be related to any internal heterogeneity of the artefact material.

Overall, the flake is a typical example of the site's industry, showing flat centripetal knapping used by its inhabitants. It has significant wear on its edges and atypical damage to both edges and surfaces. The potlid-like damage is rare for this type of artefact. The accumulation of heterogeneous ochre-coloured material is linked with this unfinished potlid-like damage, suggesting that the association is likely not incidental.

Techno-morphological characteristics of flint objects similar in some features.

ZskV:1993:17A/G:II:300/330:db292 (fig. 3) is a proximal fragment of a small flake, measuring 10 × 19 × 3 mm and weighing 0.6 g. The fragment shows damage on the left edge and light use wear on the dorsal right edge. The types of dorsal pattern and striking platform are not definable. On the bulb, within the terminal part of a longitudinal bulbar scar with a deep, wave-like surface relief, there is a 3 × 1 mm area with adhered particles of ochre-coloured material (fig. 3: a). This material is similar to that observed on item db 271. A small micro-residue in the form of a light grey spot, about 0.6 mm, is on the striking platform. There are no signs of surface cracking on this flint artefact.

ZskV:1993: z/ch:17A/G:II:300/330:db291 (fig. 4: 1) is a terminal fragment of a semi-primary centripetal flake, measuring 26 × 25 × 8 mm and weighing 4.7 g. The surfaces are polished, and all edges, including the breaks, have small scars from use or trampling. The right edge opposite the break

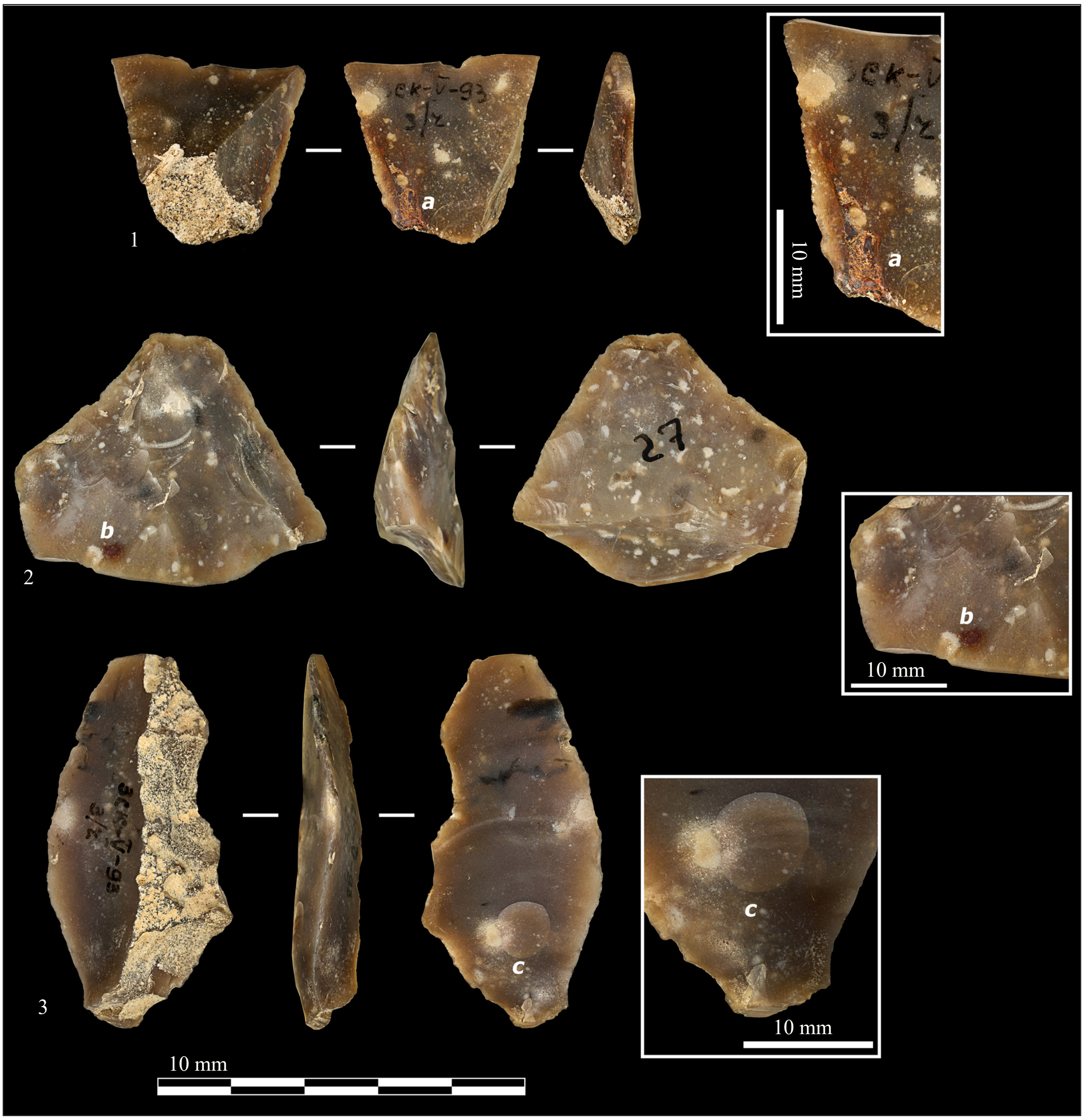

Fig. 4. Zaskelna V, layer II. Flint artefacts that are similar in some features to flakes db 271 and db 292. *1* — a terminal flake fragment (db 291) with brown-red staining in the form of stripes (*a*). There are no pigment traces on the cortex and no signs of cracking on the artefact; *2* — a terminal fragment of a large item with partial bifacial flaking (db 293) and a zone of ochre-coloured particles with a brown-reddish hue (*b*). There are no signs of destruction on the flint surface; *3* — a blade flake with an unfinished circular potlid-like crack on the ventral surface (*c*). There are no traces of pigment and no obvious mechanical damage related to the potlid-like cracking

has a brown-red staining in the form of stripes, up to 15 mm long and 3 mm wide (fig. 4: a). This staining is superficial and consists of tiny particles of pigment or coloured sediment (up to 0.1 mm) adhering to the flint surface. No pigment traces are found on the nearby cortex area, and there are no signs of cracking on the flint.

ZskV:1993:17A/G:II:300/330:db293 (fig. 4: 2) is a terminal fragment of a large item with partial bifacial treatment, measuring 26 × 25 × 8 mm and weighing 11.7 g. The fragment has two longitudinal retouched edges, each up to 25 mm long, and a short transverse edge, up to 8 mm. The dorsal surface is fully covered with shaping scars. The left and right edges have flat retouching in one or two rows, with the right edge showing bifacial processing, meaning the ventral surface had been flaked before the dorsal surface was shaped. The point of longitudinal edge convergence is missing. The transverse edge is formed by bifacial scars along the fragment's long axis, likely caused by vertical actions that broke the terminal part. The direction of the fracture's waves aligns with this movement. The fracture edge shows minimal wear evidence. On the more convex surface near the fracture that destroyed the piece, there is a rounded area (~2 × 2 mm) of densely packed ochre-coloured particles with a brown-reddish hue (fig. 4: b). These remains are similar to those observed on item db 271. There are no signs of destruction to the flint surface.

ZskV:1993: z/ch:17A/G:II:300/330:N/A (fig. 4: 3) is a straight-axis blade flake with a plunging termination, measuring 51 × 25 × 9 mm and weighing 9.3 g. The dorsal pattern is parallel with the cortex (up to 50 %). The micro-striking platform is plain (one removal). The convex left edge is sharpened with one- or two-row retouching and shows damage, possibly from trampling. The right edge, covered with a cortex along its full length, has microbreaks and wear that suggest use. On the ventral surface, in the proximal third above the bulb, there is an unfinished circular potlid-like crack with a diameter of 7.9 mm (fig. 4: c). The surface within the contour of this damage is smooth, showing no disruption. The opposite area on the dorsal surface shows no signs of impact. No traces of pigment are visible, either by eye or under magnification. The cause of the circular cracking is unclear, as there is no obvious mechanical damage.

Results of modelling the expected circumstances that cause potlid cracking.

Since we hypothesised the cracking of the db 271 artefact resulted from a short-term and localised thermal stress exerted by a hot pigment-containing compound, our experiments were designed to replicate these conditions. The modelling involved various interacting materials (flint, glass, sealing wax, resin, glue) and encompassed a range of temperature regimes.

During the experiments, we observed various effects. At ambient temperature, hot sealing wax — whether pure or with additives — adheres to the surface of the flint, but fails to spread over a glass and does not stick very firmly (fig. 5). Sealing wax adheres more strongly to the flint when the contact area is extensive (fig. 7: 2) that in part depends on the temperature regime. To remove it, the object must be reheated or frozen to crack the wax layer. After removing the wax, small, unevenly coloured stains often remained at low temperatures (fig. 7: 4). When flint and glass were cooled to around −15°C, the melted wax did not spread, but adhered well (figs. 5: I, 1, 3; II, B; 7: 3). Extreme temperature differences were achieved by burning a mixture of sealing wax, organosilicon polymer glue, and pine resin on a flint or glass surface cooled to −15°C (figs. 5: I, 2, 3; II, B; 7: 3). At high concentrations of sealing wax, it spread over the surface, but with more polymer glue, the mixture burned away almost completely (fig. 7: 1). A common outcome of all these experiments was that no phenomena resembling potlid cracking were observed (figs. 5, 7).

Additional experiments involved rapidly cooling artefacts that had been preheated for some time. Flint and glass bases were heated in sand (approx. 300 °C) or boiling water (approx. 100 °C), with sealing wax applied to both percussed and intact areas. After heating, the samples were submerged in cold water or had cold water poured over them. We observed deformation of the wax: changes in shape, darkening, and swelling due to absorption of sand grains (fig. 6: 1a — d; 2d; 3b, 3c). By contrast, boiling alone caused only slight degradation and surface lifting of the wax, with no major colour or shape changes.

No noticeable damage occurred on the flint surfaces beneath the wax. However, the glass bases cracked extensively in both struck and unstruck areas. Adhesive tape on the underside likely prevented full breakage. Of all the cracks, only one resembled a potlid scar; others were linear (fig. 6: 3b, 3c). Flint flakes also showed intense internal fracturing. Some of the cracks follow structural weaknesses created during knapping, while others show potlid-like damage (fig. 6: 2b, 2c, 2d). On one flake, several micro potlid-like scars likely formed from contact with hot quartz sand grains (fig. 6: 2a).

These experimental conditions may help explain the formation of the potlid-like fracture observed on the archaeological artefact. The main conclusion is that, regardless of the experimental conditions, potlid fractures are not associated with the areas where sealing wax was applied. Therefore, our experiments did not support the hypothesis regarding the possibility of cracking the body of the db 271 artefact due to short-term and localised temperature effects. Instead, they provide insight into the conditions under which potlid fractures and mixtures of dark-coloured pigment with sediment particles may form.

Discussion

The flint artefacts under discussion share many similarities, including their state of preservation, raw material quality, as well as typological, techni-

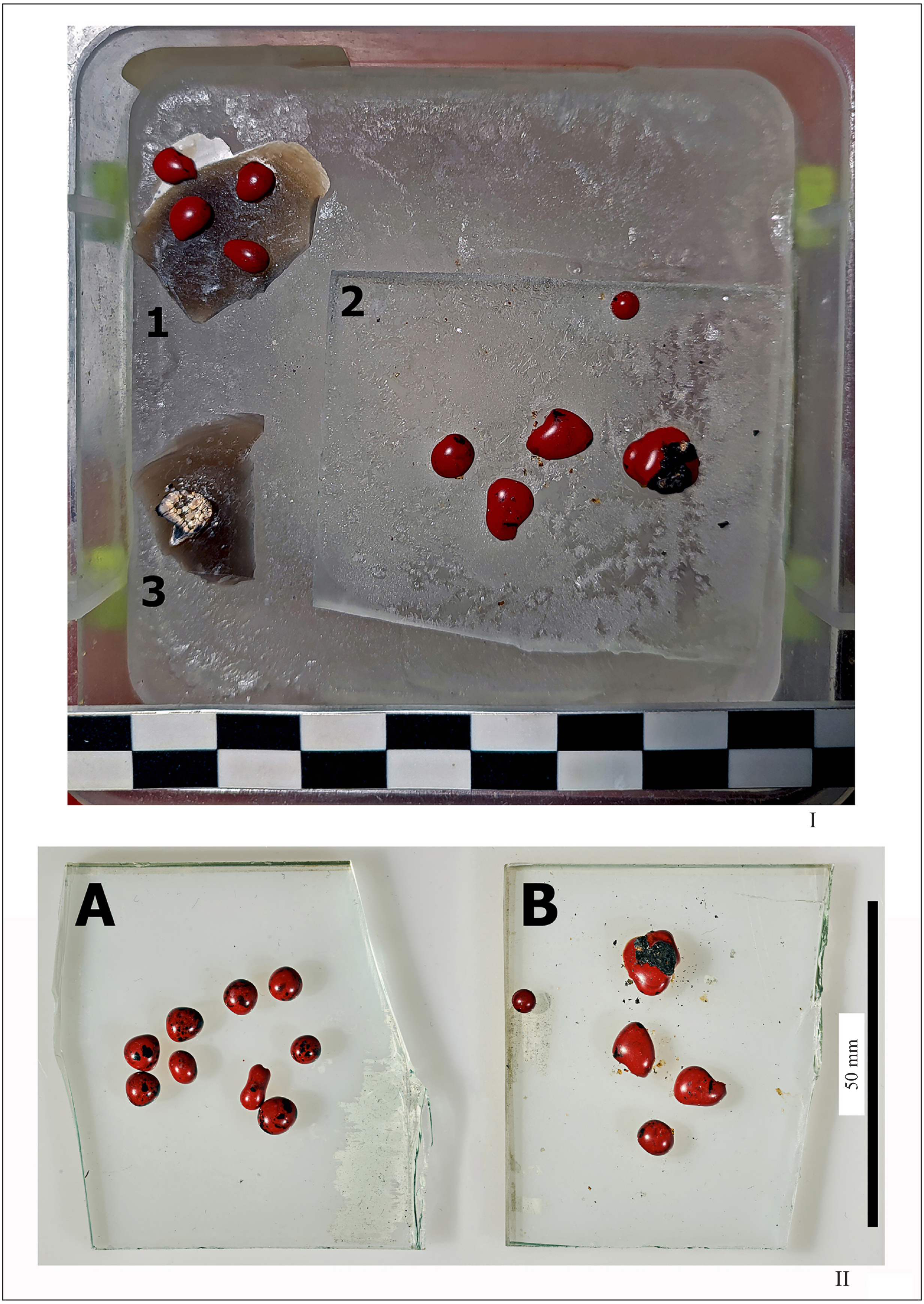

Fig. 5. Experimental data. *I* — molten sealing wax (*1, 2*), also in a mixture with pine resin, or burning polymer adhesive (*3*) was applied to the pre-cooled −15°C base. Flint flakes (*1, 3*) and a fragment of untempered 10 mm thick glass (*2*). *2* — melted sealing wax is holding well on the surface both at normal temperature (*A*) and when cooled to −15°C (*B*). Non-tempered glass with a thickness of 10 mm

Fig. 6. Experimental data. *1* — a flint flake with a percussion mark (a, arrow indicates the point of impact), application of sealing wax (*b*), after heating in sand (*c*), sealing wax partially removed (*d*). *2* — fragments of flake surfaces after heating in sand and subsequent rapid spot or general water cooling: (*a*) micro-damage resembling potlid-type fracturing, possibly caused by heated quartz grains, (*b*) single potlid fracture, spot water cooling, (*c*) multiple potlid fractures, cooled with running water, (*d*) same, with fused remnants of sealing wax mixed with sand, note the darkening. *3* — unhardened glass, 10 mm thick: a percussion zone with applied sealing wax (*a*), potlid-like fracturing after heating in sand (*b*), same, viewed from below (*c*)

Fig. 7. Experimental data. Examples of experimental objects with hot substances containing pigments applied to their surface. *1–3* — dot applications of polymer glue (*1*) and sealing wax (*2, 3*) on flint flakes. The sealing wax does not spread on a cooled surface (*3*) compared to an object at room temperature (*2*); *4* — more intensive application of sealing wax on flint flake. To remove the sticky layer, it must be reheated or frozen. After removing the sealing wax, small unevenly coloured spots remain. There are no potlid-like cracks on any experimental object

cal and morphological characteristics. They align with the typical characteristics of the layer II of Zaskelna V, showing centripetal knapping and bifacial flaking, consistent with the Middle Palaeolithic Micoquian industry. Therefore, there is no reason to suggest these artefacts are intrusive. Three objects have localised ochre-coloured micro-remains similar in composition and colour. Each artefact shows traces of intensive use, such as facets, breaks, and edge destruction. The presence of potlid-like cracks on two objects, in the absence of clear evidence of heating, burning, or mechanical impact, is unusual. The association of heterogeneous ochre-coloured material with a potlid-like crack on one object suggests a possible connection, though it may be coincidental.

Not all pigment residues found in coloured areas, microremains on objects, or ochre fragments can be directly linked to human activity. Some of these residues may have a natural origin, potentially linked to formations within the local limestones. Additionally, some ochre-coloured material could have been produced *in situ* within the layer through accidental heating of iron oxide-containing and hydroxide-containing substances. The ochre residues on artefacts db 271 and db 293 vary in colour, but are generally dark and subdued, with dark brown shades being common. This variation and muted tones suggest the colours were created by prolonged intensive heating, as confirmed by our experiments. The heterogeneity in the colour of individual particles suggests a multicomponent composition of the residues. Evidence indicates that Neanderthals were capable of producing adhesives, including ochre-based ones (Wadley, Hodgskiss, Grant 2009; Kozowyk 2023; Schmidt et al. 2024), and the Crimean sites also provide indications of ochre-based adhesives usage (Ryzhov et al. 2022). Therefore, it is plausible that the pigment residues on the surfaces of these artefacts may be remnants of a multicomponent artificial adhesive compound.

The punctate pigmentation observed on many objects could be attributed to random contact with tiny pigment fragments. Larger fragments or extensive coloured areas appear less random and may indicate intentional application. The main challenge is distinguishing between natural and anthropogenic origins of pigment residues on Middle Palaeolithic artefacts from the Crimea. The artefacts discussed in this article show punctate pigmentation, meaning the pigment residues on their surfaces may be from accidental contact rather than intentional Neanderthal activity. However, as our experiments show, this may simply indicate that the residues remained in place due to surface irregularities, while originally covering a larger area. This highlights the need for careful assessment to avoid over-attributing such residues to deliberate human actions.

Our data shows that suspected pigment residues have been found on various objects from Neanderthal sites in the Crimea, including pebbles, flint artefacts, fossil shells, and bones. These pigments usually appear as small coloured areas or residues, ranging from yellow to red. On flint artefacts, pigment residues are frequently confined to areas with a cortex, suggesting the potential for natural colouring due to prolonged exposure of unprocessed flint to soils rich in iron compounds. However, since no flint deposits are linked to such soils near the site, this thesis remains unproven. This raises the possibility that the pigments may have other origins, including human activity or contact with environmental factors, which require further investigation.

Natural inclusions within flint bodies, which differ in composition and grain size from the primary material, are occasionally observed. However, the ochre-coloured residues on the db 271 artefact significantly diverge from such inclusions. These residues are distinctly associated with areas exhibiting extensive superficial disturbances on the flint surface. Under high magnification, the coloured material appears as a conglomerate that disintegrates into many tiny parts, suggesting it is not a solid structure. The residues do not penetrate deeply into the flint and are absent from the dorsal surface, even though the flake is only 3.3 mm thick. Similar characteristics are observed in other artefacts with suspected pigment residues, indicating that these deposits are surface phenomena rather than deeply embedded natural inclusions. This pattern suggests the residues are likely external additions, possibly resulting from specific, non-natural processes. There is a clear similarity in the character of the residues observed on both archaeological and experimental flakes (figs. 2; 3; 6: 2d).

The experimental results did not support the hypothesis that the cracking on the db 271 artefact was caused by short-term and localised temperature effects. Therefore, the proposed connection between the concentric potlid-like cracking and the pigment residues on the artefact was not confirmed. This suggests that the observed damage and the residues may not have originated from the same processes, initially considered, indicating the need for alternative explanations.

Previous research has shown that cracks can form on heated flint flakes when rapidly cooled in water (Purdy, Brooks 1971; Whittaker 2015). We applied various heating and cooling methods to flint and obtained results comparable to those observed on archaeological specimens. Notably, we identified the conditions under which a single potlid fracture may form — specifically, droplet contact on a heated artefact. The experiments also provided insights into the likely causes of micro potlid formation and clarified the conditions under which small, localised residues of darkened (originally bright) pigment may form.

We observe corresponding analogies in the archaeological materials. For example, a blade flake from the layer II has a potlid-like defect on its ventral surface. This damage is similar to the circular crack on the db 271 artefact, both in its location (on the ventral) and in its dimensions (diameter of 7–8 mm). However, a key difference is that while the surface within the potlid contour on the artefact without pigment residues remains intact, the corresponding area on the artefact with pigment residues shows significant damage, including several potlid-like micro-cracks.

The ochre-coloured material seems to have stayed on the artefact's surface mainly due to surface irregularity and damage. This is supported by the location of the pigment residues on the db 292 artefact, found in a bulbar scar zone with a pronounced wave relief. Similarly, the db 293 artefact has pigment traces in a deep scar area. While the damage in the unfinished potlid zone of the db 271 artefact might explain the pigment retention, the occurrence of such potlid-like damage may be related to droplet cooling.

Conclusions

This study focuses on a flint artefact with potlid-like damage, which is spatially associated with residues of ochre-coloured material. The artefact was discovered in 1993 in the layer II of the Zaskelna V site, which dates back between 45,000 and 36,000 calibrated radiocarbon years ago. A review of materials from the 1993 excavations identified several objects with similar characteristics, including one with potlid-like cracking and three with residues of ochre-coloured material. A comprehensive technical and typological analysis confirmed that these artefacts align with the lithic industry characteristics of the Micoquian layer II at the site, indicating they are not intrusive but belong to the Middle Palaeolithic. The examination of the artefacts revealed significant use-wear. Many items were broken, but continued to be used afterwards. This observation aligns with the high density of artefacts and faunal remains in the layer, indicating a high level of activity and intensity of use of this site area.

It has been established that the pigment residues are not linked to the structural properties of the artefacts' material, making it unlikely they formed naturally. Instead, these residues are most probably associated with Neanderthal activities. The indicators of high occupation activity intensity of life in the section of the layer II uncovered in 1993, along with the extensive use of the artefacts, further suggest a strong likelihood that the pigment is related to Neanderthal activity rather than resulting from natural causes or accidental anthropogenic factors.

The working hypothesis suggested that the potlid-like cracking was caused by applying a heated adhesive containing pigment. However, our experiments, using various isotropic base materials, different pigment-containing compositions, and multiple temperature regimes, did not confirm this hypothesis. Two key observations can be highlighted. First, the formation of a large potlid-like scar appears to result from the sudden, localised cooling of a preheated flint surface, as demonstrated by our experimental findings. Second, the pigment residues — darkened and mixed with what are likely sediment particles — seem to have originated from a heated, pigment-bearing substance that adhered to the archaeological artefact due to surface damage. Chronologically, these two events likely occurred in sequence. However, how these presumed episodes in the history of artefact db 271 are related remains unclear.

Accessibility of materials

The artefacts discussed in this article are currently stored in the the Institute of Archaeology, National Academy of Sciences of Ukraine, Kyiv. The 3D model of the flake with the spot on the ventral surface can be accessed via the following link: https://sketchfab.com/3d-models/flake-with-spot-zaskelna-v-671ed1da2a864cbe9c0bf074f6bbf508.

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Губонина, З. П. 1985. Условия обитания палеолитического человека в предгорьях Крыма. В: Гричук, В. П., Заклинская, Е. Д. (отв. ред.) *Палинология четвертичного периода.* Москва: Наука, с. 95-103.

Колосов, Ю. Г. 1983. *Мустьерские стоянки района Белогорска*. Киев: Наукова думка.

Колосов, Ю. Г. 2003. Багатошарова мустьєрська стоянка Заскельна V у Криму і нові дані про абсолютну хронологію її культурних шарів. *Кам'яна доба України*, 2, с. 22-31.

Колосов, Ю. Г., Степанчук, В. М., Чабай, В. П. 1993. *Ранний палеолит Крыма*. Киев: Наукова думка.

Колосов, Ю. Г., Кухарчук, Ю. В., Рыжов, С. Н. 1994a. Работы у скалы Ак-Кая. В: Кутайсов, В. А. (отв. ред.). *Археологические исследования в Крыму, 1993*. Симферополь: Таврия, с. 146-150.

Колосов, Ю. Г., Кухарчук, Ю. В., Рыжов, С. Н. 1994b. *Отчет о работах на стоянке Заскальная V в 1993 г.* Науковий Архів ІА НАНУ, ф. 1993/10.

Науменко, О. О., Радієвська, Т. М. 2022. Стоянка Іскорость та її місце в кам'яній добі України: історіографічний і типолого-технологічний аспекти. *Археологія*, 3, с. 88-112. https://doi.org/10.15407/arheologia2022.03.088.

Рижов, С. М., Тислюк, В. В. 2024. Когнітивні можливості дослідження пігментів на кам'яних артефактах. *VITA ANTIQUA, 15. Методи моніторингу та дослідження об'єктів археологічної спадщини,* с. 79-91. https://doi.org/10.37098/VA-2024-15-79-91

Степанчук, В. М., Ковалюх, М. М., Ван дер Плихт, Й. 2004. Радіовуглецевий вік пізньоплейстоценових палеолітичних стоянок Криму. *Кам'яна доба України*, 5, с. 34-61.

Степанчук, В. М., Нездолій, О. І., Вєтров, Д. О. 2018. Природні барвники в матеріалах багатошарової мустьєрської стоянки Пролом ІІ. *Археологія і давня історія України*, 3 (28), с. 7-21. https://doi.org/10.37445/adiu.2018.03.01

Степанчук, В. Н. 2006. *Нижний и средний палеолит Украины*. Черновцы: Зелена Буковина.

Степанчук, В. М. 2024. Юрій Георгійович Колосов (до 100-річчя від дня народження). *Археологія*, 4, с. 125-138. https://doi.org/10.15407/arheologia2024.04.125

Степанчук, В. Н., Васильев, С. В. (ред.). 2018. *Поздние неандертальцы Крыма. Заскальная VI (Колосовская). Слои III и IIIa*. Киев: ЧП «Издательство «СЛОВО».

Abdolahzadeh, A., Leader, G. M., Li, L., Olszewski, D. I., Schurr, T. G. 2023. Heat Exposed Lithics: An Experimental Approach to Quantifying Potlids by Temperature. *Journal of Archaeological Science: Reports*, 48, 103894. https://doi.org/10.1016/j.jasrep.2023.103894

Agam, A., Hattermann, M., Pinkas, I., Richter, J., Uthmeier, Th. 2023. Heat Treatment of Flint at the Late Neanderthal Site Sesselfelsgrotte (Germany). *Quaternary*, 6 (4), p. 52. https://doi.org/10.3390/quat6040052

Cârciumaru, M., Ion, R.-M., Niţu, E.-C., Ştefănescu, R. 2012. New Evidence of Adhesive as Hafting Material on Middle and Upper Palaeolithic Artefacts from Gura Cheii-Râşnov Cave (Romania). *Journal of Archaeological Science*, 39 (7), p. 1942-1950. https://doi.org/https://doi.org/10.1016/j.jas.2012.02.016

Chabai, V., Uthmeier, T. 2017. New Excavations at the Middle Paleolithic Site Zaskelna 5, Crimea. The 2012 and 2013 Field Seasons: A Preliminary Report. *Quartär*, 64, p. 27-71. https://doi.org/10.7485/QU64_2

Degano, I., Soriano, S., Villa, P., Pollarolo, L., Lucejko, J. J., Jacobs, Z., Douka, K., Vitagliano, S., Tozzi, C. 2019. Hafting of Middle Paleolithic Tools in Latium (Central Italy): New Data from Fossellone and Sant'Agostino Caves. *PLoS One*, 14 (6), e0213473. https://doi.org/10.1371/journal.pone.0213473

Doronicheva, E. V., Golovanova, L. V., Kostina, J. V., Legkov, S. A., Poplevko, G. N., Revina, E. I., Rusakova, O. Y., Doronichev, V. B. 2022. Functional Characterization of Mousterian Tools from the Caucasus Using Comprehensive Use-Wear and Residue Analysis. *Scientific Reports*, 12 (1), 17421.

Fiers, G., Halbrucker, É., De Kock, T., Vandendriessche, H., Crombé, P., Cnudde, V. 2021. Thermal Alteration of Flint: An Experimental Approach to Investigate the Effect on Material Properties. *Lithic Technology*, 46 (1), p. 27-44. https://doi.org/10.1080/01977261.2020.1805215

Kolosov, Yu. H., Stepanchuk, V. N. 2000. Crimean Assemblages with Bifacial Tools: Brief Review. *A la recherche de l'homme préhistorique Etudes et Recherches Archeologiques de l`Universite de Liege*, 95, p. 265-276.

Kozowyk, P. R. B. 2023. Archaeological *Podocarpus* tar supports the cognitive complexity of Neanderthals. *Proceedings of the National Academy of Sciences of the USA*, 120 (7), e2221676120. https://doi.org/10.1073/pnas.222167612

Mazza, P. P. A., Martini, F., Sala, B., Magi, M., Colombini, M. P., Giachi, G., Landucci, F., Lemorini, C., Modugno, F., Ribechini, E. 2006. A New Palaeolithic Discovery: Tar-Hafted Stone Tools in a European Mid — Pleistocene Bone-Bearing Bed. *Journal of Archaeological Science*, 33 (9), p. 1310-1318. https://doi.org/10.1016/j.jas.2006.01.006

Moore, M. W., Sutikna, T., Morwood, M. J., Brumm, A. 2009. Continuities in Stone Flaking Technology at Liang Bua, Flores, Indonesia. *Journal of Human Evolution*, 57 (5), p. 503-526. https://doi.org/10.1016/j.jhevol.2008.10.006

Niekus, M. J. T., Kozowyk, P. R., Langejans, G. H., Ngan-Tillard, D., van Keulen, H., van der Plicht, J., Cohen K. M., van Wingerden W., van Os B., Smit B. I., Amkreutz L. W. S. W., Johansen L., Verbaas A., Dusseldorp, G. L. 2019. Middle Paleolithic Complex Technology and a Neandertal Tar-Backed Tool from the Dutch North Sea. *Proceedings of the National Academy of Sciences*, 116 (44), p. 22081-22087. https://doi.org/10.1073/pnas.190782811

Patterson, L. W. 1995. Thermal Damage of Chert. *Lithic Technology*, 20 (1), p. 72-80.

Purdy, B. A., Brooks, H. K. 1971. Thermal Alteration of Silica Minerals: An Archeological Approach. *Science*, 173 (3994), p. 322-325. https://doi.org/10.1126/science.173.3994.322

Reimer, P. J., Austin, W. E. N., Bard, E., Bayliss, A., Blackwell, P. G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Hajdas, I., Heaton, T. J., Hogg, A. G., Hughen, K. A., Kromer, B., Manning, S. W., Muscheler, R. et al. 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 Cal kBP). *Radiocarbon*, 62 (4), p. 725-757. https://doi.org/10.1017/RDC.2020.41

Ryzhov, S. M., Stepanchuk, V. N., Sapozhnikov, I. V. 2005. Raw Material Provenance in the Palaeolithic of Ukraine: State of Problem, Current Approaches and First Results. *Archeometriai Műhely*, 4, p. 17-25.

Ryzhov, S., Stepanchuk, V., Nezdolii, O., Vietrov, D. 2022. Analysis of Micro-Residues on Stone Tools from Zaskelna IX, Crimea: First Results. *Arheologia*, 1, p. 5-25. https://doi.org/10.15407/arheologia2022.01.005

Schmidt, P., Iovita, R., Charrié-Duhaut, A., Möller, G., Namen, A., Dutkiewicz, E. 2024. Ochre-based Compound Adhesives at the Mousterian Type-Site Document Complex Cognition and High Investment. *Science Advances*, 10 (8), eadl0822. https://doi.org/10.1126/sciadv.adl0822

Stepanchuk, V. N. 2022. Pebbles with Ochre Residues from Neanderthal Sites of Eastern Crimea. In: Cîrstina, O., Niţu, E.-C. (eds.). *A Life Dedicated to the Paleolithic: Studies in Honorem Marin Cârciumaru*. Târgovişte: Cetatea de scaun, p. 53-69.

Stepanchuk, V., Naumenko, O. 2022. A New Aspect of Post-Depositional Alterations of Lithic Artefacts: The Case of Medzhibozh Lower Palaeolithic Assemblages. *Materials and Studies on Archaeology of Sub-Carpathian and Volhynian Area*, 26, p. 11-31. https://doi.org/10.33402/mdapv.2022-26-11-31

Stepanchuk, V., Naumenko, O. 2024. Investigating the Post-Discard Alteration of Flint Artefacts at Medzhibozh 1 Lower Palaeolithic Site, Ukraine. *Journal of Archaeological Science: Reports*, 53, p. 283-303. https://doi.org/10.1016/j.jasrep.2024.104374

Thiébaut, C., Claud, É., Costamagno, S. (dir.) 2019. *L'acquisition et le traitement des matières végétales et animales par les néandertaliens: quelles modalités et quelles stratégies?* Palethnologie, 10. https://doi.org/10.4000/palethnologie.4070

Wadley, L., Hodgskiss, T., Grant, M. 2009. Implications for Complex Cognition from the Hafting of Tools with Compound Adhesives in the Middle Stone Age, South Africa. *Proceedings of the National Academy of Sciences of the United States of America*, 106 (24), p. 9590-9594. https://doi.org/10.1073/pnas.0900957106

Whittaker, J. C. 2015 Fire-and-Water Knapping: Origins of an Anthropological Folk Tale. *Lithic Technology*, 40 (1), p. 40-51. https://doi.org/10.1179/2051618514Y.0000000006

Yegorov, D., Marder, O., Khalaily, H., Milevski, I., Rosen, S. A. 2020. Heat Treated or Not Heat Treated: Archaeological and Experimental Interpretation of Flint Assemblage from the Middle Pre-Pottery Neolithic B Site of Yiftahel. *Journal of Archaeological Science: Reports*, 29, p. 102090. https://doi.org/10.1016/j.jasrep.2019.102090

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ВИВЧЕННЯ ЗВ'ЯЗКУ МІЖ ЗАЛИШКАМИ ПІГМЕНТУ ТА РОЗТРІСКУВАННЯМ КОВПАКОПОДІБНОЇ ФОРМИ: ПРИКЛАД ІЗ ЗАСКЕЛЬНОЇ V

Основним об'єктом дослідження є крем'яний артефакт із потлідоподібним пошкодженням і просторово пов'язаними залишками вохристо-забарвленого матеріалу. Артефакт був знайдений у 1993 р. в мустьєрському II шарі стоянки Заскельна V, який датується між 45 000–36 000 каліброваних радіовуглецевих років тому. Під час спеціальної перевірки матеріалів цього шару з розкопок 1993 р. також були виявлені кілька предметів із подібними характеристиками, а саме артефакт із потлідоподібним розтріскуванням і три артефакти із залишками вохристо-забарвленого матеріалу.

За даними техніко-технологічних аналізів, зазначені артефакти цілком відповідають параметрам кам'яної індустрії II шару стоянки. Згідно з цим, предмети не є сторонніми та належать до середнього палеоліту. Вивчення техніко-морфологічних атрибутів виявило значну інтенсивність підправок і використання артефактів. Частина предметів зламані, але застосовувалися надалі. Це спостереження узгоджується з високою насиченістю шару артефактами та рештками фауни, що вказує на значну активність мешканців на цій ділянці стоянки.

Встановлено, що залишки барвника не пов'язані з особливостями структури матеріалу артефактів, тобто мають зовнішнє, не пов'язане походження і, ймовірно, є результатом діяльності неандертальців. Показники інтенсивності життєдіяльності ділянки II шару, розкритої в 1993 р., й активності використання знарядь також вказують на високу ймовірність асоціації барвника з діяльністю неандертальців, а не на прояв природного або випадкового антропогенного чинника. Елементний аналіз складу барвника не проводився.

Припускалося, що потлідоподібне розтріскування тіла відщепу виникло через вплив гарячого клею (?) з пігментом. Однак наші експерименти з різними матеріалами, компонентами складу з пігментом і температурними режимами не підтвердили цю гіпотезу. Імовірно, ми маємо справу зі збігом. Потлідоподібне пошкодження утворилося внаслідок локалізованого раптового охолодження, тоді як залишки барвника, ймовірно, походять від нагрітої речовини, що прилипла до пошкодженої поверхні. Ці події, очевидно, відбулися послідовно, хоча їх точний взаємозв'язок залишається нез'ясованим.

Ключові слова: Східна Європа, Крим, середній палеоліт, потлідоподібне розтріскування, залишки пігменту.

References

Gubonina, Z. P. 1985. Usloviia obitaniia paleoliticheskogo cheloveka v predgoriakh Kryma. In: Grichuk, V. P., Zaklinskaia, E. D. (eds.) Palinologiia chetvertichnogo perioda. Moscow: Nauka, p. 95-103.

Kolosov, Iu. G. 1983. Musterskie stoianki raiona Belogorska. Kyiv: Naukova dumka.

Kolosov, Yu. H. 2003. Bahatosharova mustierska stoianka Zaskelna V u Krymu i novi dani pro absoliutnu khronolohiiu yii kulturnykh shariv. *Kamiana doba Ukrainy*, 2, p. 22-31.

Kolosov, Iu. G., Stepanchuk, V. N., Chabai, V. P. 1993. *Rannii paleolit Kryma.* Kyiv: Naukova dumka.

Kolosov, Iu. G., Kuharchuk, Iu. V., Ryzhov, S. N. 1994a. Raboty u skaly Ak-Kaia. In: Kutaisov, V. A. (ed.). *Arkheologicheskie issledovaniia v Krymu, 1993.* Simferopol: Tavriia, p. 146-150.

Kolosov, Iu. G., Kuharchuk, Iu. V., Ryzhov, S. N. 1994b. *Otchet o rabotakh na stoianke Zaskalnaia V v 1993 g.* Scientific Archive of the Institute of Archaeology, the NAS of Ukraine, f. 1993/10.

Naumenko, O. O., Radiievska, T. M. 2022. The Iskorost Site and its Place in the Stone Age of Ukraine: Historiographical, Typological and Technological Aspects. *Arheologia*, 3, p. 88-112. https://doi.org/10.15407/arheologia2022.03.088.

Ryzhov, S. M., Tysliuk, V. V. 2024. Cognitive Possibilities of Studying Pigments on Stone Artefacts. *VITA ANTIQUA,* 15. *Methods for Monitoring and Research of Archaeological Heritage Objects*, p. 79-91. https://doi.org/10.37098/VA-2024-15-79-91

Stepanchuk, V. M., Kovaliukh, N. N., Van der Plicht, J. 2004. Radiovuhletsevyi vik piznopleistotsenovykh paleolitychnykh stoianok Krymu. *Kamiana doba Ukrainy*, 5, p. 34-61.

Stepanchuk, V. M., Nezdolii, O. I., Vietrov, D. O. 2018. Natural Pigments in Materials of the Multilayered Mousterian Site of Prolom II. *Archaeology and Ancient History of Ukraine*, 3 (28), p. 7-21. https://doi.org/10.37445/adiu.2018.03.01

Stepanchuk, V. N. 2006. *Nizhnii i srednii paleolit Ukrainy*. Chernivtsi: Zelena Bukovyna.

Stepanchuk, V. N. 2024. Yurii Heorhiiovych Kolosov (to the 100th Anniversary of His Birth). *Arheologia*, 4, p. 125-138. https://doi.org/10.15407/arheologia2024.04.125.

Stepanchuk, V. N., Vasilev, S. V., (eds). 2018. *Late Neanderthals of Crimea. Zaskalnaya VI (Kolosov site). Layers III and IIIa*. Kyiv: CHP "Izdatelstvo "SLOVO"".

Abdolahzadeh, A., Leader, G. M., Li, L., Olszewski, D. I., Schurr, T. G. 2023. Heat Exposed Lithics: An Experimental Approach to Quantifying Potlids by Temperature. *Journal of Archaeological Science: Reports*, 48, 103894. https://doi.org/10.1016/j.jasrep.2023.103894

Agam, A., Hattermann, M., Pinkas, I., Richter, J., Uthmeier, Th. 2023. Heat Treatment of Flint at the Late Neanderthal Site Sesselfelsgrotte (Germany). *Quaternary*, 6 (4), p. 52. https://doi.org/10.3390/quat6040052

Cârciumaru, M., Ion, R.-M., Nițu, E.-C., Ştefănescu, R. 2012. New Evidence of Adhesive as Hafting Material on Middle and Upper Palaeolithic Artefacts from Gura Cheii-Râşnov Cave (Romania). *Journal of Archaeological Science*, 39 (7), p. 1942-1950. https://doi.org/https://doi.org/10.1016/j.jas.2012.02.016

Chabai, V., Uthmeier, T. 2017. New Excavations at the Middle Paleolithic Site Zaskelna 5, Crimea. The 2012 and 2013 Field Seasons: A Preliminary Report. *Quartär*, 64, p. 27-71. https://doi.org/10.7485/QU64_2

Degano, I., Soriano, S., Villa, P., Pollarolo, L., Lucejko, J. J., Jacobs, Z., Douka, K., Vitagliano, S., Tozzi, C. 2019. Hafting of Middle Paleolithic Tools in Latium (Central Italy): New Data from Fossellone and Sant'Agostino Caves. *PLoS One*, 14 (6), e0213473. https://doi.org/10.1371/journal.pone.0213473

Doronicheva, E. V., Golovanova, L. V., Kostina, J. V., Legkov, S. A., Poplevko, G. N., Revina, E. I., Rusakova, O. Y., Doronichev, V. B. 2022. Functional Characterization of Mousterian Tools from the Caucasus Using Comprehensive Use-Wear and Residue Analysis. *Scientific Reports*, 12 (1), 17421.

Fiers, G., Halbrucker, É., De Kock, T., Vandendriessche, H., Crombé, P., Cnudde, V. 2021. Thermal Alteration of Flint: An Experimental Approach to Investigate the Effect on Material Properties. *Lithic Technology*, 46 (1), p. 27-44. https://doi.org/10.1080/01977261.2020.1805215

Kolosov, Yu. H., Stepanchuk, V. N. 2000. Crimean Assemblages with Bifacial Tools: Brief Review. *A la recherche de l'homme préhistorique Etudes et Recherches Archeologiques de l`Universite de Liege*, 95, p. 265-276.

Kozowyk, P. R. B. 2023. Archaeological *Podocarpus* tar supports the cognitive complexity of Neanderthals. *Proceedings of the National Academy of Sciences of the USA*, 120 (7), e2221676120. https://doi.org/10.1073/pnas.222167612

Mazza, P. P. A., Martini, F., Sala, B., Magi, M., Colombini, M. P., Giachi, G., Landucci, F., Lemorini, C., Modugno, F., Ribechini, E. 2006. A New Palaeolithic Discovery: Tar-Hafted Stone Tools in a European Mid — Pleistocene Bone-Bearing Bed. *Journal of Archaeological Science*, 33 (9), p. 1310-1318. https://doi.org/10.1016/j.jas.2006.01.006

Moore, M. W., Sutikna, T., Morwood, M. J., Brumm, A. 2009. Continuities in Stone Flaking Technology at Liang Bua, Flores, Indonesia. *Journal of Human Evolution*, 57 (5), p. 503-526. https://doi.org/10.1016/j.jhevol.2008.10.006

Niekus, M. J. T., Kozowyk, P. R., Langejans, G. H., Ngan-Tillard, D., van Keulen, H., van der Plicht, J., Cohen K. M., van Wingerden W., van Os B., Smit B. I., Amkreutz L. W. S. W.,Johansen L., Verbaas A., Dusseldorp, G. L. 2019. Middle Paleolithic Complex Technology and a Neandertal Tar-Backed Tool from the Dutch North Sea. *Proceedings of the National Academy of Sciences*, 116 (44), p. 22081-22087. https://doi.org/10.1073/pnas.190782811

Patterson, L. W. 1995. Thermal Damage of Chert. *Lithic Technology*, 20 (1), p. 72-80.

Purdy, B. A., Brooks, H. K. 1971. Thermal Alteration of Silica Minerals: An Archeological Approach. *Science*, 173 (3994), p. 322-325. https://doi.org/10.1126/science.173.3994.322

Reimer, P. J., Austin, W. E. N., Bard, E., Bayliss, A., Blackwell, P. G., Bronk Ramsey, C., Butzin, M., Cheng, H., Edwards, R. L., Friedrich, M., Grootes, P. M., Guilderson, T. P., Hajdas, I., Heaton, T. J., Hogg, A. G., Hughen, K. A., Kromer, B., Manning, S. W., Muscheler, R. et al. 2020. The IntCal20 Northern Hemisphere Radiocarbon Age Calibration Curve (0–55 Cal kBP). *Radiocarbon*, 62 (4), p. 725-757. https://doi.org/10.1017/RDC.2020.41

Ryzhov, S. M., Stepanchuk, V. N., Sapozhnikov, I. V. 2005. Raw Material Provenance in the Palaeolithic of Ukraine: State of Problem, Current Approaches and First Results. *Archeometriai Műhely*, 4, p. 17-25.

Ryzhov, S., Stepanchuk, V., Nezdolii, O., Vietrov, D. 2022. Analysis of Micro-Residues on Stone Tools from Zaskelna IX, Crimea: First Results. *Arheologia*, 1, p. 5-25. https://doi.org/10.15407/arheologia2022.01.005

Schmidt, P., Iovita, R., Charrié-Duhaut, A., Möller, G., Namen, A., Dutkiewicz, E. 2024. Ochre-based Compound Adhesives at the Mousterian Type-Site Document Complex Cognition and High Investment. *Science Advances*, 10 (8), eadl0822. https://doi.org/10.1126/sciadv.adl0822

Stepanchuk, V. N. 2022. Pebbles with Ochre Residues from Neanderthal Sites of Eastern Crimea. In: Cîrstina, O., Nițu, E.-C. (eds.). *A Life Dedicated to the Paleolithic: Studies in Honorem Marin Cârciumaru*. Târgovişte: Cetatea de scaun, p. 53-69.

Stepanchuk, V., Naumenko, O. 2022. A New Aspect of Post-Depositional Alterations of Lithic Artefacts: The Case of Medzhibozh Lower Palaeolithic Assemblages. *Materials and Studies on Archaeology of Sub-Carpathian and Volhynian Area*, 26, p. 11-31. https://doi.org/10.33402/mdapv.2022-26-11-31

Stepanchuk, V., Naumenko, O. 2024. Investigating the Post-Discard Alteration of Flint Artefacts at Medzhibozh 1 Lower Palaeolithic Site, Ukraine. *Journal of Archaeological Science: Reports*, 53, p. 283-303. https://doi.org/10.1016/j.jasrep.2024.104374

Thiébaut, C., Claud, É., Costamagno, S. (dir.) 2019. *L'acquisition et le traitement des matières végétales et animales par les néandertaliens: quelles modalités et quelles stratégies?* Palethnologie, 10. https://doi.org/10.4000/palethnologie.4070

Wadley, L., Hodgskiss, T., Grant, M. 2009. Implications for Complex Cognition from the Hafting of Tools with Compound Adhesives in the Middle Stone Age, South Africa. *Proceedings of the National Academy of Sciences of the United States of America*, 106 (24), p. 9590-9594. https://doi.org/10.1073/pnas.0900957106

Whittaker, J. C. 2015 Fire-and-Water Knapping: Origins of an Anthropological Folk Tale. *Lithic Technology*, 40 (1), p. 40-51. https://doi.org/10.1179/2051618514Y.0000000006

Yegorov, D., Marder, O., Khalaily, H., Milevski, I., Rosen, S. A. 2020. Heat Treated or Not Heat Treated: Archaeological and Experimental Interpretation of Flint Assemblage from the Middle Pre-Pottery Neolithic B Site of Yiftahel. *Journal of Archaeological Science: Reports*, 29, p. 102090. https://doi.org/10.1016/j.jasrep.2019.102090