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A NEW ASPECT OF POST-DEPOSITIONAL ALTERATIONS OF LITHIC ARTEFACTS: THE CASE OF MEDZHIBOZH LOWER PALAEOLITHIC ASSEMBLAGES

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Flint artefacts have been identified in the materials of the Lower Palaeolithic sites of Medzhibozh, which have experienced the effects of post-depositional alterations (PDA). We suggest a particular combination of anthropogenic and natural effects on lithic artefacts.

In the vicinity of Medzhibozh in the Khmelnytskyi region in the West of Ukraine, several multilayered stratified Lower Palaeolithic sites are currently known. Artefacts and accompanying fauna have been identified in subaerial buried soils, initial hydromorphic soils, and alluvial deposits. The ages of the artefact-bearing sediments are preliminarily estimated to be between 1.2 and 0.4 Ma. The lithic assemblages of all horizons contain technologically and typologically archaic artefacts, the industry being referred to as Mode 1.

Various types of rock were used as raw materials, including locally occurring flints in the form of pebbles and flattened nodules. Flint products from many assemblages are characterized by rounding and sheen due to their extended exposure to water-permeable horizons.

Most of the flint artefacts belonging to a particular assemblage are of a similar type of preservation. The assemblages also contain artefacts with surfaces of different states of preservation, suggesting that they are of different ages. These could either be products of reutilisation or natural alterations. However, more recent surfaces tend to be isolated and do not form a removals system. Moreover, most of the individual PDA pieces show a technological and morphological consistency of differently preserved surfaces, indicating that a force initiating detachment was applied simultaneously. We, therefore, consider artefacts showing a variate state of scar preservation to be PDA products.

We assume we are dealing with a new aspect of post-depositional alterations of lithic artefacts. Natural alteration had subjected artefacts, which received internal damage to the structure earlier when processed by man. The bipolar-on-anvil technique was actively used at Medzhibozh. Many artefacts show signs of multiple attempts of knapping, accompanied by a change in the position of the segmenting item. Such signs are impact pits, visible cracks, and Herzian cones disturbing the rock's texture.

We believe that the internal cracks that appeared in the area of the not detached spall contribute to the accelerated natural alteration of the item in this area and, ultimately, to the detachment of the flake. The probability of spalling depends on the intensity of the internal distress, the structure of the rock, the climatic conditions, and the post-depositional environment. The most responsible factor for the effect of the "time-delayed spalling" seems to be repeated cycles of temperature changes.

A comprehensive study of post-depositional modifications of lithic artefacts is essential in studies of Lower Palaeolithic sites, particularly the technological Mode 1 (Oldowan). This is due to the highly heterogeneous raw materials used, the bipolar-on-anvil knapping technique, and a long period of post-discard behaviour of artefacts.

Key words: Lower Palaeolithic, Medzhibozh, stone artefacts, post-depositional alterations, time-delayed spalling, taphonomy.

1. Introduction

From the moment of discarding, the lithic item begins to meet a process of post-depositional changes [Odell, 2004, p. 11–12; Andrefsky, 2005, p. 30]. The examination of various aspects of the post-depositional behaviour of lithic artefacts constitutes the focus of many studies [Flenniken & Haggarty, 1979; Keeley, 1980, p. 28–35; Gifford-Gonzalez et al., 1985; Levi Sala, 1986; Boot, 1987; van Gijn, 1989, p. 51–57; Shea & Klenck, 1993; Odell, 2004, p. 66–74, 138; Andrefsky, 2005, p. 83; Glauberman & Thorson, 2012; Venditti et al., 2016; Caux et al., 2018]. Research into the alteration of artefacts, inspired initially by the microwear studies [Tringham et al., 1974], is now further stimulated by the interest in objectively evaluating the parameters of so-called archaeological taphonomy (in terms of Bertran et al. [2017, p. 124]), i.e. exploring the measure of transformation of archaeological sites and remains of ancient human activities by the natural agents. Post-depositional surface modifications (PDSM) or post-depositional alteration (PDA) of lithic artefacts cover a variety of anthropogenic and natural processes resulting in changes in integrity and physical and chemical properties of artefacts. PDSM and PDA can result in alterations to the colour and surface structure of the pieces and deforming the original morphology and integrity of the lithic artefacts. For instance, sheen, edge damage, cracks, fractures, striations, plastic deformations, edge and ridge rounding, polished surfaces, pits and surface colour are mentioned by Burroni et al. [2002, p. 1278] and Asryan et al. [2014, p. 10] among the most common PDSMs.

We suppose that there are also post-depositional alterations of stone artefacts in the materials of Lower Palaeolithic sites near Medzhibozh. The Medzhibozh 1, Medzhibozh A, Holovchintsy 1 and 2 assemblages belong to technological Mode 1. An important diagnostic feature of Mode 1 assemblages is the use of the bipolar-on-anvil technique, which is accompanied by a significant number of pits, dents and cracks on the passive element, especially in conditions of intense knapping activity [van der Drift, 2012; Naumenko, 2021]. We suggest that some artefacts may demonstrate the effect of post-depositional damage along with fractures and the weakened planes inside the rock, which appeared as a result of the preceding knapping.

Due to frequent temperature changes or sediment pressure, such defects further can lead to natural post-depositional damages, which may possess all signs of anthropogenic modifications. This article aims to present such post-depositional damage on stone artefacts, mainly based on Lower Palaeolithic assemblages of the Medzhibozh 1 site.

2. Materials and methods

2.1. The general context of Medzhibozh sites

Several stratified Lower Palaeolithic sites are currently known in the vicinity of Medzhibozh in the Khmelnytskyi region [Stepanchuk, 2020; 2022]. Sites are usually multi-layered. Some include up to six distinct artefact-bearing layers. The ages of the sites are tentatively estimated at between 1.2 and 0.4 million years. The lithic industry of all horizons contains technologically and typologically archaic artefacts and is defined as Mode 1. Lithic artefacts and accompanying, sometimes numerous, bone remains have been identified at different stratigraphic levels and in different geomorphological contexts. Sediments that include the remains of the ancient occupations are not homogeneous and have a different genesis. Artefacts have been identified in subaerial soil deposits, initial hydromorphic soils, and alluvial deposits. In all cases, the hominin activity sites are associated with low areas located – at the time of accumulation – directly beside bodies of water characterised by the gentle flow. However, the varying geomorphological position and lithological features of artefact-bearing layers suggest a different post-accumulation history for different archaeological assemblages. Various types of rock were used as raw materials, including locally occurring flints in the form of pebbles and flattened nodules. All assemblages revealed at any Lower Palaeolithic site around Medzhibozh yield flint items.

2.2. The context of Medzhibozh 1 site

The multilayered Lower Palaeolithic site of Medzhibozh 1 locates near the eponymous town in Khmelnytskyi Region, western Ukraine. The first artefacts were discovered here in the mid-1990th by geologists and palaeontologists [Rekovets et al., 2007]. The archaeological investigations were carried out in 2008–2012 and 2018 [Stepanchuk et al., 2013; 2014]. In total, assemblages of Medzhibozh 1 contain 383 artefacts; there are two comparatively rich culture-bearing layers, dated to early Lubenian units and Zavadivian, i.e. MIS 15–13 and MIS 11, respectively [Matviishyna et al., 2013; Matviishyna and Karmazynenko, 2014]. The sediments containing artefacts of the uppermost layer III also include numerous fauna remains. Zoogeographically and zonally, the fauna of the Lichvinian time of Medzhibozh is attributed to the Singilian complex [Krokhmal' et al., 2021]. The available biostratigraphic data on large and medium-sized mammals [Stepanchuk & Moigne, 2016; Stefaniak et al., 2021], the micro-mammalian fauna [Rekovets, 2017] and ESR dates [Qi et al., 2018] ranging between 373–399 thousand years are in good agreement and unanimously support the version of the Holsteinian age of layer III. Bone splinters often demonstrate various anthropic transformations, such as intentional fragmentation, cut marks, chop marks, percussion marks [Stepanchuk & Moigne, 2016]. Some bones were exposed to high temperatures (over 700°C) consistent with fireplace evidence recognised at the level of layer III. The age and sex composition of animals is evidence of intentional, mainly deer hunting [Stepanchuk & Moigne, 2016]. Both assemblages utilise local raw materials, namely flint, quartz, granite, granitoids, limestone, quartzite, and other rocks of the Ukrainian crystalline shield. Industries are principally similar and demonstrate close typological and technological features.

They are characterised by the dominance of bipolar-on-anvil technique and archaic set of artefacts. These latter include rounded, sub-rounded, and angular fragments of various types of raw material, sometimes with likely wear. Besides, there are simple unifacial choppers and isolated retouched or trimmed flakes; the rest of the flakes generally have no intentional modifications. MIS 11 layer III show practically no signs of freehand knapping; there are no freehand cores and no indications for biface production [Stepanchuk et al., 2021]. The same technology and morphology features are characteristic for MIS 15–13 layer IV [Stepanchuk, 2022].

2.3. Methodology

Lithic artefacts from Lower Palaeolithic layers IV (MIS 15–13) and III (MIS 11) of the Medzhibozh 1 site were examined for post-depositional modifications. The focus was on macro-damage. The Digital Microscope Biwyily USB 500x was also used. Flint and quartz artefacts were predominantly studied, as they possess easier recognizable and identifiable signs of alterations and damages. The general patterns of occurrence, location and morphology of macro-damages that described in a number of works [Flenniken & Haggarty, 1979; Gifford Gonzalez et al., 1985; Boot, 1987; van Gijn, 1989; Odell, 2004; Venditti et al., 2016] were compared with situations observed on archaeological artefacts from Medzhibozh.

Various types of natural modifications were considered and analyzed in the study of the post-depositional macro-damage. We proceeded from the assumption that one of the critical attributes of post-depositional macro-modifications of lithic artefacts is the relative "freshness" of local scars and ridges, which contrasts with the general level of preservation of the item. In particular, we considered the presence of various types of patina, rounding, and weathering of the surface. Special attention was paid to signs of anthropogenic transformation, such as dents, pits, cracks, etc. Such signs are evidence of unproductive attempts to split the piece of rock. As we suggest, such damages could result in post-depositional fracturing under certain taphonomic circumstances.

3. Results

3.1. Taphonomy features of artefacts and artefact-bearing layers

3.1.1. Artefacts' taphonomy. There are two artefact-bearing Lower Palaeolithic layers in the Medzhibozh 1 profile, whose age correlates with MIS 15–13 (layer IV) and MIS 11 (layer III). Flint artefacts belonging to different assemblages differ in terms of the type of preservation. The type of preservation implies the type and degree of patina, the measure of roundness and the associated sheen (or so-called gloss patination) of the surfaces. The white patina is almost absent in flint artefacts. Only two of 219 flints show weak signs of a white patina. Flints with greenish and dark (rarely yellow and orange-brown) patina dominate the layer IV assemblage (fig. 1, *5, 7, 9*; fig. 5, *4*); the more recent layer III assemblage includes mainly unpatinated and less frequent lightly patinated items (fig. 1, *1–4, 10*). Flint products from artefact-bearing layer IV are characterised by roundness and intense sheen (fig. 1, *5–7*). To a considerably lesser extent, this feature applies to the younger assemblage.

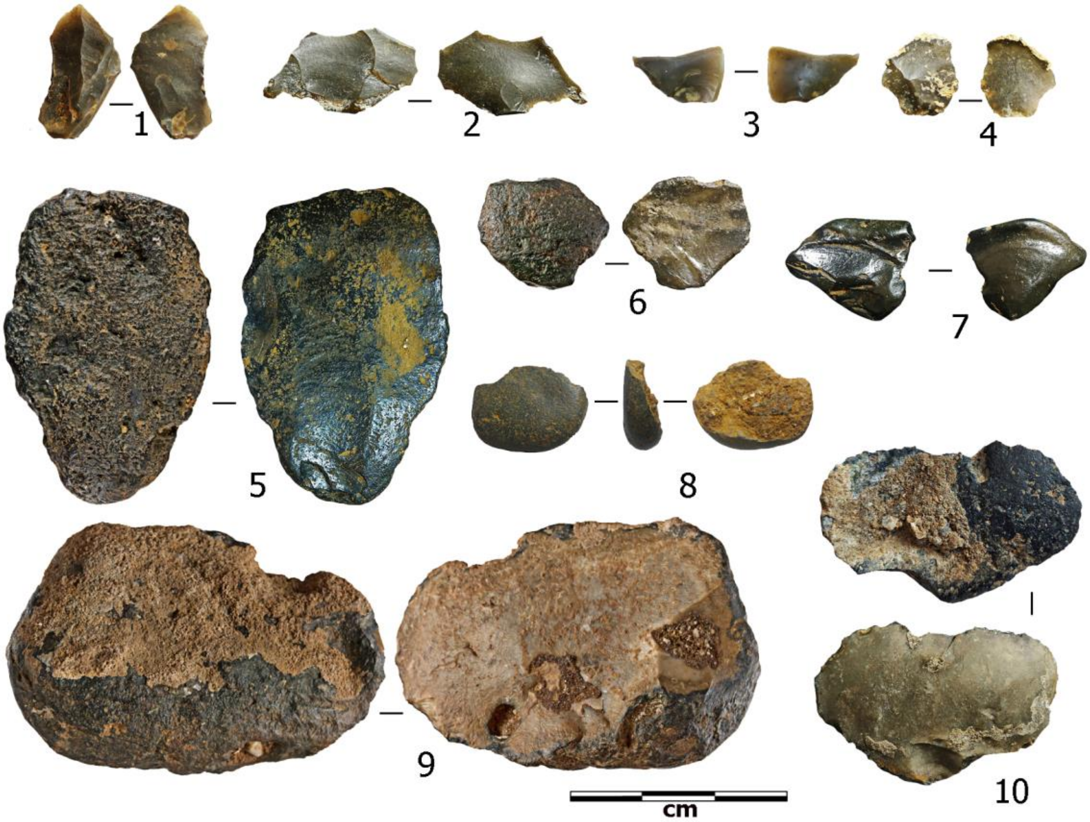

Fig. 1. Medzhibozh 1, artefact taphonomy features. Flint flakes from layer III (1–4, 10) and layer IV (5–9). Database IDs: *1* – MJ1/18/16a/156, *2* – MJ1/11/16a/35, *3* – MJ1/03/III/131, *4* – MJ1/08/III/33, *5* – MJ1/12/16b/17, *6* – MJ1/09/16b/25, *7* – MJ1/11/16b/72, *8* – MJ1/11/16b/112, *9* – MJ1/09/IV/23, *10* – MJ1/00/16/37

Рис. 1. Меджибіж 1, тафономічні особливості артефактів. Крем'яні відщепи з шару III (1–4, 10) та шару IV (5–9). Ідентифікатори у базі даних: *1* – MJ1/18/16a/156, *2* – MJ1/11/16a/35, *3* – MJ1/03/III/131, *4* – MJ1/08/III/33, *5* – MJ1/12/16b/17, *6* – MJ1/09/16b/25, *7* – MJ1/11/16b/72, *8* – MJ1/11/16b/112, *9* – MJ1/09/IV/23, *10* – MJ1/00/16/37

Both assemblages also contain flint artefacts with surfaces of different preservation, suggesting that they were not formed simultaneously (fig. 2, *1–3*; fig. 3, *2*). Most often, such artefacts have single breaks or scars with a less altered surface and ridges. The better preservation of surfaces and more sharp ridges ensure a well noticeable contrast with other scars present in the artefacts. The more preserved surfaces' alteration is not consistent and may vary from artefact to artefact.

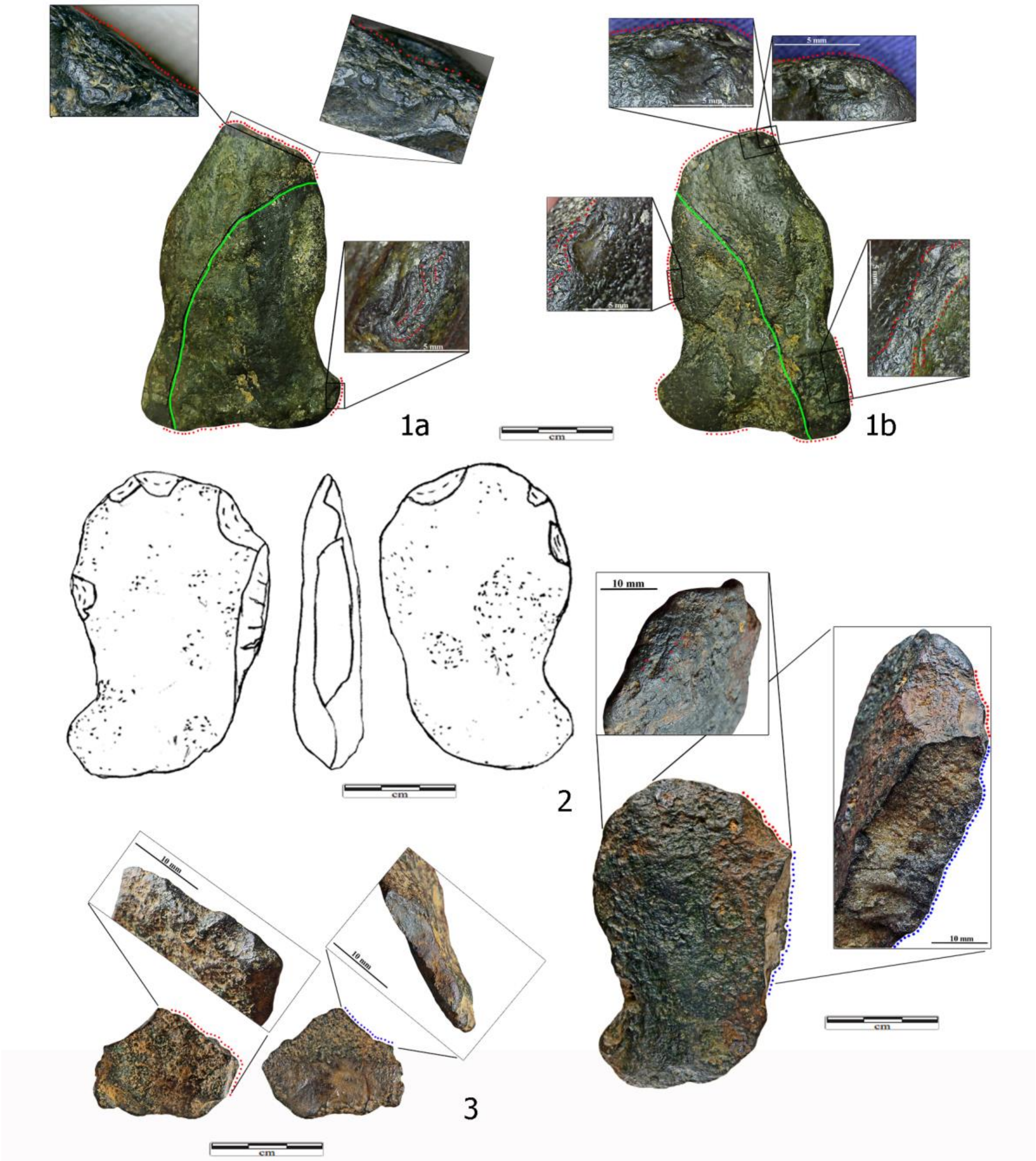

Fig. 2. Medzhibozh 1, artefacts with post-depositional alterations. Refitted flint pebble (1), chopper on flint pebble (2), flint flake with retouched and trimmed edges from layer IV (3). Numbers 1 and 2 demonstrate cracks and pits, and numbers 2 and 3 show scars of different states of preservation. Red dots point to artificial damage; blue dots point to post-depositional alterations; green line marks a border between joining fragments. Database IDs: *1* – MJ/1/09/16b/96, *2* – MJ1/09/16b/30, *3* – MJ1/00/IV/27

Рис. 2. Меджибіж 1, артефакти з постдепозиційними модифікаціями. Відновлена за допомогою ремонтажа крем'яна галька (1), чоппер на крем'яній гальці (2), крем'яний відщеп з ретушованими та відсіченими краями з шару IV (3). Номери 1 та 2 мають тріщини та вибоїни, а номери 2 та 3 демонструють негативи сколів різного стану збереження. Червоними крапками позначено пошкодження, що утворились під час обробки артефактів людиною, синіми – постдепозиційні модифікації; зеленими лініями вказано межі фрагментів артефактів, з'єднаних за допомогою ремонтажа. Ідентифікатори у базі даних: *1* – MJ/1/09/16b/96, *2* – MJ1/09/16b/30, *3* – MJ1/00/IV/27

However, less altered scars do not dissonate with the original product's overall technological and morphological context nor with the industry's appearance. «Recent» scars often do not overlap the «older» ones and do not form any removal system, mostly being isolated (fig. 2, *2, 3*). We emphasise that this inconsistency would be almost inevitable if we dealt with conventional reutilization. Reutilised artefacts are also present in Medzhibozh assemblages. For instance, the dorsal surface of flake MJ1/18/16a/133 [Stepanchuk et al., 2021, fig. 11, 7] exhibit scars typical for layer IV surface weathering, which are overlain by scars typical for layer III preservation type. The artefacts discussed in this paper, on the contrary, look as if their processing, which began at some point in time, was not completed until a considerable time interval later.

Hypothetically, the more recent preservation of some local areas on artefacts could be due to specific preservation conditions. Resistant sediment can protect an artefact or part of it from alteration. Thus, there are examples of undamaged small bird bones of exceptionally high preservation found within fragments of clay sediment (Medzhibozh A, layer VI) or stone artefact in the core of manganese concretion (Medzhibozh 1, layer III). Besides, many bones from layer III and isolated artefacts from layer IV were found inside consolidated pieces resembling sand breccia.

3.1.2. Artefact-bearing layers' taphonomy. The artefact-bearing layers of Medzhibozh 1 are mainly associated with Middle Pleistocene floodplain facies, alluvial, alluvial-meadow sediments, laminated loamy-sandy floodplain soils, and facially correspondent subaerial deposits. Worthy to note, that sediments of layer IV are very sparsely preserved and have likely been water-eroded in some areas. The intensity of the erosion of sediments containing finds of layer IV is probably linked to their low thickness, which is explained in terms of low sediment accumulation rates in the area during the Middle Pleistocene [Stepanchuk et al., 2021, p. 40–41]. A Middle Pleistocene pack is overlying basal Archean granites. A weathering crust provides fragments of various rocks that could supply raw materials for toolmaking. During the possible erosion of sediments of the lower part of the Middle Pleistocene sequence, the natural stone fragments may also have undergone alteration. Hypsometrically, many of the artefact-bearing horizons are currently also very close to the present-day river Southern Bug level. Both lithology and geomorphology predict a high probability of moisture saturation for artefact-bearing sediments. Under conditions of high sediment moisture, active processes of chemical alteration of the flint surface take place, resulting in rounded surfaces and ridges [Stapert, 1976; Burroni et al., 2002]. We see this in the Medzhibozh material. The so-called gloss patina or sheen is also associated with rounding artefacts. It has been reported that gloss patina results from prolonged exposure of artefacts to soil water solutions [Howard, 2002]. The degree of rounding depends on the duration of the process and the properties of the flint. The time factor can explain the differing appearance of the products from the different assemblages of Medzhibozh 1. The dark-coloured patina, specific to the items from the lower layer, is most likely due to the involvement of iron and manganese, which are saturated in the deposits, in the alteration process [Matviishyna & Karmazynenko, 2014].

In the artefact-bearing sediments, stone tools and bones, much more numerous in the younger layer, are deposited together. In the investigated areas, the remains are deposited evenly and sub-horizontally. Both larger and smaller remains of different types of material are represented in the joint occurrence. Documented cases of refitting of knapped flint pebble fragments have been remote by up to a few metres. However, the granulometric characteristics of the flint artefacts appear to be distorted, as the fine fraction is few, no more than 20 % of total lithics. There is also a tendency to micro-stratification of lithic artefacts and fauna in some areas; as it is noticed, larger and heavier finds occur here slightly lower than smaller and lighter pieces [Stepanchuk, 2014]. These features indicate a partial re-deposition of younger assemblage residues in alluvial sediments. Some bone fragments show abrasion scratches [Stepanchuk, 2012, fig. 5], probably caused by contact with hard and sharp object under the effect of water flow. The re-deposition process was not intensive and was initiated by a low-energy water flow. An aquatic environment with such indicators (lakeshore or dead arm of a river) is reconstructed by natural-science data [Kovalchuk & Rekovets, 2014; Dykan, 2014; Stefaniak et al., 2021] for alluvial deposits of Medzhibozh 1, containing the remains of layer III.

Thus, the probability of damage and fragmentation of artefacts as a result of exposure to high-energy water flow is low. The position of the finds on sub-horizontal surfaces precludes the possibility of mechanical damage during slope movements. The artefact-bearing sediments show no signs of cryoturbation, so there are no related damage factors either.

Fig. 3. Medzhibozh 1, flint pebbles with damage and post-depositional alterations from layer IV. Altered flint pebble presenting chopper-like artefact (2) and the context of its recovery (1); fractured flint pebble (3). Cracks are marked red. Database IDs: *1*, *2* – MJ1/11/16b/84, *3* – MJ1/11/IV/364
Рис. 3. Меджибіж 1, крем’яні гальки з пошкодженнями та постдепозиційними модифікаціями з шару IV. Модифікована крем’яна галька, у вигляді чоппероподібного знаряддя (2), контекст, у якому її було виявлено (1), тріснута крем’яна галька (3). Тріщини позначені червоним кольором. Ідентифікатори у базі даних: *1*, *2* – MJ1/11/16b/84, *3* – MJ1/11/IV/364

Accidental macro-fractures during excavation and further collection processing must also be eliminated. Single instances of damage to items were recorded immediately at the accident; besides, fresh surfaces are easily distinguishable due to the lack of fading colour and any signs of sheen. During the selectively or total sieving of artefact-bearing sediments, we have used plastic screens and running water, which eliminates any significant alterations.

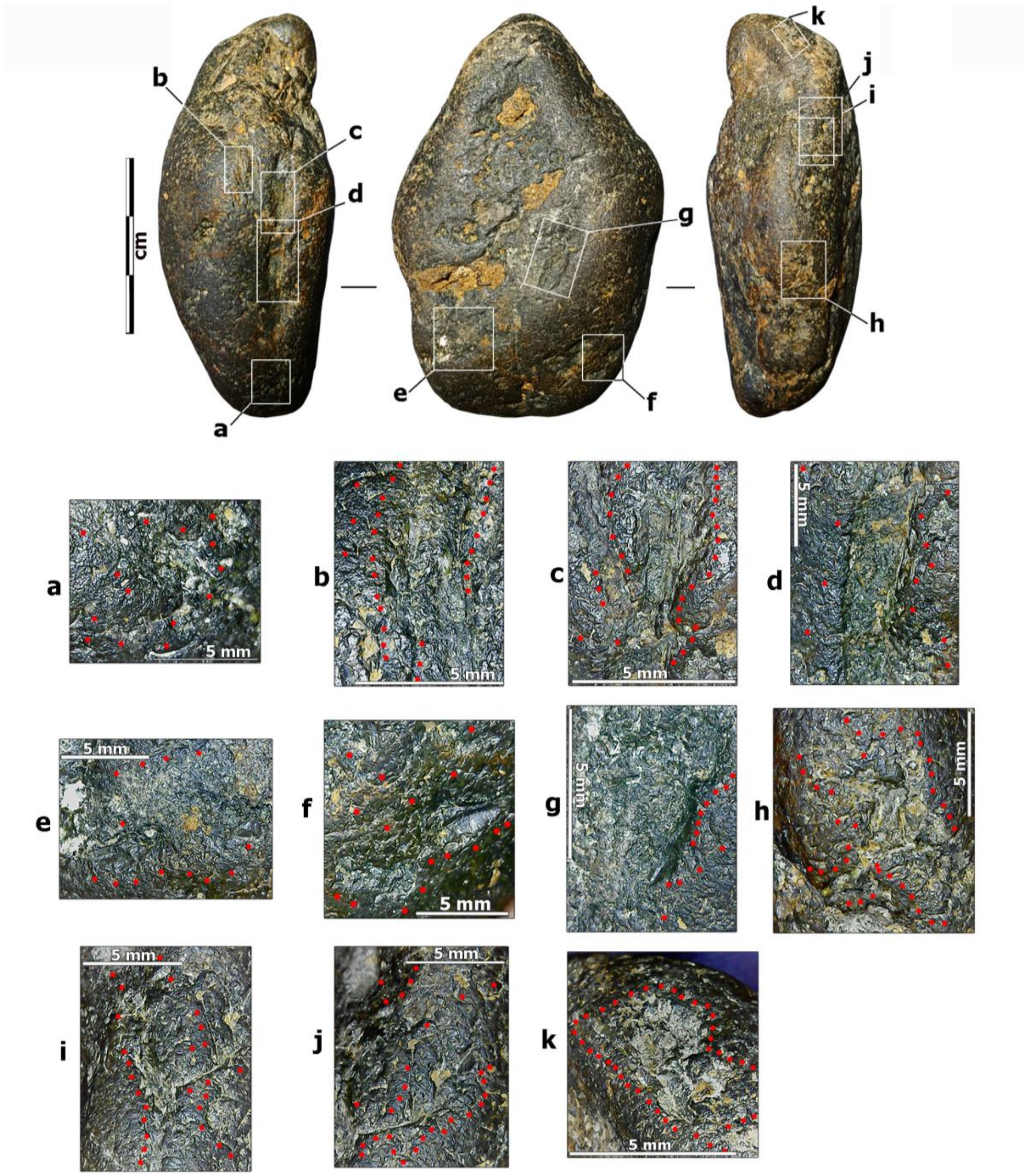

Fig. 4. Medzhibozh 1, flint pebble with numerous damages from layer III. Pits and cracks are marked red. Database ID: MJ1/09/16a/215

Рис. 4. Меджибіж 1, крем'яна галька з численними ушкодженнями з шару III. Вибоїни та тріщини позначені червоним кольором. Ідентифікатор у базі даних: MJ1/09/16a/215

However, natural causes of damage to lithic artefacts cannot be completely ruled out, and some of the fragments of fine flakes, micro-fractures, or scars along the edges could have been caused by them. However, massive fractures and large scars appear to be of a different nature.

3.2. Some instances of post-depositional alteration of lithic artefacts

181 (47%) lithic artefacts from the assemblage of Medzhibozh 1 have damage in the form of pits, dents, cracks, and fractures. There are 72 such items among the assemblage of layer III (43% of all layer artefacts) and 109 (51 %) among all knapped lithic objects of layer IV. In particular, 8.6 % (7.7% – layer III, 9.3% – layer IV) of the assemblage of Medzhibozh 1 are pebbles showing cracks. These damaged but complete pebbles demonstrate systems of pits and cracks along the edges and/ or over flat surfaces (fig. 3, *3*; fig. 4). These fractured pebbles are generally interpreted as evidence of ineffective hominin attempts of segmenting raw material pieces.

Damage of this type seems to cause some post-depositional alterations. Sometimes these alterations have markedly altered the lithic objects. For instance, one object found in soft sediments of layer IV is a pebble with a scar of definitely artificial origin, seemingly detached by an active element with a point-like working area (fig. 3, *1, 2*). The impact formed a chopper-like tool. However, the scar surface and, more importantly, the edges and ridges appear sharper than on other artefacts from this layer and, therefore, could be comparatively recent.

The other item is a two-element refit, and it is possible to restore it to its original appearance (fig. 2, *1*). Initially, it is blade-shaped according to [Zingg, 1935] flat-convex in profile flint pebble. It has several areas along the edges with a crushed cortical surface accompanied by cone-shaped cracks, dents, and diving fractures. In some areas, small scars on ribs form a pseudo-biface pattern. The artefact may have passed through several function roles and been used both as an active and a passive element in knapping. Internal damage to the integrity of the rock's structure caused a natural post-depositional alteration of the object. Despite the apparently natural cause of the disintegration into two large fragments, the inner surface of the fracture shows signs of anthropogenic modification. In particular, a flat bulb formed following precision impacts on limited contact area is observed. The joined interior surfaces of this refit only show a slight degree of weathering, and the edges of the joining fragments are too sharp.

Two other items, a flake and a pebble show a combination of scars with different degrees of preservation (fig. 2, *2, 3*). The bi-convex in profile and sub-oval in plan flint pebble exhibits a series of alternating and sometime pseudo-bifacial scars, produced mainly by bipolar-on-anvil and possibly freehand knapping (fig. 2, *2*). Formally the product is a chopper with a peripheral edge. The flat surfaces of pebble are also dented and cracked, resulting from attempts to segment the pebble in a horizontal mode. Probably associated with this operation is an area of post-depositional damage, which contrasts markedly with other parts of the artefact in terms of preservation but also displays signs of anthropogenic transformation.

The flint flake (fig. 2, *3*) has secondary processing scars on the right lateral and distal parts. The area of post-depositional damage is located on the distal part of the left lateral and forms a convergent edge with the contiguous modified right edge. The edges in the area of post-depositional alteration are excessively sharp against the roundness of the artefact. Nevertheless, the surface of the recent damage is already weathered, too. Made in proper time, an attempt of edge trimming was unsuccessful, which, however, led to the appearance of internal rock defects that further led to the observed flake fracture.

Both the more weathered and the lighter weathered, all scars are technologically similar and likely result from bipolar-on-anvil knapping. However, in scars with better-preserved surfaces, the force points are farther away from the edge when compared to those of poorer preservation. The existing edges of more recent scars are also sharper and less weathered.

Potlids and frost-pit-like damages represent a particular kind of post-depositional alterations in Medzhibozh sites. There is a good example of potlid in the materials of Medzhibozh 1 with some signs of further processing or use (fig. 5, *1*). Several artefacts also have likely frost-pits. It is noteworthy that this alteration is associated with areas of deliberate hominin segmentation of pebbles or flint fragments (fig. 5, *2–4*).

4. Discussion and conclusions

4.1. The nature and main features of post-depositional alterations

The nature of post-depositional changes of stone artefacts after their discarding depends both on the general taphonomic situation and environmental conditions [e.g. Bertran et al., 2019] and on the quality and parameters of the raw materials [e.g. Burroni et al., 2002] and the technique and intensity of the cleavage [Hovers, 2003, p. 155]. Post-depositional macro-damage of stone artefacts (in the form of retouching and fracturing) is characterised by dimension diversity, fragmentedness, random locations and, as a rule, small dimensions [Gifford-Gonzales et al., 1985]. Rather the exception in the archaeological literature is the claim that the appearance of angular fragments results from the natural processes of artefact destruction in deposits [Hovers, 2003]; this opinion is partly supported by the experimental data simulating sediment pressure [Eren et al., 2011]. Retouching scars and marginal fractures of thin sections of flakes are often recorded during trampling [Tringham et al., 1974; McBrearty et al., 1998; Vallin et al., 2001; de la Peña & Witelson, 2018] and displacement in gravelly sediments [Levi Sala, 1986]. So-called cryoturbation retouching [Stapert, 1976], resulting from soil pressure on the edges of flake products, has been reported. Marginal retouching and edge fractures appear on objects that have experienced forceful collisions in fluvial and marine gravels, in moraine deposits and under pressure by gravely and bouldery matrix [Petraglia & Potts, 1994; Manninen, 2007; Eren et al., 2011].

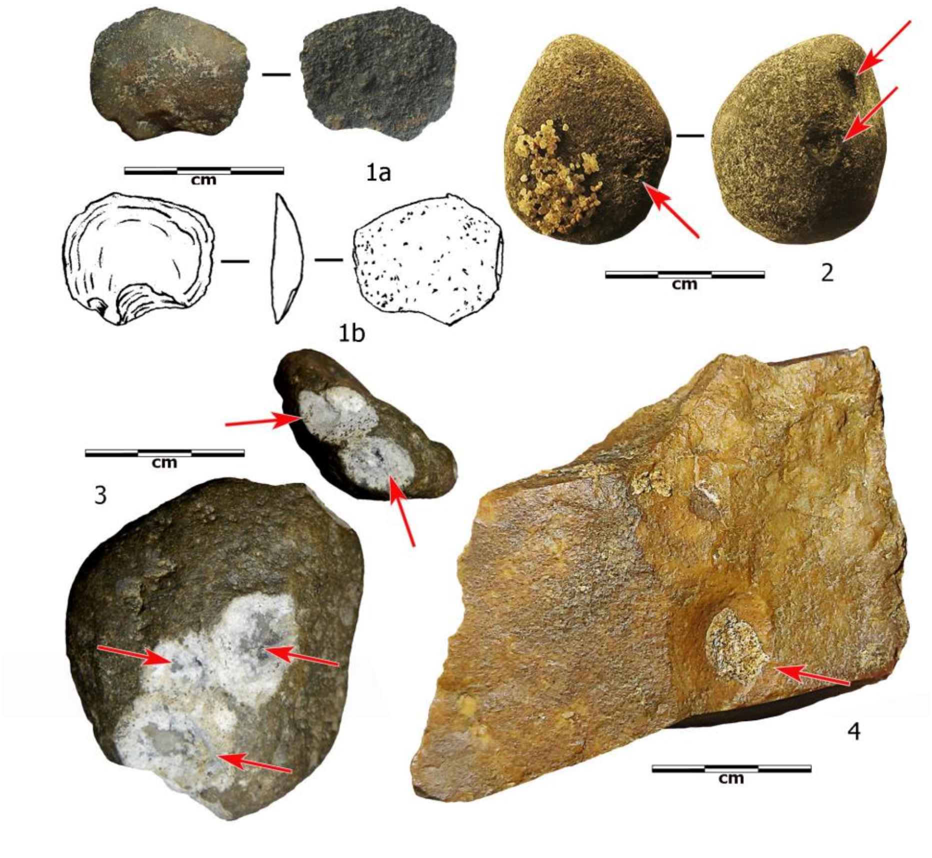

Fig. 5. Potlid (1) and artefacts with frost-pits (2–4) on flint (1, 3, 4) and quartzite (2) from Medzhibozh 1 layer III (1), Medzhibozh A layer V (2), Medzhibozh A layer VI (3), and Medzhibozh 1 layer IV (4). Arrows points to frost-pit-like damage. Database IDs: *1* – MJ1/11/III/22, *2* – MA/15/V/3A-3B, *3* – MA/16/VI/6A, *4* – MJ1/18/16b/307

Рис. 5. Морозобійний скол (1) та артефакти з морозобійними вибоїнами (2–4), виготовлені з кременю (1, 3, 4) та кварциту (2) з стоянок Меджибіж 1 шар III (1), Меджибіж А шар V (2), та Меджибіж 1 шар IV (4). Стрілками позначено місця морозобійних пошкоджень. Ідентифікатори у базі даних: *1* – MJ1/11/III/22, *2* – MA/15/V/3A-3B, *3* – MA/16/VI/6A, *4* – MJ1/18/16b/307

Post-depositional modifications of stone artefacts can significantly modify their initial appearance and influence the determination of the artefact status of the assemblage as a whole, the interpretation of the individual lithic item, and the characterisation of wear [Unger-Hamilton, 1984; Peacock, 1991; Bordes, 2002; Andrefsky, 2005, p. 197; Lenoble et al., 2008; Bertran et al., 2012; Asryan et al., 2014; Lemorini et al., 2014; Schoville et al., 2016; Michel et al., 2019]. Both Medzhibozh 1 assemblages contain artefacts possessing surfaces of different states of preservation, suggesting that they are of different ages. This kind of evidence may point either to reutilisation or natural alterations. However, no removals system is traced in detachments that left more recent surfaces, what could be expected in the case of reutilisation. Besides, more recent scars tend to be isolated. Notably, most individual pieces demonstrating post-depositional alterations show a technological and morphological consistency of differently preserved surfaces. This regularity indicates that a force initiating detachment was applied simultaneously. We, therefore, consider artefacts showing a variate state of scar preservation to be PDA products.

Which features should be considered natural modifications? The question is particularly critical in the case of Medzhibozh, as we are dealing here with relatively ancient assemblages. The antiquity of assemblages suggests a lengthy period during which artefacts, depending on the local conditions of their position, were influenced by natural modifying agents of various intensities and effects. This is fully applicable to Lower Palaeolithic sites [Hovers, 2003; Grosman et al., 2011; Garcia et al., 2013; Lemorini et al., 2014; Titton et al., 2021].

A variety of local raw materials were used in Medzhibozh and a bipolar-on-anvil technique was predominantly used for knapping [Naumenko, 2021; Stepanchuk et al., 2021]. As a result, many artefacts show no apparent signs of artificial splintering, in a sense usually understood by specialists studying more recent lithic assemblages [e.g. Wiśniewski et al., 2014]. When assessing the measure of artefactual or geofactual affiliation of Medzhibozh objects, one must also consider the factor of the probability of post-depositional modifications of lithics.

In our opinion, one of the key signs of the presence of post-depositional macro-modifications of stone artefacts in the Medzhibozh assemblages is a clearly localized relative "freshness" of scars and associated ridges, namely: different sharpness or degree of pitting, lustre, absence of patina, or its different type, etc. It is a common approach, as different degrees of weathering or patination on different scars are usually perceived as an indication of the different timing of occurrence and, therefore, a sign of natural forces [Peacock, 1991, p. 352].

The observed features of Medzhibozh flint items preservation, particularly their rounding and sheen, could result from water flow transport or long-term exposure to water-saturated soil. The low frequency of small flakes evidences the first version. However, most of the other observations testify against it. Stone artefacts from different rock types and faunal remains are deposited together. The spatial pattern of finds does not indicate intense movement by flow, although signals of secondary stratification in size and weight are present. The flint artefacts show no evidence of surface sand abrasion. Therefore, the version of the long-lasting stay of artefacts in water-saturated sediments seems preferable when explaining the type of surface preservation.

In explaining the causes of macro-fractures, the pressure and collision version of the sediment movement seems unlikely. Breakages are unlikely due to being in a high energy flow (of which there are no signs) or in a matrix saturated with gravel and debris, as the nature of the sediment observed at the site is different. The trampling version does not seem tenable in our case from the macro nature of the damage, which is inconsistent with the basic type of damage typical of trampling. Artefact-bearing sediments do not yield signs of cryoturbation, so concomitant damage factors (pressure, displacement, collision) are also unlikely. Assemblages contain no burned flints, though there is evidence of fire use [Dmytruk & Stepanchuk, 2017]. Therefore, the most likely cause of post-depositional macro-damage in Medzhibozh assemblages appears to be natural cyclic temperature changes.

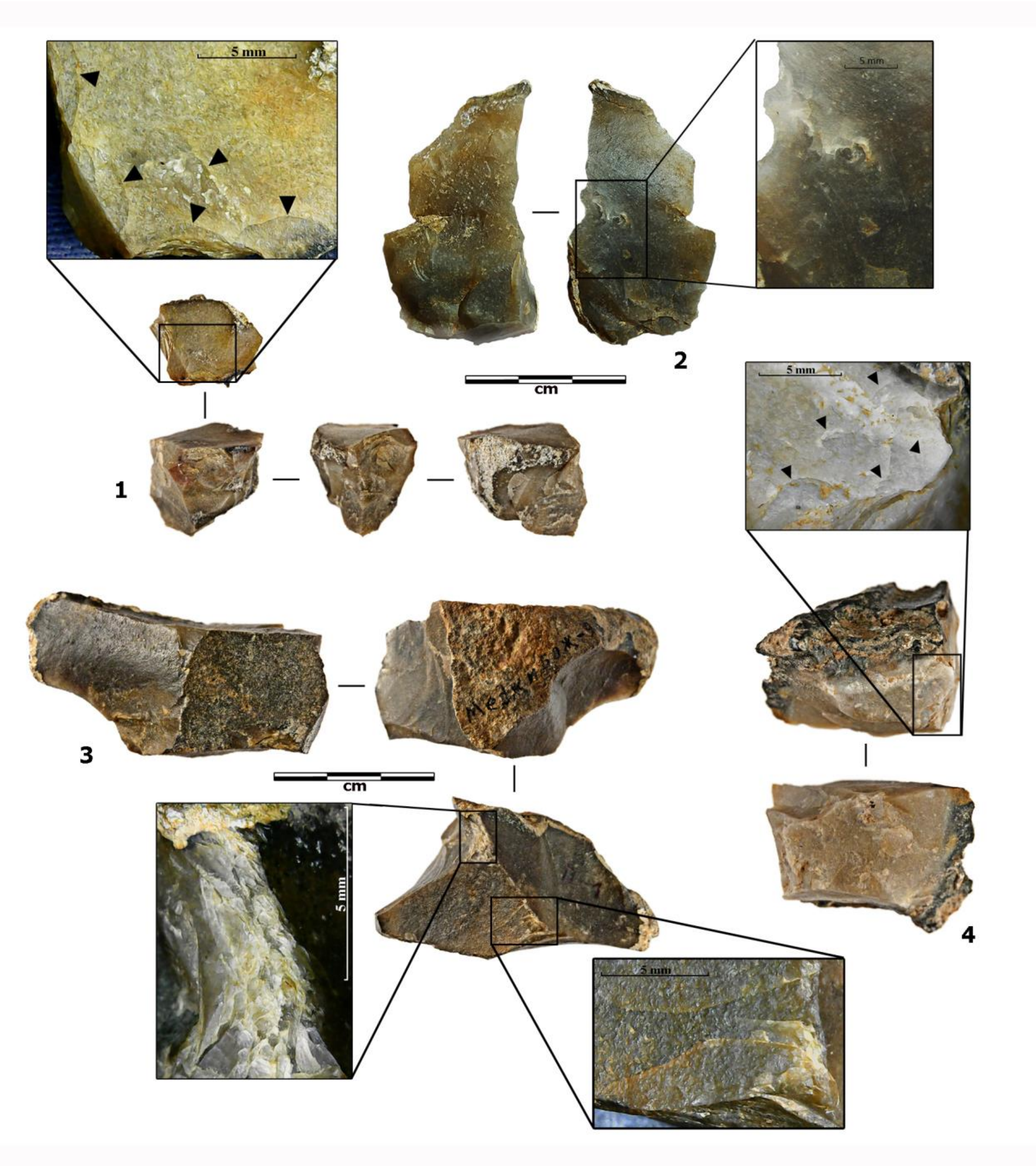

Fig. 6. Medzhibozh 1, flint artefacts, displaying damages to the internal integrity of rock (1–4). Cores (1, 3, 4) and flake (2) from layer III. Black arrows point to cones and cracks. Database IDs: *1* – MJ1/09/16a/50, *2* – MJ1/11/III/116, *3* – MJ1/96/III/60, *4* –MJ1/III/130

Рис. 6. Меджибіж 1, крем'яні артефакти, що демонструють сліди внутрішнього пошкодження сировини (1–4). Нуклеуси (1, 3, 4) та відщеп (2) з шару III. Чорні стрілки вказують на конуси та тріщини. Ідентифікатори у базі даних: *1* – MJ1/09/16a/50, *2* – MJ1/11/III/116, *3* – MJ1/96/III/60, *4* –MJ1/III/130

4.2. Thermal alterations and the time-delayed spalling effect

In nature, there are multiple processes of rock fracture due to expansion and contraction as a result of temperature changes [Hall, 1999]. Burroni et al. [2002, p. 1278] emphasise that thermal processes, like freezing-thawing, result in cracks, fractures, and pits. The frequent alternation of freezing and thawing, argues Stapert [1976, p. 14], leads to the formation of small cracks in the flint, along which splitting can occur.

Different rocks react differently to thermal processes. For instance, the heterogeneous texture of a stone ensures greater stability when heated [Homand-Etienne & Troalen, 1984]. Belonging to the same type of rock also does not guarantee that the alteration effects are identical. Thus, it has been reported that flints of different origins do not respond in the same way to heating [Bustos-Pérez & Baena Preysler, 2016, p. 79]. For surface rocks, a distinction is made between «insolation weathering» caused by thermal stress and repeated thermal expansion and contraction, and «thermal shock» [Shtober-Zisu et al., 2015].

The principle of insolation weathering is similar to exposure to freeze-thaw cycles in terms of repeatability. The frequency of the latter depends on many factors, even the orientation of the site; on the southern slope, there are more such cycles over the same period [Masson et al., 2014, p. 248]. The patterns of destruction of carbonate rocks by thermal shock during wildfire also depend on the type of rock and its exposition. In the context of a study of intentional heating processes during tool production, many experimental observations have emerged which describe the different responses of flint of different origins to the same thermal process conditions heating [Bustos-Pérez & Baena Preysler, 2016].

The spalled product of stone fracture caused by the thermal stress fatigue process has a distinctive morphology (fig. 5, *1*). As Barnes [1939, p. 106] emphases, temperature changes may result in the appearance of circular or elliptical flakes, known as «pot lids», leaving on the block corresponding hollows or pits known as «frost pits». Similar lenticular-shaped rock flakes have been described by Stober-Zuis et al. [2015], who observed accelerated thermal effects of wildfire on carbonate rocks. Potlids are necessarily present among the fracturing elements of experimentally heated flint products [Bustos-Pérez & Preysler, 2016]. Therefore, it can be assumed that the morphology of thermal alteration products is independent of the intensity of the thermal influence. However, the intensity of the thermal shock does, of course, affect the rate at which the stone breaks down.

It can be assumed that the thermal process alterations are intensified if there are already cracks or damage in the rock. Assemblages of Medzhibozh belong to Mode 1 industries with active use of the bipolar-on-anvil technique. A large number of artefacts have pits, dents and cracks (fig. 2, *1*; fig. 3, *3*; fig. 4). The observed abundance of damage is due to the technique used, the small size of the pebble flint and quartz raw material, and the technological intention for crushing to small fragments (fig. 6, *1–4*). Damage occurs on the object to be knapped (the so-called passive element) due to the intensive counterpressure [van der Drift, 2012; Naumenko, 2021]. The effectiveness of any type of intentional knapping is ensured by the formation of a crack, which propagation leads to the detachment of a flake (fig. 7, *1*). A relatively thin flake is results under a combination of bending and compressive forces [Cotterell & Kamminga, 1987]. These authors also state that in bipolar knapping the crack in the processed material is characterised by the most stable propagation (fig. 7, *4*). Under compressive stresses, cracks are completely stable and grow only as the load is increased [Cotterell & Kamminga [1987] (fig. 7, *3, c*; 3, *f; 4, d*). This means that the physical dimensions of the crack: length, depth, and width, depend only on the impact force. A force insufficient to split will nevertheless damage the integrity of the rock that has been subjected to the load. It should also be taken into account that any load in bipolar knapping (as in any other type of knapping) leads to internal gradually damped breaks in the monolithic texture of the item being worked (fig. 7, *2, b*). Medzhibozh assemblages contain numerous instances of such damages (fig. 6, *1–4*).

Freeze-thaw cycles can re-activate the crack propagation process in an item that has already lost structural integrity. Such a process in crack-containing artefacts of Mezhibozh could result in post-depositional macro-damage. In this case, a crack naturally propagates along the planes that weaken the rock's integrity at hominin processing. The thermal stress fatigue process detaches a flake, whose shape and location are already largely man-determined and are, therefore, in perfect agreement with the morphological and technological appearance of the artefact. In this way, the mechanism of the post-depositional effect of time-delayed removal, initiated by the ancient toolmaker and terminated by natural alteration, can be described.

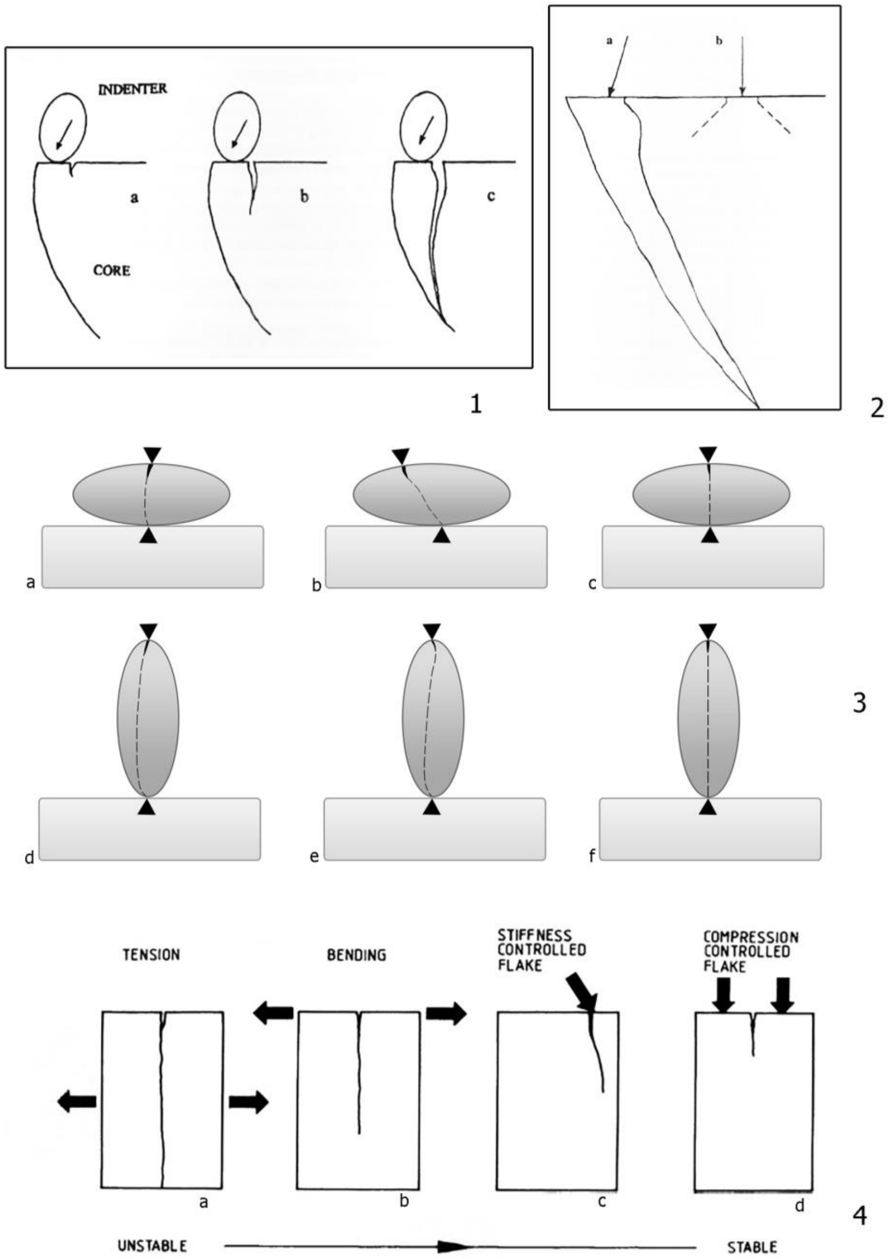

Fig. 7. Some basic features of a flake detachment process. 1. Scheme of crack propagation: initiation (a), propagation (b), termination (c) after Odell [2004, fig. 3.1]. 2. Flake detachment through Herzian fracture near the edge of core (a) and far from the edge (b), after Odell [2004, fig. 3.7]. 3. Scheme of some variations of bipolar-on-anvil knapping, a–f, after van der Drift [2009, fig. 5]. 4. The stability of crack propagation is higher in the case of bipolar knapping (d) after Cotterell & Kamminga [1987, fig. 16]

Рис. 7. Деякі важливі характеристики процесу відокремлення сколу. 1. Схема поширення площини розщеплення: початок (a), поширення (b), завершення (c) [за Odell, 2004, fig. 3.1]. 2. Конус Герца при розщепленні по краю нуклеуса (a) та на віддалі від краю (b) [за Odell 2004, fig. 3.7]. 3. Схема окремих варіантів техніки біполярного розщеплення на ковадлі, a–f [за van der Drift 2009, fig. 5]. 4. Стабільність поширення площини розщеплення вища у випадку застосування біполярної техніки (d) [за Cotterell & Kamminga 1987, fig. 16]

4.3. Some further instances of time-delayed removals

Examples of post-depositional alterations of artefacts with multiple instabilities of the internal structure obtained during processing and use phases are not limited to Medzhibozh 1. They have also been found in other Lower Palaeolithic sites near Medzhibozh. Of special interest are items with scars and surfaces of varying preservation and alterations resembling frost-pits.

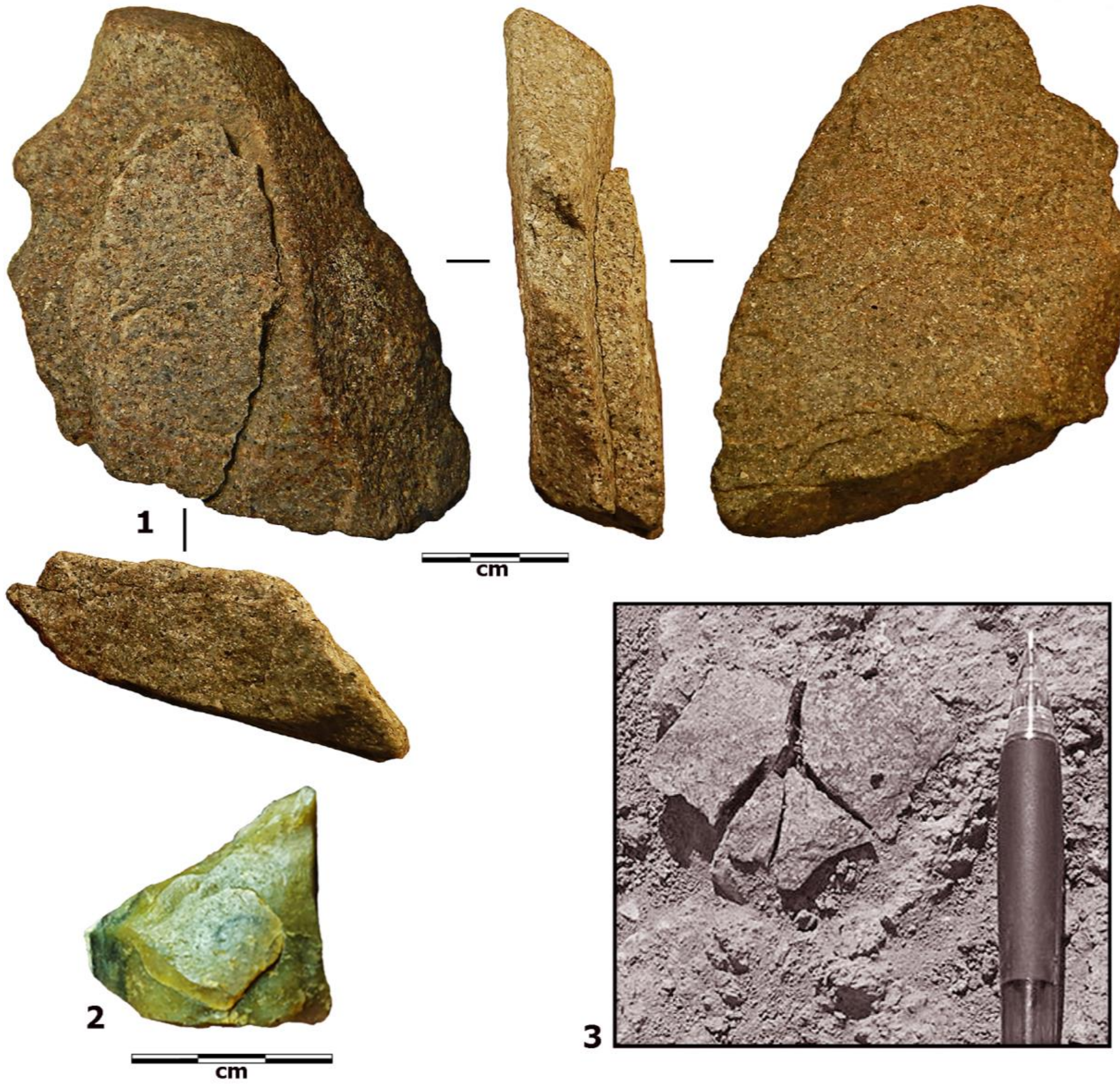

Fig. 8. Lithic artefacts, showing signs of time-delayed spalling. 1. A large basalt flake with another, partially altered, not completely spalled, flake on its dorsal surface, Crimea, courtesy A. Chepalyga; 2. A flint flake with another, partially spalled, flake on its ventral surface, Medzhibozh 1, layer III; 3. A cracked flake from locality A.L. 894 (Hadar, Ethiopia), after Hovers [2003, fig. 2]

Рис. 8. Вироби з каменю з ознаками відкладеного у часі розколювання. 1. Великий базальтовий відщеп з ще одним частково модифікованим, не повністю відокремленим, сколом на дорсальній поверхні, Крим, надано А. Чепалигою; 2. Крем’яний відщеп з іншим, частково відокремленим сколом на вентральній поверхні, Меджибіж 1, шар III; 3. Розтрісканий відщеп із місцезнаходження A.L. 894 (Хадар, Ефіопія) [за Hovers 2003, fig. 2]

We assume that potlids and frost pits in the context of Mode 1 industries may also represent a variant of post-depositional alteration of artefacts that have experienced an anthropogenic impact but were later modified by a thermal factor. They have yet to be recorded and studied. In remote areas and sites, there are also instances of the post-depositional effect of time-delayed removal(s). A remarkable case of time-delayed removal has been identified in the Crimea in assemblage collected in Middle Pleistocene sediments of Black sea terrace V (fig. 8, *1*). A large basalt flake on its dorsal surface has survived remnants of another, not completely spalled, flake. The unproductive impact had likely formed weakness zones in the rock structure. Subsequent alteration has led to partial spalling of marginal areas of the flake, which still remains incompletely spalled. Principally the same case is reported for Medzhibozh, although in this case, the basal part of the not-detached flake has spalled (fig. 8, *2*).

A probable case of time-delayed destruction is presented by an item published by Hovers [2003] (fig. 8, *3*). The author describes it as an object that a natural factor has destroyed. This explanation can be accepted with a remark that a natural factor may have affected the lithic artefact through weaknesses in the rock's integrity. The interposition and configuration of the fragments suggest a point impact of force on the surface of the artefact, possibly obtained during an attempt to process the object by man. Something similar can be observed on a flake from Medzhibozh 1 layer III (fig. 6, *2*). Several attempts to fragment this flake were unsuccessful, but cones and diagonal cracks affected the rock's internal integrity. Therefore, it must be assumed that the factor resulting in the occurrence of not fully detached flakes was not limited to the parameters of a single artefact-bearing layer, a single site or a local area. The cyclic temperature changes seem to be the most likely and broadly acted factor.

4.4. Concluding remarks

Concluding, we claim that in the case of the Lower Palaeolithic industries of Medzhibozh, we are dealing with post-depositional alterations (PDA) of lithic artefacts. We consider it a peculiar combination of anthropogenic and natural effects. Post-depositional alterations have affected artefacts, which previously, while still in the process of hominin processing, have experienced internal structure damage. The internal cracks formed in the impact zone of the non-detached flake later, after some indefinite (presumably long) time, contributed to the accelerated alteration of the object in this area and, eventually, to the final detachment of a flake. We assume the temperature effect to be the main factor in the stage of natural alteration. The effect of the «time-delayed spalling» or combined human-and-nature alteration effects needs additional study. Further work is required to revise existing assemblages and conduct experimental work to simulate the conditions under which «time-delayed spalling» occurs.

Author's contribution

VS: conceptualization; methodology; investigation; writing original draft; visualization; writing review & editing. ON: formal analysis; methodology; investigation; data curation; visualization; writing original draft.

Declaration of Conflict of Interest

The authors have declared that no competing interests exist.

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НОВИЙ АСПЕКТ ПОСТДЕПОЗИЦІЙНИХ МОДИФІКАЦІЙ КАМ'ЯНИХ АРТЕФАКТІВ: ЗА МАТЕРІАЛАМИ НИЖНЬОПАЛЕОЛІТИЧНИХ КОЛЕКЦІЙ МЕДЖИБОЖА

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У матеріалах нижньопалеолітичних стоянок Меджибожа виявлено крем'яні артефакти, що зазнали впливу постдепозиційних модифікацій (ПДМ). Висунуто припущення, що маємо справу зі своєрідною комбінацією антропогенного та природного впливу на кам'яні артефакти.

Зазначено, що в околицях смт Меджибіж (Хмельницька обл.) наразі відомо кілька багатошарових стратифікованих пам'яток нижнього палеоліту. Артефакти й палеонтологічні рештки виявлено в субаеральних ґрунтових відкладах, ініціальних гідроморфних ґрунтах, а також в алювіальних седиментах. Загалом вік стоянок попередньо визначено між 1,2 і 0,4 млн років. Констатовано, що кам'яні колекції всіх без винятку горизонтів містять вироби архаїчного вигляду, індустрія належить до технологічної моделі 1 (олдовану).

Встановлено, що як сировину використовували різні породи каменю, зокрема кремінь місцевого походження у формі гальок і сплощених необкатаних фрагментів. Визначено, що частина крем'яних виробів характеризується обкатаністю та блиском, що спричинено їхнім тривалим перебування у горизонтах, насичених водою, а також корodованістю поверхонь сколів.

Зазначено, що здебільша крем'яні артефакти III і IV шарів мають подібний рівень збереженості, у колекції також наявні артефакти з поверхнями з різним типом збереженості, що передбачає їхню різночасність. За нашими підрахунками встановлено, що частина артефактів, яка демонструє багатоваріантну збереженість негативів, належить до продуктів постдепозиційних модифікацій. Стверджено, що більшість окремих ПДМ продуктів демонструє технологічну й морфологічну узгодженість поверхонь різної збереженості, що свідчить на користь одночасності отримання імпульсів сили.

Висунуто припущення, що маємо справу з новим різновидом постдепозиційних модифікацій кам'яних об'єктів. Встановлено, що змін зазнали артефакти, внутрішня структура яких була пошкоджена під час обробки людиною; у Меджибожі активно застосовувалася біполярна техніка на ковадлі; багато артефактів мають ознаки численних спроб розколювання, що супроводжуються зміною положення сегментованого предмета. Відзначено, що на предметах такі характеристики набувають форми просадок, зовнішніх тріщин, внутрішніх конусів (напівкільцевих тріщин). Вірогідно, внутрішні тріщини, які утворилися в зоні удару несколених відщепів, надалі сприяли пришвидшеному видозмінюванню предмета на цій ділянці і, зрештою, відриву сколу. Зауважено, що поява такого типу ПДМ залежить від багатьох умов: інтенсивності порушень внутрішньої цілісності, структури породи, кліматичних умов, постдепозиційних обставин. Найімовірнішим визнано кліматично зумовлений чинник множинних циклів зміни температурного режиму.

Всебічне вивчення постдепозиційних модифікацій набуває особливого значення під час досліджень нижньопалеолітичних стоянок, зокрема технологічної моделі 1 (олдовану), що зумовлено специфікою використання різнорідних видів сировини й архаїчних технік розколювання, а також тривалим періодом, протягом якого матеріал залишався похованим.

Ключові слова: нижній палеоліт, Меджибіж, кам'яні артефакти, постдепозиційні модифікації, відкладене в часі розколювання, тафономія.