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A Microhistory of a Prehistoric Copper Artefact at the Foothills of the Eastern Carpathians

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Abstract. *In which mention is made of an earlier investigation conducted along the Nechit stream valley, in the commune of Borlești, Neamț County, a contemporary field survey, and the necessity of providing a coherent narrative. The research team developed a theoretical and methodological framework, formulated a set of objectives, and adopted a cumulative approach—evaluating sources, understanding the working area, descriptive elements, typology and functionality, and the comparative method. All of this serves to reconstruct the varied history of a Pickelhacke, the principal actor in the reconsideration of terminology and in the inquiries concerning the function of an artefact discovered at the foothills of the Eastern Carpathians.*
Rezumat. *În care se vorbește despre o cercetare mai veche pe valea pârâului Nechit, în comuna Borlești, județul Neamț, o investigație de teren actuală și despre necesitatea unei narațiuni. Echipa de cercetare a realizat un cadru teoretic și metodologic, a stabilit o serie de obiective și a adoptat o abordare cumulativă – evaluarea surselor, cunoașterea spațiului de lucru, descrierea elementelor, analiza tipologică și funcțională, precum și metoda comparativă. Toate acestea pentru a construi istoria diversă a unui Pickelhacke, actorul principal al recompunerii unei terminologii și al întrebărilor privind destinația unui artefact descoperit la poalele Carpaților răsăriteni.*
Keywords: Eastern Carpathians, Nechit watershed, Cucuteni settlement, *Pickelhacke*.

The history of Eneolithic research east of the Carpathians is known by a long and gradual evolution, characterised by the accumulation of significant certainties concerning the nature of the inhabited landscape and the communication networks employed by prehistoric communities. Over more than a century, this research has generated a substantial body of data on the archaeological materiality of the region, alongside bold attempts to decipher intangible aspects such as social structure and the spiritual practices of the period's inhabitants.

Despite the progress achieved over time, minor or incidental archaeological discoveries continue to play an essential role in refining and complementing both the quantitative and qualitative dimensions of the area's ancient history. Such contributions, at times seemingly modest, can nonetheless provide important clarifications or open new avenues of interpretation regarding the development of Eneolithic communities.

The present endeavour focuses on bringing to light an area that has been comparatively less explored from an archaeological perspective, namely the western extremity of the Cracău–Bistrița depression. Research has concentrated on an important connecting route that begins in the Nechit–Borlești saddle and leads towards the Tazlău River valley, Borlești commune, Neamț County (Fig. 1). This hydrographic basin serves as a link southward to the Tazlău–Cașin/Onești depression, as well as westward and northwestward towards the Trotuș River basin and, beyond it, to eastern Transylvania. Through this approach, the aim is not only to update the archaeological map of the area but also to integrate the newly acquired data into

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the broader context of communication networks and mobility patterns of Eneolithic populations in the eastern Carpathian region.

Research Objectives

The primary aim of this study is to enhance our understanding of the Cracău–Bistrița Depression from the perspective of prehistoric periods. This overarching goal reflects the need to integrate new data and interpretations in order to better comprehend the dynamics of habitation and communication within this region, located at the western fringe of the East Carpathian area.

From this central objective derives a secondary one, prompted by the chance discovery of a metal object during a surface survey. This circumstance necessitated a series of analytical steps, defined as the specific objectives of the research endeavour:

• **Presentation of the theoretical and methodological framework:** This involves outlining the foundations that facilitate an understanding of the object's history, its discovery location, and the prehistoric communication networks of the region.

• **Identification and definition of the sources used:** This step provides the basis for evaluating existing knowledge concerning local archaeological research, grounding the analysis in relevant works and resources.

• **Definition of the study area:** The thorough delineation of the geographical setting has enabled the identification of environmental and topographical features that would have favoured human settlement within this territory, thereby furnishing a comprehensive contextual framework essential for the informed interpretation of the archaeological findings.

• **Description of the artefact and typological and functional analysis:** These stages aim to enhance chronological precision by contextualising the artefact with regard to its morphological characteristics, functional attributes, and the cultural-historical period to which it can be securely assigned.

• **Multidisciplinary analysis:** By approaching the artefact from multiple perspectives, this objective aims to enrich and distinguish its physical, functional, and compositional characteristics.

• **Cumulative analysis:** This synthesis supports the reconstruction of the artefact's history, thereby enabling a more nuanced reconstruction of the life of Eneolithic communities "in the shadow of the mountains", within the broader framework of supra-regional interactions.

The research objectives, as outlined in this study, reflect an integrated approach that seeks both to broaden knowledge of archaeologically underexplored areas and to deepen the analysis of chance discoveries made in the field. Emphasis is placed on correlating archaeological information with prehistoric communication networks, thereby providing a broader interpretive framework for understanding the mobility and interactions of Eneolithic communities in the East Carpathian region.

By addressing these objectives, the study aims to contribute significantly to our understanding of how archaeological discoveries, even fortuitous ones, can enrich and refine the narrative of prehistoric life in the western sector of the Cracău–Bistrița Depression.

Methodology

The theoretical approach to a singular discovery, such as the one examined in this study, falls within the cultural-historical paradigm. The primary aim of this perspective is to construct an understanding of the artefact as a representative element of a specific Eneolithic community, based on the material and contextual characteristics of the piece.

The methodological framework is grounded in the integration of data concerning both the local and regional context. Relevant information about the landscape in which the object was found is therefore considered, alongside descriptive data that enable its individualisation in relation to the discovery site. Technological details, together with established typological and functional interpretations, are essential for the proper classification of the artefact.

From an analytical standpoint, the investigation involves a sequence of complementary methods: macroscopic analysis, microscopic examination, and chemical analysis. Each of these stages contributes to the scientific rigour of the study, supporting the conclusions and reinforcing the narrative constructed around the discovery.

The presence of copper artefacts of this category is recorded in relatively small numbers east of the Carpathians[3], most discoveries being serendipitous. This situation highlights the particularity of the region, where such objects are not frequently encountered and their recovery often depends on chance rather than on systematic archaeological investigations.

The publication of archaeological objects discovered accidentally offers several significant benefits for the advancement of research in this field. On the one hand, it contributes substantially to clarifying the morphology and functionality of the artefacts, thereby enabling a deeper understanding of the typology of copper items recovered in the region. On the other hand, publishing such artefacts enriches the archaeological database for the area under study, providing additional reference points for the interpretation, contextualisation, and integration of these finds within the broader framework of Eneolithic communities east of the Carpathians.

The study commenced with a critical appraisal of the current body of published archaeological discoveries. For this purpose, both synthesis works and primary sources addressing individual artefacts were consulted. The progressive approach initially involved the examination of available archaeological data for the Cracău-Bistrița Depression, subsequently extending the investigation to neighbouring areas, both at the national level and within Central and Southeastern Europe. The results of these efforts were synthesised through the creation of a map illustrating the spatial distribution of the discoveries.

The presentation of the discovery context aims to situate the object within an already investigated archaeological framework. Although the artefact was discovered by chance, during a field survey, efforts were made to establish a possible direct connection between the artefact and its findspot, as well as to associate it with other Eneolithic artefact remains reported in the area. Thus, the object was analysed from both spatial and temporal perspectives in order to achieve the most precise contextualisation possible.

For the description of the artefact, terminology and criteria established in the literature were employed, including the *Prähistorische Bronzefunde* series, considering the most recent typological classifications and subdivisions. Based on existing typological analyses, the research process involved refining the characteristics of the artefact and details regarding its use, with the objective of integrating the piece into established typological classifications and the relative chronology of the period.

Sources and digital resources consulted

To facilitate dialogue and to enhance the readability of the working area, various cartographic sources were employed, including Google Earth and *Moldawischen Districten* (1788–

[3] MONAH 1969, 299-300.

1790) – First Military Survey[4]. In addition, the QGIS application was used for the visualisation and analysis of spatial data, alongside aerial photographs capturing different categories of current topographic markers. These resources proved useful for accurately situating the discovery and for correlating it with similar finds. Such tools also aid in linking the narrative elements that remain otherwise unresolved. These data were complemented by a summary presentation of an archaeological investigation conducted at the findspot, concise information regarding the archaeological material, and our observations concerning the discovered artefact.

The Nechit River basin, a tributary of the Bistrița River, provided favourable conditions for settlement in ancient periods (water sources, woodland, and accessible terrain with moderate slopes), as evidenced by the evaluation of the relevant literature[5] and our own field observations (Fig. 2).

The archaeological site at *Capul Dealului/La Verdeș*[6] was identified and preliminarily investigated by Ștefan Cucoș[7]. In 1976 an intrusive archaeological investigation was conducted, consisting of the excavation of a 20×2 m trench and a 4.75×2 m test pit, both orientated transversely to the settlement[8]. Following these preliminary investigations, the remains of a dwelling constructed directly on the ground were uncovered (Fig. 3). The archaeological research revealed the existence of a single occupation level, attributed to the Cucuteni B1 phase, featuring pottery of the ε style and possibly ρ, as well as "isolated" ceramic fragments assigned to the Cucuteni A phase[9]. Additionally, on the high terrace of *Dealul Mare*, to the south, fragments of Dacian pottery were also identified[10].

From the field survey, we were able to identify materials that can be attributed to the aforementioned Eneolithic culture (Fig. 3). The archaeological material present on the surface is sporadic and fragmentary, having been displaced by agricultural machinery. Most of the recovered objects consist of ceramic fragments and daub remains; however, in smaller quantities, a few stone tools were also identified, including a grinder.

Study area

This discovery brings renewed attention to an area already acknowledged in the archaeological literature[11], albeit addressed only tangentially. Geographically, the analysed area is located in the western part of the Cracău-Bistrița Depression, within the central sector of the Nechit River (Fig. 4). Significant areas for the Eneolithic period are typically identified on the high terrace of watercourses. In the classification proposed by Gh. Lupașcu, these surfaces fall

[4] https://maps.arcanum.com/en/map/firstsurvey-moldva/?layers=148&bbox=2984493.616265169%2C5923861.129775487%2C3016277.808467614%2C5937289.335008303

[5] MATASĂ 1938, 115-116, 125-127; CUCOȘ 1992, 13-14.

[6] These toponyms are not known to the local inhabitants. This information was verified on 15 November 2025 through interviews with the C.N. and C.E. family from Borlești, who own agricultural property on Dealul Mare and reported that, since the land has been in their possession "from grandmother, from mother, and now us," it has been referred to as Dealul Mare. This information was further confirmed on 9 December 2025 by the Department of Urbanism, Territorial Planning and Environmental Protection, Heritage Administration of Borlești Commune, Neamț County. Consequently, the toponym *Dealul Mare*, which is recognised by the inhabitants of Borlești Commune, has been adopted for use in this study.

[7] CUCOȘ 1992, no. 10.1.b, 13.

[8] DUMITROAIA 1981, 341-342.

[9] CUCOȘ 1999, 28, 176.

[10] CUCOȘ 1999, 28, 176.

[11] MATASĂ 1938; VULPE 1964, 129-130; CUCOȘ 1969, 417; FLORESCU 1970; CUCOȘ 1999, 28, 176; MUNTEANU 2010, 42-43, 45; POPESCU 2024.

within the category of 35–40 m terraces. Formed during the Upper Pleistocene, these terraces cover extensive areas and are characteristic of the fluvial relief specific to the Bistrița Valley[12]. Referring to the pedology of the area, the terraces are predominantly covered by brown argilluviated soils and brown luvisols, underlain by a gravel horizon[13].

The microzone investigated on *Dealul Mare* extends across the high terrace on the right bank of the Nechit River, at an elevation of approximately 360 m (Fig. 5/left). To the south and east, the high terrace is bounded by the Podului stream, which has acted as the main agent of erosion on the upper terrace, a process particularly evident on the eastern side. The total area of this terrace is approximately 50 ha, taking the shape of a peninsula that separates from the rest of the right terrace, with a point of connection, a 200 m-wide neck, located in the western part (Fig. 5/left).

The average slope of the terrace is approximately 0.3% along the N–S axis (approximately 200 m), with an elevation decrease of 0.33 m, and 10.4% along the W–E axis (approximately 300 m), with an elevation decrease of 6.7 m (Fig. 5/a-c). To the north and northwest, the terrace is crossed by the county road DJ 156A. At present, the land is predominantly used for agriculture. The terrace edge is covered by tall spontaneous vegetation and black locust woodland.

The archaeological site is located at the northeastern end of the terrace, on a spur known as *Dealul Mare*, in the area where the Podului stream converges with the Nechit River. This location, 340 m above sea level, offers good micro-regional visibility and natural protection, owing to the steep slopes and the natural enclosure of the area.

The area of this terrace ridge is approximately 0.35 ha, orientated along the ENE–WSW axis. The site is bounded on three sides by steep slopes, with an average gradient of 30–35% to the north and east and an elevation difference of 20 m relative to the lower terrace. These steep slopes constituted a natural barrier, providing the site with both protection against easy access from the outside and the advantage of extended visibility to the west, north, and east, which could have facilitated surveillance of the area and defence against potential threats. The only access to this zone is along the southwestern side of the terrace, emphasising the secluded and strategic character of the site, limiting entry and exit points and thereby enhancing control over the occupied space. An analysis of these topographic elements reveals not only the insularity of the terrace and settlement but also their strategic significance for observation and oversight of movements across the Bistrița and Tazlău basins.

Furthermore, the positioning of the site between two major river basins, the Bistrița and the Tazlău, may have contributed to its historical role as a link or control point for access routes between the riparian areas, facilitating both exchanges and the monitoring of movements within the region. The terrace could have served not only as a habitation area but also as a strategic point of the area, factors that help explain the preference for such locations in prehistoric times, when security and visibility were essential for local communities. Thus, the geographical characteristics of the site are directly reflected in its utilisation and its significance for past inhabitants.

Discovery context

The analysed object is a copper artefact belonging to the Eneolithic period, identified by chance during non-intrusive field investigations conducted in the Tazlău–Borlești area. The primary aim of these investigations was the systematic positioning and recording of prehistoric sites previously reported in the literature.

[12] LUPAȘCU 1996, 34.
[13] LUPAȘCU 1996, 35.

Field research undertaken in the Cracău-Bistrița Depression is part of a wider initiative aimed at a comprehensive scientific analysis of the area. This methodology sought to identify archaeological materials relevant to the Eneolithic culture, as well as to delineate areas with high archaeological potential, thereby contributing to a deeper understanding of the presence and development of prehistoric communities in the region.

Within Borlești Commune, several prehistoric archaeological sites have been documented, including *La Stânci*, *Gropile Cățânului*, *Mastacăn*, *Dealul Cucului*, *Dealul Mare*, and *Ursești*[14]. To enhance knowledge of these archaeological objectives, our efforts focused on providing precise topographic data regarding the location and dimensions of the sites, producing accurate photographic documentation, and protecting these locations by recording and updating information about them in the National Archaeological Record (RAN).

One of the points of interest, known as *Dealul Mare*, has been cited in the literature as an Eneolithic archaeological site, specifically attributed to phase B of the Cucuteni culture. Its location on a terrace ridge detached from the Nechit River right bank (Fig. 4) facilitated its identification, owing to the privileged geographical position that aligns with the criteria for Cucuteni settlements in this region.

As a result of agricultural activity, sporadic archaeological materials were observed on the surface, including a green-patinated metal axe made of copper, typical of Cucuteni phase B (Fig. 6/a-b, Fig. 7). This artefact was discovered directly within the ploughed layer and recovered from the topsoil. Its discovery reinforces both the presence of Cucuteni communities on *Dealul Mare* and the importance of such artefacts for understanding metallurgical technology and social dynamics of the period.

Such accidental discoveries underscore the value of field surveys and non-intrusive investigations in areas with archaeological potential, particularly where the land is subject to frequent agricultural interventions. These methods allow for the identification and protection of archaeological heritage without disturbing the stratigraphic context, enabling rapid documentation of artefacts and contributing to the completion of regional archaeological maps. The benefits of non-intrusive approaches are further demonstrated by other similar studies, which have led to the identification of significant sites and the preservation of valuable artefacts before their accidental destruction.

Artefact description

The analysed piece has a maximum length of 15.2 cm, a maximum width at the through-hole of 4.0 cm, and weighs 416 gr. Its structure is divided into three morphometrically distinct segments (Fig. 8). Considering its current shape, with visible traces of use or post-depositional modification, this artefact can be classified within the morpho-technical group of double-headed axes/pick-axes, with one horizontal cutting edge and one pointed tip (*Pickelhacke*[15], *Hackepickel*[16]). Objects of this type, at least within the local context[17], were known from only a

[14] CUCOȘ 1992, 10, 13-15.

[15] VULPE 1975, 48, note 47; MAREȘ 2002, 112, 158, notes 320, 322.

[16] SCHUBERT, 1965, fig. 1.

[17] Considering the relatively small dimensions of the axe from Borlești–*Dealul Mare*, it is argued that the designation of 'adze-pick' would be more appropriate for defining the functional characteristics of this object. The artefact under study displays a morphology closely comparable to that of a modern mattock. Within the same analytical framework, the identification of the artefact as a TT-10 adze-axe type is also supported (CHERNYCH 1978, 96, Fig. 5/1; pers. comm. Neculai Bolohan).

single published artefact[18]. Another example illustrating this category is the specimen from Bojnice, Slovakia[19].

The axe segment bearing the horizontal cutting edge, commonly designated as the 'adze arm', is shorter and typically exhibits its active component on the right side, whereas the longer segment terminating in a pointed tip is referred to as the 'pick arm'. The overall profile of these axes is straight, with a curvature of the longitudinal axis in the upper portion; the degree of curvature of the axe arm itself may vary according to the specific specimen.

For the analysed piece (Fig. 9), the 'adze-arm' has a maximum length of 5.5 cm (measured from the through-hole) and a maximum width of 2.6 cm. The active part, slightly curved and flared, shows visible traces of use, more pronounced at one of the corners. On the upper surface, a visible incision is present, which is interpreted as accidental, resulting from casting or post-depositional marks. The 'pick-arm', or cutting-edge arm, has a maximum length of 7.5 cm and a maximum width yet to be specified. The active part is heavily worn, with only a partial preservation of its original shape. The cross-sections of both arms are rectangular, with a rounded upper edge.

The through-hole, circular in shape and carefully crafted, is located in the median part of the artefact, with an internal diameter of 2.2 cm, a rim thickness of 0.9-1.0 cm, and a depth of approximately 2.8 cm. At the upper end, the through-hole terminates in a circular rim of 0.01 cm, while at the lower end, it forms an interrupted rim of approximately 0.8 cm, which, according to comparable examples, cannot be considered a through-hole[20]. These extensions, on either side of the through-hole, exhibiting slight asymmetry, are described as "tangs"[21] and serve to stabilise the attachment area for the wooden haft of the artefact (Fig. 10/a-b, e-f).

The artefact under analysis displays relatively small dimensions. It is presumed that the substantial wear traces have modified its initial morphology, particularly in the region of the 'adze arm'[22]. The structure is slender and graceful, with well-finished, sharply defined edges. The implement exhibits unequal proportions between its two components, the 'adze arm' with the horizontal cutting edge being distinctly shorter than the 'pick arm'. Moreover, the curvature of the profile is more accentuated along the pick-bearing side.

On the upper surface of the 'adze arm', a distinct, interrupted ridge is visible, resulting from the casting process. This ridge was flattened either by hammering or by breaking off excess material. Casting defects, such as wrinkles or rough areas, are also noted. Overall, the artefact exhibits a uniform green-bronze patina.

Typological analysis

Based on our own observations and on sources presenting this category of objects, we analysed their spatial distribution and the characteristics that allow the identification of technical and typological details, both within the study area in the western part of the Cracău-Bistrița Depression and at the broader Central and Southeastern European level.

Within the morpho-technological group of *two-armed pick axes, with a horizontal and sharp edge*, a single variant has been defined based on the discovery of the axe from Crizbav/Krizba/Krebsbach-Brașov, which has been assigned to the *Pickelhacke* category[23]. The

[18] MAREȘ 2002, 112 and notes 307 and 322, which refer to the various typologies of cooper axes.
[19] NOVOTNÁ 1970, 25, pl. 7, no. 121.
[20] MONAH 1969, 301.
[21] ROSKA 1942, 143, fig. 166, map no. XIV, point no. 55; MAREȘ 2002, 107 with note 243a, 150, 185.
[22] See the following observations result from the macroscopic and microscopic analyses.
[23] MARȚIAN 1920, 16, no. 212; ROSKA 1942, 143; MAREȘ 2002, 112; 215, pl. 48/7.

shape of this axe closely resembles that of the axe found at Borlești-*Dealul Mare*, with the exception of the through-hole, which in the former case is conically shaped and well-defined, whereas in the latter it is almost imperceptible. A similar situation is observed for the specimen from Lizanovka, Cherkasy Oblast, Ukraine, from the northeastern extremity of the Tripolye area[24]. Another technical feature specific to the 'adze-pick' is the lateral tangs at the base of the through-hole, which are quite similar to those observed on the Ariușd-type axe from Muscel-Berevoiești[25], the Jászladány type, and the *special form* variant from Moeciu-*Cetățuie*[26]. This technical detail is present in many artefacts of the *Streitäxte* category of the Șiria type from the Intra-Carpathian Region, noting that typologically these are defined by a body with a round cross-section and a hammer arm that maintains the same diameter along most of its length[27]. We do not exclude the hypothesis that some specimens of the *Nógrádmarcal* type from Slovakia, such as that from Malé Leváre, Malacky District, Bratislava Region[28], may have belonged to the same category. Two exceptional specimens, also belonging to the *Pickelhacke* artefact category, originate from a cenotaph in the Varna necropolis and are considered symbols of power[29], though they share no features with the Borlești axe. Based on the known types and variants, certain similarities, particularly regarding the general aspect of the pick arm, have been identified in the following artefacts: Hinova[30], Mehedinți County, classified as Jászladány type, Târnăvița variant; Crizbav[31], Brașov County; and Bojnice[32], Trenčín Region (Slovakia), classified as Târgu Ocna–Nógrádmarcal type.

The dating of this artefact can be inferred from the observations made by Ștefan Cucoș, from our own field observations, and from its association with other discoveries. The first two sets of data suggest that this specimen may be associated with a Cucuteni B habitation level at the foothills of the Eastern Carpathians, which aligns with the discoveries mentioned above, as well as with a broader category of metal finds, including Târgu Ocna-type and Nógrádmarcal-type axes, as well as those from the Intra-Carpathian Region. This association corresponds to the period of maximum development of the Copper Age, represented by the transition from the Tiszapolgár culture to the Bodrogkeresztúr culture, which coincides with the Cucuteni A–B and B phases.

Casting method

The technologies employed in the production of these artefacts reflect the existence of specialised metallurgists, complemented by assistants responsible for procuring raw materials, a task that required communication skills and the ability to interact with diverse individuals and communities. Current knowledge indicates that the manufacturing process involved the acquisition and transport of raw materials, the preparation of primary processing installations, the sourcing of fuel, the controlled heating of copper, and the casting of molten metal into clay or stone moulds, which could be either open (monovalve) or closed (bivalve). The through-hole

[24] DERGAČEV 2002, 193 and note 43, pl. 58/A 22.
[25] MÂRȚU 1962, 101, fig.1; VULPE 1975, 36, no. 88, pl. 11/88; MAREȘ 2002, no. 103, 185, pl. 25/2.
[26] COSTEA, COȘULEȚ 1989, 5-6, fig. 3; MAREȘ 2012, 107, 259.
[27] PATAY 1984, 63-66, Taf. 25/284, 286, 293, 294; 26/309, 310.
[28] NOVOTNA 1970, 25, Taf.7/125. The graphical depictions did not permit firm conclusions to be drawn concerning the working hypothesis.
[29] TODOROVA 1981, 50-51, Taf, 18/100-200.
[30] BĂRCĂCILĂ 1924, 295, no. 2, fig. 264; VULPE 1975, 38, no. 102, pl. 13/102; MAREȘ 2002, 244, no. 1180, pl. 26/5.
[31] MARȚIAN 1920, 16, no. 212; BERCIU 1939-1942, 54, no. 3, fig. 1/8; VULPE 1975, 50, no. 233, pl. 30/23; MAREȘ, COJOCARU 1995-1996, 213, no. 74, fig. 9/4; MAXIM 1999, 155, no. 337; MAREȘ 2002, no. 541, 215, pl. 48/7.
[32] NOVOTNÁ 1970, no. 121, 25, pl. 7.

was preserved by placing a core within the mould[33]. The copper axe from Borlești-*Dealul Mare* was produced using a bivalve mould, as evidenced by the fragmentarily preserved metal crest on the convex surface and by exhibiting a concave hollow of triangular shape at the lower bottom of the 'pick-arm' (Fig. 13/2). Subsequently, the artefact underwent additional finishing operations, such as hammering, grinding, sharpening, or bending, carried out through forging[34].

Macroscopic Analysis

Upon initial examination, the axe was found to be covered, in addition to dusty corrosion products, by a substantial layer of soil over its entire surface, with the hafting hole completely filled by the same type of deposits. After a preliminary cleaning using a soft-bristled brush, which did not compromise the artefact's state of preservation, it was observed that the noble patina is predominantly concentrated in the concave triangular indentation (Fig. 13/2). Several areas exhibiting the same patina were also identified on both sides, as well as on the outer surface of the axe (Fig. 8). Additionally, minor active corrosion areas were noted, appearing as small, pale greenish spots with a powdery texture; their limited extent, however, indicates they do not pose an immediate threat to the artefact's integrity.

Microscopic Analysis

Following the preliminary assessment of the artefact and the evaluation of its state of preservation, a series of microscopic observations were conducted, both optical and digital. These microscopic investigations enable the detailed characterisation of specific features of the analysed object, providing valuable information regarding its structure and microstructure, the distribution of corrosion products, and the identification of any traces of use or deterioration.

Digital microscopy was performed using a Bresser Wifi1080P, capturing images at a 1:1 scale. The surfaces of the axe were thus examined to identify potential wear traces, manufacturing defects, or post-depositional alterations. Optical microscopy was carried out using a Zeiss Imager.a1M microscope, equipped with an integrated AXIOCAM camera and operated via AxioVision Release 4.7.1 software.

At this stage[35], the areas exhibiting the primary patina on the surface of the axe were more clearly observed (Fig. 10/a-f), as well as the regions where active corrosion was visible. The latter were predominantly located in close proximity to the areas with noble patina (Fig. 10/b, c, e, f).

Wear traces on the axe are predominantly located on the tip, the through-hole, and the adze-blade, all exhibiting smooth edges consistent with the period of use of the artefact. In addition, casting marks are present on the artefact body, appearing as a ridge or crest, which is occasionally interrupted. The 'adze-blade' also shows evidence of intensive use, with the edge appearing more rounded and worn on the left side, suggesting that the artefact was primarily used by a right-handed individual (Fig. 11/a-c). Another significant aspect relates to the use mode. The pronounced wear on the left side may result from either extended use over time or working with hard materials, and it is also plausible that both factors contributed simultaneously. These

[33] Some deformations within the through-hole were produced mechanically, likely during the removal of the core (HEEB 2014, 71).

[34] HEEB 2014, 74; RENFREW 1970, 31-33.

[35] ROBBIOLA *et alii* 1998.

observations suggest that this type of axe was not merely symbolic but served a practical function and was employed extensively.

As a post-depositional alteration, a large and deep indentation was observed on the outer surface of the 'adze-blade'. This damage, which most likely occurred after the artefact was discarded, may be linked to agricultural activities and is probably the result of contact with a substantial sharp object, such as a ploughshare (Fig. 10/c; Fig. 11/b).

Through optical microscopy, two of the most common copper corrosion products[36] were identified: malachite and cuprite (Fig. 12/a-d). Malachite, a basic copper carbonate with an intense green colour, occurs as a stable secondary phase. Cuprite, with a reddish hue, represents the cuprous oxide formed during the initial stages of the corrosion process. The simultaneous presence of both phases indicates a typical progression of copper corrosion, in which internal cuprite gradually transforms into malachite.

Compositional Analysis

Elemental characterisation was carried out using a VEGA II LSH (Tescan) scanning electron microscope (SEM), equipped with a QUANTAX QX2 (Bruker/Roentec) energy-dispersive X-ray (EDX) detector. The results are expressed as percentages, and all samples were analysed without any metallic or graphite coating.

Sampling and Analysis

To obtain elemental data, samples were collected from three distinct areas of the axe to identify corrosion products (Fig. 13/1), the noble patina (Fig. 13/2), and the underlying metal (Fig. 13/3).

Analyses of the areas covered by corrosion products and patina confirmed the presence of compounds characteristic of copper degradation, notably malachite[37] ($Cu_2[(OH)_2|CO_3]$) and cuprite (Cu_2O) (Table 1/1, 2). In addition, elements indicative of soil contamination were detected, including phosphorus (P), aluminium (Al), silicon (Si), potassium (K), and iron (Fe)[38]. SEM micrographs and elemental mapping reveal a uniform distribution of the mineralised structures and the elements associated with corrosion processes and patina formation (Fig. 14).

The analysed axe was manufactured from copper, with no trace elements originating from the ores used in metal production being detected (Table 1/3). Moreover, SEM micrographs of the metal revealed no features or structures suggestive of impurities[39] (Fig. 15).

Discussion

Within the context of the Eneolithic period, refining copper to a high degree of purity is considered unlikely. The presence of trace elements at concentrations below the detection limit remains a possibility, providing a plausible explanation for the data obtained. Nevertheless, the occurrence and processing of copper artefacts attributed to the Eneolithic period, free of detectable impurities, has been documented at the settlement of Tăcuta–*Dealul Miclea* (Vaslui County)[40]. Archaeological literature also mentions a *Pickelhacke*-type axe discovered at Crizbav, which contains approximately 2.5% arsenic. These data suggest a typological similarity in this case, but not a compositional one[41]. Although this evidence does

[36] SCOTT 2002.
[37] KOWALSKI *et alii* 2019, 53.
[38] MIRCEA *et alii* 2012, 1472; SANDU *et alii* 2012, 1646-1652.
[39] KOWALSKI *et alii* 2019, 53.
[40] LAZANU *et alii* 2025, 155-181.
[41] POPESCU *et alii* 2013, 136.

not provide concrete insights regarding typology or raw materials, given that objects from other functional categories were studied rather than those examined here, it represents the most recent contribution addressing copper artefacts within the Cucuteni area[42].

Ascertaining the raw material's provenance calls for further analytical investigation and rigorous geochemical comparison, which would enable the composition of the analysed metal to be correlated with existing databases and prior research on known ore sources[43]. Within the chronological framework of the axe discovered at Borlești, several copper artefacts are documented as originating primarily from Slovakia[44], although no direct analogies between individual items have been identified. In the absence of more comprehensive analytical data, current interpretations must rely on archaeological evidence, drawing on typological, technological, and contextual analogies to formulate coherent hypotheses regarding the sourcing of copper.

Conclusions

The Nechit stream basin, in the area of Borlești commune, is recognised for several metal finds dating to the Eneolithic period[45] and the Bronze Age[46]. It is possible that the proximity of eastern Transylvania facilitated communication through hubs such as Poduri, Borlești, Vermești, and Păuleni-Ciuc. While this route was *sprinkled* with salt, it is unlikely that salt alone determined mobility. It must also be acknowledged that other factors, neighbouring communities, kinship relations, exchanges of goods and gifts, alliances, and shared celebrations, played a significant role in fostering awareness and the desire for communication. These social stresses were further conditioned by everyday life necessities, including shelter, food, and the perpetuation of the community.

For the study area, there is a limited number of sources resulting from multiple investigations or invasive archaeological approaches that have been adequately integrated into a continuous narrative of the site. Unintended finds frequently initiate the development of targeted case analyses, as occurred at Borlești–*Dealul Mare*. Repeated familiarity with a location at the foothills of the Eastern Carpathians ensures the necessary perspective for understanding the configuration of the current landscape and allows accommodation of the probable prehistoric landscape. Soil traces, vegetation patterns, older cartographic sources, and current topographic applications all contribute to a closer engagement with a workspace that, in ancient times, combined most of the natural conditions favourable for settlement and communication.

The artefact identified prompted a careful immersion in the diversity of approaches, typologies, and functional interpretations, all structured according to criteria that also reflected the subjectivity of the specialist. In the specialised literature, such artefacts are uniformly classified within the developed ("classic") Eneolithic, dated to the late 5th and early 4th millennia BCE. Most examples originate from Transylvania, Banat, Hungary, and Slovakia, although they occur far less frequently in Moldova and the eastern and southeastern Carpathian regions (Fig. 16).

[42] HANSEN 2021, 43-45.
[43] MARCOUX *et alii* 2002; BARON *et alii* 2020; KMOSEK *et alii* 2020
[44] SIKLÓSI *et alii* 2022.
[45] CUCOȘ 1992; 1999.
[46] See recently POPESCU 2024, 148-156, an update history of the metallurgical finds located approximately 2.4 km south-west of the Borlești-*Dealul Mare* site.

The current interpretive approach began with the details of the findspot, identification and description of the artefact's elements, and comparative regional and supraregional analysis, leading to a proposal of functionality aligned with the needs of an Eneolithic individual. This emphasises the dynamic role of these artefacts within the cultural and economic context of the Eneolithic[47]. The procurement of raw material or acquisition of a copper object, its production technology, and its utility both as a functional and symbolic item are all aspects that must be considered. Our interpretation, recognising the object as a potential "Swiss multi-tool" for household activities, woodworking, and stoneworking, or possibly an identity symbol, offers broader perspectives on its significance.

The multidisciplinary analysis, supported by a specific methodology, enhanced the objectives through scientific insights into composition, technology, and hypotheses concerning the source of raw material. Moreover, use-wear analysis on the working area of the adze provides data on how he/she used this tool more often with their right hand.

Overall, the study offers a comprehensive body of knowledge derived from a robust theoretical and methodological framework, paving the way for extended investigations at the foothills of the Eastern Carpathians. This contributes to a more complete understanding of a landscape with diverse cultural representations from prehistoric periods, exemplified in this case study by the life history of a single artefact.

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[47] RENFREW 1970, 17; RADIVOIEVIĆ, ROBERTS 2021, 207, 235.

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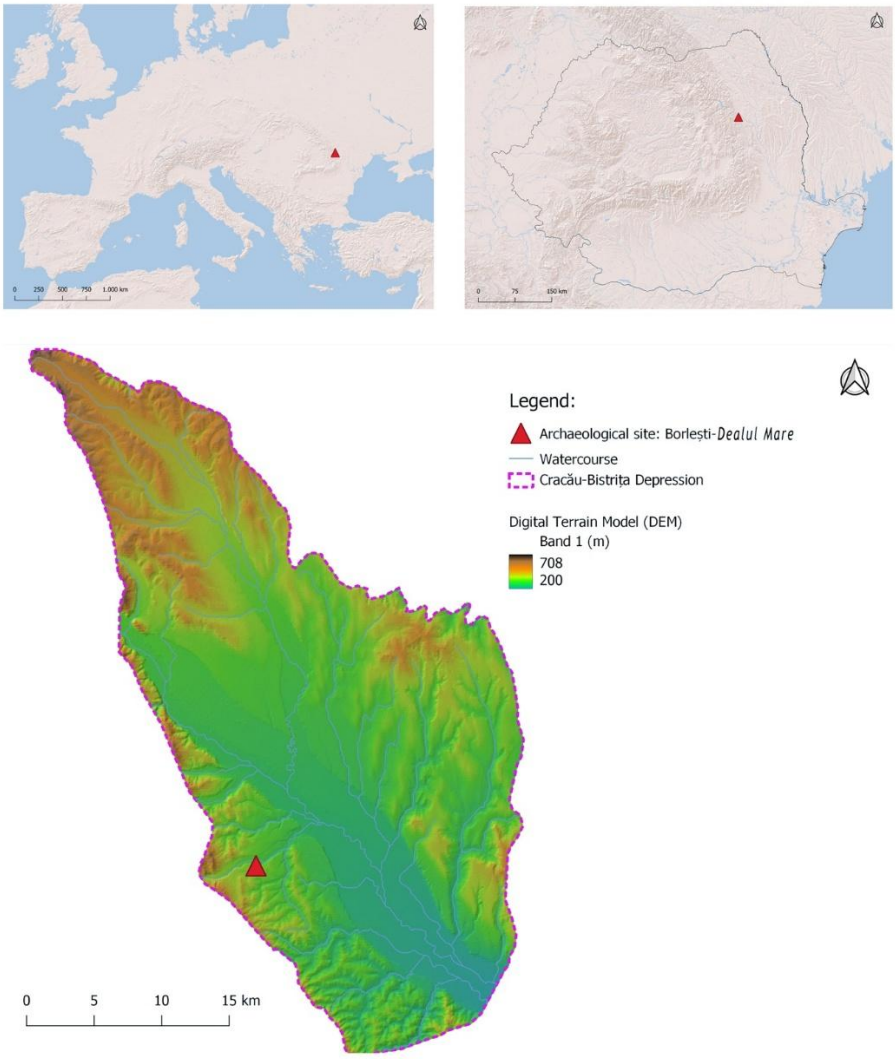


Fig. 1. Borlești-*Dealul Mare* archaeological site, Borlești commune, Neamț County: **a.** Map of Europe; **b.** Map of Romania; **c.** Placement of the site within the Cracău-Bistrița watershed (QGIS 3.28.13).

Fig. 2. Borlești-*Dealul Mare* archaeological site, oriented northeast–southwest (photograph taken with DJI mini SE 2).

Fig. 3. Borlești-*Dealul Mare* archaeological site: view from the south-west toward Bistrița Valley
(photograph taken with DJI mini SE 2).

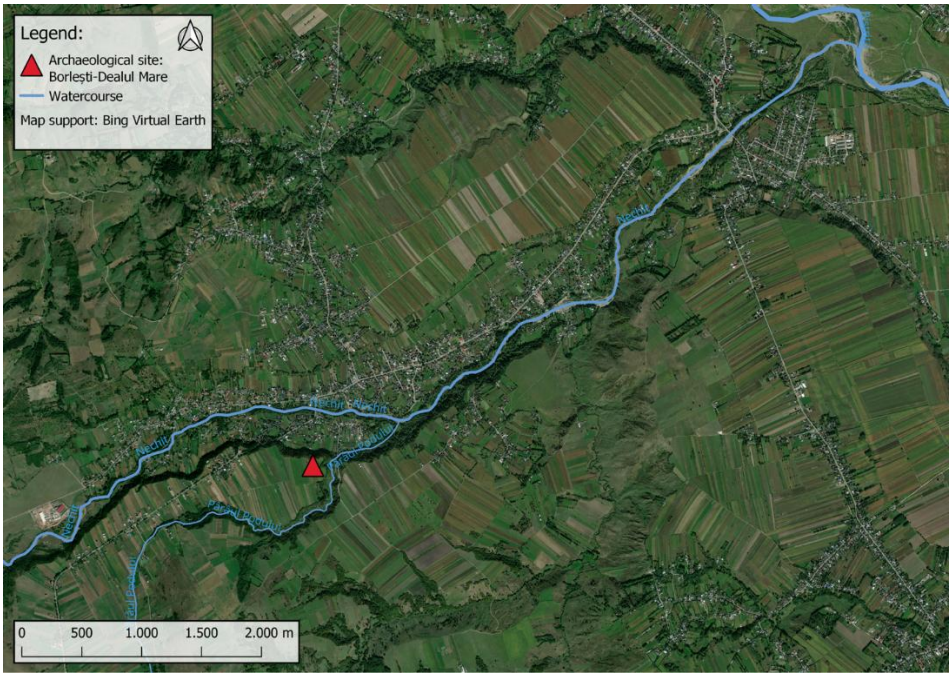


Fig. 4. Borlești-*Dealul Mare* archaeological site: red triangle – watershed of Nechit River.

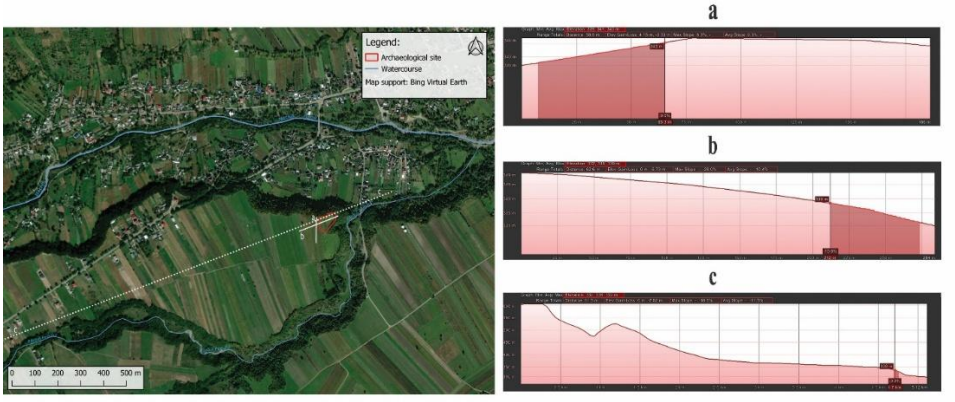


Fig. 5. Borlești-*Dealul Mare* archaeological site (marked with a red outline) within the Nechit micro-basin (QGIS 3.28.13) and assessment of the terrace surface slope: **a.** Topographic profile along the north–south axis; **b.** Topographic profile along the east–west axis; **c.** Topographic profile along the southwest–northeast axis, spanning the entire length of the upper terrace (Google Earth Pro).

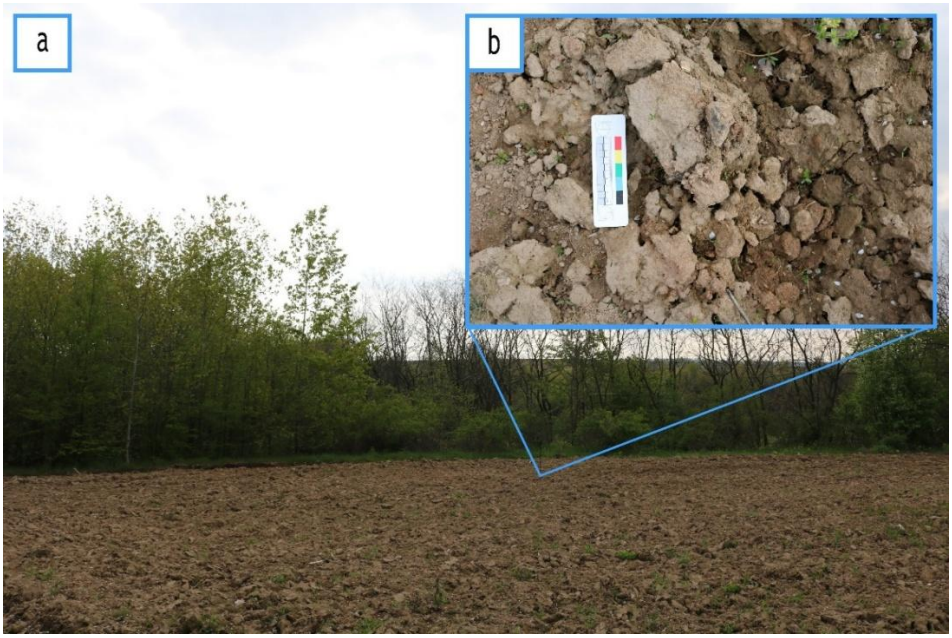


Fig. 6. Borlești-*Dealul Mare* archaeological site:
a. Perspective towards the north-eastern terrace edge; **b.** Archaeological material present at the topsoil.

Fig. 7. Borlești-*Dealul Mare* archaeological site: Eneolithic pot sherds.

Fig. 8. Borlești-*Dealul Mare*. *Hackepickel.*

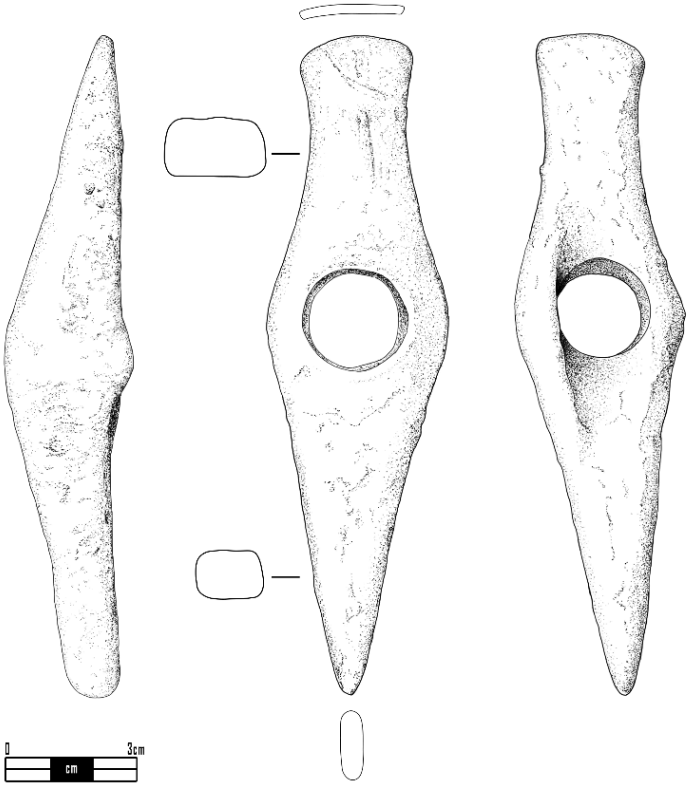


Fig. 9. Borlești-*Dealul Mare*. The scaled archaeological drawing of the *Hackepickel.*

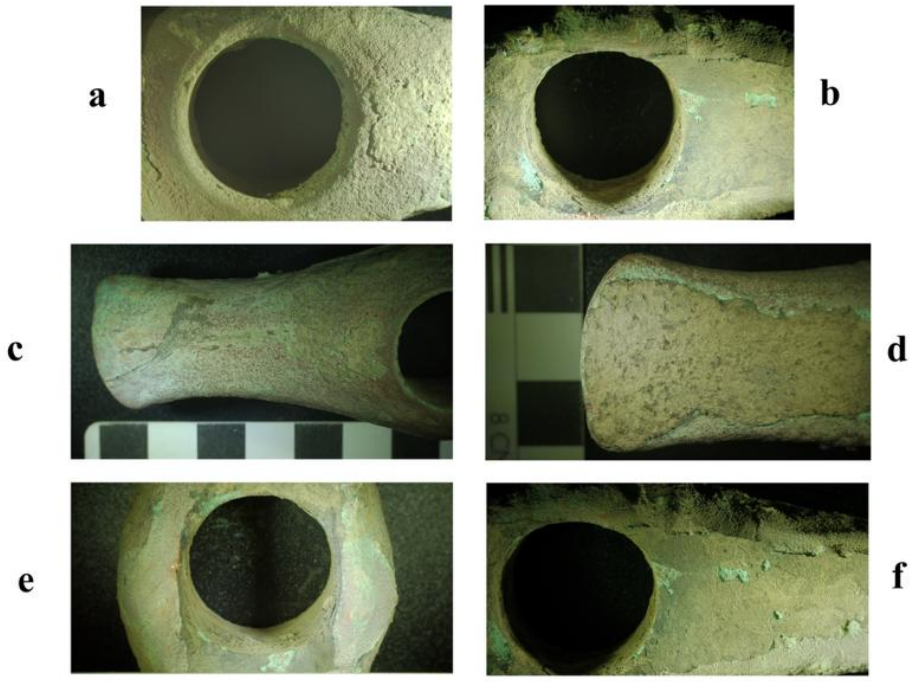


Fig. 10. Borlești-*Dealul Mare*. Digital microscopy images (1:1 scale) of the analysed *Hackepickel*.

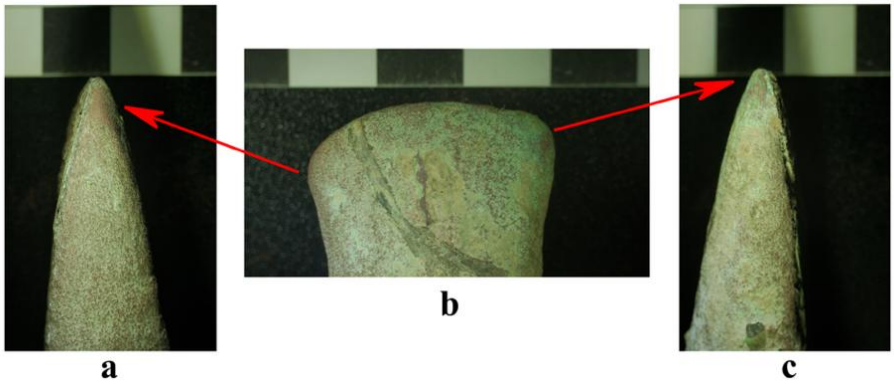


Fig. 11. Borlești-*Dealul Mare*. Digital microscopy images of wear traces on the 'adze-arm' at a 1:1 scale: **a.** left edge 'adze-arm'; **b.** outer surface of the 'adze-arm'; **c.** right edge of the 'adze-arm').

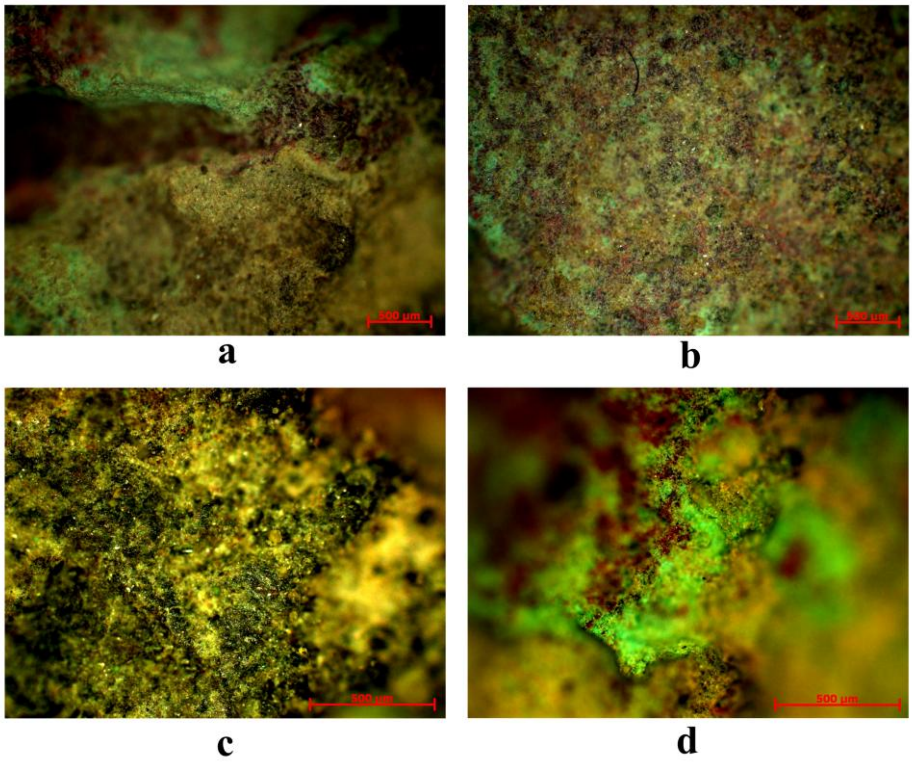


Fig. 12. Borlești-*Dealul Mare.* Optical microscopy images of the corrosion products identified on the analysed *Hackepickel* at 50× (a, b) and 100× (c, d) magnification.

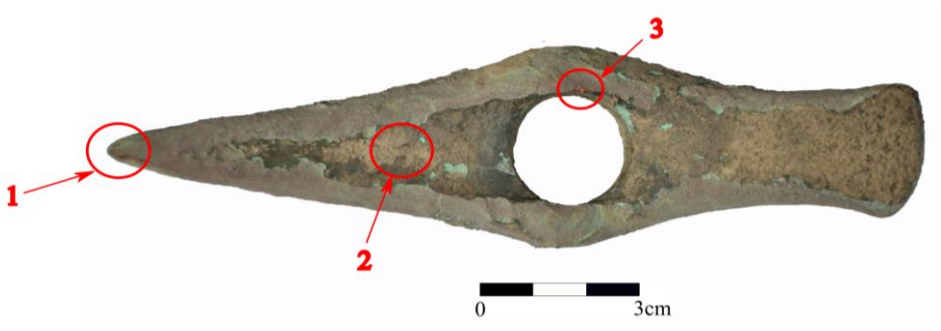
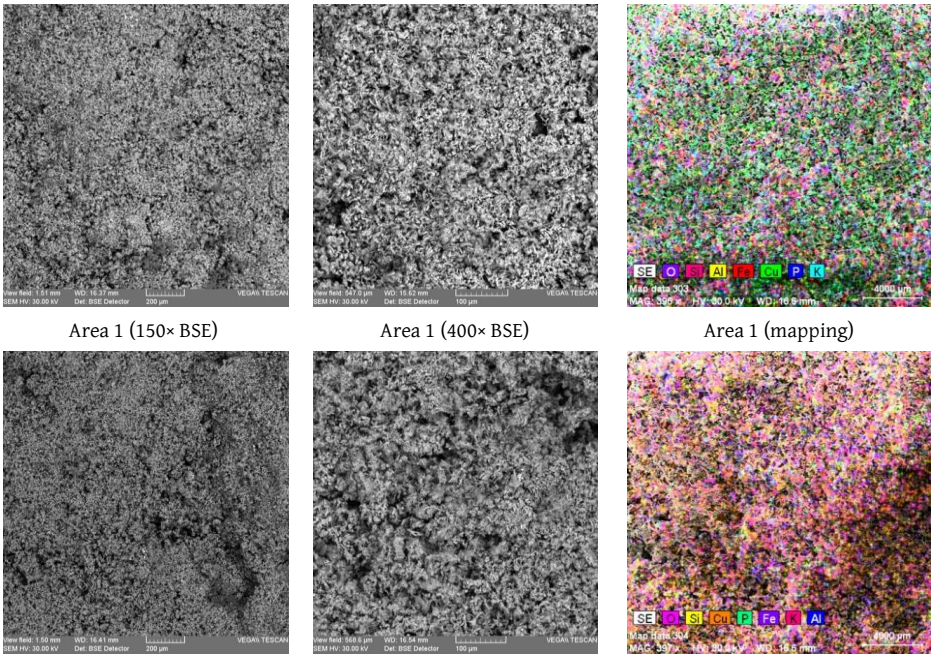


Fig. 13. Borlești-*Dealul Mare.* Sampling areas for compositional analysis of the *Hackepickel*.

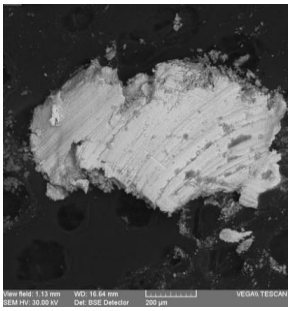
Table 1. Borlești-*Dealul Mare.* Elemental composition of the three analysed areas

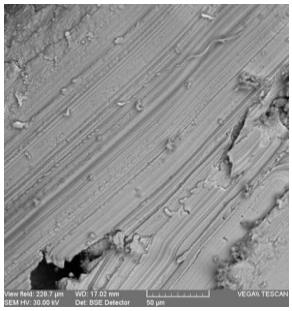
	Cu	Fe	Si	Al	K	P	O	C
Composition of area 1	53.18	1.43	8.97	3.98	0.62	1.00	29.25	1.55
Composition of area 2	50.06	1.96	10.66	3.67	0.97	1.48	29.97	1.22
Composition of area 3	98.37	-	-	-	-	-	1.63	-



Area 1 (150× BSE) Area 1 (400× BSE) Area 1 (mapping)

Fig. 14. Borlești-*Dealul Mare.* SEM micrographs and elemental mapping of the axe tip (area 1) and the central inner region (area 2) at different magnifications


Area 3 (200×BSE)


Area 3 (1000×BSE)

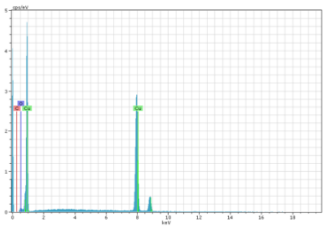

Area 3 (EDX spectrum)

Fig. 15. Borlești-*Dealul Mare.* SEM micrographs and EDX spectrum of the *Hackepickel*