GEOARCHAEOLOGY AS MULTIDISCIPLINARY APPROACH IN CIVIL AND MINING ENGINEERING – CASE STUDY OF SOME EARLY NEOLITHIC STONE AXES (HUNEDOARA COUNTY)

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Abstract: There is less information about the raw material from which they were made polished stone tools such as axes used in Prehistory. In this context, there are necessary numerous interdisciplinary studies, such as the geo-archaeological studies like this one. This article was made based on the field investigation of the archaeological sites, mineralogical analyses of the prehistoric artifacts made in the laboratory, but also the bibliographical study was very important. In the article we present the case of five pieces of stone axe discovered in two archaeological sites from South-Western part of Transylvania (Romania). After the archaeological and geological study of the Neolithic axes, we hope to be able to identify, in the future, the main sources of the local raw material used by the Starčevo-Criş communities settled in the Middle Mureş Valley, based on the interdisciplinary investigations.

Keywords: Geoarchaeology, Civil and Mining Engineering, Raw Material Resource, Hunedoara County, Accidental archaeological discoveries, Starčevo-Criş culture, Stone tools, Petrographical analysis.

1. Introduction

The European Union and our country are developing operational programs for the period of 2007-2013, co-financed by the European Regional Development Fund (ERDF) and the Cohesion Fund (CF), (Ex.: Operational Programme - Transport POS-T). Their main objective is to develop a modern and sustainable transport infrastructure that will facilitate a safe and efficient movement of people and goods at national and European level and contribute positively and significantly to the economic development of Romania. These programs have generated significant civil, mining etc. engineering challenges, as well as the decommissioning of large areas of land. Among the difficulties encountered have proved to be significant, as well, the issues related to the archeological discharge of important sites intercepted by the new road routes in various stages of design or execution.

Also, in many cases the exploitation of useful mineral substances is dependent by archaeological and geoarchaeological research in ore deposit development area. An landmark from this perspective is found in our country at Roşia Montana where there are well extensive such activities.

In the general context of the intensification of archaeological research at national level, interdisciplinary sciences as Geoarchaeology have increasingly individualized in Romania as well.

A recent field of research, the Geoarchaeology is a multi-disciplinary approach which uses the techniques and subject matter of geography, geology and other Earth sciences to examine topics which inform archaeological knowledge and thought [24].

The aim of this article is to study a small sample of polished stone tools, axe category, from geological point of view, with the purpose to determining the main types of raw materials used in Prehistory. In this case, there have been analyzed artifacts from the first period of the Neolithic, between 6150/6050-5500/5400 B.C. [5, 16, 21, 22, 23, 26, 27, 28]. In that period, the Starčevo-Criş communities [5, 9, 14, 15, 16, 18, 20, 22, 23, 27, 37, 38] have been made this type of polished stone tools used especially in cutting the tress, wood, bone and antler working, like weapons etc. For this study we used stone axes, found in late Starčevo-Criş settlements, from the phases IIIB-IVA.

2. Geographical position and researches history

In the following lines, we will refer to some polished stone tools found between 2009-2011, in archaeological sites from Orăştie-*Dealul Pemilor* X_8 and Subcetate-*Halta/Canton Covragiu* (Romania, Hunedoara County), materials which are kept in the archaeological collection of the Museum of Dacian and Roman Civilization Deva, Table 1/Map 1; (In the text we will use the abbreviation MCDRD).

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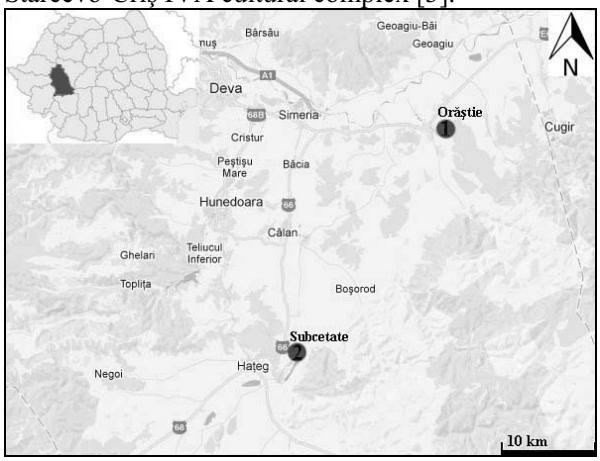
Table 1. *GPS coordinates of the archaeological points Orăştie-Dealul Pemilor X_8 and Subcetate-Halta/Canton Covragiu;*

ARCHAEOLOGICAL SITES	
Orăştie-*Dealul Pemilor* X_8	Subcetate-*Halta/Canton Covragiu*
45^0 51' 1,5" N 23^0 13' 0,2" E 235,5 M	45^0 36' 58,3" N 230 0' 24,0" E 283,3 M

Orăştie-*Dealul Pemilor X_8* (Map. 1/1, Table 1). The archaeological site is located on the right bank of Orăştie River, on the second medium height terrace and benefits by a dominant position in the area. The Early Neolithic settlement is bounded to the North by the archaeological point called *Dealul Pemilor X_2* [18, 19] and to the South by the point named *Fares* [24]. The Early Neolithic settlement from Orăştie-*Dealul Pemilor X_8* belongs to the Starčevo-Criş IIIB-IVA cultural horizon [18, 19, 20, 23, 27].

Subcetate-*Halta/Canton Covragiu* (Map. 1/2, Table 1). The archaeological point is located on the first natural terrace which is on the left side of the Strei River. The terrace is a geomorphologic extension of Subcetate hills (Commune Sântămăria Orlea), which is cut to the West by the railway segment Simeria-Petroşani. The archaeological site came in the literature because of ceramics materials belonging to the Turdaş culture or to Hallstatt period [10, 12, 19, 27, 34]. Latest archaeological research, during the years 1987 and 1989, indicate the presence of a settlement which belongs to the Starčevo-Criş IVA cultural complex [3].



Map 1. *The position of archaeological sites: Orăştie-Dealul Pemilor X_8 (1) and Subcetate-Halta/Canton Covragiu (2); [11]*

3. Archaeological context and typological description of polished stone tools

In 2011 there were public utility works in the area of archaeological sites Dealul *Pemilor X_1*, *X_2* and *X_8*, unfortunately without professional archaeological assistance, which led to disturbing Neolithic levels and of later cultural deposits. From the first archaeological point *Dealul Pemilor X_8*, we have been able to recover a lot of archaeological material, of which we mention fragments of axes. At Subcetate – *Halta / Canton Covragiu*, during activities of agricultural development of terrace, were discovered a fragment from an axe which belongs to the pattern type. Since archaeological pieces were revealed accidentally, as a result of urban and land exploitation works, in these conditions, the archaeological context cannot be specified precisely. For these reasons, only ceramic remains could be able to date this archaeological situation, in both cases belonging to the IIIB-IVA phases of the Starčevo-Criş cultural complex.

In the next rows we will describe the pieces from archaeological and typological point of view, following the alphabetical order in which they are submitted in the first part of this study. For the typology of the polished stone tools we have been used Ursulescu 2000 [38] and Antonović 2003 [1]. In the artifact description we have been followed the next order: artifact type, place of discovery, preservation, traces of use, dimensions (maximal length and width), transversal and longitudinal profile form;

axe (Fig. 1/2), Orăştie-*Dealul Pemilor X_8*, fragmentary preserved, green-greyish stone, proximally part, L=27,08 mm, W=17,23 mm, flattened red transversal profile, because of fragmentation, we cannot specify exactly the typology of this piece and even of elongated profiles;

axe (Fig. 2/2), Orăştie-*Dealul Pemilor X_8*, fragmentary preserved, greyish-white stone, medial and partially proximally part, L=24,20 mm, W=44,72 mm, plane-convex transversal profile, because of fragmentation, we cannot specify exactly the typology of this piece and even of elongated profiles;

axe (Fig. 3/2), Orăştie-*Dealul Pemilor X_8*, fragmentary preserved, greyish-green stone, distal and partially medial part, L=39,40 mm, W=52,94 mm, because of fragmentation, we cannot specify exactly the typology of this piece and even of transversal or elongated profiles;

axe (Fig. 4/2), Orăştie-*Dealul Pemilor X_8*, fragmentary preserved, greyish stone, proximal and partially medial part, L=67,82 mm, W=49,02 mm, ellipsoidal transversal profile, the longitudinal one, because of fragmentation is possible elongated, type Sl/Fig. 31/I/2/d [1];

axe (Fig. 5/2), Subcetate-*Halta/Canton Covragiu*, fragmentary preserved, greyish stone, medial part, L=43,62 mm, W=39,52 mm, plane-convex transversal profile, the longitudinal one, because of fragmentation is uncertain, type Sl/Fig. 31/I/3/a [1].

4. Research methodology

For mineralogical and petrographical investigations were performed thin sections on five pieces, pointing out (for a small group of artifacts) some raw materials used in Early Neolithic for making these kinds of artifacts like axes. These analysis was performed in accordance with: STAS 6200/4-1981; SR EN 932-3/1998;

5. Analysis and results

5.1. Sample T1, Orăştie-Dealul Pemilor X_8; (Fig. 1/1-2).

1. The structure: grano-lepidoblastic
2. The texture: schistose
3. Mineralogical composition: a) The quartz – appears as granular and as elongated prisms with irregular cracks; b) The feldspar – often appears granular, rarely prismatic, with irregular contour due to intense alteration processes (kaolinizations); c) The biotite – appears as lepidoblaste with irregular contour, strongly altered by intense chloritization processes, which frequently occurring form like green masses; d) Opaque minerals – frequently occurring;
4. Name of rock: quartzo feldspathic schist

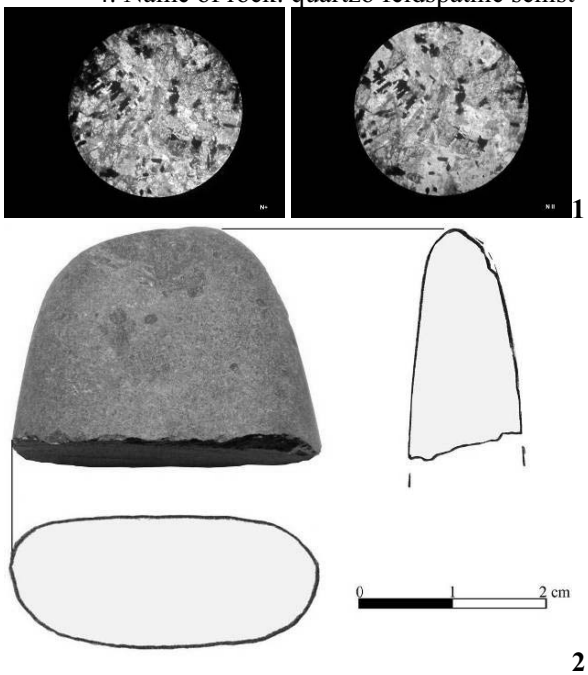


Fig. 1. *Axe of quartzo feldspathic schist found at Orăştie-Dealul Pemilor X_8 (2); X40 Magnifying (1).*

5.2. Sample T2, Orăştie-Dealul Pemilor X_8; (Fig. 2/1-2).

1. The structure: granoblastic
2. The texture: schistose
3. Mineralogical composition: a) The Quartz – appears as irregularly contoured granoblaste; b) The feldspar – appears as granoblaste with irregular contours, surfaces strongly altered and transformed in sericite and kaolinite; c) The biotite – rarely appears like brown lepidoblaste with intense alteration processes (limonitization);
4. Name of rock: quartzo feldspathic schist with biotite

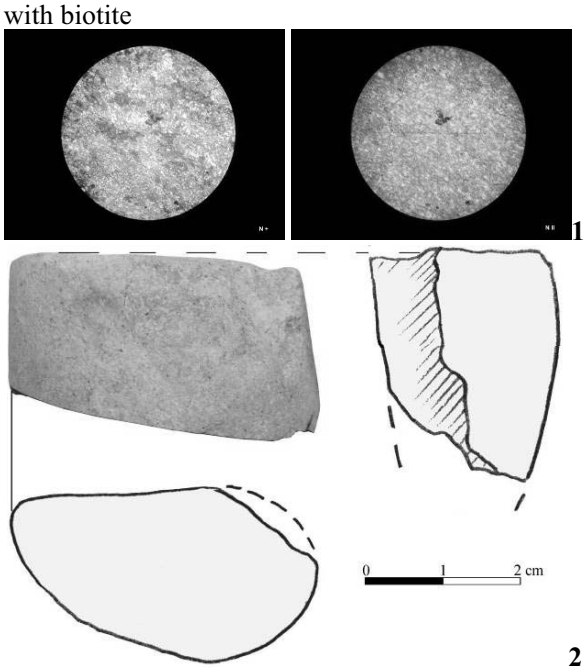


Fig. 2. *Axe of quartzo feldspathic schist with biotite found at Orăştie-Dealul Pemilor X_8 (2); X40 Magnifying (1)*

5.3. Sample T4, Orăştie-Dealul Pemilor X_8; (Fig. 3/1-2).

1. The structure: lepidoblastic
2. The texture: schistose

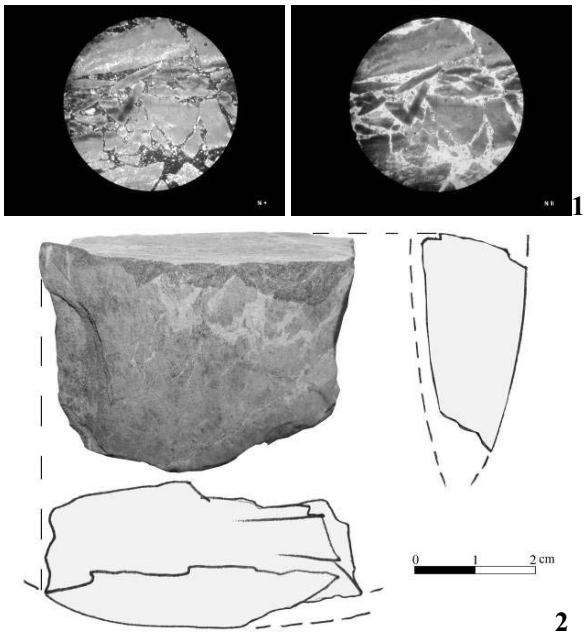


Fig. 3. *Axe of amphibolic schist with Tremolite and Actinolite found at Orăştie-Dealul Pemilor X_8 (2); X40 Magnifying (1).*

3. Mineralogical composition: a) The Amphiboles (Tremolite $Ca_2Mg_5Si_8O_{22}(OH)_2$, Actinolite $Ca_2(Mg, Fe)_5Si_8O_{22}(OH)_2$) – appear as greenish acicular lepidoblaste, intensely altered by transformations into chlorite; b) The feldspar – appears as elongated crystalloblast, strongly altered and transformed in kaolinite and sericite; c) The Quartz – appears as irregularly contoured granoblaste;

4. Name of rock: Amphibolic schist with Tremolite and Actinolite

5.4. Sample T5, Orăştie-Dealul Pemilor X_8; (Fig. 4/1-2).

1. The structure: granoblastic

2. The texture: schistose

3. Mineralogical composition: a) The Quartz – appears as irregularly contoured granoblaste and translucent surfaces; b) The feldspar – appears as granoblaste with irregular contours and strongly altered surfaces and transformed in sericite; c) The biotite – rarely appears like brown lepidoblaste with alteration processes (limonitization) d) Opaque minerals – occasionally occurring;

4. Name of rock: quartzo feldspathic schist

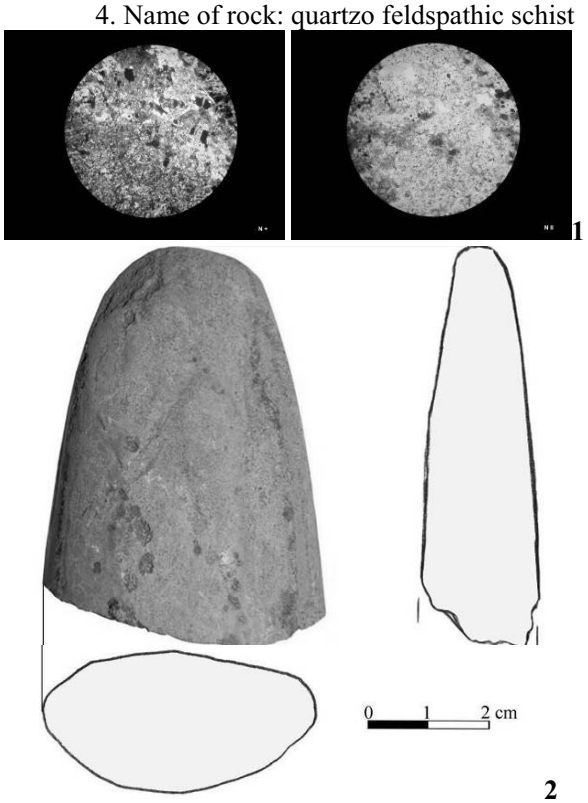


Fig. 4. *Axe of quartzo feldspathic schist found at Orăştie-Dealul Pemilor X_8 (2); X40 Magnifying (1).*

5.5. Sample T3, Subcetate-Halta/Canton Covragiu; (Fig. 5/1-2).

1. The structure: unlaminated

2. The texture: clastic texture (psammitic-psefitic)

3. Mineralogical composition: a) The Quartz – in this sample, the origin of metamorphic quartz is proved by undulatory extinction; appears granular (grains/clasts), often psammitic and rarely psefitic; b) The feldspar – appears as grains (clasts) often psammitic and rarely psefitic; The psefitic grains of feldspar presents turbid surface with intense alteration processes, which denote appearance of caolinitizations and sericitization phenomena. c) The biotite – is rarely; appears like mineral grains (clasts), with intense alteration processes (limonitization); The matrix (cementing materials) is siliceous.

4. Name of rock: siliceous sandstone

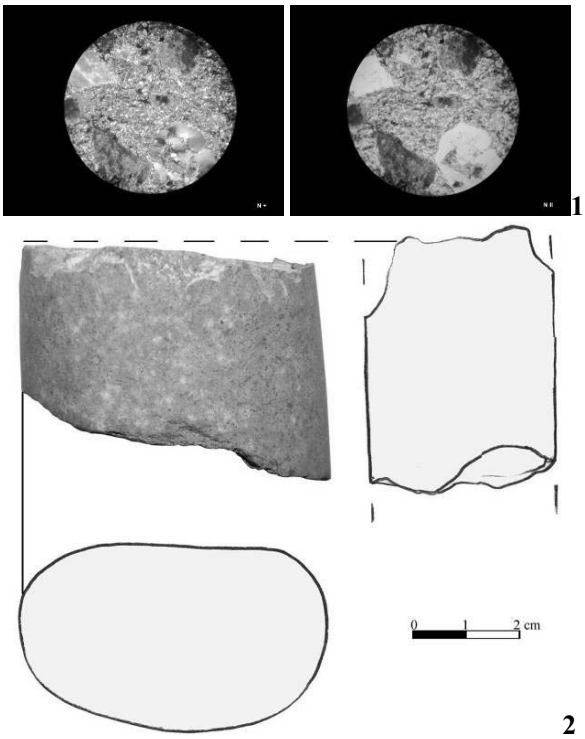


Fig. 5. *Axe of siliceous sandstone found at Subcetate-Halta/Canton Covragiu (2); X40 Magnifying (1).*

6. A geoarchaeological perspective

Although still a science at the beginnings as a stand-alone one, geoarchaeology won an important field in interpretation of possible concepts that were taken as a basis of geological knowledge of prehistoric man. Practically, with the help of this new science, which includes data on geography, geology, petrography and archeology etc., we try, in our case, to understand the ability of Early Neolithic communities to "supply" with a specific raw material and, in the end, to process it. Some of the first Romanian researchers who brought the contribution in the definition and the development of a new research field on the borderline between

archeology and geology are I. Mac and I. Mârza [25, 28, 29]. Polished stone axes' petrographic analyses raise many questions about the role played by "empirical" knowledge of rock's geology of some agro-pastoral communities [28, 29]. As we will see at the conclusion, the petrographical data, possible sources of raw materials, analogies on Romanian territory or outside it, indicate possible variants of work relating to the exploitation of similar raw material in the Early Neolithic with the purpose of manufacture polished stone tools with edge. In this context will be located at least two directions of research in a wider series of geoarchaeology, precisely prospective geoarchaeology and petrogeoarchaeology, after classifications proposed by I. Mârza [29]. Another problem that has been highlighted, recently, on the polished stone tools in Early Neolithic has been drafted by A. Boroneanț. The researcher emphasizes the importance of modern methodologies, in order to have a more complex image as well as on the impact of manufacture and exploitation of such tools [4]. Last but not least, we point out that populations of phase III to IV of cultural horizon Starčevo-Criş are well represented in Transylvanian area, if we count the number of significant archeological sites belonging to these chronological stages [23]. This aspect could indicate a better knowledge of the accessible raw material in the surroundings. A confirmation of this hypothesis might came from the large quantity of polished tools coming from archaeological sites, compared to what is known at the level of first phases – Starčevo-Criş I-II [4].

Conclusions

The analysis by thin section has been established that edged of polished stone tools found at Orăştie-*Dealul Pemilor* X_8 they were made of metamorphic rocks such as: quartzo feldspathic schists (sometimes with biotite) or amphibolic schists (with tremolite and actinolite). For the axe fragment from Subcetate-*Halta/Canton Covragiu*, petrographic determinations, indicates its achievement of sedimentary rocks such as siliceous sandstone. Unfortunately, studies on raw materials used by the Early Neolithic communities in Southwestern Transylvania, in making polished stone tools, are lacking. In these circumstances, we are gone reported, further, to a few across mineralogical analysis from Transylvania, and to the determinations carried out on similar pieces chronologically and typologically identified in Hungary, Serbia and Croatia. At Gura Baciului are mentioned the amphibolites, dolerite, micro-dolerite, diabase, epidotic cornean (granofels), shales and limestones [16, 30]. N. Ursulescu has been indicated that some Early Neolithic axes found in Moldova were made of schist and sandstone [38]. Regarding the location of raw materials sources used in manufacturing of axes, are more difficult to specify, just in terms of the lack of similar data to be compared. Another aspect would be that polished axes were a tool category spread on large spaces, like a currency exchange, many of these items with other functions, such as the ritual one. In fact, some of Starčevo-Criş settlements, by the impressive quantities of polished stone tools found at surface or in a closed archaeological complex, may have in the past the workshop function, as the authors of research at Silagiu-*Valea Secerii* [17] and Valea Lupului [6, 7, 8] suggest. Under these conditions, the materials used for making these artifacts could come virtually from any area, not infrequently in Neolithic settlements reached the end product rather than raw buckets. At Gura Baciului, in the phase Starcevo-Criş IIA, during the second migration of early Neolithic communities, geological analysis showed that rocks source are in Mureş Valley, possibly in Trascăului Mountains [16, 30]. Finally, after the geological investigations by thin section of axes analyzed in this article, we assume that the source of raw materials is in the South Apuseni Mountains and in same time other occurrence could be establish in West and Southwest of Poiana Ruscă Mountains [13, 32], on the rivers Orăştie, Mureş and Strei valleys, or in Northern Sebeş Mountains until the Cugir valley [31, 32], stating that such tools could have a large area of movement. In the neighbouring area, green schist was used to fabricate parts from Endrőd whose occurrence could be established in the eastern Alps [33]. More than ten pieces of polished stone tools from category of axes, adzes and chisels were made from schist in Early Neolithic deposits from Lepenski Vir [2]. Moreover, different types of schist are behind the manufacture of these kinds of artifacts from Blagotin [1]. In Croatia, the Early Neolithic Starčevo communities from Zadubravlje and Slavonski Brod exploited raw materials nearby the rivers or in the mountains. The archaeological literature indicates that the green schist, which occurs naturally in this country, could be exploited by Neolithic communities, even there are not so many clues in this direction of research [35, 36].

References

1. Antonović, D.
Neolitska industrija glačanog kamena u Srbiji, Beograd, Serbia, 2003;

2. Antonović, D.
Stone tools from Lepenski Vir. Cahiers des Portes de Fer, Monographies 5, Belgrade, Serbia, 2006;

3. Bărbat, I. A.
Descoperiri aparținând neoliticului timpuriu din colecțiile de arheologie ale muzeului devean. Terra Sebus, Romania, IV, 2012, pp 23-64;

4. Boroneanț A.
Early Neolithic lithic industries (The Banat and Transylvania). In Honorem Silvia Marinescu-Bîlcu (ed. M. Neagu), Cultură şi civilizație la Dunărea de Jos, XXII, 2005, pp 19-35;

5. Ciută M.
Începuturile neoliticului timpuriu în spațiul intracarpatic transilvănean, Bibliotheca Universitatis Apulensis, XII, Alba Iulia, Romania, 2005;

6. Comşa E.
Uneltele din piatră şlefuită din neoliticul timpuriu de pe teritoriul României. Muzeul Național, Romania, II, 1975, pp 209-222;

7. Comşa E.
Aşezarea de tip Criş de la Valea Lupului. Arheologia Moldovei, Romania, XIV, 1991, pp 5-35;

8. Comşa E.
Unelte din piatră şlefuită din arealul culturii Starčevo-Criş din Moldova. Carpica, Romania, XXVI/1, 1997, pp 7-30;

9. Draşovean F.
Cultura Starčevo-Criş în Bazinul Mureşului Mijlociu. Apulum, Romania, XIX, 1981, pp 33-45;

10. Floca O.
Activitatea de cercetare istorică a Muzeului județului Hunedoara din Deva (1932-1972). Sargetia, Romania, IX, 1972, pp 11-28;

11. http://maps.google.com

12. Kalmar Z., Tatu H.
Materiale neo-eneolitice descoperite în Țara Hațegului. Sargetia, Romania, XVIII-XIX, 1984-1985, pp 91-100;

13. Kräutner H. G.
Poiana Ruscă. Colecția Munții Noştri, 30, Bucureşti, Romania, 1984;

14. Lazarovici G.
Neoliticul Banatului. Bibliotheca Musei Napocensis, IV, Cluj-Napoca, Romania, 1979;

15. Lazarovici G.
Neoliticul timpuriu în România. Acta Musei Porolisensis, Romania, VIII, 1984, pp 49-104;

16. Lazarovici G., Maxim Z.
Gura Baciului, monografie arheologică. Bibliotheca Musei Napocensis, XI, Cluj-Napoca, Romania, 1995;

17. Lazarovici G., Sfetcu O.
Descoperiri arheologice la Silagiu-Buziaş. Banatica, Romania, 10, 1990, pp 45-57;

18. Luca S. A.
Aşezări neolitice pe Valea Mureşului (I). Habitatul turdăşean de la Orăştie-Dealul Pemilor (punct X2). Bibliotheca Musei Apulensis, IV, Alba Iulia, Romania, 1997;

19. Luca S. A.
Repertoriul arheologic al județului Hunedoara. Bibliotheca Brukenthal, XXVI, Alba Iulia, Sibiu, Romania, 2008;

20. Luca S. A., Boroffka N., Ciută M.
Aşezarea neolitică aparținând culturii Starčevo-Criş de la Orăştie-Dealul Pemilor. Punct X8 (Campaniile 1993-1994). Apulum, Romania, XXXV, 1998, pp 17-29;

21. Luca S. A., Suciu C. I.
Bază de date deschisă (C14) pentru neoliticul şi eneoliticul din zona carpato-danubiană. Dimensiunea europeană a civilizației neolitice Est-Carpatice (ed. N. Ursulescu), Iaşi, Romania, 2006, pp 215-228;

22. Luca S. A., Suciu C. I.
Migrations and local evolution in the early Neolithic of Transylvania, The typological-stylistic analysis and the radiocarbon data. Acta Terrae Septemcastrensis, Romania, VII, 2008, pp 39-56;

23. Luca S. A., Suciu C. I., Dumitrescu-Chioar F.
Starčevo-Criş culture in Western part of Romania – Transylvania, Banat, Crişana, Maramureş, Oltenia and Western Muntenia: repository, distribution map, state of research and chronology. The first Neolithic sites in Central/South-East European Transect, volume II, Early Neolithic (Starčevo-Criş) sites on the territory of Romania (ed. S. A. Luca, C. I. Suciu), BAR International Series, Oxford, 2011, pp 7-18;

24. Lorinț C., Bărbat I. A.
Geoarchaeological study o some Neolithic polished stone tools recently discovered in the south-west of Transylvania. Annals of the University of Petroşani, Mining Engineering, Romania, vol. 13, XXXX, 2012, pp 241-252;

25. Mac I.
Geografie şi arheologie. Analogii şi convergențe. Acta Musei Napocensis, XXIV-XXV, 1987-1988, pp 867-871;

26. Mantu C. M.
Relative and absolute chronology of the Romanian Neolithic. Analele Banatului, Serie Nouă, Romania, VII-VIII, 1999-2000, pp 75-105;

27. Maxim Z.
Neo-eneoliticul Transilvaniei, Date arheologice şi matematico-statistice. Bibliotheca Musei Napocensis, XIX, Cluj-Napoca, Romania, 1999;

28. Mârza I.
La géologie empirique et la géoarchéologie. Acta Musei Napocensis, 33/1, 1996, pp 593-596;

29. Mârza I.
„Geoarheologia" sau „Studiul geoarheometric" al vestigiilor arheologice la Cluj-Napoca. Moment aniversar (1987-2007). Arheometrie în România (ed. Z. Maxim, D. Bindea, L. Săsăran), vol. 3, Cluj-Napoca, 2008, pp 45-90;

30. Mârza I., Maxim Z.
Date petroarheologice din staţiunea Starčevo-Criş de la Gura Baciului, Acta Musei Napocensis, Romania, 32, I, 1995, pp 165-180;

31. Oncescu N.
Geologia României, Bucureşti, Romania, 1965;

32. Savu H., Pavelescu M., Stancu J., Lupu D.
26. Orăştie L - 34 -XXIV. Harta Geologică, Bucureşti, Romania, 1968;

33. Starnini E., Szakmány Gy.
The lithic industry of the neolithic sites of Szarvas and Endrőd (South-Eastern Hungary): Techno-Typological and Archaeometrical aspects. Acta Archaeologica Academiae Scientarum Hungaricae, Hungary, Tomus L, Fasciculus 4, 1998, pp 279-342;

34. Tatu H., Popa O., Kalmar Z.
Contribuţii la repertoriul arheologic al Ţării Haţegului (judeţul Hunedoara). Sargetia, Romania, XXI-XXIV, 1988-1991, pp 93-119;

35. Težak-Gregl T.
Glačane kamene rukotvorine neolitičkog i eneolitičkog razdoblja u Hrvatskoj. Opuscula Archaeologica, Croatia, 25, 2001, pp 7-25;

36. Težak-Gregl T., Burić M.
Polished stone implements of the Neolithic Starčevo culture in northern Croatia. Opuscula Archaeologica, Croatia, 26, 2002, pp 13-17;

37. Ursulescu N.
Evoluţia Culturii Starčevo-Criş pe teritoriul Moldovei, Suceava, Romania, 1984;

38. Ursulescu N.
Contribuţii privind neoliticul şi eneoliticul din regiunile Est-Carpatice ale României, vol. I, Iaşi, Romania, 2000.