

Palaeolithic heat treating in Northeastern Hungary?: An archaeometric examination of the possible use of fire-setting in Stone Age quarries in the Bükk area

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During the excavations conducted by Árpád Ringer in the Palaeolithic quarries of Avas-Tűzköves in Miskolc, located at the eastern foot of the Bükk Mountains, signs of thermal alteration were observed on many of the finds. Within the scope of my PhD thesis, laboratory testing was carried out on those artefacts, with the support of experts from the University of Miskolc Department of Mineralogy and Petrology, including samples procured from other significant Stone Age sites of the area and results from experimental archaeology. On the basis of results achieved so far, the Palaeolithic use of fire-setting to extract lithic raw material in our region cannot be excluded.

KEY-WORDS: Bükk region, Stone Age, fire-setting, archaeometrical analysis

During the excavations conducted by Árpád Ringer (2011) in the Palaeolithic quarries of Avas-Tűzköves in Miskolc, located at the eastern foot of the Bükk Mountains, signs of thermal alteration were observed on many of the finds. These apparent thermal alterations led Ringer to hypothesize that prehistoric miners quarried the benches of limnic origin (in fact, postvolcanic siliceous rock, i.e. – limnosilicite) not only by using large hammerstones, but employing another technique. After clearing the limnosilicite benches, the quarrymen applied a thin layer of sand, then set extensive fire on this surface fed with fresh bones. The heat exploded the thick upper cortex of the rock, breaking it up into small pieces, and, at the same time, heat-treating the good quality Avas limnosilicite (Ringer and Szakáll 2005: 28). This method is basically similar to the fire-setting flint extracting technique employed in many places in the world (e. g. Norway, Australia), in which pieces of sizes easy to handle were split from bigger blocks of raw material by using small, controlled fire (Akerman 2006: 326; Storemyr 2013). Árpád Ringer presented several Palaeolithic artefacts made of Avas limnosilicite that he believed probably had been quarried by using the fire-setting method. To sup-

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port his hypothesis, the results of the short experiment conducted under laboratory conditions was published (Ringer and Szakáll 2005: 27, 30) but the conclusions met with scepticism in Hungarian academic circles although – sadly – written responses to the brief and generalized descriptions of the results have not been published.

During the course of my PhD thesis research I examined the available finds from the excavations carried out on the Avas hill in 1928–1935, 1961, 2001 and 2002 (Ringer 2011: 7, 8, 9). The lithic assemblage from the last excavations conducted contains a relatively high proportion (4,5%) of pieces showing macroscopic signs of thermal alteration, and many of them were subjected to infrared (IR) spectroscopic analysis at the University of Miskolc, Department of Mineralogy and Petrology. We used the following reference samples:

- 3 samples of cortical Avas limnosilicite with probable traces of thermal alteration from the excavations of 2001;
- 2 samples of the same rock type from the Szeleta-cave with probable signs of thermal alteration;
- 1 piece of Avas-type rock from the archaeological site of Méhész-tető, in Sajóabony with probable traces of heat alteration;
- 87 samples from the debitage excavated in 2002 on Avas-Tűzköves were heat-treated in the laboratory in 2014. The Avas-type limnic silicite, called Avas

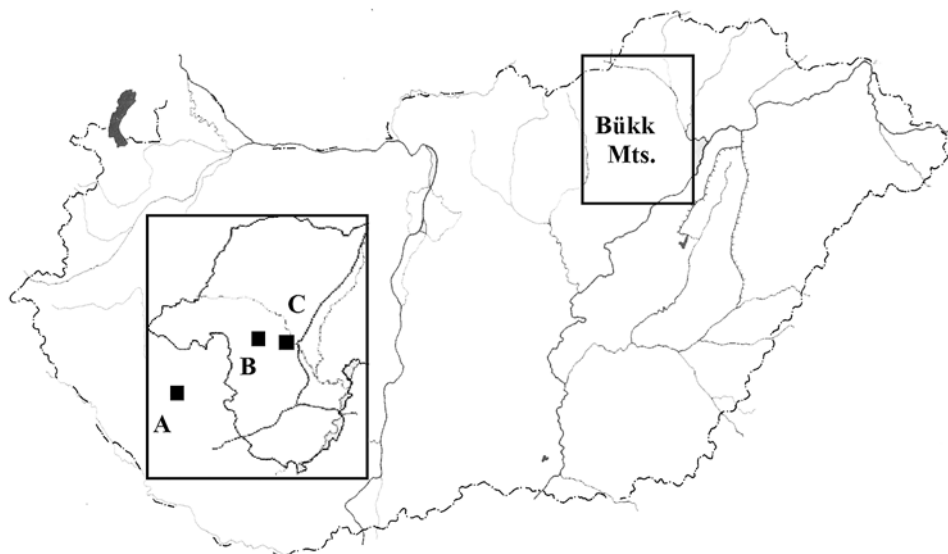


Fig. 1. Prehistoric stone quarries in the Bükk Mountains region. A. Egerbakta, Eger district (silicified tuffite); B. Bükkszentkereszt, Miskolc district (metarhyolite); C. Miskolc, Avas-Tűzköves, Miskolc district (Avas-type limnosilicite). Graphic design: Henrik Zoltán Tóth.

Flint – ‘avasi kova’ – in the Hungarian language, was divided into three groups by colour and exposed to heat (260°C and 360°C) in an annealing furnace.

- Geological samples collected on the Tűzköves site were also subjects of simulation experiments controlled by measuring instruments by different methods. Nine pieces from our experiments were also placed among the reference samples.

Effects of heat-treatment on the Avas rock were compared to other lithic types present in the same region. Principal among them is the silicified tuffite from Egerbakta, macroscopically very similar to certain variants of quartzite known from the Czech Republic and Germany. Though the number of artefacts made of this material is relatively low (Fig. 1), the beginning of its use is dated to the end of the Eemian interglacial (layers 1–3 of Subalyuk Cave), and the rock was still popular during the Middle Bronze Age (Mester 1989: 24; Fischl *et al.*, 2015: 360). Pieces discoloured possibly by elevated temperature are found in many places of the outcrop, where blocks with huge concave depressions (fracture negatives of pieces broken up by fire) also are observed (Fig. 2). Since this raw material was in use up to the end of the Prehistoric Age, the fire-setting extraction technique possibly employed here cannot be dated accurately. In our studies pieces from Egerbakta were heat treated both in simulation experiments and under laboratory conditions.

The other studied raw material is the glassy quartz-porphyry, felsitic porphyry, or, according to the modern terminology, metarhyolite. This rock was one of the most popular lithic raw materials in the Palaeolithic in Hungary (Szolyák 2011: 62–66), and so common on the archaeological sites of the Avas-hill that it was thought it might have been quarried on the spot. The best candidate for an exploitation site of metarhyolite was identified in 2012 (Tóth *et al.*, in press). In an area covering more than 40 acres large cores and pieces with reddened edges occurred in great numbers, but only a dozen pieces



Fig. 2. Silicified tuffite block with huge concave depressions, Egerbakta, Eger district. Photo: Henrik Zoltán Tóth.

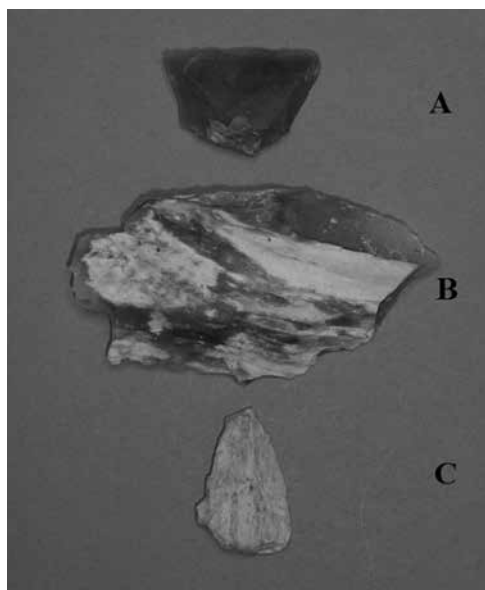


Fig. 3. Metarhyolite samples; A. Raw, grey flake; B. Raw, grey flake with partially patinated surface; C. Burned terminal end of a metarhyolite blade, Bükkszentkereszt, Miskolc district. Photo: Henrik Zoltán Tóth.

with dull, white colour have been found so far (Fig. 3). Macroscopically similar pieces also were reported from the Middle Palaeolithic site of Vanyarc, Pásztó district (Markó 2008–2009: 184–187). These artefacts are clearly not patinated but considered as traces of thermal impact. Importantly, metarhyolite, similarly to the tuffite of Egerbakta, reacts very slowly to elevated temperatures. During the simulation experiments using measuring instruments, only the samples that were heated over 600°C turned white (Tóth 2011: 12). Source collected samples heat-treated under laboratory conditions were also subjected to archaeometrical examination.

The heat release rate of bonfires fed with bone, wood or dried dung (Tóth *et al.*, in press) were compared to show the thermal effects on lithic samples placed next and underneath the fires.

CHARACTERISTICS OF THE AVAS LIMNOSILICITE

Due to its higher water content, the Avas rock made up of microcrystalline quartz and moganite (Hartai and Szakáll 2005: 20) reacts more dramatically to heat than tuffite or metarhyolite. It is possible that Avas-type limnosilicite, heated over 360°C, explodes into pieces (Tóth and Kristály unpubl.). That is the main reason, in my view, why the extensive fire setting method reconstructed by Rigner might not have been applied. Furthermore, there are a number of things that make it difficult to draw distinctions between heat-treated and untreated pieces:

- Unlike other rock types, it takes a long time for the Avas limnosilicite of brown colour variation to turn red (in mineralogical terms, for goethite to transform to hematite);
- the greasy luster of the layers underlying the cortex of the raw Avas rock is identical to that observed on the surface of the fractured stone altered by heat;
- microfractures typical of heat-treated pieces can also be found in the raw material without heating (perhaps the result of freezing);
- natural reddish discoloration occasionally occur under the cortex of the rock, as well as burgundy discoloration can be seen along the micro-fractures;
- it is virtually impossible to determine the origins of the signs of thermal alteration (e. g. pot lid fractures, micro-fractures – Schmidt *et al.*, 2012)

RESULTS OF ARCHAEOMETRIC ANALYSIS OF THE AVAS-TYPE RAW MATERIAL

Based on our earlier studies (Tóth and Kristály unpub. ms.) scanning electron microscope (SEM), X-ray diffraction analyses and thermoanalytical techniques did not give satisfactory answers to the questions if the samples had ever been subjected to heat and how

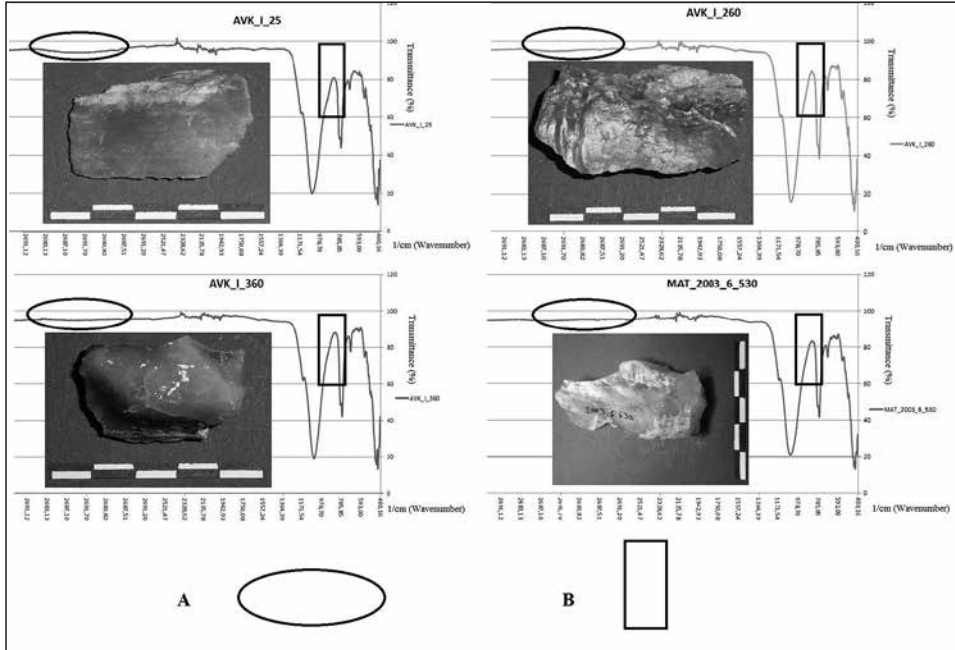


Fig. 4. IR spectroscopy diagrams: A. The decreasing of water content in the Avas-type limnosilicite (Typ 1.) samples; B. Recrystallization of the amorphous SiO₂. Graphic design: Henrik Zoltán Tóth.

high had been the temperatures transmitted to them. Contrarily three discrete variants of Avas limnosilicite could have been distinguished by applying SEM and thermoanalytical methods (MOM Derivatograph). Sharing the view of colleagues studying the same area (Schmidt *et al.*, 2012), I am also of the opinion that those methods are unsuitable for analysing thermal effects on silicified rock. The application of infrared (IR) spectroscopic imaging, on the other hand, following the investigations of Schmidt *et al.*, (2011, 2012), yielded satisfactory results. Using this latter method, we could distinguish several pieces with greasy luster from the assemblage of the 2002 excavations at Avas-Tűzköves, which might have been made after being subjected to thermal alteration; for example, the broken blade of transparent material (Inventory number in the Herman Ottó Museum, Miskolc: 2003. 6. 530.) and three reference pieces – untreated, heated 1 (260°C) and heated 2 (360°C), from the same type of Avas limnosilicite (Fig. 4; Tóth unpubl. ms.).

CONCLUSIONS: REASON FOR USING FIRE-SETTING

To support the hypothesis of heat treatment and to interpret the results of IR spectroscopy investigation it is important to ask: Why should Stone Age people have used fire-setting to extract stone in the Bükk region? The notion of producing more suitable raw material for toolmaking by using the method seems very unlikely, since hardly any palaeoliths have been found in the area made of heat-treated lithic raw material. It seems more reasonable to believe that, by creating high shear stress using small, controlled fires, the aim of prehistoric flint extractors was to crack bigger blocks of raw material and - in case of Avas-Tűzköves - limnosilicite benches, without using hammerstones that would have possibly pulverised the stone. This could have happened when they ran out of smaller pieces in the quarries, due to the increased need for raw material. On the basis of our results achieved so far, the palaeolithic use of fire-setting to extract lithic raw material in our region cannot be excluded.

REFERENCES

- Akerman, K. 2006. High tech–low tech: lithic technology in the Kimberley Region of Western Australia. In J. Apel and K. Knutsson (eds), *Skilled production and social reproduction – aspects of traditional stone-tool technologies proceedings of a symposium in Uppsala, August 20–24, 2003 SAU Stone Studies* 2, 323–346. Uppsala
- Fischl, P.K., Kienlin, T.L., Pusztai, T., Brückner, H., Klumpp, S., Tugya, B. and Lengyel, Gy. 2015. Tard-Tatárdomb: An Update on the Intensive Survey Work on the Multi-Layer Hatvan and Füzesabony Period Settlement. In: T.L. Kienlin, P. Valde-Nowak, M. Korczyńska, K. Cappenberg and J. Ociepka (eds), *Settlement, communication and exchange around the Western Carpathians*, 341–379. Cologne.

- Hartai, É. and Szakáll, S. 2005. Geological and mineralogical background of the Palaeolithic Chert mining on the Avas Hill, Miskolc, Hungary. *Prehistoria* 6 : 15–21.
- Markó, A. 2008–2009. Raw material use at the Middle Palaeolithic site of Vanyarc (northern Hungary). *Prehistoria* 9–10: 183–194.
- Mester, Zs., 1989. The revision of the Middle-Palaeolithic industries of the Suba-lyuk Cave (A Subalyuk-barlang középső paleolitikus iparainak újraértékelése). *Folia Archaeologica* 40: 99–106.
- Ringer, Á. and Szakáll, S. 2005. Palaeolithic stone raw material mining and processing on the Avas Hill of Miskolc. *Prehistoria* 6: 23–31.
- Ringer, Á. 2011. Paleolithic chert mines on the Avas Hill in Bükk Mountains, North-East Hungary. *D'Université Valahia Targoviste* 13 (2): 7–11.
- Schmidt, P., Badau, A. and Fröhlich, F. 2011. Detailed FT near-infrared study of the behaviour of water and hydroxyl in sedimentary length-fast chalcedony, SiO₂, upon heat treatment. *Spectrochimica Acta Part A* (81): 552–559.
- Schmidt, P., Masse, S., Laurent, G., Slodczyk, A., Le Bourhis, E., Perrenoud, C., Livage, J. and Frölich, F. 2012. Crystallographic and structural transformations of sedimentary chalcedony in flint upon heat treatment. *Journal of Archaeological Science* 39 (1): 135–144.
- Szolyák, P. 2011. Primary processing of the raw material in the site of the Szeletian Quartz-porphyr (Bükkszentlászló, Hungary). *A Herman Ottó Múzeum Évkönyve* 50: 47–66.
- Storemyr, P. 2013. Burning rock: fire setting at the Stone Age Melsvik chert quarries. Electronic document, <http://www.pasthorizonspr.com/index.php/archives/11/2013/burning-rock-fire-setting-stone-age-melsvik-chert-quarries>
- Tóth, Z.H. 2011. Heat-treatment experiment on the limnic-quartzite Raw Material of Rátka-Hercegköves. *Archeometriai Műhely* 8(3): 9–13.
- Tóth, Z.H. 2015. Comparative heat-treating Experiments on Avas-Limnosilicite. Unpublished manuscript.
- Tóth, Z.H., Németh, N. and Ringer, Á. 2015. Neuer Beitrag zum Vorkommen des Szeletian Quartzporphyr in Bükkszentlászló und Bükkszentkereszt. *Prehistoria*. In press.
- Tóth, Z.H. and Kristály, F. 2015. Laboratory comparative heat-treating experiments on Avas-type stone material. Unpublished manuscript.

