

Dark Coloured Laminae Within Speleothems as an Indicator of the Prehistoric Man Activity: Case Study from Domica Cave (Slovakia), Preliminary Results

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Abstract

The paper deals with the dark coloured laminae which occur within speleothems in Domica cave (Slovakia). The laminae are composed of charcoal particles and organic aromatic compounds.

The components were formed during combustion of wood inside the cave. Thus, they are connected with the prehistoric man activity. It is in concordance with the earliest archaeological studies which proved that Domica was settled during Neolithic times. Uranium series dating the laminae are in progress.

Introduction

The prehistoric man activity is often recorded in caves. Besides typical archaeological materials, such as pottery or flint tools, some traces of men can be recognized within speleothems (HILL, 1982).

Some of the most spectacular ones were found in Domica cave, situated in Slovakian Karst (ROTH, 1948; PETRŃNEK, & POUBA, 1951). The origin of this laminae is an aim of this paper. Moreover, an attempt at using such laminae as a tool in dating prehistoric man's activity is made.

Domica Cave

Domica cave is located in Slovakian Karst, near the Slovak - Hungarian border (Figure 1). The cave is more than 5000 m long (DROPPA, 1970). The name Domica refers to the Slovakian part of a big cave (25 km long), whose Hungarian part is named Baradla.



Figure 1



Figure 2

Figure 1 : Location of Domica cave

Figure 2 : Neolithic vessel partly covered with flowstone, Domica cave, Sien Odvachi

Domica cave was settled by prehistoric man during Neolithic times (BARTI, 1963; LICHARDUS, 1968). Afterwards the entrance was blocked by a boulder chock and the cave was not accessible up to the twenties of the last century. There are four periods of Neolithic human inhabitation. The first is connected with early Neolithic StarĚevo - Karanovo - Kriö pottery, the second with Linear Neolithic pottery, the third with B₃kk culture while the fourth with late B₃kk culture (LICHARDUS, 1968). Many archaeological materials were found in Domica cave, that is more than 45 000 fragments of pottery, numerous flint and bone tools (Figure 2). More than 85% of all archaeological materials belong to B₃kk culture and thus the cave is one of more important sites of this culture in Slovakia. Neolithic men settled cave periodically, probably during winter seasons by several hundred years. The cave was a place of subterranean exploitation of fine grained deposits for producing pottery, a source of water, as well as, a holy place. The foot traces indicated that Neolithic man visited deep, completely dark, part of the cave, as far as a few hundred meters away from the entrance.

Dark Coloured Laminae

The cave is also famous for numerous speleothems. Dark coloured laminae occur inside some of them. The laminae were found in several small stalagmites as well as in flowstones situated in the hall called Sien Odvachi and the lower part of the passage called Panenska Chodba (Figures 3-5). Macroscopically, the laminae are less than 0.8 cm thick. In some cases the lamina is composed of a few thinner ones.



Figure 3

Figure 3: Polished slab of a stalagmite from Sien Odvachi hall (specimen 1); position of dated samples are indicated; scale bar 3 cm.

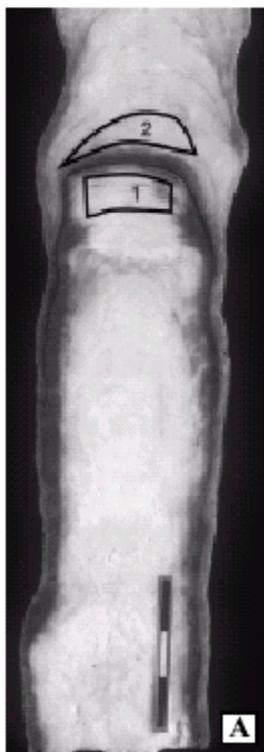


Figure 4

Figure 4: Polished slab of a stalagmite from Sien Odvachi hall (specimen 3); position of dated samples are indicated; scale bar 3 cm.

The dark coloured laminae are built of opaque particles and semiopaque components. The former possess angular shape and jet black colour (Fig. 6). They differ in size and shape. The smallest are only some micrometers long, while the largest are up to 1 mm long. The shape of opaque particles is isometric or elongate. Under a petrographic microscope some of the particles display porous internal structure. The opaque particles are nonfluorescent. All the above characteristics prove that particles in question are charcoal fragments (PATTERSON et al., 1987). The above statement is confirmed by the observation of their internal structures by means of SEM (Figures 7-8). The majority of the particles is characterized by homogenization of cell wall ultrastructure (SANDER & GEE, 1990; JONES & CHALONER, 1991; VAUGHAN & NICOLS, 1995). Some of them are destroyed by cracking which leads to disintegration of larger particles.

The processes of homogenization are due to combustion of wood in the temperature of about 400°C (JONES & CHALONER, 1991; VAUGHAN & NICOLS, 1995).

The semiopaque components are intensively brown in transparent light and display yellow-brown UV fluorescence. It indicates that they are composed of non carbonized organic compounds (TEICHMÜLLER & WOLF, 1977; DREVIES & YUREVICZ, 1985).

These components occur together with charcoal particles. The opaque and semiopaque components, which the form dark coloured laminae occur on uncorroded calcite crystals (Figure 6) and, seldom, on corrosional surfaces (Fig. 9). In the former case they wrapped the crystal terminations with the layer so thick that younger crystals start to grow competitively (cf. GONZÁLEZ et al., 1992; SUNAGAWA, 1994).

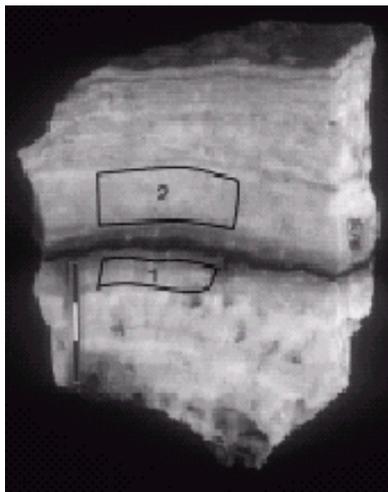


Figure 5

Figure 5 : Polished slab of a flowstone from Panenska chodba passage (specimen 7); position of dated samples are indicated; scale bar 3 cm

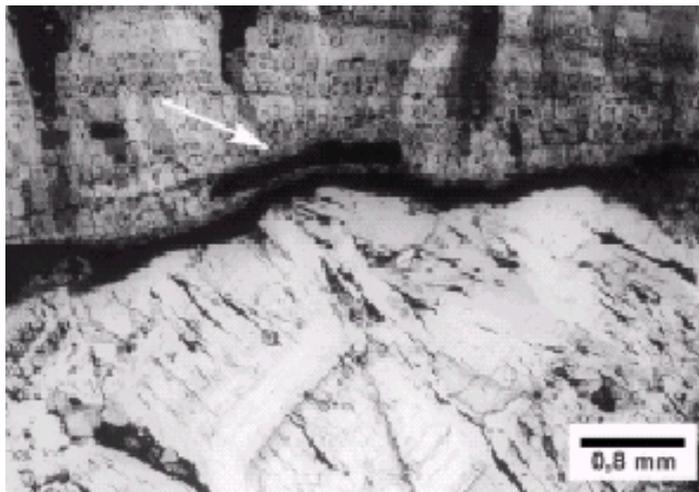


Figure 6

Figure 6 : Charcoal particles and organic compounds occur on the corrosional surfaces, note the tiny spike shape of large charcoal particle (arrow), thin section

Deposition of Dark Coloured Laminae

The laminae in question were deposited when Neolithic men settled the cave. The small particles of charcoal together with aromatic organic compounds were formed during combustion of wood inside the cave. They were spread around due to convection flow of hot air (CLARK, 1988) and subsequently were trapped on the surface of speleothems (cf. BURNEY & BURNEY, 1993) and, in the end, formed dark coloured laminae. The origin of such laminae seems to be a relatively common feature connected with the human activity and therefore the laminae are good indicator prehistoric settlement in caves. Charcoal particles and dark laminae have been found also within speleothems in other caves of Slovakian Karst (KUNSKÝ, 1939; BĚRTA, 1961; KUŠERA, 1964), some caves in the Cracow-WieluŃ Upland, Poland (GRADZIŃSKI et al., 1996) and a cave in Norway (LAURITZEN et al., 1990). Soot derived from torches of prehistoric miners was recognized in the Mammoth Cave System and Salt Cave too (BENNINGTON et al., 1962; WATSON, 1966; HILL, 1982).

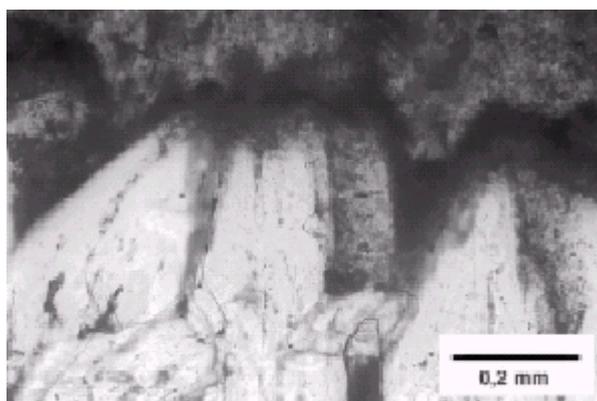


Figure 9 : Charcoal particles and organic compounds covered uncorroded calcite crystals, thin section

Dating of Prehistoric Man Activity

In the light of the above presented origin of dark coloured laminae they are good indicator of human inhabitation in caves. Thus, it is possible to date the episodes of human activity on the base of these laminae by using standard dating techniques for speleothems (e.g. Th/U or 14C).

The samples of 4-14 g in weight were cut just below and above the dark coloured laminae in three speleothem samples. After cleaning and adding 228Th/232 U spike, the samples were dissolved in ca. 7M HNO₃. Uranium and Thorium separation were done using chromatography method. After purification, the U and Th fraction were electroplated on stainless steel discs. Activities of U and Th

isotopes were measured by an α -spectrometry using OCTETE PC equipment (ORTEC product). The spectra were processed by NURANTHOR 2.0 program. Quoted errors are 1s.

The results of preliminary analyses are shown in Table 1. All samples are very low in Uranium content (0.03-0.05 ppm). They contain significant amount of 232Th and hence need correction for nonradiogenic Thorium. Unfortunately, we have no information about isotope composition of detrital contamination in these speleothems. At present, we are able to use only correction assuming value 230Th/232Th activity of detrital contamination equal to 1.5±0.5 (cf. IVANOVICH & HARMON, 1992). Low Uranium content and the above correction increase the errors and thus further work is necessary to obtain better results.

The dark laminae in sample 7 are younger than 33±3 ka and older than 9.8±2.5 ka. One can compare this age with the age of charcoal detritus collected within the cave clastics in another part of Domicia and dated using 14C method in the sixties. The age of charcoal is 6080±75 ka (BjRTA, 1964). Hence, the dark lamina seems to be older than charcoal, even taking into account a possible error of the upper age limit. However, due to the above presented imperfections of the so far obtained uranium dates, the problem should be regarded as being still open.

Table 1. U-series dating results

Lab No	Sample	U cont. [ppm]	²³⁴ U/ ²³⁸ U	²³⁰ Th/ ²³⁴ U	²³⁰ Th/ ²³² Th	(²³⁴ U/ ²³⁸ U) ₀	Age [kyr]	Corrected age [kyr]	Remarks
W 609	1-1	0.05±0.03			1.8				lost U
W 610	1-2	0.04±0.005	1.405±0.171	0.154±0.009	3.3	1.417±0.561	18.1±1.1	10.3±3.8	
W 607	3-1	0.05±0.02			3.8				lost U
W 608	3-2	0.05±0.005	0.847±0.119	0.474±0.032	2.3	0.83±0.58	71±6	31±23	
W 611	7-1	0.03±0.003	1.741±0.157	0.295±0.012	12.7	1.813±0.325	37±2	33±3	
W 612	7-2	0.03±0.003	1.132±0.126	0.122±0.008	4.8	1.135±0.314	14±2	9.8±2.5	

Conclusions

1. Dark laminae occurring in speleothems in Domicia cave are coloured due to charcoal particles and organic compounds.
2. Charcoal particles and organic compounds developed during wood combustion inside caves.
3. Dark laminae in speleothems are good indicator of prehistoric settlement in caves.

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References

- BjRTA, J. 1961. Zur Problematik der H²lensiedlungen in den slowakischen Karpaten. Acta Archeologica Carpathica 2 : 5-39.

- BjRTA, J. 1964. Contribution to the prehistoric settlement of the caves of the Domica system. (In Slovak, English summ.). Slovensk½ kras 5 : 58-73.
- BENNINGTON, F., MELTON, C. & WATSON, P. J. 1962. Carbon dating prehistoric soot from Salts Cave, Kentucky. American Antiquity 28 : 238-241.
- BURNEY, D. A. & BURNEY, L. P. 1993. Modern pollen deposition in cave sites: experimental results from New York State. New Phytologist 124 : 523-535.
- CLARK, J. S. 1988. Particle motion and theory of charcoal analysis: source area, transport, deposition and sampling. Quaternary Research 30 : 67-80.
- DREVIS, J. J. & YUREWICZ, D. A. 1985. Enhanced carbonate petrography using fluorescence microscopy. Journal of Sedimentary Petrology 55 : 795-804.
- DROPPA, A. 1970. Contribution to the development of Domica Cave. (In Czech, English summ.). »eskoslovensky Kras 22 : 65-72. GONZjLEZ, L. A., CARPENTER, S. J. & LOHMANN, K. C. 1992. Inorganic calcite morphology: roles of fluid chemistry and fluid flow. Journal of Sedimentary Petrology 62 : 382-399.
- GRADZI—SKI, M., G”RNY, A., PAZDUR, A., & PAZDUR, M. F. 1996. Origin of black coloured laminae in speleothems from Cracow-WieluÓ Upland. In: (S.-E. Lauritzen, ed.): Climate Change: The Karst Record, Extended Abstracts of a Conference held on The Department of Geology, University of Bergen, Norway, August 1- 4th 1996. Karst Water Institute, Charles Town: 46.
- HILL, C. A. 1982. Origin of black deposits in caves. National Speleological Society Bulletin 44 : 15-19.
- IVANOVICH, M. & HARMON, R. S. 1992. Uranium Series Disequilibrium. Applications to Environmental Problems. Clarendon, Oxford, 571 p.
- JONES, T. P. & CHALONER W. G. 1991. Fossil charcoal, its recognition and paleoatmospheric significance. Paleogeography, Paleoclimatology, Paleoecology 97 : 39-50.
- KU»ERA, B. 1964, The karst and the development of Ardovo Cave in South-Slovakian Karst. (In Czech, English summ.). »eskoslovensk½ Kras 16 : 41-56.
- KUNSK, J. 1939. Ardovsk· jeskynĚ ve SlovenskĚm Krasu. Rozpravy II, TrĚdy »eskĚ Akademie 49, 21 : 1-11.
- LAURITZEN, S.-E., LØVLIE, R., MOE, D., ØSTBYE, E. 1990. Paleoclimate deduced from multidisciplinary study of the half-million-year- old stalagmite from Rana, Northern Norway. Quaternary Research 34 : 306-316.
- LICHARDUS, J. 1968. Domica-HĚle, die bedeutendste Siedlung der B,kker Kultur. (In Slovak, German summ.). VydavateĚstvo Slovenskej AkadĚmie Vied, Bratislava, 121 p.
- PATTERSON III, W. A., EDWARDS, K. J. & MAGUIRE, D. J. 1987. Microscopic charcoal as a fossil indicators of fire. Quaternary Science Reviews 6 : 3-23.
- PETRjNEK, J. & POUBA, Z. 1951. Dating of the development of the Domica Cave, based on the study of the dark zones in the travertine formations. (In Czech, English summ.). SbornĚk /stĚdnlĚho /stavu GeologickĚho 18 : 245-272.
- ROTH, Z. 1948. Description de quelques formations concrĚtionnĚes des grottes de Domica. (In Czech, French summ.). SbornĚk StĚneho /stavu GeologickĚho 15 : 65-88.
- SANDER, P. M. & GEE, C. T. 1990. Fossil charcoal: techniques and applications. Review of Paleobotany and Palynology 63 : 269-279.
- SUNAGAWA, I. 1994. Nucleation, growth and dissolution of crystals during sedimentogenesis and diagenesis. In: (Wolf, K. H. & Chilingarian, G. V. eds.): Diagenesis, IV. Developments of Sediementology, 51. Elsevier, Amsterdam : 19-47.
- TEICHMĚLLER, M & WOLF, M. 1977. Application of fluorescence microscopy in coal petrology and oil exploration. Journal of Microscopy 109 : 49-73.
- VAUGHAN, A. & NICHOLS, G. 1995. Controls on the deposition of charcoal: implications for sedimentary accumulations of fusain. Journal of Sedimentary Research A65 : 129-135.
- WATSON, P. J. 1966. Prehistoric miners of Salt Cave, Kentucky. Archeology 19 : 237-243.