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The $\delta^{18}O$ record of a Holocene stalagmite from V11 Cave, NW Romania

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Stable isotope analyses on a Holocene stalagmite from V11 Cave yield a paleoclimate record for the last 9200 years. The stalagmite chronology is based on seven high precision U-Th ages obtained by thermal ionization mass spectrometry (TIMS).

The V11 Cave is located in the SE part of Varasoaia Glade (Bihor Mountains, NW Romania), at 1254 m a.s.l. The cave is formed in Anisian limestones and dolomites, has 1166 m of surveyed passages and a vertical extension of 67 m (–37 m; +30 m) (Damm, 1993). The cave area is a typical karst plateau with sinkholes and ponors, with vegetation mainly consisting of spruce stands and alpine herbs (Bodnariuc *et al.*, 2002). The present-day climate of the area is predominantly influenced by west-northwest oceanic air masses. The mean annual temperature is 5˚C and the mean annual precipitation exceeds 1200 mm. The mean annual temperature and the relative humidity in the cave, measured between 2003 and 2004, are 6.5°C and 97–98%, respectively (Tamas *et al.*, 2005).

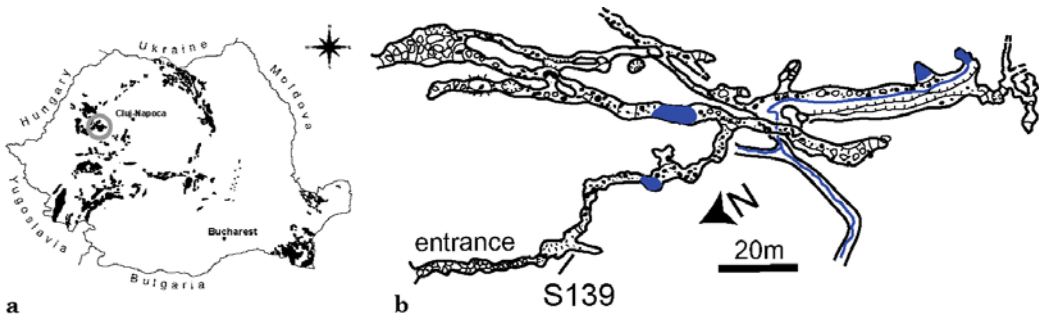

Fig. 1. a) V11 cave location in Romania (gray circle); b) Cave map with position of S139.

The S139 stalagmite has 20.5 cm in length, and a fairly constant diameter of 5-6 cm, except for the first two cm at the top (3 cm in diameter). S139 was active when sampled, growing on the wall of a small room, which intersects the main passage some 30 m from the cave entrance and about 20 m below the surface. It is composed of pure white calcite with columnar fabric, with few pores and hardly visible growth

laminae, and shows no signs of recrystallization. At 25 mm from the top, a short growth hiatus occurs, associated with dissolution of the central part of the sample. Another small concavity is noticed at 60 mm from base, indicating dripwater corrosion, but with limited extension (3 mm) in depth. Such features may be explained by the faster-dripping unsaturated water feeding the stalagmite during summer, fact noticed during dripwater sampling in 2003-2004.

Seven calcite subsamples (0.8-2 g weight, 3 mm thick) were taken for the TIMS dating. Chemical separation followed procedures from Tamas and Causse (2001) and Constantin *et al.* (2007). Uranium and thorium ratios were measured in peak jumping mode on a Finnigan-MAT262 mass spectrometer.

All samples show relatively high uranium contents, ranging from 3.5 to 5 ppm. No correction for detrital contamination was performed, as $^{230}Th/^{232}Th$ ratios obtained are fairly high (660 – 9000). The lower $^{230}Th/^{232}Th$ value for the top subsample (~107) is obviously due to the small amount of ^{230}Th. The ages range between 9257±23 yr and 52±3 yr BP, the latter obtained for the first 3 mm from the stalagmite top. A growth hiatus is recorded between 2178 and 929 yr BP. The average growth rate for the whole stalagmite is 22 mm/ky, but faster growth is recorded in the intervals 9.2-8.4 ky BP (36 mm/ky) and 7.2-6.4 ky BP (93 mm/ky).

203 samples for stable isotope analyzes were taken at 1 mm along the growth axis and 3 growth layers were checked for kinetic isotopic fractionation. Tests for equilibrium deposition show little correlation between $\delta^{18}O$ and $\delta^{13}C$ values along the stalagmite ($r^2 = 0.2$), however on the last growth interval, from 929 yr. to present, we found a strong covariation between the two records ($r^2 = 0.8$). The maximum variations of $\delta^{18}O$ values within the growth layers were 0.14‰, 0.3‰, and 0.34‰ respectively. All these data point to calcite deposited under equilibrium conditions with respect to oxygen and carbon isotopes (Hendy, 1971) along most of the stalagmite.

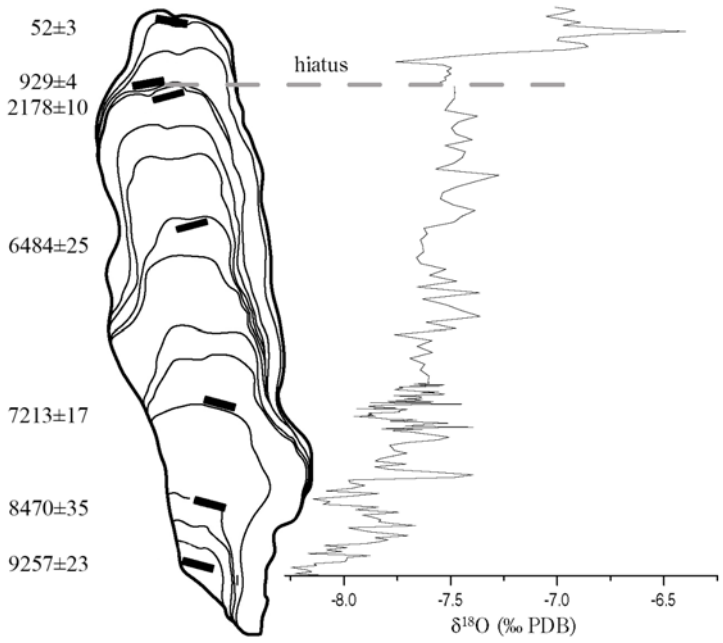

Fig. 2. Ages and position of samples for U-Th dating on S139 and the $\delta^{18}O$ record.

The $\delta^{18}O$ values range between -6.40‰ and -8.25‰ PDB along the stalagmite growth axis, with a mean value of -7.64‰. $\delta^{13}C$ values vary between -3.5‰ and -7.14‰ PDB. A comparison of the S139 record with isotope data obtained from two other stalagmites (S22 and S117) sampled from the same cave (Tamas *et al.*, 2005) shows there is a good correlation between the three records over the common 9.2 ky – 5.6 ky period. Two small drops to values < -8‰ centered at 9.2 and 8.2 ky are ascribed to cold events detected in the Greenland ice cores and other paleoclimate proxies (e.g., von Grafenstein *et al.*, 1999; Bond *et al.*, 2001). Between 7.8 and 2.1 ky, the oxygen record slightly increases, but has lesser variation. The last growth interval, from 900 yr to present, is marked by a sharp increase of $\delta^{18}O$ and $\delta^{13}C$ values at around 700 yr BP As a whole, the isotope record allows comparison with pollen and paleovegetation data from the area.

References

Bodnariuc, A., Bouchette, A., Dedoubat, J.J., Otto, T., Fontugne, M., Jalut, G. 2002. Holocene vegetational history of the Apuseni mountains, central Romania. *Quaternary Science Reviews*, **21**: 1465-1488.

Bond, G., Kromer, B., Beer, J., Muscheler, R., Evans, M.N., Shower, W., Hoffman, S., Lotti-Bond, R., Hajdas, I., Bonani, G. 2001. Persistent solar influence on North Atlantic climate during the Holocene. *Science*, **294**: 2130–2136.

Constantin, S., Bojar, A.-V., Lauritzen, S.-E., Lundberg, J. 2007. Holocene and Late Pleistocene climate in the sub-Mediterranean continental environment: A speleothem record from Poleva Cave (Southern Carpathians, Romania). *Palaeogeography, Palaeoclimatology, Palaeoecology*, **243**: 322-338.

Damm, P. 1993. Consideratii asupra sistemului carstic Varasoaia-Boga. *Anuarul Stiintific al Societatii Ardelene de Speologie*, pp. 30-49.

Hendy, C.H. 1971. The isotopic geochemistry of speleothems. Part 1. The calculation of the effects of different modes of formation on the isotopic composition of speleothems and their applicability as paleoclimatic indicators. *Geochimica Cosmochimica Acta*,**35**: 801 – 824.

Tămaş, T., Causse, C. (2001). U–Th TIMS chronology of two stalagmites from V11 Cave (Bihor Mountains, Romania). *Theoretical and Applied Karstology*, **13-14**: 25-32.

Tămaş, T., Onac, B.P., Bojar, A.-V. 2005. Lateglacial - Middle Holocene stable isotope records in two coeval stalagmites from the Bihor Mountains, NW Romania. *Geological Quarterly*, **49** (2): 185-194.

von Grafenstein U., Erlenkeuser H., Brauer A., Jouzel J., Jonsen S. 1999. A mid-European decadal isotope climate record from 15,500 to 5000 years BP. *Science*, **284**: 1654–1657.