

CUPULAS OF THE MALACHITDOM CAVE (SAUERLAND/NRW) – CRYOGENIC SPHEROLITHES WITH UNUSUAL CALCITIC STRUCTURE AND C/O-ISOTOPIC COMPOSITION

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The calcitic cupula-spherolithes, first described from the Malachitdom cave (Schmidt, 1992) show sizes between 1 mm and 11 mm, and a dish-shaped depression on one side. The concave side of the cupulas is quite smooth, whereas the convex side shows subparallel oriented rhomboedral faces at the end of the calcite fibres.

According to Scanning Electron Microscope (SEM) observations these rhomboedral faces are bent-shaped, which coincides with the results of Electron Backscatter Diffraction (EBSD) analyses. These pigmented single fibres are distinguished by a diverging *c*-axis orientation within the crystals. Beak-shaped spherolithes, which do not have the characteristic indentation but show the same alignment of fibres, are counted to the cupulas in the broader sense as they are found next to the real cupulas.

The results of the C/O-isotope analyses of the cupulas showed $\delta^{13}\text{C}$ -values ranging from -1 to -5 ‰ VPDB and $\delta^{18}\text{O}$ -values between -7 and -14 ‰ VPDB. Within the spherolithes a trend becomes apparent for a lighter O-isotopy and a heavier C-isotopy from the inner to the outer parts. According to Žák et al. (2004) those values differing significantly from the composition found in other speleothemes, are explained by the formation of calcites due to slowly freezing water. During this process, the O-isotopy is mainly affected by the formation of ice whereas the C-isotopy is merely influenced by the degassing of CO_2 .

The cupula-spherolithes show age ranges from 14.48 ± 0.12 kyr to 15.61 ± 0.20 kyr (U/Th-analyses by Denis Scholz, Heidelberg). This substantiates a genesis during the Weichselian-glacial shortly before the Bölling-interstadial. Probably due to a slow climatic warming lasting for centuries water infiltrated temporary into the cave (lying within the permafrost) and formed an ice-body. On top of the ice liquid water form small pools in which cryogenic calcites formed very slowly (*sensu* Žák et al., 2004). These were enclosed when the water froze and were later sedimented on the cave floor during the melting of the ice.

Two remain problems:

1. The Weichselian formation of an icebody could not yet be proven for the Malachitdom cave.
2. The dish-shaped depression of the real cupulas needs to be explained.

Schmidt, F. X. (1992): Mineralogische Besonderheiten aus dem Höhlensystem Kreiselhalle Malachitdom. – In: Geologisches Landesamt Nordrhein-Westfalen [Hrsg.]: Der Malachitdom. Ein Beispiel interdisziplinärer Höhlenforschung im Sauerland: 91–104; Krefeld.

Žák, K., Urban, J., Cilek, V. & Hercmann, H. (2004): Cryogenic cave calcite from several Central Europe caves: age, carbon and oxygen isotopes and a genetic model. – *Chemical Geology*, 206: 119–136; Amsterdam.