



## Authigenic burbankite in the Cioclovina Cave sediments (Romania)

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This study reports the occurrence of the rare anhydrous carbonate, **burbankite** -  $(\text{Ca,Na})_3(\text{Ca,Sr,Ba,REE})_3(\text{CO}_3)_5$  in a complex cave mineral assemblage for the first time. Burbankite was identified by means of single-crystal and powder X-ray diffraction, energy dispersive spectrometry, and electron-microprobe analysis in a lacustrine-like sediment sequence near the Bivouac Room in Cioclovina Cave, Romania. It appears as a thin crust composed of sub-millimeter yellow grayish anhedral crystals. Nearby its occurrence, we also identified foggite, churchite-(Y), sampleite, colorless or milky white needle-like brushite and gypsum crystals.

Single-crystal X-ray investigations gave  $a = 10.5138(4)$  and  $c = 6.4770(3)$  Å, space group  $P6_3mc$ ,  $Z = 2$ . The structural refinement converged at  $R = 0.033$  for  $828 F_o > 4\sigma(F_o)$ . The structure refinement was performed to verify the order at the two sites A and B. The A site is [8] coordinated with an average A—O distance of 2.491 Å; the B site is [10] coordinated, the average B—O distance is 2.678 Å. As expected the Na and Ca atoms are concentrated in the smaller  $\text{AO}_8$  polyhedron whereas the larger cations occupy the B site. The carbonate groups are planar within the accuracy of structure refinement, C—O varies from 1.266(5) to 1.294(4) Å.

The origin of burbankite is considered to be as follows: Sodium is initially leached from the surrounding silicates and then transported into the cave by the underground stream and percolating waters. The alkali becomes balanced in solution by  $\text{OH}^-$  ions through hydrolysis and after reacting with carbon dioxide, yields locally alkali carbonates solutions that precipitated burbankite under dry and poor or no drainage con-

ditions.