MINERALOGY AND ORIGIN OF GEODES IN THE BALATONFELVIDÉK SANDSTONE FORMATION AT CSOPAK VILLAGE, BALATON HIGHLAND, HUNGARY

KISS, G. & MOLNÁR, F.
Department of Mineralogy, Eötvös Loránd University, Pázmány Péter sétány 1/C, H-1117 Budapest, Hungary
E-mail: gabriella-kiss@chello.hu

The Balatonfelvidék Sandstone Formation – in which geodes can be found – is a continental, siliciclastic flood-plain sediment of uppermost Permian age. Locally it contains carbonate knots as remnants of palaeosoil carbonates formed in a swamp environment (MAJOROS, 1983). The sandstone is covered by the lower Triassic Werfen Group, which is a lagoonal and/or shelf carbonate sediment

At some localities, the sandstone locally contains large amount of geodes with up to 5-cm diameter (Fig. 1). Along the wall of a typical geode opal-CT forms millimetre thick encrustation. Towards the centre of geodes coarse grained, subhedral to euhedral, short prismatic quartz crystals ("Cumberland" habit) can be found. They contain large amounts (up to approx. 20-30 mass %) of inclusions of euhedral to anhedral anhydrite crystals. Geode centres are usually hollow; tabular barite crystals grown up on the surface of quartz can be found in these spaces. Barite crystals have sometimes a light blue colour, and have elevated (several wt%) Sr content. Main forms of barite crystals are *c*{100} and *m*{110}. Faces of *d*{102} are less developed on some crystals, which otherwise have well developed *o*{011} faces. Encrusting late stage calcite fills up the centre of some of the geodes.

Fluid inclusion (Fig. 2) petrography of quartz revealed extreme differences among the phase proportion of primary inclusions. This indicates inhomogeneous fluid inclusion entrapment from a parent fluid with heterogeneous phase composition. Because of this, no inevitable conclusion can be drawn in connection with the temperature of the formation on the basis of fluid inclusion microthermometric studies. Considering salinities of fluid inclusions, two fluid types were recognised: the first one is characterised by a concentration of 2,07–1,73 NaCl equ. wt%, and the second one is characterised by a concentration of 1,05–0,35 NaCl equ. wt%. Microthermometric behaviour of some inclusions suggests carbonic/organic gas content of fluids.

The geodes are evidently epigenetic formations in the sandstone and probably were formed at the time of deposition of the Lower Triassic cover. Mineralization of geodes could have formed in the mixing zone of two types of fluids. The first type of fluids descended from the Triassic cover and, because of the characteristics of that depositional environment, it contained Ca^{2+}, Sr^{2+} and SO_4^{2-}. The second type was an ascending, probably higher temperature fluid, which contained Ba^{2+} and H_3SiO_4 from alteration of rock forming feldspars in the deeper zones of the sandstone and gas from decaying organic material. In the mixing area, at first the upwelling fluid dissolved carbonate knots in the sandstone and thus prepared the space for geodes. Cooling of those fluids by mixing with the descending solutions resulted in oversaturation in silica due to drop of temperature and that is why opal-CT formed at the first stage of mineralization. Quartz started to precipitate by decreasing of silica saturation. Because of their retrograde solubility, anhydrite and barite had precipitated by warming up of descending fluids in the mixing zone together with silica minerals.

Reference

MAJOROS, GY. (1983): Acta Geologica Hungarica, 26: 7–20.

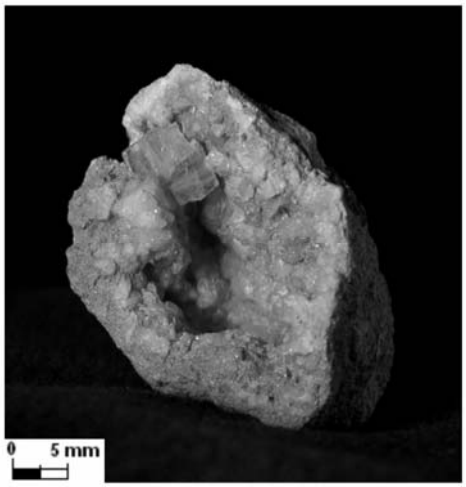

Fig. 1. (left): A geode with tabular barite crystal. Encrusting calcite can also be seen.

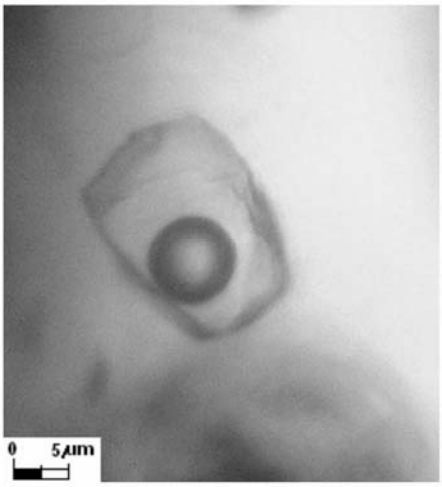

Fig. 2. (right): Fluid inclusions are usually 15-45 µm in size. This is a little one, with a concentration of 0.4 NaCl equ. wt%.