

## CONGOLITE FROM THE KŁODAWA SALT MINE (CENTRAL POLAND) AND ITS IMPORTANCE AT EVALUATION OF METAMORPHIC CONDITIONS IN THE SALT DOME

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Congolite,  $(\text{Fe,Mg})_3\text{B}_7\text{O}_{13}\text{Cl}$ , a mineral belonging to the boracite group (boracite, trembathite, congolite, chambersite and ericaite), occurs in nature exceptionally rarely in marine evaporites. For the first time this mineral was described from Mesozoic salts of Kouilou Department in Republic of Congo, Brazzaville (WENDLING *et al.*, 1972), and then was only found in the Penobsquis and Millstream evaporate deposits of southern New Brunswick, Canada (ROULSTON & WAUGH, 1981; BURNS & CARPENTER, 1996; GRICE *et al.*, 2005), and in the Boulby potash mine, Loftus, Cleveland, England (<http://www.mindat.org>). The Kłodawa salt dome, with active underground salt mine, is a following occurrence of congolite.

Congolite has been recognized in the Underlying Halite and Youngest Halite units of the Zechstein profile, separated with the Pegmatite Anhydrite unit. The Underlying Halite, forming the top of the PZ–3 cyclothem, is represented by three-meter-thick layer of grey-orange rock-salt containing 93.4–96.1 wt% NaCl. The Youngest Halite of the PZ–4 cyclothem forms *ca.* 70-meter-thick lode of almost pure halite (98.5–99.0 wt% NaCl), pale orange to pale pink in colour. Congolite occurs at the bottom of the layer, about 3–4 m from the contact with the Pegmatite Anhydrite, in an interval of further 4–5 m.

The Kłodawa congolite forms euhedral, pseudo-cubic crystals with dominant {100} and less prominent {111} forms, with sizes commonly ranging from 0.3 to 0.6 mm. Only a dozen crystals out of some hundred distinguished from the rock-salt samples proved to be bigger than 1 mm, but not more than 1.2 mm. The crystals are of vitreous lustre, commonly translucent to transparent, with colour varying from yellowish through pale-violet to pale-violet-brown and brownish, with zonal texture often visible in hand specimens. Back-scattered-electron (BSE) images show complex internal texture of the congolite crystals in detail. They are commonly composed of numerous Fe-rich endomorphs with delicately-marked oscillatory zoning, which emphasizes growth stages of the {100} rhombohedral form. The endomorphs are overgrown with numerous medium to dark grey zones grading into the {100} orthorhombic form. Furthermore, such orthorhombic subcrystals are overgrown with some distinct concentric

zones parallel to faces of the {100} and, less commonly, {111} cubic forms. Compositions of all zones correspond to congolite with varying Fe, Mg and Mn contents, but always with Fe exceeding Mg. Such a crystal texture distinctly reflects phase-transitions from rhombohedral congolite to orthorhombic ericaite and finally to cubic, high-temperature Fe-dominant analogue of boracite during crystallization of the Fe-dominant borate at increasing temperatures. Currently, parts of the crystals exhibiting the orthorhombic and cubic morphology represent congolite paramorphoses after the higher-temperature orthorhombic and cubic borate,  $(\text{Fe,Mg})_3\text{B}_7\text{O}_{13}\text{Cl}$ , unstable in the room-temperature.

Diversified composition of the congolite in the border zones, with morphology passing from rhombohedral to orthorhombic and from orthorhombic to cubic presented in the system *temperature–atomic proportion Fe* that reflects phase relations in the series boracite-trembathite-congolite (BURNS & CARPENTIER, 1996), gives an opportunity to evaluate temperature of the metamorphic processes within the salt dome (*ca.* 230–250°C and 310–320°C, respectively), initiating migration of  $(\text{BO}_3)^{3-}$  and  $\text{Mg}^{2+}$ -bearing brines and fluids and crystallization of  $(\text{Fe,Mg,Mn})_3\text{B}_7\text{O}_{13}\text{Cl}$  in Fe-enriched, pinkish-coloured rock-salts (from *ca.* 100–150°C to *ca.* 350–360°C). Two stages, which can be related to inflows of  $\text{Mg}^{2+}$ -bearing fluids, are marked by decreasing Mn/(Mn + Fe) ratio during growth of the rhombohedral endomorphs and follow the cubic borate. Differentiation in composition of all the remaining zones connected with increasing Mn/(Mn + Fe) ratio is rather a result of Mn-Fe fractionation and different diffusion of  $\text{Mg}^{2+}$ ,  $\text{Fe}^{2+}$  and  $\text{Mn}^{2+}$  to the crystals growing under disequilibrium conditions.

### References

- BURNS, P.C. & CARPENTER, M.A. (1996): Canadian Mineralogist, 34: 881–892.  
 GRICE, J.D., GAULT, R.A. & VAN VELTHUIZEN, J. (2005): Canadian Mineralogist, 43: 1469–1487.  
 ROULSTON, B.V. & WAUGH, D.C.E. (1981): Canadian Mineralogist, 19: 291–301.  
 WENDLING, E., HODENBERG, R.V. & KÜHN, R. (1972): Kali und Steinsalz, 6: 1–3.