

## A FLUID INCLUSION STUDY OF Pb-Zn MINERALISATIONS OF THE WESTERN PART OF THE NÍZKE TATRY MTS. (WESTERN CARPATHIANS, SLOVAKIA)

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The Nízke Tatry Mountains are an E-W mountain range, one of the core mountains of the Inner Western Carpathians. Western part of the mountains is built by Hercynian crystalline complex (granitoid rocks, gneisses and migmatites) and Mesozoic allochthonous and sub-autochthonous sedimentary sequences.

The Hercynian crystalline complex of the Nízke Tatry Mts. hosts a number of hydrothermal ore deposits, variable in their mineralogical and chemical composition. There are many different mineralisation types developed at these deposits, but this contribution focuses exclusively on Pb-Zn hydrothermal veins and fluids that formed them. The Pb-Zn veins that we studied occur at three deposits exposed on the southern slopes on the mountains: Jasenie-Soviasko, Dve Vody-Ždiar, and Mlynná Dolina- Brestová.

The primary ore minerals in the studied samples are galena and sphalerite. Locally, pyrite becomes abundant. Sulfosalts are common but only in small quantities. Of these, tetrahedrite and bournonite are more frequent. Boulangerite, meneghinite and freibergite are scarce. The gangue comprises mostly massive white quartz, occasionally large aggregates of carbonates, and dispersed minute crystals of illite.

Quartz from **Jasenie-Soviasko** deposit contains two- or three-phase inclusions, with aqueous phase, vapor bubble (<10 % by volume), and halite. They are regular in shape, and occur mainly in clusters or trails. Trails do not intersect grain boundaries. The inclusions in growth zones are too small to measure. Eutectic temperatures vary within the range -56 and -49.6°C, which suggests the presence of Na-Ca-Cl solute. Ice melting occurs between -30.0 and -22.3°C. Hydrohalite decomposes at temperatures above 0°C, halite melts in the range of 161.2 - 290.7°C. The inclusions homogenise to the liquid phase in temperature range from 170.4 to 322°C, with most values clustering between 230 and 260 °C. Halite melting occurs both before and after total homogenisation (vapour bubble disappearance). This allowed us to estimate minimal PT conditions of fluid trapping, considering 40 wt% NaCl liquidus (Bodnar 1994). Minimal formation temperature and pressure for Pb-Zn mineralisation at this deposit are 292°C and 220 MPa, respectively. Salinities are in the range of 30.1-37.5 wt% NaCl eq, and fluid density is near 1.1 g/cm<sup>3</sup>. Derived contents of NaCl and CaCl<sub>2</sub> are within 24.0-31.0 wt% and 8.1-16.5 wt%, respectively.

Quartz from **Mlynná Dolina-Brestová** contains commonly two-phase inclusions, with aqueous phase and a vapour bubble (~15 vol.%). Additional third phase, either halite or unidentified anisotropic acicular crystals, is rare. The inclusions occur isolated or as trails that do not intersect grain boundaries or as smaller inclusions that outline the crystal growth zones of the quartz. Hence, at least some of these inclusions are considered primary with respect to the host quartz. The sulfides appear to postdate the quartz. Eutectic melting temperatures of -43 and -50°C indicate presence of a divalent metal chloride. Ice melting temperatures of -12.8 to -24.1°C correspond to salinities of 16.3 to 22.5 wt.% CaCl<sub>2</sub> eq. The inclusions homogenise over a broad temperature range 95 - 202°C with no sharp maxima in this range. The halite cubes are too small to reliably measure the temperature of halite dissolution. The vein material probably formed in epithermal, near-surface environment, at temperatures < 200°C and pressure ≤150 MPa.

Quartz from the **Dve Vody-Ždiar** deposit contains two-phase aqueous inclusions. All measured inclusions appear to be primary. They are oval and occur in clusters or trails that follow crystal growth zones. The vapour bubble does not exceed 10 % of the total inclusion volume. The temperatures of first melting are lower than the NaCl-H<sub>2</sub>O eutectic point, again indicative of divalent cations in the fluid. Ice melting occurs between -24.1 and -4.8 C with two sharp maxima around -7 and -10°C. These maxima correspond to salinities of 11 and 14 wt% NaCl eq. The inclusions homogenise to liquid in the range of 182 - 228.5 °C, with most data points lying between 200 - 220 °C.

In summary, the Pb-Zn mineralisations in the Nízke Tatry Mts originated from NaCl-CaCl<sub>2</sub>-H<sub>2</sub>O fluids. The characteristic signature of these fluids was their relatively low temperature (100-290°C) and pressure (≤150-220 MPa), indicating epithermal formation conditions.

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### References

BODNAR, R. J., (1994): *Geochimica et Cosmochimica Acta* **58**, 1053-1063.