Ore-forming fluids associated with Pb-Zn-Ag-sulfide mineralization at Rogozna and in the South Kopaonik mineral belt

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Rogozna and Kopaonik Mountains are a part of the Western Vardar zone (WVZ), situated between the Drina-Ivanjica block on the West and the Kopaonik Ridge on the East. The WVZ is composed mainly of a Jurassic ophiolite complex, placed within a mélange formation. It is sporadically cross-cut by Tertiary volcanic rocks. Volcanic rocks in the area consist of Oligocene-Miocene basalt-andesites, latites, quartz-latites and associated pyroclastite rocks. The Neogene syncollisional volcanism produced numerous Pb-Zn-Ag mineral deposits, which extend northward from Kosovo and southern Serbia (Trepča, Belo Brdo, Crnac) along the Kopaonik Ridge. The metallogenic district hosts skarns, hydrothermal replacements and vein type deposits. The on-going studies on Trepča, Belo Brdo and Crnac mines are focused on the P-T-X formation conditions and refinement of genetic models in order to improve exploration on similar deposits in the region.

The Trepča mine: Mineralization is hosted by limestones with paleokarst, covered by Triassic schists. The ore forming process is related to a phreatomagmatic event (maar type). Commonly skarn minerals (ilvaite, hedenbergite, garnet) precede sulfide mineralisation. Fluid inclusion (FIs) studies were carried out on skarn (hedenbergite: Th=385-410°C, 14.8-16.5 wt% NaCl equ.), sulfide (sphalerite: Th=240-305°C, 8.0-14.6 wt% NaCl equ.) and gangue minerals (quartz: Th=295-355°C, 4.5-12.0 wt% NaCl equ.; carbonates: Th>295, 4.5-11.0 wt% NaCl equ.).

The Belo Brdo mine: Mineralization is located on and close to the tectonic contacts of Cretaceous carbonates with volcanoclastic rocks and/or serpentinite. The additional hydrothermal veins are located within Tertiary andesites. The preliminary FIs study was applied to quartz from a hydrothermal replacement ore body (Th=135ºC-350ºC, with mode value at 230ºC and two weaker maxima at 150ºC and 320ºC, 1.0-14.0 wt% NaCl equ.). The bivariate Th vs. salinity diagram may indicate a mixing trend of magmatic and meteoric fluids.

The Crnac mine: There are two types of mineralization: vein type, hosted by Jurrassic amphibolites, and listwaenite mineralization developed at the contact between amphibolites and overlying serpentinites. A FIs study on quartz from the listwaenite mineralization reveals the presence of a high-temperature – low-salinity fluid (Th=249 - 324ºC, 2.9 – 6.7 wt% NaCl equ.). Primary fluid in late stage carbonates ($CaCl_2$-NaCl±KCl-H_2O, Th=247-325ºC, 5.1 – 7.0 wt% NaCl equ) overprinted by a lower temperature fluid ($CaCl_2$-NaCl-H_2O-CO_2, Th=219-268ºC, 4.3 – 11.7 wt% NaCl equ.) suggests an influence of meteoric water.

Despite the variations between ore types and host-rock characteristics, major similarities are recognized in the fluid inclusion data, structural controls and sulfide mineralogy. It appears that the spectrum of mineralization styles, shown by these deposits represents different responses to the same magmatic events.