



## **Arsenic-enriched Cu-Ni-PGE Mineralization in Wetlegs, Duluth Complex, St. Louis County, Minnesota, USA**

Sara Raič (1), Aberra Mogessie (1), Zsolt Benkó (1), Ferenc Molnár (2), Steven Hauck (3), and Mark Severson (3)  
(1) University of Graz, Universitätsplatz 2, 8010 Graz, Austria, (2) Geological Survey of Finland, Helsinki, Finland, (3) NRRI, University of Minnesota, 5013 Miller Trunk Highway, Duluth MN 55811, U.S.A

The magmatic sulfide ore deposit Wetlegs is found within the troctolitic Partridge River Intrusion (PRI) of the 1.1 Ga Duluth Complex. It is of great interest, due to its highly mineralized zones containing Cu-Ni-Fe-Sulfides, platinum-group minerals (PGM) and arsenic-enriched ores. Sulfides appear as disseminated patches of primary pyrrhotite, chalcopyrite, Co-rich pentlandite and cubanite within a plagioclase, olivine and pyroxene matrix. Ores associated with hydrous silicate phases are secondary chalcopyrite, arsenic-enriched minerals, PGMs like sperrylite, stibiopalladinite and other precious minerals such as clausthalite, parkerite and electrum. Based on textural relationships, mineral compositions and sulfur isotopic studies, a paragenetic sequence of ore genesis in Wetlegs could be reconstructed starting with the formation of composite sulfides such as pyrrhotite, chalcopyrite, Co-enriched pentlandite and cubanite (at increased sulfur fugacity), defined as the Sulfide Stage. The Arsenide Stage is characterized by increased arsenic fugacity and a strong drop in sulfur fugacity with the following succession of precipitated minerals: 1) Monoarsenides (nickeline) found as remnants in diarsenides. 2) Diarsenides comprising members of the rammelsbergite – safflorite – loellingite solid-solution series (RSLs) and minerals of the rammelsbergite – loellingite solid-solutions series (RLs). Their crystallization temperature is between 550 and 625°C, estimated with solvus lines postulated by ROSEBOOM (1963) and GERVILLA & RØNSBO (1992) in the system CoAs<sub>2</sub> – NiAs<sub>2</sub> – FeAs<sub>2</sub>. This is subsequently followed by an Arsenide/Sulfide Stage which marks the formation of sulfarsenides of the cobaltite – gersdorffite solid-solution series at increased sulfur fugacity (drop in arsenic fugacity). Sulfarsenides display a clear cobalt trend from core to rim, and formed around 650°C with a decrease in temperature to ~ 500°C, documented by cobalt enriched rims, based on the solvus lines from HEM & MAKOVICKY (2004) and HEM (2006) in the system CoAsS – NiAsS – FeAsS. The presence of arsenides, sulfarsenides and graphite in footwall rocks may suggest the metasedimentary Virginia Formation as a potential source of As, Sb, and C. These elements were remobilized by hydrothermal fluids and introduced in the crystallizing magma to form arsenic-enriched Cu-Ni-PGE mineralization within the basal ultramafic rocks.  $\delta^{34}\text{S}$  of sulfides from representative samples of Wetlegs vary between 2.04 and 22.80 ‰. This suggests the involvement of crustal materials in addition to the magmatic source of sulfur in the Cu-Ni-PGE mineralization, as documented in previous studies (MOGESSIE & STUMPFL, 1992).

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