

Distribution and enrichment mechanisms of germanium (Ge) in the Zn-Pb-Ag Prairie Creek Deposit, NWT, Canada.

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Germanium (Ge) is essential in the advancement of technology, especially in fiber optics and photovoltaics. Recovered commonly as a byproduct of zinc (Zn) production, Ge faces potential supply risks due to increasing demand, defining it as a critical mineral. Ge is often extracted from sediment-hosted Zn-Pb deposits; however, the processes controlling the distribution and enrichment in these deposits remain poorly understood. To address this, we apply macro- to nano-scale analytical techniques to investigate the Ge-bearing Zn-Pb-Ag Prairie Creek deposit in Canada. We aim to refine the genetic model of this deposit and identify the key factors driving Ge accumulation.

This deposit exhibits two main mineralization styles: 1) stratiform and 2) quartz-carbonate vein. Whole-rock geochemical analysis indicates that only the stratiform style is significantly enriched in Ge (up to 300 ppm) and a strong correlation between Ge and Zn is observed, implying that Ge content is associated with Zn-mineral species such as sphalerite. The analysis of the three major minerals (sphalerite, ZnS; galena, PbS; and pyrite, FeS₂) by EMPA shows that sphalerite is the primary host for Ge. At least two generations of sphalerite (Sp I and Sp II) occur in stratiform mineralization. LA-ICP-MS analysis of sphalerite reveals significant Ge enrichment (up to 2600 ppm) exclusively in Sp I, whereas Sp II exhibits much lower Ge concentrations (0.5 to 100 ppm).

LA-ICP-MS trace element mapping in Sp I have revealed a spatial correlation between Ge and other elements, including copper (Cu), silver (Ag), and thallium (Tl). However, only Cu shows a consistent positive relationship in spot analyses conforming to a molar ratio that suggests a potential substitution mechanism between Cu, Ge, and Zn. In contrast, atom probe tomography analyses indicate that Ge primarily occurs as nano-inclusions along with Cu in Sp I.

To better understand how physiochemical factors influence Ge incorporation we will collect additional fluid inclusion and isotopic data. This will provide information about the source of metals and sulfur, the ore-forming fluids, and metal precipitation mechanism(s). This study will offer insights into Ge's behavior in hydrothermal fluids, guiding strategies to improve exploration and extraction of Ge-bearing deposits.