Interpreting volatile trace-element signatures in volcanogenic massive sulfide deposits of the Bathurst Mining Camp, Canada: Evidence from a LA-ICP-MS study on sulfide minerals

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The world-class massive sulfide deposits of Zn-Pb type from the Bathurst Mining Camp (BMC), Canada were subjected to integrated mineralogical and geochemical studies of volatile trace-elements (As, Cd, Hg, In, Sb, Tl) in sulfide mineral assemblages. An analytical setup is examined and developed by combining laser ablation (LA) and inductively coupled plasma mass spectrometry (ICP-MS) techniques. The improved analytical protocols include an evaluation of optimized ablation conditions, choice of external standards, internal standardization and data reduction strategies.

The outcomes to date indicate that all forms of pyrite at the BMC are arsenian in nature. Cadmium occurs in sphalerite, galena, and pyrite with the former hosting the highest concentrations (845-1996 ppm). Sphalerite is the dominant host for Hg (1.4-174.9 ppm). Indium is locally elevated in sphalerite, chalcopyrite, and pyrite. Antimony typically occurs in galena, as well as pyrite. Finally, Tl is locally enriched in pyrite (0.06-338 ppm) and galena.

Sulfide mineral textures, in particular pyrite, display a strong correlation with their volatile element concentrations. 'Primary' pyrite (i.e., pre-deformational) displays higher volatile element concentrations than 'secondary' (i.e., syn-deformational and post-deformational) pyrite. In contrast, some deposits displays high contents of volatile trace-elements in late recrystallized pyrite. Therefore, upgrading trends in the primary pyrite suggests that metamorphism and syn-deformational processes do not have major effect on redistribution of these elements. Whereas signature of liberation of these elements in recrystallized pyrite offers association to the origin of the ore deposition. Hence, these primary and secondary dispersions of volatile trace-elements in sulfide minerals, particularly in texturally distinct pyrite, potentially can be used as a trace-element vectoring tool in exploration for massive sulfide deposits.