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Resolving the Distribution of Energy Critical Elements in Ore Systems through in situ Chemical mapping of Mineral Phases

Sean H. McClenaghan
Trinity College Dublin, Dublin, Ireland

The mineral sphalerite is found in a wide-range of ore forming conditions including sedimentary and volcanogenic massive sulphides, as well as epigenetic mineralization associated with intrusive settings such as porphyries, skarns and epithermal veins. Sphalerite is a known host for In, Sn, Ge, Te, and Ga; these represent valuable commodities increasing the value of Zn production worldwide. These elements along with their deleterious counterparts Se, Hg, Tl, and Cd can reveal much about the genesis and evolution of a mineralizing system. From the standpoint of understanding the genesis of various ore systems, mineral chemistry, in particular the accommodation of trace elements in the sphalerite structure, is an ideal proxy for comparing both inter- and intra-deposit variations in hydrothermal geochemistry as well as enabling broad comparisons across a wide spectrum of mineral deposit types. The mineral chemistry of sphalerite will often differ between deposits of an ore district and can even exhibit considerable variability across individual mineral grains in response to evolving hydrothermal fluids and distinct fluid sources.

Recent improvements in the field of in situ microanalysis have coupled advances in ICP-MS technology with newer classes of UV Excimer lasers and sample cells with smaller active volumes. This has effectively decreased the amount of ablated material required for analysis, allowing for more discrete analyses and permitting micro-chemical mapping at much smaller scales (<10 microns). Laser-ablation ICP-MS analyses of sphalerite from epigenetic veins of the Leinster Batholith in Ireland have revealed anomalous values of ECE's, specifically In, Ga, and Ge; element maps (raster analysis) display a strong zonation of ECE's, which correspond to oscillatory growth and sectoral zoning within grains. The zonation of trace elements across several generations of sphalerite indicates highly variable sphalerite chemistry in response to evolving hydrothermal conditions. It is important to note that while bulk analyses remain a good estimate of bulk metal contents, they do not portray the heterogeneous nature of trace elements in mineral systems, which could indicate the fertility of a system and the delineation of vein sphalerite enriched in ECE's.