Trace Element Geochemistry of Pyrite and Marcasite as a Vector Towards Mineralization in Irish-Type Zn-Pb Deposits

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Irish-type Zn-Pb deposits were formed via the replacement of carbonates during the mixing of metal-bearing hydrothermal fluids and saline brines with bacteriogenically reduced sulfur resulting in the precipitation of polymetallic sulfide assemblages. Both pyrite and marcasite are associated with the Zn-Pb orebodies and occur in both proximal and distal positions relative to the economic portions of the deposits. The iron-sulfides incorporate trace elements through solid-solution within the crystal lattice and by nano- and/or micro-inclusions. Therefore, the geochemistry of pyrite and marcasite can record changes in fluid chemistry and the evolution of the hydrothermal system. In this study, multidimensional, multimethod statistical classification of trace element geochemistry of pyrite and marcasite is applied to new and historic data from the Rathdowney Trend, which includes the Lisheen and Galmoy deposits and the Rapla prospect. Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) is used to collect trace elements from the different pyrite and marcasite paragenetic phases utilizing drill cores positioned proximal and distal to orebodies and interpreted with whole-rock geochemistry of the same samples. Trace element (LA-ICP-MS) maps accompanied by petrographic imaging show that morphological and textural variation (e.g., framboidal, spongey texture, growth banding, and plumose textures) correlate with a distinct geochemical signature and therefore the paragenetic phase. Trace elements obtained from LA-ICP-MS spot analyses show hydrothermally sourced pyrite and marcasite are enriched in As and Tl in comparison to diagenetic pyrite, which is enriched in Mn, Mo, and Cu, with correlation observed between Co and Ni; As and Tl; and Mn and Mo. On a regional scale, pyrite and marcasite distal to orebodies show greater enrichment in Mo, Cu, and Sb. Thus trace elements of iron-sulfides can be used to vector towards zones of potentially economic Zn-Pb concentrations by informing proximity to hydrothermal sources.