SEG 2022 Conference: Minerals For Our Future

Pyrite Geochemistry as a Vector Toward Mineralization in Irish-type Zn-Pb Deposits

Claire Geel[1], Koen Torremans[1], Aileen Doran[1], Oakley Turner[1], Tadgh Dornan[2], Murray Hitzman[1]
1. iCRAG SFI Research Centre in Applied Geosciences, Dublin, Ireland, 2. Trinity College Dublin, Dublin, Ireland

Pyrite is the most abundant sulfide mineral in the Earth's crust and is commonly associated with economic mineralization. The geochemistry of pyrite can record the conditions of orebody formation and the composition of associated fluids and may provide a vector toward mineralization. Irish-type Zn-Pb mineralization was facilitated through the mixing of hot metal-bearing hydrothermal fluids and cold hypersaline brines with bacteriogenically reduced sulfur. Associated pyrite occurs in both non-economic and economic zones and their trace element ratios such as Co/Ni; As/Cu; Tl/Fe can act as fingerprints of hydrothermal fluids, thereby aiding in estimating the quality and tenor of nearby ore. Therefore, pyrite trace elements may form geochemical halos around Zn-Pb orebodies similar to other metal distribution haloes in Ireland. Additionally, hydrothermal pyrite grains also display zonation with geochemical variation such as increasing Ag, As and Tl that records changes in the fluid composition from core to rim related to hydrothermal pulses. From previous work, we know those trace elements incorporated into the pyrite crystal lattice record different element assemblages depending on whether they are hydrothermally sourced (As-Cu-Co-Tl-Zn enriched) or derived from bacterial sulfate reduction (Mo-Mn-Ni-Se enriched), as determined from in-situ $\delta^{34}S$ measurements. In this study, multidimensional multimethod statistical classification of pyrite is applied to new and historic data. Laser ablation-inductively coupled plasma-mass spectrometry (LA-ICP-MS) and whole-rock lithogeochemistry data sets, collected from drillcores positioned both proximal and distal to orebodies in the Irish Midlands, are analysed using Multivariant Analysis of Variance, Correlation Cluster Analysis, Principal Component Analysis and Factor Analysis. Additionally, both Logistic Regression and Random Forest machine learning algorithms will be applied, building on methodologies developed for fingerprinting pyrite in building aggregates in Ireland. These results will further inform the generation of a systematic standardized method for measuring trace element geochemistry from pyrite in different orebodies and mineral exploration cores.