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Geochemical discrimination of pyrite in diverse ore deposit types through statistical analysis and machine learning techniques

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Abstract

Pyrite is a ubiquitous mineral in many ore deposits and sediments, and its trace element composition is mainly controlled by temperature, oxygen fugacity, pH, compositions of fluids, and host rock composition. A discriminant analysis (DA), based on multi-element compositions of pyrite, distinguishes iron oxide-apatite (IOA), iron oxide copper-gold (IOCG), skarn Cu-(Fe), porphyry Cu-Mo, orogenic Au, volcanic-hosted massive sulfide (VMS), sedimentary exhalative (SEDEX) deposits, and barren sedimentary pyrite. Testing of the DA classifier yields an accuracy of 98% for IOA, 96% for IOCG, 91% for skarn Cu-(Fe), 94% for porphyry Cu-Mo, 87% for orogenic Au, 84% for VMS, 96% for SEDEX, and 85% for barren sedimentary pyrite. Furthermore, neural network, support vector machine, and random forest, were performed for selecting the optimum classifier more accurately. In these three techniques, the support vector machine yielded the highest overall accuracy (98% for IOA, IOCG, skarn Cu-Fe, and porphyry Cu-Mo, and 97% for orogenic Au, VMS, SEDEX, and barren sedimentary pyrite) and thus is an appropriate technique in predicting pyrite types.

Keywords: Pyrite, trace elements, discrimination diagrams, machine learning