

Reapproaching Iron Deposit Discrimination Through Magnetite Geochemistry and Machine Learning

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Discriminant analysis of trace element magnetite geochemistry has been used to determine the genetic ore deposit relationships between iron oxide-copper-gold (IOCG), Kiruna apatite-magnetite, banded iron formation (BIF), porphyry Cu, Fe-Cu skarn, Fe-Ti, V, Cr, Ni-Cu-PGE, Cu-Zn-Pb volcanogenic massive sulfide (VMS), and Archean Au-Cu porphyry deposit types. Pairwise biplots of elements, their ratios, or other arithmetic combinations are the standard tool to characterize these relationships. The Ni+Cr vs. Si+Mg biplot discriminates Ni-bearing deposits, Al/(Zn+Ca) vs. Cu/(Si+Ca) defines VMS deposits, and Ca+Al+Mn vs. Ti+V plots geochemical boundaries for BIF, IOCG, Kiruna, porphyry, skarn, and BIF deposits. These geochemical biplots are well established in their boundaries for ore-genetic fingerprinting. However, recent advancements in machine learning algorithms have enabled the simultaneous analysis of all combinations of these geochemical biplots within a single plot, while preserving the ore-genetic fingerprints of each deposit type. Here, we present new methods and preliminary analysis of iron deposits through a combined lens of machine learning and geochemistry. This analysis has enabled new broader relationships to be described using all available analytes, rather than a portion of elements. Lastly, these algorithms enable the computation of similarity metrics and clustering to determine the degree of geochemical similarity among all deposits.