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Analyzing the occurrence of environmental indicator minerals using clustering techniques and mineral networks

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Indicator minerals have special physical and chemical properties that can be analyzed to glean information concerning the composition of host rocks and formational (or altering) fluids. Clay, zeolite, and tourmaline mineral groups are all ubiquitous at the Earth's surface and shallow crust and distributed through a wide variety of sedimentary, igneous, metamorphic, and hydrothermal systems. Traditional studies of indicator mineral-bearing deposits have provided a wealth of data that could be integral to discovering new insights into the formation and evolution of naturally occurring systems. This study evaluates the relationships that exist between different environmental indicator mineral groups through the implementation of machine learning algorithms and network diagrams. Mineral occurrence data for thousands of localities hosting clay, zeolite, and tourmaline minerals were retrieved from mineral databases. Clustering techniques (e.g., agglomerative hierarchical clustering and density based spatial clustering of applications with noise) combined with network analyses were used to analyze the compiled dataset in an effort to characterize and identify geological processes operating at different localities across the United States. Ultimately, this study evaluates the ability of machine learning algorithms to act as supplementary diagnostic and interpretive tools in geoscientific studies.