Identifying sulfide mineralization from physical property measurements and its application to mineral exploration inversions

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Mass density and magnetic susceptibility data can be used to identify anomalous sulfide accumulations based on a set of end-member components expected in a sample. With selection of appropriate end-members and their physical properties, our mineral estimation filter can be applied either to measurements from drill core or calculated properties from 3D inversion results. When applied to district- or regional-scale inversion models it can be used to prioritize exploration targets.

The filter was tested on measured density and susceptibility values from drill core for which mineralization had been independently assessed. The measurements are from a large physical property dataset for the Perseverance Ni-sulfide deposit in Western Australia, including 42,953 susceptibility and 80,050 density measurements for 109 different rock and mineralization groups.

The abundance of six major end-member components (monoclinic and hexagonal pyrrhotite, pentlandite, pyrite, magnetite, and barren host rock) was calculated for each group based on the density and susceptibility values of the group and each component. The problem is underdetermined, with three data constraints and six unknowns, so estimates are obtained using linear and nonlinear programming methods. Two different objective functions give the minimum and maximum proportions of the Ni-bearing pentlandite end-member in any sample. The results provide realistic estimates of the possible range of pentlandite in each group; a high proportion of samples with known anomalous sulfide content were identified from their physical properties alone using different cut-off criteria.

Application of this procedure, with a different set of end-members, to gravity and magnetic inversion models from the Olympic Fe-oxide Cu-Au province in South Australia demonstrates how it can be used to map, in 3D, areas of potentially anomalous sulfide accumulation to aid exploration and target selection.