Mesh- and surface-based geophysical inversion of IOCG deposits

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Geophysical inversion is a data processing technique that calculates models of the Earth's subsurface physical properties (e.g., density and magnetic susceptibility) from geophysical survey data (e.g., gravity and magnetic measurements). Inversion provides the means to integrate geophysical measurements, petrophysical data and other geological information. Standard mesh-based inversion strategies discretize the Earth region of interest into a mesh of space-filling cells, for example a 3D rectilinear mesh comprising prisms. The relevant physical properties are assumed to be uniform within each cell but possibly different from one cell to the next, creating pixelated models. The inversion attempts to determine a distribution of the relevant physical properties that could have given rise to the measured survey data. The numerical data-fitting problem is highly non-unique, meaning there are an infinite number of models that could fit the survey data to an acceptable degree. Common practice is to create a tractable inverse problem by accepting only smoothly varying distributions, a so-called "minimum-structure" approach.

Models recovered through a minimum-structure meshbased inversion approach are often at odds with existing geological knowledge of the subsurface. Geologists' interpretations about the Earth typically involve distinct rock units with contacts (interfaces) between them, each unit having essentially homogeneous physical properties. While there are mesh-based inversion methods that can produce models closer to that character, we are also developing a fundamentally new and different type of inversion that works directly with a 3D geological Earth model comprising wireframe contact surfaces of tessellated triangles. This parameterization is sufficiently flexible to allow the representation of arbitrarily complicated subsurface structures. The inversion moves the contact surfaces as required to fit the data, while honouring any a priori geological knowledge.

We are applying both our mesh- and surface-based inversion approaches to investigate Iron Oxide Copper Gold (IOCG) type deposits in South Australia. Preliminary results using gravity and magnetic survey data have produced subsurface models consistent with current understanding of the deposits.

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