Geophysical Expression of Ore Bodies and Mineral Systems

Description

The primary role of this project is to develop and integrate methodologies for better use of Magnetic and Gravity potential field data in mineral exploration projects. Magnetic and Gravity data are critical for most integrated exploration programs, from grass-roots exploration to production:

1. Regional prospectivity assessment in areas undercover requires accurate estimation of cover sequence thickness because areas of shallow cover are much cheaper to explore. Cover thickness can be estimated using forward modelling, and various inversion techniques (e.g., tilt-depth method) used to estimate the depth to magnetic source.

2. Preliminary targeting of potential ore-systems requires a conceptual exploration model, based on an understanding of the geology and structure of a given area. This knowledge is commonly inferred from magnetic and gravity data. Interpretations of lineaments and structures can be very important for structurally controlled deposits, while interpretation of magmatic lithologies can be important for intrusion-related, porphyry and skarn deposits. Interpretation can be visual or semi-automated (e.g., "worms").

3. Drill targeting of ore bodies (with density or magnetic contrasts) requires estimation of source size, dimensions and location which can be achieved through 3-D forward modelling and inversion (e.g., Euler depth estimation). Forward modelling and Inversion generally assume that the magnetisation is caused by the Earth’s Natural Magnetic Field. However, in some cases a component of remanent magnetisation can make interpretation more problematic. Issues of self-demagnetisation must also be accounted for when dealing with highly magnetic bodies (Magnetic Susceptibility approaching 1 SI) such as Magnetite Ores and some IOCGs.

4. High resolution magnetic and gravity surveys in conjunction with detailed petrophysical and palaeomagnetic studies of drill core can be used to generate more cost-effective resource estimation models for bodies with significant contrasts in density and magnetic susceptibility.

The main focus in this project is to help develop interpretation methodologies within the group, but more importantly, integrate the solutions with spatial datasets in GIS and 3-D visualisation packages (e.g., Discover 3-D, Leapfrog, Geomodeller) and Geophysical Modelling packages (e.g., Modelvision). The broad project incorporates several sub-projects that deal with different scales (e.g., Deposit-scale to Regional to Deposit Class), different regions (e.g., Gawler Block, Mount Isa Inlier, Lachlan Orogen, Thomson Orogen) and different styles of mineralisation (e.g., IOCG, Cobar-type Polymetallic, Orogenic Gold, VHMS, BHT).

Some Key Projects include:
- Magnetic and Gravity Signatures of IOCGs (as a class of deposit).
- Deposit-scale petrophysical mapping of IOCGs using Discover 3-D: application to geophysical inversions and self demagnetisation - Ivanhoe Cloncurry.
- Deposit to terrain scale studies on Petrophysics, Palaeomagnetism, Geophysical modelling and inversion of several IOCG deposits, Gawler Block - PIRSA, & OzMinerals
- Lineament Analyses, "Worm" analysis and GIS-based weights-of-evidence prospectivity mapping of the SE Lachlan Orogen - NSW dpi
- Predictive modelling of Cobar-type deposits: application to exploration undercover in the Thomson Orogen - NSW dpi
- Palaeomagnetic Studies of Ore Deposits, e.g., Candelaria IOCG, Chiles - Dave Clark
- 3-D Geological mapping underneath cover, Stawell Area, Vic

Researchers

James Austin
Postdoctoral Fellow, CESRE
james.austin@csiro.au

Collaborators

Simon van der Weilen, PIRSA
Bob Musgrave, NSW dpi
Dave Robson, Ivanhoe Australia
Arianne Ford, CET @ UWA

CESRE Publications

Figure 1: A perspective view of the magnetic anomaly (top) and gravity anomaly (bottom) over the Ernest Henry Iron Oxide Copper-Gold deposit in northwest Queensland. The modeled ore pipe (in yellow) causes coincident gravity and magnetic anomalies, but the overall signal is dominated by unmineralised magnetite-bearing shear zones (purple). The model is viewed from the southeast.
Key References

IOCGs


Spatial Exploration Techniques


Predictive Modelling