Dr Jim Austin

Team Leader and Principal Research Scientist: Potential Fields Geophysics

Thinking outside the Bullseye: Simple hacks for differentiating ore systems from background in geophysical data.

Abstract

The difference between magnetite and hematite, or pyrite and pyrrhotite, may not be overly important to a geological model, but it is critical to a geophysical model. Petrophysics provides the link between geology and geophysics that allows geophysical differentiation of Ore Deposits from background, and it is pivotal to maximising the potential of geophysical datasets to find new mineral deposits.

In this talk Jim will present a selection of 3-D, geophysically constrained ore deposit models from the Cloncurry district, QLD and the Cobar District, NSW. He'll provide an overview of the range of geophysical possibilities within the IOCG/ISCG basket, reviewing geophysical models of Ernest Henry, Osborne, Starra, Monakoff and Maronan. He will also explore some of the key differences between VHMS, skarn and epithermal-style Cobar deposits, based on models of Mallee Bull, Nymagee and the main Cobar Mineral Field. He will provide some insights into different types of zonation in mineral systems, and some of the geological factors that underpin observable petrophysical zonation in different deposit types. Attendees should walk away with some simple "hacks" that can be used to better differentiate geophysical responses of ore deposits and other anomalous sources in background geology.

Read On...

Pigeon-holing of ore deposits is a common and necessary practice. It allows geologists to recognise commonalities of specific deposit types and provides guidance on which tools may be best optimised for their detection. Most of the classic ore deposits categories are based on exemplars, a few examples that best illustrate the generic features of a specific ore deposit category. They are useful, but can be too specific, too generic or outdated, and they rarely encapsulate the subtle variations that come with different geological histories, variations in host rock, rheology, kinematics, metamorphism, etc.

In mineral exploration, geophysics provides targets, red bullseyes that may or may not get drilled depending on a range of factors, both economic and geological. Whilst most ore deposit categories have associated "geophysical expressions" that can be used to target such deposits, the geophysical targeting criteria are all too often overly simplistic (e.g., the combined mag-grav high). Geophysical ore deposit models however demonstrate that the alteration footprints and ore zonation observed in many mineral deposits, also controls petrophysical zonation. A geophysical ore-deposit model thus retains all the complexities and ambiguities of their geological counterparts. Ore deposit petrophysics and associated geophysical expression is however far more variable, and far more complex.

As with alteration zonation and metallogenesis, petrophysics is controlled by subtle differences in a range of factors (e.g., temp, pressure, rheology, kinematics, pH, redox, etc.), which control the precipitation of metal-oxides and sulphides. The petrophysical metrics associated with such minerals can be highly variable. Some properties, such as magnetisation can vary by 8 orders of magnitude over cm scales, whilst others such as density vary by half an order of magnitude over global scales. Properties can also be complex, for example, conductivity can be non-linear (scale dependant), conductivity and magnetics can be anisotropic, and magnetisation is comprised of multiple vectors (e.g., induced and remanent magnetisation). Those properties may coincide, inversely coincide or not coincide, both spatially and temporally.

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Biography

Jim Austin is a Principal Research Scientist with CSIRO Mineral Resources in Sydney, and Associate Editor, Minerals Geophysics, for the ASEG's preview magazine. He studied structural geology and applied geophysics at Macquarie University, and was a cartographer for Australian Geographic magazine, prior to undertaking his PhD on the Cloncurry District with the Predictive Mineral Discovery CRC at JCU. He worked as an exploration geologist in Broken Hill, Mount Isa, Papua New Guinea and the Thomson, and as a GIS & Geophysics consultant with Encom Technologies, before joining CSIRO as a post-doc in 2011. Since joining CSIRO, Jim and collaborators have developed world-leading capabilities, linking magnetic petrophysics with SEM-mineral scanning technologies, to understand the inner workings of mineral systems. He's worked on a broad range of mineral deposits, spanning numerous deposit categories, across most of the major Australian Mineral provinces. His approach to minerals petrophysics is not to just "provide numbers to plug into models", he sets out to understand the links between ore forming processes, structural controls and geophysical expression. Jim links large-scale drivers with detailed characterisation studies via geophysics-based mapping and modelling. By integrating different silos (e.g., geophysics, geochemistry and geology) in 3-D and extrapolating across scales Jim hopes to provide holistic insights into mineral systems and trusted guidance on how explore them.