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GAWLER *Project breaks cover*

New datasets aid area selection and targeting

Roger Skirrow, Patrick Lyons, Anthony Budd, Evgeniy Bastrakov

Over the past five years, the Gawler Mineral Promotion Project has shed considerable light on the 1590 Ma iron oxide–copper–gold (IOCG) mineral systems of the eastern Gawler Craton and the coeval lode-gold systems of the central Gawler Craton. The project, under the National Geoscience Accord, has been a joint-effort of Geoscience Australia and Primary Industries and Resources South Australia.

Acquisition and interpretation of deep crustal seismic reflection data in the region of the giant Olympic Dam Cu–Au–U mine (see *AusGeo News 76*) delivered huge gains in our understanding of the crustal architecture and tectonic evolution of the eastern and central Gawler Craton. We now recognise that the IOCG mineralisation, which includes the Olympic Dam deposit, occurred inboard of a convergent margin, with first-order controls on fluid pathways being northwest-trending thrust faults.

The three-dimensional picture afforded by the seismic results constrains our interpretation of potential-field data and enables clear comparisons with the Mesozoic–Cainozoic IOCG systems of the Andean margin of South America.

Apart from geophysics, other advances in the project have come from granite studies and geochemistry. We have also refined and improved the geochronological framework of the eastern and central Gawler Craton.

The result is a coherent model of mineralisation of the eastern and central Gawler Craton that links the IOCGs with their coeval lode-gold deposits for the first time. This knowledge gives explorers valuable spatial guides towards mineralisation in these almost completely hidden terranes.

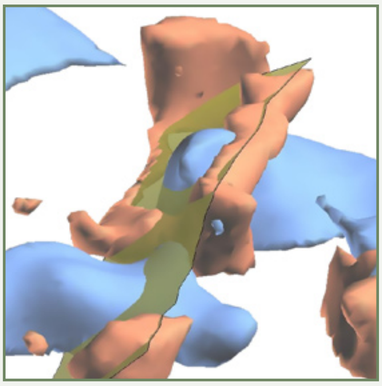

Figure 1. Three-dimensional inversion of magnetic and gravity data predicts the distribution of haematite and magnetite alteration, represented here as isosurfaces (haematite in brown, magnetite in blue). Mapping the distribution of iron oxides associated with IOCG mineralisation also gives information about possible structures controlling mineralisation, such as the fault-plane shown in green, allowing explorers to define drill targets. Although this example covers an area of about 30 km by 30 km, the inversion method is independent of scale.

Potential-field data

In areas of little or no outcrop, potential-field data are critical to understanding the geological make-up of the basement. Because the Gawler Craton is particularly deficient in outcrop—with the crystalline basement of the eastern Gawler Craton almost completely covered by younger rocks—potential-field data are vital for gaining necessary regional knowledge of the prospective basement.

Interpretation of potential-field data is normally constrained by the extent of available petrophysical and spatial data, but these data may be difficult to obtain. Fortunately, the unique density and magnetisation of the iron oxide alteration of IOCG mineralisation allows us to map the likely locations of ore deposition using 3D inversion of the potential-field data (figure 1), even where constraints are lacking (see *AusGeo News 74*).

New subdivision of Hiltaba granites

A new subdivision of the Hiltaba Association granites (which supersedes the Hiltaba Suite) and their comagmatic Gawler Range volcanics comprises four supersuites. The Roxby and Venus Supersuites show A-type characteristics, while the Venus and Malbooma Supersuites are I-type.

Significantly, the A-type granites were hotter and required more elevated geotherms than the I-types. The Olympic copper–gold province in the eastern Gawler Craton is characterised by the presence of A-type supersuites, indicating that the elevated crustal temperatures of the eastern Gawler Craton at 1590 Ma were a key ingredient for generating IOCG mineralisation.

The lower temperature I-type supersuites show many of the characteristics of granites associated with intrusion-related gold deposits. These granites are more abundant in the central Gawler gold province.

There is no demonstrated direct genetic link between the granite supersuites and the broadly coeval IOCG and lode-gold mineralisation. It may be that the granites are symptomatic of certain crustal geotherms that determine the style of mineralisation, with the hotter crust producing some of the conditions required for IOCG mineralisation and cooler crust leading to lode-gold mineralisation.

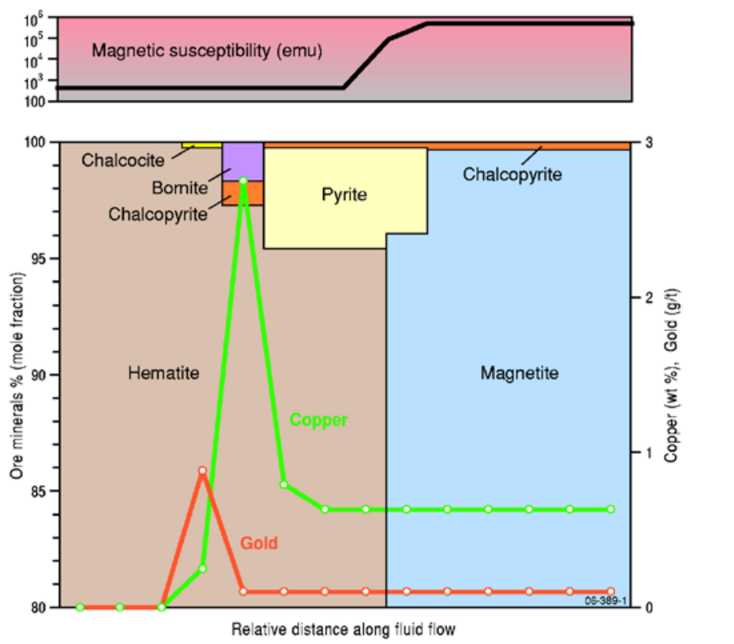

Figure 2. Computer modelling shows that flushing of magnetite alteration, containing sub-economic copper and gold, by oxidised fluids produces haematite alteration and upgrades copper and gold. The characteristic suite of sulfides associated with IOCG mineralisation is predicted. A consequence is that maxima of magnetic anomalies are not optimal drill targets for copper–gold. One must combine mineralogical data with magnetic and gravity data to locate haematite alteration adjacent to magnetite alteration.

Chemical modelling

Chemical modelling predicts that reaction of a low-grade magnetite protore (containing 0.1% Cu, in chalcopyrite, and 0.1 g/t Au) with an oxidised fluid may result in a mineral assemblage with appreciable upgrading of copper and gold (up to ~3% Cu as bornite, chalcocite and chalcopyrite; up to 1 g/t Au) (figure 2). Mineralisation will be contained within the haematite alteration zone adjacent to the magnetite–haematite oxidation front. Our modelling agrees with observations from several known occurrences of copper–gold mineralisation in the Gawler Craton and shows that favourable sites of mineralisation are less likely within magnetite alteration, but may occur at the juncture of offset haematite and magnetite alteration zones. The two-stage upgrading model complements previously published models of copper and gold precipitation due to simultaneous mixing of reduced and oxidised fluids in accounting for the range of styles of copper–gold mineralisation in the eastern Gawler Craton.

Mineral potential map

A 1:500 000 scale map released in February this year—*Iron oxide Cu–Au (–U) potential of the Gawler Craton, South Australia* (figure 3)—summarises key results of work on IOCG systems and shows the distribution of several 'essential ingredients' of IOCG ore-forming systems, including:

- supersuites of the Hiltaba granites
- faults and shear zones with interpreted age of youngest significant movement
- copper geochemistry (>200 ppm) from drillholes intersecting crystalline basement
- hydrothermal alteration assemblages and zones, based on drillhole logging
- distribution of IOCG alteration based on inversion modelling of potential-field data
- host sequence units considered important in localising IOCG alteration and mineralisation
- neodymium isotopic data and the mineral isotopic ages of late Palaeoproterozoic to early Mesoproterozoic magmatism and hydrothermal minerals
- prioritised areas of maximum potential for IOCG mineralisation.

The map may be downloaded from the Gawler Project website.

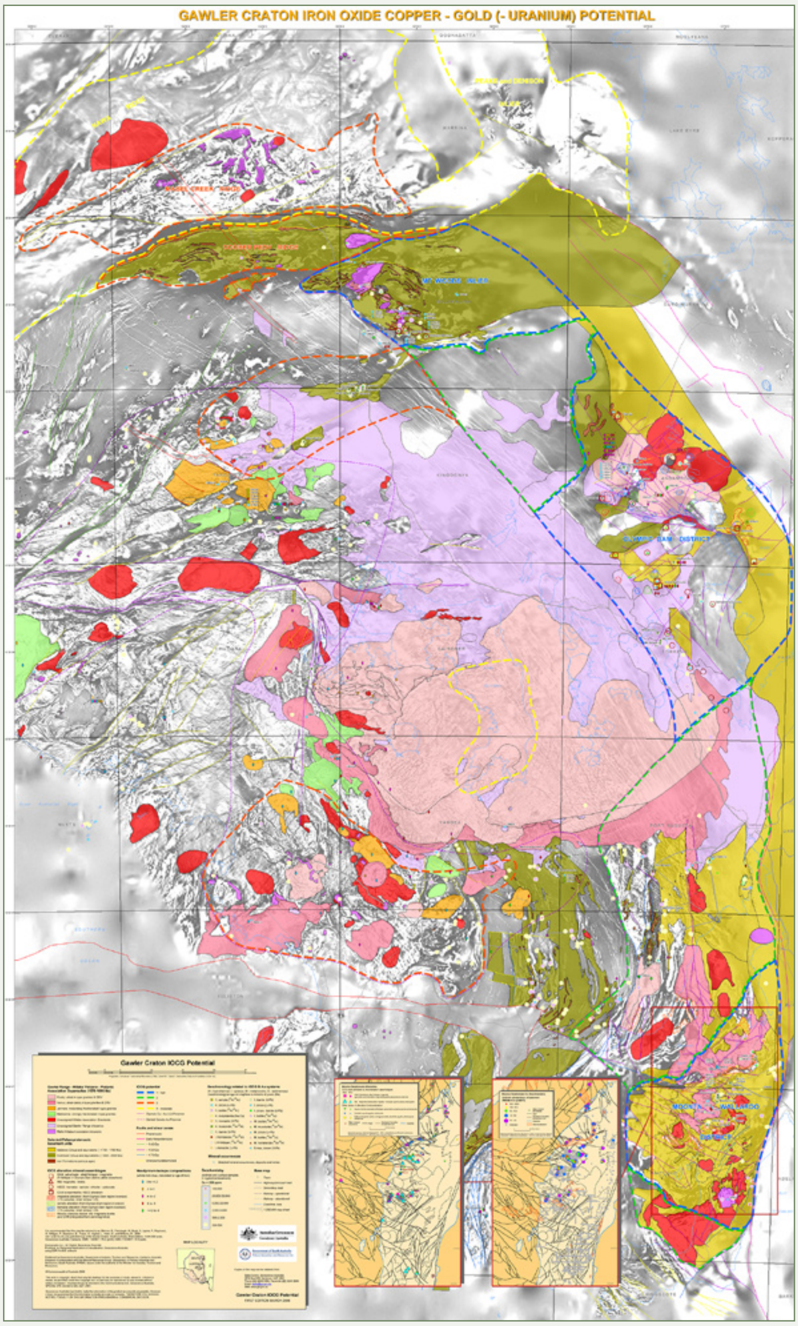

Figure 3. Iron oxide Cu–Au (–U) potential of the Gawler Craton, South Australia map produced by the Gawler Mineral Promotion Project is a summary of 'essential ingredients' for IOCG mineralisation in the Gawler Craton. *This map can be downloaded from the Gawler Project website.*

Project lessons

The Gawler Mineral Promotion Project demonstrated how to come to grips with the geology and mineralisation of a region generally obscured by hundreds to thousands of metres of cover. The most important lesson is that a multidisciplinary and collaborative approach is essential.

Geophysics, geochemistry, petrology, drillhole data, and geochronology combined to provide guides to ore and to help us understand the tectonic environment of the Gawler Craton's IOCG mineral systems and coeval lode-gold systems.

We are now able to take what we have learned about working in such a difficult terrane to other frontier parts of the Australian Proterozoic.

More information

phone Roger Skirrow on +61 2 6249 9442
email roger.skirrow@ga.gov.au
web www.ga.gov.au/minerals/research/regional/gawler/gawler.jsp
link

Related links

AusGeo News 76
Gawler seismic study.

AusGeo News 74
Thick cover no obstacle to field inversion, Iron oxide Cu–Au (–U) potential of the Gawler Craton, South Australia 1:500 000 scale map.

www.ga.gov.au/minerals/research/regional/gawler/gawler.jsp Gawler Mineral Promotion Project

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