New Insights into Intrusion-related Gold-Copper Systems in the Tasmanides

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Some Au-rich intrusion associated systems of eastern Australia

Red Dome (1.3 Moz)
Kidston (3.4 Moz)
Ravenswood (3.1 Moz)
Mt Leyshon (2.5 Moz)
Mt Morgan (8 Moz)
Timbarra (0.3 Moz)
North Parkes (1.3 Moz)
Cadia (19 Moz)
Lake Cowal (3.0 Moz)
Mineral Hill, Mt Adrah, Braidwood

Epithermals
Nth Drummond
Basin deposits
Kilkivan
Cracow
Mt Rawdon
Drake
Mt Terrible
Outline

• Review of igneous metallogeny - commodity type & intrusion parameters

• Intrusion-related Au in E Australia

• GA project: Igneous metallogenesis in eastern Australia
Blevin et al. (1996) showed a strong relationship between commodity types & intrusion parameters:

- oxidation state, and
- compositional evolution
Igneous Metallogenesis

Simple but powerful relationship

Can be used predictively

e.g., Sn related to reduced, strongly fractionated granites

Why? Sn⁴⁺ substitutes into ilmenite, biotite, titanite. Sn²⁺ is incompatible in magmatic minerals, thus: buildup of Sn occurs in reduced evolved magmas.
Sn – North Qld

Igneous Metallogenesis

Fe$_2$O$_3$ FeO ratio

$10^0$  $10^1$

Cu-Au  Cu-Mo  Mo  W-Mo  W

Increasing Oxidation

Increasing Fractionation

Fractionated

Reduced

strongly fractionated & reduced granites (red)
Sn – North Qld

Fract/Reduced granites & Sn

strongly fractionated & reduced granites (red)
Igneous Metallogenesis - Au

What about Au?

Strong relationship between Cu-Au mineralisation and intrusions.

Au-only systems controversial.

Cu-Au: strongly oxidised, compositionally unevolved (island arc-like) magmas.

Why? Cu partitions into magmatic sulfides - buildup is preferred in very oxidised magmas where reduced S is absent.
Cu-Au intrusion related systems – Ordovician, NSW

- Peak Hill
- Goonumbla
- Cu Hill
- Cargo
- Cadia
- Cowal
- Marsden
- Gidginbung

Belt:
- Junee - Narromine Belt
- Molong Belt
- Rockley - Gulgong Belt

Location:
- SYDNEY

Scale:
- 100 km
Lachlan Fold Belt Magmatism

Ordovician Sil-Carb

Increasing fractionation

Increasing oxidation

Ordovician of LFB most prospective for porphyry Cu-Au

(Blevin et al., 1996)
Cu-Au – North Qld

Str oxidised unfract. granites
Cu-Au – North Qld

- unevolved, strongly oxidised granites largely absent from north Qld

- as are significant Cu-Au deposits
Eastern Australian exploration

- many E. Australia granites apparently not oxidised enough to fall in the porphyry Cu-Au window

- Exceptions include the Ordovician of NSW; & perhaps Calliope & younger arcs in New England F.B.).

What about other intrusion-related gold mineralisation?
‘Intrusion-related gold’ (IRG) Model

Au ± Bi, W, Mo associated with intermediate to felsic intrusions (e.g., Lang & Baker, 2001)

Examples:
- Fort Knox, US (>200 t Au),
- Kidston, Aust (~140 t),
- Timbarra, Aust,
- ?Pogo, US (~160 t)

Variety of styles
(sheeted veins, stockwork veins, breccias, disseminated & greisens, skarns, distal veins?)

Controversial
Intrusion-related Gold

Timbarra

- Au disseminated in granite
- Looks like Sn system
- Intrusion-related deposit
- <1/2 million ounces Au (sealed though)
Australian IRG deposits associated with weakly to moderately oxidised, & fractionated intrusions.

Distinct from Cu-Au.
Australian IRGs vs por Cu-Au

Strongly oxidised Cu-Au vs weakly oxidised Au systems

(Blevin, 2005)
Lachlan Fold Belt Magmatism

Ordovician  Sil-Carb

Lachlan F.B. prospective for granite-related Au-only systems

(Blevin et al., 1996)
N Qld also prospective. (& by analogy southern New England F.B.)
Conclusions 1

• Granite characteristics exert strong control on commodities (Sn, W, Mo, Cu, Au)

• Granite-related Au in E. Australia covers a range of styles – need to look beyond Cu-Au systems

• Eastern Australia still prospective for granite-related gold systems
GA’s Granite-related mineralisation Project

Metallogenesis of granites of E. Aust., using a Minerals System approach.

Project commenced 2003-04.

Current partners:
• Geoscience Australia, Mineral Resources Tasmania, Phil Blevin (PetroChem), Geological Survey of Qld, GeoScience Victoria.

(www.ga.gov.au/minerals/research/national/felsic/aust_felsic_igneous_rocks.jsp)
Project Aims – stage 1

• collate & synthesise available data (e.g., lithology, mineralogy, geochem, geochron, mineralisation),

for all significant intrusive & country rock units of E. Australia.

(most of this data/knowledge not currently accessible in digital format)

• produce comprehensive, easily-accessible, easily-interpretable, digital datasets, on the web.

All linked to GA’s Geological Map of Australia.
### Compilation datasets

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**Geol Map**
Why this data?

e.g., Kidston region, Qld
Example - Intrusion-related gold

Some IRG ingredients

- weakly oxidised, evolved, granites
- emplaced at high crustal levels
Example - Intrusion-related gold

**IRG ingredients**

- weakly oxidised, fractionated, granites emplaced at high crustal levels
- larger granite system at depth
- major structures
Example - Intrusion-related gold

**IRG ingredients**

- characteristic metal signature (Bi-Au, Mo, W)
- mineral zonation
Example - Intrusion-related gold

**IRG ingredients**

- graphitic and carbonate-bearing country rocks
Example - Intrusion-related gold

Some IRG areas?

- Potential areas?
Conclusions

• Granite characteristics exert strong control on commodities

• Granite-related Au mineralisation covers a range of styles – need to look beyond Cu-Au systems

• Eastern Australia still prospective for granite-related gold

• digital datasets from GA/state surveys will facilitate the search for intrusion-related Au systems

(www.ga.gov.au)