Intrusion-Related Gold Systems in North Queensland

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Digging Deeper
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### IRGS NQ

**NQ Au total and >1Moz deposits**

<table>
<thead>
<tr>
<th>CLAN</th>
<th>TOTAL Moz</th>
<th>Deposit Moz</th>
<th>DEPOSIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRGS</td>
<td>19.3</td>
<td>5.0</td>
<td>Kidston</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.8</td>
<td>Ravenswood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.5</td>
<td>Mt. Leyshon</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.1</td>
<td>Red Dome</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1</td>
<td>Mungana</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0</td>
<td>Mt. Wright</td>
</tr>
<tr>
<td>Epithermal</td>
<td>8.9</td>
<td>3.6</td>
<td>Pajingo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.4</td>
<td>Mt. Carlton</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1</td>
<td>Wirralie</td>
</tr>
<tr>
<td>Orogenic granite-hosted</td>
<td>8.6</td>
<td>6.8</td>
<td>Charters Towers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.0</td>
<td>Croydon</td>
</tr>
<tr>
<td>Orogenic turbidite-hosted</td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Placer (estimated)</td>
<td>~4</td>
<td>1.6</td>
<td>Palmer River alluvials</td>
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<tr>
<td>VMS total</td>
<td>0.3</td>
<td></td>
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</tbody>
</table>

- 17 deposits +1Moz in Qld
- 12 deposits +1Moz in NQ
- >40Moz total endowment NQ
- >19 Moz in IRGS
- In all ~130 IRGS in NQ
- Some bi-product Cu
- But no major Cu deposits is unusual

**So NQ has a concentration of IRGS**
c.f. Yukon-Alaska Cretaceous
IRGS NQ

The INTRUSION-RELATED CLAN

DEPOSIT

BRECCIA & ALTERATION

INTRUSION

SYSTEM IS WHOLE THING

IR

= intrusion intimate to hydrothermal system and deposit

IRMS

Intrusion-Related Mineral System

Commodity independent

IRGD

Intrusion-Related Gold Deposit

Gold only commodity

IRGS

Intrusion-Related Gold System
Cluster of IRGS in north Qld
Permo-Carboniferous age
Related to Kennedy Igneous Association

Townsville Mornington Island Belt
is oblique to the arc
Cauldron subsidence => extension
Rhyodacite composition
Au-Sn-W-Mo metallogeny

Connors arc
extensive under Bowen Basin
Andesite stratovolcanoes
Cu-Mo-Au metallogeny

So NQ Permo-Carboniferous
is an IRGS Province
in an off-arc setting
IRGS NQ

IRGS CAMPS ON KENNEDY IGNEOUS

Permian linears
Early Carboniferous to mid Permian (345-260ma)
Dominated by cauldron subsidence complexes i.e. extension in continental crust
I-type throughout with Permian A +/- S-type
High $\text{SiO}_2 \ K_2\text{O} \ & \ \text{LILE}$, strongly fractionated
Derived from homogeneous mainly Proterozoic lower crust with limited mantle input, variations due to fractionation
Distinct from NEO of same age which has andesitic stratovolcanoes and is more conventional arc
Metallogeny is Au Sn W U not Cu-Mo-Au like NEO
Fractionation represented by Rb/Sr vs SiO2

Increases with SiO2, K and volatile elements

Au is with the less fractionated intrusions, but favours the volatile phase in any system

Therefore is best at moderate fractionation in mafic suites

This figure is of a continental suite with limited mafic members, so the gold is in Cu-Mo and Mo-W-Bi associations
**Mesozonal veins and breccias dominate**

**Polymetallic systems but only 1-2 commodities**

**Bi-Te diagnostic of Permo-Carb IRGS**

<table>
<thead>
<tr>
<th>Environment &amp; style</th>
<th>n</th>
<th>ENDOWMENT t Au</th>
<th>Element Class</th>
<th>Core</th>
<th>Example</th>
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<tbody>
<tr>
<td>Epizonal Vein</td>
<td>8</td>
<td>0.26</td>
<td>Au PM Bi +/-Te</td>
<td>Cu-Mo</td>
<td>Wellington Springs</td>
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<tr>
<td>Epizonal Stockwork</td>
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<td>0.15</td>
<td>Au As Bi Te</td>
<td>Mo-W-Bi</td>
<td>Mt Wando</td>
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<tr>
<td>Epizonal Breccia</td>
<td>5</td>
<td>32</td>
<td>Au BM Bi Te</td>
<td>Mo-W-Bi</td>
<td>Mt Wright</td>
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<tr>
<td>Mesozonal Skarn</td>
<td>2</td>
<td>66</td>
<td>Au PM Bi Te</td>
<td>Mo-W-Bi</td>
<td>Red Dome</td>
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<tr>
<td>Mesozonal Lode</td>
<td>5</td>
<td>0.5</td>
<td>Au PM Bi</td>
<td>Mo-W-Bi</td>
<td>Cardross</td>
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<tr>
<td>Mesozonal Vein</td>
<td>68</td>
<td>200</td>
<td>variable</td>
<td>variable</td>
<td>Ravenswood</td>
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<tr>
<td>Mesozonal Stockwork</td>
<td>4</td>
<td>2.3</td>
<td>Au PM Bi Te</td>
<td>Cu-Mo</td>
<td>Upper Cape</td>
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<tr>
<td>Mesozonal Breccia</td>
<td>26</td>
<td>270</td>
<td>Au PM Bi Te</td>
<td>ALL</td>
<td>Kidston, Mt Leyshon</td>
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<tr>
<td>Hypozonal Lode</td>
<td>1</td>
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<td>Au As (BM)</td>
<td></td>
<td>Cardigan Creek</td>
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<tr>
<td>Hypozonal Vein</td>
<td>10</td>
<td>2</td>
<td>Au PM Bi</td>
<td>Mo-W-Bi</td>
<td>Mareeba</td>
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<tr>
<td>Hypozonal Stockwork</td>
<td>1</td>
<td>16</td>
<td>Au PM Bi</td>
<td>Mo-W-Bi</td>
<td>Mountain Maid (Cardross)</td>
</tr>
</tbody>
</table>

BM (basemetal) = Cu-Zn-Pb; PM (polymetallic) = Cu-Pb-Zn+/ Bi, Te, Mo, W, Sn, As, Sb.
IRGS NQ

NQ Examples

- Pajingo, 3.5Moz
- Mt Wright, 1.3Moz
- Mt Wandoon
- Kidston, 5.0Moz
- Welcome, 0.21Moz
- Mt Leyshon, 3.5Moz
- Ravenswood, 3Moz
- Mountain Maid (Cardross, 0.5Moz)
- Cardigan Creek
- Sherwood, 0.5Moz
- Wellington Springs
- Red Dome, 2Moz
- Mungana, 1.2Moz
- Electric Light, 0.2Moz
- Far Fanning, 0.12Moz
- Redcap BM (Au, Ag, As)
- Mareeba
IRGS NQ  

System identification & interpretation

SYSTEM FINDERS

1. Geology interp of Minocc
2. ‘Jetrex’ topo silica + rhyol
3. Reverse mag anomalies
4. In-district geochem including alluvials

SYSTEM INTERPRETERS

1. drill, drill, drill & interpret
2. Ore control domains especially permeability
3. Metal zoning

Kidston
Two parallel districts sit inside the gravity & mag boundary
One driven by diorite on batholith side and other by rhyolite nearer sediments
Disrupted by prominent linear fault
IRGS NQ

Cardross region deposit zoning model

LEGEND
- Au-PM
- Au-As
- Cu-As (Au)
- Cu-Zn-Pb (Mo)
- Sn ± W
- Alteration
- Dyke

CARDROSS REGION
PERMO-CARB INTRUSIONS & MINERAL CAMPS
A profound reverse anomaly is ascribed to hydrothermal magnetite in the contact aureole of the mother intrusion pre-ore. The reverse mag epoch (~320-280 Ma) is useful thru NQ
KIDSTON PIPE
Metal Zoning

+1200m tall
Within pipe

Barren top

Au only above sill with Pb-Zn-Cu

central Cu-Zn-As-Sb

deep Mo-W-Bi-F

Overall zoning on a Thermal gradient
IRGS NQ

Mt Wright soil and rock metal zoning

3km diameter soil anomaly Zn, Bi, Au only 5ppb on hill

1km tall system, well zoned
Au 0.1ppm at surface, Best Au ore 500-800m below
Au vein only to start
More vein sets isolated
Mag shows intrusive centre
Geochem shows zoned system

→ Only seeing ¼ of system!
• A distinct NQ IRGS province with +20 Moz
• Existing work defines >130 systems
• ~30 explored well
• In current climate good targets can be identified in system interpretation
• Especially via system facies geometry & multi-element geochemical zoning