Alteration and mineralisation settings in the Olympic Cu-Au province, Gawler Craton, South Australia

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Outline

• Where and what is the Olympic Cu-Au province?
• Key alteration types & relation to Cu-Au
• Event timing
• Metal contents of fluids (PIXE results)
• Crustal settings of Cu-Au hydrothermal systems

Acknowledgements

GA Gawler Project: N. Direen, G. Fraser, Liz Jagodzinski, P. Lyons, P. Milligan
PIRSA (MER)
Companies: Adelaide Resources, Gunson Resources, MIM, Minotaur Resources, Tasman Resources, WMC
Where and what is the Olympic Cu-Au province?
Gawler Craton - Tectonic Domains

Olympic Cu-Au Province

Lithostratigraphy

MESOPROT.
- Hiltaba Suite granitoid (1595-1570 Ma)
- Mafic intrusions
- Gawler Range Volcanics
- Mafic Gawler Range Volcanics

PALAEO PROT.
- Wallaroo Gp - metasedimentary & metavolcanic rocks
- Intrusive rocks, mainly felsic; mafic
- Hutchison Gp & equivalents; BIF
- Undifferentiated Archaean to Palaeoproterozoic rocks

Prominent Hill
Olympic Dam
Moonta–Wallaroo
Cu-Au
Cu-U-Au
Cu-Au
Alteration types

- CAM: calcsil - alk feld - mt
- MB: mt - bt + Cu-Fe sulfides

Lithostratigraphy

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Stuart Shelf basement:

High-temp CAM assemblages

siltstone

magnetite-act-Kfs-pyrite-dol

K-feldspar - magnetite-act-apatite-pyrite
Moonta-Wallaroo Cu-Au district
CAM & MB assemblages

Albitisation along foliation

DDH 160

granite

actinolite

magnetite-biotite-albite
chalcopryrite-pyrite

DDH 160
Alteration types

- CAM: calcsil - alk feld - mt
- MB: mt - bt + Cu-Au
- HSCC: hm - ser - chl - carb + Cu-Au-U
- HSCC overprinting CAM / MB

Hiltaba Suite granitoid (1595-1570 Ma)
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Gawler Range Volcanics
Mafic Gawler Range Volcanics
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## Unifying assemblages

### Alteration / mineralisation

<table>
<thead>
<tr>
<th>CAM (calcsil-ALB-mt-ap)</th>
<th>MB (mt-bt + Cu-Au)</th>
<th>HSCC + Cu-Au-U (Prom. Hill)</th>
</tr>
</thead>
<tbody>
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<td></td>
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<td>CAM (calcsil-ALB-mt)</td>
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<td>HSCC (hm-chl-qtz) + Cu-Au</td>
</tr>
</tbody>
</table>

### ‘Footprint’

- Mt Woods Inlier
- Stuart Shelf basement
- Moonta-Wallaroo
Stuart Shelf basement: architecture

**Alteration types**
- CAM: calcsil - Kfs - mt + Cu-Au
- HSCC: hm-ser-chl-carb + Cu-Au-U
- HSCC over CAM

**Lithostratigraphy (pre-Pandurra Fm)**
- Hiltaba Suite granitoid (1595-1570 Ma)
- Mafic intrusions
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Timing of regional events and hydrothermal activity -

New U-Pb and Ar-Ar constraints
Olympic Cu-Au prov: event timing

Time, Ma

(new GA-PIRSA results in red; other data from Fanning, Mortimer, Creaser, Johnson, Daly and others)
Metal contents of fluids
(Stuart Shelf basement)

• Brines assoc with CAM alt - hypersaline, 350-500°C
• Fluids assoc with HSCC - lower salinity, <300°C, surficial origin
• But which of 2 fluids carried Cu, Au, U?
• Targeted FI’s in CAM & HSCC quartz
Stuart Shelf basement

Alteration types

- **CAM**: calcsil - Kfs - mt + Cu-Au
- **HSCC**: hm-ser-chl-carb + Cu-Au-U
- **HSCC over CAM**

Lithostratigraphy (pre-Pandurra Fm)

- Hiltaba Suite granitoid (1595-1570 Ma)
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High-temp Cu-bearing brines
(drill hole BD1)
CAM alteration: magnetite-qtz-amp-Kfs-ap-py (trace cpy)
PIXE Analysis of a single fluid inclusion

BD1 897.4
(images: CSIRO)

0.03 mm
Copper in fluids: Fe-ox Cu-Au systems

Cl, wt% vs Cu, ppm plot showing data points and annotations:
- BD1
- SAE7
- Starra (Williams et al. 2001)
- Lightning Creek (Perring et al. 2000)

Annotations:
- CAM alt’n, Gawler
- cpy in inclusions
- no cpy
Fluid Br/Cl:
Fe-ox Cu-Au systems

CAM alt’n, Gawler

Mt Isa Fluids

Magmatic fluids

BD1
SAE7

+ Starra (Williams et al. 2001)
+x Lightning Creek (Perring et al. 2000)

Bromine, ppm

Chlorine, wt. %
Implications of PIXE results

• Only minor copper was deposited in mt-rich CAM alt despite brines carrying >300-600 ppm Cu

• Brines too hot to saturate Cu-minerals?

• Efficient Cu deposition requires cooling and/or gradients in redox, pH, Cl, S

• Peripheral zones with HSCC + Cu-Au?

• Ongoing work - HSCC-related fluids
Central Olympic Cu-Au province: ~1590 Ma
Schematic Cu-Au ore-forming system
(view to ENE)
Conclusions

• Three regional ‘footprints’ of hydrothermal & magmatic systems in Olympic Cu-Au province
• High-T CAM alt and lower-T HSCC in each footprint
• Alteration & Cu-Au at 1580-1600 Ma in 3 regions
• Magnetite-related brines carry 300-600 ppm Cu
• But - efficient copper deposition requires a strong chemical or physical (T-P) gradient + sulfur
• Crustal levels of exposure differ in the 3 footprints