Surface Geochemistry in the Central Gawler Craton – Past, Present and Future

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Central Gawler Craton Geoscience Workshop

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Surface Geochemistry – the story so far...
Surface Geochemistry – the story so far...

Surface Geochemistry Samples – Central Gawler (window view)

Vegetation = 218
Stream Sediments = 1,502
Soil = 27,180
Surface Geochemistry – the story so far...

Surface Geochemistry Samples – Central Gawler (window view)

Calcrete = 215,840 (GeoData)
Legacy Data
Target elements and pathfinder elements have already been determined from past investigations:

**Christie Domain:**
- Au; associated elements Ag and Cu (plus As, Cd, Cr, Cu, In, Ni, Pb, Sn, Zn);
- Ni, Cr and PGE targets with elevated Cr, V, Zn, W, Pb and Cu.

**Harris Greenstone Belt:**
- Ni, Cr, PGE and Au; associated elements Cr, V, Zn, W, Pb, and Cu.
- Lithogeochemical characterisation - felsic vs greenstone-derived regolith (higher Ni, Cr, Ti and lower Zr)

**Nuyts Domain:**
- Au, Cu, Ag and U; associated element Th, use As and Ni to discriminate metasedimentary vs granitic basement in covered terrains.
Element dispersion controls (variation in chemical condition within regolith):

- **Redox potential (Eh) & hydrogen ion activity (pH)**
- **Hydrological factors**
- **Availability of complexing and oxidising agents**
- **Temperature and evaporation**
- **Physical processes causing mechanical dispersion, i.e. bioturbation, tree-throw etc**

Potential mechanisms for the generation of anomalous geochemical responses in weathered transported regolith in Australia. Access of vegetation to palaeo-accumulations or the current water table in contact with mineralization is considered a key factor in the formation of geochemical responses at the surface (Anand et al. 2016).
Regolith Geochemistry

Weathering regimes

Changing chemical conditions through time

• Under arid conditions, solubility and mobility of particular elements is affected, particularly for Au, whereas Pb, Ba and Hg remain relatively fixed as insoluble Cl⁻, SO₄²⁻ or CO₃²⁻.

• Sulphide deposits undergoing weathering produce pH gradients that influence broader dispersion of elements (e.g. As, Cu and Zn).

Figure - Stratigraphic correlation of post Permian sedimentary deposits on the central Gawler Craton. (from Central Gawler Craton: Explorers Guide)
Legacy Data – Regolith Element Associations

- **Calcrete (CaCO$_3$ +/- Mg):** widespread ‘evaporative’ pedogenic horizon on Gawler Craton and useful sampling medial for Au, Ag, Cu, Zn, Pb, Ni and V
- **Dune-hosted carbonate:** can contain low order anomalous Au, Ag and Cu when located above mineralisation
- **Ferruginous materials:** from weathered bedrock, not widespread on GC. May incorporate Au and other trace elements (As, Bi, Cu, Sb, Se, Zn, W) for local surface geochemical sampling (esp. Au/Cu and Pb/Zn)

*Calcrete coated saprolite and bluish quartz clasts nb 208636, Birthday Gold Deposit*
Regolith Sampling – Tips and Tricks

Choosing sampling medium – understanding of local and regional regolith landform processes and transport history

Pedogenic carbonate widespread in region, reflects evaporative concentration of elements

Calcrete nodule and pisoliths on sandy soil, Birthday Gold Deposit nb 208568

Black oak (causaurina pauper) At Tunkillia prospect, from Central Gawler": Explorers Guide
Regolith Sampling – Choose your own adventure

- Calcrete Soils
- Lag
- Siliceous materials
- Ferruginous materials
- Bedrock/saprock/saprolite
- Vegetation
- Groundwater
Past data, present day ideas

Surface Geochemistry
Samples – Central Gawler (window view)

Calcrete = 23,387
(CalcreteReanalysed Adjusted Below Detection Limit)
Past data, present day ideas – cover sequence materials

Surface sampling and chemical element migration – Yorke Peninsula example

High/elevated Cu concentrations preserved within pedogenic and some intermediate carbonate rocks

- Pedogenic carbonate: \( \text{Ca/Sr} < 650 \) (Ca/Mg < 28)
- Intermediate carbonate
- Marine carbonate: \( \text{Ca/Sr} > 1260 \) (Ca/Mg > 35)

**Data**
- Carbonate rocks samples: \( n = 215 \) (Wolff et al. 2018)
- Marine carbonate rocks: \( n = 12 \) (Wolff et al. 2017)
- Pedogenic carbonate rocks: \( n = 19 \) (Wolff et al. 2017)

Wolff et al. 2017 & 2018a; J. Geochem. Exploration
Applying new thinking to old data

$Ca/Mg$

$< 1 = \text{Lithic}$

$< 28 = \text{Calcrete}$

$> 35 = \text{Limestone}$
Central Gawler Pedogenic Carbonates

Mg% vs Ca%

Definitely pedogenic carbonates!

Dolomite/magnesitic mixed carbonates?
Past data, present day ideas

DETCRC

Lithogeochemical workflow

### Central Gawler Prospect History

<table>
<thead>
<tr>
<th>Study Name</th>
<th>Surface Anomaly?</th>
<th>Depth Cover (m), approx</th>
<th>Origin of Geochemical Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunkillia</td>
<td>No (transported)</td>
<td>50 m</td>
<td>Hydrogeochemistry plus Au in Calcrete - palaeochannels</td>
</tr>
<tr>
<td>Edoldeh Tank</td>
<td>No (transported)</td>
<td>15 m</td>
<td>Au - transported/dispersion?</td>
</tr>
<tr>
<td>Monsoon</td>
<td>Weak</td>
<td>8 m</td>
<td>Au - weakly anomalous above mineralisation, lateral dispersion from subcropping mineralisation.</td>
</tr>
<tr>
<td>✓ Jumbuck</td>
<td>Eastern section</td>
<td>5-8 m</td>
<td>Connected to saprock mineralisation</td>
</tr>
<tr>
<td>South Hilga</td>
<td>Strong</td>
<td>2-4 m</td>
<td>Downslope calcrete from mineralisation, originates from mafic saprolite</td>
</tr>
<tr>
<td>✓ Golf Bore</td>
<td>Moderate</td>
<td>4-10 m</td>
<td>Weathered rock below; Au anomalies in saprolite below calcrete hosted Au anomalies</td>
</tr>
</tbody>
</table>
New technologies – UltraFine+

The workflow

- Merging past regolith sampling with updated analytical techniques and machine learning
- Proposed CSIRO Collaborative project and survey areas to compliment Krapf and Gonzalez-Alvarez landscape studies
UltraFine+ - Context and Value-add

☑️ UltraFine+

☑️ CSIRO Cloud UltraFine+ AI

Ranked anomalies

DEM slope %

Regolith type

Element X by regolith type

Element X or overall uncertainty %

Element X by regolith type

Regolith type

Ranking anomalies
New Technologies – New Releases

Download here: https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1
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