River red gums and mineral exploration in Australia

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Australia
River Red Gums

- *Eucalyptus camaldulensis*
Widespread regional distribution
- one of the most widespread tree species in Australia!

Distribution of river red gums throughout Australia.
Widespread local distribution
e.g. Broken Hill Domain

River red gum distribution along major creeks in the Broken Hill region (Hill, 2001)
Widespread local distribution
e.g. Pinnacles Broken Hill

- Pinnacles Mine
- River red gums
Easy to identify
- mostly mono-specific stands along alluvial systems
Ease of sampling

• Spreading evergreen canopy
  – therefore media available all year

• Large, smooth and waxy leaves
  – minimise detrital contamination

• Easy to find and sample along stream transects
Chemical Characteristics

- extensive root system
  - $> 4000 \text{ m}^3$
- dispersion pathways
  - stream sediments
  - perched aquifers
  - primary dispersion halo
  - primary ore source
Sampling procedures

• chest height
• samples (leaves, fruit, bark and twigs)
• at compass sectors of 45°
• sample size ~ 300g
• latex non-powdered gloves
• brown paper bags
Field sites
– mineral exploration significance

Tibooburra → Alluvial Au
Williams Peak → Au & diamonds
Teilta → potential Cu-Au/Ag-Pb-Zn
Flying Doc → Ag-Pb-Zn
Bindarah → possible Ag-Pb-Zn
Yunta → potential Cu-Au
Some of the highlights from my PhD research
In particular...
– temporal element variations and their implications for mineral exploration....
– mineralisation discovery through transported cover at the Barrier Pinnacles Mine....
Biogeochemical studies ....

- **Cold to temperate environments**
  - Demonstrated temporal variations
  - Greatest Au assays achieved from the spring time

- **Semi-arid and arid regions (limited understanding)**
  - No distinct/regular growth pattern
  - Irregular rainfall patterns

- **Therefore....**
  - Does the *E. camaldulensis* display equivalent/similar temporal chemical trends?
Tielta field site...

- ~ 150 km NNW of B Hill
- Potential Cu-Au and Zn-Pb-Ag mineralisation
- Paleoproterozoic Willyama Supergroup
- Neoproterozoic Adelaidean metasediments
Teilta Temporal results...

- **Zn** – 23 ppm
- **Summer**
- **Chlorophyll synthesis**

- **Cu** – 12 ppm
- **Summer**
- **e- transfer**
Teilta Temporal results…

- Non-essential element
  - Plays no physiological role in plant nutrition
  - Relationship to Au and sulphide pathfinder properties

- Highest assay recorded for winter
  - River red gum considered to be less active
  - As associated with P uptake
  - Decreased P during winter increase in As

- As – 0.17
- Winter
Teilta Temporal results...

- **Non-essential element**
  - Economic interest
  - Plays no physiological role in plant nutrition
- **Highest assay recorded for autumn**
  - Period of peak biomass
  - Distribution of other elements across a large biomass
- **Below detection**
  - Spring/summer dilution due to increase in cellulose & starches
  - Winter period of dormancy

*Gold (ppb) vs. Months*

- Au – .56 ppb
- Autumn
Element variability results...

- High seasonal variability > 80% → Au
- Intermediate seasonal variability ~ 50% → As
- Low seasonal variability ~ 30% → none
- Slight seasonal variability < 30% → Zn and Cu
A DISCOVERY!!!

Unearthing the buried Barrier Pinnacles mineralisation...
Pinnacles field site…

- Barrier Pinnacles Mine
  ~ 10 km SW of Broken Hill
- Base metal Pb-Zn-Ag
- Paleoproterozoic Willyama Supergroup
Pine Creek…

Sample spacing
– every “collectable” RRG

- 215 RRGs sampled
  – Media
    - Leaves
    - Chest height
    - Sample size ~300 g

- Analytical methods
  - XRF
  - ICP-MS

Hyperspectral Image, courtesy NSW DPI
Results...

- Pb up to 205 times background levels
- Geochemical footprint ~ 2.5 km
- 2:1 Pb/Zn & 3:2 Pb/Zn
  - 0 – 36 ppm
  - 37 – 99 ppm
  - 100 – 190 ppm
  - 191 – 411 ppm

Hyperspectral Image, courtesy NSW DPI
Results...

- Ag up to 136 times background value

- Geochemical footprint 2.2 km
  - 0.005 – 0.100 ppm
  - 0.101 – 0.340 ppm
  - 0.341 – 0.710 ppm
  - 0.711 – 1.360 ppm
Results…

• Zn up to 7 times background values
• Erratic pattern (repeated)
  – mobility
  – peaks related to floodouts
  • 17 - 47 ppm
  • 48 - 80 ppm
  • 81 - 141 ppm
  • 141 – 338 ppm
Results...

• Pb/Zn ratio
  – Zn ‘peaks’ related to floodouts
  – reduces “false” or transported anomalies

  - 0 – 0.1 ppm
  - 0.11 – 0.38 ppm
  - 0.39 – 0.97 ppm
  - 0.98 – 2.1 ppm
Detrital contamination…

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<th>Elements</th>
<th>Unwashed</th>
<th>Washed</th>
<th>Unwashed</th>
<th>Washed</th>
<th>Unwashed</th>
<th>Washed</th>
<th>Pine Crk 5b</th>
<th>Pine Crk 6</th>
<th>Pine Crk 6a</th>
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<tr>
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<td>7.400</td>
<td>5.490</td>
<td>5.780</td>
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<tr>
<td>As ppm</td>
<td>7.400</td>
<td>8.040</td>
<td>4.360</td>
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<tr>
<td>Ag ppm</td>
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<td>1.070</td>
<td>0.530</td>
<td>0.480</td>
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<td>266</td>
<td>354</td>
<td>383</td>
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<td>Zn ppm</td>
<td>168</td>
<td>148</td>
<td>106</td>
<td>132</td>
<td>215</td>
<td>269</td>
<td>168</td>
<td>148</td>
<td>106</td>
</tr>
</tbody>
</table>

- No significant decrease in element concentration
  - elements partitioned to veins
  - movement of mobile elements (N, P, K, Mg …)
  - element concentration variable \(\therefore\) difference between washed & unwashed is within the range of natural variation
Sources...

- Stream sediments
- Perched aquifer
- Bedrock
- Primary ore source
Excavation…
– ‘Gibbo’
(earnest hard-working CRC LEME Honours student)
Conclusions...

• Temporal variations in *E. camaldulensis* may not be extreme but they do exist
• Macro- and micro-elements possibly outline periods of growth development
• The understanding of growth periods and associated element variations allow optimal sampling periods to be defined
• The slight to intermediate variability for Cu, Zn and As suggests that samples from throughout the year would be comparable
• Large seasonal variations for Au reveals a restricted sampling period…possibly autumn for southern Australia
Conclusions…

• River red gums are a useful regional exploration sampling media across large parts of Australia

• These results show polymetallic expression of buried polymetallic mineralisation

• Biogeochemistry can “see through” surface contamination in upper transported regolith

• This has now resulted in the discovery of previously unknown mineralisation lodes
Acknowledgements

• CRC LEME
• NSW DOPI
• Craig Williams (Pinnacles)
• Dallas and Helen Bright (Balaclava Station)
• David Garnett
• John Pike & Bill Pappas (Geoscience Australia)
• Becquerel Laboratories