Understanding the regolith
A proposal for regional airborne EM survey to support exploration under cover

Theo Aravanis
RTX Chief Geophysicist
UNCOVER – Adelaide
April 1 2014
Regolith map of Australia
What benefits would this provide explorers?

A semi detailed map of the broad composition, depth and specifically the variation in depth of the regolith is required by todays & future explorers

- Feasibility of rapid drilling to bedrock

- The suitability of geochemical exploration techniques is largely controlled by the depth of transported cover

- The effectiveness and interpretability of surface and airborne geophysical techniques are dependent on the depth of overburden
Ground Rules

Regolith = Transported overburden + Weathered bedrock \hspace{1cm} (1)
Regolith = Overburden \hspace{1cm} (2)
Regolith \neq \text{Cover} \hspace{1cm} (3)

Images sourced from Geoscience Australia

At this scale Gravity & Magnetic coverage of Australia look equivalent. They are not

AGG is the only realistic means to bridge the gap in resolution and thereby improve the detection of deposits undercover

GRAVITY
Av. Data Spacing
4 km centres

MAGNETICS
Av. Data Spacing
400 m line spacing @ 10 m
Factors effecting Airborne Gravity Gradiometry (AGG)

Density changes ($\Delta \delta$) relative to average bedrock geology

1) **Topography** $\Delta \delta \approx -2.6$ g/cc

2) **Regolith**
   - Transported o/b $\Delta \delta \approx -0.8$ g/cc
   - Weathered b/rock $\Delta \delta \approx -0.4$ g/cc

3) **Bedrock geology** ($2.4 – 2.8$ g/cc)
Airborne Gravity Gradiometry
Sensitivity to overburden thickness variations

Geological noise only
-20 Gzz

Next Generation AGG
(1 Eö/root Hz)
-10 Gzz

Current Generation AGG
0 Gzz

-10 Gzz

Overburden
Δδ = -0.8 g/cc

Overburden

Overburden

Bedrock

Bedrock

Bedrock

Left side
2 m variation with channels
10 m deep
180 m wide

Right side
10 m variation with channels
30 m deep
300 m wide

60 km

80 m

~2 Eö

~5 Eö

~6 Eö

~20 Eö

~2 Eö

~2 Eö

~2 Eö

~2 Eö
Geological noise in AGG Balgarri, Eastern Goldfields WA

AGG Profile
Without instrument noise

Density Profile
Assumed densities

Regolith Profile
derived from 50 DH

- Sheetwash
- Alluvium
- Saprolite
- Saprocks
Geological noise in AGG Balgarri, Eastern Goldfields WA

Density Profile
- Alluvium 1.8 g/cc
- Saprolite 2.2 g/cc
- Saprock 2.6 g/cc

Regolith Profile
- Sheetwash
- Alluvium
- Saprolite
- Saprrock

1 km scale
Recap

1. AGG will improve the detection rate of Tier-1 deposits undercover but…

2. …variations in the regolith could adversely impact on the interpretability of AGG

Therefore an independent and cheap means of account for density variations due to the regolith is required
Geological signal in AGG and AEM Balgarri, Eastern Goldfields WA

AGG Profile
- Next Generation

AEM Profile
- TEMPEST

Regolith Profile
- derived from drilling

Gzz (E₀)
- 0
- 20

Saprolite <10 ohm m
- Saprock > 10 ohm m

Saprock
- Alluvium

Sheetwash
- Alluvium
- Saprolite
- Saprock

m ASL
- 320 m
- 420 m

1 km
Conclusion

1. AEM can potentially correct for density variations in the regolith post survey (like terrain corrections) …
   …if AEM is collected on an adequate line spacing

2. Feasibility of acquiring AGG can be based on the modelled response of the interpreted regolith (from AEM) relative to the target response before acquiring AGG

Having access to AEM before surveying is of greater value for AGG and for exploration in general
Wide spaced traverses of AEM across the shallow (<500 m) covered portion of the Australian continent, supplemented with ancillary information from existing drilling, water bores,…

What is wide spaced?
- Along line variation more important than full coverage
- 10 km seems reasonable

What about hyper saline areas?
- Even an indication of depth of the regolith is better than no information

What this likely to cost?

Proposal

Image from: "Mapping through cover with regional AEM surveys" Williams et al, Mining 2010, Brisbane
Cost Estimate*

Australian continent 7.7M km\(^2\)

**Assumption #1**

2M km\(^2\) required to be flown

**Assumption #2**

10 km line sp. \(\approx\) 200,000 km

**Assumption #3**

acquired @ $100/km \(\approx\) $20 M

*collected over multiple years

* Needs to be validated
UNCOVER initiatives - Priorities

1. Characterisation of the regolith (not cover)

2. Investigating the lithospheric architecture

3. Distal footprints

4. Resolving the 4D geodynamic & metallogenic evolution

Note a little internal debate within RTX re swapping the order of 2 & 3