Unravelling Australia’s geological architecture

Marie-Aude Bonnardot (and many colleagues at Geoscience Australia)
Introduction

Characterise the composition and architecture of the cover to advance our knowledge on resource distribution and de-risk exploration under cover.

Surface geology 1:1M

- Major mines and deposits

2000 km
Exploring for the Future – Extended and expanded ($225 M)

- **3 Continental-scale projects** with a focus on southern Australia:
  - Australia’s Resources Framework
  - Australia’s Future Energy Resources
  - National Groundwater Systems

- **3 Deep-dive projects** in two trans-continental corridors:
  - Barkly-Isa-Georgetown
  - Darling-Curnamona-Delamerian
  - Officer-Musgrave

- **2 Program-support projects**
  - Enhanced data delivery
  - Geoscience knowledge transfer
EFTF Australia’s Resources Framework project

National Geological Framework

Provide geological understanding of lithospheric architecture

National Geochemical Framework

Deliver a portfolio of geochemical surfaces to complement geophysical grids

Critical Minerals Mapping Initiative

Mineral Systems Combination of features

National Mineral Potential

Deliver predictive tools to stimulate exploration investment and drive new discoveries

Economic feasibility

Investment
3D geological model workflow

Pre-competitive datasets
- AEM
- Seismic data
- MT data
- Passive seismic
- Magnetics
- Gravity
- Inorganic geochemistry
- Bare Earth
- Boreholes
- Metamorphic geology
- Solid geology

Database and tools
- Estimates of Geological and Geophysical Surfaces (EGGS)
- Uncover ML
- LOOP

Predictive datasets
- Cover thickness
- Geochemical backgrounds
- https://github.com/

3D integrated model
- Soil composition
- Base Cretaceous
- Base Mesozoic
- Base Permian
- Base Neoproterozoic

Cover thickness
Geochemical backgrounds

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CMMI Update 16 March 2022
A Chronostratigraphic Approach

Outcrop Geology 1:1M
Seamless Solid Geology Mapping

Outcrop geology 1:1M

Stewart et al., 2020
Seamless Solid Geology Mapping

Stewart et al. (2020)

Goscombe et al. (2020)
World largest Airborne Electromagnetic Survey - AusAEM

A collaboration with State and Territory geological surveys

- Neoproterozoic to Paleozoic basins
- Mesozoic basins
- Cenozoic basins and Paleovalleys
- Resistive basement

Uncover ML (Wilford et al., in prep)
AusAEM – Mapping the near surface

Cover mapping
Basin extent
Paleovalleys

Wong et al., 2020
Estimates of Geological and Geophysical Surfaces (EGGS)

- Consistently store point depth estimates from geological and geophysical data – Depth estimate pick, not interpolation
- Be dynamic and grow with evolving geological framework
- Track changes, e.g. new data, new interpretation, new processing
- Capture uncertainties
- Accessible to external users though the GA portal
Estimates of Geological and Geophysical Surfaces (EGGS)

Australian Stratigraphic Units Database (ASUD)

Hope et al., in prep

Total Depth 1617.25 m

Cragaceous sedimentary rocks 76566
Tindall Fmt
MES-Base

Antrim Plateau Volcanics
Cox Fmt
PAL-Base

Bukalar sandstone
Kyalla Member
NPR-Base

Within Velkerri Fmt
MPR-Within

PAL - Paleozoic
CEN - Cenozoic
MES - Mesozoic
NPR - Neoproterozoic

EGGS unconformity
Estimates of Geological and Geophysical Surfaces (EGGS)

~ 220,000 depth estimates

Depth (m)

Age boundary name

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<td>500</td>
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Mathews et al., 2020

Base of Cenozoic
Base of Mesozoic
Base of Paleozoic
Within Paleozoic
Base of Neoproterozoic
Within Neoproterozoic
Base of Mesoproterozoic
Within Mesoproterozoic
Base of Paleoproterozoic
Within Paleoproterozoic

AEM data
Depth to magnetic tops
Released

MarieAude.Bonnardot@ga.gov.au  CMMI Update  16 March 2022
Depth to cover modelling

Depth (m)

0 200 500 7000

50-100 km
Depth to cover modelling

68,414 input points

Observations

Predictive input datasets

2km cell size

Interpolation

Machine Learning

Wilford et al., 2020
Bonnardot et al., 2020
Cover thickness models – Base Mesozoic

3D integrated model (interpolation)

Bonnardot et al., 2020
What are the next steps?

(1) (Hydro-)Geochemistry (major elements, isotopes etc...)
(2) Soil composition
(3) Base Cenozoic
(4) Base Mesozoic
(5) Base Paleozoic
(6) Base Neoproterozoic

Mineralogy
Heavy minerals
Barest Earth
Alkaline rocks
3D gravity and magnetic inversion
Isotopic crustal boundaries
Magnetotellurics
Active & Passive Seismic

How do we identify which geochemical parameters will improve targeting for basin-hosted base-metals and critical minerals deposits?

What is temporal and spatial distribution of alkaline rocks, their relationship to mineralisation and their geophysical expression?

How deep are the prospective rocks and could that make an economically viable prospect?

How well do our conceptual mineral system models actually predict observed deposition?

How do we better identify which sedimentary basins are most prospective for basin-hosted mineralisation?
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Thank you!

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https://github.com/GeoscienceAustralia/uncover-ml
https://loop3d.github.io/