The National Drilling Initiative: Bringing geological mapping into the 21st Century at GSWA

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‘The map that Changed the World’:
Powering the Industrial Revolution: The search for coal
The 1979 Geological map of Western Australia

- Compiled from 1960s to 1970s 1st edition, 1:250 000-scale mapping
  - Drawn and scribed by hand: Variable spacial accuracy and consistency
  - Lithoprinted

2015 Geological map of Western Australia

- Compiled from extensive 1:100 000-scale remapping
- Use of SHRIMP U–Pb zircon geochronology and Nd, Hf isotopes
- Geophysics
  - Magnetics
  - Gravity
  - Seismic: active and passive
- Drawn and stored digitally using GIS software: spatially accurate; consistent between scales
- Lithoprinted! But most GSWA map products are plotted-on-demand
Multi-layered: Everything is available online from DMIRS website

The Future of Mineral Exploration Geoscience in Australia: UNCOVER Roadmap, Resources 2030 Taskforce

- Mineral Systems approach
- Characterise the cover
  - Confidently explore beneath the cover
- Lithospheric architecture
  - Identify fluid pathways through the crust — link to mantle reservoirs
- 4D geodynamic evolution and metallogensis
  - Identify tectonic settings and associated mineral deposits through time and space
  - Improve predictive ore deposit targeting
- Characterising and detecting the distal footprints of ore deposits
  - Multiscale compilation and integration of geology, geophysics and geochemistry datasets.
  - Understanding deposit models and commodities in mineral systems
- Data Strategy
  - Collect, integrate and make available additional pre-competitive geoscience data
WA’s Exploration Incentive Scheme: 2009–2019

• Aims:
  – Encourage Greenfields exploration
    • Exploration under regolith and thin sedimentary basin cover
  – Architecture
    • Crustal-scale 2D and 3D models
    • Integrate robust interpreted bedrock geology maps with deep seismic, MT, magnetics and gravity
  – Geodynamic setting and geological history (4D)
    • Integrate geological mapping, geophysics, geochemistry, geochronology, isotopes, structure, metamorphism and mineral deposits

EIS 4 – programs (5)

• Program 1: Innovative Drilling ($5 million)
  – Government-Industry co-funded exploration drilling
  – Stratigraphic and mineral potential drilling using new technologies
• Program 2: Geophysical Surveys
  – Airborne gravity surveys
  – Airborne electromagnetic surveys (AEM)
  – 2D deep crustal seismic data
  – Passive seismic data
  – Magnetotelluric (MT) data
• Program 3: Encouraging exploration through cover
  – Drilling decision support and targeting
  – Depth of cover and its interfaces

  • Program 4: 3D prospectivity mapping
    – Mineral Systems Atlas
    – Onshore Petroleum Systems
    – WA Geology Online
    – Lithosphere visualisation
    – Mapping geodynamic settings
    – Enhanced geochronology and isotopic fingerprinting

• Program 5: promoting strategic research with industry
  – MRIWA ($350,000/annum)
Before the NDI there was the Eucla basement stratigraphic drilling program

- Between 2013 and 2014 GSWA drilled 8 stratigraphic diamond holes collecting about 200 m of basement in each hole; total 1,560 m
- Cost was approximately $3.5 million – with lessons learnt could reduce this
- We then carried out very detailed work on those drillcores and also the sparse existing company drillcores
- Coupled with geophysical data acquisition and interpretation, the results have been province-defining and we consider the program highly successful
- But it has taken time and significant investment – outside of the scope of most companies to take this type of regional mineral systems approach

[Diagrams showing drillhole locations for the Eucla basement on an SRTM image showing the Eucla Basin cover; overlay is gravity (colour) and 1VD aeromagnetics (grayscale)]

Western Coompana Province

Mafic remnants of probable Toolgana Supersuite in Undawidgi Supersuite (FOR011):
- Contain early fabrics/structures
- Are geochemically similar, including subduction signature
- High-K metagabbro shows a mantle (N-MORB) component

[Diagram showing age distribution and geochemical composition of Coompana Province samples]

From Spaggiari et al. Rodinia 2017 presentation
Before the NDI there was the Eucla basement stratigraphic drilling program

- It has taken time but there is now considerable tenement uptake
- BHP Seahorse project primarily located along the suture zone – Rodona Shear Zone; primarily Ni, but open to other commodities
- Red Metals has various tenements throughout Madura Province, and one in the Coompana Province; IOCG is the main focus, but also Cu-Au
- We opened up new ground and opportunities - these search spaces are very different to adjoining areas
- Both companies have received offers for EIS co-funded drilling

Tectonic units map showing live tenements (green) and pending (blue), Oct 2019. Pink triangles are GSWA stratigraphic drillholes; orange dots are company drillholes, including two granted EIS holes yet to be drilled. Yellow area shows the extents of the Eucla Basin.

Where we will work

- The Gap: remote desert country in WA
- A major frontier in geoscience mapping
- Areas of prospectivity to pure greenfields
- Some data collection, but much more needed
- Aligned to broader GSWA work program
Key areas

- Five key areas
  - West Arunta
  - Paterson
  - Anketell Ridge
  - E Yilgarn/Yamarna
  - Canning Basin

- Access agreement with Kiwirrkurra Traditional Owners

West Arunta at the crossroads

- The West Arunta region lies at the intersection of several Proterozoic basins and major structures, including the Central Australian Suture (CAS).
- North to northeasterly trending faults bounding the southeastern edge of the Canning Basin are coincident with significant gravity highs.
- This region offers opportunities to investigate relationships between basement structures, basin evolution, and diamond, gold, and base metal mineralization.
Flat, variable weathered, low lying outcrops, extensive eolian dune fields and sandplains. Regolith cover will vary from > 1 m thick to 90 m thick.

Ferruginised lag, lateritic residuum, variably ferruginised lithic fragments at surface (localized veneer, silcrete) rock and insitu weathered rock at shallow depths < 1 meter.

Sand dunes, qtz-rich, east west orientation, 15 m high, over tens of Km long, spacing between dunes from few 10s of meters to several 100s meters (eolian sand cover is variable from 5m to 20m).

Regional-scale paleovalleys occupy topographic depressions, as part of an internal drainage network. Regolith infill in paleovalleys are likely up to 90 m thick.

Weathering profile can be near 60m thick near paleovalleys.

Planned GSWA work and the NDI

- More EIS co-funded drillcores coming in (Norwest Minerals, three diamond holes across the CAS)
- New MinEx embedded researcher onboard (Emily Finch)
- Field mapping next year (Proterozoic Margins: Dave Kelsey, Raphael Quentin de Gromard)
- Map compilations integrating geophysical data interpretations
- Geophysical data acquisition (AusLAMP, AusArray)
- NDI planning and logistics
- Plus more to come........

Photo by Matt Kuchel, 2007
The NDI and the future of the Geological Map

- The geological map will remain the essential tool for resource exploration
- But 2D geological maps are obsolete
- The map of the future will be digital and delivered on-line as a multi-layered 3D/4D product
  - Fully integrate geology with geophysics, geochemistry, geochronology, isotopes, mineral systems
  - NDI: ‘mapping with a drill rig under cover’
- It’s a challenge for MinEx CRC/NDI to get it right for the next 200 years……..