

Exploring for the Future

A program to discover the resource potential of northern Australia

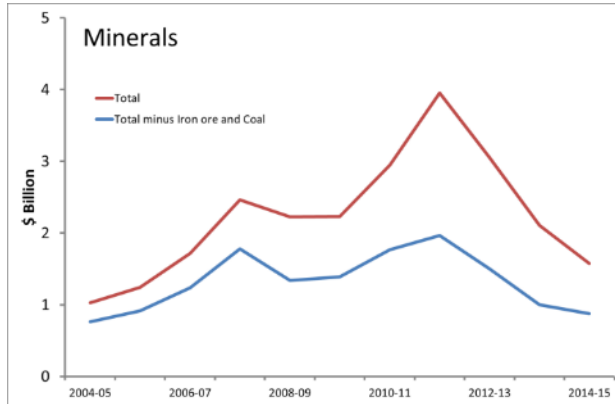


Australia's National Resource Wealth



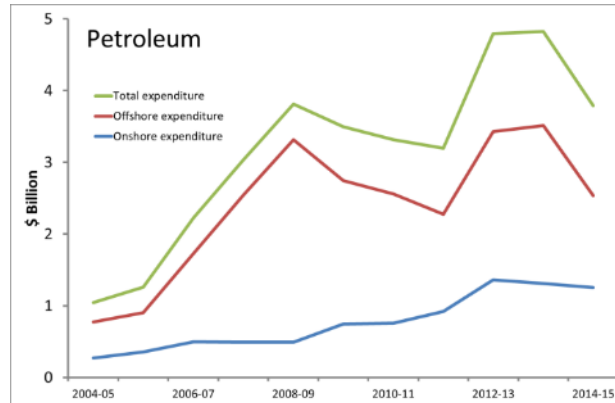
- “The north has untapped promise, abundant resources and talented people. It is also Australia’s closest connection with our key trading markets and the global scale changes occurring in Asia.” White Paper on Developing Northern Australia

The National Picture



Australia seen as a 'mature' exploration destination

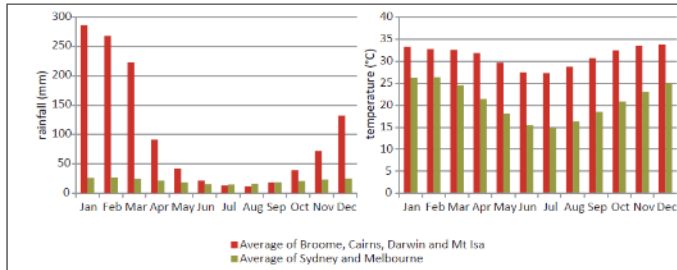
- Australia's percentage of global resources exploration investment has decreased significantly
- Greenfield and brownfield expenditure has dropped dramatically
- A focus on brownfield exploration has seen fewer large discoveries



Declining investment in resource exploration will affect the Mining Equipment, Technology and Service (METS) sector

The National Picture

Average rainfall and maximum temperature comparison (from: Northern Australia White Paper)



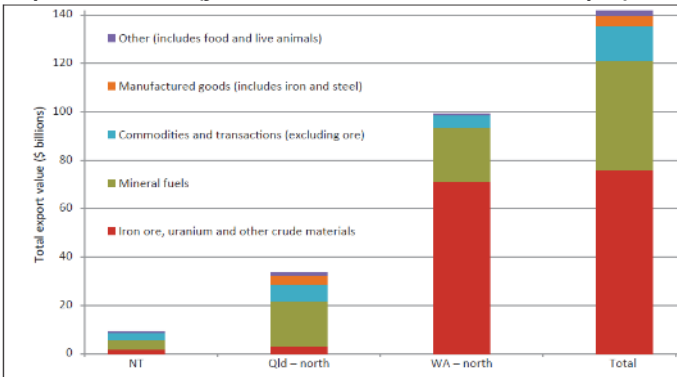
Notes: Data from weather stations closest to city centres, over periods for which data is available for a given station.
Source: BOM, 2015

Contributes an estimated ~\$6.8bn per annum to GDP.

Groundwater plays a critical role in National Water Security:

- Water is required for resource and agricultural development and for community supply.
- Groundwater represents ~17% of available water within Australia.
- Many mineral & energy deposits occur in remote areas where groundwater is the only secure local water source.
- Recently, the development of new energy sources has identified the potential for impacts on groundwater.

Export value of major commodities through northern Australia sea ports 2013-14 (from: Northern Australia White Paper)



Source: BITRF, 2015

Examples of Pre-competitive Return on Investment

Ichthys Project (Energy – offshore WA; 1996)

- Largest liquid petroleum discovery since 1960's
- Australian Government Expenditure: \$3M
- Industry Expenditure: \$34B
- Export Revenue (40 years): \$72B



Source: Inpex

Olympic Dam (Minerals – SA; 1960s)

- Giant copper-gold-uranium mine discovery
- Australian Government Expenditure: \$350K
- Value of ore body: \$1T



Source: BHPBilliton

Ord Valley Irrigation Expansion (Water – WA; 2005-10)

- Ord River Irrigated Agriculture
- Australian Government Expenditure: \$6M
- Industry and Infrastructure Investment: \$1.2B



Source: abc.net.au

Exploring for the Future

- A major new investment in **pre-competitive** geoscience from the Minister for Resources and Northern Australia
- Federal Budget measure of \$100.5 million over 4 years (2016 to 2020)
- Comprises three integrated elements:
 - Minerals
 - Energy
 - Groundwater



Exploring for the Future

A resources prospectus for Northern Australia

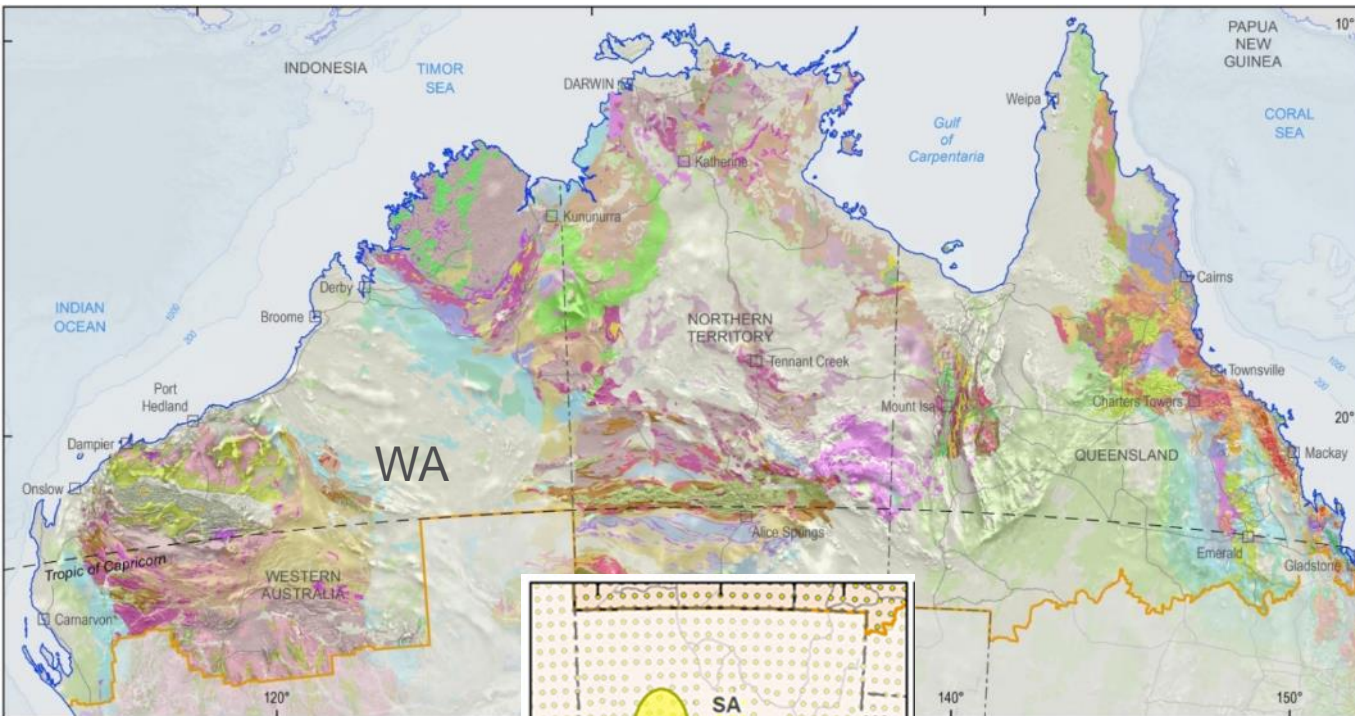
.... a targeted resource prospectus aimed at attracting industry investment through the delivery of a suite of new pre-competitive geoscience data and knowledge across tropical Western Australia, Queensland, all of the Northern Territory and parts of South Australia.

..... deliver a vastly improved understanding of the resource potential of selected regions of Northern Australia, **where the resource potential is limited or unknown**

Exploring for the Future – Aim and Approach

- Aim is to increase the attractiveness for exploration investment by technically de-risking key underexplored greenfield regions in northern Australia
- A prospectus to inform the integrated assessment of mineral, energy and groundwater resource potential based on:
 - New pre-competitive data acquisition, analysis and interpretation, and
 - Novel regional studies addressing specific prospectivity questions
- Undertaken by Geoscience Australia in collaboration with State/Northern Territory government agencies

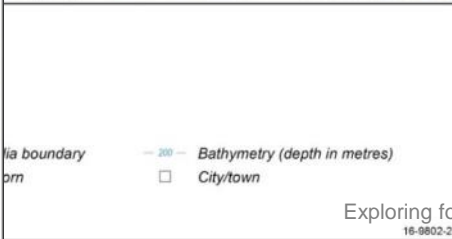
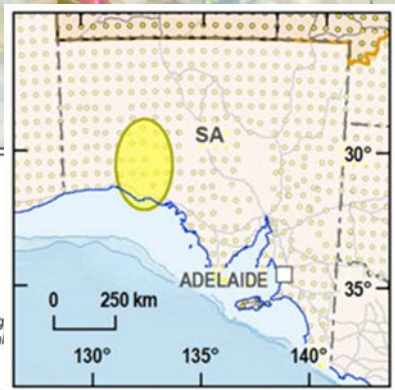
Northern Australia: where is it?



Approximately 40% of Australia's land area. Plus parts of **South Australia**

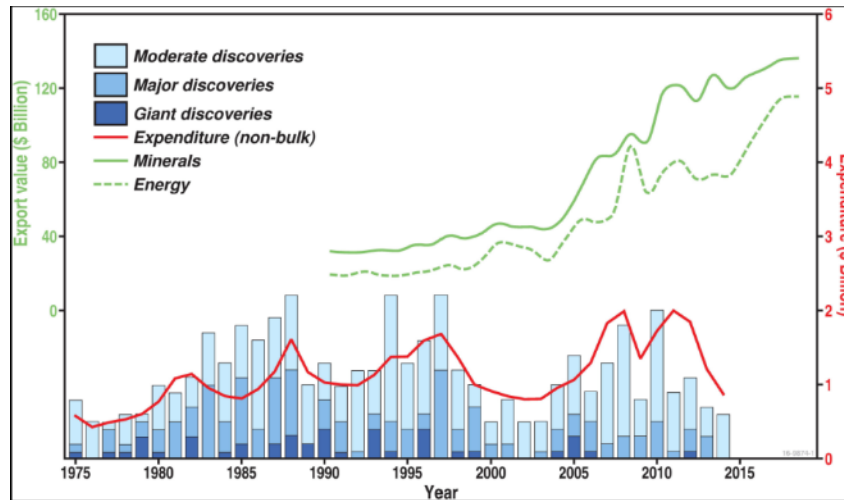


Background image: 1:5 million scale Surface Geolog background magnetics (greyscale)



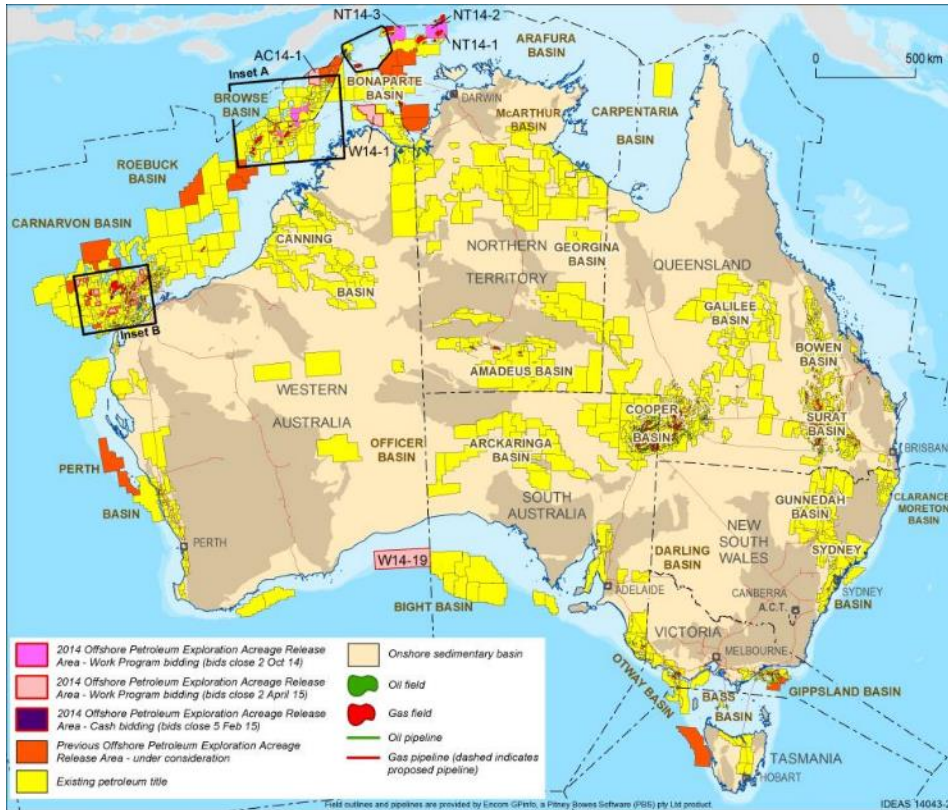
Minerals: Value Proposition

- Northern Australia has vast potential for under cover mineral resources
 - *Exploring for the Future* is a major contribution to the National Mineral Exploration Strategy and the UNCOVER Initiative
 - Minerals activities are focussed on delivery of UNCOVER's Highest and High Priority knowledge/data gaps



Sources:
MinEx Consulting
Australian Bureau of
Statistics

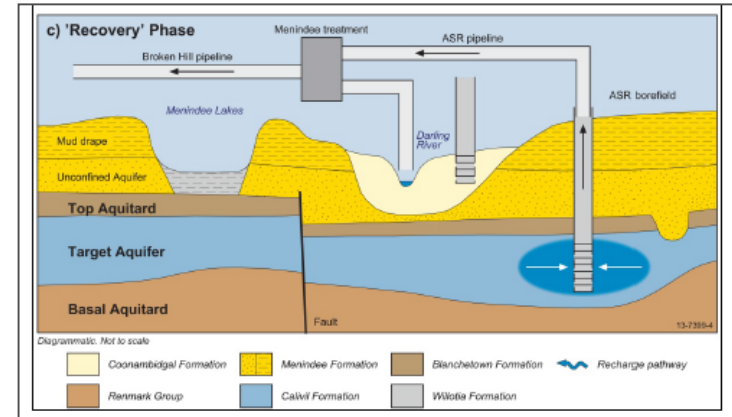
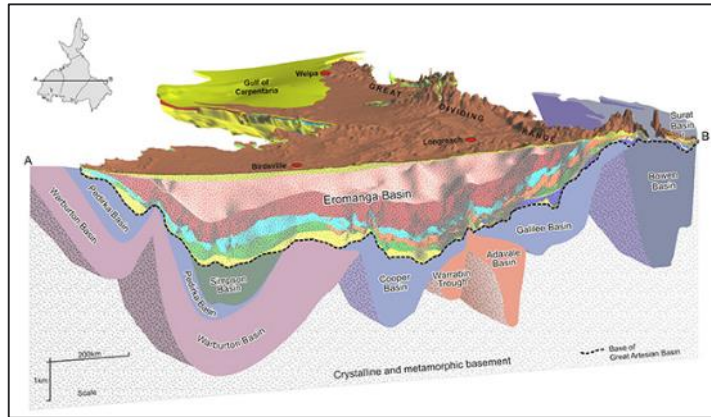
Energy: Value Proposition



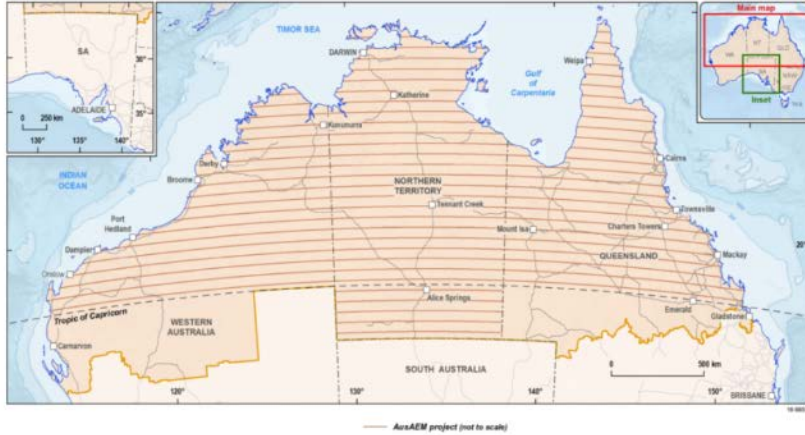
- Northern Australia hosts vast amounts of untapped oil & gas resources.
- Australia's domestic gas market requires security of supply to satisfy increasing energy demand
- LNG is the third largest export after iron ore and coal (Department of Foreign Affairs and Trade, 2015)
- Australia's LNG exports predicted to be the Worlds largest in 2019-20 (Department of Industry and Science, 2015)
- Natural gas is an energy commodity that will help limit Australia's greenhouse gas emissions

Groundwater: Value Proposition

- Major gaps in our knowledge of the location, size and quality of groundwater resource, and rates of use or depletion.
- Lack of relevant data to inform potential alternative groundwater-related options including water banking opportunities.
- Due to the seasonal nature of surface water and high evaporation rates in northern Australia, groundwater resources represent a significant opportunity for water security.
- Need to de-risk resource and agricultural investment, and inform water management options, including infrastructure development.



Proposed Activities: all Northern Australia

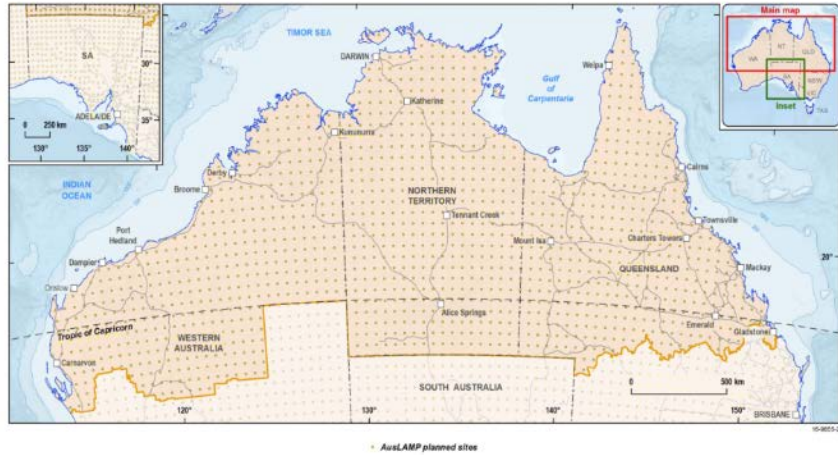


AusAEM:

- Airborne electromagnetics
- Systematically map thickness and character of cover
- 175,000 line-km
- 20 km line spacing

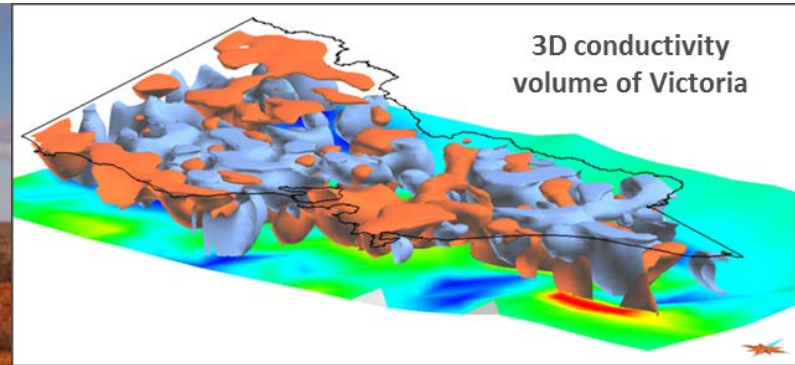


Proposed Activities: all Northern Australia

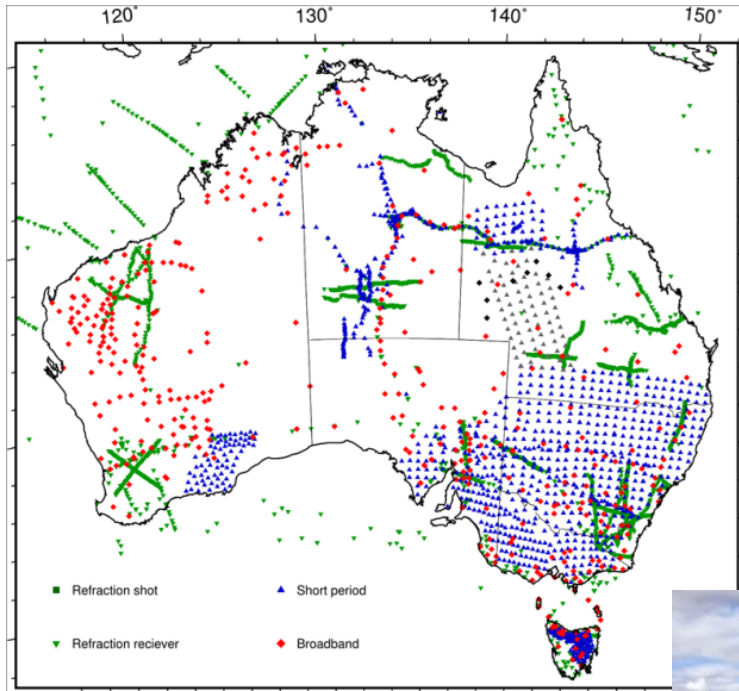


AusLAMP:

- Magnetotellurics
- Map deep conductivity structure
- Building on data in southern Australia
- 1244 stations



Proposed Activities: all Northern Australia

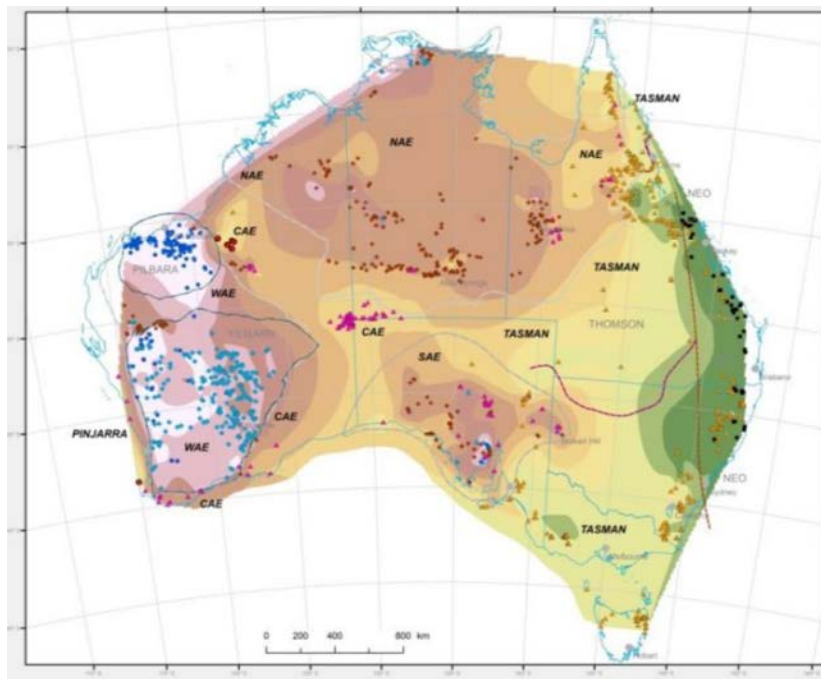


AusARRAY

- Passive seismic using distant earthquakes
- GA earthquake catalogue recalculation
- Map deep velocity structure
- Links with AusLAMP magnetotellurics
- Builds on RSES deployments



Proposed Activities: all Northern Australia



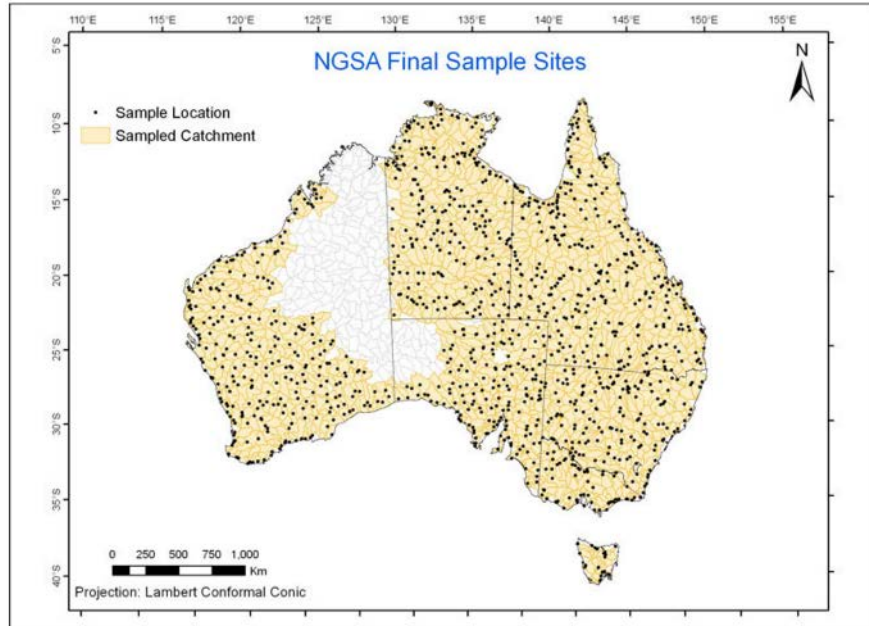
White
Brownish
Yellow
Green

very old
old
intermediate
young

Isotopic Atlas of Northern Australia

- Improve national crustal age map (neodymium)
- Collect lead, hafnium-oxygen isotopes
- Uranium-lead and argon ages
- Map the fundamental structure of Northern Australia crust
- Determine timing
- Minerals in basement
- Basins evolution (energy and groundwater)

Proposed Activities: all Northern Australia



National Geochemical Survey of Australia

- Complete gap in national coverage
- National benchmark/background
- Full multi-element geochemistry and select isotopes
- Predict buried mineralisation



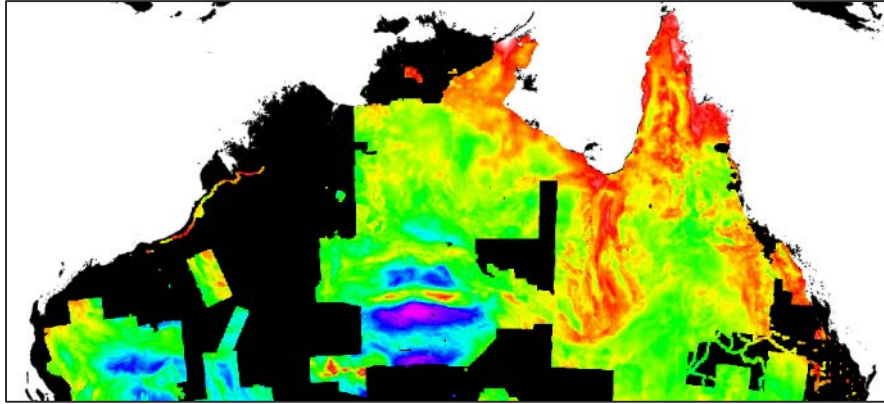
Proposed Activities: Regional studies



Hydrogeochemistry Survey

- Focused studies in regional projects
- Characterise groundwater
 - Link to AEM data
- Map potential buried mineralisation through groundwater
- Full multi-element geochemistry and selected isotopes

Proposed Activities: Regional studies



Regional Gravity

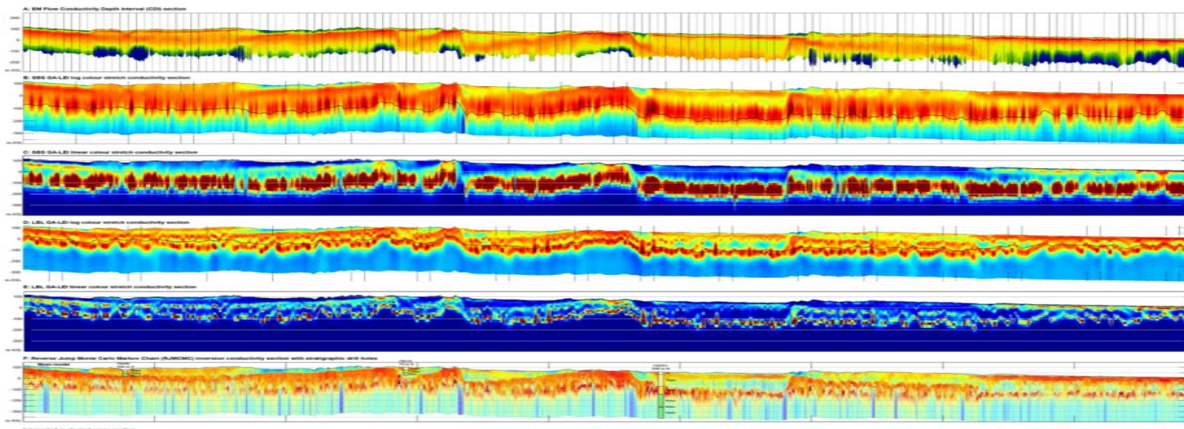
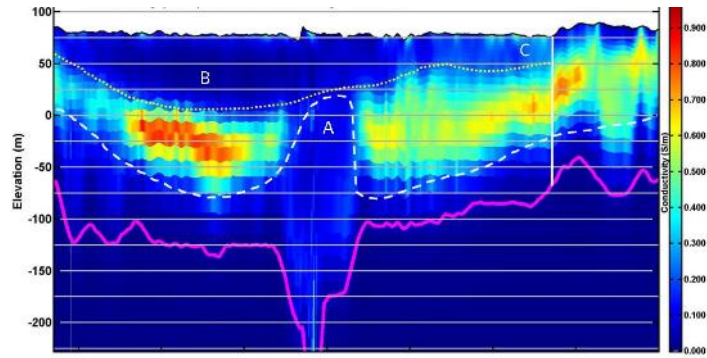
- Map density structure
- 16,000 stations in low spatial density regions (black)
- Towards a national 4 km grid



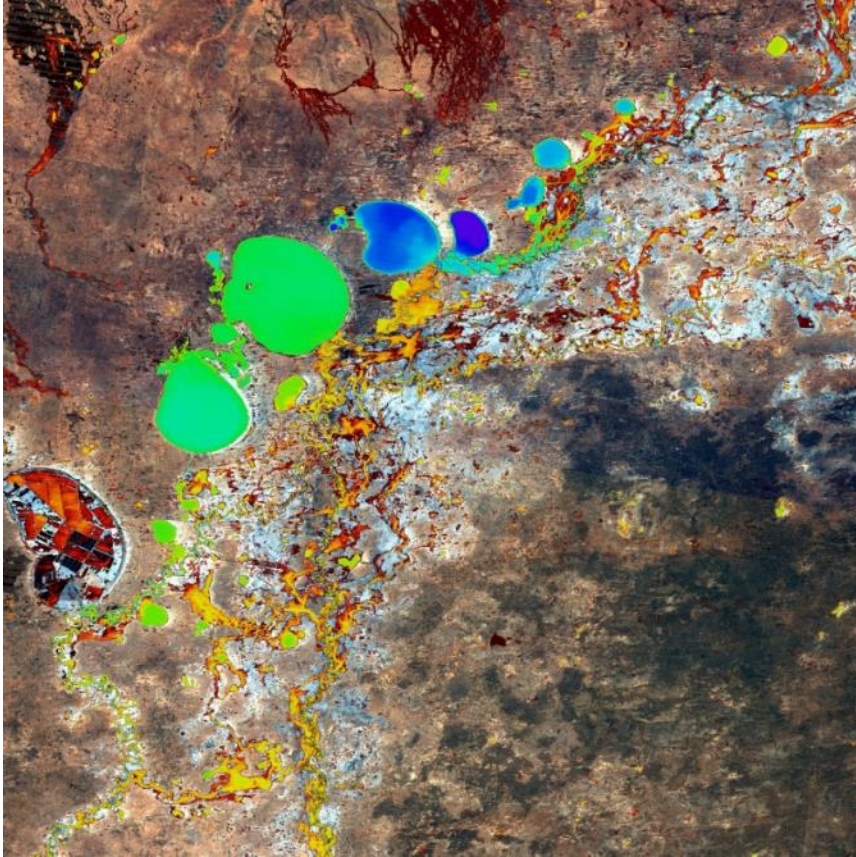
Proposed Activities: Regional studies

Regional Airborne electromagnetic data

- Targeted surveys with ~1-5 km line spacing, focused on top ~200 m
- Map near surface stratigraphy and structure
- Identify variations in conductivity associated with fresh vs saline groundwater



Proposed Activities: Regional studies



Remote Sensing data

- Use of Australia Geoscience Data Cube at the regional to local scale
- Map surface water availability, water balance
- Predict soil moisture & recharge-discharge
- Estimate vegetation condition & ecological response to water budget
- Bare earth derivatives for improved mineral maps

Proposed Activities: Regional studies

Groundwater projects will integrate AEM inversions, drilling, hydrogeology, hydrochemistry, elevation models and remote sensing data to:

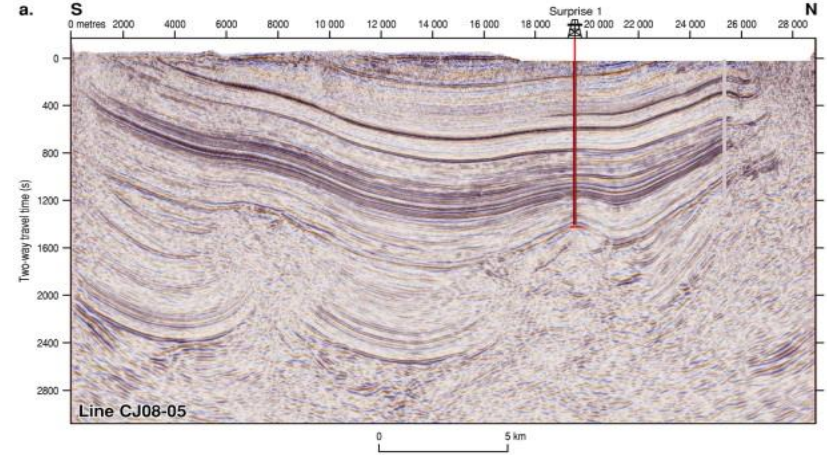
- develop 3D maps describing the depth of bedrock, distribution of aquifers and aquitards, groundwater salinity, hydraulic properties and bedrock geology;
- identify salt store and groundwater salinity hazard maps (and seawater intrusion in coastal zones);
- document potential risks to agricultural, mineral and energy development and environmental assets.



Proposed Activities: Regional studies

Regional 2D seismic data

- Identification of sedimentary depocentres
- Imaging of tectonic architecture
- Assessing the regional extent of key sequences



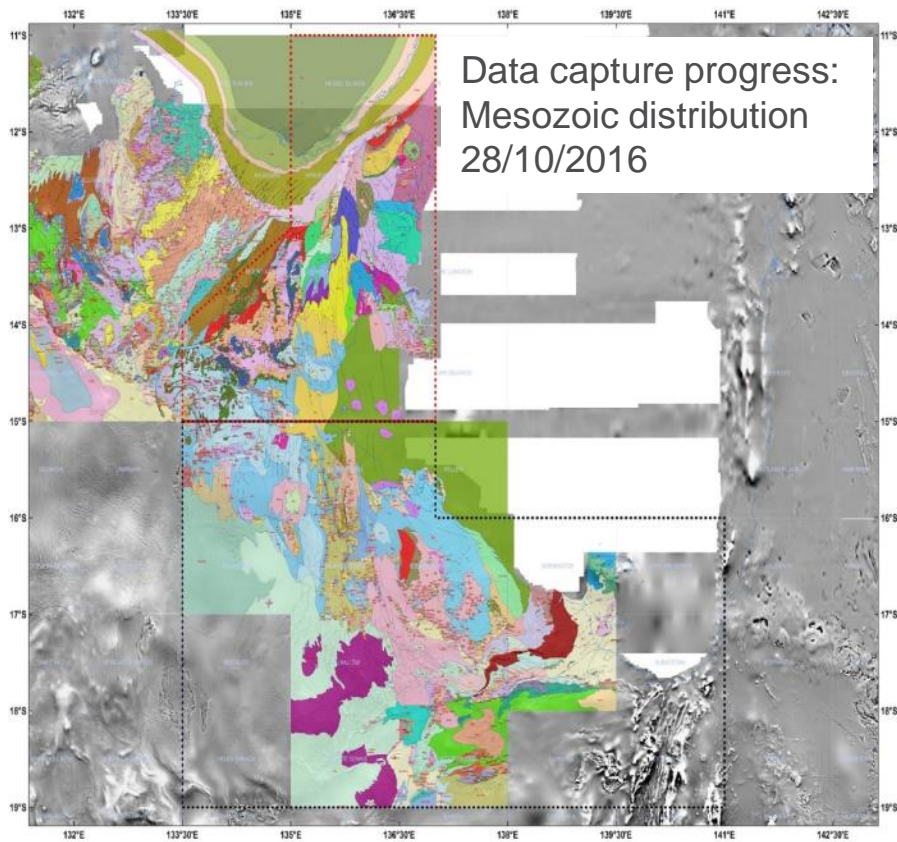
Proposed Activities: Regional studies

Stratigraphic Drilling:

- Energy, Mineral and Groundwater systems synthesis
- Site selection informed by new geophysical data
- Penetration of sedimentary sequences and into the basement
- Full multi-element geochemical sampling, and selected isotopes
- Sampling and analysis of 300 existing water bores (hydro-geochemistry)
- Collect samples for a range of geoscience analysis



Proposed Activities: Regional studies



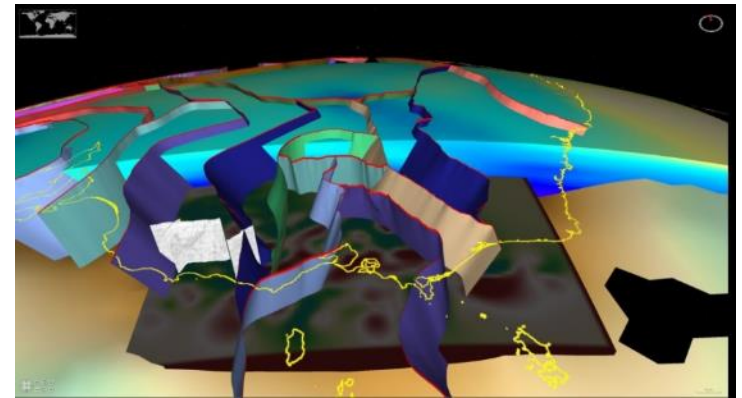
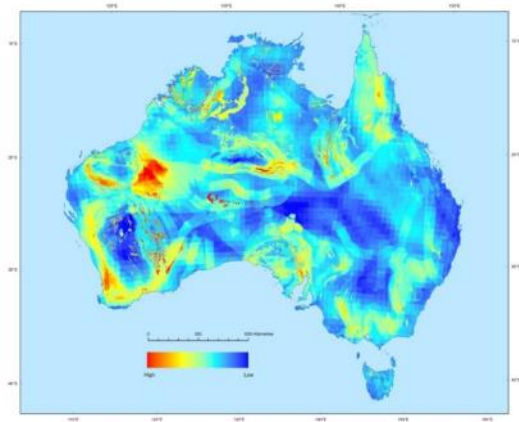
Solid Geology

- Chronostratigraphic geological maps of Northern Australia
- Seamless digital GIS datasets linked to the Australian Stratigraphic Units Database (ASUD)
- Cover-thickness estimates → basis for 3D model

Proposed Activities: Regional studies

3D visualisation and integrated analysis,
interpretation and mapping

- Build an updated 3D Northern Australia Architecture Model (including cover)
- Resource potential assessments for basin Cu, IOCG, Au, U....
- Tool kits including
 - Build on our virtual laboratory (ANVGL)
 - How to Explorer Guides



Data and Information Delivery

A suite of existing publicly available web-based platforms

The image displays four overlapping browser windows showcasing various geological data services:

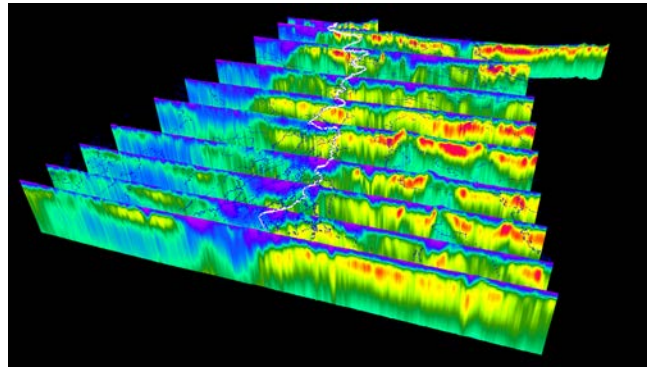
- Rock Properties:** A map of Australia with various geological layers overlaid.
- geoscience.gov.au:** The main Geoscience Australia website interface.
- vgl.auscope.gov.au:** The Virtual Geology Library (VGL) interface.
- Australian Stratigraphic Units Database:** A search interface for stratigraphic units, including fields for:
 - Names entered or modified in period from:** 01-JAN-1964 to 28-JUN-2016
 - Names reserved in period from:** (DD-MON-YYYY) to (DD-MON-YYYY)
 - Stratigraphic name(s):** (Help)
 - State/region(s):** A dropdown menu with options: Australian Capital Territory, Antarctica, New South Wales, Northern Territory, Offshore and islands, Queensland, South Australia, Tasmania, Victoria, Western Australia.
 - Province(s):** (Help)
 - Stratigraphic number(s):** (Help)
 - Reserved By (Originator):** (Help)
 - Minimum Age:** (Help) | **Maximum Age:** (Help)
 - Current:** (dropdown) | **Rank:** (dropdown) | **Status:** (dropdown)
 - Buttons:** Start Search, Print Version, Reset

Outputs

- Annual delivery of pre-competitive data and regional geological studies that technically de-risk greenfield regions to:
 - Help identify the location, quantity and quality of new mineral, energy and groundwater resource potential in northern Australia, and
 - Allow for the rapid, quantitative and cost-effective mapping, characterisation and assessment of resource systems
- Data and information that can help underpin a co-ordinated and consistent approach to mineral, energy and groundwater resource assessment
- Provision of authoritative, independent information and advice to stakeholders

Exploring for the Future: Outcomes

- Safeguarding Australia's future economic prosperity
- Positioning Australia for the next wave of exploration investment
 - For Government: A resources prospectus
 - For Industry: A foundation for new discoveries
- Redress Australia's declining share of global resource exploration investment



Exploring for the Future

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