

# ONSHORE ENERGY SECURITY PROGRAM 5 YEAR PLAN

## Summary

This document outlines Geoscience Australia's Onshore Energy Security Program and a working plan for its implementation over five years commencing August 2006.

Part 1 summarises the budget, principles of the Program, consultation, objectives, outputs, program governance and structure, and communication.

Part 2 outlines the plan of activities for each of the five years, and describes where some of the major datasets will be acquired, including radiometric, seismic reflection, airborne electromagnetic and geochemical data.

Part 3 describes in brief the national and regional projects. The national projects are: Uranium, Geothermal, Onshore Hydrocarbons, and Thorium. The first four regional projects of the Program, in Queensland, South Australia, Northern Territory and northern Western Australia, are summarised.

Appendix 1 outlines the objectives of current seismic reflection data acquisition as well as proposed and possible seismic reflection surveys.

Appendix 2 outlines proposed and possible airborne electromagnetic surveys.

## Part 1. Introduction

### 1.1 Prime Minister's statement and budget

The Australian Government's Onshore Energy Security initiative was announced by the Prime Minister on 14 August 2006 (see AusGeo News 84) as part of a broader package of energy exploration initiatives. The \$58.9 million, five-year Onshore Energy Security Program (OESP) will deliver pre-competitive data packages with scientifically based assessments of the potential for energy resources of onshore Australia including oil, gas, uranium, thorium and geothermal energy.

The budget breakdown for the five financial years of the program is as follows (\$million).

	06/07	07/08	08/09	09/10	10/11
<b>Totals (\$M)</b>	<b>7.4</b>	<b>14.8</b>	<b>14.8</b>	<b>12.7</b>	<b>9.3</b>

Major components of the OESP will be the acquisition of new seismic reflection, airborne electromagnetic, radiometric, heat flow,

and magnetotelluric data. When integrated with new geological and geochemical information, these geophysical datasets will provide unprecedented insights on the potential for undiscovered energy and mineral resources concealed beneath the Earth's surface.

### 1.2 Principles of the OESP

All elements of the onshore program will be conducted under the National Geoscience Agreement (NGA) between State and Northern Territory governments and the Australian Government. This agreement requires a high degree of consultation and cooperation between Geoscience Australia and State and NT government geoscience agencies. The NGA has proved to be a successful working model in past years, and will be a foundation for the delivery of the OESP.

Geoscience Australia's project work under the OESP is prioritised according to the following principles:

- Promoting investment in exploration for energy-related resources, especially in greenfields areas;
- Improving discovery rates for energy-related resources;
- Projects will be of national and/or strategic importance.
- Gaps in science knowledge will determine where and what new data are acquired; and
- Projects will operate under the auspices of the National Geoscience Agreement.

### 1.3 Consultation

Initial discussions on the OESP have been held with all State and NT government geoscience agencies. Agreements have been reached on several of the major data acquisition programs, and consultation is ongoing with these agencies. Stakeholders within the minerals, geothermal and petroleum industries have been consulted. Presentations and a workshop on the OESP have been given at several industry conferences including AMEC (Perth, March 2007), APPEA (Adelaide, April 2007), SAREIC (Adelaide, May 2007), and the AusIMM *Australia's Uranium Conference* (Darwin, May 2007).

## 1.4 Objectives of the OESP

The Australian Government's intent through the OESP is to:

- Secure diverse energy sources through the provision of new geoscience data for explorers to test the potential of frontier provinces;
- An improved understanding of Australia's onshore energy resource base;
- Attract exploration investment by reassessing and promoting the potential of onshore Australia for petroleum and gas resources, geothermal energy resources, and uranium and thorium and other mineral resources; and
- Provide advice as required on the nation's onshore energy resources.

## 1.5. Outputs

The OESP will produce a wide range of products to assist exploration and discovery of new energy and mineral resources.

These include:

- New geophysical datasets from targeted seismic, airborne electromagnetic (AEM), aeromagnetic, radiometric, gravity, and magnetotelluric surveys;
- Databases of new heat flow and thermal conductivity measurements;
- Maps and interpretations of the new geophysical data including new national radiometric and magnetic anomaly maps;
- Integrated regional geological interpretations and energy and mineral potential assessments;
- 3-D geological maps and models of targeted petroleum basins and mineral provinces;
- New assessments of Australia's geothermal potential.
- Reports and publications of energy and mineral systems

The proposed outputs are subject to ongoing program review of priorities as results of the earlier surveys come to hand.

## 1.6 Scientific questions

The key geoscientific challenges and questions to be addressed are as follows.

- Onshore hydrocarbons
  - a. Which basins have high potential for undiscovered petroleum and natural gas resources?
- Uranium
  - a. What is the spatial distribution of known uranium resources and anomalous enrichments across Australia?

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- b. Which regions have high potential for undiscovered uranium resources?
- c. How can such regions be targeted by explorers?
- d. What is the magnitude of Australia's potential uranium resources?
- Geothermal
  - a. What is the spatial distribution of high heat flow across Australia?
  - b. Are thermally 'insulating' geological formations present in areas of high heat flow, that are favourable for geothermal reservoirs?
  - c. Are there resources of naturally heated water available near major population centres?
  - d. What is the magnitude of potentially available geothermal energy in Australia?
- Thorium
  - a. What is the spatial distribution of known thorium resources and anomalous enrichments across Australia?
  - b. Which regions of Australia have high potential for undiscovered thorium resources?

These questions will be addressed through the application of a holistic or 'systems' approach, involving an understanding of the geological processes of formation of the energy or mineral resources. The approach will enable assessment of the potential for undiscovered energy and mineral resources in 'greenfields' regions where such resources previously have not been recognised.

### 1.7 Performance indicators

The impact of Geoscience Australia's work in delivering the OESP may be measured in a number of ways, including:

- uptake of new data and concepts by the minerals, geothermal and petroleum exploration industries;
- changes in exploration expenditure in regions promoted by Geoscience Australia;
- uptake of exploration licences in regions promoted by Geoscience Australia; and
- number of discoveries of energy resources in areas promoted by Geoscience Australia, and their value.
- Increased energy security through increased energy resources.

These indicators, however, are influenced by factors beyond the control of Geoscience Australia, such as variations in commodity prices, national and global economies, the political climate, and industry restructuring. Additionally, the time scales of impacts of the OESP are expected to vary from relatively short term (1-2 years) for uptake of some datasets and concepts, to long term (5-10 years) for impacts on discovery rates.

## 1.8 Program governance and structure

The OESP is currently the Onshore Energy and Minerals Division's largest program. It consists of projects across four Groups within the Division. The Geothermal, Uranium, and Onshore Hydrocarbon projects are commodity-based and national in scope, and will run for the duration of the program (Fig. 1). An initial fact-finding project on thorium is underway.

More detailed regionally-focussed studies of energy resources will be undertaken in a staged manner in at least four regions of Australia (Fig. 1). Scoping of major science questions and selection of methods to apply to solving these questions will be done through the regional projects by key personnel in Geoscience Australia and discussions with the State and territory geoscience agencies. Acquisition and processing of major geophysical datasets such as seismic and AEM data will be undertaken by projects within the Geophysics Group. Acquisition and processing of geothermal datasets will be undertaken by the Geothermal Project. Interpretation of new datasets and delivery of value-added products will be undertaken collaboratively by the regional and national projects as well as with state and territory geoscience agencies.

OESP work on onshore petroleum and gas is carried out within the Petroleum and Marine Division.

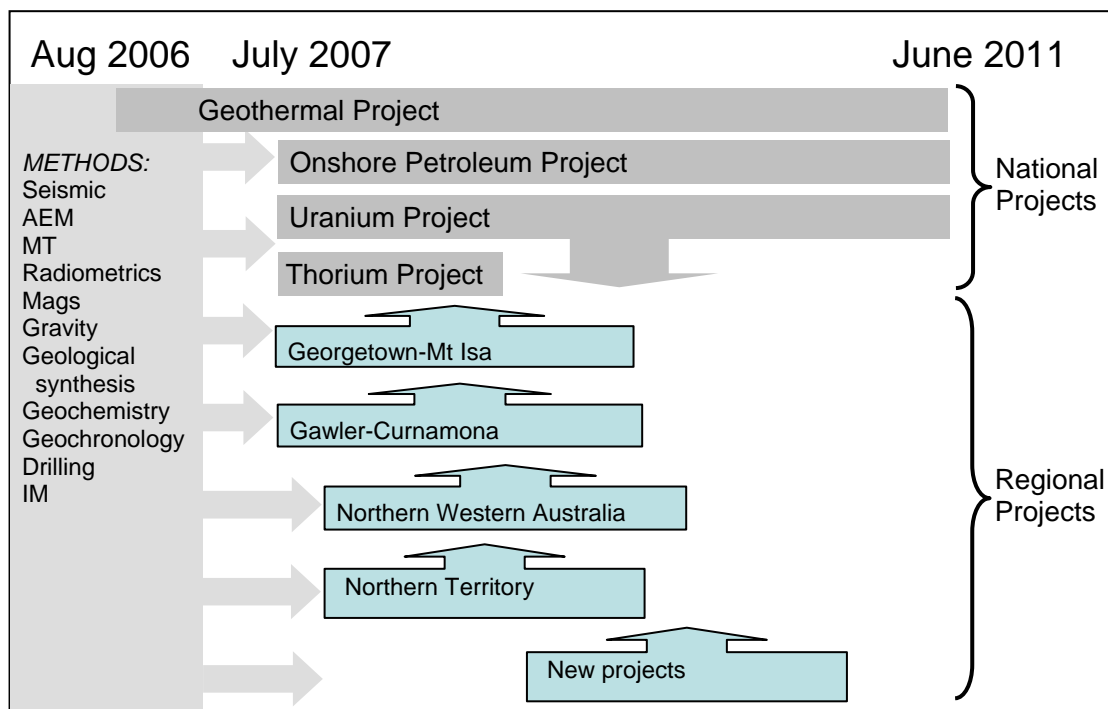


Figure 1. National and regional projects, generalised timeframe, and methods to be employed in the OESP. Flow of information and results will be two-way between regional projects and national projects, to deliver OESP outcomes.

## 1.9 Communication of OESP news and results

- OESP Website ([www.ga.gov.au/minerals/research/oesp/](http://www.ga.gov.au/minerals/research/oesp/))
- Presentations at conferences – industry and research
- OEMD Email Alert  
([www.ga.gov.au/minerals/research/pubs/minalert/](http://www.ga.gov.au/minerals/research/pubs/minalert/))
- AusGeo News ([www.ga.gov.au/ausgeonews/download.jsp](http://www.ga.gov.au/ausgeonews/download.jsp))
- Publications in scientific journals
- Regular meetings with stakeholders
- Annual Chief Government Geologists Conference

## Part 2. Outline of 5 Year Plan for the OESP

### 2.1 Proposed plan of activities (subject to variation post-2007)

#### 2006-07

- Consult with State and NT geoscience agencies.
- Consult with industry stakeholders (conferences, workshops).
- [Develop initial plan for data acquisition](#) and devise new project structure for OESP.
- Commence Geothermal Project.
- Tender for year 1 geophysical acquisition.
- [Commence acquisition of new data](#) (seismic reflection data, Mt Isa & Georgetown surveys; Australia-wide radiometrics and aeromagnetics datum; aeromagnetic survey, Canning Basin; gravity survey, Cooper Basin)
- Complete seismic acquisition in the Mt Isa Province.
- Develop 5 Year Plan for the OESP.

#### 2007-08

- Commence new national projects (Uranium Systems, Thorium Systems, Onshore Hydrocarbons); scope science questions and project plans in detail.
- Establish Geothermal heat flow measurements capability and commence field program.
- Complete desk-top analysis of geothermal potential and ranking of areas for prioritisation of future OESP data acquisition.
- Commence new regional projects (Mt Isa-Georgetown, Gawler-Curnamona, northern WA, Northern Territory); scope science questions and project plans in detail.
- Complete acquisition of second OESP seismic survey (Cloncurry-Georgetown-Charters Towers regions of Queensland, in collaboration with GSO).
- Complete acquisition and processing of the AWAGS2 radiometrics-aeromagnetics tie-line survey.
- GA in receipt of processed radiometric and raw magnetic data.
- Complete Canning Basin aeromagnetics survey; release processed point-located and raster datasets and deliver interpreted results.
- Commence and complete 3<sup>rd</sup> OESP seismic reflection survey (Rankin Springs Trough in western NSW, in collaboration with GSNSW).
- Commence 4<sup>th</sup> OESP seismic reflection survey (Curnamona-Mt Painter region and/or Gawler Craton of SA).
- Deliver interpreted results of Mt Isa seismic survey.
- Deliver results of Cooper Basin gravity survey.
- Review the OESP and re-scope as necessary.

#### 2008-09

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- Complete Gawler-Curnamona seismic survey.
- Commence and complete 2<sup>nd</sup> AEM campaign (region to be decided).
- Commence 5<sup>th</sup> OESP seismic survey (region to be decided).
- Deliver interpreted results of Cloncurry-Georgetown-Charters Towers seismic survey.
- Deliver interpreted results of Paterson AEM survey.
- Levelled magnetic and radiometric databases released via GADDS.
- Release a new Magnetic/Radioelement Anomaly Grid & Map of Australia and subsequent value-added products.
- Review the OESP and re-scope as necessary.

### 2009-10

- Complete 5<sup>th</sup> OESP seismic survey.
- Deliver interpreted results of Rankin Springs seismic survey.
- Deliver interpreted results of Curnamona-Gawler seismic survey.
- Deliver interpreted results of 2<sup>nd</sup> AEM campaign.
- Commence acquisition of 3<sup>rd</sup> AEM campaign (region to be decided).
- Commence acquisition of 6<sup>th</sup> seismic survey (region to be decided).
- Review the OESP and re-scope as necessary.

### 2010-2011

- Complete 6<sup>th</sup> OESP seismic survey.
- Complete 3<sup>rd</sup> AEM campaign.
- Deliver results of 6<sup>th</sup> seismic survey.
- Deliver results of 3<sup>rd</sup> AEM campaign.
- Synthesis and delivery of final results of Geothermal Project
- Synthesis and delivery of final results of Uranium Systems Project
- Synthesis and delivery of final results of Onshore Hydrocarbons Project

## 2.2 Where will major datasets be acquired in the OESP?

### 2.2.1 Australian Radioelement Datum and Upgraded National Magnetics Database

The Australia-wide geophysical survey (AWAGS2) is acquiring airborne radiometric and magnetic tie-line data (Fig. 2), to develop a new datum for re-levelling of previous airborne radiometric and magnetic surveys. The survey commenced in March 2007 in Albany WA, and flying is expected to be completed in the third quarter of 2007/2008. Using the new datum to merge and level hundreds of previous surveys, a new radioelement anomaly map of Australia will be delivered in 2008/09. It will show patterns in the near-surface concentrations of uranium, thorium and potassium as expressed by the gamma-ray flux from radioactive daughters of these elements. These data will be of direct benefit to explorers of uranium and thorium but will also find a range of uses in geological mapping and land management.

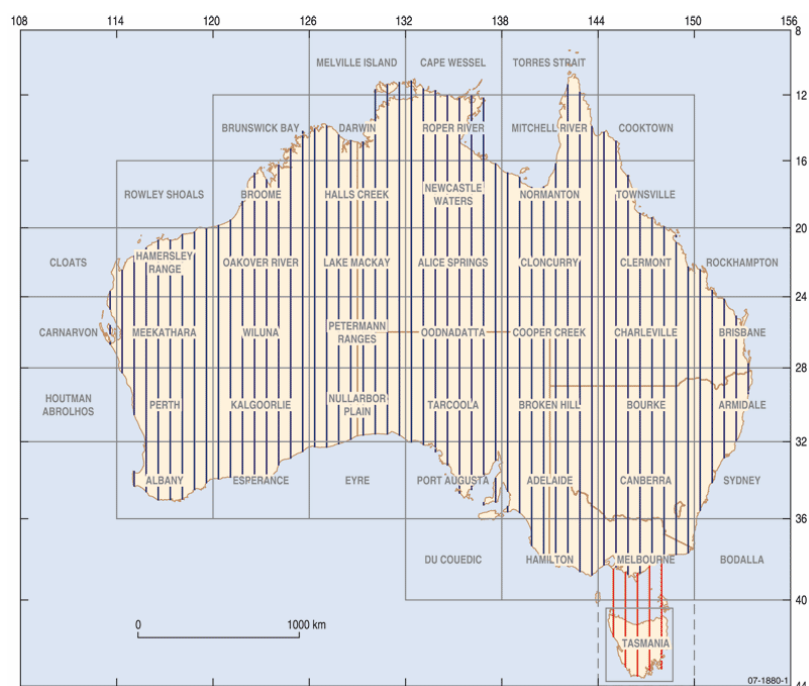


Figure 2. Flight paths for the AWAGS2 airborne radiometrics and magnetics tie-line survey, at nominal line spacing of 75km in north-south direction and east-west along 1: 1m map sheet boundaries and a nominal terrain clearance of 80m.

### 2.2.2 Seismic reflection and MT surveys

Previous seismic reflection surveys of Australian mineral provinces and basins (Fig. 3) have demonstrated the utility of the method in imaging crustal structure, basin stratigraphy, and the architecture of mineral systems. Its application in the petroleum industry is unquestioned. There is growing use of seismic data by the mineral exploration industry to assist in area selection and targeting of mineralisation. More recently seismic data have been used by geothermal energy explorers in Australia.

A major program of seismic data acquisition is underway (Fig. 3) to image the crustal architecture and basins of regions considered prospective for uranium, hydrocarbons and geothermal energy. Seismic reflection data are a key tool in understanding continental evolution to identify relevant events, pathways and traps for uranium, hydrocarbons and buried granites. When integrated with other regional geological data and an understanding of the tectonic evolution, the new seismic data will enable prediction of possible areas of undiscovered mineral and energy resources. The advantages of deep versus shallow seismic acquisition are considered in the scoping of seismic surveys for each region.

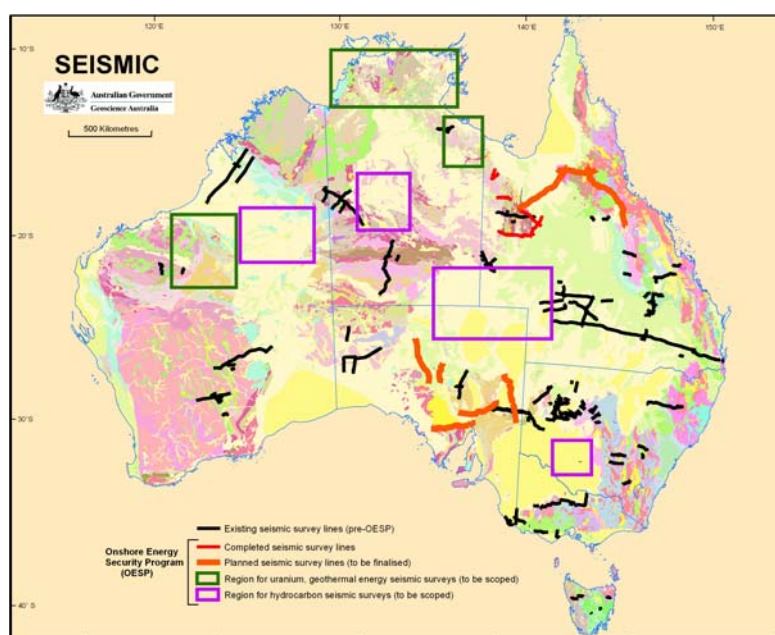


Figure 3. Summary of existing seismic surveys, planned lines, and areas of possible seismic reflection data acquisition in future years of the OESP.

Magnetotelluric (MT) data acquisition is planned along OESP seismic lines. This method images variations in electrical conductivity through the crust. It is particularly useful in conjunction with seismic imaging in defining crustal- to regional-scale architecture and, in some circumstances, may directly image granites or parts of uranium and other mineral systems (e.g., alteration zones).

See Appendix A1 for summary descriptions of proposed and possible seismic lines, and scientific justification.

### 2.2.3 Airborne electromagnetic surveys

Airborne electromagnetic surveying is now widely used in uranium exploration in Australia, particularly in the search for sandstone-hosted and unconformity-related uranium deposits. Nevertheless, there are vast areas of Australia where industry surveys are either non-existent or relatively small, and yet these areas have high potential for uranium. A major program of AEM surveys is planned in the OESP, aimed at providing new regional-scale datasets for such greenfields to brownfields uranium provinces. The AEM datasets will provide a regional context for more detailed existing or new industry electromagnetic surveys. The data will also be used to directly interpret the subsurface geology of the surveyed region, particularly in relation to uranium mineralising systems. For example the AEM conductivity data are expected to image palaeochannels and unconformities, both of which may be associated with uranium mineralisation.

A summary of areas under consideration for airborne electromagnetic acquisition is given in Appendix 2 and is shown in Figure 4. A survey in the Paterson Province of WA is expected to commence in July 2007. A limited number of additional surveys will be flown during the OESP, subject to further scoping and prioritisation.

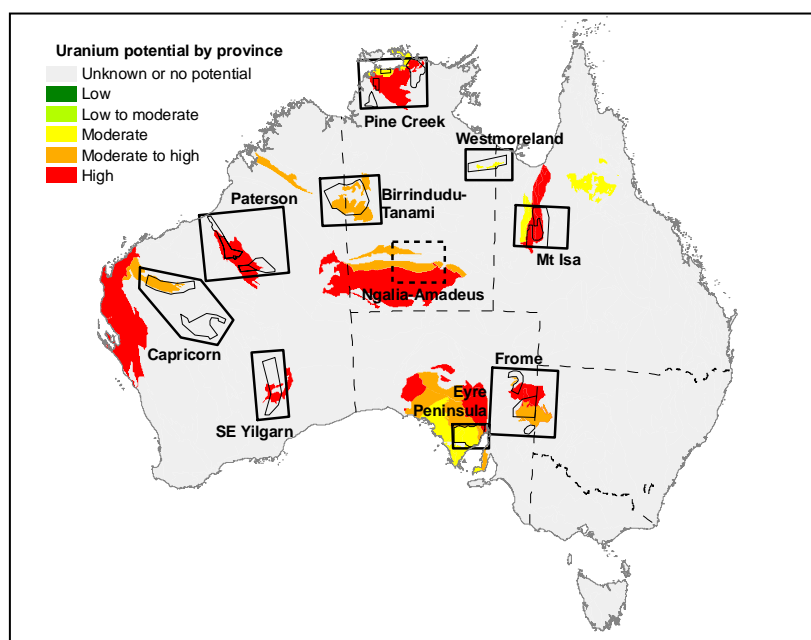


Figure 4. Regions under consideration for airborne electromagnetic data acquisition during the OESP. Possible surveys are shown as areas outlined by thin lines within heavier rectangles. Uranium potential compiled from Mines Atlas of Australia information ([www.ga.gov.au](http://www.ga.gov.au)).

#### **2.2.4 National Geochemical Survey of Australia**

The National Geochemical Survey of Australia (NGSA) involves collaboration with all States and the Northern Territory. The purpose is to provide high quality, nationally consistent geochemical data and information regarding the distribution of elements, particularly those relating to geothermal and energy resources. Based on favourable experience from overseas surveys, and effective pilot surveys in Australia, the NGSA will be a low density survey. It will gather data on the geochemical composition of transported regolith at ~1300 sites around Australia. At each site samples will be collected from the surface and the sub-soil. It is anticipated that the NGSA will provide valuable data and information relevant to:

- interpretation and calibration of airborne radiometric survey data (in conjunction with AWAGS2 survey);
- exploration for uranium, thorium and other mineral deposits.

#### **2.2.5 Heat Flow Measurements**

Heat flow measurements are the most robust method of detecting areas of high heat flow. The thermal gradient is measured in drill holes of at least 300 m depth, and the thermal conductivity of rock are measured from samples of the drill core. Data will be acquired throughout the continent, but a desktop study of geothermal potential will be completed to provide a prioritisation for which areas should be studied in greater detail.

## Part 3. National and Regional Project Descriptions

### 3.1 Summary of National Projects in the OESP

Project Title & duration	Description
<p><b><i>Geothermal Project</i></b> January 2007-June 2011</p>	<p>This project aims to improve our knowledge of the type and location of geothermal resources in Australia on a national scale, and encourage investment, exploration &amp; exploitation of this energy source through provision of precompetitive geoscience datasets relevant to geothermal energy. Objectives of the Geothermal Project are:</p> <ul style="list-style-type: none"> <li>• Collect new heat flow data across Australia to better define and locate geothermal resources.</li> <li>• Complete source and trap modelling to identify potential 'hot rock' geothermal systems.</li> <li>• Compile national datasets for use by the geothermal industry, such as bottom-of-hole temperatures, groundwater temperatures, granite and sediment geochemistry and heat production, rock thermal conductivities, locations of recent volcanic activity and hot springs, and thermal-IR imaging of shallow hydrothermal circulation systems.</li> <li>• Build a geothermal information system to effectively store new heat-flow data and make this data easily accessible to the public, industry and researchers.</li> <li>• Use these new datasets to produce a revised estimate of Australia's total contained geothermal resource.</li> </ul> <p>A gravity survey (4 x 4km spacing) to identify granites beneath parts of the Cooper Basin in southwest Queensland was completed in June 2007.</p>
<p><b><i>Uranium Systems Project</i></b> July 2007-June 2011</p>	<p>The Uranium Systems Project will focus in 2007-2008 on documenting the spatial distribution of uranium-rich rocks and uranium occurrences in Australia, commencing in the regional project areas of the OESP. Other work on uranium mineral systems will address the mineralogical siting of uranium within U-rich igneous rocks, and the processes of uranium transport and deposition, including numerical modelling of U mineralising processes.</p> <p>In future years of the OESP the Uranium Systems Project in conjunction with the regional projects will progressively focus on regional prospectivity analysis of uranium as results begin to flow from the regional projects (e.g. seismic, AEM). The results will be synthesised at both regional and national scales. GA will carry out this work in consultation and collaboration with the State and NT geological surveys.</p> <p>The radiometrics datum survey (AWAGS2, commenced March 2007) and National Geochemical Survey will provide key datasets for the Uranium Systems Project.</p>
<p><b><i>Thorium Project</i></b> July 2007-June 2008</p>	<p>Limited resource data indicate that Australia probably holds at least 15% of the world's thorium resources that could constitute a cleaner nuclear fuel alternative for power generation some time in the next 15 to 20 years. This project will provide informed advice on thorium resources to the Government and</p>

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	<p>the power generation industry, and maintain a strategic watch-brief on developments in thorium fuel for nuclear power generation. It will include an initial report on Australia's thorium resources and the geochemical processes controlling the distribution of thorium in the Earth's crust. Following the initial report, it is planned to upgrade the available data on Australia's thorium resources for publication in Australia's Identified Mineral Resources.</p>
<p><b><i>Onshore Hydrocarbons Project</i></b> July 2007-June 2011</p>	<p>The Onshore Petroleum Project will involve a staged program of dataset acquisition involving the collection of airborne magnetics and radiometrics and where appropriate gravity followed by seismic reflection data. Three areas have been identified for potential investigation:</p> <ul style="list-style-type: none"> <li>• Sub-salt plays in the Kidson Sub-basin (WA).</li> <li>• Eromanga, Cooper, Pedirka, and Warburton Basins (SA, Qld, NT) - A whole-of-crust geodynamic framework study is required to better understand the geodynamic and petroleum system evolution. This area contains some of the oldest and poorest quality magnetics datasets in onshore Australia. Basement structures beneath many parts of these basins are poorly defined.</li> <li>• Lander Trough (NT) - Deep crustal seismic survey proposed.</li> <li>• Darling Basin (Rankin Springs Trough, NSW) - identify potential source rocks for a Darling Basin petroleum system, and seismic acquisition.</li> </ul> <p>An aeromagnetic survey (800m line spacing) of the Kidson Sub-basin in northern WA commenced in April 2007. Additionally, seismic data from surveys carried out in the 1980s in the Canning Basin have been transcribed to modern digital formats, and will be available from GSWA in late 2007.</p>

### 3.2 Summary of Regional Projects in the OESP

Project Title & duration	Description
<p><b><i>Mt Isa-Georgetown Project</i></b> July 2007- June 2009</p>	<p>This project builds on earlier GA/AGSO/BMR work in the Mt Isa region. GA's continuing involvement in this region centres on interpretation of a seismic reflection survey carried out jointly with GSQ in late 2006 as the first seismic survey in the OESP (results due for public release in March 2008) and the compilation of regional datasets to support this interpretation. Under the OESP a major new seismic dataset is being acquired, from the Mt Isa region to Georgetown thence to Charters Towers. These data will be integrated with existing and new geological, geochemical and geochronological data to define the uranium and geothermal energy potential of northern Queensland, as well as potential for other mineral commodities.</p>
<p><b><i>Gawler-Curnamona Project</i></b> July 2007- June 2009</p>	<p>This project will collect geological and geophysical datasets and synthesise existing information to reduce the risk associated with exploration for uranium, geothermal energy, and other mineral systems in the Curnamona Province, Mt Painter region, and Gawler Craton of South Australia, and to identify areas with untested potential. The Project will be undertaken in collaboration with PIRSA. Activities for 2007-08 include a data compilation and analysis phase, including scoping of the key science questions, and the planning and commencement of acquisition of seismic reflection data.</p>
<p><b><i>Northern Territory Project</i></b> July 2007- June 2009</p>	<p>This project will collect geological and geophysical datasets and synthesise existing information to reduce the risk associated with exploration for uranium, thorium and other mineral systems in the Northern Territory, and to identify areas with untested potential. This will involve close linkages with the Northern Territory Geological Survey. Main activities for 2007-08 include a data compilation and analysis phase, scoping of the key science questions, and commencing acquisition of geological data to assist in the interpretation of future seismic and AEM data sets.</p>
<p><b><i>Northern Western Australia</i></b> July 2007- June 2009</p>	<p>This project will collect geological and geophysical datasets and synthesise existing information to reduce the risk associated with exploration for uranium, thorium, geothermal energy, and other mineral systems in the northern part of Western Australia, and to identify areas with untested potential. This will involve close linkages with the Geological Survey of Western Australia. Main activities for 2007-08 include a data compilation and analysis phase, scoping of the key science questions, and acquisition, processing and preliminary interpretation of an AEM dataset in the Paterson Province.</p>

## Appendix 1.

### Summary of proposed and possible seismic reflection surveys in the OESP

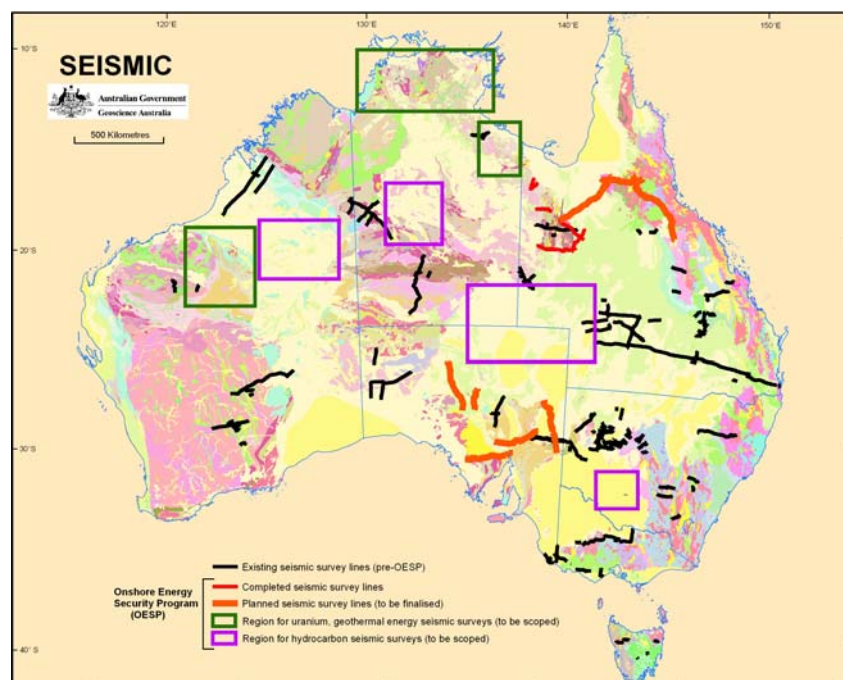


Figure A1. Summary of existing seismic surveys, planned lines, and areas of possible seismic reflection data acquisition in future years of the OESP.

### Mount Isa-Georgetown-Charters Towers (commenced May 2007)

#### Summary:

Three principal seismic reflection traverses are proposed for the Mt Isa-Georgetown-Charters Towers regions. Line 07GA-IG1 crosses the eastern margin of the Mt Isa block and extends to the western margin of the Georgetown Province. Line IG2 further examines the western margin of, and internal structure of the Georgetown Province. Line GCT1 probes the internal structure of the Georgetown, Cape River and Broken River Provinces and the northern part of the Drummond Basin. IG3 will also image the location and geometry of the Tasman Line and a number of regionally significant NE-SW fault systems.

#### Objectives – energy-related

- Determine the depth to top of Proterozoic and Carboniferous granites for geothermal potential.
- Image possible oil reservoirs in the Carpentaria Basin (IG1).
- Identify favourable basin geometry, crustal architecture and crustal scale controls on potential U mineralisation, including U-rich iron oxide Cu-Au (IOCG) and unconformity-related U deposits in the eastern Mt Isa and Georgetown regions (IG1, IG2).
- Identify suitable Proterozoic and Carboniferous granites (IG2 & GCT1) that may be associated with U mineralisation.

#### Objectives - geodynamics and tectonic environments

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- Image deep crustal architecture between the Mt Isa and Georgetown provinces in order to advance current tectonic models linking the two regions.
- Image deep crustal geometry of the Tasman Line, a fundamental boundary between Proterozoic and Palaeozoic Australia.
- Investigate the internal structure of, and relationships between, the Georgetown Province, Cape River Province and Broken River Province and the northern margin of the Drummond Basin.

### Curnamona Province and linkages to Gawler Craton

#### Summary:

Three seismic traverses are proposed. An east-west traverse (line 1) extends from the eastern margin of the Gawler Craton across the Adelaide Fold Belt to the north-central region of the Curnamona Province. Line 2 extends northwards from an existing E-W traverse in the south of the Curnamona Province to the Mt Painter region in the north. Line 3 extends E-W across the northern region (Mt Painter) of the Curnamona Province.

#### Objectives – energy-related

- Image the crust related to the South Australian Heat Flow Anomaly (SAHFA) and its margins. Two of the seismic lines are designed to image the subsurface location, extent and depth of the granites believed to be important for geothermal energy in the northern Curnamona Province and Mt Painter region.
- Identify crustal structures and geological units favourable for U mineralisation including:
  - IOCG-U style mineralisation in the northern Curnamona Province related to igneous rocks similar in age to the host rocks of the Olympic Dam Cu-U-Au deposit (lines 2,3).
  - Possible Palaeozoic IOCG-U style mineralisation in the Mt Painter region (lines 2, 3).
  - Palaeochannels and Mesozoic and Tertiary basin geometry (lines 2, 3).

#### Objectives - geodynamics and tectonic environments

- Image the crust between the Curnamona Province and the Gawler Craton, a better understanding of which is critical for testing models for the evolution of the Australian Proterozoic.

### Gawler Craton-Musgrave Block-Amadeus Basin

#### Summary:

The proposed seismic line traverses the northern margin of the Gawler Craton, Officer Basin, Musgrave Block, and parts of the Amadeus Basin. Areas traversed by the proposed line south of the Officer Basin, across the Gawler Craton, are considered by Geoscience Australia to hold the highest potential for uranium and geothermal energy resources. This section of the line therefore is viewed as higher priority for OESP funding than northern sections of the line (as shown in Fig. A1).

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### Objectives – energy-related

- Image the subsurface distribution of Mesoproterozoic granites, and depth of overlying sedimentary cover, for assessing geothermal energy potential.
- Test whether NW trending structures in Mt Woods and Coober Pedy regions are similar in geometry to crustal-scale structures in the Olympic Dam IOCG-U region, and hence could have been important in U systems of the northern Gawler Craton.
- Image palaeochannels that may be favourable for sandstone-hosted U mineralisation.
- Image basement topography beneath the Pandurra Formation to facilitate modelling of fluid flow, U transport and deposition of sandstone-hosted and/or unconformity-related U mineralisation.
- Determine basin architecture in upper stratigraphic levels of the eastern Officer Basin and Amadeus Basin to assess Neoproterozoic and Cambrian gas and oil potential.
- Image the Archaringa Basin to assess coal potential beyond known reserves.

### Objectives - geodynamics and tectonic environments

- Image the crust between the Musgrave Block, the Gawler Craton and the North Australian Craton to test reconstructions of Proterozoic Australia.

## Central Gawler Craton - northern Eyre Peninsula

### Summary:

The proposed seismic line commences at the eastern margin of the Gawler Craton (beneath the Flinders Ranges) and traverses westwards across the northern Eyre Peninsula to the central Gawler Craton.

### Objectives – energy-related

- Image the crust across the western margin the SAHFA to understand how it is different to the crust hosting the SAHFA.
- Determine the depth of sedimentary cover over granites in the eastern Gawler Craton, to assess geothermal energy potential.
- Image palaeochannels that may be favourable for U mineralisation.
- Image the base of the Pandurra Formation to assess prospectivity for unconformity-related U mineralisation and facilitate modelling of groundwater flow, U transport and deposition of sandstone-hosted and/or unconformity-related U mineralisation
- Test the model in which IOCG-U mineralisation is preferentially situated near the margins of the Archaean core of the Gawler Craton, controlled by crustal-scale shear and fault zones.

### Objectives - geodynamics and tectonic environments

- Test models of the tectonic setting of the Hiltaba Suite and Gawler Range Volcanics, with possible implications for models of Olympic Dam style IOCG-U mineralisation

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### Paterson Province

#### Summary:

Four seismic lines are proposed, traversing different parts of the Paterson Province and surrounding terranes.

#### Objectives – energy-related

- Crustal architecture and controls on unconformity-related U mineralisation similar to the Kintyre U deposit.
- Image the basin architecture of parts of the western Officer Basin and the Kidson Sub-basin, to assess the petroleum and gas prospectivity.
- Determine the subsurface location and distribution of granites (overlain by Canning Basin), to assess the geothermal energy potential.

#### Objectives - geodynamics and tectonic environments

- Image the crustal architecture of the Canaughton-Talbot and Tabletop terranes to understand their relationship with known magnetic and gravity ridges that link the Paterson Province with the Musgrave Complex in central Australia.
- Determine the architecture of the Yeneena Basin and its relationship with the Tarcanyah Group sedimentary sequences.

### Pine Creek Orogen

#### Summary:

Three principal traverses have been proposed for the Pine Creek Orogen. Line 1 traverses the central Pine Creek Orogen crossing the Cullen Batholith, the Pine Creek Shear Zone (Au) and the mineralised (U, Au and PGE) Alligator Rivers region. Line 2 crosses Neoproterozoic basement (Rum Jungle) and earliest Palaeoproterozoic Nanambu Complex. Line 3 traverses the major tectonic boundaries that separate the high-grade Litchfield Province from the Central Pine Creek region. This line also crosses the unconformably overlying Meso-Palaeoproterozoic Tolmer Group sediments.

#### Objectives – energy-related

- Image the geometry of the deep crustal structures and plumbing systems in the Alligator Rivers region that may have been important in unconformity-related U mineral systems (Lines 1 & 2).
- Image the 'depth to (Archaean) basement' across the central Pine Creek Orogen in order to assess U prospectivity for Rum Jungle-style U mineralisation (line 2, 4).
- Determine the distribution, depth and geometry of Palaeoproterozoic (Cullen Batholith) and Archaean (Rum Jungle) granites, to assist with understanding U mineral systems (line 1, 2, 3, 4).

#### Objectives - geodynamics and tectonic environments

- Image Archaean basement architecture in order to better assess models of basin evolution within the Pine Creek Orogen (line 1, 2, 4).
- Assess the litho-stratigraphic relationships and the nature and tectonic significance of the major terrane boundaries between the central Pine Creek region, Litchfield Province and the Nimbuwah Complex (line 1, 2, 3).

## Appendix 2.

### Summary of proposed and possible airborne electromagnetic surveys in the OESP

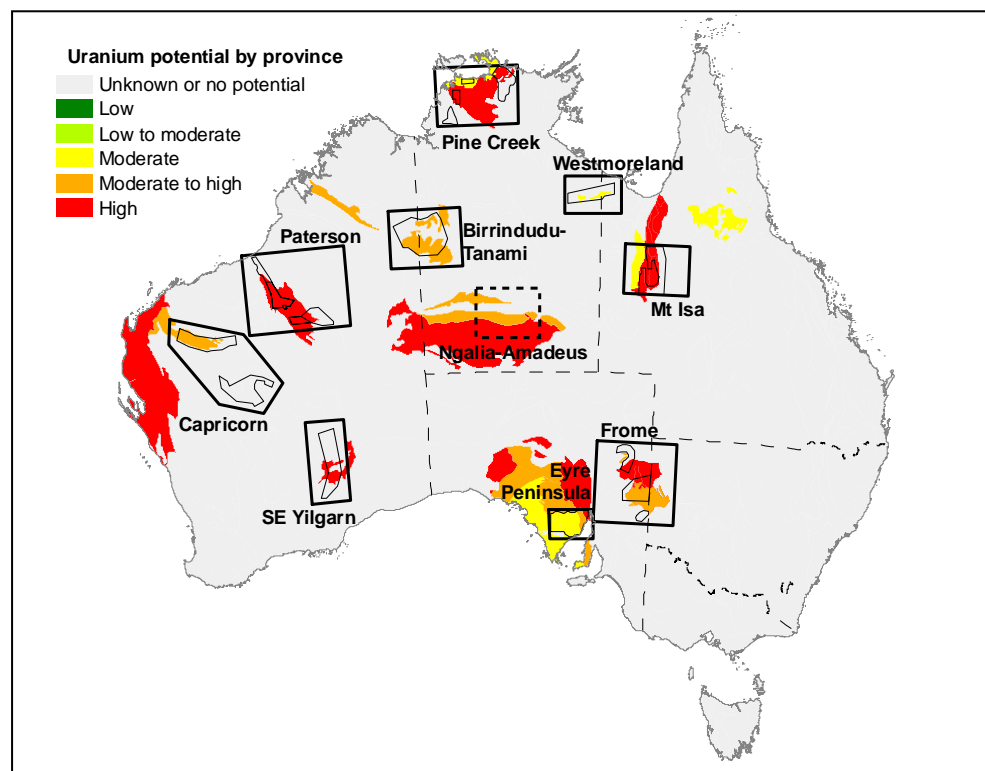


Figure A2. Regions under consideration for airborne electromagnetic data acquisition during the OESP. Possible surveys are shown as areas outlined by thin lines.

Proposed and possible airborne electromagnetic surveys are listed below in order of level of scoping to date (note: not all surveys will be funded in the OESP; prioritisation is yet to be finalised).

#### **Paterson Province, WA** (acquisition to commence July 2007)

Target mineral systems: Unconformity-related U

Example: Kintyre U deposit

Geology: Graphitic units in Rudall Complex basement  
Overlying Coolbro Sandstone  
Major structures facilitating fluid flow

Proximity to Archaean (Pilbara) granite in northwest of survey area

Comments: Survey excludes Rudall River National Park

#### **Frome Embayment, SA** (proposed; scoping well advanced)

Target mineral systems: Palaeochannel U, Sandstone U

Examples: Beverley, 4 Mile, Honeymoon

Geology: Namba Formation (Cz), Eyre Formation (Cz)  
Eromanga Basin (K)  
U-rich Mesoproterozoic granite

Comments: Brownfields – AEM to provide regional context to outline palaeochannels and K-Cz faulting

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### **Pine Creek, NT** (proposed; scoping well advanced)

Target mineral systems: Unconformity-related U

Examples: Ranger, Jabiluka

Geology: Archaean granitic domes  
Graphitic units in Palaeoproterozoic rocks  
Overlying Kombolgie Sandstone

Comments: Aim to map thickness of Kombolgie Fm as well as identify graphitic schists in basement; brownfields

### **Birrindudu/Tanami, NT** (possible; proposal being scoped)

Target mineral systems: Unconformity-related U

Geology: Archaean - Proterozoic granite in domes  
Carbonaceous units in Tanami Group basement  
Overlying sandstone units in Birrindudu Group

Comments: Greenfields, but known minor U prospects

### **Northern Eyre peninsula, SA** (possible; proposal being scoped)

Target mineral systems: Unconformity-related U

Geology: Mesoproterozoic Hiltaba Suite granites  
Carbonaceous units in the Hutchison Group  
Overlying Pandurra Formation, Corunna Conglomerate and Blue Range Beds

Comments: Greenfields but some minor U prospects known

### **Capricorn Orogen /Northern Yilgarn margin, WA** (proposal being scoped)

Target mineral systems: Unconformity related U

Geology: Abundant U-rich, low Ca, Archaean granite  
Adjacent-overlying Palaeoproterozoic sediments (Yerrida and Earahedy Basins)  
Major structures in the Archaean basement

Comments: Greenfields project but has several of key ingredients of unconformity-related U

### **Westmoreland, Qld** (proposal being scoped)

Target mineral systems: Mafic intrusive-related U / unconformity-related U

Geology: Murphy Tectonic Ridge/Cliffdale Volcanics (source of U?)  
Overlying Westmoreland Conglomerate

Comments: Brownfields – numerous small U deposits

### **Mount Isa – eastern margin, Qld** (proposal being scoped)

Target mineral systems: Sandstone U - Cainozoic palaeochannels

Geology: High-U Mesoproterozoic Williams Batholith granites

Comments: Greenfields region but numerous generally small U deposits in Mt Isa Inlier

### **Ngalia – Amadeus Basin region, NT** (proposal being scoped)

Target mineral systems: Cainozoic palaeochannels

Geology: U-rich granite in Arunta Complex  
Poorly known palaeochannels with >200 m of fill and some evidence of lignite

Comments: Greenfields region

### **Southern Yilgarn margin, WA** (proposal being scoped)

Target mineral systems: Palaeochannel U

Example: Mulga Rock

Geology: Abundant U-rich, low Ca, Archaean granite to north/northwest  
Palaeochannels containing lignite which has fixed U