

GSQ: What is happening in Queensland?

The Geological Survey of Queensland (GSQ) is actively engaging in geophysical projects with funding from both the \$18 million Greenfields 2020 Program and the new \$30 million Future Resources Programme. The money from these programmes is being invested in a variety of geophysical projects, including a substantial amount of new precompetitive data collection (Figure 1). The GSQ is also working on more effective ways of delivering open file data to companies and, as part of wider Queensland Government reforms, working to reform the way geophysical data is reported to the government to ensure that this valuable resource is not lost to future explorers.

Geophysical data collection programmes

The focus for geophysical data collection has largely shifted back to north-west Queensland with the start of the \$9 million Mount Isa Geophysics Initiative, part of the Future Resources Programme, in 2014. A major component of the geophysical work programme in Mount Isa is the collection of three new deep crustal seismic surveys. These lines will provide new understanding of major crustal architecture across the entire Mount Isa Inlier and surrounding terranes. They will also improve the understanding of the location and relationships between Phanerozoic basins through central and western Queensland. Broadband magnetotelluric and gravity data is also being collected to complement these seismic lines. Data collection for all three seismic lines was completed in January 2015, with processing and interpretation ongoing.

In addition to the collection of magnetotelluric data along the seismic lines, the GSQ is pioneering the collection of 2D and 3D magnetotelluric surveys on a regional scale. The first of these surveys is the Isa Extension survey collected to the west and northwest of Boulia. This survey includes the collection of more than 800 broadband stations on a 2 km x 5 km grid and over 900 audio magnetotelluric (AMT) stations with a station spacing of 500 m. Data collection of the broadband component and half of the AMT was completed in 2014 with the remaining AMT stations to be collected after the wet season.

Another project being conducted by the GSQ is the trial of the new VTEM Supermax system in the Osborne area, 200 km south of Cloncurry. The aim of this survey is to establish the effectiveness of the high powered EM system in an area where the presence of conductive cover has historically led to very poor depth penetration for airborne EM systems. The main block of the survey will be flown at 1 km line spacing with every second line extended into areas of deeper cover to determine the full depth penetration of the system.

The GSQ is also part of a collaborative project in the Thomson Orogen with

Geoscience Australia and the Geological Survey of New South Wales. This project is located in southern central Queensland around the town of Eulo. A combined work programme with gravity, AEM and MT data collection was conducted in 2014-2015 with the hopes of gaining a new understanding of this relatively unknown and potentially prospective area.

Planning is currently underway for data collection in the 2015-2016 financial year, again focused in the Mount Isa region, with surveys currently in the planning phase.

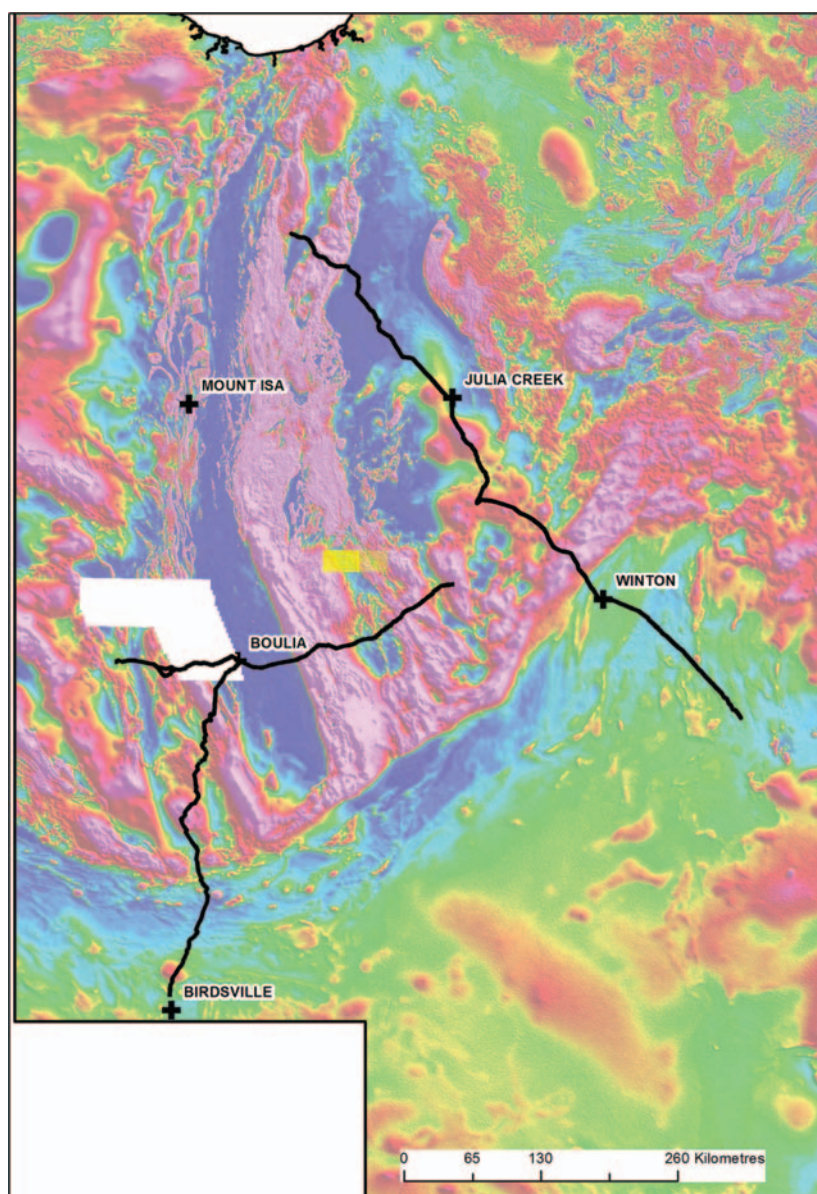


Figure 1. Geophysical data collection in Mount Isa: deep crustal seismic in black, Isa Extension MT in white and VTEM Supermax survey in yellow.

QDEX data

The new Queensland Digital Exploration (QDEX) Data system enables the Geological Survey of Queensland's customers to search for and freely download large spatial datasets and forms part of the Queensland Government Open Data Strategy. Previously, data were manually packaged and sold on an ad hoc basis by request or were available as pre-packaged products. The QDEX Data system allows index and spatial searching in a simple web interface and uses Geosoft's DAP Server technology.

The data currently delivered on QDEX Data includes:

- Airborne geophysical survey data including State, Federal, open-range and open file company exploration surveys packaged by survey and state-wide merges of the magnetic and radiometric data

- Ground geophysical data including all gravity data available in Queensland
- Geochemistry including drill hole locations, down-hole assays and geology, and assays of rock chips, stream sediment, soils and whole rock samples packed by broad region
- All available hyperspectral images from the Next Generation Mineral Mapping (NGMM) project
- Seismic survey processed data and field data packaged by survey
- Wireline log data packaged by well
- 3D geological and geophysical models created by the Geological Survey of Queensland staff.

As the system is further established more GSQ data will be available on QDEX Data possibly including GIS packages, mineral occurrence data and other large spatial datasets. All data in QDEX Data has extensive metadata attributed on creation that details the data source,

location, creation and modification dates and important information specific for each data type. The metadata also contains keywords to facilitate easy searching, links to QDEX reports or other external links to related information and contact details for the data custodians.

The data on QDEX Data can be accessed via a simple web portal (Figure 2) or via Geosoft Seeker in Oasis Montaj, ArcGIS or MapInfo. The QDEX Data system currently hosts over 3800 data objects totalling more than 317 GB in size. The majority of files in QDEX Data can be downloaded or streamed but some larger files (currently over 4 GB) are not downloadable and must be ordered. This requirement will change as network speeds and capabilities improve.

For more information contact Janelle Simpson Janelle.Simpson@dnrm.qld.gov.au.

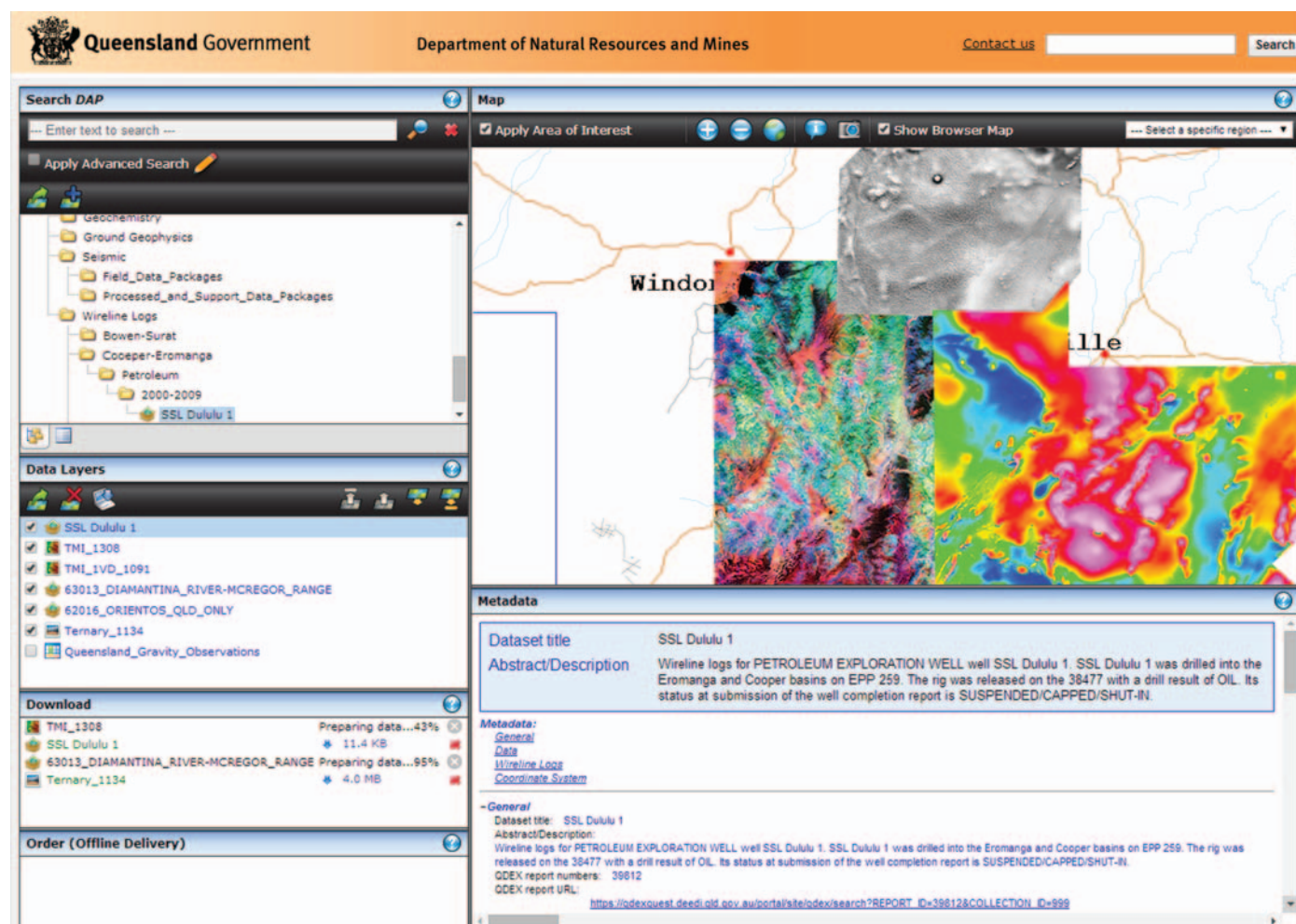
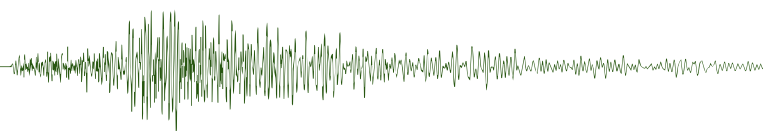


Figure 2. The QDEX Data flamingo web portal showing the data and metadata view and the different data types available.



GSNSW: recent and current activities

The Geological Survey of New South Wales (GSNSW) collects and manages geological, geophysical and geospatial data to inform the government, exploration and mining industries and the community about the state's geology, mineral, coal and petroleum resources. Regional work projects are supported by the New Frontiers Exploration Initiative, which is funded by industry through mineral and petroleum annual rental fees – it aims to stimulate investment in under-explored areas within NSW and includes acquisition of pre-competitive geophysical data to provide essential support for geoscience mapping and mineral exploration. Some major projects which acquire and/or evaluate geophysical data are highlighted here, along with other Departmental activities.

New geophysical data evaluates basement geology and structures beneath cover: Southern Thomson Orogen Project

GSNSW is involved in two collaborative ventures that aim to better understand the geological character and mineral potential beneath cover in the Southern Thomson region, straddling the NSW – Queensland border. Multi-disciplinary geophysical, geochemical and geological data are being acquired and interpreted within these projects.

The collaboration between GSNSW, the Geological Survey of Queensland (GSQ), and Geoscience Australia (GA) commenced late in 2013 and geophysical acquisition is now complete for:

- electromagnetic (AEM) data from a regional helicopter survey over the Eulo Ridge (Hungerford area). Inversion

products have been released and are available for download. The results provide an indication of conductivity and locally indicate the depth to resistive bedrock along each flight line to a depth of around 300 m (Figure 1).

- gravity readings, AEM flight lines, and magnetotelluric (MT) measurements along two regional geophysical transect lines within NSW, each approximately 250 km in length – a western line between Tilpa and Hungerford, and an eastern line between Gongolgon and Barrington. These will help understand both cover units and also deeper basement and crustal geology to depths of several kilometres.

Interpretation of seismic sections from company and government surveys is being integrated with potential field modelling to provide 3D understanding of critical structural areas, including the Paka Tank Trough and the Olepoloko Fault.

Detailed analytical studies are underway to improve the understanding of the stratigraphic units which have interpreted from geophysics and the few available drill samples. The age constraints and mineralogical associations are being gained by U-Pb and K-Ar isotope work. The mineral systems potential for a range of commodity types is being appraised, including indications of metallic mineralisation discovered under cover during recent company mineral exploration drilling. The next phase in the project will be selection of stratigraphic drilling targets following synthesis of all data. This drilling is anticipated for the 2016–17 financial year, utilising new drilling technology via the Deep Exploration Technologies Cooperative Research Centre.

A second collaborative project commencing in 2015 will be a 3-year ARC Linkage research project between University of Newcastle, GSNSW, GSQ, University of Queensland and Queensland University of Technology. This project aims to test competing geodynamic models for the evolution of the Thomson Orogen, and will involve coordinated research projects to tackle specific geological questions within the context of available geophysical data.

These two collaborative studies will contribute to the understanding of the relationship between the Thomson Orogen and the Lachlan Orogen to its south. They will help define basin and basement structures within the Southern Thomson that may control mineralisation or mineralised terranes. The intended impact of this work is to provide the mineral exploration industry with pre-competitive data, information and knowledge that reduces risk and encourages exploration in the region.

Yathong Trough Seismic Reflection Survey

Final processing will be completed in February 2015 for a deep seismic reflection survey in the Yathong Trough, an eastern sub-basin of the Darling Basin (Figure 2). The results will be used to better define the 3D basin geometry of the Yathong Trough and understand the stratigraphy; indicate possible petroleum systems (thick sandstone reservoir units and proximity to petroleum source rocks); identify deeply buried granites which may generate heat suitable for geothermal energy generation; and help locate suitable areas for carbon dioxide

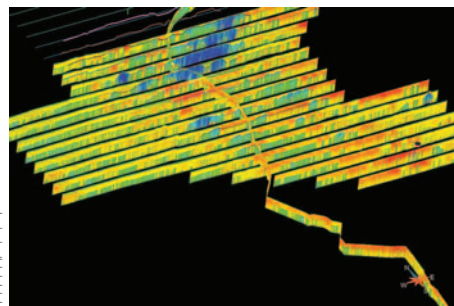
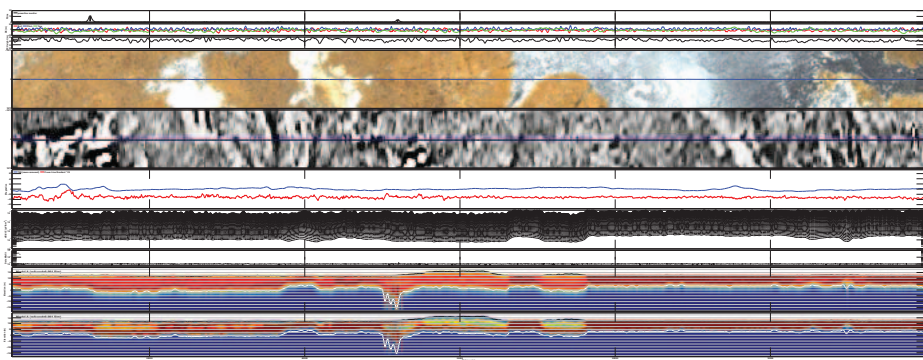


Figure 1. Example AEM multiplot (left) and perspective survey view (right) for the Southern Thompson region show contrast between near-surface conductive layers of saturated sandstone beds (red-orange) of the Eromanga basin and more resistive areas of granitic basement highs (blue).

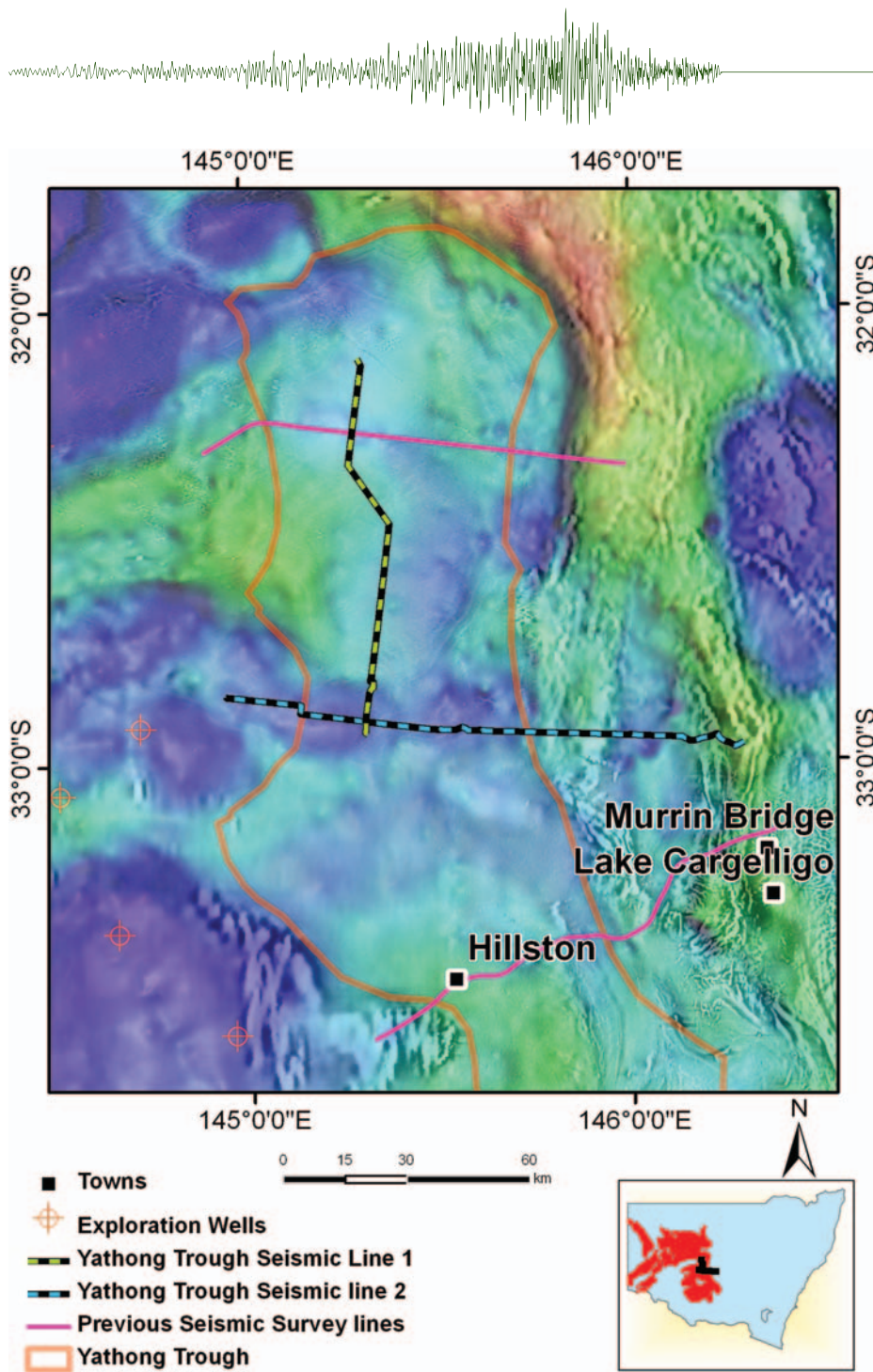


Figure 2. Yathong Trough 2D Seismic Survey: Background image is greyscale first vertical derivative of total magnetic intensity, underlain by pseudocolour Bouguer gravity data.

storage. Longer recording for deeper reflections will provide structural framework information for sub-basin basement rocks, and for rocks of the Cobar Basin located immediately east of the trough.

The Yathong Trough has a surface area of about 15 000 km² and is considered to be under-explored for petroleum. Two regional east-west seismic lines, each about 120 km long, were acquired in the northern and southern parts of the trough in 2008 by the Onshore Energy Security Programme managed by GA. The rocks within the Yathong Trough were

interpreted as a fault-bounded, thick (up to 5 km) sequence of Devonian marine sandstones and mudstones. To date there has been no deep exploration drilling in the trough.

The two new seismic lines total 230 km in length – one north-south, aligned with the long axis of the trough, and a second east-west line running across it. The latter investigates the boundary between the Yathong and Ivanhoe troughs, and the eastern extension of this line includes outcropping Late Silurian to Early Devonian units of the Cobar Basin and major structural elements.

Acquisition, reprocessing and interpretation of geophysical data and spectral imagery in the Wagga area (Central Lachlan Orogen)

Systematic field mapping on the Ardlethan and Barmedman 1:100 000 map sheet areas commenced in 2014. The project integrates field mapping with specialist studies such as geochronology (with GA), palaeontology, spectral analysis, geophysical modelling, reinterpretation of existing seismic lines, 3D modelling of geology and fluid flow, mineral systems, prospectivity analysis, and hydrogeochemistry (with CSIRO). The area is prospective for a range of deposit-styles, including intrusive tin-tungsten deposits (e.g. Ardlethan), orogenic gold, intrusion-related gold, and copper-gold porphyry systems.

High-quality geophysical data in the East Riverina Mapping Project (Figure 3) has been enhanced by recent acquisition, reprocessing and interpretation. Airborne magnetic and radioelement acquisition was previously completed through the area, with line spacing of 250 or 400 m, and flight heights of 60 or 100 m.

Reprocessing of existing radioelement data completed in 2013 (Minty Geophysics) has significantly improved the detail evident in imagery. The Riverina Gravity acquisition programme in 2013 greatly improved the resolution of gravity data in the region. Data was collected by helicopter on 2 km and 1 km grids, with some road traverses in the Ardlethan area. Potential field modelling will be undertaken in 2015, starting along the deep crustal seismic line (GA99AGSL3) acquired in conjunction with GA in 1999. This east-west line runs across the Barmedman and part of the Temora 1:100 000 map sheets.

Dr Robert Hewson (RMIT University) has been studying the application of ASTER and geophysical data to assist mapping and mineral exploration. GSNSW Quarterly Note 140 was published in May 2014 examining these data in the Wagga Wagga and Cobar areas. A second study in the Ardlethan and Barmedman 1:100 000 map sheet areas is scheduled for completion in early 2015.

Ongoing management and delivery of geophysical data

GSNSW strives to continually improve the management and delivery of geophysical data (located data, gridded

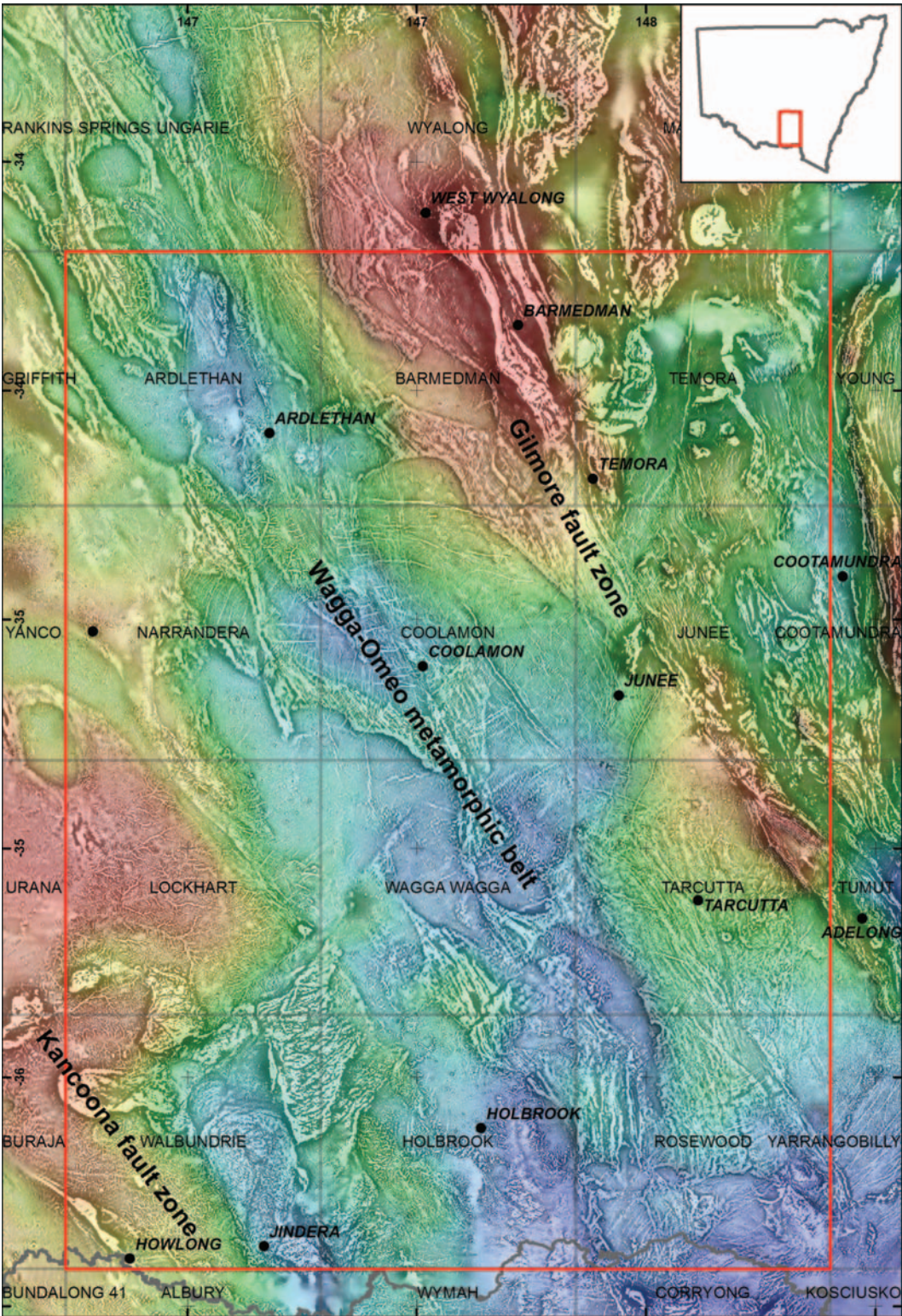
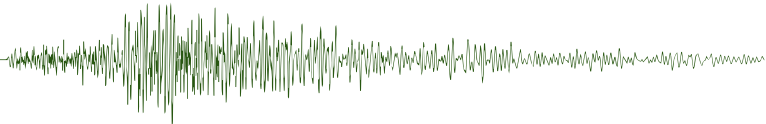


Figure 3. East Riverina Project location (red box). Background image is greyscale first vertical derivative of total magnetic intensity, underlain by pseudocolour Bouguer gravity data.

data, and images) to internal projects and to external stakeholders such as the exploration industry, other government agencies, universities and the general public. This includes:

- mobile phone app downloads of the NSW geology map and geophysical

- images for smartphones and tablets,
- incorporating latest survey acquisitions to enhance the statewide data grid and products, and
- reprocessing problematic regional radiometric surveys to ensure high quality data now that uranium

exploration tenements can be sought within NSW.

For more information contact Rosemary Hegarty geophysics.products@trade.nsw.gov.au.

GSV

The Geological Survey of Victoria (GSV) is committed to providing the exploration industry, government and other stakeholders with expert regional-scale precompetitive geoscientific data and knowledge. In recent years the survey has moved away from localised projects, instead implementing a targeted whole of crust minerals system approach to its work programme. A recent major focus of this approach has been work carried out in western Victoria on the Miga Arc, a predominantly undercover Andean-type Cambrian arc system (<http://dpistore.efirst.com.au/product.asp?PID=1079&CID=6&c=8227>). The backbone of this methodology has been the acquisition of a deep crustal seismic transect in 2009, to which other data can be constrained and correlated. This work led to a collaborative stratigraphic drilling programme with Geoscience Australia (GA) and the DETCRC in 2014–15 to test the geological model. This involved a programme of pre-drilling geophysics run by GA to test the validity of various techniques for determining depth to basement estimations. This work has highlighted a number of geological issues which, in order to be addressed, require more detailed geophysical data. Funding has been allocated for local geophysical surveys including gravity, magnetics, magnetotellurics and seismic reflection to address some of these issues. It is expected that data acquisition will begin in the 2015–16 financial year. The GSV is also involved in collaborative work with Adelaide University acquiring and interpreting crustal scale magnetotelluric data across western Victoria.

Using the workflow already proven to advance mineral systems understanding in central (<http://www.energyandresources.vic.gov.au/earth-resources/geology-of-victoria/geological-survey-of-victoria-programs/earth-echoes>) and in western Victoria, GSV plan to acquire geophysics along a series of transects in NE Victoria, with the aim of completing a continuous geophysical transect across the strike of the Lachlan Fold Belt in the region of best existing structural and stratigraphic control. The aim is to acquire deep seismic reflection, detailed gravity and MT along a route which crosses, from east-to-west, the Tabberabbera, Omeo, Deddick, Kuark and Mallacoota zones. The geophysics transect will be a definitive test of geometrical predictions

arising from the Lachlan Orocline concept (<http://www.nature.com/nature/journal/v508/n7495/full/nature13033.html>) currently under collaborative development by GSV and GSNSW and modelled conceptually as part of the 3-D Victoria project (<http://dpistore.efirst.com.au/product.asp?PID=1098&CID=53>) – these predictions include the presence of Macquarie Arc crust at shallow depth beneath the Deddick Zone, and at deeper locations beneath parts of the Omeo and Kuark zones, with a range of fundamental implications for the mineral systems analysis of the region – in NSW the Macquarie Arc has proven world-class mineral deposits. As part of this work, GSV is sponsoring and supervising MSc research to acquire and model detailed gravity data in transects crossing the Buchan Rift of Eastern Victoria. Inversion modelling will deliver a better understanding of depth and the margin geometries of a major rift superimposed over the Deddick and Tabberabbera zones in the Early Devonian.

In July 2014, a ground gravity survey was acquired for GSV by Atlas Geophysics in the Gippsland Basin. The Gippsland Basin Gravity Survey (Figure 1) consisted of 1,213 stations along 12 regional traverses with a nominal station spacing of 500m. The results of this survey enable greater constraints on basement architecture in the west of the basin, and further enrich the statewide gravity database.

Over the past few years, GSV has been involved in a collaboration between ANU, University of Tasmania, FROGTECH, and Mineral Resources Tasmania (Australian Research Council grant LP110100256) to deploy a passive seismic array of 24 broadband stations that straddles Bass Strait, in order to illuminate, for the first time, the 3-D crustal structure beneath Bass Strait. The aim of the project is to further constrain the nature of the geology of this region by providing passive seismic data that can be linked onshore into existing

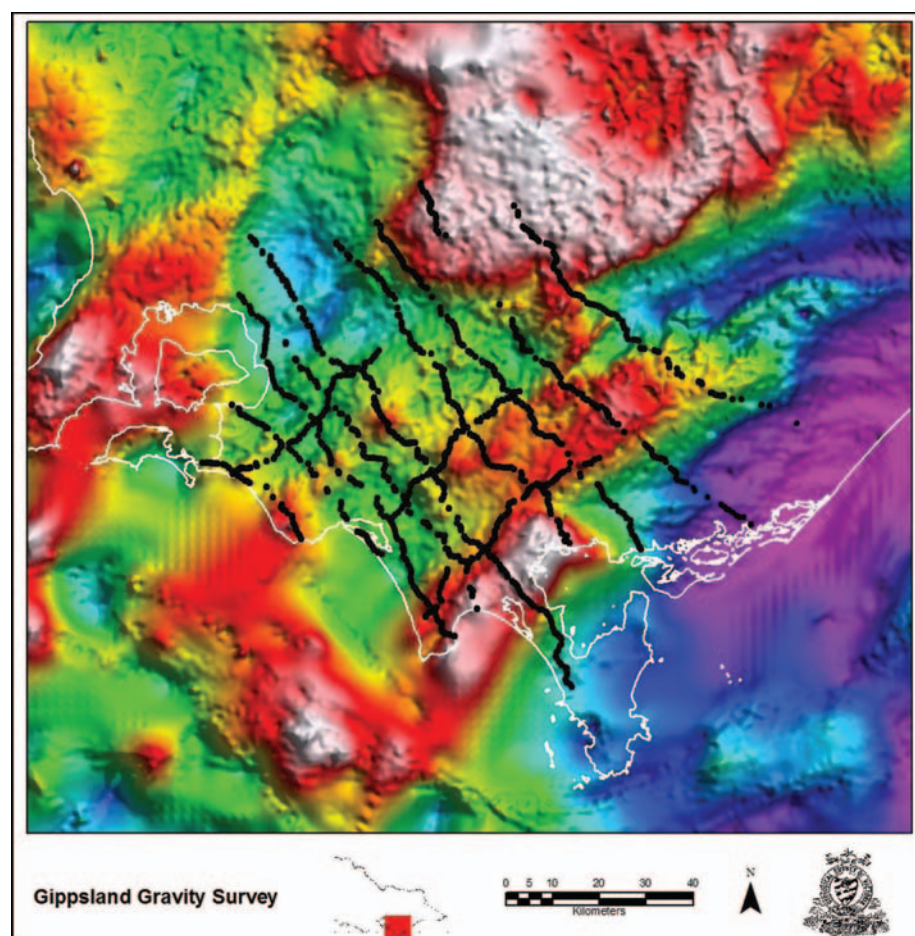
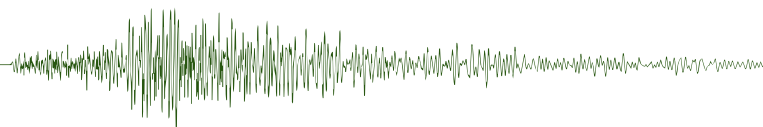


Figure 1. Gippsland Basin Gravity Survey traverse locations overlaid on regional gravity data.



passive seismic data from the WOMBAT deployment (eg. <http://onlinelibrary.wiley.com/doi/10.1002/grl.50878/abstract>), and from similar data in inland Tasmania. The results of the project are becoming available in a series of collaborative research papers (<http://www.sciencedirect.com/science/article/pii/S1342937X14002901>). Ultimately, this data will feed into development of a crustal-scale geological model of Bass Strait by GSV and MRT that enables unification of existing Victorian and Tasmanian crustal-scale 3-D models, improved correlation of interstate

geology, and of the mineral-systems within them.

In addition to the geoscience work carried out by GSV, the Victorian Government's \$15 million TARGET initiative is an exploration acceleration initiative which will boost new mineral exploration in Victoria. The initiative includes a \$12 million grants programme over 4 years which will see the Victorian Government co-fund exploration works with industry to drive more exploration for minerals in Victoria, particularly for copper and other base metals. The initial grant round is

intended to open in the first half of 2015. The initial focus of TARGET will be on exploration in the State's west, north and north-east. Grants will be available for works including drilling, geoscience surveys and laboratory analyses. Exploration projects will be selected on merit, with advice from an expert evaluation panel. Interested potential applicants are encouraged to register their interest. More information and details of how to register interest in the TARGET initiative are available at www.energyandresources.vic.gov.au/TARGET.

Geophysics at MRT: an overview

Geophysics is a cornerstone of Mineral Resources Tasmania's provision of pre-competitive geoscientific data. In addition to curating surveys conducted in Tasmania by explorers and federal government agencies since the 1930s, Mineral Resources Tasmania (incorporating the Tasmanian Geological Survey) and predecessor organisation the Tasmanian Department of Mines have directly and indirectly acquired geophysical data covering all areas of the State. All this data is freely available (unless obtained commercially on mine leases, or within the last five years on current exploration licences) via download from the MRT website.

Potential field data account for a large portion of these holdings, with almost 90,000 gravity stations and hundreds of thousands of line kilometres of magnetic data across Tasmania including King, Flinders and other offshore islands. In the north and west, encompassing the most prospective regions of the State, the aeromagnetic data are supplemented with multichannel radiometrics, all at a line spacing of 200 metres or better (Figure 1). Gravity station coverage in this same area is generally less than 1 km spaced or better.

Frequency domain airborne EM was obtained over extensive areas of western

and northwestern Tasmania by MRT in 2003. Surface and downhole electrical and electromagnetic surveys have been conducted successfully by explorers in Tasmania. Data and other records of these investigations are obtainable via MRT's general mineral exploration database, which is completely available online.

MRT's petrophysical database has grown significantly in recent years, building on a major acquisition project conducted in the Mount Read Volcanics and other key components of western Tasmanian geology in the late 1980s. The database contains substantial sonic velocity, conductivity, chargeability, gamma ray spectrometry, thermal and magnetic remanence information in addition to susceptibility and density. All significant components of Tasmanian geology are now represented.

Substantial contributions to Tasmania's geophysical knowledge have been made over several decades by a series of collaborations with the School of Earth Science/CODES at the University of Tasmania. This excellent, mutually beneficial relationship continues to be maintained. Current projects, including second generation 3D geological and geophysical modelling, additionally involve commercial partners, tapping into MRT's 3D modelling expertise.

Geophysical data have played a key role in major mineral discoveries at Savage River (magnetite), Que River (Zn-Pb-Ag-Au-Cu), Avebury (Ni) and Mount Lindsay (Sn), plus extensions to mineralisation at Rosebery (Zn-Pb-Ag), Mount Lyell (Cu-Au) and Renison Bell (Sn).

More information about the data and associated reports outlined in this brief overview can be obtained from Mark.Duffett@stategrowth.tas.gov.au or (03) 6165 4720.

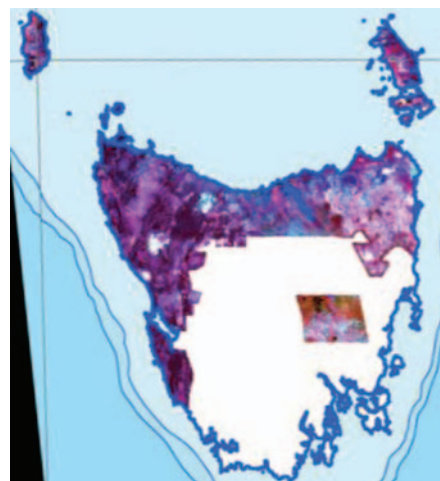


Figure 1. Extent of high resolution (200 m line spacing or better) airborne radiometric data coverage of Tasmania, excerpted from GA's Radiometric Map of Australia.

GSSA: Eucla Gawler Seismic Line 13GA-EG1

Seismic line 13GA–EG1 was undertaken in 2013 as a cross-border survey extending from Haig in Western Australia to Tarcoola in South Australia (see Figure 1). The cross-border survey is a collaboration between the Geological Survey of South Australia (GSSA), the Geological Survey of Western Australia (GSWA), Geoscience Australia (GA) and AuScope Earth Imaging. The survey aimed to provide key information about the largely unknown crust between the

highly prospective Gawler and Yilgarn Cratons, and to image beneath the thick cover of the Nullarbor Plain.

After completion of the survey in February 2014, GA performed an initial round of processing, culminating in a joint interpretation workshop of the Eastern section of the line in November 2014 (Figure 2). Initial interpretations made by GSSA, GSWA and GA suggest significant variation in depth to the

Moho, and complexity in the lower crust. Following the first interpretation workshop, a second round of processing will occur before a second round of interpretations in March/April 2015.

Processed SEG-Y data for the Eastern part of seismic line 13GA-EG1 will be released at SAREIC 2015 (<https://www.saresourcesconf.com/>). For more information contact Phil Heath philip.heath@sa.gov.au.

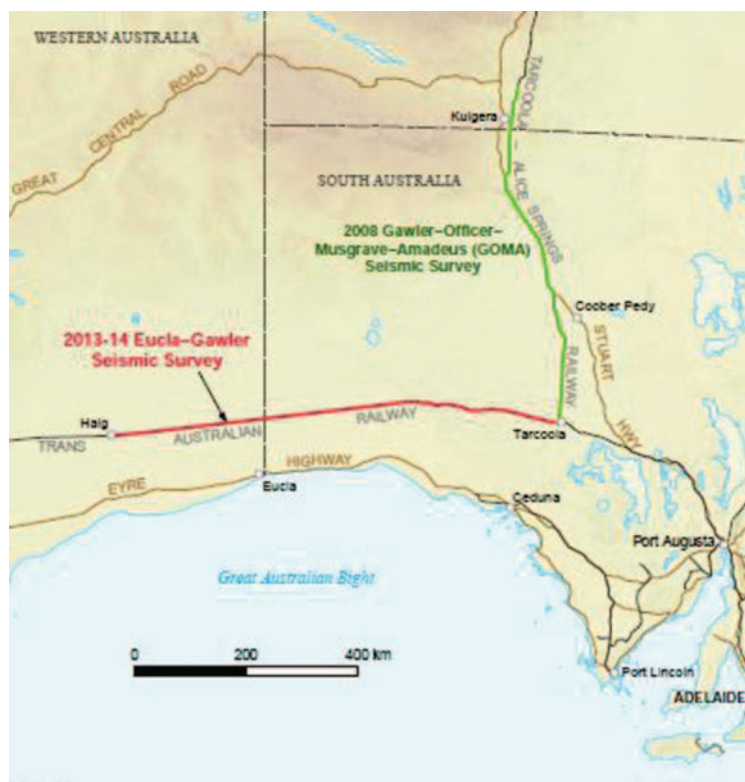


Figure 1. Location of cross-border Eucla-Gawler survey.



Figure 2. Steve Hill (GSSA), Ian Tyler (GSWA) and Richard Chopping (AuScope) interpreting line 13GA-EG1.

NTGS: Creating Opportunities for Resource Exploration in the Northern Territory

The NT Government's Creating Opportunities for Resource Exploration (CORE) initiative was announced in the 2014 Northern Territory Budget. It delivers \$23.8 million over four years, continuing and expanding the 2013 initiative with an additional \$2 million annually for an accelerated programme to assess the Territory's shale gas resources and potential.

The initiative focusses on acquiring new precompetitive geoscience information to stimulate exploration, establishing collaborative regional assessments of shale gas potential, providing industry grants for high-risk exploration and promoting programmes to attract investment into resources projects in the Territory. The CORE initiative has a focus on stimulating a new generation of resource discovery in the Territory's onshore sedimentary basins, which have a high potential for unconventional petroleum and large base metals deposits. Programmes include the acquisition of a number of new geophysical datasets (Figure 1). At the completion of the initiative, both the greater McArthur Basin and the Amadeus Basin will have gravity coverage at 4 km spacing or better.

Increased gravity station density over smaller areas is also achieved through collaboration with Industry. The opportunity to infill will continue to be offered to companies operating in the area for future surveys. To date the Southern McArthur Basin, Southern Wiso Basin and West Amadeus Gravity Surveys have been acquired and released. A number of key airborne magnetic and radiometric datasets will also be acquired under the CORE initiative, including the Dunmarra Survey which is currently in progress.

These new geophysical datasets, complimented by the acquisition and compilation of rock property measurements will feed into a three-dimensional model of the greater

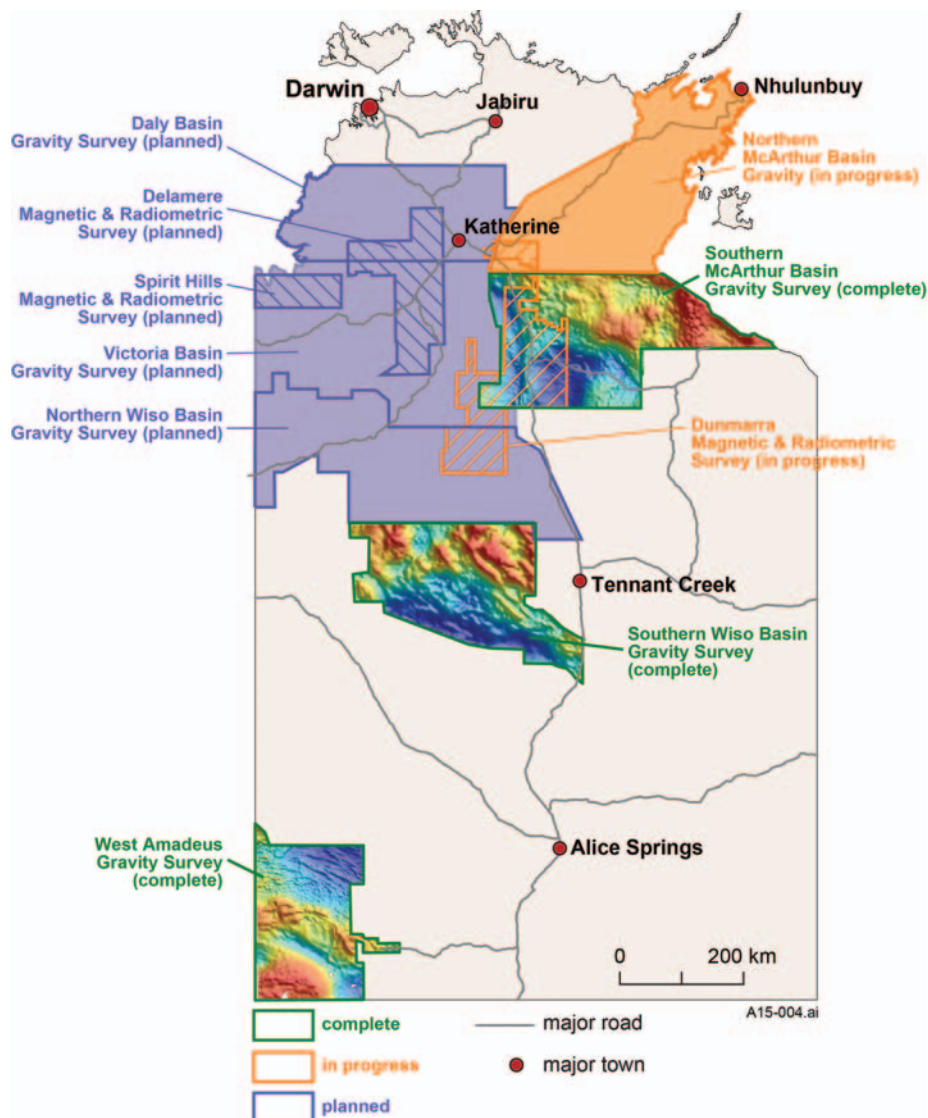


Figure 1. Location of CORE initiative geophysical surveys that have been completed (green) are currently in progress (orange) or are planned (purple) to commence in the next 18 months.

McArthur Basin. The model also incorporates structural interpretation, HyLogger™ hyperspectral data and industry seismic data and will be updated over the life of the initiative as new datasets become available.

Images of the new geophysical datasets are available on the Geophysical Image Web Server (<http://geoscience.nt.gov.au>)

giws) and the gridded and located data can be requested from the Minerals and Energy InfoCentre (geoscience.info@nt.gov.au). Results from the first year of the CORE initiative will be highlighted at the Annual Geoscience Exploration Seminar (AGES) 2015 to be held in Alice Springs on 17–18 March (for more information visit www.ages.nt.gov.au).

GSWA: Exploration Incentive Scheme regional geophysics programmes 2009–15

During the past five years, the injection of more than \$40 million for geophysical data acquisition as part of the Western Australian government's Exploration Incentive Scheme (EIS) has resulted in an unprecedented amount of new regional geophysical data being released for public access by the Geological Survey of Western Australia (GSWA) at the Department of Mines and Petroleum (DMP) (Figure 1).

Magnetic and radiometric surveys: An accelerated programme of airborne magnetic and radiometric surveys between 2009 and 2012 resulted in the acquisition of almost 3.5 million line kilometres of data in 34 separate contracts to provide complete 'second-generation' coverage of the state with publicly available data at a line-spacing of 500 m or better. ('First-generation' aeromagnetic and radiometric coverage is taken to be the 800 m – 3 200 m BMR survey coverage of Australia flown prior to about 1980.)

This was followed in 2013 and 2014 by a new programme of more detailed surveys with a line-spacing of 100 m over selected areas of the state. The first areas to be surveyed at this resolution were in the Goldfields with the acquisition of 720 000 line-kilometres of data. With the inclusion of non-confidential, high-resolution private company datasets, a significant area of Western Australia, particularly in the south-western half of the state, is now covered by aeromagnetic data at a line spacing of 300 m or less. This data coverage has permitted the compilation of a 40 m resolution grid of the state, believed to be the highest resolution aeromagnetic dataset presently available over such a large area (see *Preview* December 2014).

Gravity surveys: During the same time, 16 new gravity surveys added almost 109 000 new ground stations at a nominal spacing of 2.5 km to the national database. The new data have resulted in contiguous second-generation coverage at a station spacing of 4 km or less of a region extending from the Capricorn in the northwest of the state, through the central Yilgarn Craton and the Albany-Fraser Orogen, to the Eucla Basin in the southeast. ('First-generation' gravity coverage is taken to be the 11 km BMR survey coverage of Australia.)

Early in the regional gravity programme, more detailed gravity and terrain elevation data were acquired in a joint project with Geoscience Australia, Rio Tinto Exploration and Fugro Airborne Surveys (now CGG Airborne) to establish the RJ Smith airborne gravity and gravity gradiometry test range at Kauring, about 100 km east of Perth.

Reconnaissance AEM surveys: The EIS geophysical funding also enabled GSWA to initiate a programme of reconnaissance airborne electromagnetic (AEM) surveys at 5 km spacing following from the success of the Paterson AEM surveys that were carried out by Geoscience Australia in 2008. The Paterson surveys and other reconnaissance Geoscience Australia AEM surveys demonstrated the ability of wide-spaced AEM surveys to determine trends in regolith thickness and to map regional variations in bedrock conductivity under cover.

The first GSWA reconnaissance surveys were undertaken in the area of the Capricorn: a pilot project in conjunction with CSIRO of approximately 2000 line-km at 5.5 km line spacing over the Bryah Basin in 2012 followed by a \$2.5 million, 30 000 line-km survey at 5 km spacing covering some 145 000 square kilometres of the central Capricorn Orogen undertaken with Geoscience Australia.

Reflection seismic and magnetotelluric surveys: These regional potential field and AEM surveys were complemented by extensive programmes of reflection seismic and magnetotelluric (MT) surveys along selected traverses throughout the state in cooperation with Geoscience Australia, AuScope, Adelaide University and the Centre for Exploration Targeting (CET) at the University of Western Australia. The network of traverses now allows the construction of quasi-continuous transects through the major tectonic domains of Western Australia providing the potential to map key crustal structures and tectonic boundaries.

Passive seismic surveys: The seismic reflection and MT surveys are themselves being complemented by targeted programmes of passive seismic surveys by GSWA, CET and ANU to provide additional information about large-scale structures to mantle depths. Surveys are

presently underway in the areas of the Capricorn and Albany–Fraser Orogens.

Satellite ASTER Geoscience Map of Western Australia: A collaborative venture between GSWA and the Centre of Excellence for Three Dimensional Mineral Mapping led by CSIRO's Minerals Down Under Flagship project saw the release of a series of 'mineral group' composition maps over Western Australia. The project was subsequently extended by CSIRO and other state and territory geological surveys to cover the rest of Australia.

Data interpretation and analysis: GSWA, together with its research partners in CET, CSIRO and Geoscience Australia, is using these extensive and complementary geophysical datasets together with geological mapping and stratigraphic drilling data to create a new generation of 3D geological maps and models at project and craton scales.

The Capricorn seismic, MT and AEM datasets are key inputs to the Science and Industry Endowment Fund (SIEF) UNCOVER project 'Distal footprints of giant ore systems: Capricorn Orogen case study' being undertaken by a consortium of partners including GSWA, CSIRO, CET and Curtin University.

Data delivery: All data acquired from these surveys and results from the analyses are made available for online public access via the DMP and collaborator websites:

- Western Australia Department of Mines and Petroleum: www.dmp.wa.gov.au
- GSWA interactive data delivery system, GeoVIEW.WA: www.dmp.wa.gov.au/geoview/
- GSWA geophysics datasets and compilations: www.dmp.wa.gov.au/geophysics/
- Geoscience Australia Data and Publications Search: www.ga.gov.au/search/
- National Geophysical Archive Data Delivery System (GADDs): www.ga.gov.au/gadds/
- Virtual Geophysics Laboratory: <http://vgl.auscope.org/VGL-Portal/>
- Pawsey Data Portal: <https://data.ivec.org/public/>

Besides making the data available, GSWA is also seeking to promote fuller

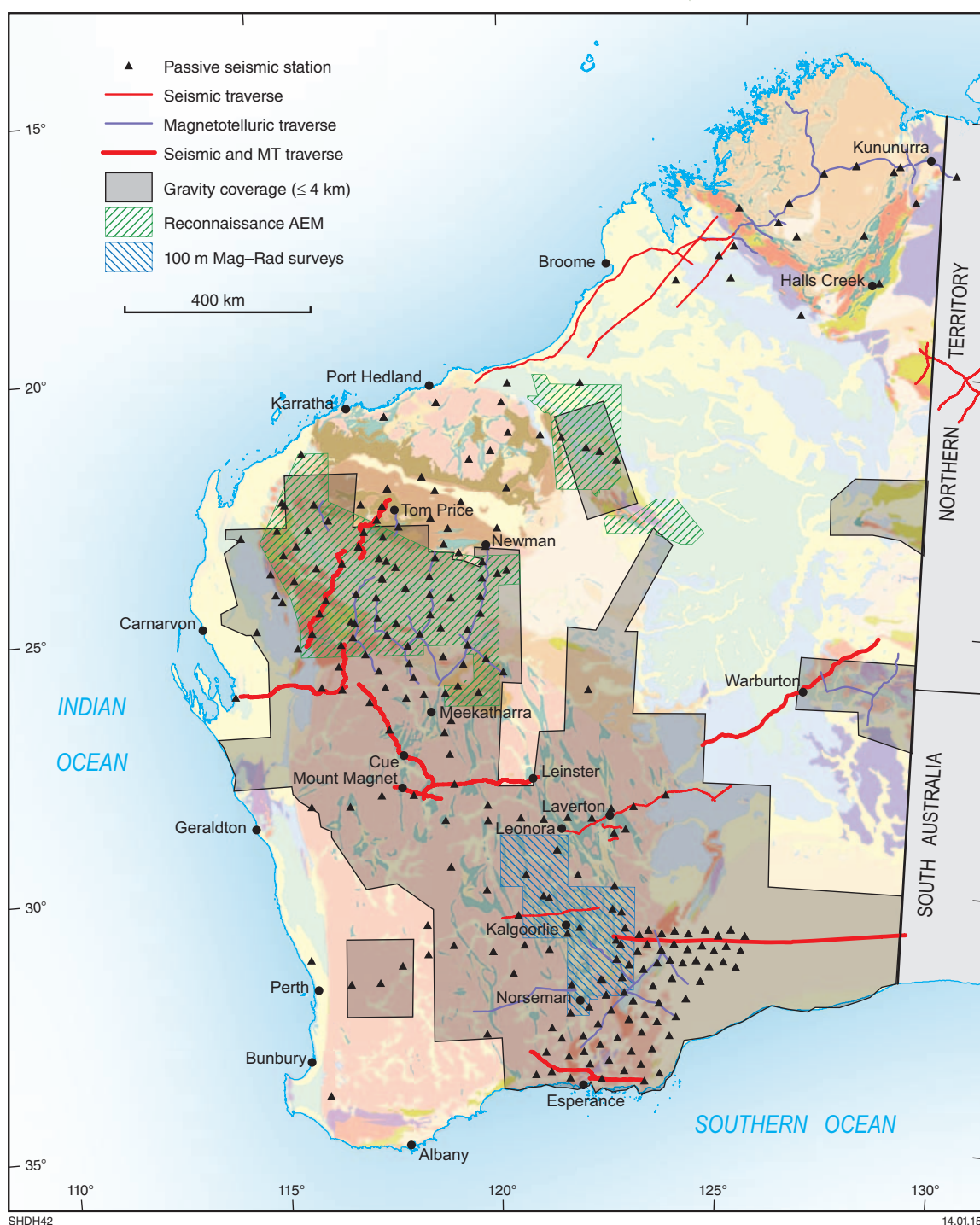


Figure 1. WA Exploration Incentive Scheme regional geophysics programmes 2009–15.

utilisation of the data by collaborating with CET in the development of an Integrated Exploration Platform — a suite of software tools that will allow the integration of 2D and 3D geological, geophysical, geochemical and drilling datasets and their derivative products.

Conclusions

The large area of the state of Western Australia — greater than 2.5 million

square kilometres, ranked 10th in the world by area if it were a country — has always meant that the provision of regional geoscience data coverage by GSWA has been a slow and expensive process.

The Western Australian government's Exploration Incentive Scheme has gone a long way to change that situation. From being the poor cousin of Australian states and territories in terms of regional geophysical data coverage in 2009,

Western Australia can now boast of a wealth of publicly accessible geoscience datasets and products that matches if not surpasses the best in the world.

The impact of the new data, analyses and delivery tools in the perception of the state's prospectivity has been recognised by the elevation of Western Australia to the number one spot in the 2013 Fraser Institute survey of mining companies released in March 2014.

Update on Geophysical Survey Progress from the Geological Surveys of Western Australia, South Australia, Northern Territory, Queensland, New South Wales, Victoria and WA Department of Water (information current on 7 January 2015)

Tables 1–3 show the continuing acquisition by the States and the Northern Territory of new airborne magnetic, radiometric, gravity and AEM data over

the Australian continent. All surveys are being managed by Geoscience Australia (GA). Further information is available from Murray Richardson at GA via

e-mail at Murray.Richardson@ga.gov.au or telephone on (02) 6249 9229.

Table 1. Airborne magnetic and radiometric surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Spacing AGL Dir	Area (km ²)	End flying	Final data to GA	Locality diagram (Preview)	GADDs release
Dunmarra	NTGS	GA	GPX Surveys	28 Jun 2014	103 985	400 m 80 m N–S	36 280	100% complete at 10 Oct 2014	Raw data were supplied to GA on 24 Oct 2014. Final processed data were received for assessment in Nov 2014.	PV 170 – Jun 2014 p. 24	TBA
Coompana	GSSA	GA	GPX Surveys	Not before 7 Feb 2015	255 265	400 m 80 m E–W	The survey covers all or part of Noorina, Wyola, Cook, Coompana, Nullarbor, Ooldea, Maurice, Wells and Birksgate standard 1:250 000 standard Map Sheets. The survey commenced on 7 Feb 2015 with project management by GA and funding from GSSA's PACE 2020 Initiative.				

Table 2. Gravity surveys

Survey name	Client	Project management	Contractor	Start survey	No. of stations	Station spacing (km)	Area (km ²)	End survey	Final data to GA	Locality diagram (Preview)	GADDs release
Sir Samuel-Throssell	GSWA	GA	IMT	19 Jun 2014	11 702	2.5 km regular grid	73 800	100% complete at 7 Sep 2014	Final data expected to be released via GADDs before the end of 2014	PV 171 – Aug 2014 p. 39	17 Dec 2014
West Amadeus	NTGS	GA	Atlas	29 Jun 2014	8127	4 km regular with areas of 0.5, 1 and 2 km infill	45 050	100% complete at 11 Aug 2014	Final data expected to be released via GADDs before the end of 2014	PV 171 – Aug 2014 p. 39	17 Dec 2014
Southern Thomson	GA/GS NSW/GSQ	GA	Atlas	17 Jul 2014	3660	8 traverses at 333 m station spacing	TBA	100% complete at 17 Sep 2014	Final data expected to be released via GADDs before the end of 2014	PV 170 – Jun 2014 p. 24	17 Dec 2014
Gippsland	GSV	GA	Atlas	30 Jun 2014	1440	12 traverses at 500 m station spacing	8358	100% complete at 21 Jul 2014	Final data expected to be released via GADDs before the end of 2014	PV 170 – Jun 2014 p. 25	TBA
North McArthur Basin	NT	GA	Atlas	16 Sep 2014	7175	4 km regular grid with areas of 2 km infill; 1 area of traverses spaced 4 km apart with a station spacing of 1 km.	71 030	100% complete at 4 Nov 2014	Preliminary final data were supplied to GA at the end of Nov 2014	PV 171 – Aug 2014 p. 39	The survey covers all or part of Arnhem Bay, Gove, Mt Evelyn, Mt Marumba, Blue Mud Bay, Katherine, Urupunga and Roper River standard 1:250 000 standard map sheets

Table 3. AEM surveys

Survey name	Client	Project management	Contractor	Start flying	Line km	Spacing AGL Dir	Area (km ²)	End flying	Final data to GA	Locality diagram (Preview)	GADDs release
Southern Thomson Orogen	GA/GS NSW/GSQ	GA	Geotech Airborne Ltd	8 Apr 2014	4198 (3327 in survey and 871 in traverses)	5 km E–W	16 270	100% complete at 5 May 2014	Additional work (traverses) over the Paroo and Darling Rivers to examine the potential for new groundwater resources was completed on 5 Jun 2014	PV 168 – Feb 2014 p. 24	The data were released by GA on 28 Aug 2014 via http://www.ga.gov.au/search/index.html#/

TBA, to be advised.

Southern Thomson Orogen VTEM Airborne Electromagnetic Survey

In August 2014 the processed data from the Southern Thomson Orogen VTEMplus® AEM Survey were released in the Phase 1 data release package that is available free of charge from Geoscience Australia's web site (see http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_81852). The Phase 1 package includes the final processed electromagnetic data, waveform files, multiplots, conductivity estimates from the EM Flow® conductivity depth imaging algorithm, and an operations and processing report, all produced by the contractor Geotech Airborne Ltd.

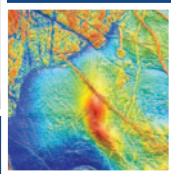
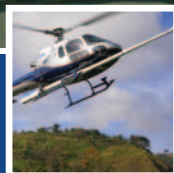
Phase 2 data was released on 24 December 2014 and the package contains two different types of inversion algorithm, a deterministic regularized gradient-based algorithm, which has been called GALEISBS (Roach, 2010), and a reversible-jump Markov chain Monte Carlo algorithm, which has been called GARjMcMC (Brodie and Sambridge 2012; Brodie and Reid 2013). Both algorithms assume a layered earth or 1D conductivity structure. Each airborne electromagnetic sounding is inverted independently and the results are then stitched into combined sections.

The Southern Thomson Orogen is a priority area for mineral systems research.

Much of the area lies underneath cover of sedimentary basins and is a poorly-understood element of Australia's geology. The Orogen contains Cambro-Ordovician rocks that have potential for Iron Oxide Copper-Gold (IOCG) resources, porphyry copper-gold and Volcanic-Hosted Massive Sulphide (VHMS) deposits. Survey data will add to knowledge of cover thickness and character and will inform future geological mapping in the region.

YOUR EXPLORATION ADVANTAGE.

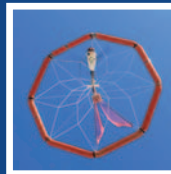
UTS GEOPHYSICS



The Geotech Group of companies is a leader in technological innovation for geophysical surveys that offer you better, clearer, deeper images.

As an innovator in the design and application of detailed airborne geophysical surveys for over 30 years, the Geotech Group of companies provides our clients with the most advanced geophysical exploration platforms, data processing and data interpretation available in the market today.

GEOTECH
AIRBORNE GEOPHYSICAL SURVEYS



VTEM® • ZTEM® • Gravity • Magnetics • Radiometrics
Data Processing • Interpretation • Modeling

T: +61 8 6310 4000

F: +61 8 6310 4099

W: www.uts.com.au

W: www.geotechairborne.com

info@uts.com.au

sales@geotechairborne.com

Active member of



International
Airborne Geophysics
Safety Association