

Survey maps north Queensland in depth

Project throws light on architecture, energy potential



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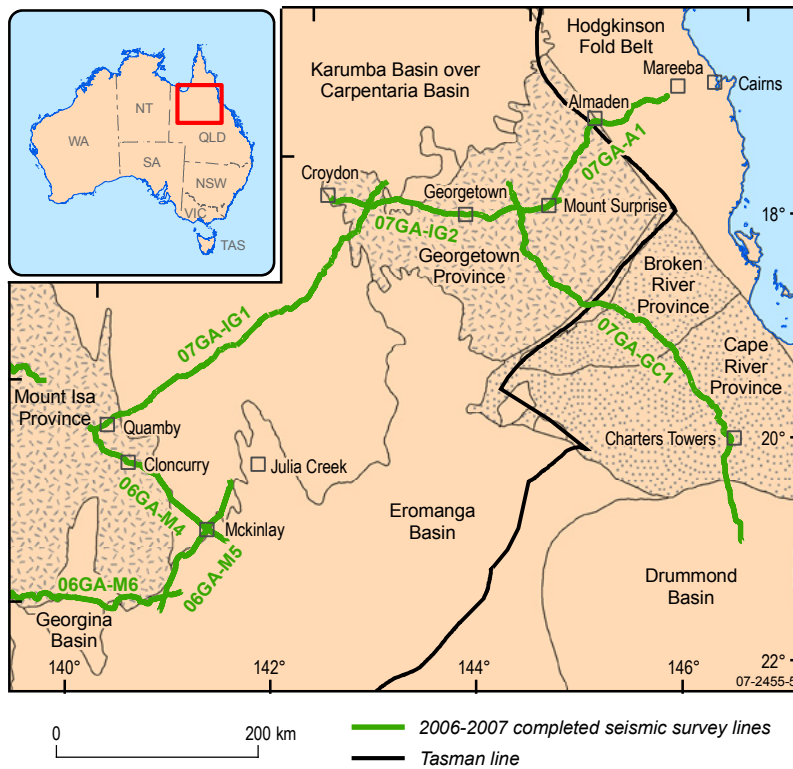
The first results are in from a major project to assess the potential of north Queensland for new onshore petroleum and mineral energy resources.

Geoscience Australia launched the geophysical data acquisition program as part of the Onshore Energy Security Program. The project will also assess the potential for geothermal energy from high-heat producing terrains and from under blankets of sedimentary cover.

The project was extended in scope and size when Geoscience Australia joined forces with the Queensland Department of Mines and Energy through the Geological Survey of Queensland. The Geological Survey was working under the state's Smart Mining—Future Prosperity Program.

The project involved the collection of deep seismic reflection, gravity and magnetotelluric data along a series of traverses from the eastern edge of the Mt Isa Province, across the Georgetown Province, and south-east through the Charters Towers region and into the Drummond Basin.

Meanwhile, AuScope, the National Collaborative Research Infrastructure Scheme's 'Organisation for a National Earth Science Infrastructure Program—2007–2011', funded a seismic reflection transect that crossed the Palmerville Fault – Tasman Line. Figure 1 shows the location of the traverses.



The Isa – Georgetown – Charters Towers region survey

The Isa – Georgetown – Charters Towers (IGCT) region survey consisted of three regional deep seismic reflection traverses (07GA-IG1, 07GA-IG2 and 07GA-GC1) covering 1187 kilometres (figure 1). The objectives were to map the three-dimensional geology between the Mt Isa Province, the Georgetown Province and the Drummond

Figure 1. The positions of the 2007 Isa–Georgetown–Charters Towers survey (07GA-IG1, 07GA-IG2, 07GA-GC1) and the 2007 Far North Queensland AuScope (07GA-A1) traverses.

Basin region to image whole-of-crust architecture (surface to 60 kilometres depth) and the geological structure within the upper 5 kilometres. The survey also collected gravity readings and high-frequency magnetotelluric data along each traverse.

The project investigated:

- the eastern margin of the Mt Isa Province
- the western margin of the Georgetown Province
- the relationship between the Georgetown, Cape River and Broken River provinces and northern margin of the Drummond Basin
- the geodynamic setting of the Mt Isa, Georgetown, Cape River and Broken River provinces and the Drummond Basin
- the internal structure of the Georgetown, Cape River and Broken River provinces
- relationships between crustal architecture, geodynamic setting, mineral and energy systems and geothermal systems.

For each traverse, specific research questions were identified.

Traverse 07GA-IG1 focused on helping to assess the geodynamic setting along a line from the Mt Isa Province into the Georgetown Province, including the characteristics of the postulated 1680 Ma northeast-oriented extension direction; the geometry of the eastern margin of Mt Isa Province and possible rift setting; and the geometry of the western margin of the Georgetown Province.

The results will provide insights into the potential for minerals deposition, including metasomatic uranium in Mt Isa Province and evidence for the occurrence of undercover IOCG-U (iron oxide – copper – gold – uranium) deposits. Within the eastern Mt Isa Province, the survey will help to identify potential geothermal sources, including hot granites in the Mt Isa Province and high-heat producing Proterozoic and Carboniferous granites in Georgetown Province. Buried mineralisation potential is also addressed by investigating the potential for undercover deposits, including zinc–lead–gold and copper–gold. The traverse runs near the Ernest Henry Mine and through the Croydon (gold) and Esmeralda (mesothermal gold) areas.

The seismic survey will reveal the thickness of the Carpentaria Basin (a potential petroleum basin and possible cover sequence for hot granites) and of any underlying basins, shedding light on the shape of those basins at depth—information that will aid our understanding of the petroleum potential of the region.

Traverse 07GA-IG2 focused on providing insights into the geodynamic setting of the Georgetown Province, including its internal structure. The results will reveal the structure within and beneath the Proterozoic Croydon volcanics near Croydon, the structure within and beneath the Carboniferous Newcastle Range volcanics to the east of Georgetown, and the geometry of the western margin of the Georgetown Province.



Figure 2. IVECO Hemi60 Vibroseis trucks working along traverse 01GA-IG1. The trucks generated seismic waves by sending small vibrations into the ground. The vibrations are reflected off changes in rock.

The seismic results will be used to investigate the potential for uranium mineralisation associated with high-heat producing Carboniferous magmatism that is now hosted by Carboniferous sediments and volcanics in the Newcastle Range, provide evidence for the occurrence of high-heat producing Proterozoic and Carboniferous hot granites in the Georgetown area, and map the depth to the top of those granites.

The seismic results will also provide information on possible controls on the mineralisation potential of the Croydon–Georgetown region. The seismic reflection data will image the deeper structure, which might indicate the source of the alluvial diamonds known from the Mt Surprise gem fields.

Traverse 07GA-GC1 was oriented to cross the grain of the main provinces in the area. It intersected a series of northeast–southwest major fault systems, including the Tasman Line (the major structure that marks the boundary between the Proterozoic craton margin



Figure 3. Terrex seismic crew laying out the geophones to record the reflected seismic waves along traverse 01GA-IG1.

to the northwest and the Early Palaeozoic rocks to the southeast) and Balcooma, Burdekin and Clarke River structures. The traverse data will shed light on the location and geometry of the Tasman Line and the internal structure of, and relationships between, the Georgetown, Cape River and Broken River provinces and the northern margin of the Drummond Basin. It will image the stratigraphy of the northern part of the Drummond Basin.

The data will identify relationships between crustal architecture and energy and geothermal systems. The traverse crossed the northern margin of the Drummond Basin and will provide information on the nature and petroleum prospectivity of that area.

The traverse also crossed the eastern Georgetown region, an area known for uranium mineralisation associated with high-heat producing Proterozoic S type granites. It crossed the Burdekin Basin (with potential for uranium mineralisation) and several gold provinces, including the Kidston, Charters Towers (mesothermal Au, veined Au), Mt Leyshon (breccia-hosted Au) and Pajingo (epithermal Au) provinces, as well as VMS (volcanic massive sulfide) base metal deposits at Balcooma and the Highway Mine south of Charters Towers.

AuScope seismic survey

The AuScope seismic survey consisted of one regional traverse (07GA-A1) covering 205 kilometres. Traverse 07GA-A1 aimed to provide a dataset that will image the Tasman Line. The resulting interpretations

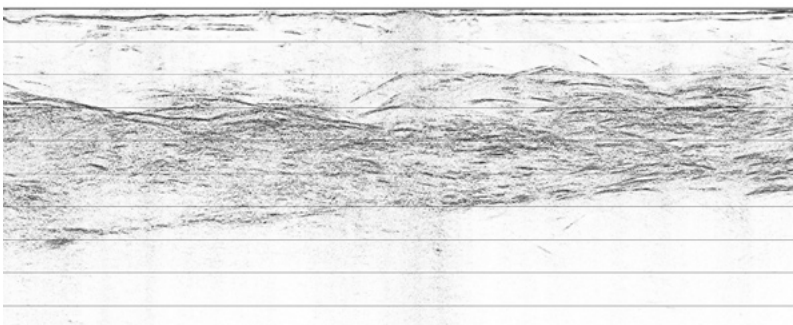


Figure 4. Raw field processed section from part of traverse 01GA-IG.

on the geodynamic setting of the region will reveal the processes of Australian continental growth. The seismic results will also be used to determine the internal structure of both provinces by linking the surface structure and rock units with deep structure. The seismic results will be used to tie the internal structure to geodynamic evolution and mineralisation events.

IGCT seismic acquisition

The IGCT seismic acquisition will provide images of the crust at high resolution. It promises to reveal the crustal architecture and the region's energy and mineral resource potential close to the surface.

Terrex Seismic did the survey (figures 2 and 3), which ran for three months from May 2007, under the supervision of ANSIR staff at Geoscience Australia. The survey's objectives and timing were discussed with local shires, Aboriginal groups, property owners and mining companies.

Table 1 shows the acquisition parameters, which were designed to provide high resolution through the entire crust and images of the top five kilometres.

IGCT gravity and magnetotelluric acquisition

Gravity and magnetotelluric datasets complemented the seismic reflection dataset for the IGCT traverses. The gravity readings were acquired at a

Table 1. Project survey parameters

Geophone group interval	40 m
Number of channels	240 for 07GA-IG1, 300 for 07GA-IG2, -GC1 and -A1
Spread configuration (IG1)	Split spread, 4800 m – 0 – 4800 m (240 channels).
Spread configuration (IG2, GC1, A1)	Split spread, 6000 m – 0 – 6000 m (300 channels).
VP interval	80 m nominal, 40 m where there is crooked line or near ‘noisy’ areas.
Source parameters	3 x Hemi60 vibes (plus 1 spare).
Sweep parameters	3 x 12 s sweeps, 6–64 Hz, 12–96 Hz and 8–72 Hz.
Correlated record length	20 sec
Sample rate	2 ms
Acquisition filters	Hi cut 200 Hz, Lo-Cut nil or 3 Hz.
Nominal fold	60 fold (was increased to 120 fold around some bends or near ‘seismically noisy’ areas).

400-metre station spacing along each traverse. High-frequency magnetotelluric data were collected along 07GA-IG1, 07GA-IG2 and 07GA-GC1 at 10-kilometre spacing.

Working to Geoscience Australia’s specifications, Dynamic Satellite Surveys did the gravity work and Quantex Geosciences handled the magnetotelluric data acquisition from late June until early September.

The results from both surveys and existing aeromagnetic data will be integrated with the seismic reflection data to build a comprehensive image of the third dimension within the region.

IGCT results

The initial field raw stacks show some remarkable and unexpected images of the regions’ crustal-scale geology. Figure 4 shows a portion of the field-processed raw seismic section from traverse 01GA-IG. It is an image of the entire crust between the Mt Isa Province and the Georgetown Province. The Moho stands out as the base to the band of crustal reflectivity in the middle of the figure. It deepens from east to west from approximately 33 to 42 kilometres, indicating that the crust thickens towards the Mt Isa Province.

The middle and lower crust is very reflective. On this field-processed section, the upper crust is non-reflective; however, on the more detailed daily quality control sections, a lot more structure is visible. This detail will be greatly enhanced with further processing, but even in this section there is evidence of both dipping events and sub-horizontal reflectors.

The seismic image has also revealed a series of shallow, large-scale, east dipping structures within the middle crust. The reflection

patterns above and below suggest that the structures underwent considerable extension and later contraction, indicating considerable crustal movement between the Georgetown Province and the Mt Isa Block. This raises the question of whether there has ever been a geological relationship between the two provinces, other than the coincidental temporal one.

Acknowledgments

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