Geological Survey Record
2006-004

Progress under Building the Territory’s Resource Base
from July 2003 to March 2006

JN Dunster

Northern Territory Geological Survey
Darwin, November 2006
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Bibliography
ISBN 0 7245 7108 6

Keywords: Building the Territory’s Resource Base, BTRB, Northern Territory Australia, Northern Territory Geological Survey, Titles, progress report, economic geology, areal geology, mineral exploration, petroleum exploration, data bases, information systems.

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PREFACE

In February 2006, ACIL Tasman was commissioned by the Department of Primary Industry, Fisheries and Mines (DPIFM) to undertake a review of the effectiveness of the NT Government’s exploration investment attraction strategy. This strategy encompasses two consecutive programs: the NT Exploration Initiative (NTEI: 1999–2003) and Building the Territory’s Resource Base (BTRB: 2003–2007). The timing of the review, during the third year of BTRB, was mandated by a Government decision in 2003 in awarding the then-Department of Business, Industry and Resource Development $15.2 million to fund the program. The purpose of the review was to assist the Government in deciding whether ongoing investment was warranted beyond BTRB and, if so, what form it would take.

The ACIL review was conducted during February–April 2006. Its final report, which included several costed options for future NT Government investment attraction efforts, was delivered to DPIFM on 27 April 2006. Staff of the NT Geological Survey (NTGS) compiled much of the information used by the ACIL team in completing its review. This information is presented in NTGS Record 2006-004.

At the time of release of Record 2006-004, the ACIL Tasman review report had not been made public. However, it is anticipated that an edited version of the report will be released by the end of 2006.

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Director
Northern Territory Geological Survey
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EXECUTIVE SUMMARY

The Northern Territory Government’s four-year $15.2 million exploration investment attraction initiative Building the Territory’s Resource Base (BTRB) began in 2003. The following have occurred during the first three years:

**Additions to NT’s commodity resource base**

- Toms Gully gold reserves were upgraded and mining has begun; NT’s gold resources were increased incrementally by drilling at Mount Porter, Zapopan and Cosmo Deeps.
- Reserves at Ranger uranium mine were increased (prolonging projected mine life); other uranium deposits [eg Napperby (New Well), Bigfly, Mount Fitch uranium] are being drilled to bring them to JORC-compliance (ASX reporting standard).
- World-scale mining of bauxite (Gove), manganese (Groote Eylandt) and base metals (McArthur River) continued; new projects are underway for manganese (Bootu Creek) and other metals (Redbank, Browns, Mount Fitch copper).
- New commodities are being added to NT’s minerals inventory and others are being revisited; BTRB has seen significant developments in iron ore (Francis Creek), mineral sand (Melville Island), rare earth elements (Nolans Bore), and garnets (Harts Range); the resource levels of most of these have been substantially increased and many projects are undergoing advanced feasibility studies and could be mined shortly.

**Better land access and increased exploration activity**

- Mineral and petroleum exploration activity in NT has significantly increased in terms of number of applications, square kilometres and expenditure.
- Turnover of ground is improving as the Titles group becomes more proactive.
- Processing of applications and grant of titles has improved; for example, Matilda Minerals have been able to fast-track their mineral sands discovery on Melville Island.
- Land access issues relating to Native Title issues are being resolved.

**Delivery of world-class pre-competitive geoscientific data in areas that assist exploration**

- The Arunta Region has seen recent success with less-conventional targets (Nolans Bore rare earth elements, Molyhil tungsten-molybdenum, Harts Range abrasives); under BTRB, known mineralisation (conventional and unconventional) has been studied in detail to generate exploration models.
- A collaborative deep-seismic program, undertaken during the first initiative, demonstrated that exploration models based on the “Batten Trough” in the McArthur Basin were fundamentally flawed; this highly-prospective area is about to be reinterpreted by a pmd*CRC–NTGS collaboration under BTRB.
- Under the first initiative and BTRB, there have been fundamental breakthroughs in understanding the prospectivity of the Arunta Region; several new provinces have been recognised and are being evaluated by NTGS; for example, the Warumpi Province is now recognised as having rocks of the same age as the highly-mineralised Mount Isa and Broken Hill areas.
- Diamond exploration has been re-invigorated by increased exploration around the Merlin mine and the separate discovery of a diamond-bearing kimberlite in the McArthur Basin; the latter was achieved by a junior company who brought state-of-the-art technology into the NT. Exploration has been assisted by the release of Australia’s first diamond indicator database by NTGS; diamonds now rank third in terms of exploration expenditure in the NT and account for 10% of the total.
- Combined technologies (collaborative deep-seismic and NTGS 3D modelling) were used to generate and test gold mineralisation models in the Tanami; this fundamentally changed the interpretation of the area and will allow explorers to prioritise their exploration holdings and better focus their efforts.
- A major emphasis has been placed on the Amadeus Basin, including NTGS stratigraphic drilling, to re-invigorate petroleum exploration in this producing, but largely unexplored basin; there are now over 1000 line km of seismic data and five wells planned on four granted exploration permits, and another nine exploration permit applications pending.
- There has been a major upturn in petroleum exploration; Timor sea drilling success rate has substantially improved; there have been 22 new applications onshore in the last two years from nine new operators; the private sector has committed a minimum of $55M over five years to onshore exploration, with nine out of 33 permits now granted; the first onshore seismic program since 1999 is about to begin; better data provided by NTGS has contributed to this increase in activity.
- Over 30 new scientific publications (reports, records, refereed publications) have been released by NTGS during BTRB to date.

**Improved data delivery systems**

Improved data delivery has been achieved via the following:

- The NTGS website has been redesigned.
- Geoscientific data can now be webserved to clients via the recently implemented STRIKE application.
- There has been a significant upgrade to the webserver for leading-edge geophysical datasets.
- There have been major updates to the geospatial data being webserved.
- There has been an upsurge of 250% in requests for technical data in the last six months.

**Active marketing and promotion of NT as destination to explore and mine**

- The Central Australian Basins Symposium was convened (August 2005).
- The Top End Roadshow successfully promoted the NT as an exploration and mining destination and resulted in increased enquiries and applications.
INTRODUCTION

The Northern Territory (NT) Government’s exploration investment attraction initiative Building the Territory’s Resource Base (BTRB) was announced in May 2003, and subsequently commenced on 1 July 2003. There are four elements to BTRB:

1. A continuing program involving the acquisition of high-quality pre-competitive geoscientific data and provision of this data to the mining and petroleum sectors.
2. An enhanced capability to process and manage exploration and mining tenure.
3. A commitment to working with the mining industry and Indigenous organisations to encourage partnerships and Indigenous involvement in mining.
4. A continuing program of communication to promote the Territory as an attractive exploration investment destination.

Funding for the program was generated by an amendment to the Exploration Expenditure Certificate (EEC) aspect of the Mineral Royalty Act. Planning, implementation and management of this four-year $15.2 million program is the responsibility of the Minerals and Energy Group of the Department of Primary Industry, Fisheries and Mines (DPIFM). The Northern Territory Geological Survey (NTGS) is charged with overseeing items 1 and 4, which together account for over 85% ($13 million) of the allocated funding. DPIFM’s Titles Division (Titles) manages item 2 ($1 million), and the Indigenous Business and Industry Services unit (IBIS) of the Department of Business, Economic and Regional Development (DBERD) has prime responsibility for outcomes relating to item 3 ($1.2 million).

BTRB builds on the previous 4-year, $16 million NT Exploration Initiative (NTEI) which ran from 1999/2000 to 2002/2003. This program focused solely on the acquisition, management and delivery of pre-competitive geoscientific data. A review and assessment of NTEI by Dugmore and Fardon (2003) regarded NTGS as the pre-eminent geological survey in Australia at the time. The review included recommendations adopted under BTRB.

The Dugmore and Fardon (2003) report was released at the same time as a much broader review of the role of public geological surveys in Australia by Australian Bureau of Agriculture and Resource Economics (ABARE; Hogan 2003), who attempted to theoretically demonstrate the economic efficiency of geological surveys.

The following year, Winlaw (2004) independently reviewed the management structure and performance of NTGS. He identified a number of organisational opportunities to move DPIFM forward in attracting, enhancing and retaining exploration investment in NT, and to ensure that resource development is a significant ongoing contributor to GSP. Winlaw attempted a return-on-investment comparison between the various Australian geological surveys.

Kirby (2004) reviewed the composition, trends and issues in private sector mineral and petroleum exploration in the NT. Several of the graphs in this report have been updated from Kirby’s original.

The Fraser Institute conducts annual surveys of >1000 mining companies to obtain a “report card” on the attractiveness of Government policy for exploration and mining across the leading jurisdictions worldwide (Table 1). Use of a rankings approach by Fraser can be misleading, since in many cases there is little substantive difference (only a few percent) between the absolute ratings of many jurisdictions, and this is probably within the margin of error in the survey.

Trevena (2005) critiqued the 2004/05 Fraser Report. He regarded it as a useful tool, but stated that it should not be seen as an absolutely reliable guide to exploration and mining company views of the NT’s exploration attractiveness. Richard Brescianini provided comments on the 2005/06 report and these are included below.

Current mineral potential is the best measure of overall investment attractiveness, according to the Fraser Institute. Fraser ranked NT 8th out of the 53 jurisdictions surveyed in 2003/04 and 8th again out of 64 jurisdictions surveyed in 2004/05. In 2005/06, NT slipped to 24th, having mostly been overtaken by countries in Africa and South America and by South Australia, Tasmania, Queensland and New South Wales. All of the Australian jurisdictions except South Australia have fallen significantly and Victoria is the only Australian state to rate lower than NT.

In overall policy potential, NT went from 12th out of 53 in 2003/04 to 25th out of 64 in 2004/05 and was the lowest ranked of all the Australian states. In 2005/06, NT climbed ahead of Queensland and Victoria.

<table>
<thead>
<tr>
<th>Fraser Institute Survey Criteria</th>
<th>2003/04</th>
<th>2004/05</th>
<th>2005/06</th>
</tr>
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<tr>
<td>Number of jurisdictions surveyed</td>
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<td>64</td>
<td>64</td>
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<tr>
<td>Current mineral potential</td>
<td>8th</td>
<td>8th</td>
<td>8th</td>
</tr>
<tr>
<td>Policy potential</td>
<td>12th</td>
<td>25th</td>
<td>24th</td>
</tr>
<tr>
<td>Geological database (Fraser)</td>
<td>3rd</td>
<td>22nd</td>
<td>20th</td>
</tr>
<tr>
<td>Geological database (DPIFM, using only positive incentives)</td>
<td>3rd</td>
<td>5th</td>
<td>11th</td>
</tr>
<tr>
<td>Uncertainty over Native Title</td>
<td>47th</td>
<td>60th</td>
<td>56th</td>
</tr>
<tr>
<td>Environmental regulations</td>
<td>6th</td>
<td>14th</td>
<td>2nd</td>
</tr>
</tbody>
</table>

Table 1. Relative rankings of NT and the number of jurisdictions surveyed in Fraser Institute Surveys. Only selected criteria are shown and the difference between DPIFM and Fraser interpretations is explained in footnote 1 (overpage). NT ranks well in terms of mineral potential under the current circumstances and is comparable to other Australian states in most other criteria. However, uncertainty over Native Title is seen as a significant deterrent to exploration investment by the majority of companies surveyed.
In terms of the quality of its **geological database**, in 2003/04 NT ranked 3rd out of 53, and 22nd out of 64 in 2004/05, and 26th in 2005/06 when NT was supplanted by Alberta, Chile, Saskatchewan, Alaska and some Scandinavian countries. Although NT rates higher when only incentive criteria are used, in 2005/06, it has still been overtaken by several of the Canadian provinces and is behind all other Australian jurisdictions. NT remains in the range of 85% to 100% of respondents who consider our geological databases encourage investment.

NT consistently ranked very poorly in terms of **uncertainty concerning Native Title claims**, but appears to have made up some ground during 2005/06 by having pulled ahead of the likes of the Democratic Republic of the Congo, Venezuela and Bolivia. However, 41% of respondents still see this issue as a disincentive to investment in NT, compared with 26% in 2004/05 and 31% in 2003/04 (Fraser Institute 2004, 2005, 2006).

Given the current McArthur River Mine situation, it is ironic that NT rose to second best in the 2005/06 survey as **Environmental Regulations** not being a deterrent to investment (R Trevena, DPIFM Mining Development group, written communication, 23/03/2006).

Reports tracking progress against each of the elements of BTRB are provided to the Minister for Mines and Energy on a six-monthly basis. BTRB will conclude on 30 June 2007. The plan required that an independent review of progress and strategic direction be undertaken in year three. In February 2006, the contract for this review was awarded to ACIL Tasman and, in conjunction with them, Ross Fardon and Associates.

This current review of BTRB is concurrent with:

- a review of the **Mining Act**; recommendations in the September 2005 draft proposals have been considered here
- a review of the Titles group within DPIFM by Stanton Partners
- a larger Priorities Review within the NT Government in which BTRB was identified as one of the programs to be assessed for effectiveness and to examine future lower-cost options.

Some material, such as updates of Kirby’s (2004) graphs, were undertaken jointly by Titles and NTGS staff to assist both Stanton Partners and ACIL Tasman. This report was provided as background to ACIL Tasman and Ross Fardon and Associates to assist in their review. It focuses on progress made on the first element of BTRB (geoscientific data) in the first three years of the program (1 July 2003–mid March 2006), with lesser background material on the other elements largely condensed from the six-monthly reports; as such it is a snap-shot at mid-March 2006. Wherever possible, progress has been quantified and expressed in simple graphics. Extra supporting material, as requested by Ross Fardon and ACIL Tasman, has been included. This text is accompanied by spreadsheets that contain all the raw statistical data and graphs used herein.

### INDUSTRY OVERVIEW

The mining and petroleum sector is the major contributor to NT’s economy. In 2002/03, the total value of mineral products accounted for 13% of GSP. In 2004/05, this was over 20%; the second highest proportion of any jurisdiction in Australia. The mining industry directly employs more than 4000 Territorians. The Alcan Gove expansion will increase this by 1700 (Alcan Gove 2006). Mineral exploration expenditure in Australia has climbed each year since 2001/02 and is approaching the previous-best levels set in the mid to late 1990s (Figure 1). In contrast, expenditure in NT fell to $42.5M during 2003/04. This was redressed by a 30% increase to $55.6M in 2004/05. Western Australia is consistently the dominant state, receiving 59% of Australian mineral exploration spending in 2004/05. However, NT and Western Australia were almost identical in the relative increase in expenditure (30%) from 2003/04 to 2004/05; both are similar to the national average of 31%. Victoria was the only state to experience a decline in spending during 2004/05 (Australian Bureau of Statistics 2005, Huleatt and Jaques 2006).

The NT proportion of the Australian total rose slightly to about 6.0% from 2004/05 to 2005/06 but is little more than half the >10% levels set a decade ago (Figure 2). This situation is being addressed by actively marketing NT as an exploration destination in other states and overseas.

The current global resurgence in mineral exploration is partly driven by commodity prices that have risen to near-record or record levels. Oil has tripled in price since 2002. Uranium has climbed steadily since mid 2003 and gold since early 2001. Both had sharp increases in early to mid-2005. Copper, lead and zinc prices also climbed during 2005. NT expenditure on base metal exploration is relatively low, despite a world-class endowment of Pb-Zn-Ag and a diverse range of types of base metal deposits, such as McArthur River, Jervois, Redbank and Manbarrum, in a number of different geological provinces.

Federal intervention led to a uranium exploration boom resulting in over twenty companies becoming involved in NT. They join Cameco who has been the mainstay of uranium exploration in NT for several years, and ERA who operates the Ranger

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1 Several criteria in the Fraser reports have been reversed. In 2003/04, Fraser reported on the percent of respondents who considered that the jurisdictions’ geological database encouraged exploration investment, while in 2004/05 they used this factor as a deterrent to investment. Charted percentages, but not rankings, are thus reversed and the emphasis has changed. DPIFM puts more weight on the positive incentives than Fraser (2005), who charted the negatives to obtain their rank order. To compare relative rankings from different numbers of jurisdictions in different years, statistics need to be normalised. This was done by Trevena (2005), but not in the Fraser reports. Also, the Fraser report puts most emphasis on relative rankings rather than the absolute percentages of respondents. When the latter are considered, it is apparent that, although NT has fallen in some rankings relative to other jurisdictions, the perceptions about NT itself have not significantly changed in many cases.

2 Figures are from Australian Bureau of Statistics (ABS) Catalogue 8412.0 available on the ABS website.
Mine. As the pie charts (Figures 3 and 4) show, NT has about the same proportion of gold exploration as the rest of the world but has considerably more uranium exploration. Australia has approximately 30% of the world’s known uranium resources and NT may contain as much as 20% of the world’s potential total uranium. Uranium exports in the five years to mid 2005 were valued at over $2.1B (UIC 2006, World Nuclear Association 2005).

Global exploration trends for 2005 are discussed in Goulden (2006). Australian mineral exploration during 2005 has been summarised by Aegis (2005) and Huleatt and Jaques (2006), and NT exploration and mining highlights for 2004 and 2005 are summarised in Brescanini and Dunster (2005) and Dunster (2006), respectively.

The previous NT record mineral exploration expenditures set in the mid to late 1990s were largely by multinational companies. For the period from 1995/96 to 1997/98, these were, in rank order, Newmont, AngloGold Ashanti, Otter, Santexco, Ashton, Cameco, Rio Tinto, Sons of Gwalia, MIM, De Beers and BHPBilliton. Collectively, these companies were responsible for over $93M or 57% of the total exploration expenditure during that period. Seven of these companies no longer exist as such, or are no longer active in Australia. Currently, Newmont, Cameco and Tanami Exploration are the biggest spenders.

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Footnote: Australian Bureau of Statistics (ABS) figures for uranium exploration in NT are misleading and have not been used here. ABS report as “confidential” any expenditure where the company could be deduced. Since, until recently, Cameco were responsible for the bulk of uranium exploration expenditure, their expenditure is presumed to be under “confidential”.

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Figure 1. Annual private exploration expenditure on mineral (excluding petroleum) exploration over time in NT compared to Australia and other Australian States.

Figure 2. NT mineral exploration expenditure as a proportion of the Australian total.
on mineral exploration to date under BTRB and are responsible for about 40% of expenditure. Seven companies with world operating revenues in excess of a hundred million Australian dollars currently hold mineral exploration licences in the NT. Of these seven, BHPBilliton (GEMCO), Newmont, ERA and OM Holdings either have operating mines or projects in advanced feasibility stages in the NT. Of the others, Rio Tinto is largely focused on diamonds on de-facto titles and farm-outs, AngloGold Ashanti is not active and Mincor is a relatively new arrival. During the six months ending 31 December 2005, BHPBilliton, the largest diversified resource company of all, spent US$99 million on minerals exploration worldwide.

Expenditure on private onshore and offshore petroleum exploration in NT increased from previous near-20-year lows to $163.8M in 2004/05 (Figure 5). In 2003/04, expenditure in NT represented less than 4% of the Australian total. In 2004/05, it was over 12%, but still below the late 1980s figure of 30%. The relative increase from 2003/04 to 2004/05 was significantly greater in NT than any other state, and almost ten times the national average net change. As with minerals, Western Australia accounts for the bulk of Australian expenditure. However, in marked contrast to the NT, Western Australian petroleum expenditure decreased slightly in 2004/05. Petroleum permit work commitments in NT from 2005–2010 total 2230 km of seismic surveys and 25 wells for an estimated $55M.

Figure 3. Mineral exploration spending in NT by commodity during 2005. This is based on DPIFM data because ABS figures are misleading 3. It is still only an estimate because companies are not obliged to disclose their target commodity and many companies are exploring for multiple commodities in the same ground.

Figure 4. World mineral exploration expenditure in 2005 by commodity (from Metals Economics Group/PDAC).

Figure 5. Annual petroleum exploration expenditure over time in NT compared to Australia and other Australian states. NSW, Tasmania and SA have incomplete figures and have been omitted individually but are included in the Australian total.
NT PROSPECTIVITY RELATIVE TO OTHER MAINLAND STATES

More than 43% of NT’s landmass is prospective for minerals and could be explored using current technology. About 28% of the land area is prospective for petroleum. In addition, 50–60% of the offshore area administered by NT is prospective for petroleum and there is some offshore exploration for diamonds. About 50% of the land mass of Western Australia is prospective for minerals (Figure 6) and, in absolute square kilometres, Western Australia has more than double the prospective area of NT. NT has over a dozen geological provinces that extend into the adjacent states, and only half this number are confined entirely to the NT. However, relative proportions of the types and ages of geological provinces vary enormously between states. For example, Western Australia has a significantly greater endowment of highly-prospective Archaean terranes. Queensland has a higher percentage of Mesozoic basins than the NT and so has higher prospectivity for coal. NSW and Victoria lack the highly-prospective metalliferous Proterozoic basins present elsewhere. This dissimilarity in area and geology must be borne in mind when making any direct comparison between the NT and the states.

![Figure 6. Areas of each state prospective for minerals relative to the total area of the state.](image)

GOVERNMENT OPERATING ENVIRONMENT AND FUNDING

There were significant changes to the operating environment during BTRB with functions of the former Department of Business, Industry and Resource Development (DBIRD) being dispersed between the new Department of Business, Economic and Regional Development (DBERD) and the Department of Primary Industry, Fisheries and Mines (DPIFM). As part of this restructure, NTGS and Titles were placed within DPIFM and the IBIS team transferred to DBERD as part of the Regional and Indigenous Economic Development group. BTRB funds where also allocated to the Resource Development and Policy group within DPIFM as part of a move to better market the NT as an exploration and mining destination.

BTRB RESOURCE ALLOCATION AND NTGS BUDGET

One of the recommendations of the Winlaw (2004) report was for NTGS to receive rolling 5-year funding and not be dependant on the renewal of sporadic and variable initiative funding. This has not been implemented. At present, NTGS cannot differentiate between BTRB and baseline funding as all current work is taken to be under the auspices of BTRB. Under BTRB, NTGS receive $13 million over four years, including $2.2 million for promotional activities. The Titles group get $1 million and IBIS $1.2M. The marketing and promotion effort comes from the NTGS allocation even though staff are in another group within DPIFM. The operational portion of the NTGS budget has been declining in real terms since 2000/01, because of escalating EBA wage costs, the NTGS organisational restructure and because other expenses that were previously borne at corporate level are now being passed down to NTGS. The introduction of accrual accounting, specifically the effects of depreciation, the NT Government 2% efficiency dividend and IT outsourcing have all had an impact. NTEI had a large component of outsourced geophysics, hence the operating budget was relatively higher than BTRB with its more people-intensive programs.
NTGS PROJECTS

NTGS consulted with industry, the Minerals Council, other state surveys and Geoscience Australia (GA) in recommending projects to be funded under BTRB. This process will be revised, in view of the decision not to implement the Advisory Board as recommended by Winlaw (2004). The following sections describe progress and highlights of NTGS projects under BTRB to date, and refers to regions labelled in Figure 7.

Amadeus Basin

The Amadeus Basin covers a vast area of some 170 000 km², south and southwest of Alice Springs. The basin has existing producing hydrocarbon fields (Mereenie and Palm Valley) and historic gold and copper mines, as well as uranium deposits and evaporite prospects. Less than 30% of the basin is adequately explored. Exploration, particularly for petroleum, had stagnated for almost a decade prior to BTRB. Under BTRB, a multi-disciplinary initiative was designed to stimulate exploration by developing new genetic models and delineating the most-prospective host stratigraphy for possible accumulations of both hydrocarbons and minerals (base and precious metals and industrial minerals). Specific objectives were:

- determining basin thickness, the nature of the underlying basement and the timing of major fault activity
- interpreting basin and basement architecture
- analysing petroleum-style fluid histories
- developing new thermal models that document the tectono-stratigraphic evolution of the basin, to determine prospective fluid-flow conduits and potential hosts.

To date under BTRB, most emphasis has been on petroleum. Exploration has been assisted by the following activities and products directed towards determining the distribution, depth, thickness and juxtaposition of likely hydrocarbon source, seal and trap combinations:

- Over 8350 km of legacy seismic data was re-interpreted.
- Regional time-structure maps defining favourable anticlinal trends have been produced and new potential traps have been highlighted.
- A regional shot point base map has been derived, giving explorers better locations of previous work.
- A simulated hydrocarbon fluid flow model was produced. This model identifies a number of separate catchment areas and a number of highs within those catchment areas that would focus hydrocarbons, assuming suitable source, maturation and pathway conditions.
- A comprehensive report on the petroleum potential of the Amadeus Basin, entitled “Importance of fault seal and strategic assessment of future petroleum exploration potential of the Amadeus Basin” was released at the Central Australian Basins Symposium (CABS).
- A regional study of the architecture, and tectonic and structural history of the Amadeus Basin and its relationship to basement terranes was undertaken by specialist consultants. This work allows explorers for both base metals and hydrocarbons to better focus their efforts.
- An NTGS drilling program was designed to evaluate untested rock successions similar to known petroleum-bearing horizons elsewhere in the basin. The holes were designed to test the entire geological section of rocks ranging from mid-Neoproterozoic to Ordovician. These two deep stratigraphic drillholes (621 m and 1224 m), completed in 2005, provide geological control for future mineral and petroleum explorers. Key observations include intersections of potential oil/gas source rocks, as well as weak redbed-style copper mineralisation. The resulting drill core was placed on public display at DPIFM’s Darwin drill core facility from the end of October 2005. Geochemical and other analyses of selected intervals of core will be undertaken during 2006. Results should yield additional important ideas on the regional geology and the petroleum/mineral potential of this poorly explored region.
- Significant improvements have been made in the levels of petroleum exploration under BTRB, there are currently four granted petroleum exploration licences in the Amadeus Basin, with a commitment for five wells and the collection of over 1000 km of seismic data; there are also nine applications yet to be granted; collectively these cover more than 75% of the basin.

In addition,

- mineral exploration geochemical data capture has been completed and added to the Explorer 3 database, giving mineral explorers a GIS dataset to assist in desktop studies to focus mineral exploration.

Arunta Region

The Arunta Region is a complex basement inlier in central Australia, with Alice Springs providing the logistic hub. The Arunta has been a focus of activity for NTGS under BTRB, as the area is underexplored and large areas are obscured by surficial
Figure 7. Geological provinces of the NT.
cover. Major known prospects in the Arunta include copper-lead-zinc, gold, tin, tungsten, tantalum, mica, nickel, chromium and industrial minerals including abrasives. Past production is estimated at 2 Mt copper and 100 000 oz gold. The Arunta Region is subdivided into three, largely fault-bounded terranes, with distinct geological histories: the Aileron, Warumpi and Irindina provinces. The Aileron Province has untested gold-potential. Recognition by NTGS that the Warumpi Province is the metamorphosed equivalent of highly-prospective 1640 Ma Mount Isa, McArthur Basin and Broken Hill rocks that host world-class ore bodies is a major breakthrough in focusing exploration for base metals in the Arunta Region. The Irindina Province has only recently been recognised as a metamorphosed equivalent of Palaeozoic basins and NTGS has directed several projects into this highly-prospective, but almost entirely untested area. Under BTRB, known mineralisation has been studied in detail to generate exploration models. Prospects studied include:

- zinc-copper prospects in the eastern Arunta
- base metal and molybdenum deposits at Jervois
- Molyhil molybdenum prospect (including follow-up of some unexpectedly high gold values)
- Stokes Yard, Ulpuruta and Haasts Bluff base metal mineralisation
- Nolans Bore rare earth-phosphate-uranium deposit.

Exploration activity in the Arunta has suffered from a perceived lack of prospectivity, which largely stemmed from the lack of a coherent geological framework of this highly complex area. Under BTRB, NTGS has endeavoured to change this perception, through a campaign of geological mapping and geophysical studies, accompanied by large amounts of geochronology and geochemistry. Five 250k outcrop geology maps have been released, with a further four to be released within the next 2–3 months. Geophysical interpretation of nine 250k sheets has been completed, with five interpreted geology maps already released, and the remaining four to be released in the next few months. This provides explorers with the first maps depicting subcropping geology, which is obscured by sand cover over extensive areas of the western and northern Arunta. In June 2005, NTGS staff led a field trip for industry clients through the newly recognised and highly prospective Warumpi Province. With the completion of mapping in the western and northern Arunta, accompanied by renewed industry interest in these regions, NTGS commenced mapping of the eastern Arunta in 2005, and preliminary results are indicating the existence of numerous domains with differing histories, and high potentials for base metal and nickel mineralisation.

**Georgina Basin**

The Georgina Basin is a 330 000 km² erosional remnant of a series of originally interconnected central Australian intracratonic basins, including the Savory, Officer, Ngalia and Amadeus basins, which range in age from Neoproterozoic to Palaeozoic. The Georgina Basin covers most of the central-eastern NT and extends into Queensland. It is prospective for a number of commodities, principally lead-zinc, copper, phosphate, and petroleum, all of which are known to occur in sub-economic amounts. During the last 5 years, there was a burst of diamond exploration in the southern and western areas and most recently, activity has been focused on Mississippi Valley-style base metal mineralisation in the south. The aim of the program under BTRB is to develop a three-dimensional appreciation of the stratigraphy, structure and sedimentary facies of the southern and central parts of the Georgina Basin, leading to an improved understanding of the regional prospectivity. It follows on from a basin-study undertaken by consultants for NTGS in 2002. NTGS work on phosphate near the Alice Springs–Darwin railway was released at AGES 2005. Mapping of the Tobermorey, Sandover River, Avon Downs and Ranken 250k sheets has been completed and fully-attributed GIS datasets have either been released or are in the final stages of production. The Woodgreen 100k mapsheet was remapped to better understand the host rocks to known copper mineralisation. All this work is being incorporated into a 500k summary map of the southern Georgina Basin. A long-standing GIS compilation and accompanying report on the mineral and hydrocarbon potential of the southern Georgina Basin is nearing completion.

**McArthur Basin**

The Palaeo- to Mesoproterozoic McArthur Basin (1800–1500 Ma) is exposed over an area of about 180 000 km² in the northeastern NT. The McArthur Basin is amongst the most-prospective regions in Australia. It hosts the world-class McArthur River (HYC) lead-zinc-silver deposit and several smaller uranium and base metal deposits, as well as diamond-bearing kimberlite pipes at Merlin and Abner Range. The McArthur Basin has a history of >20 years of mining worth $3B and remaining resources are estimated to be worth $38B. It is partly equivalent to the Mount Isa Basin in Queensland which also hosts world-class mines, undeveloped ore bodies and ongoing new discoveries. The northern McArthur Basin is under-explored with a drilling density of 1% that of the Mount Isa area. Current research is directed at establishing linkages and elements in common between the two terranes. NTGS mapped the McArthur Basin during the late 1990s, concurrent with several major GA, academic and collaborative projects. Under BTRB, two major projects in the McArthur Basin are testing these previous models and seek to generate fresh insight into the three-dimensional mineralising systems. Results of the 2002 seismic imaging survey across the Batten Fault Zone near Borroloola were jointly released with GA during BTRB. By proving that the “Batten Trough” did not exist, this work fundamentally changed many base metal exploration models in this highly-prospective area. A major new collaborative project between
NTGS and the Predictive Mineral Discovery CRC (pmd*CRC) to investigate the three-dimensional geological structure and mineral systems of the southern McArthur Basin has commenced under BTRB. This forms part of the CRC’s 17 project “Multi-scale Analysis of the Mt Isa-McArthur Region and its Metallogenic Significance”. Work to date by NTGS includes the capture of 750 exploration drillhole collars across five 250k maps (Mount Young, Bauhinia Downs, Robinson River, Wallhallow, Mount Drummond), and the compilation and preliminary interpretation of geophysical data by pmd*CRC. The petroleum prospectivity of the Beetaloo Sub-basin has been addressed and there are currently three granted permits and two applications. The granted titles carry a commitment to a highly commendable 15 wells and almost 1000 line km of seismic, with work due to begin this year. This will be the first petroleum exploration seismic acquired in the McArthur Basin since 1991.

**Musgrave Province**

The Musgrave Province (formerly Musgrave Block) is an extensive Mesoproterozoic basement inlier in central Australia, in South Australia, Western Australia and the NT. It became a focus of exploration activity, largely for nickel, in the late 1990s. The South Australian portion of the province is currently being actively explored. Most of the NT portion is under exploration tenure, but the range of prospective commodities is not well understood and conceptual targeting is still in the early stages, so little on-ground work has been conducted to date. BTRB concluded work in the Musgrave Province undertaken during NTEI. Major accomplishments under BTRB included:

- 500k outcrop and interpreted geology maps
- report entitled “Geology of the Musgrave Block, NT”

**Ngalia Basin**

The Ngalia Basin is a 15 000 km², east–west-trending, intracratonic basin, located in central Australia. It is an underexplored greenfields basin, with potential for petroleum, particularly gas. It contains potentially economic uranium deposits, but other mineral targets remain largely untested. This basin was recently the target of a pegging rush by uranium explorers. The Lake Mackay, Mount Doreen and Napperby 250k maps cover the basin. Interpreted geology maps have been released under BTRB.

**Offshore hydrocarbon basins**

The offshore Bonaparte and northern Browse basins cover an area approaching one million square kilometres in the Timor Sea, and produce oil and gas that is important to the economy of the NT. NTGS and the Territory Government have generally worked hard to encourage and focus exploration and development. The NT offshore Bonaparte and Browse basins were showcased at the Timor Sea Symposium in June 2003. Publication of the symposium proceedings was underwritten by NTGS and the volume released as a special publication. In the 2.5 years since the symposium, technical success rates (i.e. wells with recovered hydrocarbons and/or log pay) in offshore basins rose from 25% to nearly 60%.

**Dunmarra Basin**

The Dunmarra Basin occupies the area between the highly-prospective McArther Basin and the Tennant Region. The unknown thickness and content of this basin have been a hindrance to explorers keen to look beneath it. A project is underway using drillhole and waterbore data, in conjunction with geophysics, to model the thickness of the basin.

**Ord Basin**

The Ord Basin straddles the NT–Western Australia border. Numerous copper and barite prospects and occurrences are known. Caves Prospect is the largest identified, with 2000 t of ore grading 2–20% copper. A summary of the geology, palaeontology and mineral prospectivity of the NT portion of the Ord Basin has been released on CD. This includes a digital version of the Limbuunya 250k explanatory notes.

**Pedirka Basin**

The Pedirka Basin underlies the Eromanga Basin in the southeastern border region between South Australia, Queensland and the Northern Territory; 60% of the basin is in the NT. It is prospective for coal and hydrocarbons, including possible in situ coal gas, but until recently, the petroleum potential of the area has been largely ignored by industry. A study aimed at invigorating exploration commenced in 2005 and is due for completion in 2007. Under BTRB, company interest in the basin has already increased; there have been exploration license applications for coal and there are currently two granted petroleum exploration permits and three applications. The petroleum titles carry a commitment to 1400 km of seismic and seven wells.
Pine Creek Orogen

The Pine Creek Orogen is a highly-prospective multi-commodity province in the northwestern NT. It is ideally situated with respect to infrastructure, including a port and railway. The Pine Creek Orogen is one of the more-mature NT provinces in terms of exploration. It hosts over a thousand mineral occurrences, contains about 20% of the world’s low-cost uranium resource and has significant potential for gold. Past production of gold is 4.5 Moz and known resources of 9 Moz remain. Considerable resources of lead-zinc-silver, platinum, palladium, tin-tantalum-tungsten, iron and various other commodities also exist in the Pine Creek Orogen. Current major operating mines include Toms Gully underground gold mine and Ranger, which is the world’s second largest uranium mine, accounting for 11% of world production. The Frances Creek iron ore project is at an advanced stage and there are several other multi-commodity prospects undergoing appraisal drilling, including the Browns polymetallic project. The program under BTRB aims to establish a new geological framework and regional correlations within the Pine Creek Orogen. Investigations are objective-oriented and are based on solving metallogenic, tectonic and stratigraphic problems, to highlight the base metal and polymetallic precious metal potential. The following investigations have been completed to date, or are currently underway:

- Revised interpretation of the stratigraphy.
- Revised geophysical interpretation.
- Ongoing structural reinterpretation of the Litchfield Province.
- 500k digital basement interpretation.
- Examination and documentation of the prospectivity of the Daly River Mineral Field.
- Digital capture of western Pine Creek geochemistry.
- Explanatory notes for the Noonamah 100k mapsheet and a fully attributed GIS of Mount Evelyn 250k mapsheet
- A collaborative project with academia to acquire ground gravity at Frances Creek iron ore field.
- A report on the tin-tantalum prospects.
- Analyses of quartz veins to ascertain the gold-potential of the western Pine Creek Orogen.

Tanami Region

The Palaeoproterozoic Tanami Region is an important gold-producing province that straddles the NT/Western Australia border. Despite its remoteness, the region has been the focus of gold exploration and mining since the 1890s. Past production is estimated at 5.5 Moz. It contains the economically important Callie and Granites-Tanami gold mines. Recently, most activity by major exploration and mining companies has been focused in Western Australia. The NT program under BTRB, involves regional mapping, geophysical interpretations and geochronology, and follows on from work under NTEI.

Work completed to date includes the following:

- Mapping of the Birrindudu, Tanami and The Granites 250k mapsheets, with maps in progress.
- Updated and expanded fully interactive 3D geological model released on the web.
- The Tanami Deep Seismic Project, in partnership with GA, GSWA, Newmont Australia and Tanami Gold, which acquired 720 line km of data during May–July 2005 at a cost of $1.2M. This was accompanied by a gravity survey by NTGS, which complements and tests the above 3D model. Interpretations of the combined dataset will fundamentally change interpretations of the area and public release of the seismic interpretation is scheduled for June 2006.
- A report on “Gold Minerals Systems of the Tanami Region”. A research paper has also been submitted to Mineralium Deposita.

Tennant Region

The Tennant Region (1870–1400 Ma) is a composite term that includes Warramunga basement and the unconformably overlying Palaeo- to Mesoproterozoic Davenport and Ashburton provinces. The Warramunga Province hosts major deposits of gold, copper and bismuth. Tin-tungsten, uranium, nickel, copper, lead and zinc occur in the Davenport Province, and manganese in the Ashburton Province. The region has a long history of mining with Tennant Creek as the hub. The area has high exploration potential for archetypical Tennant Creek-style ironstone-hosted gold deposits that have produced about 5.5 Moz historically. Chariot gold mine closed late in 2005. Estimated past production of silver is 1.8 Moz and copper is 400 000 t. There is renewed interest in the Rover Field (gold-copper), to the west of Tennant Creek, and the Bootu Creek manganese mine in the Ashburton Province, valued at $41.2M, is emerging as an export revenue earner. Work undertaken during BTRB includes the following:

- 500k outcrop and basement interpretation map.
- A major upgrade of the drilling data in NTGS databases with the addition of the locations of 6476 open-file drill collars. These represent the most important drilling programs undertaken in the area over the past 30 years. The spatial locations are linked to their corresponding Company Report numbers, to enable clients to source additional information. Downhole geochemical data from these and other closed-file drillholes, amounting to over 38 000 records, has also been captured.
NT-wide geological compilation

Work continues on a comprehensive publication providing an overview of the geology and mineral resources of NT. This will be similar to volumes available for other states.

Regolith-landscape framework

This project, in partnership with CRC LEME, was conceived and completed under BTRB. It was designed to establish a regolith-landforms map of the NT, supported by the characterisation of the regolith present, suitable for addressing the diverse needs of minerals exploration and land management.

The two main products below were released at AGES 2006.

- 1:2.5 million-scale “Regolith Map of the Northern Territory” this complements similar-scaled maps of geology, magnetics, radiometrics, gravity and elevation/relief.
- The publication “Atlas of Regolith Materials of the Northern Territory”. This photographic archive of regolith types in the Territory was captured during the field component of the project. It provides explorers with a very useful tool in the identification and analysis of regolith types that commonly hamper effective exploration in NT. It is comparable to smaller-scale products generated under a company-sponsored project in Queensland, but the NT version is available digitally to clients free of charge.

These products will be accompanied by a full GIS package.

NTGS DATABASES

NTGS database system

NTGS has played a key role in developing a holistic corporate database policy that will ensure whole-of-government compatibility and significantly enhance the management of, and access to geoscientific data and hence support NTGS’ objectives. Explorers already expect to be able to “drill down” through multiple layers of Government data in their area of interest in the hope of finding previously unknown correlations and anomalies that might be pathfinders to a new discovery. This will be more easily achieved once the present disparate databases are linked. The first phase of the process involves the conversion of one existing MS Access database of geochemistry and drillhole collars and the creation of a spatial database for a 250k geological map sheet.

IRMS (Industry Reports Management System)

The mineral component of IRMS is the database index of statutory reports under the Mining Act received from mineral exploration and mining companies. These reports go back to the 1950s and constitute a critical reference for explorers to ascertain what previous work has already been done in an area. IRMS is also used by NTGS in project scoping, to source data for exploration geochemical, mineral occurrence and drillhole data capture. IRMS is a complex, fully-searchable, database that internally contains hot links to the associated data and abstracts of the reports. There are currently (19/02/2006) 13,263 open-file reports and 3801 closed file reports in IRMS; 685 new records were added in 2004 and 892 in 2005 (Figure 8). An audit of IRMS in 2004 indicated that 6000–7000 existing records were in need of a significant upgrade. Over 500 legacy reports, some dating back several decades, were released to open-file during BTRB. During 2005, over 900 records were substantially upgraded by the inclusion of subject keywords, drilling and geochemical information, locations and abstracts. Over 50% of the database was amended to a lesser extent using batch modification techniques to correct errors in searchable fields such as designated keywords, assigned map sheet locations and authors’ names. An ongoing project to index a collection of reports, field and environmental plans from the former Mines and Energy has resulted in the addition of 102 new records in IRMS. Scanning of exploration company reports has been ongoing for the last six years and 1210 reports have been scanned to date under BTRB. To date, 89% of all open-file records are available in digital format.

The petroleum component of IRMS is an index to the industry reports and data submitted under the Commonwealth Petroleum (Submerged Lands) Act 1967 and the Petroleum Act. As of 19/02/2006, it contains 2188 open-file, 1060 closed-file and 360 other confidential records. Typically, about 150 records are added annually (Figure 9). A contractor undertook a major update of onshore drilling records in 2000 and a stocktake and data audit was begun in 2005. This has already identified duplicates, items that were not included in IRMS, and inaccurate or incomplete database records. This database needs a complete overhaul because the multiple data types in early reports have not been separated, making it difficult to find specific information. The front-end of IRMS petroleum was redesigned in 2005, to make it more useful and to remove redundant fields.
MODAT

MODAT is a database inventory of, and location data for, mineral occurrences, prospects and mines in NT. Such a database is a cornerstone of company exploration and has been maintained by NTGS, in various forms across different platforms, since 1987. In its present configuration, it has over 40 searchable fields and contains 2836 entries (20/02/2006). Since July 2003, about 50 records have been added or updated annually. The user-interface has been updated recently. MODAT is released on CD several times a year.

COREDAT

The COREDAT database functions as a catalogue to the material stored in NTGS Core Libraries. The database also contains information such as drillhole depths and locations. It currently (20/02/2006) contains 3899 records. An audit in 2004 determined that there were a large number of records with no drillhole coordinates. A contractor was employed to update the database. This project involved cross-referencing COREDAT records with MODAT and Explorer 3, and sourcing relevant information from exploration company reports. Over 1000 records were updated and 80 duplicate/incorrect records were removed from COREDAT. An additional benefit of this project has been to cull unwanted drill core from the core repositories.

Explorer 3

Explorer 3 is the database compilation of all the drilling, downhole and surface geochemical information captured from mineral industry company reports and from NTGS surveys. It uses templates developed for the Australian exploration industry and
currently (21/02/2006) contains assays of 344 496 located samples. Of these, there are in excess of 100 000 each of drillhole collars, stream sediment and soil samples with fewer rock chips and whole rock analyses. Explorer 3 is updated sporadically as batches of new exploration data are captured (see Figure 10, note the log scale). In addition, during BTRB there have been several major projects employing contractors to capture legacy data. Recent emphasis has been placed on the surface samples and drillholes in the Amadeus Basin, and Pine Creek Orogen and drillhole data from the Tennant Creek Region and McArthur Basin (Figure 11). Open-file data are fully attributed and are released in industry-standard formats via CD and the website (STRIKE).

Organic geochemistry, biostratigraphy and reservoir-facies data for petroleum wells

The GA National Petroleum Wells Database was designed in collaboration with the Australian Petroleum Research Centre and is maintained and weberved by GA. Capture of basic data for NT onshore wells was funded by NTGS in 2004.

NTGS CLIENT SERVICE

Minerals and Energy Information Centre (MEIC)

As part of the MEIC, NTGS maintains technical libraries in both Alice Springs and Darwin. Facilities are available to external clients, DPIFM and other Government groups. There were 1041 loan or copy transactions in the Darwin MEIC during 2005. MEIC staff field client enquiries that range from simple over-the-counter questions from the general public to company requests for complex datasets that may require many man-hours of preparation for distribution. Figure 12 shows the increasing total number of client enquiries to the MEIC during BTRB and the proportions of different types of clients are shown in Figure 13. Just over half the requests during the second half of 2005 were from industry. It excludes downloads from the website. Average customers satisfaction ratings based on independent client surveys commissioned as part of DBIRD Reporting on Outcomes are shown below (Table 2). These surveys have now been discontinued.

Core libraries

Under the Mining Act, Petroleum Act and various other legislation, exploration companies are required to deposit cores with DPIFM. NTGS selects those it considers of value for submission to Government core libraries. Core and samples also come from stratigraphic drilling undertaken by NTGS, from government drilling by the former Mines Branch, and from water bores. These drill core and samples are held by NTGS Core Libraries in Darwin and Alice Springs. There were 193 visitors to these facilities in fiscal 2004–05.

NTGS PRODUCTS

Introduction

Historically, NTGS products have been thought of as hardcopy geological maps of outcrop with accompanying explanatory notes. Map products are still important but have been transformed into much more useful, seamless, multi-thematic, interpretative digital information. Although NTGS has a long history of acquisition of pre-competitive geophysical information, it has only

![Figure 10](A06-129.ai)

Figure 10. Records entered in Explorer 3 annually, note the logarithmic scale.
been under initiative funding that this has been of sufficient quality and quantity to attract major exploration efforts. As an incentive to clients, NTGS products are available free of charge or, at most, incur a copying charge. There has been a demonstrable growth in demand for NTGS products since the inception of BTRB and each successive year since.

Map products

NTGS has always maintained a high cartographic standard in the maps it produces. In 1991, it was awarded the PICA Gold Award for conventionally printed maps. In 2002, the Urapunga 250k was awarded the Corporate Montage Grand Prize and was highly commended in the MSIA

Figure 11. Comparison of number of drillholes in Explorer 3 database in March 2004 and December 2005. Note that considerable work remains to achieve a reasonable level of NT-wide coverage.

Figure 12. Number of enquiries received by the MEIC.

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<tr>
<th>Performance Measure</th>
<th>2003–04</th>
<th>2004–05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality – customer satisfaction</td>
<td>89%</td>
<td>88%</td>
</tr>
<tr>
<td>Quality – cartographic products to national standards</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Timeliness – customer satisfaction</td>
<td>92%</td>
<td>89%</td>
</tr>
</tbody>
</table>

Table 2. NTGS performance measures from DBIRD 2004-2005 Annual Report
awards. In 2006, updated and more-rigid NTGS cartographic standards were introduced to maintain best-practice and ensure consistency is maintained in the face of higher demand.

Mapping has been integrated with, and is now augmented by, other NTGS activities such as targeted geophysical and geochemical surveys, stratigraphic drilling and geochronological studies. Field work in the northern half of the Territory will always be dependant on the seasonal weather and most mapping there will necessitate a minimum of two field seasons. However, cartographic processes have been improved, enabling the field data to be captured in a matter of weeks or months rather than years.

Before BTRB, including NTEI, the average time taken to collect the data in the field, undertake the cartography and produce a conventional geological map (250k or 100k) and accompanying explanatory notes was 6.0 years. Under BTRB, this has decreased to 4.8 years. This average includes a number of legacy mapping projects began before BTRB and others delayed by loss of staff. Much more significantly, however, NTGS has moved away from traditional methods of blanket field mapping, conventional cartography and publishing. The emphasis is now to be more focussed and selective in what is mapped and in what detail. The end-products are seamless all-digital maps that can be integrated with other packages in a GIS. This is a deliberate move away from the strictures of framed one-dimensional rectangles of surface outcrop that have been the stock-in-trade geological maps produced all over the world for 180 years. The new generation of products can be digitally manipulated, updated as needed, distributed electronically or printed on demand. On average, 1.9 new map products were released annually pre-1999. Under NTEI, this rose to an average of 17.5/yr with a peak of 41 products released in 2001 (Figure 14). Currently under BTRB, NTGS is averaging 12.5/yr.

As of 01/02/2006, 16 fully attributed datasets corresponding to the 250k and 100k map tiles were available on CD or over the web. Digital maps in .pdf format are available on a single DVD as DIP-004. Originally, this contained 61 maps when released in March 2002; but as of January 2006, 178 maps (including all GA maps) were available digitally. There were 30 requests for DIP-004 from 10/08/2005 to 17/02/2006. This equates to the distribution of 2064 digital maps. Over the same period, there were an additional 129 individual digital map products and 548 hard copy maps distributed in response to client requests.

Initiative funding has allowed the introduction of new thematic maps, such as the Interpreted Geology Series. As the name implies, they include a combination of geological and geophysical interpretation, which is much more useful to exploration companies than conventional surface maps.

Figures 15 and 16 compare the status of 250k GIS map products in 2004 and 2006. In two years, seven maps have been graphically attributed and six fully attributed. At present, a further 16 sheets are in various stages of field work, data capture or attribution.

**Digital information packages**

This type of product was introduced under NTEI to distribute raw and interpreted geochemical survey data (acquired by NTGS or from company reports), MODAT, IRMS, GIS packages and other digital products that may be sporadically or regularly updated. The CD version of MODAT and IRMS are updated several times a year and the webserved versions are updated at a maximum of monthly and weekly respectively. In September 2003, under BTRB, diamond databases (DIM and DMC) that document diamond and indicator mineral occurrences and indicator mineral geochemistry were first released. An April 2005
update has since been added to cater to on-going industry interest in diamonds in NT. To 17/02/2006, there have been 202 copies of these diamond databases distributed in response to client requests.

NTGS mineral publications and reports

NTGS reports and records dealing with minerals released to date under BTRB include:

1. geology of the highly prospective Musgrave Province
2. digital version of 2001 commodity reviews of iron ore, manganese and bauxite,
3. gold systems of the Tanami Region
4. a comprehensive review of tin-tantalum mineralisation in NT
5. rare-earth mineralisation in the Arunta Region.

Petroleum publications and reports

In the interval from 1990 to 1998, NTGS only produced two external petroleum publications. Since then, there have been 29. This has been achieved by one or two staff and by using occasional contractors. Under BTRB, NTGS have produced over a dozen papers and nine data CDs dealing with the petroleum prospectivity of NT.

Geophysical surveys

NTGS was the first Australian State or Territory survey to acquire, process, interpret and repackage pre-competitive airborne geophysical data for the mineral exploration industry. NTGS has undertaken some of the largest surveys of their time (Figure 17) and it has endeavoured to remain amongst the leading Geological Surveys in this field. Large airborne geophysical surveys (total magnetic intensity and radiometrics) were key elements of NTEI and have been well-accepted by industry with several companies citing them as one of the main reasons they took up exploration licences (eg Elkedra Diamonds quoted in Dugmore and Fardon 2003) and chose targets (AusQuest 2006). Targeted gravity surveys were also undertaken under NTEI; some were in collaboration with industry, GA and/or academia, others were in sole-funded in support of NTGS mapping projects. Some pre-existing open-range company data and data acquired by GA were also reprocessed to a better standard and re-released. Under NTEI from 1999 to 2002, 1,745,608 line km or 557,248 km$^2$ were acquired at a cost of $6,961,153 or an average of $3.99/line km. During BTRB, five airborne combined magnetic and radiometric surveys, covering a total of 101,950 km$^2$, were completed and released in 2004. In 2003, an airborne gravity survey was flown in West Arnhemland, mainly funded by Cameco and Rio Tinto with additional support from NTGS and GA. An on-ground gravity survey, undertaken at Birrindudu, was released last year. Turn-around time from

![Figure 14. Number of map products released annually, note the logarithmic scale.](image-url)

1. geology of the highly prospective Musgrave Province
2. digital version of 2001 commodity reviews of iron ore, manganese and bauxite,
3. gold systems of the Tanami Region
4. a comprehensive review of tin-tantalum mineralisation in NT
5. rare-earth mineralisation in the Arunta Region.
completion of acquisition, through processing to client-delivery is usually a matter of months. The majority of these data are already being webservsed to clients, indeed NTGS was the first Australian survey to webservse preliminary images. All final products will be available by the end of BTRB. By the end of BTRB, NTGS will have excellent territory-wide stitches of its geophysical and elevation data. In particular, the quality of the uranium stitch, obviously of use to uranium explorers, is superior to that of any other State.
Product demand

The number of geoscientific products NTGS generates has increased under initiative funding; as has the demand for those products. As Figure 18 shows, the overall demand for government geoscientific products distributed by the MEIC in 2005 is significantly greater than the previous year. The number of exploration company reports distributed has climbed sequentially since records stated in January 2004. The last half of 2005 was over three times that of the first half of 2004.

WEBSITE

Web delivery of products and user-interactive information was considered a priority under BTRB. The Minerals and Energy and NTGS websites were completely redesigned and moved into an Oracle database content management system. New tools...
and delivery systems have been introduced. The website has been continuously maintained and regularly updated by a full-time NTGS staff member dedicated to the task. Website statistics are being monitored using NetTracker software via Department of Corporate and Information Services.

STRIKE

On 13 May 2004, the Department’s new geoscience web mapping system STRIKE (Spatial Territory Resource Information Kit for Exploration) was launched. At the time of launch, there were 38 individual layers of data. There are currently in excess of 50 layers of data. Figure 19 shows the number of hits registered over six-monthly intervals.

Geophysics image webserver (GIWS) and geophysical standards and formats

GIWS was introduced under NTEI to enable clients to view, manipulate and download geophysical images of NT. In May 2005, GIWS was significantly upgraded, providing clients with more features delivering interactive capability through their web browsers. During the last half of 2005, GIWS was reconfigured to act as a fully-functional web mapping service which obviates the need for special plug-ins and made GIWS compliant with standards promoted by the Open Geospatial Consortium. After
considerable effort under BTRB, NTGS geophysical data are now fully compatible with, or exceed, the GA standard for GADDS (Geophysical Archive Data Delivery System), bringing it up to the Australian best-practice benchmark. It enables GA to web-serve NTGS data as part of the Australia-wide data set. NTGS geophysical data are also now in a format that will be suitable for the next generation of data delivery (XML) and, in this respect, NTGS is ahead of any other state and even GA.

TITLES

The Titles group received funding under BTRB. Titles are currently being independently reviewed by Stanton Partners and material from the Stanton report is not reproduced here.

Mineral titles

Of the 848 mineral titleholders (granted and applications, mining and exploration and including extractives) at 16/02/2006, 461 were individuals and 387 were companies. Most geological provinces have a healthy mix of small, medium-tier and multinational companies. GBS Gold has recently acquired many titles in the Pine Creek Orogen and the Tanami Region is dominated by Tanami Gold and Newmont, but there are no real monopolies. Twelve of the leaseholder companies in NT are Aboriginal corporations. The majority of Exploration Licences (ELs) are held by companies, whereas most of the Mineral Claims (MCs) and many of Mining Leases (MLs) are held by private individuals. About half of the mining tenements are historic and languishing with minimal or no activity. There are hundreds of ungranted ML and MC applications that have not been actioned since the grant of Kakadu National Park. Only 102 new MLs have been granted since the commencement of the Mining Act in 1982. In contrast, the number of exploration licences granted has almost trebled since 1999/2000. On 30 June 2000, there were 285 granted ELs; as of 30 June 2005, there were 773.

The total number of granted exploration licences (ELs, SELs and ERLs) at years-end began to increase in 2001. It peaked at near record levels in 2003 and has remained reasonably steady through to 2005 (Figure 20).

The total number of titles of all types (including MCs and MLs) declined from 1994 to 2000, but has remained at a very stable level since. The present level probably represents the steady-state balance between industry activity (land wanted), land available and tenement size. Figure 21 contains a significant number of stagnant mining titles and mining title applications.

Increase in Exploration Licence applications

There was a significant increase in the number of Exploration Licence (EL) applications for minerals received during calendar 2005 (Figure 23). In 2005, there were 365 new mineral exploration applications compared with 197 in 2004; an increase of
As of the end of 2004/05, there were 21,405 Processing of applications on Aboriginal land been specifically addressed in the review of the Mining Act. Over 2004/05 fiscal, there were 79 applications on Aboriginal land and 153 on non-Aboriginal land.

**Turnover of ground**

Under the NT Mining Act, explorers are required to relinquish 50% of each EL annually starting in year two. The Act also allows for waivers of reduction at the Government’s discretion. Such waivers have been granted almost routinely, especially in the first few years of a tenement. The graphs show the proportion relinquished or surrendered in each of NT’s most-prospective provinces by fiscal year and by province. Over 5 years, the amount of ground freed-up from ELs is significantly greater in the Arunta Region (2.94%) than Pine Creek (only 0.64%); the largest proportion dropped in any year in any province was 9.73% 2003/04 in the South Nicholson. Such criteria are somewhat misleading in that they don’t take into account the perceived prospectivity of the ground (if it is immediately repegged by others) or the amount of work undertaken on the relinquished/surrendered ground. There was very little land released from ELs in 2001/02 and 2002/03 (Figure 24). The on-going lack of turnover of ground in proportion to statutory requirements and new grants, especially in more-prospective terranes, such as Pine Creek (Figure 25), remains an impediment to effective exploration of NT. Difficulties in accessing land because of Native Title and the low level of activity prior to the present boom had necessitated a lenient attitude towards waivers of reduction. The situation is now being addressed and this is clearly demonstrated in the sequential series of maps from 2000/01 to 2004/05 (Figure 26). These maps show that the turnover of ground is increasing and that this is now happening across all the prospective provinces. However, there is still considerable scope for improvement. This has been specifically addressed in the review of the Mining Act.

**Processing of applications on Aboriginal land**

As of the end of 2004/05, there were 21,405 km² of Aboriginal freehold land (ie land subject to the ALRA) granted for mineral exploration. This compares with 74,645 km² on non-Aboriginal land. There is no significant difference between the

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**Figure 21.** Total number of mining and exploration titles at year-end through time.

**Figure 22.** Minerals titles status within each of the most-prospective provinces.

**Figure 23.** Recent increase in the number of EL applications received per year.
size of applications or granted licences on Aboriginal vs non-Aboriginal land, but geological provinces vary enormously in the amount of Aboriginal land they contain. The Tanami Region is almost all Aboriginal land whereas less than half of the Victoria/Birrindudu Basin is Aboriginal freehold land.

The grant of exploration licences on pastoral lease (native title affected land) is now relatively routine and very few objections to the grant are experienced. However, as shown in Figure 24, the number of grants of exploration licences on Aboriginal land is still a cause for concern. As of 31/01/06, there were 325 outstanding applications on Aboriginal land, which include 229 in the negotiating process, 58 pending grant of Deed and 38 awaiting proposals to Land Councils. There are 152 in moratorium and 53 new applications pending. These numbers have fluctuated over the years but have not significantly improved. This issue is being addressed at several levels within Titles and by the Stanton Review. It will be assisted by suggestions in the Mining Act review and recent revisions to ALRA legislation, but significant improvements will probably only be achieved by fundamental changes at higher Government levels and within the Land Councils.

Onshore petroleum

In the six-year period from 1997/98 to 2003/04, there were ten applications for onshore exploration permits. Two were granted, two withdrawn, two renewed and three surrendered. Under BTRB to time of writing (13/03/2006), there were 258 applications. The present rate of grant per year is more than double that prior to BTRB.

INDIGENOUS LIAISON AND KNOWLEDGE BUILDING PROGRAMS

The Indigenous Business and Industry Services (IBIS) Division of DBERD, formerly the Indigenous and Mining Industry Services Branch of BIRD, has continued its knowledge-building programs throughout the Territory under BTRB. Routine work included assisting traditional owners and indigenous companies, co-ordination of workshops to formulate new perspectives and partnerships, community visits, land access support for NTGS, formulation of resource kits to assist mining and petroleum companies and participation in the Indigenous Mining and Enterprise Task Force (IMETF). Recent examples of specific tasks include involvement with the traditional owners of the Bootu Creek manganese mine site and assistance to North Barkly Indigenous Development Pty Ltd. DPIFM and DBERD have worked together to foster better relations with the Land Councils.

MARKETING AND PROMOTION

Active marketing of NT’s exploration potential and of the government services available to support exploration and mining was a key element of BTRB. Funds were allocated to the Resource Development and Policy group within DPIFM and a full-time staff member was dedicated to the role.

Figure 26. A series of maps showing newly granted ELs and the amount surrendered or relinquished in each of the major geological provinces; the increasing amount of red through time shows proportionally more ground being freed-up for turnover.

Advertising, editorials and press releases

The STRIKE website has been advertised on the Miningnews.net website and the number of click-throughs in six month period began at 263 for January – June 2004, peaked at 3086 for July – December 2004 and was 2278 for July – December 2005. Conventional advertisements for STRIKE, Top End Secret and the AGES conference have also appeared in various
industry trade journals including Paydirt, Gold Mining Journal, Mining Chronicle and AIG News and also in the Inflight magazine. Journals and newspapers were targeted for editorials and press releases. There were 22 such articles released during 2005, including seven press releases by the Minister.

Top End Secret

The Top End Secret Campaign was developed to promote BTRB. The objective of the campaign was to generate more exploration and mining business by promoting NT:

- as a competitive destination for exploration, mining and investment
- NT Government services and resources offered by:
  - NT Geological Survey
  - Minerals and Petroleum Titles
  - Indigenous Business and Industry Services
  - Resource Development and Policy.

The Top End Secret Roadshow was designed as a high-profile, high-level “doorknock” presentation of Top End Secret marketing material. It was conducted in partnership with KPMG, Clayton Utz, AMEC, Australian Gold Council and Minter Ellison. Minister Vatskalis led the delegation and made himself available for one-on-one discussions with clients. The Roadshow was presented in Brisbane, Sydney, Perth – April 2005 and Adelaide, Melbourne – November 2005. It afforded the opportunity to engage with over 800 decision-makers from Australia’s exploration sector including exploration, mining, banking, finance and investment executives. Feedback from the Top End Campaign and Roadshow is being monitored. For example, 35% of the MEIC enquiries April to June 2005 were from Roadshow participants and 29% of the new applications for Exploration Licences over the same three months were also from participants. In February 2006, the Top End Secret Roadshow won the DPIFM Star award for outstanding contributions in assisting the Department meet Government priorities.

NT Investment Alert

The NT Investment Alert was developed in September 2005 to maintain contact with Roadshow participants, build relationships and develop new business. It is an email ‘alert’, sent every 6–8 weeks, to in excess of 500 clients, with the following objectives:

![Figure 27. Comparative areas of Aboriginal land in the most-prospective geological provinces.](image)

![Figure 28. Mineral exploration licences granted on Aboriginal vs non-Aboriginal land by fiscal year. Mabo Number 2 decision was handed down in 1992 and the Native Title Act came into force on 1 January 1994. The most significant changes reflected above were the Wik High Court decision in December 1996 and the introduction of Right to Negotiate in late 2000.](image)
• promote investment and exploration opportunities
• promote government services to exploration and mining
• send key messages to challenge current negative perceptions eg. land access
• provide NT industry success stories.

The alerts have generated proactive web hits from around a third of participants with most interest in “NT Junior Explorers Update” and “Undeveloped Mineral Deposits”. Notably, “Land Access Developments” was amongst those listings with the fewest hits.

**NTGS update email subscription**

A new service to promote NTGS products was launched in December 2005. The quarterly and ad hoc email service is managed through automated listserv software and concentrates on listing new products and promoting events such as AGES. There are currently (19/02/2006) 250 subscribers.

**Conferences and trade show participation**

NTGS and other associated NT government groups attend selected national and international conferences and actively market using booths and plenary presentations. NTGS appearances at both minerals and petroleum conferences are summarised in [Table 3](#).

**Annual Geoscience Exploration Seminar (AGES)**

AGES is an annual conference convened by NTGS and held in Alice Springs. As well as presenting NTGS results to industry, presentations are invited from selected industry representatives, other NT Government groups, GA, academia, Land Councils and other stakeholders. Attendance has remained high during BTRB ([Figure 29](#)). In 2006, it was combined with the Mining Services Expo organised by DBERD and attracted 160 external delegates, a considerable increase on the previous year.

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<thead>
<tr>
<th>Year</th>
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<tr>
<td>2003</td>
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<td>2005</td>
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*Table 3. Number of conferences attended under BTRB.*

**Central Australian Basins Seminar (CABS)**

The Central Australian Basins Symposium (CABS) was convened by NTGS in Alice Springs 16–18 August 2005. It attracted over 100 geoscientists, both international and domestic. The symposium was underwritten and sponsored by NTGS and covered a wide range of petroleum and minerals exploration topics. NTGS staff contributed 15 out of a total of 52 papers (including 3 keynote addresses). Nine of the papers were by NTGS petroleum staff. A published volume of abstracts was distributed at the conference and a special publication will be released in 2007.

**CONCLUSION**

Exploration activity, for both minerals and petroleum, has increased under BTRB to date. NTGS must continue to deliver and market world-class pre-competitive geoscientific data to retain its reputation relative to other jurisdictions. Indigenous engagement and Titles processes have improved, but access to Aboriginal land remains an impediment to onshore petroleum and minerals exploration and this needs to be addressed at a higher level than possible under the scope of BTRB.

![Figure 29. Number of external delegates attending AGES.](image-url)
ACKNOWLEDGEMENTS

Thanks to all those DPIFM staff who were harassed for facts, figures and maps; to Jenny Saunders for research; Peter Stoner for titles information and the land access maps. Tracey Rogers and Ian Scrimgeour proof-read the manuscript. Tony Jelusic prepared figures and formatted the text.

REFERENCES