

AUSTRALIAN NATIONAL SEISMIC IMAGING RESOURCE

ANNUAL REPORT FOR 1996/97¹

Summary of Achievements [18.2a]

Contracts for establishing the Facility were signed by DIST, AGSO and ANU on 19 June, 1997. This was close to the end of the Financial Year, and consequently very little action followed in this reporting period (to 30 June). The Executive Director of AGSO, Dr Neil Williams, and the Director of the Research School of Earth Sciences at the ANU, Professor David Green, met with the Interim Director and Interim Deputy Director to consider membership of the Board of Management of the Facility. Potential Board Members will be approached with a view to formulating the Board in the early part of 1997/98.

Establishment of the Facility has begun along the lines set out in the agreement with DIST. Construction began on the first batch of 30 stand-alone seismic data loggers at the ANU. AGSO conducted a market study of available seismic reflection recording equipment and vibratory seismic sources prior to setting tender specifications once the Facility contracts were signed.

Planning is also at an advanced stage on several projects that will use either new Facility equipment, or equipment borrowed from elsewhere and drawing on the expertise being assembled in the Facility. A tomography program is planned for the Rabaul Caldera in Papua New Guinea, and agreements are in place with Professor Chris Powell's Tectonics Special Research Centre at the University of Western Australia for a study of the Hamersley Basin in the remote northwest using existing equipment at AGSO. The Australian Geodynamics Cooperative Research Centre has indicated that it requires a scientific program based near the emerging copper-gold province in central New South Wales. In these three projects, field experiments will be undertaken in 1997/98, and therefore no results were available during the reporting period. However, early indications are that these projects will provide a springboard into a successful start to ANSIR's scientific program in 1997/98.

Research Undertaken [18.2b]

No research results are available at the end of the reporting period. The following research projects are planned:

1. The Papua New Guinea city of Rabaul was destroyed by the eruption of a volcano in 1994. Much of the seismological monitoring network that formed a critical part of the early warning system for volcanic eruptions was put out of action. In retrospect, more accurate information on earthquakes associated with magma ascent prior to the eruption would

¹ The components of ANSIR Annual Reports are set out in the Commonwealth Agreement. Numbers in square brackets against section headings indicate the clauses in the Commonwealth Agreement which define the requirement for this section.

have been possible if accurate models of the distribution of seismic velocities under the volcano had been available. The seismological network is being replaced by AusAid, and a project is proposed that will conduct a seismic tomography experiment using Facility instruments to build a three dimensional velocity model of the region. During the project, seismic energy from earthquakes and carefully placed and timed explosions will be recorded using Facility instruments. Australian researchers participating in the project will be funded by AusAid. The project has established international links, with researchers from Hokkaido University in Japan and the University of Wisconsin in the United States now participating.

2. The Australian Geodynamics Cooperative Research Centre has active research programs underway in Broken Hill and central New South Wales.
 - With the major mineral lodes at Broken Hill almost exhausted after many decades of mining, the rush is on to find more ore bodies. Broken Hill city is a major regional centre, and if its livelihood is lost social disruption will occur throughout much of western New South Wales. The lead and zinc smelters which comprise the main industry in the city of Port Pirie will also be without feed stock, with subsequent financial and social disruption in South Australia as well. Metallogenic models form the basis of exploration strategies applied by mining companies. The models which seek to describe how the Broken Hill silver, lead and zinc ores formed predict the presence in the Earth's crust of mafic rocks. Hence one test of these models would be whether rocks with high seismic velocities are present. This can be measured by seismic refraction profiling.
 - Central New South Wales is emerging as a major copper gold province, with a number of major deposits lying in a corridor oriented approximately east-west, orthogonal to the overall north-south regional geological trend. Geological mapping has indicated that the region was first subjected to north-south shortening, which may have emplaced the primary east-west structure, and then regional east-west shortening, which emplaced the regional north-south geological grain. Seismic refraction profiling should indicate whether crust to the north and south of the corridor has fundamentally different properties, confirming whether the east-west corridor is real rather than apparent, and the tectonic history of shortening in north-south and then east-west directions can be tested by seismic reflection profiling.
3. The Tectonics Special Research Centre at the University of Western Australia, headed by Professor Chris Powell, is studying the evolution of the Hamersley Basin in the northwest of Western Australia. The study is directly relevant to the iron ore mining companies active in the region, because it seeks to test a new model for the formation of the iron ore deposits in the basin. It also has international significance, because the Hamersley Basin formed at the end of the Archaean period of geological time. The Archaean is thought by some to have had geological processes that acted on different spatial and temporal scales to present-day processes. It is also a period when many of the world's greatest gold and nickel provinces were formed. However, many of the geological processes interpreted in the rocks of the Hamersley Basin are more consistent with those of today than those inferred elsewhere for the Late Archaean. This study will therefore provide fundamental information on Archaean tectonics. The Facility has been asked to record a regional seismic reflection transect of the eastern part of the basin in order to constrain structural models of the basin at depth. The Facility will provide data acquisition services, and specialist geophysical expertise for the data processing and interpretation phases.

4. Many millions of dollars in building permits are being delayed along Australia's eastern seaboard because of concerns that the ground water is acidic. Acidic ground water corrodes concrete building foundations and sewerage and water pipes. Geologists at the Australian Geological Survey Organisation studying coastal zone processes have developed a geological model which predicts whether ground water will be acidic, based on a knowledge of the distribution of ancient coastal sand dune systems. A series of trials of super-high resolution seismic equipment (source frequencies to 500 Hz) was made on the Gold Coast in Queensland during the 1996/97 year to test whether seismic reflection profiling could map old sand dunes. Vibra-core drilling was then used to test the seismic sections. Following the technical success of these trials, a funding bid was made to AGSO to purchase equipment for super-high resolution seismic reflection profiling equipment for use in ground water studies. If the funding bid is successful, this equipment will be added to the ANSIR equipment pool. The equipment would also be useful for ground water salinity studies, eg., in the Murray Basin, for regolith studies, and mine site studies at the ore body scale.
5. Earthquake hazard assessment involves not only estimating the likelihood that earthquakes will happen, but also the effects that earthquakes will have on a range of ground conditions. This in turn requires the measurement of *in situ* bulk and shear modulus of the soil and rocks in the ground. Bulk and shear modulus can be estimated using compressional and shear wave velocities if the density of the soil and rocks is known. The field trials of super-high resolution seismic reflection equipment on the Gold Coast (see [4] above) also tested three component sensors placed down drill holes. A funding bid has now been made through AGSO's Cities Project for the purchase of suitable equipment to aid in hazard assessment of Australia's major cities.

Facility Promotion [18.2c]

Apart from Press Releases at the time the successful bid for the facility was announced, which led to articles in the popular scientific magazines *New Scientist*, *EOS*, *Transactions of the American Geophysical Union*, and *First Break* (monthly publication of the European Association of Geoscientists and Engineers) publicity for the Facility was deliberately kept low key until the Facility was formally established with the signing of the Agreements with DIST on 19 June. Publicity mainly took the form of informal meetings with mining and petroleum industry geologists and geophysicists and university researchers, and participation by the Interim Director and Interim Deputy Director in several workshops attended by a wide range of exploration and research industry people. More formally since June 19, an article was prepared for inclusion in *AusGeoNews*, which is published by AGSO and has a mailing list of several thousand world wide. Articles have been promised to *PESA News* (the magazine of the Petroleum Exploration Society of Australia) and will also be provided to *The Australian Geologist* (The Australian Geological Society) and *Preview* (Australian Society of Exploration Geophysicists). The Interim Director has agreed to attend meetings of the International Association of Geophysical Contractors in September (Brisbane and Perth) to explain the role of the Facility and discuss petroleum industry interaction.

Impact of the Facility [18.2d]

An assessment of the extent to which the use of the Facility by national and international researchers contributed to:

(i) stimulating international scientific and technological collaboration:

- The Facility was asked to tender for a seismic reflection transect of the South Island of New Zealand. This project involves scientists from the Institute of Geological and Nuclear Sciences, Victoria University in Wellington and Otago University in New Zealand, and a number of United States universities (Purdue, Stanford, Southern California, State University of New York/Binghamton, Woods Hole Oceanographic Institute). David Johnstone, a geophysicist with the Facility at AGSO visited the project area to study the logistics of transect. Given the extremely difficult nature of the transect, and the likelihood that the Facility's new equipment would be barely on stream for the field season in February, the project was turned down. However, a further transect of the North Island is now being planned for several years time, and ANSIR has received an invitation to consider bidding on this transect when it occurs. The request was that we consider not only participating in the data acquisition phase but we also consider providing scientific input, especially in geophysics.
- Dr Tim Pharaoh of the British Geological Survey has approached the Facility on behalf of the Geological Survey of Papua New Guinea to seek our participation in the design and conduct of a refraction tomography-based transect of Papua New Guinea that is currently being planned for several years time.
- The establishment of the facility was promoted at the 7th Deep Seismic Imaging Conference in the United States in September, 1996. Prof. Karl Fuchs, formerly President of the International Lithosphere Program and recently retired head of the geophysics group at the University of Karlsruhe in Germany has now indicated that he wants to come for a visit to Australia to plan future collaborative research built around a long range transect of the Australian continent using both earthquake sources to the north of Australia and explosive sources, as well as pooled equipment from ANSIR and overseas institutes. This proposal requires a lot more work before it is implemented, but illustrates the drawing power to Australia of the ANSIR equipment pool combined with our geographic location in relation to earthquake sources to the north.

(ii) fostering interdisciplinary research and better linkages between academic and research institutions and industry; and

- The Australian Geodynamics Cooperative Research Centre has as its participants AGSO, CSIRO Division of Exploration and Mining, and Monash and LaTrobe Universities.
- The Hamersley project currently involves collaboration between AGSO and the Tectonics Special Research Centre at the University of Western Australia, and involves BHP Iron Ore and Robe Iron Mining Company Pty Ltd. The collaboration is formally managed through the Minerals and Energy Research Institute of Western Australia (MERIWA). The Tectonics Special Research Centre has also approached the Facility concerning the future deployment of the ANSIR portable recorders for a

tomography experiment. This would create linkages between the ANU and the University of Western Australia.

- The AGCRC's project in central New South Wales has input from the Geological Survey of New South Wales. The field program will include visit by school children.

(iii) enhancing the skills base and training level of Australian technologists and providing new opportunities for doctoral and post-doctoral training in research.

- The Interim Director and Interim Deputy Director attended a workshop at Mandurah in Western Australia in October 1996 which addressed potential approaches to advancing the education of geophysics in Australia. The workshop was sponsored by the Australian Research Council, and was attended by representatives of a number of Australian universities, research organisations and the Australian mining industry.
- The Australian Mineral Exploration Technologies CRC sponsored a meeting at the conference and exhibition of the Australian Society of Exploration Geophysicists held in Sydney in February, 1997, at which invited speakers gave their thoughts on trends in geophysics into the next century. The Interim Director was invited to present a paper on the theme of seismic in the mining industry.

Contribution to Australian Industry [18.2e]

- The initial research program outlined above highlights the growing links into the minerals industry. The program also has a strong social theme. This high level of interest, particularly from the minerals industry, is forecast to continue throughout the first half of the life of the Facility. Early indications from the informal promotion of the Facility outlined above are that the exploration industry will benefit in two ways.
 - ⇒ New geological results are already emerging, built on the success of previous studies conducted by AGSO and ANU. These new results include both
 - a) a better understanding of geological processes and
 - b) better two and three dimensional structural models of parts of the Australian continent (eg., through tomography studies at ANU) and of geological features within the continent (through controlled source studies at AGSO).
 - ⇒ The second benefit will come through stimulation of the geophysical contractor community. Informal approaches have been made from several contract companies seeking either to lease the Facility's equipment in order to compete in the contract market place, or to test their own new concepts for data imaging or processing prior to commercialisation. These will not be pursued until the Facility's new seismic reflection equipment is in place.
- When the initial bid was made for a major National Research Facility, natural hazard, environmental and ground water studies were flagged as future potential research areas, but the rate of growth of these areas of research was underestimated. These areas now appear likely to grow rapidly over the next few years, to become a major element of the Facility's research focus in the second half of its existence.

Opportunities to Enhance the Facility [18.2f]

A bid has been made to AGSO for further funding of equipment for ultra-high resolution seismic reflection equipment.

Performance Measures [18.2g]

(i) publications referring to the Facility's operations;

No publications are available because the research using the Facility resources only began during the reporting period. However, a number of publications have been submitted for publication in international scientific journals, using older data sets but emphasising the style of research that might be conducted using the Facility, and stressing the breadth and depth of expertise of researchers in the Facility. This was a deliberate strategy designed to raise the international profile of the Facility early in its life. These publications will be listed in the next annual report, following publication.

(ii) Personnel involved with the Facility's operations;

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(iii) Facility asset purchases and disposals.

Construction has begun on data loggers but no complete instruments were complete at the end of the reporting period. The Assets Register remains the same as that set out in the Agreements.

Financial Report

The cash flow reports for the 1995/96 and 1996/97 financial years are attached. These reports are not audited. The Board of Management had not been convened by the end of the reporting period, so no independent Auditor has been appointed. However, the Australian National Audit Office audits AGSO's accounts in the normal course of AGSO business.

Two sets of figures are provided. The first set indicates cash flow within the accounts of AGSO, the facility agent. Their expenditure figures include payments made by AGSO to ANU, as set out in the accompanying Notes. The second set of figures shows the cash flow through the ANU accounts.

FINANCIAL REPORTS FOR THE YEARS 1995/96 AND 1996/97

CONSOLIDATED CASHFLOW REPORTS FOR FUNDS HELD AT AGSO

FINANCIAL REPORTS FOR THE YEAR 1996/97
CASHFLOW REPORTS FOR FUNDS HELD AT ANU

Auditor's Report (I understand this is not required for 1996/97)

Throughout the Funding Period, the Facility Annual Report shall incorporate a statement by an Independent Qualified Accountant certifying that the financial statement presents fairly that the Funding Assistance has been expended solely upon the establishment of the Facility and in accordance with the Establishment Plan and relevant Australian accounting concepts and applicable Australian standards.