RESEARCH FOR THE UPSTREAM PETROLEUM SECTOR: THE CROWN RESEARCH INSTITUTE CONCEPT

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Abstract

New Zealand's scientific institutions have been restructured so as to be more responsive to the needs of the economy. Exploration for and development of oil and gas resources depend heavily on the geological sciences. In New Zealand, these activities are favoured by a comprehensive, open-file database of the results of previous work, and by a historically publicly funded, in-depth knowledge base of the extensive sedimentary basins. This expertise is now only partially funded by government research contracts, and increasingly undertakes contract work in a range of scientific services to the upstream petroleum sector, both in New Zealand and overseas. By aligning government-funded research programmes with the industry's knowledge needs, there is maximum advantage in improving the understanding of the occurrence of oil and gas resources. A Crown Research Institute can serve as an interface between advances in fundamental geological sciences, and the practical needs of the industry. Current publicly funded programmes of the Institute of Geological and Nuclear Sciences include a series of regional basin studies, nearing completion; and multi-disciplinary team studies related to the various elements of the petroleum systems of New Zealand: source rocks and their maturation, migration and entrapment as a function of basin structure and tectonics, and the distribution and configuration of reservoir systems.

Introduction

Recent change in both the energy resource industry and in the structure and funding regime for scientific research in New Zealand makes it topical to review current relationships and opportunities for mutual benefit. The upstream petroleum sector has strong interests in scientific research related to efficient exploration and development of oil and gas. Since petroleum is a geological resource, research into the conditions of its formation should not be ignored. Geology, geophysics and geochemistry are fundamental to understanding the distribution and conditions of occurrence of underground resources. The new structures and systems of government research in New Zealand should facilitate attention to emerging problems in petroleum geoscience, and to the sound design and operation of innovative, problem-oriented research programmes.

This paper reviews the reforms to government science in New Zealand and demonstrates how these can be of benefit to the industry in tightening the linkage between research and application. However, these benefits may be compromised by severe reductions in government science funding in this area.

The Heritage: NZGS and Other DSIR Programmes

Geology was one of the first scientific endeavours to be funded by government in New Zealand, with the establishment of a geological survey in 1865 (some provincial governments had retained geologists even earlier). Exploration of the country for mineral and energy resources was the primary reason for this priority, and this effort was immediately successful with the discovery of extensive coal and gold deposits in several parts of the country. Investigations by Geological Survey staff related to oil exploration go back at least to 1899 when Alexander McKay was dispatched to Taranaki and Kotuku on the West Coast. James Park made important recommendations to operators on the East Coast during the same period. There is little indication that geology was regarded as an essential guide to exploration in those days. By the 1930s however, the role of geology had become established in North America and elsewhere. The Vacuum Oil Company, exploring around Gisborne, retained HJ Finlay as a micropaleontologist on the recommendation of NZGS paleontologist J Marwick. When Vacuum ceased their New Zealand operation a year later, Finlay moved onto the Survey's staff, and he and Marwick subsequently developed together the basis for biostratigraphic zonation of New Zealand's Cretaceous and Tertiary strata — a scheme which remains an essential factor in exploration programmes to the present day.

After the Second World War, New Zealand had essentially no oil or gas production, and a rapidly growing demand. Dr David Kear, who rose through the NZGS ranks to become Director-General of DSIR, has outlined how geological research (fundamental and applied) during that period was influential in drawing the investment of Shell and BP to Taranaki Basin. The principal of their local partner, Bryan Todd, was apparently a personal friend of a senior member of the Survey's staff, Charles Fleming (both of these men were subsequently knighted for their services to business and science respectively), and kept himself appraised of the emerging results of two important lines of research with a bearing on the potential for exploration in Taranaki. One

was the pioneering seismic experiments, which revealed a very thick section beneath the easily correlated Oligocene limestone (drilling in the basin up to that time had only just reached the Lower Miocene). The other related to the significance of coal rank variations in West Coast coalfields, and the implications for oil and gas generation from the late Cretaceous–early Tertiary strata which were prognosticated for the deeper parts of Taranaki. Some of the latter insights were not entirely credible to the European explorers, and have only really been accepted during the past decade.

An important result of the long history of government science involvement in exploration has been the development of a comprehensive database including such records as well reports and the results of geological and geophysical surveys. The Petroleum Act in 1937 formalised a requirement to lodge exploration results with government, and made provision for data to become open-file after expiry or relinquishment of exploration rights, so that they could be integrated into scientific investigations as well as subsequent exploration ventures. These provisions are essentially continued under the Crown Minerals Act (1991).

The degree to which government scientists and institutions have been directly involved in the operations of exploration programmes has waxed and waned over the decades. As outlined below however, the present framework for government science does not provide for hands-on involvement in exploration programmes except where explicitly commissioned by the operator.

DA Francis in a recent issue of Petroleum Exploration in New Zealand News, relates variable degrees of bullishness on the part of NZGS staff assigned to the East Coast during the 1920s. No doubt their opinions had some influence on investors' decisions. At the zenith of government proactivity, in the 1970s the Muldoon government moved very quickly to set up a state oil company, and a celebrated row blew up within the Geological Survey when staff were directed to draw up an exploration programme. At about the same time, NZGS moved to focus research on determining and demonstrating the prospectivity of New Zealand's sedimentary basins with the establishment of the Cretaceous–Cenozoic Programme. To date, this programme has produced four monographs each summarising the geological development and resource potential of a basin or region, as well as a vast number of other publications and related material such as map sets.

For the critically important Taranaki Basin, the task of compiling and reinterpreting the vast amount of exploration data in the public domain commenced in the mid 1980s. Already by the 1987 Oil Exploration conference some significant insights into the further prospectivity of Taranaki were demonstrated. For example, Robinson and King identified the potential for commercial resources in both the Tikorangi Limestone and the Mount Messenger Formation, before their subsequent "discoveries" at Waihapa and Kaimiro fields respectively. Similar forward-looking reviews are being presented by the same team at this conference (King, 1994; Thrasher et al., 1994).

Other recent major contributions to the further exploration of Taranaki have included a synthesis of organic geochemical data (Cook, 1987); the basin-wide seismic map sets (Thrasher and Cahill, 1989; Thrasher, 1991), elucidation of the rift-phase history of the basin (Thrasher, 1992), and work being presented at this conference on thermal modelling and source rock maturation (e.g. Armstrong et al., 1994, Killops et al., 1994; Allis and Funnell, 1993). Increasingly, the Institute's research portfolio seeks to address the total "petroleum system", simultaneously improving knowledge of source rocks, their maturation, hydrocarbon migration and entrapment in reservoir systems.

Industry interest in New Zealand's frontier basins has been somewhat sporadic since Taranaki has become established as a producing region. Government-funded research has played an important role in assessing and demonstrating the potential of these areas, which are extensive. Of particular note is the offshore Northland Basin, where Conoco has acknowledged the contribution of pre-publication research results in developing the decision to take out an exploration permit in 1993.

Science Restructuring in New Zealand

Since 1989, the New Zealand government has undertaken two significant reforms of government science, aimed at improving the flow of research benefits to the nation.

Funder/provider/policy split

The Department of Scientific and Industrial Research conducted the majority of government-funded science in New Zealand from its establishment in 1926 (when the Geological Survey and other science organisations were incorporated into one department). The DSIR had several roles. As well as conducting research in a myriad of programmes, the department itself allocated science funding amongst its 23 divisions (reduced to 11 by amalgamations in 1990), and provided government with science policy advice. In 1989, its policy advice role was transferred to a new Ministry of Research, Science and Technology, and the department's funding was largely transferred to a Foundation for Research, Science and Technology (FRST), to phase in a contestable funding system. The DSIR was left solely as a "science provider", but continued to operate on a broad front coordinated by a headquarters group.

Restructuring of major "Science Providers" into CRIs, by sector

In 1991, the government decided to further rationalise its science efforts by breaking up the DSIR (and research units of other departments, especially the Ministry of Agriculture and Fisheries) and establishing 10 independent "science providers", called Crown Research Institutes (CRIs).

Crown Research Institutes are government-owned companies, accountable to boards of directors appointed by the shareholding Ministers. In general, each CRI conducts research addressing the needs of a sector or group of related sectors of the economy. The Institute of Geological and Nuclear Sciences incorporates the former New Zealand Geological Survey, Geophysics Division, Institute of Nuclear Sciences, and elements of Chemistry Division and the Physics and Engineering Laboratory. Its focus is on the science needs of resource industries, regional authorities, and a range of government agencies such as Civil Defence, as well as other stake-holder groups.

Foundation Mechanisms and Strategies

The Foundation for Research, Science and Technology allocates some $230 million/year from the Public Good Science Fund, as research contracts, typically, each in the

range of $100 000–$1 million. These contracts are awarded on a competitive basis to CRIs, Research Associations, universities (introduced progressively beginning this year), and private-sector researchers. Applications (typically 20 pages long) are submitted by late November, and those which pass a basic eligibility test are reviewed for their scientific quality by up to 5 referees. A separate "merit" review" is applied by one of five Advisory Committees which each covers a range of output classes. Depending on these reviews, and the level of competition within each output, funding is awarded to selected programmes for the subsequent financial year, and providers are notified in about April.

The Fund is divided into 40 Output Classes, which are broadly sector-oriented. Most petroleum-related research is currently funded from Output 21 (Energy), although some related programmes fall within Output 30 (Geological Structures and Processes), and the industry may also have interests in other outputs such as 33 (Climate and Atmosphere), 29 (Environmental Protection), and 16 (Materials and Industrial Processing). Original funding levels in each output were more or less determined by the allocations inherited from the budgets of DSIR and MAF. In 1991–92, the Minister of Research, Science and Technology convened a comprehensive review (the Science and Technology Expert Panel, STEP) which recommended significant transfers of funding between output classes, to be phased in over 5 years, and the Foundation has subsequently developed strategies to implement these changes.

Funding levels in the "environmental" output classes (29–35) are being reduced as a result of the STEP recommendations. Funding for "infrastructure" outputs, including 21, are being increased. Paradoxically however, the strategy adopted for Output 21 indicates that funding related to "non-renewable resources" (including oil and gas) be reduced and diverted to new areas, including "non-traditional renewable energy resources". The unfortunate effects of this decision will be to reduce funding for sedimentary basin studies (including non-completion of the Cretaceous-Cenozoic Project monograph series), as well as for some underpinning geological and geophysical programmes such as survey of the EEZ; and some strain on the Institute of Geological and Nuclear Sciences as the lead science provider in this area.

Current Crown-Funded Programmes in Energy Resources

The Output 21 (Energy) portfolio of $5 245 000 is currently split amongst 2 CRIs (12 programmes), 2 universities (3 programmes), Coal Research Association, and a consulting geologist, and covers topics related to oil and gas potential, coal assessment and utilisation, geothermal energy, and various energy utilisation technologies. The Foundation's strategy to 1997/98 is reproduced as table 1.

Underpinning Programmes: Geology

Research into Geological Structures and Processes (Output 30) clearly underpins oil and gas exploration and development, examples include the tectonic framework of the region and its evolution; developing means of dating and correlating rock sequences; assessing seismic, volcanic, and slope stability hazards as threats to production facilities,.

The Output 30 portfolio of $11 992 000 (reducing to $9 420 000 by 1997/98) is shared between the Institute of Geological and Nuclear Sciences (18 programmes), 4 universities (7 programmes), Coal Research Association, Auckland Institute and Museum, and 8 independent researchers. Topic areas include regional geology and geophysics; processes and hazards; tectonics, and mineral resource studies. At this time it is unclear exactly which lines of research are most at risk under the strategy of reduced funding, but the Marginal Plateaux and Troughs Programme, which includes marine geological and geophysical surveying of areas of the Exclusive Economic Zone away from the active plate boundary (the subject of a separate programme) seems to be particularly threatened. This has unfortunate consequences for energy resource assessment as well, since some of these areas such as the Lord Howe Rise and Campbell Plateau must be considered frontier prospects for oil. In fact, on a 1993 Institute of Geological and Nuclear Sciences cruise northwest of Northland, blocks of mid Cretaceous coal were dredged from seabed outcrop on the West Norfolk Ridge (Zhu and Symonds, 1994, this volume), confirming the occurrence of potential source rocks in that region. A 1992 Australian cruise in which the Institute participated revealed extensive sedimentary sequences and some interesting structure in the same area.

Direct Industry Funding for Research

Programmed reduction in government funding of science in the late 1980s created a surplus research capacity, which the government hoped would be utilised and funded by the private sector. The Institute of Geological and Nuclear Sciences, and a number of independent consultants, have had significant success in building consultancy services and in marketing non-exclusive reports to the industry, and by continuously improving the quality of these products and

Table 1. Five-year strategy for government research funding for energy.

	1992/93	1993/94	1994/95	1995/96	1996/97	1997/98
Non-renewable energy resources	2 643 000	2 643 000	2 500 000	2 300 000	2 000 000	1 500 000
Traditional renewable resources	1 234 000	1 234 000	1 190 000	1 170 000	1 100 000	1 135 000
Non-traditional renewable resources	51 000	51 000	300 000	550 000	750 000	1 135 000
Energy utilisation and management	742 000	742 000	950 000	1 200 000	1 650 000	2 000 000
Totals	4 670 000	4 670 000	4 940 000	5 220 000	5 500 000	5 770 000

their delivery, we intend to continue to further expand this business, both in New Zealand and overseas.

A distinction needs to be drawn between the various lines of business of a CRI: scientific services (such as routine processing or sample analyses), and more intellectually demanding consulting. The latter is most effective when consultants' efforts are closely integrated with the client's in-house resources. A case can also be made for industry subscription to more fundamental research, of the type being presented by a number of my colleagues at this conference. Industry partners can bring not only supplementary funding but also key input into project planning, and their own data, to "public-good" science projects, and can expect early access to both direct and spin-off results.

We do not advocate that funding for research should be an obligation on the industry: there must be a clear perception of value. If the industry chooses to purchase little research, it raises the question of whether current research directions are indeed delivering value. To the extent that value is not being recognised by the industry, there are opportunities to achieve competitive advantages by being first to shape the strong research capacity in New Zealand, in truly valuable directions.

A long-term perspective is essential to extract value from science. The likelihood of having immediate solutions for today's problems may not be high, but by recognising and sharing tomorrow's challenges there is much greater prospect of finding solutions of real economic impact.

Conclusions

There are more potential lines of research which may be of value to the petroleum sector than ever before; and the industry is certainly large enough to justify increased levels of funding, both direct from industry and via the Public Good Science Fund, if quality and relevance can be clearly demonstrated — in other words, if the potential benefits are sufficient to justify the expenditure. A high level of interaction between the researchers and research users is essential to ensure that effort is concentrated on the most promising initiatives, some of which may be quite high risk and/or long-range.

As a Crown Research Institute, the Institute of Geological and Nuclear Sciences occupies a unique position between a conventional government-funded research organisation (the traditional Geological Survey), and a pure consulting company. Access to government funding on a contestable basis provides opportunities to develop new research directions and capabilities relevant to the future growth and profitability of petroleum exploration in New Zealand. Close contacts with the private sector, including commissioned projects, will ensure that the maximum benefits to both exploration and production companies, and the nation, are obtained.

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Acknowledgements

I am grateful to David Kear, Norcott Hornibrook and Ian Keyes for information on the historical role of NZGS in oil exploration. Glenn Thrasher and Richard Cook improved the manuscript with their comments.

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