Australian Geoscience Council Inc.

The Council of Earth Science Societies in Australia

AGC

Towards A
National Tertiary Geoscience Education System
- invigorating university geoscience

A Discussion Paper

February 2008

Contact:
Dr Trevor Powell FTSE
President Australian Geoscience Council
15 Jaeger Circuit, Bruce ACT 2617
Ph. 02 62521428 Mob 0422 089 532
Email: tpowell@actewagl.net.au

Contents

Executive Summary

There is now widespread concern within the geoscience community and employer groups about the health of geoscience education in Australia and the demise of earth science educational opportunities, university earth science teaching departments and staffing levels. The concern is the ability of the higher educational system to provide the appropriately trained geoscientists required by the economy and Australian society, and general education of Australian society about the discipline of geoscience into the future. To a greater degree than most developed nations, Australia's economy and ability to sustain society requires solutions that arise in the geosciences. Despite the economic significance of the resources industries, they are suffering an major shortage of geoscience professionals.

At the same time over the last 10 years the number geoscience departments in Australia's universities and their staffing levels have decreased and the number of graduates has reduced, particularly a the Honours level where numbers have halved. The problem is structural with university of teaching of geoscience being fundamentally uneconomic for most universities and is dependant upon ongoing cross-subsidy with in the universities – this position is unsustainable.

An Australian National Tertiary Geoscience Education System (ANTGES) is envisaged as 'A national cooperative program to build human capital and infrastructure in the geosciences from which all stakeholders in Australian geoscience will benefit'. It is envisaged as a devolved system of processes and institutional arrangements to achieve the following outcomes:

- Appreciation geoscience as a Nationally Strategic Discipline
- Geoscience is attractive for universities administrations to support
- Emergence of a number of larger departments with critical mass in teaching and research.
- Differentiation and recognition of key strengths across the system amongst smaller and larger departments
- Externally funded teaching /research positions to create independence and engagement with stakeholder groups.
- Systematic program to attract appropriate numbers and quality of personnel to the geosciences

In order to provide a national oversight, recommend and facilitate programs of activity and advice on institutional arrangements, work with government(s) and stakeholder interests to achieve ANTGES, an *Australian Tertiary Geoscience Education Council (ATGEC)* is proposed. Its work program would focus on attracting students to the geosciences and on working with universities and government to establishe the viability and excellence of university geoscience departments. Its aim would not to duplicate exiting activities but rather provide national oversight and coordination and to identify and work to fill gaps in addressing the issues.

Membership of the council would comprise high level representation of the profession, employer groups (Minerals Council of Australia, Australian Petroleum Production and Exploration Association, Geological Surveys etc), universities with a commitment to geoscience. It would be serviced by a small office and it is envisaged for the activity to become operational in 2008.

Preamble

There is now widespread concern within the geoscience community and employer groups about the health of geoscience education in Australia and the demise of earth science educational opportunities, university earth science teaching departments and staffing levels[1] [2]. The concern is the ability of the higher educational system to provide the appropriately trained geoscientists required by the economy and Australian society, and general education of Australian society about the discipline of geoscience into the future. In the next few years with the growth of the resources industries, demand for water and the role of geoscience in managing the environment and mitigating natural hazards, this situation will rapidly reach a crisis point.

In response to these concerns the Australian Geoscience Council[3] (AGC) has undertaken a comprehensive survey of Australian universities to compile an *Australian Geoscience Tertiary Education Profile 2007* and convened a *National Summit on the Plight of University Geoscience Education and the Supply of Graduates, 27th September 2007 Canberra* attended by some 50 university, professional society, industry and employer representatives.

There was a consensus that unless a national approach is taken it is unlikely that the current situation will improve and there was a significant chance of further deterioration. It was recognized, as identified previously[2], that a range of initiatives is required and that no single measure or agency action is likely to impact the current situation. It was also recognised that a national framework is required for these initiatives and within which individual institutions can pursue their own interests.

This paper is a scoping document designed to raise awareness and support of stakeholders of the need for a national solution to the issues raised. It summarises the issues, outlines the proposed national framework and identifies in general terms the actions required and mechanisms for their implementation.

Geoscience - A Nationally Strategic Discipline[4]

To a greater degree than most developed nations, Australia's economy and ability to sustain society requires solutions that arise in the geosciences. This reflected in the critical role that the geosciences have to play in addressing important aspects of the National Research Priorities[2]:

- developing deep earth resources on land and at sea;
- mitigation of environmental impacts from resource industries,
- water supply, quality, use and re-use; identifying causes and solutions to land degradation;
- capture and sequestration of carbon dioxide;

[1] Mineral Council of Australia, Back from the Brink: Reshaping Minerals Tertiary Education, MCA National Tertiary education Taskforce, MCA, Canberra 1998.
[2] National Committee for Earth Sciences, National Strategic Plan for the Geosciences, Australian Academy of Science, Canberra 2003.
[3] AGC comprises the Presidents or CEOs of nine major geoscientific societies in Australia with a total geoscience membership of ~9000 comprising industry, government and academic professionals in the fields of geology, geophysics, geochemistry, mineral and petroleum exploration, hydrogeology, environmental geoscience and geological hazards
[4] Smith, M . 2007 Geoscience is a nationally strategic discipline. AIG News no 89 1-8.

- managing and protecting our coastal and marine environments;
- enhanced capacity in frontier technologies such as geo-informatics;
- improved data management; and protection of critical infrastructure.

Of Australia's total commodity export income of $150 billion forecast for 2007-2008, minerals and energy will account for 78 per cent. In the 2004/05 financial year the Australian and state and territory governments received taxes and royalties totaling 7.1 billion from the minerals sector and 8.1 billion dollars from the oil and gas sector.

Yet in these wealth generating industries:

'the oil and gas industry is currently experiencing shortages of professionals – particularly in the professions of petroleum engineering, geoscience and chemical engineering'[5]

and in respect of the mining industry[6]

'The shortage of graduates from minerals related disciplines and lowering of standards for entry into the industry has serious ramifications for industry innovation. People who lack in depth technical knowledge are unlikely to develop new and more efficient ways to do things; they will merely perpetuate the processes into which they are inducted. Moreover, as there are fewer graduates who undertake postgraduate studies, there will be a smaller number of professionals available to the industry with advanced research skills'.

A recent mining industry survey shows that short staffing and lack of professional experience are key issues.[7]

Other applications of geoscience requiring the application of geoscience skills in new and different ways have been discussed previously[2] and are summarized briefly here.

Urban and agricultural development has placed huge strains on our natural resources resulting in degradation and a direct financial burden. Land and water degradation alone are estimated to cost Australia up to A$3.5 billion per annum. We use groundwater more rapidly than it is replenished; we lose soils faster than they can be produced and we burn ever-increasing amounts of fossil fuels. This is not sustainable. These are all geological resources and geoscience is the field that embraces their generative processes, natural cycles and sequestration of waste products including carbon dioxide.

The security of urban communities underpins national stability, but cities and towns are vulnerable to many natural and anthropogenic hazards. Natural hazards include sudden-impact events such as earthquakes, floods, cyclones, storm erosion bushfires and landslides and slow onset phenomena such as sea level rise, soil swelling and ground subsidence. Humanly-enhanced hazards include salinity and acid-sulphate conditions, water contamination, and eutrophication in lakes and estuaries. These

[5] APPEA, 2007, Platform for Prosperity, Strategic Leaders Report to the Australian Petroleum Production and Exploration Association, GPO Box 2201 Canberra ACT 2601 , April 2007.
[6] AusIMM, 2006, Pre-budget submission 2007-2008, The Australasian Institute of Mining and Metallurgy, PO Box 660 Carlton South, Victoria 3053.
[7] AusIMM, 2007, Position paper to the National Engineering, Science & Technology Skills Summit, Parliament House, Canberra 19 June 2007.

hazards can threaten lives and damage buildings, water and poser supplies, transport and communication services. They can also seriously threaten employment, industry, commerce and public administration. In Australia natural hazards cost on average $1.3 billion annually with individual large events costing much more – the 1989 Newcastle earthquake cost the community an estimated $4.5 billion.

Australia's marine jurisdiction is vast. This jurisdiction represents a massive store of biological and seabed resources yet is on of the least and understood jurisdictions. Australia's ratification of the UN Convention on the Law of the Sea brings with it management obligations that in turn require scientific knowledge. There are also major resource opportunities for Australia, opportunities that would be lost in the absence of effective exploration of this jurisdiction.

These are emergent areas for the application of geological skills in concert with other disciplines and are now moving from a research mode to their application in management of catchments and environmental degradation; management of the coastal and marine environment; the mitigation natural hazards and the large scale sequestration of wastes, particularly carbon dioxide.

Although these issues are multidisciplinary in nature, the application of geoscience skills based on an understanding of earth process and cycles is fundamental to their resolution and there is anticipated to be a significant upsurge in demands for these skills at a high level of application.

Given its importance to the national economy and management of Australia's environment geoscience is truly a nationally strategic discipline.

Tertiary Geoscience Education - its Status

The current situation can be summarized succinctly as follows[8].

"In 1990, 28 departments offered earth sciences around the country and it was a small, but mainstream science. By the end of the this year (2006) there will be five of the original geoscience/earth science departments left in Australia and it is a niche science albeit vital to the nation The other departments have either closed or been forced into unions with biology, geography, physics, maths, or environmental science. This decade the number of honours graduates and students currently enrolled in honours courses has more than halved"

At the same time, although overall R&D expenditure in geoscience has stayed relatively static, it has declined in its share of national R&D effort. Whilst in the last decade, overall expenditure in R&D in the Higher Education and Government sectors has increased 22 % the share of the total represented by Earth Science R&D has fallen by 23.8% in the period and is only one of two out of eleven disciplines to record a fall[9]

[8] Hall, M & Hill K. Time to invest in earth sciences. PESA News Oct/Nov 2006, Petroleum Exploration Society of Australia Ltd, 118-119

[9] Federation of Australian Scientific and technological Societies, Is this what you had in mind? Science and the changing profile of R&D expenditure. FASTS Discussion paper 18 June 2007 Parts 1& 2. www.fasts.org.

A decrease in Honours students must also result in a decrease in overall research capacity down the track as low Honours enrolments flow through into the number of PhD students and then ultimately to the number of research fellows and academics. This is a significant longer – term crisis that the Tertiary geoscience sector is facing, the full effects of which is yet to be felt.

The explanation, which seems to have general consensus, has been stated by Webb[10]

"The current university funding model provides funds on a per-student basis, with the salaries of staff (academic, support and administrative) infrastructure and expendables (including field teaching) being paid from those funds. However with low student numbers such funds are inadequate to pay for the necessary infrastructure to support study in expensive and technologically sophisticated fields like geology, geophysics and petroleum engineering. …… Thus the fundamental problem: teaching areas that by their nature have low student numbers (such as geology) provide little money for the university. Thus with low student numbers, expensive science and engineering programs are not economically viable, and are thus vulnerable to closure.

Universities themselves are under no obligation to maintain teaching or research areas that are strategically critical to Australia's economy. Instead, through economic rationalization, they have been forced to depend upon market forces that are dominated by student choices for their primary funding. Popular, well attended courses …….. (e.g. arts and business) are well-funded and help the university's bottom lines, whereas expensive-to–teach, poorly attended courses (such as geoscience and engineering) are considered detriments to university finances."

This is compounded by the relatively high expense of teaching geoscience because geoscience fieldwork and practical classes need low student/staff ratios due to the inherent variability and complexity of natural rock samples and outcrops. Whereas in the past domestic PhD students could be used to carry much of the demonstrating load, in the current climate this load must be picked up by academic staff. At the same time the Commonwealth funding per student has declined by about 4% each year relative to academic salary costs. The consequence of these two factors is that increasing student numbers in themselves will not address the long term sustainability issue because beyond a certain point the extra income barely matches the increased cost of employing sufficient staff to teach them.

The 2007 AGC Summit and survey[11] have confirmed that overall, geoscience continues to lose status and visibility through merger of departments and reduction in staffing levels although there is much variation from institution to institution. Some geoscience departments have stabilised or have slightly increased staffing levels. This situation is not unique to the geosciences and under current student funding formulae reflects the underlying unfavourable economics of maintaining teaching capacity in minority disciplines such as geoscience. Many of the 'geoscience departments' in the sixteen universities identified as having the capacity to teach geosciences as a major, are

[10] Webb, Ge.E. Some thoughts on Australian universities and the petroleum industry in 2006. PESA News Aug/Sept 2006, Petroleum Exploration Society of Australia Ltd, 38-39.
[11] Australian Geoscience Council, 2007, Australian Geoscience Tertiary Education Profile 2007, Australian Geoscience Council, Canberra.

uneconomic or marginally economic based on teaching the current numbers of students. They are dependent for their survival upon internal cross-subsidy and/or coverage of overheads from external research funding whether it be from government or industry. However, whilst parent universities receive funding to support research ooverheads from the Commonwealth *Institutional Grants* and *Research Infrastructure Block Grants Schemes,* the extent to which they flow to the departments conducting the research varies. In other words, depending upon a university's funding policies, government research grants may have a net negative financial impact on geoscience departments – with research being subsidized significantly by teaching budgets.

The problem is structural with too few students per teaching academic and would still be an issue if funding per student was raised to the highest funding cluster.

In 2007, 170 academic staff were engaged in some level of teaching in geoscience whilst 187 staff were engaged in research with no formal teaching commitment. The latter are very unevenly distributed with almost all research staff confined to 10 institutions and 50% of research staff at 3 institutions. Nationally 11 teaching positions are funded externally with 6 of these positions funded by MTEC. .

Differentiation in degree types has emerged where some universities have created 'geoscience degrees' from a blend of physical geography or environmental courses and traditional 'solid earth science" courses whilst others have maintained a clear distinction between degree types. It is important for stakeholders in university geoscience to be aware of this differentiation. This change in teaching profile is reflected in areas where honours and higher degree thesis topics can be supervised. Ten universities identified themselves as having the capability to supervise theses across a full range of solid earth sciences, eleven had capability in Petroleum Geology; eight had capability in geophysics and eleven had capability in hydrogeology – several institutions indicated an expansion of capability in hydrogeology.

Nationally, student enrolments have increased 20% over the last 5 years, but all have occurred in levels 1-3 with enrolments in Honours/level 4 declining a further 9% over the 50% drop that has occurred in the previous decade. However there is much variation between universities with some undergoing a decline in all enrolments and others increasing. There is also a wide variation in student load from department to department with those with the lower values clearly at risk. Retention of students, particularly Australians, into honours and higher degree courses is a major problem and is another threat to the economic viability of many departments. This is currently exacerbated by the high salaries on offer from resource companies and is a primary cause of low retention rates in some universities, particularly in Western Australia.

Discussion of the Issues

There are three fundamental issues that underlie the current situation and its potential resolution. These have also been extensively discussed previously[2]:

Demand for Graduates – What is the appropriate level of graduate output?
AGC member organisations have 9000 geoscience memberships. Evidence of duplicate membership between the Geological Society of Australia and the Australian Institute of Geoscientists suggests these memberships represent about 6000 professionals in

industry, government and academia. Many of these professionals typically have as a minimum an honours degree or equivalent formal training with many having higher degrees. The exact demographics are not known, but many organisations have an older demographic with a bulge in the 'baby boomer' years. Many industry professionals, particularly if they are no longer doing 'hands on geoscience' may no longer be members of 'geoscience' societies. The size and skill set of the current professional population is not well known.

Replacement of this cadre of professionals with graduates with equivalent qualifications should be the minimum aim of any national Tertiary Geoscience Education System. All of the evidence suggests that the demand for higher skilled individuals will increase. Assuming a 30 year career, this suggests that a first order replacement rate should be a minimum of 200 honours or equivalent graduates per annum. This does not assume any growth in demand in the longer term or any compensation for the uneven demographic known to exist in all professional groups. It compares with the current annual output of 137[11] .

Attracting Students

Geoscience is not typically taught in high schools although currently efforts are underway to introduce geoscience to K11-12 in Western Australia[12]. Knowledge in schools of career pathways for graduates with geoscience qualifications is limited. Geoscience departments are typically dependent upon attracting students into geoscience from the cohort of science students undertaking introductory geoscience courses in Level 1 at university along with other science courses.

Students select an institution for reasons that have nothing to do with geoscience because they are not expecting to study geoscience and only fall into this subject by accident after taking it as an option in their first year. They select their university for some other reason - maybe proximity to where they live, maybe where their friends or relatives are going, or maybe based on overall reputation (e.g. sandstones versus new universities), maybe based on reputation in chemistry or engineering because this is what they originally intended to study. Closure of geoscience departments at some universities will not mean that students will be attracted to other institutions to do geoscience.

The results of the survey[10] indicate the number of student attracted to geoscience is increasing. However retention rates into honours has been declining and it has to be concluded that, in general, Honours degrees are not attractive to students completing their basic degrees. A fundamentally new approach is required for attracting students into geoscience and maintaining them in the discipline.

Viability of Geoscience Departments

Despite the reduction in academic staff that has occurred over the last decade, most 'geoscience degrees' are uneconomic on a purely teaching basis because of the combination the numbers of students and student funding and the staffing levels required to deliver a well rounded Tertiary geoscience education. Most Australian geoscience 'departments' are too small and lack economies of scale and are reliant

[12] Earth Science WA: Strengthening Earth Science Education across Western Australia; www.science.wa.net.au/index.php?option=com_content&task=view&id=1795&Itemid=603

upon internal cross subsidy within the parent university despite income derived from other sources.

Whilst external funding of teaching positions for minerals geoscience courses in certain universities by the Minerals Council of Australia ensures that at honours and masters level education in minerals geoscience is available in certain universities and is very valuable, it does not address the issue of the underlying viability of the schools. A key question is "What is the minimum economic department size that is sustainable in the longer run?" This has to have consideration of government funded student load including funding per student, fee-paying students, academic staff numbers, service teaching to other degrees, degree of specialisation and external funding for teaching and research and research funding. It is larger than most current geoscience departments. Over the longer term a number of larger and strong geoscience departments need to emerge if Tertiary geoscience education is to be sustainable. This will maximise the opportunity to leverage support from the parent university, attract the post graduate students to support teaching and create greater diversity of options for both research and teaching. However an increase in student numbers of itself will not deliver a sustainable outcome - there will be an optimum ratio of students to staff, to post graduate students to researchers that will need to be maintained.

Vision of an Australian National Tertiary Geoscience Education System (ANTGES)

ANTGES is envisaged as 'A national cooperative program to build human capital and infrastructure in the geosciences from which all stakeholders in Australian geoscience will benefit'. It is envisaged as a devolved system of processes and institutional arrangements to achieve the following outcomes:

- Appreciation geoscience as a Nationally Strategic Discipline enabling
    - the ongoing development of the resources industries and their economic importance at state and federal levels.
    - natural resource management – land, coasts and sea
    - natural hazard mitigation
    - definition of groundwater resources and water supply, and
    - society understanding the world in which we live.
- Geoscience is attractive for universities administrations to support and nurture with funding mechanisms to match, including recognition of high overhead costs of geoscience,.
- Emergence of a number of larger departments with critical mass in teaching (student numbers) and research to provide longer term flexibility and resilience to change.

- Differentiation and recognition of key strengths across the system amongst smaller and larger departments and development of mechanisms for effective transfer of students to centres of expertise and use of expertise for teaching and mentoring across universities.

- Externally funded teaching /research positions to create independence and engagement with stakeholder groups.

- Systematic program to attract appropriate numbers and quality of personnel to the geosciences
    - geoscience based education programs targeting high schools including education of science teachers in geoscience.
    - scholarship system to attract the brightest and the best
    - regular review of needs for geoscientists
    - promotion of attractiveness of academic careers with salary supplementation in appropriate cases to enable universities to compete with industry.

Invigorating Tertiary Geoscience Education - A Plan for the Future

The types of activities and arrangements that are envisaged as necessary to create ANGES are as follows:

Stakeholder Engagement

The geoscience community is a 'federation of interests' comprising the learned and professional societies; universities, industry groups and employers and government agencies. Each has a legitimate interest in Tertiary geoscience education and can benefit from an improvement, but also has its own legitimate interest and activities of relevance to its own *raison d'etre*. The challenge is to marshal these interests into a collaborative system whilst allowing for individual interests and expression and to sustain the system into the longer term. In order to achieve this, the following is proposed:

- *Australian Tertiary Geoscience Education Council (ATGEC)*
  Aim: To nurture the development an Australian National Tertiary Geoscience Education System (ANTGES)

  Role: Provide a national oversight to recommend and facilitate programs of activity and advice on institutional arrangements, work with government(s) and stakeholder interests to achieve ANTGES

  Membership: High level representation of the profession, employer groups (Minerals Council of Australia, Australian Petroleum Production and Exploration Association, Geological Surveys etc), universities with a commitment to geoscience.

Executive Arrangements - a small executive office would be needed to work with the universities and interested organizations in development of the scheme.

Attracting Students

The geoscience community and employer groups are actively engaged in geoscience and industry awareness programs in schools. There is a particularly intensive activity in Western Australia through *Earth Science WA*[12]. The Petroleum Exploration Society of Australia is developing the Teacher Earth Science Education Program (TESEP)[13] to be delivered through the Australian Science Teachers Association aimed at delivering professional development program and teaching resources in Earth and Environmental Science in the eastern states targeting years 9 and 10 with plans to expand to years to 11 and 12. Employer bodies and other societies and professional associations have their own programs. The aim is not to duplicate these activities but provide an overview and help facilitate and develop these activities as required.

These activities would be complemented by establishing a national scholarship scheme initiated by ATGEC aimed at attracting the brightest and best from high schools to the geosciences. Current TER scores for students entering science degrees in geoscience capable universities range from 50 to 85 with values in the 70's typical. Approximately 100 scholarships would be offered nationally with a value of say $10k per year in years one to three and then $20k in Honours. The aim is to demonstrate in a tangible way the demand for expertise in geoscience and to remove financial impediments for students to move to university centres of excellence in the geosciences. Such a scholarship scheme would be developed as a joint government - industry - professional program aimed at the need for skills in **Geoscience - A Nationally Strategic Discipline.** Obviously such a scheme would have to be extensively marketed in schools. The existence of such a scholarship scheme in itself would stimulate students to undertake geoscience. In this way demand for geoscience education by high quality students would be stimulated and the long term needs for geoscience professionals met. It would also encourage students to attend those schools with the best reputations. A more detailed rationale for a scholarship scheme is given in Appendix A.

Viability of Geoscience Departments

The National Strategic Plan for the Geosciences[2] has made a number of recommendations for action to improve the geoscience education system in Australia. These are summarised in Appendix B and form a basis for addressing the viability of tertiary geoscience. ATGEC would facilitate the addressing of these issues with universities and government with the engagement of stakeholders in the employer community and the professional associations and learned societies with a focus on:

- economic viability and sustainability of geoscience departments given it is minority discipline; mechanisms to achieve economic viability and quality of graduate output.

- differentiation and recognitions of key strengths in centres, identification of weaknesses and gaps required to meet national needs

- a stronger focus on world-class research and graduate centres networked with smaller department.

[13]Teacher Earth Science Education Programme www.pesa.com.au/rightbar/3rd.htm

- mechanisms to enable free movement of students to centres of expertise.

Time –Frame for Implementation

The matter is urgent but the issues are complex. A proposed timetable for implementation is as follows:

- Discussions with stakeholders and Department of Education, Employment and Work Place Relations on options early 2008
- Establishment of *Australian Tertiary Geoscience Education Council* - June 2008
- Workshop on 'Viability of Geoscience Departments' and/or meeting with University Representatives – June 2008
- Submission to universities and government – Aug - Sept 2008
- Launch of Scholarship Scheme – End 2008.

Financial Issues

A program of this nature cannot be implemented without dedicated funding. An important early step will be to identify whether stakeholders in the geoscience community and with appropriate input from government would be able to underwrite the establishment of the program.

Appendix A: Rationale for Scholarship Scheme

A fundamental issue is attracting student to the geosciences and retaining them into a professional career in geoscience. Important steps in this process are:

- Awareness of geoscience as a discipline in school and university career – a number of steps are being taken by industry and professional groups at the grassroots level to address this aspect.

- Awareness of careers in geoscience – a key responsibility of professional associations and industry.

- Removal of financial impediments to attract high quality students to attend the best geoscience schools in the country.

It is the latter point that a Scholarship Scheme aims to address. Unless the demand side for geoscience education is addressed there is no guarantee that strengthening earth science departments – the supply side will result in more students studying geoscience.

National demographics will determine that all professions will be competing for the best students in years to come. Already some professions are paying for students to study particular disciplines e.g. Accounting. The TER scores for entry into science in most universities languish in the 70's or below. If the profession is to attract the best students a scholarship scheme that addresses the considerable expense of attending university and living away from home to attend the best places to study geoscience would go some considerable way to addressing this problem. It could take the form of Cadetships such as presently adopted by Geoscience Australia or be linked to a National Internship Scheme such as recently proposed by Universities Australia[14].

If appropriately marketed to students and their parents it would be a powerful incentive to attracting high quality students to geoscience.

[14] Universities Australia, 2007 A National Internship Scheme 0ctober 2007 – Discussion Paper. www.universitiesaustralia.edu.au

Appendix B: The National Strategic Plan for the Geosciences[2] - Recommendations for Education

Note although the recommendations refer to specific programs and circumstances extant at the time of publication the underlying principles are still valid.

1. That government moves to a funding model for higher education that recognizes the national significance, and education costs, of geoscience so as to ensure the long-term viability of geoscience education and training including:

- Relocation of the geosciences from Cluster 8 to Cluster 10
- Extension of funding under the Higher Education Innovation program for a further 5 years; and
- Strong support for science, engineering and technology disciplines in general

2. That government and universities collaborate to modify the university funding model and its implementation, ensuring:

- Provision for stable, base level funding to maintain the viability of a diverse group of university geoscience department, despite cyclicity in undergraduate enrollments – specifically implement the 'variable rate learning entitlement' funding model proposed in the Higher Education review, to give direct recognition to the costs and significance of geoscience, as an area of national priority, and of small but vital disciplines such as geophysics;
- Investment in critical core-skills, including those highly specialist skills where the need is critical but is satisfied by a small number of highly competent graduates;
- Provision of scholarships by industry, government and other employers particularly geoscience-scholarships that encourage students to fill skill-gaps in the nation's ability to address the National Research Priorities (NRPs) and
- Increase incentives for universities to create graduates with the multi-disciplinary and inter-disciplinary skills necessary to address the NRPs

3. That the geoscience community expand and broaden existing and emerging networked geoscience centres (e.g. Victorian Institute of Earth and Planetary Sciences, Sydney Universities Consortium for Geology and Geophysics, Earth Systems Dynamics Network) in order to establish world-class graduate centres networked with smaller departments. Specific initiatives associated with this strategy are:

- Provision of dedicated personnel for networking with smaller departments, state government agencies, Geoscience Australia, CSIRO and industry.
- Use of infrastructure for networking
- Geoscience promotion, by a dedicated geoscience teacher in each centre, to schools and to the general public;
- Establishment of new chairs particularly in areas of national priority (including geophysics and marine geoscience)

- Introduction of a '50 early career explorer' scheme for new graduates and doctorates, with staff to be rotated between government research agencies and industry; and

- Increased research and teaching collaborations between geoscience department, and those in environmental science, geomorphology, geoinformatics, engineering, commerce and social science.

4. That all national and state geoscience bodies (government, agencies, professional and peak industry associations and lobby groups) work with the Australian Academy of sciences, the Academy of Technological Sciences and Engineering and the Australian science Teachers Association to provide professional development to teachers and schools with inspiring K-12 teaching resources. This should:

- Include excellent geoscience-based learning experiences for primary and secondary students, underpinned by affordable professional development in how to use them.

- Ensure program gaps, specifically including K-3, 4-6, 7-10 and 11-12 levels are effectively targeted through cooperatively funded strategies; and

- Provide geoscience-based learning experiences, including case-studies that can be used by non-geoscience disciplines.

5. That the geoscience community encourage government to:

- Undertake a more rational distribution of existing funds to university-based geoscience programs to reduce the large amount of lost time in applying for funding of research positions; and

- Increase the general level of science education funding so that Australia is internationally competitive.

6. That government and universities collaborate to:

- Determine and implement degree structures that will maximize the effectiveness of the geosciences, particularly in addressing national research priorities;

- Ensure that a geoscience component is in undergraduate and post-graduate courses for primary and secondary science-teacher trainees; and

- Establish effective, affordable, programs and incentives that encourage teachers and trainee teachers, at all levels and across specialist areas, to acquire the knowledge and skills they need to effectively teach the geosciences

- That whenever it is practical and feasible to do so, the geoscience community adopts a coordinated and integrated promotion of the geosciences and their relevance.

- That government re-instate its support for the Mineral Council of Australia's Mineral Tertiary Education Council program and support other similar private sector initiatives.