

TERTIARY GEOSCIENCE EDUCATION WHAT ARE THE BIG ISSUES? AND WHAT ARE THE SOLUTIONS?

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In response to the widespread concern within the geoscience community and employer groups, the Australian Geoscience Council (AGC) has over the past year been examining the health of geoscience education in Australia and the demise of earth science educational opportunities, university earth science teaching departments and staffing levels. The ability of the higher educational system to provide the appropriately trained geoscientists required by the economy and Australian society is in doubt. In 2007, only 134 Honours graduates were produced across the nation – this compares with the approximately 200 needed per annum to needed to replace and maintain current numbers of geoscientists and does not take into account any increase in demand or demographic issues concerning the current population of geoscientists.

In 2007 the AGC undertook 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* which was 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. Based on these findings the AGC, released a discussion paper "*Towards a National Geoscience Education System – invigorating university geoscience*" and has made a submission to the Higher Education Review. In the last few months, the AGC has been actively engaged along with the national committees of our member societies, university staff and employer groups in determining ways in which the profession can mitigate this situation. The following systemic problems have been identified:

- The declining status of geoscience in Australia
- Insufficient funding of teaching in universities and the funding model
- The lack of awareness in our secondary schools - this has to be seen in the context of the dearth of science teachers and the consequent poor engagement in secondary schools with Science, Technology, Engineering and Mathematics (STEM) which is a nationally recognized problem
- The lack of post-graduate students and replacement of academic staff
- Recruitment strategies and cyclicity in the resource industries

During its engagement with university geoscience educators, the AGC has identified the need for a national effort to build human capital in the geosciences from which all stakeholders in Australian geoscience will benefit. In so doing it has developed the following prioritised list of key issues facing tertiary geoscience education in Australia, and has developed possible strategies to address the problems facing Tertiary Geoscience Education:

1. **Increasing Recruitment into Geology**

We need to encourage high school students to be aware of careers in geoscience, and to choose science, preferably including geology, in their first year at university.

Strategies to achieve this important goal include:

- Getting more geology into school courses by helping teachers to deliver earth science and, in states like SA and Tasmania, to advocate the availability of Earth and Environmental Science (EES) courses. Two important initiatives need to be supported.
 - ***Earth Sciences WA*** (www.sciencewa.net.au and click Earth Science WA) has been developed in Western Australia with a top priority of getting geoscience into secondary schools with the introduction of new K11-12 course in EES starting in 2007. The aim is ~25% schools and K11-12 students taking EES by 2011. It has included work on professional development for teachers and development of classroom and field materials in conjunction with the WA Curriculum Council. EES is being introduced in K8-10 science courses and to enrich other K11-12 science courses. A key driver is the strategic importance of the resources industry in WA and willingness of key institutions to collaborate and seek resource industry funding.
 - The ***Teacher Earth Science Education Program (TESEP)*** (www.pesa.com.au and click on TESEP) has been launched by the Petroleum Exploration Society of Australia supported by some other AGC member societies to spark student interest in EES topics and to motivate and educate keen science teachers and raise the profile of EES in secondary schools nationally. It comprises 8 Professional Development workshops for science teachers who teach Years 7 to 10, to be presented at multiple centres in all eastern/central states and territories through the years 2008-2010. It is starting in Queensland, South Australia and the ACT and will be progressively rolled out as funds permit. It is planned to engage up to 500 teachers over the next five years with the potential of reaching thousands of students. The program is supported by AGC and its member societies. The program is being delivered by professional teachers under the auspices of the Australian Science Teachers Association. A key issue is developing and maintaining the funding for the execution of the program.

- Collaborating with other initiatives. There are a number of strategies at the national level designed to address STEM deficiencies in schools. For example, the Academy of Science **Primary Connection** program provides teachers with the material and methodologies to help them do a better job. It has been granted an injection of \$4.4 million from the Federal government. The Academy also has a secondary school program called **Science by Doing**, which has been allocated an additional \$2 million in Federal funding. There are also other initiatives of this nature. It is crucial that efforts in geoscience education in schools be associated with these initiatives and perhaps provide materials to them.
- AGC launched its **GeoEdLink Newsletter** in 2007 aimed at providing a forum for coordination of and collaboration in geoscience education initiatives. This activity needs to be continued and enhanced as programs develop.
- In an increasingly competitive world for talent it is essential that incentives are provided to attract the brightest and best students into the discipline. A substantial number of significant scholarships that materially improve the financial position of students undertaking geoscience will send a powerful message that geoscience is important and that graduates are needed.

2. **Surviving the Cycles of the Resources Industry: Geoscience is more than Resources**

Earth Science enrolments have always experienced a delayed decline or a delayed rise in response to economic cycles of the resource sector. It is only in the last couple of years that there has been an upturn in student numbers. In addition and in the present boom students are taking jobs in the private sector after only 3 years of study with some encouragement from sectors of the industry. This is unfortunate, since most people would agree that a 4 year geoscience degree equips students better for professional employment and will create demand for more specialist education for those wishing to advance their careers.

Coping with future cycles of graduate demand may be eased by:

- Industry representative and professional bodies being more active in promoting Geoscience as a nationally strategic discipline which recognises that, although it is absolutely of fundamental importance to the development of the resources industry, it is also increasingly important as an enabling science for natural resource management – land, coasts and seas; natural hazard mitigation; groundwater resource identification and management of water supply, and understanding the world in which we live, including climate change.
- Ensuring that University Geoscience Departments have the capability of teaching courses which do not depend on the petroleum and mineral sectors. Those departments and courses that include hydrogeology,

engineering geoscience, environmental geoscience and natural hazards must be supported as much as those that teach resource based courses.

- Encouraging the resources industry to think strategically about its recruitment needs in the face of a changing demographic environment where there will be severe competition for talent. This will require companies to work with the universities to further educate their staff in the advanced and specialist skills many will inevitably need.
- Reminding industry that it has a significant responsibility for the perception that geoscience is at best a fickle employment field and that the typical expedient of eliminating exploration staff in tough financial times leaves the industry in no position to lament a shortage of technical people when times improve.

3. **Overcoming the Inadequacy of the Current Funding Model**

Tertiary disciplines with a high level of close contact between staff and students during teaching receive insufficient funding from the Australian Government. Geoscience is a discipline which requires very strong observational skills, which are instilled during laboratory and field course components. The funding model based on cumulative Effective Full Time Student Load (EFTSL) does not provide enough money to pay for the necessary infrastructure to support teaching in expensive and technologically sophisticated fields like geology, geophysics and petroleum engineering. The fundamental problem exists that teaching areas with low student numbers (such as geology) provide little money for the university. With low student numbers, more expensive science and engineering programs are not economically viable, and are thus vulnerable to closure, and have closed or been amalgamated with other disciplines resulting in a thinning out of core subjects.

Is there a solution to the university funding deficiency?

- The AGC argues in its submission to the Higher Education Review that the Government must adopt a national strategic approach to ensure that tertiary teaching capacity is maintained in important minority disciplines (including geoscience). Funding arrangements should be changed to recognise the actual costs of teaching of different disciplines and also the progressive increase in costs of teaching and teaching resources as students move through a course of study towards a major/honours degree. The AGC proposed that the university funding should comprise a base level of block funding, determined by the real costs of course delivery, plus a per student rate based on EFTSL numbers.
- The funding issues facing minority disciplines have been the subject of submissions by both the AusIMM and AGC to Government reviews over the last several years. The Higher Education Review offers the best opportunity for this matter to be addressed, although the outcome is not

known at the time of writing. The AGC will continue its advocacy in partnership with interested parties for solutions to the fundamental systemic issues in university funding, but it is inevitably long term and uncertain in outcome.

- A vigorous research activity necessarily contributes to the viability of university departments particularly if the full cost of research is supported. Industry can assist the viability of geoscience department significantly by establishing and co-funding research into topics of direct relevance to the company and utilising the attractively priced skills of university staff who are active in the particular field of interest.

4. **Addressing the Fragmentation of Effort and the Issue of Critical Mass**

The Commonwealth funding method forces departments to be self-focused in competing with other disciplines in their institution, and selfish in struggling to survive by capturing and holding on to students. The exceptional skills of geoscience educators are applied in fragmented efforts throughout the country to the net detriment of Australian geoscience. This is exacerbated by the funding model where small departments are fundamentally uneconomic in teaching. In order to survive in the absence of exposure to earth science in schools, geoscience departments must maximise their exposure to students in the first year of their science degree in the expectation of attracting students into geoscience. This supports a model of a large number of smaller departments whereby geoscience can be exposed to the greatest number of first year science students.

Can the fragmentation of effort be reduced?

- The concept of networking the capture of students at regional centres and feeding them to appropriately skilled large departments may have merit. This requires a change in the culture of retention of students at all cost, and an acceptance of student mobility.
- The CRC approach to research has proven that a combined effort yields better results. In funding research, the Government clearly recognises and rewards collaborative efforts. It seems logical that the same incentive should be built into the funding of teaching. This would require the rejuvenation of initiatives such as the Victorian Institute of Earth and Planetary Sciences (VIEPS) and the development of similar collaborative initiatives in major population centres. It could allow universities to develop strengths in key sub-disciplines and to develop viable teaching and research strengths, without having to maintain a full suite of disciplines necessary to teach a full degree.

Many universities lack the staff to teach some sub-disciplines, or key aspects of some topics – examples include geophysics, economic geology, coal geology hydrogeology, engineering geoscience and petroleum geology (as

well as mining engineering and metallurgy). As discussed above there will be an increasing demand for specialist education of those who have entered industry with basic degrees.

How can specialist topics be delivered more effectively?

- The model of industry providing resources for teaching of specialist courses relevant to a particular industry at Honours and Masters levels has been adopted by the Minerals Tertiary Education Council. It is only relevant if there is a robust undergraduate system to build on and if specialist teachers are available which in the current resources boom is becoming increasingly problematic. It seems inevitable that industry or government specialists will have to become increasingly involved in teaching the specialist topics required for advanced courses. In combination with the need for advanced education to those in the workforce, specific arrangements will be needed between employers and universities for this to occur and may require changes in the way course options and degree structures are offered.
- The utilisation of Information and Communication Technology (ICT) may enable collaboration between many departments in the live, simultaneous and interactive delivery of specialist topics. Inevitable challenges in both the equitable funding of such teaching and the scheduling of collaborative teaching should be overcome to meet the needs of Australian geoscience. This could reduce the teaching load of some staff and might assist the survival of small departments and the effective use of specialists. Existing multi-campus lecture capabilities such as the *Access Grid Technology* used in the Faculty of Science at Monash University provide an example of such collaborative teaching.
 - The field of geophysics is taught at relatively few universities, and even at these institutions, the academics tend to be specialised in certain areas of geophysics. This topic could be developed as a case study of ICT teaching in Australia, perhaps under the auspices of the Australian Society of Exploration Geophysicists.

5. **Reducing the Cost of Geoscience Teaching**

The expense of maintaining laboratories, including microscopes and specimens, and the cost of field excursions have always been problems for earth science departments and under current funding models and current historical student loads render many departments uneconomic.

Can teaching costs be reduced?

- Many of the suggestions outlined above are targeted at improving the cost structure of tertiary geoscience education whilst maintaining and hopefully enhancing its effectiveness.

- The pooling of resource through collaborative efforts may facilitate the sharing of resources that are costly or hard to maintain in concert with ideas. The provision of high quality rock samples and microscope sections might be alleviated by the use of digital files from Data Metallogenica and from the new Virtual Core Library (a CSIRO initiative led by Jon Huntington). Teaching could be designed around digital imagery of very high quality material rather than often outdated and low quality real specimens in university archives.
- University Departments which are incapable of providing field excursions for undergraduate geoscience students may be able to access external field trips. Former academic staff have indicated interest in providing excursions to proven educational field locations at minimal cost to universities, with some financial support from both industry and professional societies

SUMMARY AND ROLE FOR THE PROFESSION

The AGC's interaction with Heads of Geoscience Departments in Australian Universities leads to the conclusion that the single biggest issue facing Tertiary Geoscience Education is our topic number one "Increasing Recruitment into Earth Science".

This conclusion indicates that the best role of the professional and learned societies united under the AGC banner is to maintain its support of school initiatives such as Earth Science WA and the development of TESEP along with the e-newsletter "GeoEdLink" and by advocating the importance of earth science as a nationally strategic discipline with wide application across the resource industries and natural resource management.

Other areas of effort should also be advanced as described below.

AGC will continue to advocate that a national strategic approach should be taken by the Commonwealth government in ensuring that minor disciplines such as geoscience are supported in our Tertiary institutions. The AGC should develop and maintain a role in advocating that Earth Science Departments have the capability of teaching courses which do not depend on the petroleum and mineral sectors, including hydrogeology, engineering geoscience, environmental geoscience and natural hazards. Periodic surveys such as those undertaken in 2007 are fundamental to assessment of the health of the sector

AGC will continue to advocate that government funding arrangements should recognise the actual costs of teaching of different disciplines and the progressive increase in costs of teaching and teaching resources as students move through a course of study towards a major/honours degree. Industry support of research at Australian universities will also be strongly encouraged.

The issue of fragmentation of effort is not easily addressed nationally without a fundamental change in the approach to funding of the sector. Nonetheless the profession has a critical role in advocating to the universities the need for innovation in the way their earth science courses are delivered. AGC believes that consortia of professional groups based on the regional branches of its members and working with interested industry groups is the best way to influence the change in culture necessary – recent initiatives in Western Australia led by Jim Ross are an example to us all. The concept of networking the capture of students at regional centres and feeding them to appropriately skilled large departments has merit, provided there is a capacity to change the culture of retention of students at all cost, and to accept the notion of student mobility.

The profession has the best perspective on the issues needed to effect the necessary change to address emerging and future education needs. Whilst the AGC will continue to explore and develop ways and means to address these issues, the real challenge lies for the profession as a whole. Does it have the interest and the will to secure its future?

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