Proceedings World Geothermal Congress 2010
Bali, Indonesia, 25-29 April 2010

Postgraduate Geothermal Training in New Zealand

J. A. Newson, M. J. O'Sullivan, and S. J. Zarrouk

Dept of Engineering Science, University of Auckland, Private Bag 92019, Auckland, New Zealand.

j.newson@auckland.ac.nz

Keywords: geothermal training, Department of Engineering Science, University of Auckland, New Zealand

ABSTRACT

After a hiatus from 2003 to 2006 the University of Auckland, New Zealand, resumed teaching postgraduate geothermal courses in 2007 with the introduction of a five month Postgraduate Certificate in Geothermal Energy Technology (PGCertGeothermTech). It is designed for students who wish to obtain a University qualification in geothermal geoscience or geothermal engineering. The course consists of three postgraduate level lecture courses and a short (5 week) research project. Students who wish to combine geothermal subjects within another course of study, can credit the geothermal lecture courses to other engineering degrees. Those who wish to take shorter professional development courses are able to attend modules of the course that are considered to be suitable as stand-alone modules.

The current PGCertGeotherm (refereed to below as the "PGCert") has now been taught for two years, in 2007 and 2008, with eight students in each year. Three students in each year were sponsored by the New Zealand company Contact Energy Ltd., and one was sponsored by MB Century Ltd. The others had their own funding arrangements with their employers or their own companies. In 2007 there was one student who attended a part of the course, but in 2008 there were 13 students, sponsored by their companies, who attended various modules of the PGCert as professional short courses, and five who enrolled in one or more PGCert papers that were credited to another course.

Thus in the first two years of the PGCert course 16 students attended the full course, from Indonesia, Iran, New Zealand, Papua New Guinea, Philippines, Slovenia, and the USA. Students from France, Germany, Iceland, Indonesia, Kenya, Mexico, and New Zealand either credited one or more of the Geothermal lecture courses to another qualification, or attended the short courses. At the time of writing, student numbers in 2009 are not finalized, but it appears that PGCert enrolments will at least double.

1. BACKGROUND

Several papers document the history of geothermal training until 2005 (Dickson and Fanelli, 1995, Dickson and Fanelli, 1998, Hochstein, 2005, Fridleifsson, 2005); in brief, by 2003 the Iceland course, sponsored by the United Nations University (UNU), was the only remaining graduate level geothermal course, with the International Summer School on the Direct Application of Geothermal Energy still running short courses. At this time people involved in the geothermal industry began to comment on the lack of young professionals in the industry, the lack of training courses worldwide, and the lack of will on the part of industry, government or educational institutions to remedy this problem.

The recent history of geothermal training is understandable in the context of energy prices. In 2003 the price of oil was around $20/barrel, but by mid 2008 oil reached a maximum of $147/barrel, climate change was becoming accepted as a reality, and expanding the use of renewable energy had become a mainstream idea.

By 2005 geothermal resources were being investigated in Australia. The growing awareness of the potential geothermal resources and engineered geothermal systems (EGS) lead to the creation of an Australian geothermal industry, strongly supported by a government looking to encourage environmentally responsible power generation and energy use. The emerging Australian geothermal energy industry expected to provide between 1000 to 2200 MW of baseload electricity by 2020 (MMA, 2008). Similarly there was increasing interest in engineered geothermal systems in the United States (MIT, 2006), and the interest in the potential of geothermal energy on every continent has continued despite the 2008 world financial problems.

The Geothermal Institute at University of Auckland ran a very successful year-long Geothermal Diploma course from 1979 to 2002 (Hochstein, 2005). Unfortunately support from the New Zealand Government for the Diploma course was withdrawn at the end of 2002. At this time regulations for the shorter, one-semester PGCert were set up but it was not taught because of the lack of support from both the University of Auckland and the local New Zealand geothermal industry. This was despite the growing concern over global warming and the required development of clean energy sources; concern among professionals over the loss of momentum in geothermal research and training in New Zealand; and a potential shortage of geothermal professionals (SKM, 2005).

In 2006 Professor Mike O'Sullivan, leader of the Geothermal Reservoir Modelling Group in the Department of Engineering Science, and Associate Professor Stuart Simmons, Director of the Geothermal Institute, assembled a group of geothermalists to activate the one-semester Postgraduate Certificate in Geothermal Energy Technology.

The philosophy was to provide through the PGCert the backbone for a comprehensive geothermal training program involving university level papers, short lecture courses for professionals, graduate research degree courses and academic research programs. With the exception of Assoc. Prof. Stuart Simmons, the people initially involved in organising the course came from the Geothermal Reservoir Modelling Group in the Department of Engineering Science.

At the time when the decision to run the course was made the University was in the process of developing a cross-faculty research group called the Institute of Earth Sciences and Engineering (IESE). Geothermal energy was considered to be an important part of the research portfolio

for new Institute and therefore the old Geothermal Institute was taken over by IESE. However because of its research-only status within the University of Auckland, IESE cannot host University degree programmes and hence the PGcert course is hosted by the Department of Engineering Science in the Faculty of Engineering. However the IESE can and does run non-degree 'professional' short course training.

2. SUPPORT FOR THE COURSE

Against the background of a small initial number of enrolments and no special financial support from government bodies, running the course relied heavily on good will: (i) of the Department of Engineering Science which provided lecture rooms, teaching support, and computer facilities; (ii) of the retired staff of the old Geothermal Institute (Manfred Hochstein, Pat Browne, and Arnold Watson); and (iii) of the New Zealand geothermal industry, who responded positively and contributed lectures, site visits, and scholarships for the course.

A feature of the inherited good will from the Geothermal Institute days has been a close connection between industry and geothermal teaching. There has been very strong industry support for the PGCert in 2007 and 2008. Contact Energy Ltd has supported the PGCert with six scholarships over the two years, with a total value of NZ$120,000, and Century Resources (now MB Century) has provided two scholarships with a total value of NZ$40,000. Sinclair Knight Merz (SKM) have donated 14 hours of lectures each year, and GNS Science Wairakei have donated 12 hours of lectures and field tuition. In addition, Contact Energy, MB Century, Tuaropaki Power, and GNS Science, have given access to borefields, power stations, and geothermal areas, with staff accompanying groups of students for informal tours, training in taking field measurements, formal lectures, and student project supervision.

Chevron Geothermal (Indonesia) provided generous funding for three aspects of the training program: (i) the development of one-week short-courses on geothermal geoscience and geothermal engineering; (ii) the development of course material for the PGCert; and (iii) archiving of course material from the Geothermal Diploma.

The success of the PGCert in 2007 and 2008 and the strong support from the geothermal industry was sufficient to convince the University of Auckland to continue support geothermal training for at least the next three years.

3. PEOPLE

Over the period 2006 to 2009 there have been a core group of five to six people involved in organization, administration, and teaching of geothermal courses, with help and lecturing supprt from the University of Auckland, IESE, and the geothermal industry. People who have been involved in the core group are:

- Professor M. J. O'Sullivan (from 2006 to present)
- A/Prof. S.F. Simmons (up to 2007)
- Dr. S. Zarrouk (from 2006 to present)
- Ms. J. Newson (from 2006 to present)
- Ms. J. Brotheridge (administration 2006)
- Ms. O. Morgan (administration 2007-present)

4. TEACHING

Geothermal teaching at the University of Auckland involves four types of courses, all directed towards post graduate and professional training:

1. The one-semester Postgraduate Certificate in Geothermal Energy Technology
2. Professional short courses taught in New Zealand (one-week or four-weeks)
3. Research studies for ME, MSc or PhD degrees
4. Professional short courses taught in other countries (one-week)

The University of Auckland is currently planning a one-year taught Masters of Energy degree, with a target start date of 2011. It will include geothermal energy as an option but will also allow for other specialisations such as wind, solar and bio-fuels. Courses from the PGCert will be available for this degree.

Postgraduate Certificate in Geothermal Energy Technology

The backbone of geothermal training at the University of Auckland is the Postgraduate Certificate in Geothermal Energy Technology (PGCert). This one semester course includes lectures and assignments; field visits with data collection and interpretation; and a short research project. The minimum entry qualification is a Bachelors degree, preferably in Science or Engineering; and the University of Auckland also has strict English language requirements for postgraduate courses.

The topics covered are both geothermal geoscience and geothermal engineering. All students are required to complete the first two lecture courses (papers) which are an introduction to 'Geothermal Resources and their Use', and 'Geothermal Energy Technology'. The class then splits; students must chose between a 'Geothermal Exploration' paper, and a 'Geothermal Engineering' paper, where specialist geothermal topics are covered in more depth. The final five weeks of the course are devoted to a short research project resulting in a research report (approximately 40 pages). During the course there are two 6-day field trips to the Taupo Volcanic Zone, which involve lectures from geothermal experts and visits to power station, natural geothermal features, geological features, and geothermal energy direct use sites.

Figure 1 shows that the first and second years of the PGCert were attended by eight students each year. This paper was completed before numbers were finalised for the third year of the course (2009), but two months before the closing date more than 25 applications were already registered with the University, and the 2009 student number (15) shown in Figure 1 is likely to be a conservative estimate.

Figure 2a) shows the country of origin for the PGCertGeotherm students; the majority (8) come from South-East Asia, continuing a trend from the 1978-2002 Geothermal Institute Diploma course (Hochstein, 2005). There have been three students from the USA, which is a break from tradition, and the remainder are literally from all over the world.

Professional short courses and PGCert papers

One of the problems of specialist training courses for professionals is that many workers cannot take 5 months

leave to attend a course such as the PGCert. In view of the lack of training courses worldwide in the last decade, causing an acute shortage of trained geothermal people, it is very difficult for those currently working in the geothermal industry to take training leave for longer than a few weeks. Our response to this problem has been to allow people to attend selected parts of the PGCert course as 'professional short courses'. These students do not attain a University qualification, but are still able to participate in modules of the course.

In 2008 each paper in the course was offered as a short course, and also the field trips were offered as one week courses. The uptake for these courses was high, with an extra 18 students attending sections of the course. Among these were three engineering students, from Germany, France, and Iceland on their 'study abroad' year, who enrolled in geothermal papers as part of their engineering courses in other departments. Thus the number of students attending part of the PGCert course increased from one in 2007 to 18 in 2008 **(**Figure 1).

Logistically, all of these short courses proved difficult to organise. Therefore in 2009 only two short courses were offered in parallel with the PGCert. The first was a five week course combining most of the first two papers of the PGCert and including one 6-day field trip. The second (four-week) short-course was on geothermal reservoir modelling which includes part of the advanced geothermal engineering paper.

Of the students that have attended all or part of the PGCertGeotherm course, shown in Figure 2b) the majority are still from South- East Asia, but the European contingent is stronger (four students) and Africa features in this picture with five short course students from Kenya. Six students from New Zealand have attended parts of the PGCertGeotherm, and one has attended the complete course.

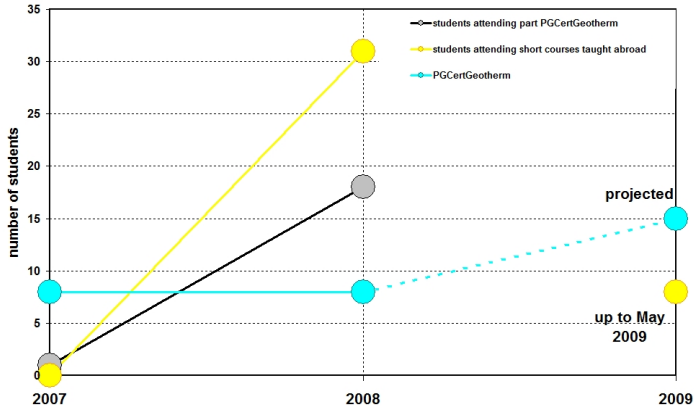
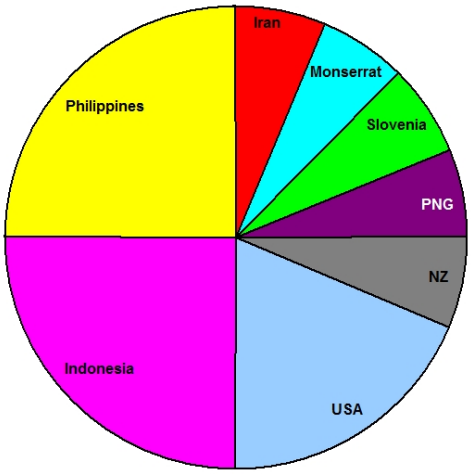


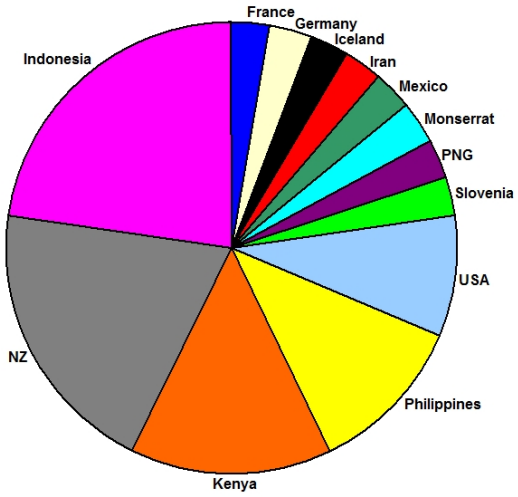
Figure 1. Number of students at geothermal courses run by the University of Auckland and IESE.

Research students

The Department of Engineering Science has six graduate students researching geothermal topics; two Masters candidates and four doctoral students. Four of the students are from New Zealand, one is from Turkey, and the other from China.



a)



b)

Figure 2. a) Nationality of students in the 2007 and 2008 Postgraduate Certificate in Geothermal Energy Technology, and b) Nationality of all students attending geothermal courses in New Zealand. Note that this paper has been written before the commencement of the 2009 PGCert course.

Other professional short courses

In addition to the PGCert and the parallel short courses there have been several one-week geothermal short courses both in New Zealand and overseas. These are organised through IESE and are advertised on their website. (http://www.iese.co.nz). Some of these short courses were commissioned by companies as part of their staff development programs. For instance, in October 2008 staff from the IESE and the Department of Engineering Science spent two weeks in Indonesia delivering two short courses for Chevron Geothermal – one week each on Geothermal Geoscience and Geothermal Engineering attended by a total of 31 students. Similar courses were delivered in April 2009 in Auckland (eight students), and more courses abroad are being planned for late 2009.

5. FUTURE

For the current postgraduate course to be as successful, there must be: a course every year, a consistent supply of students, continuing course evaluation and development, an institutional research program which 'feeds back' into the course, and cooperation and support from the geothermal industry.

Continuity is very important to the quality of an annual course. Teaching materials, laboratory and field programs and equipment, staff commitment, all need to be maintained. The closure of the Diploma course in 2002 lead to the loss of teaching materials, field equipment, teaching space, and geothermal and institutional knowledge. The people involved in delivering the PGCert course in geothermal are committed to maintaining the continuity of the course to ensure the best possible quality of geothermal training.

Maintaining the quality of geothermal training requires that the course fulfils the following criteria:

- It stays relevant - there is a responsibility on the training institution to ensure that the course stays relevant, and that it adapts to new developments. This requires that the course material is regularly reviewed, the course is evaluated by the students, and that organisers make the effort to stay abreast of developments in their own specialty and in the wider context of energy production and use.

- There is a research component – the PGCert has a small research project and we are currently working with the Engineering Faculty for PGCertGeotherm papers to be able to be credited to a masters program in Energy which will include a large research project. This will increase the research component of the geothermal program, and will strengthen ties with industry, as most engineering energy research is occupied with problems directly related to industry experience. It will also link the program to the wider energy context

- There is good cooperation with and support of industry. This is a strength of the University of Auckland program. The geothermal industry is the source, and sponsor of many postgraduate students; the industry provides real-life research problems, hosts field visits, field studies, and provides lecturers for some specialist topics.

- There is international benchmarking. This is difficult because of the small number of geothermal programs worldwide. We attempt to have good links with all of them and will collaborate with other institutions internationally over the delivery of geothermal courses.

CONCLUSION

The geothermal postgraduate courses have been offered by the University of Auckland since 2007. The PGCert, or modules of the course, have (up to May 2009) been attended by 35 students, with a further 39 attending one week short courses.

The PGCert and associated research degree courses of a Masters in Energy are offered by the University of Auckland, Faculty of Engineering, and short courses in geothermal topics are offered by the IESE.

Those involved in the PGCert and associated courses acknowledge the support of the University, the Department of Engineering Science, the IESE, and of the New Zealand geothermal industry in helping to build a successful training program.

REFERENCES

Dickson, M. H. and Fanelli, M., 1995. Geothermal Training at the International Institute for Geothermal Research in Pisa: Twenty-five years of activity, Proceedings, World Geothermal Congress 1995, Italy, vol 4, 2935-2937.

Dickson, M. H. and Fanelli, M., 1998. Geothermal Training Centres in the World. GHC Bulletin, December 1998.

Fridleifsson, I. B., 2005. Twenty-five years of geothermal training in Iceland, Proceedings, World Geothermal Congress 2005, Antalya, Turkey.

Hochstein, M. P., 2005. 25 years Geothermal Institute, Proceedings, World Geothermal Congress 2005, Antalya, Turkey.

Massachusetts Institute of Technology, 2006. The Future of Geothermal Energy. Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century. An assessment by an MIT-led interdisciplinary panel, prepared under Idaho National Laboratory Subcontract No 63 00019 for the US Department of Energy. Available at http:/geothermal.inel.gov

McLennan Magasanik Associates Pty Ltd, 2008. Installed capacity and generation from geothermal sources by 2020. Report to the Australian Geothermal Energy Association, August 2008.

Sinclair Knight Merz, 2005. Review of Current and Future Personnel Capability Requirements of the NZ Geothermal Industry. Report prepared for NZ Geothermal Association, available at http://www.nzgeothermal.org.nz/publications/Reports/NZGA_Geothermal_Capability_Review.pdf