THE GEOTHERMAL INSTITUTE (UNIVERSITY OF AUCKLAND, 1979-2003)

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SUMMARY: This short history of the Geothermal Institute (GI) at the University of Auckland describes its main activities and outputs during the last **25** years. Teaching of geothermal courses at the Institute began in **1979** and ceased at the end of **2002** when the **NZ** Aid programme withdrew its financial support of candidates from developing countries. A total of **774** fellows **(700** from **36** developing countries) had attended the annual postgraduate Diploma Course (665 fellows) and the shorter **(3** months) specialized professional training courses **(1 19** fellows). The graduate school had **108** graduates **(44** from developing countries) who completed their study programme. Alumni of the Geothermal Institute account for c. **44%** of all fellows **who** received training at the four international geothermal training centres (Auckland, Kyushu, Pisa, Reykjavik) between **1970** and 2002.

1. INTRODUCTION

Group training of candidates from developing countries in geothermal technology started at the International School at Pisa (Italy) and at Kyushu University (Japan) in **1970.** These were non-degree overview type of courses lasting on average between **9** and 2 or **4** months in Pisa and Kyushu respectively. This **was** the decade which saw a rapid expansion of geothennal projects in developing countries, sponsored by international and bilateral aid. Overview teaching, however, could not cope with the demand for a more specialized and academic type training. At the request of the UN Development Programme (UNDP) and with the support of the NZ Ministry of Foreign Affairs (MFA), the Geothermal Institute (GI) was established in **1978** at the University of Auckland (UA) to undertake, from **1979** onward, teaching of a post-graduate, **10** months long, academic Diploma course for earth scientists and engineers fiom developing countries and from New Zealand. After the course had started in Auckland, a 6-months training course also started at Reykjavik (Iceland) in **1979 as** part of a UNU training programme.

Fellows from developing countries attending the Auckland course received fellowships **from** either the UNDP - or **NZ** aid votes **(1979-1989).** From **1990** onwards MFA, later the NZ Ministry of Foreign Affairs and Trade (MFAT), became the main sponsor of fellowships and continued to do so until **the** end of **2002** when MFAT, after creating a separate NZ aid agency, cancelled its sponsoring role. Until then a total of **24** Geothermal Diploma courses had been held at the GI. The Institute increased its role in geothermal training by running parallel to the Diploma Course a shorter **(3** months) professional course, by establishing a flourishing graduate school in the Geology and Mechanical Engineering departments, by giving short geothermal courses in developing countries, and by holding annually a Geothermal Workshop marking the end of each Diploma Course. *An* overview of the activities of the Geothermal Institute (GI) is given in this paper.

2. THE GEOTHERMAL INSTITUTE (STAFF AND SUPPORT)

The core activity was the teaching of the Geothermal Diploma Course. The lectures covered **6** disciplines, namely: geochemistry, geology, and geophysics in earth sciences and geothermal fluid production, utilization, and reservoir engineering as engineering disciplines. *An* overview paper (c. **3** months) covered the role of each discipline in the context of geothermal exploration and exploitation. The structure of the Diploma Course has already been described in earlier papers (Freeston and Hochstein, **1980;** Hochstein and Freeston, **1985;** Hochstein, **1988).** In theory, the syllabus required teaching by *6* qualified staff members. Because of financial restrictions we started the course with only 4 academic staff, thus covering about **2/3** of the syllabus. For the remainder we relied on inputs by staff from other university departments, **NZ** government departments, and the NZ geothermal industry which all provided willingly support until the end. The number of staff later increased (up to **6)** and fiom **1996,** which saw the introduction of a new semester system, all disciplines were fully covered by GI staff.

Activities, policy decision, and student selection were controlled by a Board of Studies (BoS) made up by staff members of the university, representatives of NZ Government departments, the **NZ** geothermal industry, and the NZ Ministry of Foreign Affairs. Prof. R.N. Brothers

was instrumental in setting up the GI and was the first chairman of the Board (1979-1983); those who followed were Prof. R.F. Meyer (1984-1991), Prof. R. Sharp (1992-1996) and Prof. P. Brothers (1998 to 2002). Directors of the GI were: A/Prof. M.P.Hochstein (1979-1994); A/Prof. P.R.L.Browne (1994-1998) and A/Prof. A.Watson (1999-2002). A/Prof. S.F.Simmons took over directorship in 2003.

Staff at the Institute between 1979 and 2003 are listed below with reference to their main discipline or activity:

Geology:	A/Prof. P.R.L.Browne (1979-now);
Geochemistry:	Dr. K. Nicholson (1986-1989); A/Prof. S.F.Simmons (1990-now); (between 1979 and 1985 geochemistry teaching was provided by university staff, the former DSIR, and private industry);
Geophysics:	A/Prof. M.P.Hochstein (1979-1997); Dr.S.Soengkono (1990-2003); junior lectureship inputs by Mr. G.Caldwell (1981-1986) and Mr. S. Henrys (1987/88);
Engineering Disciplines:	A/Prof. D.H.Freeston (1979-1993); Dr.M.Dunstall (1994-2001); Dr.R.McKibbin (1981-1991); Mr.K.C.Lee (1992-2003); A/Prof.A.Watson (1996-2002).

An important link between students and academic staff was the non-academic staff:

Admin.Assistant:	Ms S. Forde (1979-1981); Mr.O.Huisse (1981-1999); Ms E. Biddle (1999 -2003);
Secretary:	Ms B. Newton (1979-1981); Ms M. Weston (1981-1996); Ms N.Saheed (1998-2003);
Technician:	Mr. E. Pak (1979-1985); Mr.A. Franklin (1986-1993); Mr. D. Hamilton (1993-2001).

This list, which does not include a few short stay non-academic staff, indicates the rather small turnover of GI staff during the last 25 years pointing to teaching and administration stability. Not listed are the large number (over 100) of staff and professionals from the University, NZ Government departments, and the NZ geothermal industry who willingly and with continuous interest contributed to the teaching of the Diploma Course and specialized courses. Their names and contributions are listed in the Proceedings of the Geothermal Workshops held at the University of Auckland at the end of each Diploma Course.

3. ACTMTIES OF THE GI (TEACHING AND RESEARCH)

Staff of the Institute was involved in four activities, all directed towards the training of geothermal students and professionals, namely:
1. the annual Geothermal Diploma Course (c. 10 months),
2. specialised professional courses (3 months),
3. irregular short training courses given in developing countries (usually 2-4 weeks), and
4. research studies centred on the graduate school.

3.1 The Geothermal Diploma Course (academic course)

Teaching the course was the core activity of the GI. The course was given for 24 years from 1979 to 2002. Statistical data of the course are listed in Table 1 which shows that a total 655 students (fiom 36 countries) attended the course, 52 % were earth scientists and 48% engineers. Academic records show that 592 candidates obtained the 'Diploma in Geothermal Energy Technology' (Dip GeothermTech) after passing all examinations and producing a written project report. A 'Certificate in Geothermal Technology' (Cert GeothermTech) was introduced in 1984 to recognise the achievements of candidates who passed 3 out of 4 written examinations. Between 1984 and 2002 a total of 30 fellows obtained the 'Certificate'.

The largest student group came from Indonesia and the Philippines (41%) which reflects the large training demand of these two countries where geothermal projects had been sponsored by bilateral NZ Aid programmes since the 1970's. The number of students coming from Asia (18%), Latin America and Africa (c.15% each) were each of similar proportion. About 89% of the students came from developing countries with the remainder coming from Europe (3.5%) and New Zealand (7.5%). The NZ student group in Table 1 is the only one which shows a significant decline in numbers over the years, reflecting in part the limited demand of a stagnant NZ geothennal industry. However, a significant number of NZ students (total of 101-see Table 1) also attended geothermal lectures as part of their Master program without enrolling in the Diploma Course. The proportion of female Diploma students increased steadily with time as a result of NZ Aid policy. Overall 11% of all Diploma students were female professionals. About 75 % of all Diploma students received fellowships to attend the course, either fiom the UNDP programme (1979-1989) or fkom the NZ aid votes (1982-2002). The remainder had either private sponsorship or were NZ students with subsidised entrance. The GI also sponsored some students (e.g. a few from Algeria and Turkey).

An English language training course, given prior to the Diploma Course, became more and more an integral part of the geothermal study programme. This course (c.3 months) started in Wellington in 1984 to prepare students with language difficulties for the academic course. In 1987 the course was moved to Auckland and re-organised by Dr. Judith Grant which improved significantly the language skill of all attending students. All together, a total of 284 Diploma students attended the language training course (1984-2002) with NZ MFA (later MFAT) covering the additional costs of 244 candidates and UNDP sponsoring the rest. Scientific writing tuition during semester breaks was introduced later to assist foreign students with writing good project reports.

3.2 Specialized (non-academic) geothermal training courses'

Employers of our Diploma students told us in 1984 that the Diploma course was excellent for their junior staff but it was too long for more senior staff who also were in need of some specialized training albeit through shorter courses. Results of a questionnaire showed that 1. 'Reservoir engineering' and 2. 'Environmental problems' were quoted most frequently for such prospective professional courses. Assessment by GI staff and the NZ geothermal industry showed that a specialized training course of 3 months would adequately cover each topic. The proposal was accepted by the MFA section looking after aid programmes which made 6 fellowships available for each of the courses.

The 'reservoir engineering' course was originally organised by Dr. R. McKibbin with a large input by Prof. M. O'Sullivan (School of Engineering). The first course was given in 1988. Subsequently, the reservoir engineering course was given every year until 1997 'and again in 2000 and 2001. GI staff had too little experience to mount the Environmental Course. Such a course could only be given from 1997 onwards when A./Prof.K.Brown (Geology Dept.) put together a syllabus for such a course. The 'environmental' course dealing with environmental problems associated with geothermal development was given for the first time in 1998, and then again in 1999 and 2002. Statistical data of the 3-months specialized courses are also listed in Table 1 which shows that a total of 119 candidates (from 17 countries) attended the 15 courses (i.e. an average of c. 8 fellows per year). 90 candidates received NZ Government sponsored fellowships, the remainder were privately funded. More than half (c.54%) came from Indonesia and the Philippines, only 14 students (12%) came from developed countries (Europe and New Zealand). The proportion of female students (c. 18 %) was higher than that of the Diploma Course. A total of 18 students (15%) had previously attended the Geothermal Diploma course.

3.3 Geothermal Training (in developing countries)

GI staff was also involved in teaching geothermal technology topics in several developing counties. At least 18 short courses, each lasting between 1 and 4 weeks, were given in 6 developing countries between 1979 and 2002. Most of the courses (13 out of 18) were held in Indonesia and one course each in PR China, El Salvador, Mexico, the Philippines, and Turkey. Many Indonesian courses were organised by A/Prof. Freeston, some were sponsored by NZ aid, others by PERTAMINA (Indonesian Govt. Oil Co.), and given by several GI staff members. Several short courses were given by single staff. Allowing for some repeat attendance it was estimated that at least 300 candidates attended our overseas courses.

GI staff also taught candidates from developing countries at the three other international geothermal schools and at Indonesian universities. Between 1981 and 1990 staff spend about 2 months each with teaching at Reykjavik (A/Prof. Freeston and A/Prof. Browne), at Pisa and Kyushu (A/Prof. Hochstein), and at ITB Bandung (Dr. McKibbin).

3.4 Graduate School

After the first diploma course the first graduate students started to enroll at the Geology Dept. or the School of Engineering to undertake a research study of a geothermal topic which was supervised by GI staff. A total of 108 graduates completed their MSc-, ME-, or PhD study at the Institute between 1980 and 2002. Awarded were 50 MSc degrees (earth science), 30 ME degrees (engineering), 16 and 8 PhD degrees in earth sciences and engineering respectively - the 108 awarded degrees also included 4 other degrees (MPhil, BScHons). At present (in 2003) 8 graduates are completing their studies.

A total of 44 graduates came from 8 developing countries and 64 graduates from 6 developed countries (46 from New Zealand (incl. 2 from Australia), 11 from the US, and 7 from Europe). One third of the graduates had previously attended the Diploma Course who almost all received a NZ Government fellowship for the length of their graduate studies. There were 20 female students among the graduates. The Graduate School was also attended by 10 foreign students who undertook a year of a research study without gaining a degree at Auckland University; this group included 6 Fullbright fellows.

4. RESEARCH AND AWARDS

Geothermal research has been an important activity of the Geothermal Institute involving Diploma students, the graduate school students, and staff. Diploma students had to submit a written project report (c. 2 months completion time) on aspects of geothermal exploration, assessment, production, or utilization as part of their academic course. Between 4 to 5 of the projects were annually selected for oral presentation at the NZ Geothermal Workshop. About 600 Geothermal Diploma Projects have been deposited with the Library of the School of Engineering, their abstracts are listed in the Proceedings of the NZ Workshops. Diploma students (c.60) also published some of their work in the Proceedings of the NZ Geothermal Workshops, sometimes years after they had left New Zealand. Half of the students (c. 55) in the graduate school also presented some of their research work in the Proceedings.

Geothermal Institute staff published c.60 papers in the NZ Workshop Proceedings and c.100 papers with students as co-authors; of the c. 1100 papers in the Proceedings since 1979, about 25% were therefore written by staff, Diploma students, and graduates (allowing for joint authorship between the groups). Staff of the GI also published *c.* 150 refereed scientific and technical papers (and sections in books) in internationaljournals (until 200 1). Another c.40 papers of GI staff and students appeared in the Proceedings of overseas geothermal workshops such as the Stanford Geothermal Reservoir Workshop, the (US) Geothermal Resources Council conferences, and more recently, the geothermal workshops in the Philippines and Indonesia. Most of these workshops and the Geothermal World Congress conferences (every 5 years) were attended by at least one staff member who usually presented a paper; this contributed significantly to spreading our research results. Staff also wrote a number of technical reports for international and bilateral aid agencies, for local bodies, and consulting reports. The annually published Research Reports of the University of Auckland list a total of c.70 technical reports written by GI staff since 1979. A large effort also went into the writing of teaching manuals for each of the 8 lecture courses since appropriate texts were not available.

Several awards were given every year to our geothermal students. The most prestigious was the 'Mitsubishi Prize in Geothermal Technology' which was sponsored jointly by three different Mitsubishi companies. The Prize was awarded from 1981 to 2000 to the most meritorious Diploma students on the basis of their academic performance and professionalism; it allowed for a trip to Japan to inspect geothermal developments in that country. A list of the 20 students who obtained the Prize is shown in Table 2. Other prizes were given annually at the end of the Course to the best earth science - and engineering students and were provided during the last 10 years by IGNS and Century Res. Ltd. (formerly Works Geothermal) respectively. Prizes were also presented to students at the end of the NZ Geothermal Workshop by the New Zealand geothermal industry (for example, GENZL, Sinclair Knight Merz Ltd - former KRTA, former Design Power, and Ormat Pacific Ltd.) and the Geothermal Institute.

Another important award was the annual Mitsubishi Fellowship which allowed academic staff and professionals from overseas universities and companies to join the Institute and to undertake some teaching and research in their own discipline, usually during one term; the Fellowship was awarded between 1981 and 2001. It could be split and was sometimes awarded to deserving graduate students. The Mitsubishi Fellows at the Geothermal Institute are also listed in Table 2. A few visitors (Table 2) came to us with other fellowships. All visiting fellows contributed significantly to our teaching and research.

5. IMPACT OF THE DIPLOMA COURSE

Data are available which allow some comparison of the student populations at Pisa, Kyushu, and Reykjavik during the duration of the Auckland courses (Dickinson and Fanelli, 1995; Fridleifsson, 2000; Ushijima, 2002). Teaching and training schedules indicate three types of geothermal courses which were open for candidates from developing countries:

1. dominantly overview type courses at Pisa (average c. 9 months) and Kyushu (2 or 4 months),
2. dominantly specialized teaching at Reykjavik (6 months) and Auckland (3 months course), and
3. a one year post graduate Diploma course at Auckland with integrated and linked teaching of overview and specialized topics.

Statistical data of the student population at the four international training centres are listed in Table 3. Of the total of 1764 candidates who received geothermal tuition between 1979 and 2002, 711 (c.40%) attended the courses in Pisa and Kyushu, 655 (37%) the 1-yr degree course in Auckland, and 398 (22%) the specialized teaching courses at Reykjavik and Auckland. At least 5% of all candidates attended more than one course; a total of 224 (out of 1764) students were from developed countries. The number of students (774) who attended the two Auckland courses make up c. 44% of all candidates at the four international geothermal schools.

6. SUMMARY

Geothermal Technology was taught at the Geothermal Institute, University of Auckland, from 1979 to 2002. The annual Diploma course was attended by a total of 655 candidates (595 from developing countries); c. 400 fellows and c. 100 fellows were sponsored by fellowships made available by the NZ Government and the UNDP respectively. Specialized professional training was given to 119 candidates (105 from developing countries) from 1988 to 2002; c.90 candidates received fellowships from the NZ aid programmes. Maintaining the sponsorship role for the Geothermal Institute over 25 years was one of the largest NZ aid contributions (of the order of 20 Mill. $ NZ).

A change in NZ aid policy, which will focus on aid projects to eliminate poverty, mainly in the Pacific region, and administered by the new NZ aid agency, led to the closure of the Diploma- and specialized training courses at the end of 2002. At that time there was still a significant demand by developing countries for geothermal training at Auckland, especially for the specialized courses, as documented by the numerous applications which had been received. Protests by the international geothermal community (IGA News, Nr.50, 2002) to MFAT did nothing to change its decision. It appears now that aid administrators of developed countries are not willing to sponsor such training if it involves support of teaching institutions. This argument was used by the UNDP Programme when it withdrew its support from the Auckland course in 1989; it also explains the closure of the course at Pisa and more recently that at Kyushu.

Part of the old Geothermal Diploma Course will be offered during the first half of 2004 in form of a 1-semesteracademic course at the advanced undergraduate level. It is planned to be a 'Study Abroad Programme in Geothermal Energy' for fee paying students from overseas.

7. REFERENCES

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Table 1: Statistics of the Geothermal Courses given at the Geothermal Institute

1.1 Geothermal Diploma Course

	1	2	3	4	5	6	7	8	9	10	11
1979-83	131	0	6	60	21	44	15	23	4	24	7
1984-88	141	71	9	66	23	62	22	20	5	9	16
1989-93	134	79	14	61	30	51	27	18	3	5	16
1994-98	142	69	22	78	21	68	21	16	5	9	41
1999-02	107	65	22	49	22	43	18	19	5	1	21
sum	655	284	73	314	117	268	103	96	22	48	101

1.2 Short term (3 months) professional courses

	1	2	3	4	5	6	7	8	9	10	11
1988-92	42	0	3	40	4	28	6	2	1	1	
1993-97	43	0	7	41	4	22	9	1	3	3	
1998-02	34	0	12	12	5	15	8	1	5	1	
sum	119	0	22	93	13	65	23	4	9	5	

Columns:
1: number of students
2: students attending the English Course
3: female students
4: engineering students
5: students from Asia
6: students from Indonesia and Philippines
7: students from Latin America
8: students from Africa
9: students from Europe
10: NZ students
11: NZ students taking 1 Diploma paper

Table 2: Holders of the MITSUBISHI Fellowship and the MITSUBISHI Prize

Year	MITSUBISHI Fellowship Holders (incl. other teaching fellows)	MITSUBISHI Prize (Diploma students)
2001	Dr. Feeydoun Chazban (Iran) (ES)	
2000	Dr. Cedric Malate (Philippines)(Eng)	Armando Arciaga (Philippines)
1999	Dr. Fauzi Sulaiman (Indonesia) (Eng)	Ontowiryo Alamsyah (Indonesia)
1998	(appointments delayed by 1 yr)	Imam Baru Raharjo (Indonesia)
1997	A/Prof. Ryuichi Itoi (Japan) (Eng)	Ali Mundakir (Indonesia)
1996	Prof. Ladzi Rybach (Switzerland)(ES) Dr. Al H.Truesdell (US)**	Salvius Pantangke (Indonesia)
1995	Prof. John Lund (US) (Eng)	Rosella Dulce (Philippines)
1994	Prof. Kiril Popowski (Macedonia)(Eng)	Peter Aloo (Kenya)
1993	Prof. Grant Heiken (US) (ES) Nessy Nezhadkhoujeh (NZ)* (Eng)	Glenn Golla (Philippines)
1992	Dr. Don E.Michels (US) (Eng)	Nathaniel Malaqui (Philippines)
1991	Prof. David I.Norman (US) (ES) Klaus Regenauer-Lieb (Germany)*(ES)	Julio Guidos Pineda (El Salvador)
1990	Dr.Colin Harvey (NZ) (ES) Huang Yicun (PR China)* (Eng)	Wilson Clemente (Philippines)
1989	Prof. Bill Chen (US) (Eng) Dr.Rosa Prol-Ledesma(Mexico)** (ES)	Rommel Obate (Philippines)
1988	Prof.Rudolf Gutdeutsch(Austria)**(ES) Marcel van Dijck (NZ)* (ES) Graeme Scott (NZ)* (ES)	Raj Bansh Singh (India)
1987	Dr.Hjalti Franzson (Iceland) (Eng) Dr.Doddy Abdassah (Indonesia)(Eng)	Suroto (Indonesia)
1986	Dr.Sachio Ehara (Japan) (ES) Prof. Edward Appleyard (Canada)(ES)	George Muga (Kenya)
1985	Dr.Jean-Michel Coudert (France)(Eng) James Kanyua (Kenya)* (Eng)	Francis Sta.Ana (Philippines)
1984	Basil Stilwell (NZ) (Eng) Graeme Scott (NZ)* (ES)	Mihai Sarbulescu (Romania)
1983	Kelvin Youngman (NZ)* (ES) Graeme Scott (NZ)* (ES)	Gil Batayola (Philippines)
1982	Dr. Einar Eliasson (Iceland) (Eng)	Teklu Hadgu (Ethiopia)
1981	Dr. Al H. Truesdell (US) (ES)	Ricardo Marquez (Mexico)

* Master- and PhD students (GI)

** Other fellowships (UA Foundation and overseas fellowships)

Table 3: Student population at International Geothermal Training Courses (1970-2002)

Course Length (months)	Kyushu 2 (later 4)	Auckland 3	Reykjavik 6	Pisa av. 9	Auckland c. 10
Period					
1970-78	124	0	0	95	0
1979-88	135	6	74	180	272
1989-98	96	89	139	49 [1]	276
1999-02	32 [2]	24 [3]	66	0	107 [3]
Sum	387	119	279	324	655

[1] last course in 1992; [2] last course in 2001; [3] last courses in 2002.