Iceland and the Exportation of Geothermal Expertise

The Role of the United Nations University Geothermal Training Program in Fostering International Relationships

7/29/2013
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List of Acronyms

- UNU: United Nations University
- UNU-GTP: United Nations University Geothermal Training Program
- NEA: National Energy Authority of Iceland
- ISOR: Icelandic Geosurvey

Introduction

Iceland has created a nice market for itself internationally as the engineering and geoscience experts of high-temperature geothermal energy development. This advancement of a knowledge-based economy is facilitated by the United Nations University – Geothermal Training Program (UNU-GTP) in Reykjavik. Since its inception in 1979, the UNU-GTP has acted as a coordination hub for Iceland's universities and businesses to further connections internationally. Through careful selection of partners and strategic outreach mechanisms, the UNU-GTP has forged alliances that have served to bolster the reputations of its academic institutions as well as opened project opportunities for its geothermal industry abroad. This report will provide a brief history of the UNU-GTP, examine its operation as a training program, and explore how the selection of its participants and continued involvement with graduated Fellows have helped to strengthen these international relationships.

UNU-GTP History

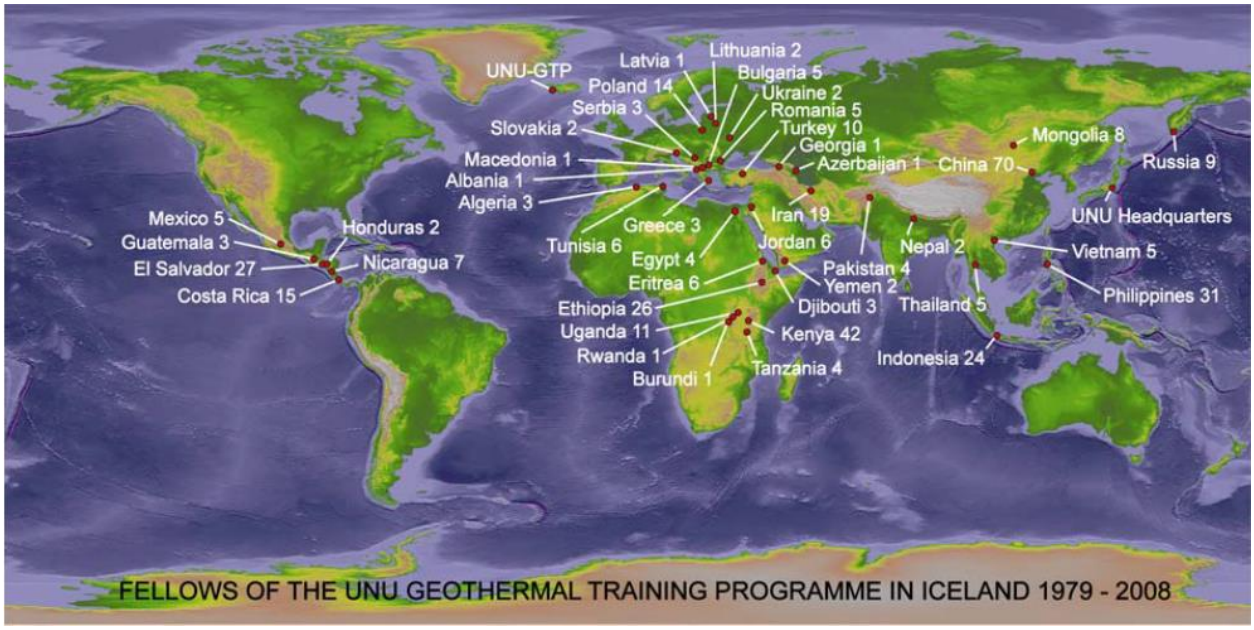
The United Nations University system was initiated under the direction of UN Secretary-General U Thant in September 1975 in order to create an academic institution dedicated to advancing the UN Charter objectives of peace and progress (UNU 2012). The seventy-five member nations were asked to support its establishment through contributions to an Endowment Fund or by hosting a research institute or training program. In January 1976, the government of Iceland submitted its first proposal to the UN with respect to offering either a geothermal or fisheries training program (Fridleifsson 2008). After an international workshop, it was agreed that a geothermal training program could best support the UN's needs at that time.

The next consideration was whether to house this program at the University of Iceland or in Iceland's National Energy Authority, Orkustofnun, hereafter referred to as the NEA. The UNU Vice Rector Walter Manshard visited Iceland in June of 1976 to tour these facilities and elected to utilize the NEA, which as a government research institute contained a large number of geothermal specialists, excellent laboratories, drill rigs, and logging equipment (Fridleifsson 2008). Although still a part of the NEA, in 2002 the Geoscience division of the Authority split off to form Iceland Geosurvey (ISOR). ISOR took over the UNU-GTP and other research aspects of the NEA to free it up to focus on its increasing administrative and regulatory responsibilities (Geosurvey 2013). To this day, the courses and lab work of the UNU-GTP are still held in the ISOR facilities.

Through 1976-1978, the NEA hired staff and developed a curriculum to prepare the way for the first class of UNU-GTP Fellows. This first class brought in only two students from the

Philippines; however, over the course of its operation, class sizes have steadily grown to an average of 30 enrollees annually. From 1979-2012, 515 scientists and engineers from 53 countries have participated as Fellows in the UNU-GTP (UNU-GTP 2009). Below is global map that indicates the number of participants and their respective countries of origin.

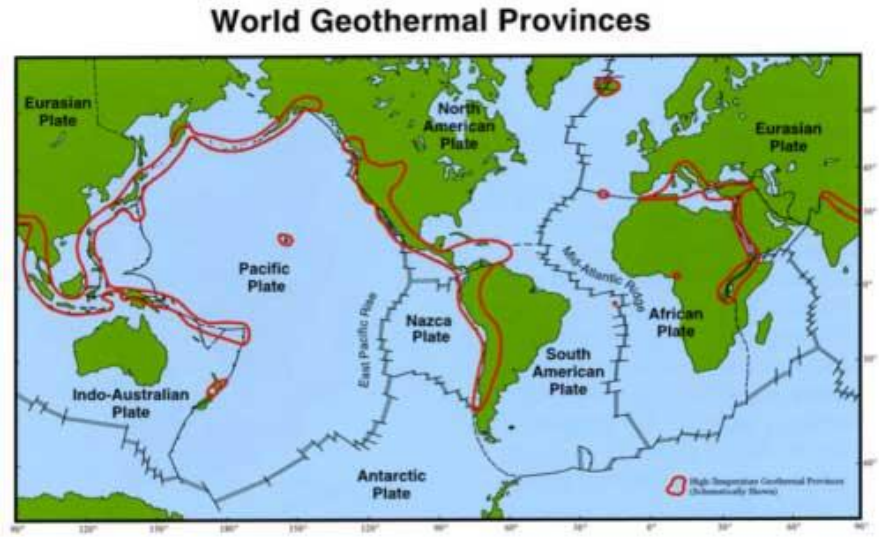
Figure 1: Map of UNU-GTP Fellows 1979-2008



(Fridleifsson 2008)

The correlation of the UNU-GTP Fellows to regions of the world endowed with geothermal resources can be viewed by comparing the student's home countries with the global geothermal map below.

Figure 2: Global Map of Regions with Geothermal Resources



(Survey September 2012)

Funding

According to the Director of the NEA, the average cost per student to attend the UNU-GTP is $60,000 (Johannesson, 2013). This cost is covered entirely by the government of Iceland, specifically, the Ministry for Foreign Affairs and the Icelandic International Development Agency. Iceland absorbs these costs as part of its financial commitment to the United Nations and the Millennium Development Goals. For these costs to be characterized as international aid, the UNU-GTP must focus on training those in the developing world. Although it would be possible for a student from the United States to attend, that person would be responsible for providing their own funding and accommodations. (Johannesson, 2013).

Training Program

The UNU-GTP is a six month postgraduate training program, aimed at assisting developing countries with significant geothermal potential in establishing groups of specialists in resource exploration and development (Orkustofnun 2012). The program is designed to recruit those already employed, or potentially employed within the industry, to receive specialized training in one of nine areas. This training combines course work with intensive on-the-job project experience with Icelandic professionals. All Fellows jointly participate in a five to six week introductory course, followed by work in their individual chosen field, and then complete a final research project. The research projects and final reports are tailor-made to fit the specific needs of the Fellow's home country or institution. In many cases, the participants bring with them data from geothermal projects in their home country to build their program experience around (Fridleifsson 2008). A breakdown of this schedule and the nine specialized areas are shown in the table below.

Table 1: Six Month Specialized Courses at UNU-GTP

<table>
<tr><th>WEEK</th><th>Geological Exploration</th><th>Borehole Geology</th><th>Geophysical Exploration</th><th>Borehole Geophysics</th><th>Reservoir Engineering</th><th>Environmental Science</th><th>Chemistry of Thermal Fluids</th><th>Geothermal Utilization</th><th>Drilling Technology</th></tr>
<tr><td>1</td><td colspan="9" rowspan="5">Introductory Lecture Course including all aspects of geothermal energy, exploration, and utilization, practical training and short field excursions.</td></tr>
<tr><td>2</td></tr>
<tr><td>3</td></tr>
<tr><td>4</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td rowspan="5">Field Geology
Maps and photos
Structural Analysis
Hydrogeology</td><td rowspan="5">Drilling
Petrological logging
Alteration
Mineralogy</td><td rowspan="5">Resistivity methods
Thermal methods
Magnetics
Gravity</td><td rowspan="5">Course on well logging and reservoir engineering including logging and well testing reservoir physics and stimulation, tracer tests, and computer programs</td><td rowspan="5">EIA planning
Chemistry
Physics
Biology
Revegetation
Health & safety</td><td colspan="2">Sampling of fluids and gas
Scaling and corrosion</td><td rowspan="5">Drilling equip & procedures
Well design
Safety
Management
Rig operationss</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="3">Analytical methods
Thermodynamics
Geothermometers</td><td rowspan="3">Heat transfer & fluid flow
Control systems</td></tr>
<tr><td>9</td></tr>
<tr><td>10</td></tr>
<tr><td>11</td><td colspan="9" rowspan="2">Excursion to the main geothermal fields of Iceland</td></tr>
<tr><td>12</td></tr>
<tr><td>13</td><td>Field work on deeply eroded strata</td><td>Aquifer modelling</td><td>Data processing techniques</td><td>Logging methods
Data evaluation</td><td>Responses to exploitation</td><td>Gas dispersion and abatement</td><td>Water rock interaction</td><td>Design of plants and systems</td><td>Cementing
Completion</td></tr>
<tr><td>14</td><td colspan="9" rowspan="3">Project Work</td></tr>
<tr><td>15</td></tr>
<tr><td>26</td></tr>
</table>

(Fridleifsson 2008)

Fellows

Those selected for participation is this program do not apply for admission individually, but are instead nominated by a local geothermal company or research entity. Potential Fellows must also satisfy the following criteria: have a university degree in science or engineering, a minimum of one year practical experience in geothermal work, speak English fluently, have a permanent position at an energy agency/utility, research institution, or university, and be under 40 years of age (Orkustofnun 2012). Of these criteria, the UNU-GTP has commented that the requirement that candidates be fluent in English has hampered participation from certain parts of the world, such as Latin American (Fridleifsson 2008).

The selection of Fellows also entails site visits from the UNU-GTP, including personal interviews with possible students. The rigorous selection process is credited as one of the keys to the programs' success, with only eight Fellows not able to complete the program; most of which were attributed to medical reasons (Fridleifsson 2008). A more in depth look at these site visits will be explored later in the report.

Instructors

Approximately 70% of the UNU-GTP's instructors are brought in from the NEA, with the remainder coming from the University of Iceland and businesses in Iceland's geothermal industry (Georgsson, 2013). These teachers are employed on short-term contracts, which allow the training program to remain dynamic and flexible. As new Fellows are brought in, the UNU-GTP evaluates the needs of their country's geothermal development, and hires those best equipped to develop that capacity. These short term contracts also allow the UNU-GTP to employ some of the brightest minds in engineering and geoscience as they do not have to leave their full time employer in order to participate as instructors.

Capacity Building Beyond the UNU-GTP

In the last decade, the UNU-GTP has decided to expand on its training program by offering workshops and short courses held overseas. These courses offer greater flexibility to cater more directly to the needs of a region, and further outreach to new partners. The first of these annual programs was conducted in Africa in 2005, and they have since expanded to Central America in 2006 and Asia in 2008. The UNU-GTP anticipates the courses may in the future develop into sustainable regional geothermal training centers (UNU-GTP 2009). .

Workshops

"Workshops for Decisions Makers" were first held in Kenya in 2005 as a part of a cooperation between the UNU-GTP, the United Nations Environmental Program (UNEP), and KenGen the largest power producing company in Kenya. Members of energy and finance

ministries as well as representatives of power companies from six East African nations were brought together for one week to promote cooperation between specialists in neighboring countries, and enlighten top level decision makers of the issues associated with geothermal energy development. Topics of discussion included the phases of development, regulations, manpower, equipment, and financing (UNU-GTP 2009). The UNU-GTP's role in this workshop was to guide political understanding, produce reference materials, and hire lecturers. Since this first workshop, these gatherings of Decision Makers have been conducted in El Salvador and China.

Short Courses

Building on the momentum of the Workshops for Decision Makers, the UNU-GTP follows these with one to three week short courses on a variety of topics. Whereas the workshops seem to highlight what is already occurring, the short courses serve to bridge gaps in understanding and foster development of greater capacity. Invited participants for these courses are young scientists and engineers who, like the Fellows, are actively or potentially employed by the geothermal industry. The short courses combine lectures with active field work and project assistance, with former UNU-GTP Fellows brought in as lecturers and mentors.

The incorporation of the short courses has allowed the UNU-GTP to reach a much larger audience and multiply trained workers in a shorter time frame (UNU-GTP 2009). In just seven years, the short courses have helped to train nearly 700 students, compared with the more than thirty years it has taken the six month program to train 500 (Georgsson, 2013). Some of the reasons they have been able to reach more students include: not requiring a college degree for participation, courses available in the local language, and shorter time commitments allowing students to remain at home to support their family. As the Deputy Director of the UNU-GTP explained, the short courses have helped to create a "critical mass" of students that go to their local governments and push them toward geothermal development. This push has become apparent in nations such as El Salvador (Georgsson, 2013).

Also as a consequence of the short courses, the UNU-GTP has had to increase the number of part-time instructors hired to about 50-60 per year. Interestingly, this expansion may not have been possible were it not for the economic downturn in 2008. From 2005-2008, the UNU-GTP experienced some difficulty recruiting teachers due to an abundance of geothermal work domestically (Georgsson, 2013). With the financial collapse, Icelandic banks were no longer able to finance projects in the country, leaving some geothermal professionals short on work. This greater availability allowed the UNU-GTP to increase its recruiting capability, and may have helped to drive the advancement of these short courses.

Customer Designed Short Courses

The latest incarnation of the UNU-GTP's outreach is the Customer Designed Short Course. This service began in 2010 as a way to provide training to those countries planning to fast-track development of geothermal. Unlike the other courses and workshops, which are funded by the UNU-GTP and other UN institutes, customers, such as local power companies, hire the UNU-GTP to provide quality content tailored to topics that they request. These courses vary in length from one week to as long as eleven, and have been held to date in Indonesia, Kenya, and El Salvador. The expansion of the UNU-GTP to these other training mechanisms has been in response to feedback from participant countries that were seeking to keep training as short and flexible as possible, while still adequately improving the knowledge and skills of the trainees (Fridleifsson 2008).

Keys to Fostering International Relationships

The UNU-GTP understands that creating strong ties internationally is important not only to the future of their institution, but to the businesses and universities they partner with in Iceland. They are methodical in fostering these bonds before, during, and after the Fellows time with them. Three of the key factors to their success are: targeted country selection and site visits, working on projects with local businesses, and maintaining contact with, and promoting the accomplishments of graduated Fellows.

Country Selection and Site Visits

The experience of the UNU-GTP suggests that in order for a technology transfer to be successful and sustainable it is necessary to train a cohort of at least ten specialists in a given country or region (Orkustofnun 2012). For this reason, they often select multiple students from the same area over a relatively short period of time. Furthermore, although they do seek to add new countries to their training program, they caution against spreading efforts too thin (Orkustofnun 2012).

When deciding to incorporate a new country, the selection process and site visits are extensive. Once a nation reaches out to the UNU-GTP, they conduct a thorough evaluation of its geothermal potential. Besides merely examining whether the resource is available, they look at the role that geothermal has within the country's master energy plan. Additionally, they evaluate the potential of its government, utilities, and universities to actually engage in geothermal research and utilization. Based on this initial data, their training needs are assessed and recipient institutions are selected. The directors of these establishments are then contacted to nominate potential candidates.

After candidates are chosen, the Director, or Deputy-Director, of the UNU-GTP visits the country. These site visits are incredibly important as they allow the Director to interview

candidates, tour geothermal fields, and look more closely at the work of local businesses and universities. Furthermore, these trips are tied in with local or regional geothermal energy conferences and seminars, at which the Director can participate or give lectures. The founding and still acting Director of the UNU-GTP, Dr. Ingvar B. Fridleifsson, has stated, "The site visits have, without a doubt, contributed very significantly to the successful transfer of technology from Iceland to the recipient countries"(Fridleifsson 2008). By conducting these trips, Iceland and the UNU-GTP are able to establish relationships internationally before the Fellows even arrive for training. These site visits have been deemed so valuable that since 1979 the UNU-GTP has undertaken 172 of them, averaging out to about six country visits per year (Fridleifsson 2008).

Working with Icelandic Businesses

The UNU-GTP maintains only six full-time staff members. Their teachers are contracted from a variety of research institutes and businesses, with ISOR contributing approximately 60% of them (UNU-GTP 2009). Some of the firms that have chosen to work with the UNU-GTP are Mannvit, Vatnaskil, and Reykjavik Geothermal. These companies are also featured as prominent players in the Gekon Geothermal Cluster (Porter 2010). The scientists and engineers of these firms contribute both as lecturers for the UNU-GTP, as well as providing opportunities for Fellows to work with them on projects. In this way, Fellows spend a significant portion of time developing relationships with Icelandic businesses during their training. Accordingly, it seems interesting to note that the top international locations listed for their projects, China, Kenya, Indonesia, Ethiopia, India and El Salvador, also correspond to the countries with the greatest enrollment at the UNU-GTP (Geothermal 2013, Mannvit 2013, Vatnaskil 2013) . This suggests that when graduated Fellows return home to develop their country's geothermal resources, they frequently sought involvement from businesses and institutions in Iceland that theu already have experience working with.

Maintaining Contact with Fellows

Upon completion, the UNU-GTP has found that 80% of all trainees continue to work in the geothermal industry for five years or more, with many going on to be the leading specialist in their home country (Fridleifsson 2008). As such, graduating Fellows are encouraged to maintain relationships with the UNU-GTP, other Fellows, and the international geothermal community. This is accomplished through the use of an alumni network, and by the continued promotion of graduate's achievements.

Regular contact is held with former Fellows by sending them the UNU yearbook, and an annual newsletter. Additionally, an updated directory of Fellows and their collaborative partners is sent out at least once a year to all alumni. The UNU-GTP also invites, and pays for, its graduated Fellows to participate in its regional workshops and short courses. This serves to

not only advertise the skill set the UNU-GTP can foster in trainees, but also to further integrate their regional connections.

Furthermore, the UNU-GTP goes to great lengths to promote the accomplishments of its graduates. Each year, the final project reports of all trainees are published in "Geothermal Training in Iceland". Copies of this text are available upon request and are sent to all former UNU Fellows, universities, and leading geothermal research institutions in over 50 countries (Fridleifsson 2008). Participation in international conferences is also encouraged by the UNU-GTP. Every five years, the International Geothermal Association organizes the World Geothermal Congress. The UNU-GTP sponsors many of its graduates to attend, including paying the way for 83 of them in 2010. These conferences are seen as a great way to network and to highlight UNU-GTP Fellows. Of the 1,034 refereed papers at the last conference, 199 (19% of them) were authored, or co-authored by former Fellows from 31 developing nations (UNU-GTP 2009). This sort of international recognition serves to cement the role of the UNU-GTP as the pre-eminent institution for geothermal training.

Advantages of a UN University

In evaluating the UNU-GTP, the question arises whether such success would be possible if it were operated as a geothermal training program not affiliated with the United Nations. While there may not be a definitive answer, operating as a UN University does carry certain advantages. First, continuity, the UN provides stability to the funding and administration of the program. As a UN partner, the government of Iceland has entered contractual agreements to maintain its funding and operation, where another program may be subject to the whims of a changing political landscape (Georgsson, 2013). Second, security, those in the developing world are generally more comfortable working with the UN than any specific country or private entity. For them, the UN is familiar and viewed as a "safe" entity that will look out for their interests (Johannesson, 2013). And third, prestige, the UN title gives the program a certain status. This status commands respect internationally, and helps in recruiting the finest teachers and students. Furthermore, graduating Fellows are able to return to their local workforce with the prestige of participating in a UN program (Georgsson, 2013).

Conclusion

The United Nations University system has characterized itself as the "network of networks", coordinating and expanding the international network of scientific institutions (UNU 2012). The Geothermal Training Program in Iceland, as one of the most sustainable and longest lasting of the UNUs, has exemplified this ability to cultivate and retain international connections. By carefully selecting participants beforehand, linking them with Icelandic

business and universities during training, and continuing outreach and engagement afterward, the UNU-GTP has helped to export Iceland's geothermal expertise abroad. This emphasis on partnership will most likely continue in the days ahead with the UNU-GTP adding more programs overseas, like their workshops and short courses. Indeed, the UNU-GTP and the nation of Iceland are a model for the successful propagation of a knowledge-based economy.

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