

The United Nations University Geothermal Training Programme



UNITED NATIONS
UNIVERSITY

GEOHERMAL TRAINING PROGRAMME



ORKUSTOFNUN

National Energy Authority



About the UNU-GTP

The United Nations University Geothermal Training Programme (UNU-GTP) was established in 1978 by the Government of Iceland and the United Nations University (UNU), with Orkustofnun (the National Energy Authority) as the host institution.

The mandate of the UNU-GTP is to assist developing countries with significant geothermal potential, to establish groups of specialists in geothermal exploration and development by offering six months specialized training for professionals employed in geothermal research and/or development and also MSc and PhD programmes.

The hallmark of the UNU-GTP is to give university graduates engaged in geothermal work intensive on-the-job training in their chosen fields of specialization. The trainees work side by side with geothermal professionals in Iceland. The training is tailor-made for the individual and the needs of his institution/country.

Admission

Candidates for training in Iceland are nominated by countries that UNU-GTP cooperates with. This is done through directors of geothermal research and utilization institutions and universities, and in the specialized fields

that are considered most relevant to promote geothermal development in their respective country. The actual participants are then selected by private interviews during site visits to the countries concerned where UNU-GTP representatives visit geothermal fields, research institutions and energy utilities. The six months training usually starts in late April and ends in October each year. Nominations (including the curriculum vitae of the candidates) should be received in Reykjavik by the 1 September each year for participation in training starting the following year.

The selection of candidates is based on certain criteria.

Generally, the candidate should have:

- A university degree in science or engineering
- Fairly good English skills, in both spoken and written English

Furthermore, it is desirable that the candidate:

- Has a permanent position at a public energy agency/utility, research institution, or university, and can utilize the skills acquired by the training
- Has a minimum of one year practical experience in geothermal work
- Is below 40 years of age

Selected candidates from developing countries and some Eastern European countries (non-EU-members), that fulfil the requirements, receive UNU Fellowships financed by the Government of Iceland. The UNU Fellowships cover all costs associated with the training in Iceland, including international travel, tuition fees and per diem. The Fellows, therefore, do not need other funds for their training. The UNU-GTP does not offer scholarships to candidates from the industrialized countries or from private companies. However, qualified candidates can be accepted if their Fellowships are financed through other mechanisms.

The Training Programme

The six months training programme consists of nine specialized courses. The approximate time schedule is shown in Table 1. All participants attend an introductory lecture course (duration of 5-6 weeks, three lectures per day) which aims to provide background knowledge on most aspects of geothermal energy resources and technology, and to generate an appreciation for the interrelationship between the various disciplines necessary in geothermal projects from the initial exploration to the stages of implementation and utilization. The introductory course is followed by lectures and practical training in the respective specialized fields (5-7 weeks), and the execution of a research project (11-13 weeks) which is concluded with an extensive research project report. Excursions are also arranged to the main geothermal fields under exploration and utilization in Iceland. Seminars are held and case histories studied on each field (2-3 weeks).

The main emphasis of the training is to provide the participants with sufficient understanding and practical experience to permit the independent execution of projects within a selected discipline in their home countries. The following nine lines of specialized training are offered:



Geological exploration offers practical training in basic geological and geothermal mapping, which is commonly the first step in the geothermal exploration of an area. Participants should have a degree in geology.

Borehole geology gives training in making geological logs, analyses of drill cuttings and cores. The identification of alteration minerals (microscope and x-ray diffraction) and the interpretation of the alteration mineralogy forms an integral part of the course. Participants should have a degree in geology.

Geophysical exploration is practical training in conducting geophysical surveys of geothermal areas and/or interpretation of such data. Emphasis is on the application of methods that relate directly to geothermal parameters such as resistivity, and high-level computer interpretation. Participants should have a degree in physics, geophysics or engineering.

Table 1: Approximate time schedule for the six month specialized courses at UNU-GTP.

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



Borehole geophysics covers the essentials of geophysical measurements in boreholes used for geothermal investigations, with an emphasis on temperature and pressure measurements, and lithological logs. Participants should have a degree in physics, geophysics or engineering.

Reservoir engineering covers the methodology needed to obtain information on the hydrological characteristics of geothermal reservoirs and to forecast the long term response of the reservoirs to exploitation. Participants should have a degree in engineering, physics, geophysics, mathematics or hydrogeology.

Environmental science covers environmental impact assessments (EIA), laws and policies, the planning and execution of EIA projects and environmental auditing. Scientific methods suitable for environmental monitoring are assessed and biological impact, pollution and occupational safety considered. Participants should have a degree in science or engineering.

Chemistry of thermal fluids gives an insight into the role of thermal fluid chemistry in geothermal exploration and exploitation, including sampling, analysis of major constituents and the interpretation of results. Participants should have a degree in chemistry, geochemistry or chemical engineering.

Geothermal utilization deals with the civil, mechanical and chemical engineering aspects of geothermal fluids in pipes, equipment and plants, and includes scientific computing and

modelling of geothermal plants and piping. The feasibility of projects and environmental factors are considered. Participants should have a degree in engineering.

Drilling technology provides engineers with the information and on-site training necessary to prepare them for the work of drilling engineers or supervisors. The course deals with the selection of drilling equipment, well design and casing programs, cementing techniques, and the cleaning and repairs of production wells. Participants should have a degree in engineering.

During their training the Fellows work side by side with professionals from ISOR (Iceland GeoSurvey) and Orkustofnun or other institutions in Iceland actively working on most aspects of geothermal research, exploration, and development. Most of the teaching during the specialized training is done through lectures, tutorials and practical work. For the lecture course, the teacher works with 3-7 trainees, and use is made of available textbooks, some published directly by the UNU-GTP, and articles in journals. Teaching material from the UNU-GTP has later often been used by the UNU Fellows on their return to train colleagues at home.

A significant part of the practical training is done in connection with the research projects of the Fellows. Here it is encouraged that the participants bring with them data from geothermal projects in their home countries, but in cases where that is not possible the research projects are



integrated with Icelandic projects. In these cases the project topic is selected with respect to the conditions in the home country of the individual participant. During the period of project work 1-3 trainees work under the supervision of an expert in the field of their specialization.

The UNU Fellows are required to write a report on their individual projects. All project reports are published by the UNU-GTP. Since 1994, the reports have been published in the annual book "Geothermal Training in Iceland" with an international publishing code (ISBN 9979). Copies can be obtained upon request. The reports are mailed to former UNU Fellows and many of the leading geothermal institutions around the world. Furthermore, full reports are available for download on the UNU-GTP website (www.unugtp.is).

The UNU Fellows are also required to deliver a presentation of their projects at a seminar open to scientists and engineers active in geothermal sciences.

One guest lecturer with an international reputation is invited every year as a UNU Visiting Lecturer to give a lecture series and to lead discussions with the trainees. Many of the lectures of the UNU Visiting Lecturers have been published and are listed by author in the reference list on www.unugtp.is.

One way to measure the overall impact of the accomplishments of UNU Fellows is to look at their participation in the international arena, such as at the World Geothermal Congress (WGC), which is organized every five years by the International Geothermal Association (IGA). The last one, WGC2010, was held in Bali in Indonesia, with over 2,000 participants from more than 100 countries. Of the 1,034 refereed papers accepted by the Technical Committee and published in the proceedings, 199 papers (19%) were authored or co-authored by 139 former UNU Fellows from 31 developing and transitional countries. The level of activity of the UNU Fellows in the international geothermal community is well reflected in the fact that one-third of the 424 graduates of the UNU-GTP between 1979 and 2009 were authors of refereed papers at the WGC 2010. Similar participation was seen at earlier events, such as at WGC2005 in Turkey.

Masters and Doctoral Programmes

Since 1999, the UNU-GTP has offered a few successful candidates the possibility of extending their studies to MSc or PhD degrees in geothermal sciences or engineering in cooperation with the University of Iceland (UI). Many of our trainees have already completed their MSc or PhD degrees when they come to Iceland for the six month programme, but several excellent students have made requests to come back to Iceland for a further academic degree in geothermal science or engineering. Their six months specialized studies at the UNU-GTP are evaluated as 30 ECTS units and fulfil 25% of their MSc programme credit requirements. The aim of establishing the MSc programme in cooperation with the UI was to go a step further in assisting selected countries in building up their specialist groups and to increase their geothermal research capacity. All MSc Fellows have received UNU-GTP Fellowships funded by the Government of Iceland. In 2008, the first two PhD Fellows were also awarded with UNU-GTP Fellowships.

Workshops and Short Courses

The UNU-GTP also organizes Workshops and annual Short Courses on geothermal development in Africa (started in 2005), Central America (started in 2006), and in one workshop Asia (in 2008). This is a contribution of the Government of Iceland to the Millennium Development Goals of the United Nations. The Workshops/Short Courses are set up in cooperation with energy and earth science institutions responsible for exploration, development and operation of geothermal energy utilities in the countries/regions. A part of the objective is to increase the cooperation between specialists in neighbouring countries in the field of sustainable use of geothermal resources. The courses may in the future develop into sustainable regional geothermal training centres. As of 2012, about 220 scientists and decision makers have participated in the Workshops (1 week), and about 500 scientists have been trained at the short courses (1-4 weeks).





UNU-GTP Customer-Designed Short Courses

In 2010 the UNU-GTP started additional capacity building efforts through customer-designed short courses. This service of the UNU-GTP has been triggered by an urgent need for training in countries planning fast-tracking of geothermal development, while it has also been an offspring of the regular training and Short Courses and the material prepared there. This has proven to be a good opportunity for some countries/institutions in need of a rapid capacity building process, beyond what the UNU-GTP can provide under its conventional operations, and which have themselves the strength or the support of external mechanisms to finance such events. The paying customer defines the outline of the Short Course, while the UNU-GTP oversees the course, hires lecturers, produces teaching material, and thus guarantees the quality of the content.

The first four courses were held for Pertamina Geothermal Energy (2) in Indonesia, and GDC (the Geothermal Development Company) and KenGen (Kenya Electricity Generating Company) in Kenya in 2010. Two additional ones were held in 2011, in El Salvador an overview course was held on geothermal exploration and development, for selected participants from Latin American countries, sponsored by OAS (the Organization of American States), and specialized training conducted for the GDC in Kenya. In 2012, a large course was held in cooperation with KenGen in Kenya, on geoscientific exploration and drilling with additional specialized hands-on training in some fields.

The contents of the customer designed courses have varied from general geothermal/geoscientific courses to more specific courses including hands-on training in the laboratory and in the field with extended follow-up by geothermal experts. The number of participants in these training events has ranged between 15 and 50.

International Cooperation

One of the roles of the UNU-GTP, according to the Agreement on the Status of Association with the UNU, is to “develop and maintain communication among developing countries and arrange, as necessary and appropriate, conferences, seminars, workshops and panels which would further the dissemination and application of practical knowledge” in geothermal energy. The UNU-GTP partly fulfils this Agreement by direct cooperation with the UNU-GTP alumni and their institutions, and partly through active participation in international geothermal conferences, workshops, and seminars (www.unugtp.is).

Gender Equality

The UNU-GTP is hosted by Orkustofnun, and as a part of the Icelandic Public Administration, it has an equal opportunity policy. Furthermore, UNU-GTP aims at fulfilling the United Nations Millennium Development Goals (MDG) of promoting gender equality and empowering women. UNU-GTP does this by giving qualified female candidates priority when selecting Fellows for training. However, the energy sector has generally not been a favoured work site for women, not least in the developing countries. This can be seen in that only 20-25% of the UNU Fellows in recent years have been female, something the UNU-GTP hopes to improve on in near future.

Finances and Cost of Training

The activities of the UNU-GTP are mainly funded by the Government of Iceland. International agencies have also financed UNU Fellowships for several trainees through the years in connection with their geothermal projects. These have both been for six months and shorter periods of time. Fellowships awarded by UNU/Iceland have been restricted to six months training and MSc and PhD studies.



The cost of the six months training is currently 30,000 Euros per Fellow (2012). This covers all aspects of the training in Iceland (teaching and associated material, personal supervision, housing, computers, etc.), international transport (from the home country and back), and standard living costs in Iceland (apartment rent, daily allowance for food and other personal expenses).

Future Plans

The UNU-GTP is at present the only international graduate school offering specialized training in all the main fields of geothermal science and engineering. From 1979-2011, 482 scientists and engineers from 50 developing countries have completed the annual six month courses. They have come from countries in Asia (41%), Africa (30%), Latin America (16%), and Central and Eastern Europe (13%). In October 2012, 33 scientists and engineers are expected to graduate after six months specialized training. Since 2000, 33 have graduated with a MSc degree from the University of Iceland.



In 2012, eleven pursued their MSc studies and three their PhD studies on UNU Fellowships at the University of Iceland. The first PhD Fellow is expected to graduate in 2012.

The UNU-GTP will continue to focus on specialized training and capacity building. New countries will be added, but care will be taken not to spread the efforts too thin. After 33 years of operation, experience strongly suggests that to make technology transfer successful and sustainable, it is necessary to build up a group of at least ten geothermal specialists in each country. In addition, support will continue to former UNU Fellows in different countries/regions in connections with site visits, workshops and seminars.

To meet the requests of the developing countries for expansion of the capacity building and degree oriented research, it will be necessary for the UNU-GTP to strengthen further its ties with the University of Iceland and ISOR, as well as with the geothermal industry. The excellent network of UNU Fellows in over fifty developing and transitional countries is of great value for the promotion and development of geothermal resources in the world. This rather unique network of the United Nations University needs to be nurtured and expanded further. To meet these tasks, the UNU-GTP has to be strengthened as an institution both in Iceland and within the UNU.

Finally, the UNU-GTP hopes to see new training centres open in Central America and East Africa under the umbrella or in cooperation with UNU-GTP. Cooperation partners on the scientific side are expected to be local energy institutions and universities in a selected country in the respective region, while on the financial side international banks or financing institutions operating in the developing countries have already expressed a will to come in and assist with this project.





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