IGA NEWS

Newsletter of the International Geothermal Association

Quarterly No. 84

IGA ACTIVITIES

Message from the President

Roland N. Horne

Greetings, Members!

In March, the Board of Directors of IGA met for the first time at the new home of the IGA Secretariat in Bochum, Germany, so in this letter to you I'd like to talk about Germany. In Germany, our new host is the Bochum University of Applied Sciences, with generous support from His Excellency Johannes Remmel, Minister for Climate, Environment, Agriculture and Consumer Protection of the State of North Rhine-Westfalia, Prof. Dr. Martin Sternberg, President, Bochum University of Applied Sciences, Dr. Christina Reinhardt, Chancellor, Bochum University of Applied Sciences, Prof. Dr. Rolf Bracke, Director, International Geothermal Center - GZB, Prof. Dr. Horst Rueter, President, GtV - Bundesverband Geothermie, and members of the Steering Committee Dr. Frank-Michael Baumann and Leonhard Thien. Our March meeting was also the first for our new Executive Director, Marietta Sander, who took up residence in Bochum shortly before the meeting and had the new Secretariat already in full operation.

At the March meeting, we were greeted by Minister Remmel, Dr. Ottilie Scholz, Mayor of the city of Bochum, and Prof. Dr. Martin Sternberg. The attendance at our meeting by such an august group, together with their substantial support of the IGA Secretariat, is a telling sign of the importance placed on geothermal energy in Germany. It is entirely appropriate that Germany should be our new headquarters for the next several years - because Germany has a commendable commitment to renewable energy in general, and geothermal energy in particular. Although at first Germany would not appear to be a "geothermal country" in the context of the famously volcanic nations like Italy, Indonesia, Philippines, Japan, New Zealand etc., Germany's geothermal industrial and research communities are world class. Perhaps because of Germany's lack of traditional volcanic resources, Germany has taken a more innovative path, and is a world leader in continental geothermal resource utilization. Importantly, Germany is operating the world's first commercial EGS plant, at Landau.

Earlier in March, I returned from a short trip to Japan after experiencing the earthquake of March 11. The events there were horrific, with so many lives and livelihoods lost to this natural catastrophe. But in addition, the news of the disaster at Fukushima Daiichi nuclear power plant sent a chill around the world. Germany's strategy of fast-tracking renewable energy instead of nuclear power now shows considerable foresight. In May, as I write this, Japan has also announced its intention to reconsider the nuclear path it had been planning for its future of electrical generation, and look again at renewable energy sources. Geothermal is certainly an attractive option in volcanic Japan, and in many other countries. Let us, the worldwide members of the International Geothermal Association, lead the way to greater utilization of this green, baseload, renewable energy source!

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IGA Western Pacific Regional Branch Holds 6th Annual General Meeting

Larry Bayrante, NGAP

The Western Pacific Regional Branch of the International Geothermal Association Inc. (IGA WPRB) conducted its 6th General Meeting on May 26, 2011 at the Bahia, Hotel Intercontinental Manila. The meeting was held in conjunction with the highly successful International Workshop on Mineral Scaling in Geothermal Environment. The new Chairman of WPRB, Dr. Herman Darnel Ibrahim, presided over the meeting which was attended by members from Indonesia, Japan, New Zealand, and the Philippines. Dr. Ibrahim stressed the need for closer cooperation and interaction among the members of WPRB especially on the training needs and capacity building of member countries of this IGA Branch. He thanked the Philippine host for the excellent and well attended workshop.

Former WPRB Chairman Jim Lawless, in his outgoing message read by Forum Secretary Larry Bayrante, remarked that "the aspect of WPRB that I am most pleased about it is that it has fulfilled my founding vision of a partnership of equals."

UPCOMING EVENTS

IUGG General Assembly 2011, 28 June – 7 July 2011, Symposia "Heat Flow, Tectonics and Geothermal Energy" and "Physics of the seismic process: from laboratory studies to field observations", Melbourne, Australia. Website: http://www.iugg2011.Com/program-iaspei.asp

Geothermal Investment Forum and Networking Event, 14 September 2011, Toronto, Canada. Website: www.cangea.ca

GeoPower Turkey, 20-21 September 2011, Istanbul, Turkey. Contact: info@greenpowerconferences.com

World Renewable Energy Congress 2011, 17-19 October, Bali, Indonesia. Website: http://wreeec2011bali.com

GRC 35th Annual Meeting, 23-26 October 2011, San Diego, CA, USA. Website: www.geothermal.org

Geothermal Power Forum and Networking Event, 9 November 2011, Calgary, Canada. Website: www.cangea.ca

9th Asian Geothermal Symposium, 7-9 November, Ibusiki, Kagoshima, Japan. Website: http://unit.aist.go.jp/georesenv/english/event-e/asia9.html

Sustainable Earth Science Conference, 8-11 November 2011, Valencia, Spain. Website: http://www.eage.org/events/index.php?eventid=551&Opendivs=s3

Der Geothermiekongress 2011, 15-17 November 2011, Bochum, Germany.
Website: www.geothermie.de

Australian Geothermal Energy Conference 2011, 16-18 November 2011, Melbourne, Australia. Website: www.ausgeothermal.com

Kenya Geothermal Conference, 21-23 November 2011, Nairobi, Kanya. Website: www.gdc.co.ke

33rd New Zealand Geothermal Workshop, 21-23 November 2011, Auckland, New Zealand. Website: www.nzgeothermal2011.org.nz

Geopower Europe 2011, 5-7 December 2011, Milan, Italy. Website: http://www2.greenpowerconferences.co.uk

37th Stanford Workshop on Geothermal Reservoir Engineering, 30 Jan-1st Feb 2012, Stanford, CA, USA. Website: http://pangea.stanford.edu/ERE/research/ geoth/conference/workshop.html

It was proposed to hold regional workshops on special topics such as geothermal reservoir engineering and well testing, and other topics of relevance to the member countries. WPRB has selected New Zealand and Indonesia to host the annual Regional Conferences in 2012 and 2013, respectively.

ARGENTINA

Petroleum Industry Overlaps With Enhanced Geothermal Systems (EGS) In Market Opportunities and Reservoir Engineering Methodologies

Cully Cavness, Thomas J. Watson Fellow

The geothermal industry shares commonality with many technically related, but otherwise disconnected industries. A non-exhaustive list of technically overlapping industries includes: oil and gas (drilling, reservoir engineering), waste heat recovery (heat exchanger thermodynamics), industrial corrosion and scaling management (piping and equipment protection), wind and solar power (financing and grid connection challenges), emissions abatement (H_2S regulations in California or in Iceland, for example), and fossil fuel power plants (turbine-generator engineering, control systems, operations). This list could easily expand to include many other industries and professions that bear similarities to geothermal energy.

These industrial and technical synergies present a valuable opportunity for the geothermal industry - collaboration could easily increase efficacy and efficiency, reduce risk, and ultimately increase profitability. A previous article in the IGA Quarterly (Ed. #83) explored collaborative ventures and future possibilities between the geothermal industry and the Asian waste heat recovery industry. This follow-up article aims to deliver a similar analysis of developments and possibilities with the oil and gas industry.

Specifically, the cutting edge of geothermal development, Enhanced Geothermal Systems (EGS), can leverage the experience and technology of the Oil and Gas (O&G) industry. The O&G industry presents opportunities in directional drilling, reservoir stimulation, and fracture proppant. Additionally, oilfields present an interesting prospective market, as showcased by a case study in Colorado.

EGS is a frontier method of geothermal energy extraction. EGS proponents seek to drill into hot rock with low permeability and/or water levels insufficient for conventional geothermal development, then fracture the rocks and inject and recover a working fluid, thereby creating an artificial geothermal reservoir. EGS techniques and technologies are fraught with all the uncertainty and risk of newness, but the methods also promise to unlock boundless resources and opportunities if they can be mastered. The majority of the earth's geothermal potential is trapped in areas that are not currently accessible to conventional geothermal methods, but which could be harnessed with the ideas of EGS.

Companies like AltaRock Energy, Geodynamics, Petratherm, Ormat, GeothermEx, as well as the American Department Of Energy and other international agencies all have interests in developing the highly prospective EGS industry. Success will depend on advances in a variety of techniques and technologies.

At the surface, developers must apply highly efficient heat exchangers and turbine-generator systems to optimize their power cycles for lower temperatures and/or flow rates. Rankine and Kalina Cycle technologies both offer this ability, with the latter being a particularly effective option for the low-temperature scenarios that typify current EGS development.

In aspects of drilling and reservoir engineering, success is largely contingent on the amount of surface area that can be accessed by circulating fluids. A combination of technologies developed by the oil and gas industry will be critical in this area.

Multistage hydraulic fracturing and directional drilling (both originated by the petroleum industry) will likely be fundamental technologies for EGS, as they allow for the targeting and expansion of artificial reservoirs. Once reservoirs have been created through hydraulic fracturing, the burden then becomes to maintain the productivity of those reservoirs. Reservoirs will become less volumetrically productive when either of the following occurs: porosity decreases (through chemical scaling or the physical collapse of pore space), or permeability decreases (when physical or chemical effects decrease the interconnectivity of pore space). Here, in porosity and permeability maintenance, through the use of proppants, for example, we may also find help from the Oil and Gas industry.

Beyond technologies and methodologies, the hydrocarbon industry may also provide an interesting market for geothermal power. Consider the fact that oil and gas fields consume massive amounts of power for their operations, often exist in remote locations far from transmission lines, and often generate power using purchased diesel or locally produced natural gas, which could otherwise be sold profitably into pipelines.

The above criteria form the exact backdrop of a scenario currently playing out in the Raton Basin, southern Colorado. Pioneer Natural Resources USA, Inc. , an independent oil and gas company is developing a Coal Bed Methane (CBM) field in the Raton Basin. Raton not only boasts significant CBM resources, but also a curiously elevated geothermal gradient, which inspired the author's thesis in geology, and led to ongoing collaboration between Pioneer Natural Resources, the Colorado School of Mines, the Institute of Earth Science and Engineering in New Zealand, and the Colorado Geological Survey in a study of the potential for an EGS development under the CBM field. . If successful, Pioneer would at least be able to substitute geothermal power for locally consumed natural gas, then sell the offset gas at a profit. Ultimately, however, the project could expand to provide regional

power and demonstrate potential for other hot sedimentary basins, hugely expanding the applicability of geothermal energy.

Part of Pioneer's attraction to the project is the tremendous overlap and synergy between the geothermal and O&G industries. Existing well bores provide exploration data to delineate the thermal anomaly, representing a dramatic cost savings to the high-risk frontend of geothermal development. Further synergies are offered by the technical expertise and infrastructure already in place at the gas field. Pioneer has drilling equipment and drilling teams, hydraulic fracture and well completion equipment, drill pads, offices, existing geophysical data and analysis, as well as experts in local geology and conditions. And, of course, Pioneer already owns land and subsurface mineral rights. Doubters only need to look at Chevron, the world's largest producer of geothermal power, to understand how powerful these synergies can be. Origin Energy (an Australian Oil and Gas company) also recently purchased 40% of Energia Andina SA (a Chilean geothermal outfit), and provides another look at how petroleum and geothermal can marry.

To conclude, perhaps it is incorrect to view the "conventional energy" industries like oil and gas (or even coal) as diametrically opposed to the goals and purposes of geothermal energy. True, geothermal energy must compete on price against natural gas and coal, and there's the pollution issue, but at the same time there are tremendous mutually beneficial opportunities to be harnessed from collaboration with hydrocarbon-based industries. After all, most of the drilling and power generation technologies that drive geothermal today were initially developed for hydrocarbon extraction or combustion. Perhaps the best approach is to embrace other industries like oil and gas, learn from their expertise, and potentially even develop new research, technologies, and projects together.

Cully Cavness is a Thomas J. Watson Fellow researching industrial synergies for the geothermal energy industry in Iceland, China, Spain, Argentina, Chile, and the United States. He is a geologist and native of Denver, Colorado, USA. He currently resides in Buenos Aires, Argentina.

Editors' response to "Petroleum industry overlaps …"

John Garnish, IGA News Editorial team

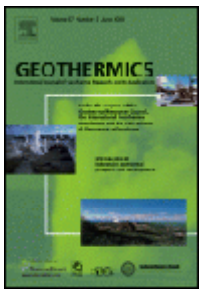
While Cully Cavness is quite right to draw attention to the considerable synergies between EGS and oil & gas activities, he does the geothermal community less than justice to suggest that such synergies have not been recognized in the past. In fact, several of the major oil companies (e.g. Shell, Unocal - now Chevron, Marathon, Total, AGIP, etc.) have had geothermal interests, including EGS, for more than 40 years. To take a specific example, the late Perry Moore - an Oklahoman oil man - was the drilling supervisor for all the pioneering EGS projects (except those in Japan) from Los Alamos in the 1970s through Rosemanowes, UK, to Soultz, and the drilling techniques drew extensively on oil field experience. Several of the projects also experimented with proppants, though with limited success.

Moreover, EGS development has been a two-way process, as exemplified in this except from a Los Alamos progress report in 1993:

> "Industry has been directly involved in the HDR Program from its beginning. All the drilling and completion work at Fenton Hill during the 1970 and 1980s was performed by private companies under contract. Novel drilling and coring bits, downhole motors, open-hole packers, and other equipment developed specifically for the HDR program have now found uses throughout the drilling industry. Logging instruments initially designed for use at Fenton Hill have also been widely adapted by the conventional geothermal, oil, and gas industries. Finally, the seismic techniques that were refined and brought to a high degree of sophistication in an attempt to understand the HDR reservoir at Fenton Hill are now being applied around the world to evaluate oil and gas reservoirs and develop methods for more efficiently recovering these fossil resources." LA-12903-PR (1993)

Specifically, several elements of the high temperature logging tools now in widespread use had their origins in the instrumentation groups at Los Alamos and Rosemanowes.

In contrast to the above, the one area where there are marked differences in practice is reservoir stimulation,



which is emphatically not hydrofracturing. EGS stimulation entails careful control of flow rates and pressures below the fracing pressure, to reopen and enhance existing fracture systems.

It is worth pointing out that the article concentrates on North America but rather ignores the progress that has been made elsewhere. In particular, there are already two operational EGS projects in Europe (Landau in Germany and Soultz in France), with several others under development. It also focuses strongly on the potential for an EGS development in a CBM field, but makes no mention of the prospects for coproduced water from oil fields. In South Australia, more than 20 years ago, Santos looked at the feasibility of using EGS-derived power at Moomba to avoid using gas to power the main compressors. The MIT report (2006) devotes a whole section to the potential for co-produced water from US oil fields, and there have been a number of studies in UK about the prospects for putting geothermal plant on North Sea platforms. (To date, these have come to nothing because of companies' concerns about added top weight or space on the platforms, but this may change in future). There has also been considerable interest (by Suncor, for example) in using EGS systems as the heat source for producing tar sands in Alberta and to mitigate the environmental issues associated with tar sands projects.

In summary, we would argue that the author is pushing at an open door. We do not believe that anyone in either field views the oil and gas industries as diametrically opposed to those of geothermal practitioners; on the contrary, there have been links between the players since the earliest days of HDR/EGS, and these can only get stronger in the future.

MEXICO

Seminar on geothermal energy in Mexico for East Africa region representatives, 11-15 April, 2011

Alfonso Garcia-Gutiérrez, Instituto de Investigaciones Eléctricas (IIE), Mexico

Geothermal Energy experts from nine countries of the East African Rift System (EARS) (Burundi, Comoros Islands, Democratic Republic of Congo, Eritrea, Kenya, Rwanda, Tanzania, Uganda and Zambia), visited Mexico from 10th to 15th April 2011. The seminar was part of the UNIDO intra-regional renewable energy cooperation initiative for industrial and productive uses, launched in the geothermal area.

From 11th to 15th April, the African experts participated in the "Seminar on Geothermal Energy in Mexico for East African Rift Valley Region Representatives" and a field visit, organized and supported in Mexico by the United Nations Industrial Development Organization (UNIDO); the Ministry of Energy (SENER); the Electricity Research Institute (IIE); the Federal Electricity Commission (CFE), and the Ministry of Foreign Affairs (SRE). The Seminar was held at the IIE's facilities in Cuernavaca, México. It was followed by a field trip coordinated by personnel from the CFE's Gerencia de Proyectos Geotermoléctricos to Los Azufres geothermal field.

The main objectives of the activities held during this week were:

- To share Mexico's experience on geothermal energy development and use;
- To share the experience of the African participant countries of the current situation in their geothermal areas, with their interests and needs; and
- To start up the general basis of a Mexico-UNIDO-East Africa Trilateral Cooperation Program in the Geothermal Area for Productive Uses.

During the seminar and field visit, the African experts learnt about the status of geothermal development in Mexico as well as the experience and capabilities of the Mexican experts regarding exploration, development and exploitation of geothermal as a clean, endogenous and reliable source of energy. Likewise, they shared information with their Mexican counterparts about the status of geothermal development in their respective

Participants in the Los Azufres field trip

countries and described the main plans and technical needs for the development of geothermal energy in the East African Region. On 15th April 2011, a wrap-up meeting took place at SENER´s facilities with the aim of discussing the possible actions and to set-up a plan of action for future activities.

The seminar and related activities were coordinated by Dr. Alfonso Garcia-Gutierrez, of the Geothermal Energy Department, Electricity Research Institute (IIE).

EUROPE

EGEC: News from Europe

Philippe Dumas, EGEC, Reports Emerge of an Increase in German Feed-In Tariffs

May 9th, 2011

EGEC welcome emerging reports that the German Federal Environment Ministry will raise the feed-in tariff for geothermal energy, within the framework of the amendment of the Renewable Sources Act (EEG).

It has been widely reported that in the draft of the EEG study report, the Federal Environment Ministry suggests the integration of existing incentives into the base compensation, and to raise that amount by about €¢ 2 per kWh. In spite of the significant increase in the compensation provided by the EEG contribution for electrical energy from geothermal, power customers should have no concerns as geothermal projects have long lead times, due to intensive exploration requirements, and different licences which have to be applied for.

Tenerife Island, note the Teide volcano, location of the geothermal project

Progress with Geothermal Projects in Spain

May 2nd, 2011

The geothermal sector is seeing progress in the Spanish market, as submissions are now being sought by the Spanish federal government for geothermal energy projects. Projects in Tenerife (geothermal electricity) and in Madrid (district heating) represent a strong development of the sector and are eligible for submission.

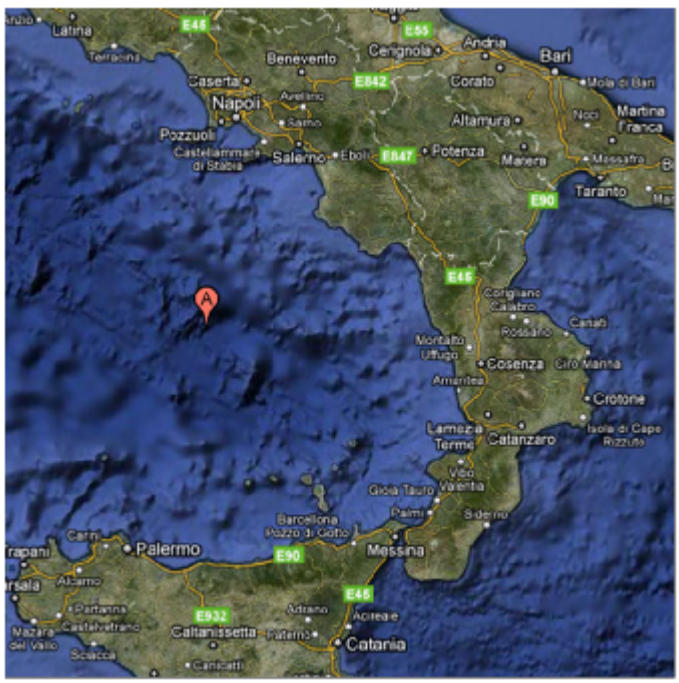
Tenerife

Petratherm España in conjunction with its 50% partner, Enel Green Power(EGP), continued to develop the Tenerife volcanic geothermal project. Three prospective drilling targets have been under consideration with a recent review of long term development potential indicating sites in the eastern and southern tenements being more attractive.

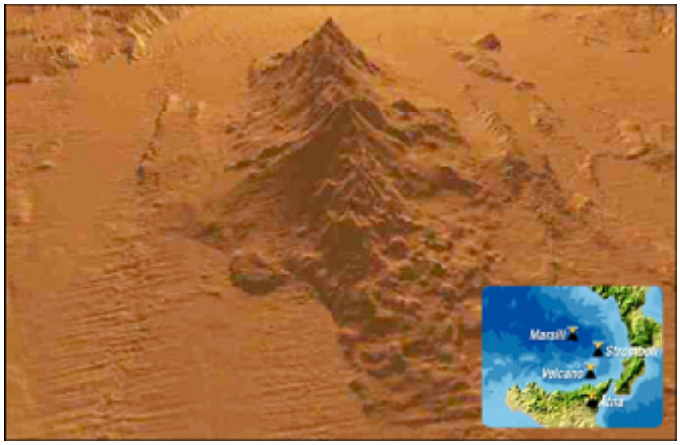
Tenerife provides a major opportunity to build a conventional geothermal project. The island has a permanent population in excess of one million that can increase to 1.5 million during peak tourist season - placing a large demand on peak power generation, in excess of 800 MW.

Madrid

Petratherm España has progressed its Madrid Geothermal District Heating (GDH) project under the



Location of the Marsili volcano



The subsurface Marsili volcano

Cooperative Agreement with the Spanish federal and Madrid regional governments. They have completed the final design of the GDH project and are engaged in discussions to assess joint venture arrangement.

Italy chosen as the site for the world's first offshore power plant

April 21st, 2011

A 2 billion euro project to utilise the heat of the Marsili, the largest undersea volcano in Europe, could begin as early as 2012. The undersea volcano is located in the Tyrrhenian Sea, and is 70 km long, 30 wide and 3,000 m high.

The venture is led by Eurobuildings, a private firm, in conjunction with a scientific committee composed of experts from Italy's leading research institutions. The project, which is sponsored by the Italian government, will employ the latest undersea research equipment. Work on the project could begin as early 2012, with the project aiming to build 4 floating power plants, supplying the energy needs of 700,000 people by 2015.

Italian Technology Platform on Geothermal Launched

April 12th, 2011

A new Italian Technological Platform on Geothermal has been officially launched, on behalf of the Italian Ministry for University and Research. The Platform, whose aim is to support technological innovation on Geothermal for both electricity production and direct uses, involves at the moment the presence of about 30 companies, about 20 research Institutions and several geothermal associations.

It is anyway opened to all the Italian companies and research Institutes that have an interest in development and innovation in Geothermal. In the constitutive meeting the participant bodies voted to assign the main coordination roles in the Platform. The role of Chairman was assigned to Assoknowledge/Confindustria SIT and the Scientific Direction of the Platform was assigned to INGV. ENEL Green Power was elected as Referent of industrial partners and IGG-CNR as Referent of research Institutes.

Report Predicts Little Sensitivity of Geothermal to Effects of Climate Change

March 31st, 2011

A report commissioned by DG Energy of the European Commission on the 'Investment needs for future adaptation measures in EU nuclear power plants and other electricity generation technologies due to effects of climate change' was today published, with a conclusion that geothermal is one of the only energies that has low sensitivity to Climate Change.

Once again, geothermal has been recognized as one of the technologies that can be relied upon to provide energy for Europe, as it is concluded that geothermal is one of the technologies that will be least affected. This means in practice that geothermal will require less investment for prevention and precaution than other technologies.

However, in spite of this fact and of the ever increasing development of the geothermal market, it is regrettable that the 2030-2050 scenario presented in the report underestimates the potential contribution of geothermal.

In addition, an inaccuracy can be noticed in Table 18, which wrongly puts the capacity factor of geothermal at 70 per cent, when it stands at over 90 per cent, as indicated in the official Eurostat figures (2007).

Overall the report concluded that:

'The relatively new… geothermal only show(s) minor climate change sensitivities, namely towards some extreme events.' (p. 11)

A new training course: Exploration & Development of Deep Geothermal Systems - DEEGEOSYS

François-D. Vuataz and Eva Schill, Laboratory for Geothermics, Neuchâtel, Switzerland

Needs in geothermal education

In Switzerland and Europe, the number of specialists in deep geothermal systems is limited. Since 2009, a new Master's degree of Science in Hydrogeology and Geothermics has been running at the University of Neuchâtel (Switzerland), organized by the Centre for Hydrogeology and Geothermics. The 3rd course will start in September 2011.

A new Certificate of Advanced Studies (CAS DEEGEOSYS) has been set up, dedicated to training scientists and engineers in several fields of applied geothermics. They will be capable of planning, preparing and leading exploration and/or development projects of deep geothermal resources (deep aquifers and Enhanced Geothermal Systems).

Organization

Centre for Hydrogeology and Geothermics of the University of Neuchâtel Laboratory for Geothermics - CREGE.

Table 1. Modules and schedule of the training course

Mod.	Topic	Date	Main lecturers
1	Geothermics and geophysics	Nov. 21-25, 2011	- Thomas Kohl - Eva Schill - Albert Genter
2	Geochemistry and hydrochemistry	Jan. 23-27, 2012	- Luigi Marini
3	Drilling and logging	March 26-30, 2012	- Sverrir Thorhallson - Pierre Ungemach
4	Reservoir evaluation and production	June 4-8, 2012	- Miklos Antics - Jan Diederik Van Wees
Technical report		July 27, 2012	

Venue

Centre for Hydrogeology and Geothermics, Faculty of Sciences, University of Neuchâtel (Switzerland).

Participants

Earth scientists (geologists, geophysicists, hydrogeologists, geochemists), civil- or energy engineers, having a M.Sc. or an equivalent degree.

Training programme

The CAS DEEGEOSYS includes four one-week long modules separated by a two-month break. Each module covers a specific topic (Table 1).

The modules include courses given by international experts, exercises, visits to geothermal installations and exams.

Lecturers

International experts from research institutes and/or from private companies will give most of the courses.

Technical report

Having followed 4 modules, the participants draft in a personal way a report on one of the themes studied during the CAS, supervised by one of the teachers. This technical report should take approximately 60 working hours and must be validated by the responsible teacher and the management of the CAS.

Credits ECTS (European Credit Transfer and Accumulation System)

The CAS DEEGEOSYS totals 10 ECTS: 2 ECTS per module (courses, exercises, examinations, technical visits) and 2 ECTS for the technical report.

Information

University of Neuchâtel (Switzerland)
Laboratory for Geothermics - CREGE
Secretary: Mrs. Sabine Erb
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Detailed information on:
http://www.crege.ch/index.php?page=news

ASIA

All geothermal power plants in northeastern Japan survived the M9.0 earthquake

Kasumi Yasukawa, AIST, Japan

The largest recorded earthquake in Japan, with a magnitude of 9.0, occurred at 2:46 pm Japan Standard Time (JST) on 11 March, 2011. Its hypocenter was located at N38.1, E142.9, 130 km ESE off Oshika Peninsula, Miyagi prefecture, at a depth of 24 km. The mechanism of the event was reverse fault type with a WNW-ESE compressional axis related to the subduction zone of the Pacific plate. The earthquake was followed by multiple tsunamis; the first one arrived at the coast only nine minutes after the earthquake, and an even higher tsunami arrived a few hours later, with heights of 9.3 m or more recorded at Soma, Fukushima prefecture, and 8.5 m or more at Miyako, Iwate prefecture, etc. The Fukushima Daiichi nuclear power plant was seriously damaged by the tsunami because the cooling system to the units and the waste fuel pits was cut off. Nevertheless, all geothermal power plants in the regions affected by this event survived safely. There are sixteen geothermal power plants in operation in Japan with a total installed capacity of 535 MW. Nine of them, with ten units, are located in northeastern to eastern Japan, which was affected by the earthquake on 11 March and the following aftershocks. Some of them were automatically shut down immediately after the first earthquake, but all were re-started in a few days and have been generating the same levels of electricity as before the earthquake. Figure 1 shows the location and installed capacity of geothermal power plants in these areas. Table 1 shows the operational status of these plant after the earthquake.

The Yanaizu-Nishiyama geothermal power plant, which is located in the same Fukushima prefecture as the nuclear power plant, maintained power supply during and after the earthquake. At this power plant, the ground acceleration is constantly monitored using three seismometers. "On 11 March, an alarm beeped from the monitors because the acceleration reached over 25 Gal. The Tohoku Electric Power Company staff and ourselves checked both the power plant and steam producing plant and found everything was all right. So the power generation continued" said Mr. Masaho Adachi, Okuaizu-Geothermal Co., Ltd. "In their safety settings, the turbine will be 'tripped' (disconnected from the power line) only when the acceleration reaches 150 Gal or higher. Such settings may differ according to the anti-earthquake design of each power station. Since the quake on 11 March didn't reach 150 Gal, the plant was not shut down."

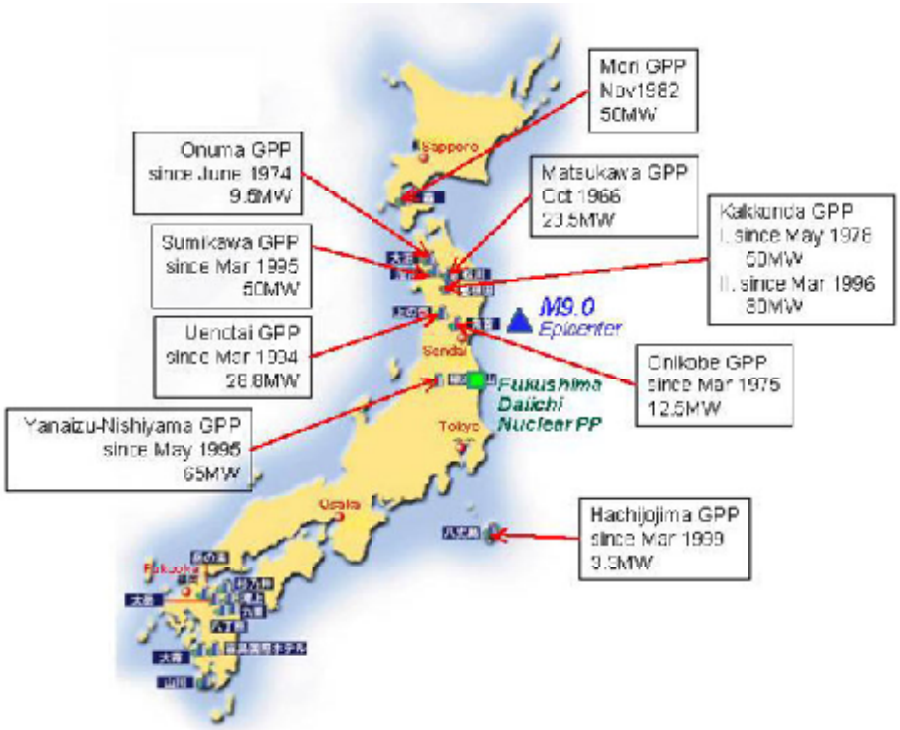

Figure 1. Geothermal power plants in the region affected by the event on 11 March, 2011

Table 1. Status of the geothermal power plants in the region affected by the earthquake at 2: 46 pm Japan Standard Time (JST) on 11 March, 2011

Geothermal Power plant (Prefecture)	**Status right after the event**	**Re-opening of operation (JST)**	**Seismic intensity (by Japan Meteorological Agency, JMA)[*1] of the event on 11 March 2011**
Mori (Hokkaido)	Continue production		2
Matsukawa (Iwate)	Automatic shut-down	6:56 pm 15 March	5 lower
Kakkonda I (Iwate)	Automatic shut-down	9:04 pm, 14 March	6 lower
Kakkond II (Iwate)	Automatic shut-down	2:39 am, 13 March	6 lower
Onikobe (Miyagi)	Automatic shut-down	6:30 pm, 14 March	5 upper
Yanaizu-Nishiyama (Fukushima)	Continue production		5 lower
Onuma (Akita)	Automatic shut-down	10:28 am, 12, March	3
Sumikawa (Akita)	Automatic shut-down	6:17 pm, 12, March	4
Uenotai (Akita)	(no operation for maintenance)		4
Hachijojima (Tokyo)	Continue prduction		1

[*1)] The JMA Scale of the seismic intensity runs from 0 to 7, with 7 being the strongest. For details, see http://www.jma.go.jp/jma/en/2011_Earthquake/2011_Earthquake_Intensity.pdf

In Table 1, 'automatic shut-down' does not necessarily mean that the power generation stopped. In the case of Sumikawa and Onuma geothermal power plants, the power stations were automatically disconnected from power lines after the earthquake, but power generation was continued at lower levels for internal uses of the power stations. A similar thing happened to the Onikobe geothermal power plant. According to Mr. Shigetaka Nakanishi, Electric Power Develoment Co., Ltd. (J-Power), "The Onikobe geothermal power plant was 'tripped' because the power line was damaged somewhere outside the plant, but the power station itself was totally fine. In a few days, the plant was connected to the line immediately after the power line recovered." As for the safety design of the geothermal power plants, Mr. Shigeto Yamada, Fuji Electric Co., Ltd., explains "Even in case of offline from the power grid, the turbine rotation is automatically controlled not to exceed 10 % of the normal speed to avoid any damage to the entire power plant." He added with confidence "Geothermal power plants are designed safely worldwide."

The safety of geothermal power plants and the status of Japanese power plants in the affected area of the earthquake will be highlighted in the coming 9th Asian geothermal symposium, on 8 and 9 November, 2011 to be held at Ibusuki, Kagoshima prefecture (Kyushu) in Japan. For more details, see http://unit.aist.go.jp/georesenv/english/event-e/asia9.html

Philippines

International Scaling Workshop Held in Manila

by Sylvia Ramos, NGAP

The "International Scaling Workshop on Mineral Scaling in Geothermal Environment" was held at the Hotel Intercontinental Manila, Makati City, Philippines on May 25-26, 2011. EDC President/COO and IGA Director Richard Tantoco, in his Keynote Address on the financial issues of scaling, focused on the high maintenance cost of geothermal facilities resulting from these mineral deposits. In due recognition of the relevance of such a gathering of experts, he emphasized the need to come up with solutions to the various scaling issues.

A wide range of topics was covered such as thermodynamics, kinetics and future research directions on silica deposition, pH modifications, recent developments in scale control, and various types of inhibitors. Case studies and controls on silica, calcite, anhydrite, clay, and sulfide scale deposition in geothermal wells, pipelines, and power plants in the Philippines, Japan, New Zealand, Papua New Guinea, Turkey, and Kenya were presented. Open forums at the end of the morning and afternoon sessions paved the way for lively discussions and exchange of ideas and experiences to resolve the critical scaling concerns.

This international workshop was jointly organized by the IGA Western Pacific Regional Branch, National Geothermal Association of the Philippines, Energy Development Corporation, and Chevron Geothermal Phil.Holdings Inc. The International Geothermal Association designated this event as the IGA Regional Meeting for 2011. It was attended by 164 local and foreign participants from the geothermal industry, government, and academe. Fifty three experts represented the large number of foreign delegations from the USA, New Zealand, Japan, Indonesia, Singapore, Korea, Papua New Guinea, Turkey, Kenya, and El Salvador. IGA also supported seventeen fellowship grants to academic and government researchers from Indonesia and the Philippines.

Following the two-day workshop was a field trip to Chevron's Makiling-Banahaw geothermal field and Tagaytay for a panoramic view of Taal volcano.

INTERNATIONAL

New Geothermal Roadmap released by the IEA

Luis C.A. Gutiérrez Negrín, Mexican Geothermal Association

On June 13, 2011, the International Energy Agency (IEA) launched in Stockholm, Sweden, its Technology Roadmap: Geothermal heat and power, the latest in the IEA series of technology roadmaps, which aim to guide governments and industry on the actions and milestones needed to achieve the potential for a full range of clean energy technologies -including geothermal.

The report shows that there is potential to achieve at least a tenfold increase in the global production of heat and electricity from geothermal energy between now and 2050. Renewable sources of energy will have to comprise a much greater share of the global energy mix in the coming years if the level of carbon dioxide in the atmosphere is to be kept below 450 parts per million - a key threshold in limiting global temperature increase to 2°C, which leaders

Workshop Group Photo

agreed to at the UN climate change talks in Cancun in 2010

The geothermal roadmap says that through a combination of actions that encourage the development of untapped geothermal resources and new technologies, geothermal energy can account for around 3.5% of annual global electricity production and 3.9% of energy for heat (excluding ground source heat pumps which the report did not consider) by 2050 - a substantial increase from current levels of 0.3% and 0.2%, respectively. "This would be an important contribution to global efforts of reducing carbon emissions, using a reliable source of energy that is available all over the world, every day of the year, as it does not fluctuate with the weather or season," said IEA Executive Director Nobuo Tanaka, who launched the report, at the EURELECTRIC annual conference in Stockholm on 13 June.

Although active geothermal exploitation has been in use for more than a century, to date efforts to extract geothermal energy have concentrated on areas with naturally occurring water or steam, often found in volcanic areas. However, Milou Beerepoot, the report's author and a senior analyst at the IEA, noted that a large share of such 'low hanging fruit' remains unexploited in developing and emerging economies. Ms. Beerepoot said that efforts should be expanded to solve economic and non-economic barriers that hinder further exploitation in these countries. Moreover, she observed that geothermal energy can also be extracted from many deep aquifer systems, of which there are many all over the world. These resources can typically be reached at a depth of 3 kilometers and produce temperatures in excess of 60ºC. Use of these aquifers is expected to grow quickly, reflecting their wide availability and increasing interest in their use for both heat and power.

In addition to these untapped areas, the vast majority of the world's geothermal energy within drilling reach - which can be up to 5 kilometres - is found in rock that is relatively dry and impermeable. These areas, which are found all over the world and contain insufficient water for natural exploration, are known as hot rock resources. Currently, technologies that allow energy to be tapped from hot rock resources - the best known is enhanced geothermal systems (EGS) - are still in demonstration stage, but the IEA report suggests that governments should provide sustained and substantial research, development and demonstration resources to plan and develop at least 50 EGS pilot plants during the next decade.

Key areas of action for governments identified in the report are the establishment of targets and economic incentive schemes for mature and nearly mature technologies as well as for advanced technologies that are not yet commercially viable. Another proposed area of action outlined in the report focuses on the need for streamlined and time-effective permit procedures, which are necessary for all new geothermal plants. In addition, the report stresses that publicly available databases, protocols and tools should be developed, which could be used to assess, access and exploit geothermal resources and thereby accelerate their development. "[This] requires co-operation among geothermal and hydrocarbon industry groupings, national authorities and research institutes," wrote Ms. Beerepoot.

More information about the geothermal roadmap can be found at: http://www.iea.org/subjectqueries/keyresult.asp?KEYWORD_ID=4156

Potential of renewable energy, including geothermal, outlined in IPCC report

Luis C.A. Gutiérrez-Negrín, Mexican Geothermal Association

More than three quarters of the world's energy supply could be met by renewable energies by mid-century, if backed by the right enabling public policies, says a recently released report from the Intergovernmental Panel on Climate Change (IPCC). The report also indicates that the rising penetration of renewables could lead to cumulative greenhouse gas (GHG) savings equivalent to 200 to 560

Giga-tons of carbon dioxide ($GTCO_2eq$) between 2010 and 2050.

The upper end of the 164 scenarios assessed, representing a cut of around a third in GHG emissions from business-as-usual (BAU) projections, could assist in keeping atmospheric concentrations of GHG at 450 parts per million (ppm). This, in turn, could contribute to holding the increase in global temperature below 2°C over this century, which is an aim agreed by the COP 16 conference held in Cancun, Mexico, in November 2010.

The findings are contained in a summary for policy makers (SPM) of the Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN), approved by member countries of the IPCC in Abu Dhabi, United Arab Emirates, during the 11th session of the Working Group III on May 9, 2011. The summary is a short version of a roughly thousand page comprehensive report, prepared by over 120 leading experts from all over the world for the IPCC's Working Group III, which will be released in the following months.

The SRREN reviews the current penetration of six renewable energy technologies and their potential deployment over the coming decades up to 2050. The technologies are bioenergy, direct solar (photovoltaics and concentrating solar power), geothermal, hydropower, ocean and wind energies. The SRREN also reviews over 160 existing scientific scenarios on the possible penetration of renewables by 2050, alongside environmental and social implications. Four of those scenarios were chosen to represent the full range and were analyzed in-depth. Challenges linked to how renewable energy can be integrated into existing and future energy systems, including electricity grids and likely cost-benefits from these developments, were also analyzed in the SRREN.

The scenarios arrive at a range of estimates, and yet the overall conclusions are that renewables will take an increasing slice of the energy market. The most optimistic of the four in-depth scenarios, assumes renewables accounting for as much as 77% of the world energy demand by 2050, amounting to about 314 to 407 exajoules per year. For comparison, in 2008 renewables represented only 13% of the global primary energy supply of around 490 exajoules.

The SRREN concludes also that the proportion of

renewable energy is likely to increase even without enabling policies, but that past experience has shown that the largest increases come with concerted policy efforts. Though in some cases renewable energy technologies are already economically competitive, the production costs are currently often higher than market energy prices. However, if environmental impacts such as emissions of pollutants and GHG were monetized and included in energy prices, more renewable energy technologies would become economically attractive. For most of them, costs have declined over the last years and significant technical advancements and further cost-reductions are expected in the future.

Public policies recognizing and reflecting the wider economic, social and environmental benefits of renewable energies, including their potential to curb air pollution and improve public health, are key for meeting the highest renewable deployment scenarios.

For geothermal energy, the summary states that currently it provides about 0.7 exajoules per year from an installed capacity of 10.7 GW electric and more than 50 GW thermal. By 2050, geothermal deployment could meet 3% of the global electricity demand and about 5% of the global heat demand, while in 2008 geothermal energy contributed only 0.1% of the global energy demand. The worldwide geothermal technical potential is comparable to the global primary energy supply in 2008.

Other findings reported in the summary are as follows:

- Of the around 300 GW of new electricity generating capacity added globally between 2008 and 2009, 140 GW came from renewable energy (geothermal contributed with 0.4 GW).
- Despite financial challenges, renewable energy capacity grew in 2009 (compared to the previous year) as follows: wind by over 30%; hydropower by 3%; grid-connected photovoltaics over 50%; geothermal by 4%; solar water/heating by over 20%; and ethanol and biodiesel production by 10% and 9% respectively.
- Developing countries host more than 50% of current global renewable energy capacity.
- The technical potential of renewable energy technologies exceeds the current global energy demand by a considerable amount - globally and in respect to most regions of the world.
- Under the scenarios analyzed in-depth, 97% of the globally available technical potential for renewable is untapped.
- According to the four scenarios analyzed in depth, the decadal global investments in the renewable power sector range from 1360 to 5100 billion US dollars to 2020 and 1490 to 7180 billion US dollars for the decade 2020-2030.

Director, Geothermal Institute

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For information please contact Gary Putt for a confidential discussion, phone +64 9 923 8206 or email gary.putt@auckland.ac.nz

Applications close 22 July 2011.

For further information go to www.auckland.ac.nz/opportunities

The University has an equity policy and welcomes applications from all qualified persons.

The formation of the "EGS Global Group".

Engineered (or Enhanced) Geothermal Systems ('EGS') represent a vast, largely untapped potential for geothermal development around the world. However, the expertise required to characterise and develop EGS projects differs from that required for conventional geothermal developments. In particular, EGS projects require conductive heat flow measurement and modelling, deep drilling, micro-seismic monitoring arrays, hydraulic stimulation of fractures, stress field analyses and, usually, cascaded direct use of heat.

A new global partnership has emerged to provide the full range of skills and advice necessary for an EGS project. Announced on 9th March 2011, the EGS Global Group ('EGS-GG') was forged in Bali during the World Geothermal Congress in April 2010 and aims to build awareness and promote development of EGS projects around the world. The EGS-GG is an alliance of experts offering complementary services, advice and guidance through all stages of an EGS project. The four founding members of the EGS-GG represent a depth and breadth of experience in identifying and developing EGS projects. The four founding members are EGS Energy (EGS-E; UK), Hot Dry Rocks (HDR; Australia), BESTEC (Germany) and GPC-Instrumentation Process (GPC-IP; France).

EGS-E provides high-level strategic guidance, project management and advice on project financing for the creation of engineered geothermal systems, as well as specific expertise in micro-seismic monitoring and induced seismicity risk mitigation. The EGS-E team has direct experience of operating engineered geothermal systems in Europe.

HDR's expertise lies in the early stages of a project; exploration and resource characterisation. Its experience covers temperature logging and 3D temperature modelling, rock thermal properties measurements, design of exploration programs, and resource reporting compliant with the Australian Geothermal Reporting Code.

BESTEC's expertise is in the development stage; engineering, design of EGS systems, drilling, fracture stimulations, reservoir analysis, and operations. In November 2007, BESTEC commissioned the world's first commercial EGS plant in Landau, Germany.

GPC-IP's expertise lies in borehole drilling, completions and testing; resource monitoring and management; chemical inhibition of scaling and corrosion; environmental impact surveys; and legal/institutional aspects of resource management. GPC-IP focuses on direct or cascaded use of lower enthalpy fluids, with experienced gained from servicing almost half of the geothermal district heating systems currently operating in that Paris Basin.

The EGS-GG aims to become involved in many EGS projects around the world at an early stage, and to provide its broad range of skills and experience to rapidly commercialise those projects by avoiding delays and mistakes caused by inexperience. The EGS-GG partners are already working together in various combinations on several projects, and hope to collectively provide the world with an integrated team for EGS project guidance and management.

Announcement of the Formation of the International Geothermal Business Coalition

and

International Call for Recognition of Geothermal Energy's Potential

To help pursue international goals, the members of several leading national geothermal trade and business associations have joined together to establish the International Geothermal Business Coalition (www.internationalgeo.org). The European Geothermal Energy Council, the US Geothermal Energy Association, the Canadian Geothermal Energy Association, the Australian Geothermal Energy Association, and the Chilean Geothermal Energy Association represent the original founders of this coalition. These groups represent the leading companies involved in developing geothermal resources to meet the energy needs of the world.

The leaders of the International Geothermal Business Coalition call upon governments around the world to expand their efforts to utilize geothermal resources as an important part of the answer to global environmental, climate change, and energy security problems. The extensiveness of geothermal's potential to address these critical problems is poorly recognized, and as a result, geothermal resources are too often undervalued in national energy plans.

Geothermal energy utilizes the earth's natural and renewable supply of subsurface heat energy and can be deployed to meet the heating, power, and other energy needs of hundreds of millions of people today. With the technology available and under development for the future, geothermal resources can be utilized on every continent and eventually in every country of the world.

Geothermal resource use is expanding globally, but it needs government support to achieve its full potential. It is evident from a review of leading geothermal countries that a range of policies provide essential support for the development of geothermal resources. Our Coalition calls upon each country to assess the potential of current and future geothermal technology to meet its national energy

objectives. Countries should institute geothermal development targets into their renewable energy goals as a first step to implementing policies that support development and should have, as part of their energy plans, effective long-term incentives and policy support for geothermal energy.

Our Coalition calls upon international and multi-national organizations to support geothermal resource assessment, technology development, and the development of policies and financial incentives for the expanded use of geothermal resources to meet the world's energy needs. These organizations should use their resources to help countries recognize the potential of geothermal resources and set appropriate national geothermal goals.

In particular, the World Bank and other multi-lateral financial institutions should expand their financial support for geothermal development and projects. There should be clear organizational goals for geothermal promotion within these institutions as well as specific senior staff designated to achieve them. The funding and support provided to geothermal should be comparable to that provided to support other technologies.

The International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) should both consider more geothermal electricity and heating & cooling in their prospective scenarios. Geothermal will be a key player to fight global warming by decreasing CO_2 emissions in decarbonizing power and heating sectors.

Signed:

Australian Geothermal Energy Association
Canadian Geothermal Energy Association
Chilean Geothermal Energy Association
European Geothermal Energy Council
US Geothermal Energy Association

May 4, 2011

FOR MORE INFORMATION:

Australian Geothermal Energy Association
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IGA News

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This issue of IGA News was edited by Eduardo Iglesias. John Garnish proofread the articles. Produced by Gestur Gíslason for the IGA Secretariat. Design layout by François Vuataz.

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