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IGA NEWS

Newsletter of the International Geothermal Association

IGA ACTIVITIES

Message from the President

John W. Lund, President

L. to r.: J. Lund, M. Zemedkun, G. Bloomquist

The President attended the First International Conference on Geothermal Energy in the East African Rift Region (ARGeo C-1) in Addis Ababa from 24-29 November 2006. The Conference emphasized the potential of geothermal in the East African Rift countries of Ethiopia, Kenya, Djibouti, Tanzania and Uganda. Papers from other countries around the world were also presented by speakers from outside of Africa. The Conference was opened by IGA Board member Meseret Zemedkun as the Chairperson of the Main Organizing Committee. The President was invited as a keynote speaker and presented a paper on "History, Present Utilization and Future Prospects of Geothermal Energy Worldwide." Dr. Gordon Bloomquist, also an IGA Board of Directors member, presented a keynote talk on "Factors Critical to Economic Feasibility." The President then presented a paper on "Direct Utilization of Geothermal Resources," Gordon Bloomquist presented one on "Economic Benefits of Mineral Extraction from Geothermal Brines", and another Board Member, Franciska Karman of Hungary, presented a paper on "Pilot Plant Geothermal Project for Multiple Integrated Use in Hungary". The President, along with Leif Bjelm of Sweden, was fortunate to tour the Alto Langano geothermal plant in the Rift Valley after the Conference. A more detailed report on the Conference can be found elsewhere in this publication.

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Gordon Bloomquist, Chair of the Finance Committee, signed the World Bank/GeoFund agreement for USD810,000 while in Ethiopia and then he and Kyoichi Shimazaka of the World Bank met in Iceland to establish the World Bank/GeoFund account with the IGA Secretariat. Gordon Bloomquist and Arni Ragnarsson, IGA Executive Director, then attended a workshop of the World Bank to prepare themselves for administration of the World Bank/GeoFund grant. Disbursement of the funds has now been approved by the World Bank, thus contracts will soon be let for the various activities specified in the grant that were detailed in earlier IGA News.

The Steering Committee (SC) formed by IGA for the World Geothermal Congress 2010 to be held in Bali, Indonesia, will be meeting with the Indonesian Organizing Committee (OC) in Bali from February 19 to 21, 2007. This will be the first joint meeting of the two groups in order to discuss progress to date, view the proposed venue, and ensure that the Memorandum of Understanding (MOU) between the Indonesian Geothermal Association (INAGA) and IGA is implemented in a timely manner. The IGA SC is composed of the following persons: Gordon Bloomquist (chair), Beata Kepinska of Poland, Eduardo Iglesias of Mexico, James Koenig of the USA, Mahmut Parlaktuna of Turkey, Roland Horne of the USA, and James Lawless of New Zealand. The Chairman of the OC is Herman Darnel Ibrahim of PLN (Persero) and the Secretary General is Surya Darma of PGEINDONESIA, both from Indonesia. The President will be a member of the Honorary Committee of the OC.

Nominations for the next IGA Board of Directors will be completed by March; the ballots will be sent out in April and counted in July. The old Board will retire and the new Board will take office at the Board meeting in Iceland in either September or October. The next IGA Annual General Meeting will also take place in Iceland at this time.

Plans are being made for the next International Summer School, organized in the past by Kiril Popovski of Macedonia. With support funding from the World Bank/GeoFund, the next school will probably be held this coming fall. A solicitation will be forthcoming from Marcel Rosca (Romania), chair of the Education Committee, for hosting this next school which must be in one of the GeoFund countries.

On-line IGA collection of geothermal proceedings

Eduardo Iglesias, Chairman IGA Information Committee

The collection in the IGA website currently includes the proceedings from: World Geothermal Congress, Stanford Geothermal Workshop, New Zealand Geothermal Workshop, European Geothermal Conference, Iceland Geothermal Conference, Indonesian Geothermal Association Conference, Beijing International Geothermal Symposium, International Geothermal Workshop – Russia, and Geothermal Energy in Underground Mines –Ustron – Poland.

We have recently added to this collection the proceedings of the 2007 Stanford Geothermal Workshop, provided by Prof. Roland Horne, at Stanford University (a member of the Information Committee); and the proceedings of the 2006 New Zealand Geothermal Workshop, provided by Juliet Newson. With these additions the collection now stands at 5,204 papers.

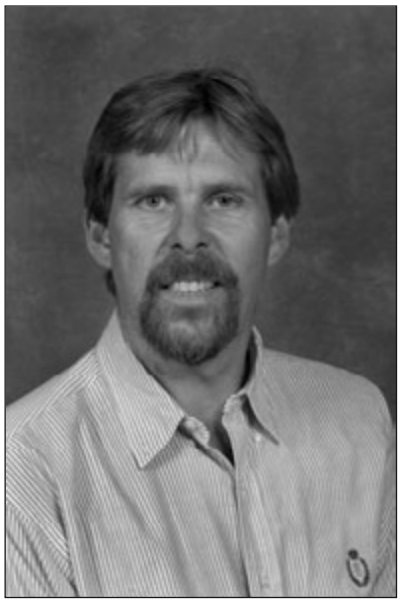
Currently, the IGA collection experiences an average of about 25 downloads per day, from countries across the world. The online collection has proven to be a very useful research tool for the international geothermal community. Please take a look in the IGA website, at "IGA Services/Geothermal conference papers search engine".

EUROPE

Iceland

Gudmundur Svavar (Bo) Bodvarsson - In Memoriam

Benedikt Steingrímsson, Grímur Björnsson



The year 2006 was a very tragic year for the Icelandic geothermal community. On July 10th,Valgarður Stefansson, the Executive director of IGA passed away at the age of 67. Then late in November, we got the shocking news that another good friend and colleague, Bo Bodvarsson had died suddenly. Bo had checked into a hospital in California two weeks earlier complaining of breathing problems and stomach pains. He was treated at the hospital and seemed to be recovering well. He expected to be released the next day when he died unexpectedly on November 29, at only 54 years old, from pulmonary embolism and heart failure.

Bo was born in Iceland in a small village about an hour's drive east of Reykjavik, Iceland's capital. His father was the headmaster of the local primary school and there Bo grew up with his parents and two older brothers, Stefan and Reynir. He graduated in 1972 from the Secondary Grammar School at Laugarvatn and decided to seek further education in the USA. He studied mathematics and physics and received a Bachelor's degree from Catawba College (in Salisbury, North Carolina) in 1974, and an M.Sc. in civil engineering from North Carolina State University (in Raleigh) in 1976. Bo spent the summers with family and friends in Iceland during these years and took summer jobs, which is customary for Icelandic university students. One of these was at Orkustofnun (the National Energy Authority) in 1974 where Bo was part of a team of four summer students, carrying out resistivity surveys for geothermal exploration. Other members of that team were Olafur Flovenz (now the director of ISOR, Iceland GeoSurvey) and Ludvik S. Georgsson (now deputy director of the UNU-Geothermal Training Programme in Reykjavik). There was always plenty of fun around Bo: stories are still being told of the lively arguments and discussions between Ludvik and Bo that summer.

After completing his degree in civil engineering Bo worked for two years at the Icelandic Building Research Institute, but building technology and concrete research was not what he wanted to do. So he moved with Mary, his wife at the time, to California where he completed Ph.D. in hydrogeology at the University of California in Berkeley in 1981. His thesis was on numerical modeling of geothermal reservoirs and the development of the well known numerical simulator PT.

In 1980, while studying for his doctorate, Bo joined the Earth Sciences Division (ESD) at Lawrence Berkeley National Laboratory (LBNL) to work on hydrogeology and reservoir engineering problems related to geothermal systems. Drawing on his strong background in physics and mathematics, Bo focused on the mathematical modeling of reservoir processes, and on the interpretation of data from geothermal fields, to help predict reservoir behavior, longevity, and output.

Over the years, Bo kept a close connection to Iceland and collaborated with Icelanders on modeling of various geothermal fields, including the Krafla and the Nesjavellir fields. He accomplished this through short-term visits to Iceland, while several Icelanders visited the "Lab" at UC Berkeley during sabbaticals and for further learning. Similarly, he and his colleagues at LBNL collaborated with geothermal experts from all over the world as ESD became the center of excellence in geothermal reservoir modeling. His long list of publications reveals his wide-ranging studies of geothermal fields in Ahuachapán (El Salvador), Baca (USA), Cerro Prieto (Mexico), Dixie Valley (USA), Heber (USA), Krafla (Iceland), Miravalles (Costa Rica), Nesjavellir (Iceland), Olkaria (Kenya), Palinpinon (Philippines), Svartsengi

(Iceland), The Geysers (USA), and more. Through these studies, as well as his work as a consultant, he became one of the leading modelers of geothermal reservoirs, especially those hosted in fractured rocks.

In the early 1990s, Bo's interest shifted towards the investigation of the physical and chemical processes taking place in unsaturated fractured rock masses. In 1993, he was appointed Head of the Nuclear Waste Department of ESD, and, a few years later, Head of the Unsaturated Zone Scientific Studies Group related to the Yucca Mountain Project. In 2001 Bo became Director of the Earth Sciences Division (ESD) at Lawrence Berkeley National Laboratory (LBNL), a position which he held to his death. Bo was the first Icelander to hold a division appointment at LBNL or, in all likelihood, any other national laboratory in the USA.

Although Bo's most recent efforts were directed primarily toward management, and the study of processes associated with geologic storage of nuclear waste, he maintained a strong involvement in geothermal energy and followed the geothermal developments in Iceland and elsewhere. He visited Iceland when he found the time, sometimes as a consultant or a lecturer. These occasions included lecturing at the United Nation University Geothermal Training Programme in Iceland, where he occasionally gave lectures and was the annual visiting lecturer in September 1995. In 2002, Bo came to Iceland for his 50th birthday and threw a typical Icelandic party, with lots of fun and stories from the past – including the arguments with Ludvik from their fieldwork days 30 years earlier.

Statistics tell us that Icelandic men live until they are 80. We therefore expected to enjoy Bo's friendship for many years to come. Bo was a strong believer in science and was always looking for data that support or contradict the existing conceptual models of geothermal reservoirs. In that sense, he has contributed enormously to our understanding, modeling and management of geothermal resources. His death was all the more surprising since he was known to be a competitive athlete who played soccer, tennis, volleyball and a number of other sports whenever he got the chance. He was a great friend and we miss him sorely.

In an obituary published in an Icelandic newspaper the same day as Bo's funeral service, an old family friend told a story that we find characterizes Bo so well. When taking a hike with a friend at age 5-6, Bo picked up a horseshoe in their path. Looking at the horseshoe, the young Bo said, "Now we only need three more of these and a horse, and then we can ride back home." This spirit of optimism and the urge to find solutions, when we look back, has been in many ways Bo's trademark. It was this spirit that was necessary in building the first generation of detailed numerical geothermal reservoir models, and later flourished in the Yucca Mountain nuclear waste storage project.

Our deepest sympathies go to Bo's family, his father Böðvar Stefansson and two brothers Stefan and Reynir and their families, and in particular to his two surviving sons, Daniel Bodvarsson, 28, and Erik Ma, 7.

Poland

The Podhale region – development of long-awaited geothermal bathing and balneotherapy projects has finally begun

Beata Kepinska, Polish Geothermal Society, Polish Academy of Sciences, Kraków, Poland

General

The Podhale region (S-Poland) is located within the Inner Carpathians. In the south it borders Slovakia - through the Tatras, the only mountains of Alpine character in Poland (the highest peak: Rysy - 2499 m a.s.l.). The central part of the region is occupied by the Podhale Basin which contains geothermal aquifers.

Podhale is well known in Poland and Central Europe as a very popular tourist and sport destination, visited by more than four million tourists annually. It belongs to one of the most valuable regions in the country because of the

variety of landscape and geological structure, unique flora and fauna, climatic, tourist and sport values, a vital, rich folk culture and tradition, and – last but not least - large resources of geothermal waters characterized by favourable parameters.

Since the end of the 1980s, the Podhale region has also been known for a large regional geothermal space heating project (Kepinska 2004, 2005). When completed, it will be among the largest in Europe with yearly heat sales around 600 TJ (it is currently providing ca. 300 TJ/y).

Apart from the district heating – essential for ecological reasons - other important geothermal applications that have been waiting for realisation for many years are bathing and balneotherapy. Due to their chemical composition (first of all H^2S and sulphides, relatively high silica content, potassium, sometimes bromide and iodide) the Podhale geothermal waters have curative properties suitable for dermatological, rheumatic, endocrinal and contagious diseases. However, geothermal recreation and healing facilities and services have been missing so far. Until 2001 only one geothermal bathing pool operated in Zakopane – the main town in the region. Earlier (mid 1800s – mid 1900s), a natural warm spring served for recreation and healing treatment.

One should point out that there are exceptionally great opportunities to build several further healing and recreation centres in this region. They should be treated as indispensable factors to increase the tourist potential and to improve the quality of rest and recreation in this part of the country. In fact, geothermal balneotherapy and bathing seems to offer a very important opportunity for sustainable development of tourism and economics in the Podhale region.

Finally, in the last period (2004 - 2006) long-awaited project works, new drillings and constructions oriented to geothermal swimming pools and water centres have begun to be realised in various localities.

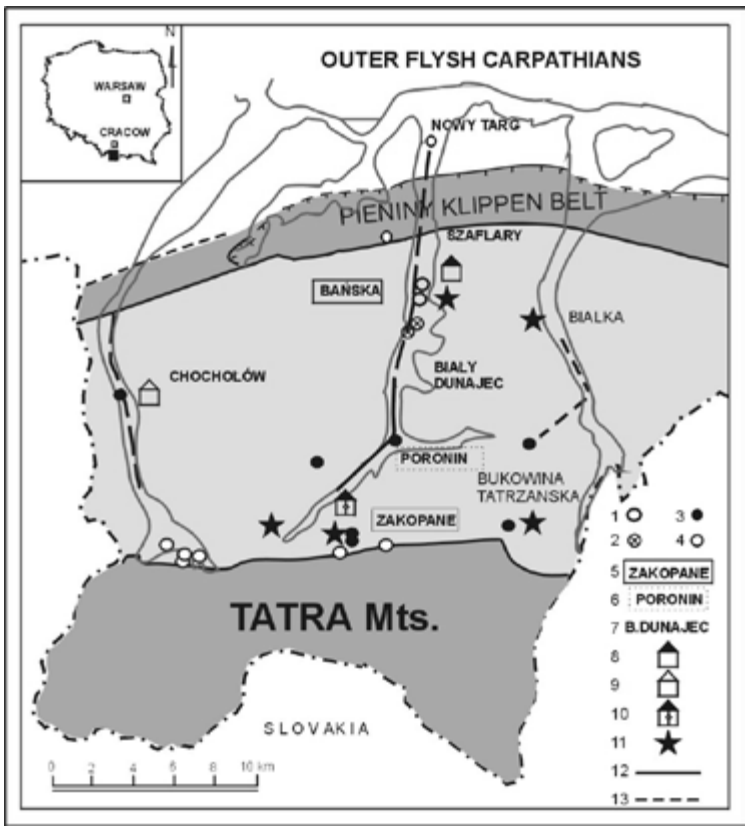


Figure 1. Geological sketch of the Podhale region showing location of geothermal bathing centres under various stages of project realisation (end of 2006), geothermal wells and main elements of the heating network under construction (based on Kepinska 2004, slightly modified)

1—3: geothermal wells: 1 – production, 2 – injection, 3 – not in use; 4 - other wells; 5. locality with geothermal heating system on-line (2006); 6. localities under connection to geothermal heating network; 7. localities planned to be geothermally heated; 8. Geothermal Base Load Plant; 9. geothermal heating plants planned; 10. Central Peak Load Plant; 11. geothermal bathing centres at various stages of realisation (end of 2006); 12. main transmission heating pipeline; 13. transmission heating pipelines planned.

Five of them are now being realised in various sites of the Podhale region (fig.1): in the villages of Banska Nizna, Bialka and Bukowina Tatrzanska, and in Zakopane town (two centres). They are in different stages of progress: in two cases new wells are being drilled aimed at water production for planned activities (Bialka, Zakopane); two other centres are being constructed (Banska Nizna and Zakopane – the latter co-funded by EU), while the project for Bukowina Tatrzanska is undergoing formal approval procedures.

They are located close to popular ski-lifts and ski stations, so such a combination of skiing and geothermal bathing will create a very attractive and wide all-day opportunity for sport, recreation, rejuvenation and rest.

In this article, some details connected with the project idea for the Bukowina Tatrzanska geothermal spa are presented.

Geological characteristics and former use of geothermal water for bathing

The Podhale geothermal system belongs to the Polish part of the extensive Inner Carpathian Palaeogene systems located mostly within Slovakian territory. Its area within Poland amounts to about 475 km^2. The Basin was formed in the Palaeogene. Its basement is composed of Mesozoic formations with a high proportion of carbonates (which contain the geothermal aquifers) outcropping at surface mostly in the Tatra Mts and other mountain ranges on the Slovakian side. The profile of the Palaeogene formations that fill the basin includes conglomerates and limestones of variable thickness (0– 350 m), and the Podhale flysch (cover of geothermal aquifers) of maximum thickness 2.5-3 km. It is worth noticing that the systems in question contain one of the largest and most prospective low-enthalpy resources in Europe.

Several geothermal aquifers have been found within the Mesozoic basement of the Podhale Basin in Poland. Reservoir rocks for geothermal waters are mainly Triassic carbonates, and sometimes Jurassic sandstones and carbonates.

The main aquifer - exploited for heating purposes since the beginning of the 1990s and planned to supply new swimming and healing facilities - occurs within the Middle Triassic limestone-dolomites and in the overlying Middle Eocene limestones and conglomerates at depths of 1-3.5 km. These formations are found over the entire Podhale system, extending into the Slovakian territory. Usually their total thickness is considerable, ranging from 100 to 700 m, while the effective thickness is equal to 100 m. Reservoir temperatures reach up to 80-90°C. The maximum flow rates vary from 50 to 150 l/s of 82-86°C water. The TDS are at the level of 0.1 – 2.5 g/l (Kepinska, 2004). The water contains several components (H^2S, sulphides and potassium, as well as silica, bromide and iodide) of curative properties suitable for dermatological, rheumatic, endocrinal and contagious diseases.

One should note that on the Slovakian side of the system in question, especially near the Tatra Mts, geothermal waters have been exploited in numerous localities for pools, water centres and balneotherapy (Fendek and Fendekova, 2005). Several of them have been built (or extended) during the last few years as a result of growing demand and interest in such recreation. They are very popular among tourists both from Slovakia and neighbouring countries, including Poland. Now it is time to develop similar facilities within the Polish Podhale.

It is also worth mentioning that in the Podhale region the tradition of using geothermal water for bathing purposes goes back to the 19th century: about 20°C water was used in a swimming pool, particularly popular at the beginning of the 20th century. In the 1950s, the spring disappeared due to mixing with cold river water. The spring was an important pointer to geothermal occurrence in the Podhale. Just before 1939, it prompted the start of geothermal theories and the first well design recognising the site.

Next, from mid 1960s till 2001, water discharged by two wells at temperatures of 26°C and 36°C was used for small pools in Zakopane. As mentioned, since mid-2001 the construction of a large geothermal spa has been underway there (expected to be opened in the coming months). So far, it was all that was available in the geothermal bathing and healing sector. Finally, the last period brought some positive activities which will be a real milestones in geothermal development and use.

The project of geothermal spa in Bukowina Tatrzanska

Bukowina Tatrzanska is one of the localities where a large geothermal spa is underway. The village was established almost 400 years ago and presently is one of the most frequented mountain resorts in Poland. At the beginning of the 20th century it started to attract people involved in science, art and politics. In the period between the two world wars the Society of Bukowina's Friends was established. Active until the present day, it has supported many local projects and development plans. Among the most recent is the construction a geothermal spa named "Terma Bukowina Tatrzanska".

In March 2006 a public presentation of the design for the geothermal centre and its main technological and economic assumptions took place in this village. The architecture of the whole complex was inspired by specific local patterns (fig.2). The facility will be built within the next three years on the slope above 1000 m a.s.l. with a marvellous

Figure 2. *Visualisation of geothermal recreation and balneotherapy centre in Bukowina Tatrzanska, Podhale region.* Source: www.termabukowina.pl

view towards the Tatra Mts. It is planned to serve about 1000 visitors/hour. It will be supplied with water discharged from a deep well (3780 m) drilled at the beginning of 1990s. The wellhead water temperature is around 65°C while the TDS is around 1.5 g/dm^3. The borehole was drilled in the framework of geological exploration of the Podhale region which was one of the first stages of the project for regional geothermal energy use in that part of the country.

The geothermal spa in Bukowina Tatrzanska will enlarge and increase the quality of tourist attraction as well as pave the way for the extension of recreation and rehabilitation infrastructure.

The near future – geothermal bathing and recreation centres to be launched

Along with the Bukowina Tatrzanska geothermal spa, two other bathing and recreation centres are expected to be opened soon – in Banska Nizna and in Zakopane, while the next two should make quick progress. Several further investors are interested in that branch of services and business. These will bring a new offer for both tourists and permanent residents as well as contributing to the realisation of the idea of wide and versatile geothermal use and sustainable development of this part of Poland. Such a concept has accompanied the Podhale geothermal project since its beginning some twenty years ago (Kepinska, 2004)..

The author hopes soon to share the next optimistic information on progress in the use of Podhale warm waters for bathing and balneotherapy, as a large geothermal aqua-park in Zakopane is going to be launched at the threshold of 2006 - 2007.

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www.termabukowina.pl

THE AMERICAS

El Salvador

Millennium Workshop in El Salvador

Ingvar B. Fridleifsson, Director of the UNU-GTP

The "Workshop for Decision Makers on Geothermal Projects in Central America" was held in San Salvador 26 November to 2 December 2006. It was co-hosted by UNU-GTP and LaGeo S.A de C.V. in El Salvador. The fifty participants came mainly from the four countries of Central America active in geothermal development, i.e. Costa Rica, El Salvador, Guatemala and Nicaragua. Geothermal power stations provide about 12% of the total electricity generation of the four countries. Only a small portion of the geothermal resources in the region has been harnessed.

The aim of the workshop was to give high level decision makers from the respective energy and environmental ministries, leading geothermal agencies, and electric utilities in the region an overview of some of the key issues of geothermal development, with a special focus on environmental issues. The Vice-President of El Salvador (Licda. Ana Vilma Albanez de Escobar) opened the Workshop. Amongst speakers on the opening day were the Economy Minister of El Salvador (Mrs. Yolanda Mayora de Gavidi), the Minister of Environment and Natural Resources of Nicaragua (Mr. Cristobal Sequeira), the Minister of Mines and Energy of Guatemala (Mr. Luis Ortiz), and the Director of the UNU-GTP (Dr. Ingvar B. Fridleifsson).

Thirty six papers were presented (and distributed printed, on CDs, and on www.os.is/unugtp/). The lecturers came from the four Central American countries as well as Iceland, Italy, Kenya, Mexico, Philippines and the USA. Among the lecturers were 9 former UNU-GTP Fellows.

The cooperation with LaGeo in organizing the Workshop was marvellous. LaGeo´s staff under the leadership of General Director Mr. José Antonio Rodriguez did an outstanding job. Sincere thanks are due to LaGeo´s management and staff for their help, hospitality and friendship. The UNU-GTP looks forward to the cooperation in capacity building with LaGeo and the countries of Central America during the next few years.

Conclusions

Geothermal development brings with it many economic, environmental and social benefits, strictly related with the Millennium Objectives;

Central America is one of the regions with greatest geothermal potential in the world, estimated at 4,000 MW (compared to less than 9,000 MW of currently installed total capacity in the isthmus);

Currently only 10% of the available geothermal potential is used in the region for electricity generation;

Since geothermal energy is a renewable and indigenous energy resource, it reduces the pressure on the economies of our countries that now depend excessively on the energy from imported fossil fuels;

The environmental impacts of this energy source are minimal as compared with other energy sources, particularly those that utilize fossil fuels;

Currently the production of fossil fuels and derivatives is not significant in the Central American isthmus;

Geothermal energy is the most stable and reliable of all renewable energies since it is available throughout the year, and has a competitive price with any other source in the region;

The possibility of installing 1,000 MW from geothermal sources in the next 10 years is a challenging but executable objective.

Recommendations within the institutions of the countries in the region

Inform the population of the benefits associated with geothermal development;

Strengthen the existing training courses in order to train high level technical and scientific personnel;

Educate and familiarize the authorities and general public on the benefits related to geothermal activities;

Promote regional agreements of technical cooperation among the institutions dedicated to geothermal activities;

Revise, update, and integrate the geo-scientific studies of the region in order to measure the advancement and geothermal development, taking into account the new technology;

Utilize in a more efficient manner the conversion of geothermal heat utilizing state of the art technology;

Revise and update the OLADE guides, considering the current technological advances;

Promote the direct industrial use of geothermal energy in the region taking into account the experiences of other countries.

Recommendations to the Governments of the countries of the Region

That they support the list recommended to the institutions;

Present legislation and regulation initiatives that allow exploration, development and exploitation of the geothermal resources that are found within protected areas;

Present legislation and regulations that promote participation of geothermal in electricity markets;

Emphasize with national and regional organizations the different financing possibilities in order to develop geothermal projects especially during the initial phases pre-feasibility and feasibility.

Mexico

2006 Annual Congress and XIV General Ordinary Assembly of the Mexican Geothermal Association (AGM)

Luis C.A. Gutierrez-Negrin

On September 8, 2006, the Mexican Geothermal Association (AGM: Asociación Geotérmica Mexicana) held its Annual Congress and its XIV Ordinary General Assembly at the facilities of the Comisión Federal de Electricidad (CFE) of the Cerro Prieto geothermal field, located in the State of Baja California, Mexico.

There were 34 participants, 27 of them being members of the AGM, coming from the CFE, the Mexican electric research institute (IIE), the Ohio and Baja California universities, the CICESE research center and from private companies. Nine technical papers were presented during the congress, most of them dealing with the Cerro Prieto field, one about the Berlin, El Salvador, geothermal field, and two more on environmental and corrosion topics. All of the papers were included in a compact disc which was given to the participants as the proceedings of the congress. Most of them will be published in the Mexican magazine Geotermia (which can be read at the Geothermal Resources Council website: http://geothermal.org).

The congress and the assembly were conducted by José Luis Quijano, Vice President of the AGM, on behalf of the President, Alejandro Abril. During the opening, Quijano read salutation letters sent by John W. Lund, President of the International Geothermal Association (IGA), and by Rafaelle Cataldi, Vice President of the Italian Geothermal Union (UGI). Both UGI and AGM are national associations affiliated to the IGA.

After the congress, the AGM assembly was held, with the following agenda:

1. Approval of the Minutes from the Ordinary General Assembly of 2005.
2. Report of the Board of Directors.
3. Report of the Treasurer.
4. Presentation of the 2006 Pathé Award.
5. Election of the 2006-2008 Board of Directors.
6. Swearing-in of the 2006-2008 Board of Directors.
7. General issues.

The minutes and reports were approved, and the 2006 Pathé Award went to Sergio Mercado González. The recognition was delivered by Héctor Alonso, the winner of the 2005 Pathé Award. Sergio Mercado is a chemical engineer who has been involved in geothermics since the sixties. In 1977 he joined the IIE where he founded the Department of Geothermics and was in charge of it until 1984. He was a geothermal adviser for the United Nations and president of the UN Geothermal Experts Panel between 1979 and 1981. In 1982 he dived to 2600 meters depth in the Pacific Ocean on board the Alvin mini submarine, discovering a zone of submarine geothermal chimneys. He has published over 120 papers, has three patents and is a former member of the Mexican national researchers system. He is still working for the IIE.

The 2006-2008 Board of Directors is constituted as follows:

President:	José Luis Quijano-León
Vice President	Raúl Maya-González
Secretary:	Rogelio Vázquez González
Treasurer:	Luis C.A. Gutiérrez-Negrín
Pro-Secretary:	Alfonso García-Gutiérrez
Pro-Treasurer:	Magaly del Carmen Flores-Armenta

Photo 1. Participants of the AGM congress in Cerro Prieto, Mexico

USA

MIT-led panel backs 'heat mining' as key U.S. energy source

John Garnish

The following report is based on a press release issued by the Massachusetts Institute of Technology in January 2007:

A comprehensive new MIT-led study of the potential for geothermal energy within the United States has found that mining the huge amounts of heat that reside as stored thermal energy in the earth's hard rock crust could supply a substantial portion of the electricity the U.S. will need in the future, probably at competitive prices and with mini-

mal environmental impact. An 18-member panel led by MIT prepared the 400-plus page study, titled "The Future of Geothermal Energy", which was sponsored by the U.S. Department of Energy. It can be found on the web at : http://geothermal.inel.gov/publications/future_of_geothermal_energy.pdf. Chapter 1 of the report includes a short synopsis and executive summary.

The goal of the study was to assess the feasibility, potential environmental impacts, and economic viability of using enhanced geothermal system (EGS) technology to greatly increase the fraction of the U.S. geothermal resource that could be recovered commercially. Existing U.S. plants have focused on the high-grade geothermal systems primarily located in isolated regions of the west. This new study takes a more ambitious look at this resource and evaluates its potential for much larger-scale deployment.

"We've determined that heat mining can be economical in the short term based on a global analysis of existing geothermal systems, an assessment of the total U.S. resource, and continuing improvements in deep-drilling and reservoir stimulation technology," said panel head Jefferson W. Tester, the H. P. Meissner Professor of Chemical Engineering at MIT and a member of the original Fenton Hill HDR project team. "EGS technology has already been proven to work in the few areas where underground heat has been successfully extracted, and further technological improvements can be expected."

The expert panel, many of whose members will be well-known to readers of IGA News, offers a number of recommendations to develop geothermal as a major electricity supplier for the nation. These include more detailed and site-specific assessments of the U.S. geothermal resource, and a multi-year federal commitment to demonstrate the concept in the field at commercial scale.

The new assessment of geothermal energy by energy experts, geologists, drilling specialists and others is important for several key reasons, Tester said.

First, fossil fuels - coal, oil and natural gas - are increasingly expensive and consumed in ever-increasing amounts. Second, oil and gas imports from foreign sources raise concerns over long-term energy security. Third, burning fossil fuels dumps carbon dioxide and other pollutants into the atmosphere. Finally, heat mining has the potential to supply a significant amount of the country's electricity currently being generated by conventional fossil fuel, hydroelectric and nuclear plants.

The study shows that drilling several wells down to reach hot rock and connecting them to a fractured rock region that has been stimulated to let water flow through it creates a heat-exchanger that can produce large amounts of hot water or steam to run electric generators at the surface. Unlike wind and solar systems, a geothermal plant works night and day, offering a non-interruptible source of electric power.

Prof. Tester and panel member David Blackwell, professor of geophysics at Southern Methodist University in Texas, also point out that geothermal resources are available nationwide, although the highest-grade sites are in western states, where hot rocks are closer to the surface, requiring less drilling thus lowering costs.

The panel also evaluated the environmental impacts of geothermal development, concluding that these are "markedly lower than conventional fossil-fuel and nuclear power plants…..This environmental advantage is due to low emissions and the small overall footprint of the entire geothermal system, which results because energy capture and extraction is contained entirely underground, and the surface equipment needed for conversion to electricity is relatively compact," Tester said.

The report also notes that meeting water requirements for geothermal plants may be an issue, particularly in arid regions. Further, the potential for seismic risk needs to be carefully monitored and managed.

Tester and colleagues emphasize that federally funded engineering research and development must still be done to lower risks and encourage investment by early adopters. Of particular importance is to demonstrate that EGS technology is scaleable and transferable to sites in different geologic settings.

In its report, the panel recommends that:

- More detailed and site-specific assessments of the U.S. geothermal energy resource should be conducted..
- Field trials running three to five years at several sites should be done to demonstrate commercial-scale engineered geothermal systems.
- The shallow, extra-hot, high-grade deposits in the west should be explored and tested first.
- Other geothermal resources such as co-produced hot water associated with oil and gas production and geopressured resources should also be pursued as short-term options. It is estimated that co-produced hot water in the US could contribute up to 11,000 MWe of generating capacity using standard binary-cycle technology.
- On a longer time scale, deeper, lower-grade geothermal deposits should be explored and tested.
- Local and national policies should be enacted that encourage geothermal development.
- A multi-year research program exploring subsurface science and geothermal drilling and energy conversion should be started, backed by constant analysis of results.

The report is concerned primarily with the situation in USA, and includes a chapter by Dave Blackwell that provides the first comprehensive estimates of the US resource base since USGS Circular 726 (1975). Nevertheless, it contains much of more general interest, including a comprehensive chapter on the technology and costs of geothermal power generation (lead author Ron DiPippo). The panel included John Garnish and Tony Batchelor from the UK to provide an historical and international perspective and to support the view that the world-wide energy prize is so large that it cannot be ignored. Technologies developed by an expanded EGS programme in USA would provide opportunities for significant projects in many other countries; this report could provide useful background for anyone seeking to make a case in their own countries.

ASIA/PACIFIC RIM

CHINA

China Promotes Geothermal Heat Pump Development

Keyan Zheng, GCES, China

The National Symposium on Development and Utilization of Shallow Geothermal Energy was held in Beijing on January 20-30. More than 400 participants from all over the country attended the symposium. Two vice ministers of the Ministry of Land and Resources presided over the symposium. Vice Minister LI Yuan gave an opening speech. Vice Minister YUN Xiaosu gave a concluding speech. The symposium collected 42 papers and published proceedings. 15 of the papers were presented in the symposium. Participants visited three demonstration systems in the suburbs of Beijing. These examples included winter heating and summer cooling in a college, office building and conference center respectively. They used open and closed systems.

China has learnt from developed countries in the world. The Chinese Government promotes renewable energy in the country, including geothermal energy and shallow geothermal energy (GHP) development. The development of shallow geothermal energy by using ground source heat pumps has been growing rapidly in recent years. The annual energy provided by geothermal heat pumps was 6,570 TJ/yr in 2004 and 14.5% of geothermal direct use in China, but it reached 17,140 TJ/yr in 2006 and 29.4% of geothermal direct use. As a result, the annual energy utilization of conventional geothermal energy plus shallow geothermal energy has reached 58,280 TJ/yr in 2006. The annual energy produced for direct heating has been 16,189 GWh/yr. A series of preferential measures have been issued by many local governments in China. The Shenyang Government (in northeast China) has decided to refurbish all old boiler heating systems in the city into geothermal heat pump systems. The Beijing Government has issued a policy to give a subsidy to those developments that use geothermal heat pumps.

Chinese National Symposium on Shallow Geothermal Energy

INDONESIA

Wayang Windu: Owner of the World's Largest Steam Well

Alex Smillie, Vice President Geothermal Operations, Star Energy

Star Energy Holdings (Pte) Ltd's new drilling programme at the Wayang Windu geothermal field, West Java, Indonesia got off to an excellent start when the first well drilled (MBD-5) achieved production of 72 kg/s dry steam at a well head pressure of 15 bar (see photo). This is equivalent to production of over 40 MWe, and was demonstrated

Star Energy's MBD-5 well producing steam sufficient to generate 40 MWe, wellhead to right showing a WHP of 15 bar, with steam rising from the rock muffler in the background. Photo: Ian Bogie

during extended testing of the well prior to placing into commercial operation. On the basis of publicly available information, this makes it the world's largest capacity dry steam well. The drilling programme is aimed at providing steam sufficient for a second 110 MWe turbine in the near future.

The well was directionally drilled to 1377 m MD with a 12 ¼" production hole. Permeability is structurally controlled within the reservoir which consists of strongly altered andesite pyroclastics and lavas. Production is from a widespread two-phase reservoir that overlies a brine reservoir in the northern part of the field. Each of the other four wells drilled from the same pad produce, on average, half as much as MBD-5. The well was targeted on the results of a geological structural study and new sets of geophysical surveys.

PHILIPPINES

PNOC EDC starts operation of Northern Negros geothermal power plant

PNOC Energy Development Corporation began commercial operation of its 49-MW Northern Negros geothermal power plant (NNGP) last February 3. President Gloria Macapagal-Arroyo inaugurated the power plant which will augment power supply in the interconnected Visayan region.

Located in Sitio Pataan, Bgy. Mailum, Bago City, Negros Occidental, NNGP is a critical installation in Negros island, which has a peak demand of 205 MW but with a dependable capacity of only 180 MW. It is intended to provide energy to an estimated 800,000 households and help the country increase its dollar savings from displaced oil imports.

The power plant's output will be distributed via 25 kilometers of transmission line to the National Transmission Corp's Mansilingan substation. "We have already signed Electricity Sales Agreements (ESA) with the Iloilo Electric Cooperative (ILECO) and the Visayan Electric Cooperative (VECO) for 606 GWh and 635 GWh, respectively, over a period of five years," PNOC EDC President/CEO Paul Aquino disclosed.

The host communities of Negros Occidental, Bago City and the municipality of Murcia will benefit from the power plant's operation through the royalty payments to the host LGUs. Of the royalty payments, 80% will be intended as subsidy for electricity consumption while the remaining 20% will be allocated for community development and livelihood projects.

The DOE-mandated one centavo per kWh benefit, meanwhile, is intended for the host LGU's electrification, development and livelihood, reforestation, watershed management, health and environmental enhancement programs.

Energy Secretary Raphael Lotilla commended PNOC EDC for its aggressive efforts in exploring and developing geothermal resources as well as for making its projects a showcase for sustainable development.

NNGP, which is PNOC EDC's first fully-owned power plant, was constructed by Japan's Kanematsu Corp. through the US$68.5 million funding provided by the Japan Bank for International Cooperation (JBIC). It utilizes both the geothermal steam and brine for power generation, which are obtained from the Fluid Collection and Recycling System (FCRS). The technology being used is the Double Flash system on a Single Unit Steam Turbine Generator (STG). Both the FCRS and the power plant are equipped with state-of-the-art instrumentation and controls including a digital control system to ensure safe and efficient plant operation.

With the operation of NNGP, PNOC EDC now counts five geothermal production fields that include those in Leyte, Southern Negros, Bicol and North Cotabato. Today, it remains the country's largest producer of geothermal energy with an installed capacity of 1,198 MW. In 2005, it accounted for 60% of the Philippines' installed geothermal capac-

ity and contributed approximately 12.4% of the country's installed capacity. Since the company began commercial operations in 1983, it has produced approximately 80,614 GWh, or 134 million barrels of fuel oil equivalent. This has generated total foreign exchange savings for the Philippines of approximately $3.75 billion.

UPCOMING EVENTS

67th Annual Meeting of the German Geophysical Society, Aachen, Germany, March 26-29, 2007. www.dgg2007.rwth-aachen.de

ENGINE Workshop 2. Exploring high temperature reservoirs: new challenges for geothermal energy, April 2-4 2007, Volterra, Italy. http://conferences-engine.brgm.fr

China Eco Expo, April 4-6, 2007, Beijing, People´s Republic of China. www.ecoexpo.com

International Geothermal Power Conference, April 19, 2007, Freiburg, Germany. www.forseo.de

European Geothermal Congress EGC2007, Unterhaching, Germany, May 30-June 1st, 2007. www.egc2007.de

ENGINE Workshop 4. Drilling costs effectiveness and feasibility of high-temperature drilling, Reykjavik, Iceland, June 28-29, 2007. http://conferences-engine.brgm.fr

ENGINE Workshop 6. Increasing policy makers' awareness and the public acceptance, Athens, Greece, September 13-14, 2007. http://conferences-engine.brgm.fr/

GRC 2007 Annual Meeting, Sparks, Nevada, USA, September 30 - October 3, 2007. www.geothermal.org

ENGINE Workshop 7. Risk analysis for development of geothermal energy, Utrecht, The Netherlands, November 8-9, 2007. http://conferences-engine.brgm.fr/

20th World Energy Congress, Rome, Italy, November 11-15, 2007. www.rome2007.it/home/home.asp

Mineral Extraction From Geothermal Brines, 22-23/11/2007, Rotorua, New Zealand. Contact: Dr. Kevin Brown. kevin@geokem.co.nz

IGA News

IGA News is published quarterly by the International Geothermal Association. The function of IGA News is to disseminate timely information about geothermal activities throughout the world. To this end, a group of correspondents has agreed to supply news for each issue. The core of this group consists of the IGA Information Committee:

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The members of this group submit geothermal news from their parts of the world, or relevant to their areas of specialization. If you have some news, a report, or an article for IGA News, you can send it to any of the above individuals, or directly to the IGA Secretariat, whatever is most convenient. Please help us to become essential reading for anyone seeking the latest information on geothermal worldwide.

While the editorial team make every effort to ensure accuracy, the opinions expressed in contributed articles remain those of the authors and are not necessarily those of the IGA.

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