GEOTHERMAL RESOURCES COUNCIL Builden Vol. 48, No. 5 September/October 2019

GRC Annual Meeting & Expo Reporting on another successful meeting



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Bulletin

Vol. 48, No.5 September/October 2019



Geothermal Resources Council

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The Geothermal Resources Council (GRC) *Bulletin* (ISSN No. 01607782) is published as a service to its members and the public, with six issues per annual volume. The GRC is an international, non-profit educational association whose purpose is to encourage research and environmentally sound exploration, development, and utilization of geothermal-energy resources worldwide through cooperation with governmental agencies, academic institutions, and the private sector. The GRC *Bulletin* provides a forum for information transfer to the public and among professionals in many fields related to geothermal resources, including geology, exploration, development, electric-power production, and direct-use technologies. The views and opinions expressed by authors in this publication do not necessarily reflect those of the GRC or its members. For changes of address or membership information, please contact us.

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COVER: "Salton Sea Infrared" by Janet Harvey, of Ladenburg, Germany. Overwintering seaguils take flight at dawn from the Salton Sea, with Rock Hill, Obsidian Butte and steam from geothermal power plants in the distance. Infrared imagery cuts through the valley haze and shows the western scarp of the Salton Trough. Salton Sea, California, January 2015. FIRST PLACE GRC GEOTHERMAL PHOTO CONTEST 2019.



President's Message

by Andrew Sabin

The Ridgecrest Earthquake: What Next?

You are all aware that a massive and destructive, M6.4 and M7.1 earthquake sequence, the Ridgecrest earthquake, occurred over three months ago. What you may not know is that it was in my backyard, in the North Ranges of the Naval Air Weapons Station China Lake ("China Lake") in California. The Navy's Geothermal Program Office (GPO) set up shop at China Lake in the late 1970s to oversee the development of a geothermal field that it discovered, also at China Lake, called Coso. Coso started selling power to the California grid in 1987. A portion of the revenue from electricity sales comes back to the Navy and supports GPO and other Navy renewable energy-related interests.

Details of this 4-5 July Ridgecrest earthquake sequence are on social media and can be found through various earth science venues like the Geological Society of America. The short story is that the M6.4 occurred on the morning of July just east of Ridgecrest on a poorly defined, NE-striking, left-lateral fault. The NE-trending aftershock sequence took a left turn forming a reverse letter "L" with a leg of this L trending to the NE (Fig. 1). On the evening of July 5, the M7.1 event occurred along this NE leg and connected many segments of what the GPO calls the Airport Lake fault (Fig. 2). The destruction in town and at China Lake was immediate and severe. Fortunately, no lives were lost. Responses from the earth science community were equally immediate and the rush to China Lake was on.

Today, anyone interested can learn a tremendous amount about the intensities, epicenters, depths and relative motions associated with the thousands of events linked to the Ridgecrest earthquake sequence. We also have a clear picture of the dramatic changes on the earth's surface due to these events. Huge cracks, 10-foot high scarps, warping and local damage caused by intense shaking are illustrated in maps, graphs and pictures at multiple scales (Fig. 3). These are on web sites, in newspapers and are now showing up in journal articles. This work is largely due to the focused efforts of the first responders, a group that included the USGS, the California state Geological Survey and other associated researchers in addition to the Navy. Much of this excellent mapping and overall characterization work has now been completed but the clean-up and repairs will require much more time. One Los Angeles newspaper speculated that damage to Ridgecrest and China Lake is \$3-\$5 billion. Consequently, there are 1 or 2 important questions that should probably be answered. Are Ridgecrest, China Lake and the surrounding communities prepared for the next earthquake and what if anything should they be doing now?

Any scientist or engineer who has given this issue some thought can probably craft 2-3 excellent follow-on studies for this region. This work would be solid and would no doubt contribute to the overall body of literature on the topics. But will it be what is needed most? To best answer this question, what really should happen next is a meeting of stakeholders and select members of the science and engineering communities. Such a meeting would put all perspectives on the table and give all decision-makers the opportunity to understand and then decide what exactly they can and should do. Plans would then be formulated and work could commence.

When the scientific/engineering and the political communities (i.e., decision-makers) intersected to address a problem, great

accomplishments have occurred. The Ridgecrest and China Lake region do not necessarily need the equivalent of the atomic bomb, development of the internet or AIDS research breakthroughs, but they could probably use some thoughtful, reasoned and holistic inputs to address their earth science and engineering needs of the immediate future. Stay tuned for what next.



117°45'0"W 117°37'30"W 117°30'0"W 117°22'30"W Fig. 2

Figure 2. Faults (red and blue lines) and M6.4 and M7.1 epicenters purple stars) in SE corner of China Lake. Dashed line is China Lake boundary (from the USGS).

1.5 - 1.99 2-2.99 3 - 3.99 4.01 - 4.9 5.36



Executive Director's Message

by Will Pettitt, PhD

Change is happening at the GRC and in the geothermal industry alike: Come along for the ride!

After a very successful Annual Meeting & Expo in Palm Springs, the Geothermal Resources Council (GRC) is focusing attention on an exciting year ahead for our organization and the geothermal industry, building to the next meeting in Reno, October 2020, and then beyond. If you are a member of the GRC you'll recently have received your renewal notice. The renewal letter follows this column for everybody to peruse and digest.

The GRC is embracing change at all levels. The Board of Directors has decided upon some important restructuring that needs changes to our bylaws. These changes are with members for review and approval in voting through November. All members have received information by email and will shortly be receiving ballots to vote for both the bylaws changes and new Directors for the 2020-21 term. Our members opinions and votes matter so please look out for all the information. If you're not receiving our emails then please contact Anh or Estela to make sure you're subscribed.¹

The GRC is also evolving its operations. Although our Annual Meeting is very important to all of us and will remain being a primary success of our year, we are transitioning to a new professional association with a much broader reach. As described in the renewal letter, our vision aims to bring geothermal energy into the mainstream of renewable carbon-free energy; in individual US States, across the USA and globally. We'll be engaging with folks on the ground in our industry, in research and development, with the general public and government at all levels, and collaborating with partner organizations across the country and internationally. We have just released a *Request for Proposals* for assistance with our geothermal energy marketing campaign and website redevelopment that will help us develop sharp and modern public relations on behalf of all our industry and community.²



Figure 1: The GRC's agenda for successfully implementing our vision of raising the recognition and acceptance of geothermal energy across society and around the world.

We'll be working for all parts of geothermal energy to raise awareness of what our industry brings to the table. As well as the power sector, which is a critical part of our future industry growth in the US, this also means heat management through district and commercial heating systems,

¹Contact by email at alay@geothermal.org or grc@ geothermal.org, or by phone at 530-758-2360

² http://geothermalresourcescouncil.blogspot.com/2019/10/ global-geothermal.html

and Geothermal Heat Pumps for residential and commercial buildings. This is because our society's fight against Climate Change and Green-House-Gas emissions needs all of the above and we as an industry and community will be at the front of that fight. This country, and the rest of the world, will be going through a deep energy transition and decarbonization over the next few decades which means electrification of our homes and transportation, and more effective energy efficiency and heat management for our buildings. We all agree that geothermal energy can make a huge impact across this whole spectrum and it's up to all of us to get that message out there.

We've focused our vision on an agenda of activities for the coming year (Figure 1). At the Policy Committee (PC) we'll be working with policy makers at all levels of government, and collaborating with other non-governmental organizations, to partner on our messages and make sure that geothermal energy is firmly at the table in critical discussions. The PC is a self-funded advocate for policy and regulatory improvement and is open to any GRC member. Join our monthly calls to find out more about PC activities and how you can help.

We'll be publishing industry reports, white papers and infographics that will help message all aspects of geothermal energy. We'll be developing more technical and educational workshops to encourage innovation and engage inside and outside the geothermal community. Our next workshop examines High-Temperature Cementing in collaboration with the Society of Petroleum Engineers (SPE), March 30 to April 1, 2020, in San Diego.³ We're also formulating workshops in Boise, Idaho, and Ithaca, New York, that will aim to inform on how geothermal district and commercial heating systems can help decarbonize our economy. Look out for more information coming soon.

If you want to get involved in any of our activities, then please contact us – we depend on our volunteers and members to help the GRC be a success. Organization of our Reno 2020 Annual Meeting is already underway with a talented Organizing Committee, Expo booths already open for registration, and our Call for Session topics closing November 8th. A Call for Papers will open shortly after that with a deadline of May 27th, 2020.

Our agenda is ambitious, but the time is right. Geothermal energy is coming of age and will play a critical role in the energy mix of the future. So, jump on board, buckle up, and come along for the ride!

JOIN the COMMUNITY

DONATE tothe GRC



³ http://cement.mygeoenergynow.org/



Dear GRC Member,

In this renewal notice you'll find additional information on:

- An Evolving Professional Association;
- International Tiered Pricing;
- Policy Committee Membership;
- Email Communications;
- Donations to Support Students;
- Local Sections.

The strength of your professional association depends on the support of members like you. Please renew your membership for 2020 and help encourage your colleagues, contacts and friends to also join us.

We hope you will also consider increasing your level of participation, either by volunteering to help with our many activities or supporting us through donations or sponsorships, such as Students, Local Sections and our Foundation Funds. You can discover more about the benefits of membership, and our activities, through the website, our news blog, social media and email communications.

An Evolving Professional Association

The GRC is embracing change and evolving into a new non-profit professional association for the geothermal industry and community in the USA and abroad.

Last year, the Geothermal Resources Council and Geothermal Energy Association (GEA) consolidated under the GRC name. This year, the GRC Board of Directors is proposing changes to our bylaws that restructure and modernize the board. All our members will be invited to vote on these changes that provide for a smaller board size, improve the board member rotation, and change the officer structure.

The GRC has a vision to raise the recognition and acceptance of geothermal energy across society. We have focused our vision on a strategy to connect with local people and companies on the ground in our industry, to bring people together in research, industry and government, and to collaborate with partner organizations, thought leaders and decision makers around the globe.

We will be developing sharp and modern public relations that reach out across society to help promote awareness of geothermal energy: from the general public and school children, through to decision makers at the highest levels. We are transforming into an association that fights for geothermal energy to be mainstream, to bring our energy into the public conscience as much as other technologies because we recognize that society needs geothermal in the future transition to clean and renewable energy.

International Tiered Pricing

The GRC's mission is to be a prestigious, dynamic, and diverse professional association that advances the global geothermal industry and educates through transfer of robust research, knowledge and guidance.

New for 2020, we are launching tiered international pricing for individual and retired memberships. Tiered Pricing is based on the current World Bank classification. To find out if a country qualifies for a discounted rate, please visit the GRC membership website: <u>https://my.geothermal.org/docs/WorldBankTier2019.pdf</u>.

All countries not listed in the document are consider Tier 1.

We encourage all our existing members to reach out to global contacts to enlist their support by joining your professional association. Many potential members can now enjoy discounted rates.

Policy Committee Membership

The GRC Policy Committee (PC) is an add-on option for members who want to fund advocacy work at the State, Federal and International levels. A continuation of the expansive work of the Geothermal Energy Association (GEA), the Policy Committee is comprised of companies and individuals from a broad spectrum of the geothermal industry.

The GRC Policy Committee advocates for public policies that will promote the development and utilization of geothermal resources and provides a forum for the industry to discuss issues and solutions.

Email Communications

We want to better connect with our members and better serve you. On the renewal form there is now the option to select the level of email communication you would like to receive from the GRC. You can also connect with us through social media, our website and our online news blog.

Please note you can update your email preference at any time, along with your membership profile (picture, resume, area of expertise, etc.), on the membership website: https://my.geothermal.org/.

Donations to Support Students

Due to generous donations from members last year, we can now offer a limited number of free memberships to students who are new to the GRC. Please encourage any students you know to join us to receive member benefits and connect in with our student network.

We hope to continue free student memberships next year with continued donations. The option to donate is available on the renewal form.

Local Sections

Members can support our initiatives to better connect with local industry folk and the geothermal community on the ground by donating to our Local Sections. We currently have Sections in Southern California and Geysers Northern California and are working on opportunities to build more.

You do not need to donate to be a member of these sections, but any donations will go directly to the Section. This is a great way for members to foster local participation and education in the geothermal community, and, as always, all donations are tax deductible.

The GRC Staff and Board of Directors wishes you success in your geothermal endeavors in 2020. We look forward to your continued participation as a GRC member throughout the coming year.

Wsfettill

Sincerely, Will Pettitt, PhD

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#### To renew your dues online:

- Go to our new membership website: my.geothermal.org
- Log in with your ID and password
- Click "Membership"
- Click "Renew Now" Button

Your membership dues will be added to your Shopping Cart. You can pay now or go back to your Shopping Cart later and pay your dues.

If you have any problems logging in or questions about your dues, please contact Anh Lay at <u>alay@geothermal.org</u> or by phone at (530) 758-2360 ext. 100.

# Joint GRC-SPE Workshop

### High Temperature Well Cementing

March 30 - April 1, 2020, San Diego, California, USA

More information at geothermal.org/cementing.html





# Communication from the GRC

by Ian Crawford Director of Communications

### GRC Publishes RFP for Geothermal Energy Marketing Plan and Website Redevelopment

The Geothermal Resources Council (GRC) has issued a Request for Proposal for Assistance with a Marketing Plan and Website Redevelopment.

The GRC is seeking proposals for assistance with developing our marketing plan, promotional materials and website.

The GRC has a vision to raise the recognition and acceptance of geothermal energy across society. We have focused our vision on a strategy to connect with local people and companies on the ground in our industry, to bring people together in research, industry and government, and to collaborate with partner organizations, thought leaders and decision makers around the globe.

We will be developing sharp and modern public relations that reach out across society to help promote awareness of geothermal energy: from the general public and school children, through to decision makers at the highest levels. We are transforming into an association that fights for geothermal energy to be mainstream, to bring our energy into the public conscience as much as other technologies because we recognize that society needs geothermal in the future transition to clean and renewable energy.

- Deadline for written questions: October 31, 2019
- Deadline for proposal submission: November 15, 2019
- Award Announcement: December 31, 2019

~ Request for Proposals: Assistance with a Marketing Plan and Website Redevelopment (PDF)......

Submission will only be accepted as a PDF by email to Estela Smith at grc@geothermal. org. Responsibility for ensuring delivery is the applicants. Estela can be contacted by telephone on 530-758-2360.

### Candidates for GRC Board of Directors 2020-2021

Thirteen candidates are on the slate for the next term of the GRC Board of Directors; just four will be elected to the Board. The voting ballots will be sent out on November 1st and the voting window will close on November 30th. The candidates are listed below - photos and short statements can be viewed online at https://geothermal.org/nominees. html and a document with more information on the candidates including biographies can be downloaded from the GRC Website......

#### Kelly Blake

Division Director of the Navy Geothermal Program Office (GPO)

Dave R. Boden Truckee Meadows Community College

Matthew Broaddus Field Services Manager, Thermochem

**Trenton Cladouhos** VP of Resource, Cyrq Energy

Neel L. Duncan, P.E. Managing Director, New IPT Inc.

Richard Holt Chief Reservoir Engineer and President of Geothermal Science, Inc

#### Elisabeth de Jong

Program Administrator - Geothermal Grant and Loan Program, California Energy Commission

#### Josh Nordquist

Manager of US Resource Operations, Ormat

Dr. Azadeh Riahi

Senior Geomechanics Engineer at Itasca Consulting Group, Inc.

**Bill Rickard** President, Geothermal Resource Group, Inc

#### Ann Robertson-Tait

Senior Geologist and Business Development Manager, GeothermEx, Inc.

Lisa Safford-Kuscu President, Blackrock Geoscience

#### Jeanine Vany

EVP / Geosciences, Eavor Technologies Inc

### GRC Annual Meeting & Expo Call for Sessions - Due November 8, 2019

The topics to be covered are listed in the agenda for the workshop posted online.....



A "Call for Sessions" has been announced for the 2020 GRC Annual Meeting & Expo to be held at the Peppermill Resort in Reno, Nevada from October 18-21, 2020. We are inviting proposals for specific sessions at next year's meeting.

Sessions can be organized and led by up to three people, a session chair and two co-chairs. Successful session chairs will be expected to assist the technical chair to recruit authors and organize reviews. A session will include at least four papers.

For more information on the Call for Sessions, please visit the GRC website.

#### Mark Your Calendar:

• Call for Sessions Deadline - November 8, 2019

• **Call for Papers Deadline** - May 27, 2020 - more information coming soon!

### Joint GRC-SPE Workshop

High-Temperature Well Cementing

"Exploring Geothermal and Oil and Gas Synergies" March 30 - April 1, 2020 Wyndham San Diego Bayside, San Diego, California, USA Download the Flyer (PDF)......

#### **Call for Abstracts**

The **Geothermal Resources Council (GRC)** together with the **Society of Petroleum Engineers (SPE)** invite you to present your latest technical work in High-Temperature Well Cementing at the special joint workshop. **Please submit your abstracts to Estela Smith** at grc@geothermal.org. Call 530.758.2360 ext 102.

### Deadline for submission of abstracts is December 1st, 2019.

The GRC together with the SPE are organizing a workshop on hightemperature cementing. Geothermal wells experience high temperatures at very shallow depths and are required

to cement casing across the entire length of each casing string set in the well. The large temperature variations over the lifecycle of thermal oil recovery wells, and the very high temperatures of highpressure/high-temperature (HP-HT) oil & gas wells drilled to ever greater depths, continue to push cement selection and placement technologies. All of these environments pose unique challenges to successful well completion. Cementing is crucial to ensure proper well integrity for the life of production and injection wells in these HT applications.

The GRC and the SPE have decided that a joint workshop would enable both industries to share their experiences, technologies, technical procedures and best practices on this important aspect of well completion. The workshop will highlight cement formulae and slurry blends, placement methods, remedial procedures and result evaluations. Case studies will be discussed and analyzed.

All drilling personnel, both geothermal and oil & gas drilling and production engineers, well-site supervisors, cementing engineers and interested personnel are welcome to attend and participate.

If you would like to chair any of the sessions, then please contact us. We would like to have two chairs for each session, one from the geothermal industry and one from the oil & gas industry. The chairs for each session will be required to assist the committee in obtaining presenters. Please volunteer.

Please contact us if you are interested in presenting in a session at the workshop. If you have a case history that you would like to present and would interest the attendees, please feel free to inform us and plan to present. Please plan to attend.

### Communication from the GRC

You can contact us at:

• Estela Smith, Events Manager, GRC: 1-530-758-2360, grc@geothermal.org

• Louis E. Capuano Jr., President, Capuano Engineering Company: LCapuano@ capuanoengineering.com

• Todd Zahacy, Senior Consultant, C-FER Technologies: T.Zahacy@cfertech.com

### **GRC Membership**

#### It's time to renew your GRC membership!

Notices were sent out in October. Please complete the form and send it back as soon as possible. Alternatively, you can go online on the my.geothermal website and renew your membership quickly and easily. There is also a PDF file of the *Membership Application* form to download and print.

### New for 2020! Tiered Pricing for International Members

The GRC Board of Directors has decided to install tiered pricing for single memberships of the association. This means that in addition to the normal individual rate there are two other levels of discounted rates depending on a World Bank classification of the member's country. The membership rates for 2020 are as follows:

#### Individual

- Tier 1: \$130
- Tier 2: \$78
- Tier 3: \$39

**Student** (student Id with a valid date or class schedule required): \$20

**Retired** (must be retired and 65 years of age or older):

- Tier 1: \$65
- Tier 2: \$39
- Tier 3: \$20

#### Benefactor: \$230

Click on this link to find out if the country you reside in qualifies for a discounted rate. All countries not listed in the document are consider Tier 1.

More information on all the benefits of membership of the GRC including through corporate representation can be found on the GRC website at: https://geothermal.org/membership. html

#### Give Students the Gift of a Free Membership!

Due to generous donations from members last year, we can now offer a limited number of **free memberships to students** who are new to the GRC. Please encourage any students you know to join us to receive member benefits and connect in with our student network.

We hope to continue free student memberships next year with continued donations. The option to donate is available on the renewal form. Contact **Anh Lay** at alay@geothermal.org for more information.

### Ensure You Receive Geothermal Resources Council (GRC) Emails

To ensure uninterrupted delivery of our newsletters and other email communications, please follow these steps:

Add us to your Contacts list

Use your email client's **Sender, Contacts** or **Address Book** menu options to add us to your contact list.

In Microsoft Outlook, this option can be found under the Message menu at: **Message >> Sender >> Add to Contacts**. This may be titled differently dependent on your version of Microsoft Outlook. The option may be found elsewhere in other email clients. • Add us to your Safe Senders list Use your email client's Junk Email options to ensure our emails are never marked as spam.

In Microsoft Outlook, do this by right-clicking one of our emails in your message list, then visiting the Junk menu and choosing the **Junk** >> Never Block Sender option. This may be titled differently dependent on your version of Microsoft Outlook. The option may be found elsewhere in other email clients.

#### • 'Whitelist' our IP Address

Whitelisting our IP address will ensure you get our newsletters by telling your systems that it is safe to accept email from our servers.

The dedicated IP address for all GRC electronic mail is **74.208.69.127** 

Contact your IT Team to perform the IP address whitelisting.

#### • 'Whitelist' our Sending Domain

If your spam solution is unable to whitelist mail servers by IP address, then the next best solution is to whitelist our sending domains. We recommend that you whitelist the following domain in conjunction with the IP address: **geothermal.org** 

Contact your IT Team to perform the IP address whitelisting.

### • Further Assistance

If you have any further questions, please call us on 530.758.2360, or email icrawford@ geothermal.org

#### Have Your Say!

If you would like to comment on any column or article in the *GRC Bulletin* or have an opinion on a topical subject that will interest our readers, please email the editor, **Ian Crawford** at icrawford@ geothermal.org or mail to Geothermal Resources Council P.O. Box 1350, Davis, CA 95617-1350.



Painted Canyon. Photo by Sam Abraham

### 130 MW in Utah, 160 MW in Oregon and 10 MW in

Idaho. Global Geothermal News......

### Inside Geothermal

### New Green Climate Fund to Advance Low-Carbon Energy Technologies

**Green Climate Fund, IRENA, SEforAll** and UNDP have launched a partnership to advance lowcarbon energy transition and raise climate ambition.

In response to country needs to mobilize lowcarbon, climate-resilient investments, a new global public good will aim to **increase the flow of capital in developing countries to meet climate ambitions.** 

The **Climate Investment Platform (CIP)** is an



inclusive partnership welcoming all stakeholders from governments and international organizations to the private sector to scale-up climate action and translate ambitious national climate targets into concrete investments on the ground. *Global Geothermal News......* 

### **NORTH AMERICA**

### NREL Model Predicts Almost 6,000 MW of Geothermal Energy Capacity in California by 2050

Regional Energy Deployment System (ReEDS), the National Renewable Energy Laboratory (NREL)'s flagship capacity planning model for the North American electricity system, simulates the evolution of the bulk power system—both generation and transmission—from present day through 2050.

Featuring high spatial resolution and advanced algorithms for representing the cost, value, and technical characteristics of integrating renewables into the electricity system, ReEDS depicts energy production and consumption through a regional lens—and it's now publicly available.

Under the **Mid-Case Scenario** the model predicts **5.84 GW of geothermal energy capacity in California** by 2050, **520 MW** of capacity in **Nevada**,



The Regional Energy Deployment System scenarios viewer displays the estimated capacity and generation for each resource. This snapshot is for geothermal.

### **Corporations Continue to Favor Renewable Power Purchase Agreements**

US corporations purchased 8600 MW of clean energy in the first half of 2019, up from 7200 MW in the same period of 2018, according to new market research from Bloomberg New Energy Finance (BNEF).

Overall, 2019 is on track to be bigger than 2018 for corporate **power purchase agreements (PPAs)** globally, with the US accounting for 69% of the activity, BNEF's corporate energy market outlook for the second half of 2019 found.

US corporations bought 5.95 GW of clean energy in 2019, closing in on the 2018 total, according to the outlook. *Global Geothermal News*......

Figure 1: Global corporate PPA volumes



Source: BloombergNEF. Note: Data in this report is through 2018. Onsite PPAs not included. Australia sleeved PPAs are not included. APAC number is an estimate. Pre-market reform Mexico PPAs are not included. These figures are subject to change and may be updated as more information is made available.

Courtesy Bloomberg New Energy Finance

#### Baker Hughes to Regain Control of Oil-Field and Geothermal Services Company

**General Electric Co. (GE)** is giving up majority control of **Baker Hughes**, selling shares in the oilfield and geothermal services firm that will raise about USD 3 billion cash but trigger a more-than-USD 7 billion accounting charge.

Baker Hughes is a long-time exhibitor at the **GRC Annual Meeting & Expo** and was a gold sponsor of the last event in Palm Springs, California. *Global Geothermal News......* 

### Enhancing Geothermal Production on Federal Lands Act Introduced

U.S. Senator Jim Risch (R-Idaho) and Congressman Russ Fulcher (R-Idaho) have introduced S. 2270, the Enhancing Geothermal Production on Federal Lands Act, a bill to streamline the discovery and permitting process for geothermal energy projects. This bill will bring geothermal to parity with oil and gas exploration on public lands.

116TH CONGRESS 1ST SESSION



To amend the Geothermal Steam Act of 1970 to promote timely exploration for geothermal resources under geothermal leases, and for other purposes.

#### IN THE SENATE OF THE UNITED STATES

JULY 25, 2019 Mr. RISCH introduced the following bill; which was read twice and referred to the Committee on Energy and Natural Resources

### A BILL

- To amend the Geothermal Steam Act of 1970 to promote timely exploration for geothermal resources under geothermal leases, and for other purposes.
- 1 Be it enacted by the Senate and House of Representa-
- 2 tives of the United States of America in Congress assembled,

**3 SECTION 1. SHORT TITLE.** 

- 4 This Act may be cited as the "Enhancing Geothermal
- 5 Production on Federal Lands Act".

6 SEC. 2. GEOTHERMAL PRODUCTION ON FEDERAL LANDS.

7 The Geothermal Steam Act of 1970 (30 U.S.C. 1001

8 et seq.) is amended by adding at the end the following:

With 90 percent of viable geothermal resources located on federally managed lands, almost all geothermal projects are subject to the **National Environmental Policy Act (NEPA)** review process. Currently, most geothermal exploration wells require an **Environmental Assessment (EA)** to be filed before exploration begins. This EA process for geothermal projects averages 10 months, meaning interested parties must wait nearly a year to determine if a viable geothermal resource even exists.

"The Enhancing Geothermal Production on Federal Lands Act will streamline the federal permitting process, unleashing the nation's geothermal potential," said **Paul Thomsen**, Vice President, **Ormat Technologies** & Chairman, **Geothermal Resource Council Policy Committee**. "This bill will allow Idaho to continue as a leader in geothermal production and further develop its indigenous renewable resources." *Global Geothermal News......* 

#### **Geothermal Leases in Northern California Voided**

In a decision hailed by some as a victory for tribal rights and ecological preservation, the **Ninth Circuit** upheld **voiding 40-year lease extensions** for geothermal energy production on 26 plots of California land deemed sacred by **Native Americans**.

The rugged, volcanic landscape of the **Medicine Lake Highlands** in **Siskiyou County** has served as a revered site for ancient customs and rituals by Native American groups, including the **Pit River Tribe**, for the last 10,000 years.

That means the bureau will not be able to renew leases for those 26 plots of land unless they undertake a required environmental review and consult with the tribal governments, because the area was designated as a cultural district in 1999 by the National Register of Historic Places.

The U.S. **Bureau of Land Management** first leased the land for geothermal energy exploration in 1982. Houston-based **Calpine Energy Corporation** inherited those leases in an area where three national forests – Modoc, Klamath and Shasta-Trinity – meet at the northern tip of the state. *Global Geothermal News*......

#### Golden State Leads the USA in Geothermal Jobs

With nation-leading public policies like the **Low Carbon Fuel Standard** and **Renewables Portfolio Standard**, California, with its more than half a

#### Inside Geothermal

million workers across clean energy industries, remains far and away the nation's shining example of clean economic prosperity.

Across all states, California supports **one out of every seven U.S. clean energy jobs**, four out of every ten U.S. solar energy jobs, and more than **one out of every four U.S. renewable generation jobs**. In fact, California's is home to more renewable generation jobs than the next top six states combined and twice as many energy efficiency jobs as the no. 2 state (Texas). **The geothermal sector in California employs 2,491 out of a national total of 8,526 - that is just under 30% of geothermal jobs in the USA**. *Global Geothermal News.......* 

#### BLM Geothermal Lease Sale Receives Bids for 37 Parcels

A massive **Bureau of Land Management** (**BLM**) sale of geothermal energy leases in **Nevada** generated bids on just 26% of the land parcels offered, with most selling at the minimum price of **USD 2 an acre**.

The sale was by far the federal government's largest offering of geothermal energy leases by acreage in recent years, with 142 parcels on 384,369.6 acres available for auction.

According to energy marketplace **EnergyNet**, which conducted the online sale, **37 parcels** representing **102,402.85 acres** received bids for a total of **USD 426,900**.

Of the parcels that received bids, all but nine sold for the minimum of USD 2 an acre. The highest price per acre was USD 20 for a 4,800-acre parcel in **Churchill County**. *Global Geothermal News*......

### Ormat Sells Interest in 48 MW McGinness Hills Phase 3 Geothermal Power Plant

**Ormat Technologies Inc.** has announced that one of its wholly owned subsidiaries that owns the **48 MW McGinness Hills Phase 3 geothermal power plant** entered into a partnership agreement with a private investor.

Under the transaction documents, the private investor acquired membership interests in the project for an initial purchase price of approximately **USD 59.3 million** and for which it will pay additional annual installments that are expected to amount to a total of approximately **USD 9 million**. Ormat will continue to operate and maintain the power plant and will receive substantially all of the distributable cash flow generated by the power plant, and the private investor will receive substantially all of the tax attributes.

The McGinness Hills Phase 3 geothermal power plant, located in Lander County, Nevada, began commercial operation on December 15, 2018. The project sells its power under the 26-year Ormat Northern Nevada Geothermal Portfolio Power Purchase Agreement with Southern California Public Power Authority, which was announced in June 2017. *Global Geothermal News*......

### Steamboat Hills Geothermal Plant Enhancement Commences

Ormat Technologies has launched an expansion project at its Steamboat Hills geothermal plant in Reno involving the installation of a new air-cooled 30 MW geothermal plant replacing an existing 10 MW system. Construction, which began this summer, is scheduled for completion early next year. *Global Geothermal News*......

### Reno Approves Funding for Geothermal Powered Pool

The regular host city for the **GRC Annual Meeting & Expo** could build a swimming pool complex heated by the same geothermal resource as the **Peppermill Resort Spa Hotel**.

**Reno City Council** has approved a **USD 9 million** pledge with the William N. Pennington Foundation toward the construction of **a pool at Moana Springs Park**, located just south of the Peppermill. *Global Geothermal News*......

### Ormat Gets Approval for Two New Wells at Puna Geothermal Venture

Applications from **Puna Geothermal Venture** (**PGV**) for **two new geothermal wells** have **been approved**, the Hawaii state Department of Land and Natural Resources (DLNR) has confirmed.

Drilling of a new 5,000 -foot deep well began in mid-October and is expected to be completed by mid-January. *Global Geothermal News*......

#### Report Concludes Potential for Combined Geothermal Power and Heat Plant at Repurposed Gas Field

A new pre-feasibility study published by Geoscience BC concludes good potential to repurpose the Clarke Lake natural gas field in British Columbia to host a pilot plant to generate geothermal energy and heat.

The report concludes that the **payback period** on development costs would be **between 12 and 24 years**. It identifies potential customers for power and uses for heat including public building heating and industrial customers. The report also identifies future opportunities that a geothermal plant could help to facilitate, including greenhouses that use heat from the plant and the potential to attract crypto-currency mining operations. *Global Geothermal News.......* 

### Eavor Closed-Loop Geothermal Project Announces Successful Well-Bore Connection

**Eavor Technologies Inc.** announced the successful completion of drilling activities at its' demonstration facility (**Eavor-Lite**) in Clearwater County, **Alberta, Canada** on September 1st. Eavor claims this is the world's **first of its kind multilateral horizontal drilling intersection.** 

On August 2nd and August 4th, 2019, two **Precision Drilling** rigs, spaced approximately 2.5km apart, commenced vertical drilling operations to an intermediate casing point of **approx. 2,400m (2.4km)**. Once these vertical sections were cased and cemented in place, both rigs continued to drill two multi-lateral wellbore sections **towards each other** until making **precise and safe wellbore intersections of the 156mm (6.125") diameter opposing boreholes**. Drilling rigs will be moved off their respective locations for the installation of surface facilities and a buried pipeline. *Global Geothermal News......* 

Vickers Venture Partners, a global venture capital firm based in Singapore, has announced their investment in Eavor Technologies Inc. The investment closes Eavor's CAD 15 million Series A investment round. The funds will be used to pursue Eavor's growing pipeline of commercial opportunities around the world including the Eavor-Loop technology. *Global Geothermal News*......

### Saskatchewan Geothermal Power Project to Drill Second Well

**DEEP Earth Energy Production Corp.** has announced that the 2019 field testing and drilling program at the **Estevan geothermal project** in southern Saskatchewan is now underway.

A **second well drill program** is planned to commence after the initial **flow and build test** is complete. This well will be drilled from the same surface location as the first well directionally to the southwest with a bottom hole located **1,500m laterally** from the original well. Once complete, **a 60-day production and injection test** will commence on the project's first combined geothermal well pair.

DEEP also announced that a **CAD 5,000,000 private placement** closed on August 20th, over subscribed to total **CAD 5,190,000**. *Global Geothermal News*......

### Government Invests in Geothermal Resource Survey of Northern British Columbia

The **Honourable Amarjeet Sohi**, Canada's Minister of Natural Resources, has announced a **CAD 1-million** investment for **Deh Tai Limited Partnership**, the economic development company of the **Fort Nelson First Nation**, to assess the resource potential of several renewable energy technologies in the far north of **British Columbia**, including a potential geothermal electricity generation project. *Global Geothermal News*......

### Alberta No. 1 Geothermal Power Project Announced

The **Honourable Amarjeet Sohi**, also announced a **CAD 25.4-million** investment in Northwestern Alberta's first commercial-scale geothermal facility. The **5 MW Alberta No. 1** project will be overseen by a partnership between **Terrapin Geothermics** and the **Municipal District of Greenview**. *Global Geothermal News*......



### Inside Geothermal

### Drilling in Gulf of California Will Measure Geothermal Energy Potential

The **JOIDES Resolution**, a 143-meter-long vessel with the capacity to dig 8,235 meters below the seabed, will carry out drilling at six different points in the **Guaymas Basin** in the **Gulf of California** off the west coast of **Mexico**.

Manet Estefania Peña of the Universidad Autónoma de Baja California (Autonomous University of Baja California) said the research will enable greater understanding of the tectonic plates beneath Mexico and a confirmation that the sediments of the Gulf of California are likely to contain a "large quantity of geothermal energy that at some point could be used." *Global Geothermal News.......* 

#### Schlumberger to Install Wells at Nevis Geothermal Power Project

**Nevis Renewable Energy International, Inc.** has selected **Schlumberger Integrated Drilling Services** to install the geothermal production and injection wells for the **10 MW initial phase** of the **Nevis Geothermal Project.** 

Schlumberger will be working with **GeothermEx**, a Schlumberger subsidiary for the well design, installation and testing of the Nevis wells. *Global Geothermal News......* 

#### First Well at St Vincent Geothermal Project Encounters Low Permeability

While the first well drilled at the geothermal exploratory site at **Bamboo Range** on **St. Vincent** was a success in relation to the heat that was found, the drilling team has not yet found the permeability they are looking for.

**Reykjavik Geothermal's Thorleifur Finnsson** said that while drilling the first well, they went down to **2700 metres**, which is 200 to 300 metres more than they thought they would need to in order to find the desired heat.

Finnsson said **drilling has begun on a second well.** A third well will also be drilled and there is a possibility that they will **revisit the first well**. *Global Geothermal News*......

### **CENTRAL & SOUTH AMERICA**

### Drilling Starts at 5 MW Geothermal Project in Ecuador

The first exploratory well has been drilled at the **Chachimbiro geothermal project** in **Imbabura** in northern Ecuador. Tests indicate satisfactory results with **temperatures of 235°C** recorded. A **5 MW power plant** is planned for construction **in 2022**. *Global Geothermal News......* 

### Construction Begins of New 33 MW Addition to Cerro Pabellon Geothermal Plant

Geotermica del Norte SA, a joint venture between Enel Green Power Chile and Chilean stateowned oil company Empresa Nacional del Petroleo SA (ENAP), has initiated the construction of a third generating unit at the Cerro Pabellon geothermal power plant to add 33 MW of new capacity.

The plant expansion will come with an investment of around USD 100 million (EUR 90.1m). The new unit is expected to **start operations in the second half of 2020.** 

Located in the **Atacama Desert** in the Chilean region of **Antofagasta**, the Cerro Pabellon plant consists of **two units of 24 MW each** already in operation. Once the third unit goes live, the plant will **generate 600 GWh per year from 81 MW capacity**. *Global Geothermal News......* 

### AUSTRALASIA

### Appraisal Drilling for New Tauhara Geothermal Power Plant to Conclude Early Next Year

**Contact**, New Zealand's second-largest energy retailer is currently drilling four appraisal wells at the **Tauhara geothermal field** to assess possible development.

James Kilty, the firm's chief generation and development officer says the drilling at Tauhara is going well and all indications are that the resource will probably be better than the company expected a decade ago when it sought consents for generation development there.

"We're confident that the resource will provide a significant uplift in megawatts for us," he said. The **appraisal drilling, due to wrap up early next year**, will "**position us really well for the next few years of fun**." *Global Geothermal News*......

#### Funding for Research Into Utilizing Deep Super-Heated Geothermal Fluids in New Zealand

The New Zealand government continues to support the geothermal energy industry by funding research through the **Endeavour Fund** of the Ministry of Business, Innovation and Employment.

A team led by **Dr Isabelle Chambefort** at **GNS Science** is ramping up its work in "next generation" geothermal energy, looking at how to tap deep, very high temperature resources.

What's called deep geothermal - "supercritical" fluids trapped far below the Earth's crust - packed the potential to deliver 10 times more energy than conventional geothermal energy, Dr Chambefort said. *Global Geothermal News*......

### Plant for Commercial Extraction of Silica & Lithium from Geothermal Brine Begins Construction

The first soil has been turned to mark the beginning of construction of a world-first commercial-scale plant to extract valuable minerals from geothermal fluid.

Geo40 has developed the technology to extract silica and other valuable minerals, including lithium, from geothermal fluid once it has been used for geothermal power generation and before the fluid is reinjected back into the underground geothermal reservoir.

Laboratory research in the USA, Japan and recently in New Zealand has confirmed that over 90 per cent of lithium from the **Ohaaki geothermal** fluid can be extracted and Geo40 will look to test this technology in its commercial demonstration plant in late 2019. *Global Geothermal News*......

See also " Geothermal Power Plant By-Product Can be Used to Decontaminate Engine Exhaust Fumes" in the Science & Technology section on page 28.

### **Record Annual Geothermal Generation for Mercury**

**Mercury** produced a strong result under unusual weather and market conditions in its financial year to 30 June 2019, Chief Executive **Fraser Whineray** said, announcing Mercury's annual results.

**Annual geothermal generation set a record**, reaching **2,896GWh**, coinciding with record high annual spot prices caused in part by gas supply and thermal generation constraints from October 2018.

"**High geothermal availability (97.7%)**, as the only renewable energy source that is not

weather dependent, maximised the opportunity of historically high spot prices," said Whineray. *Global Geothermal News*......

### ASIA

### JOGMEC to Drill Test Bores on Behalf of Potential Developers

Japan's government will play a greater role in developing the nation's geothermal power resources, seeking to lower the barrier for private-sector investment in this lagging area of renewable energy.

State-owned resources agency Japan Oil, Gas and Metals National Corporation (JOGMEC) will conduct test bores - part of the financially risky early phase of development - on behalf of potential developers starting in the fiscal year from April 2020. *Global Geothermal News......* 

### Two Japanese Geothermal Power Plants Begin Construction

**Appi Geothermal Energy Corporation** started construction work in August on the **14.9 MW Appi geothermal power plant** in **Iwate prefecture**, slated to start commercial operation in **April 2024**.

This project is the second joint geothermal power project by by Electric Power Development Co., Ltd. (J-POWER), Mitsubishi Materials Corporation, and Mitsubishi Gas Chemical Company, Inc., after the Wasabizawa geothermal power plant which started commercial operation on May 20, 2019. *Global Geothermal News*......

ORIX Corporation announced it will soon begin construction of the 6.5 MW Minami-Kayabe geothermal power plant in the Minami-Kayabe region of Hakodate City, Hokkaido with the goal of commencing commercial operations in early spring, 2022. *Global Geothermal News......* 



An artist's impression of the completed Minami-Kayabe power plant (Courtesy ORIX Corporation)

### Inside Geothermal

### World Bank Provides More Funds for Geothermal Resource Risk Mitigation in Indonesia

The **World Bank**'s Board of Executive Directors has approved a **USD 150 million loan** for **Indonesia** to scale up investments in geothermal energy by reducing the risks of early-stage exploration. The loan is accompanied by **USD 127.5 million** in grants from the **Green Climate Fund** and the **Clean Technology Fund**.

Under the **Indonesia Geothermal Resource Risk Mitigation (GREM)** project, the financing will help public and private sector developers to mitigate risks in exploration of geothermal resources, including **covering a part of the cost in case of unsuccessful exploration**. The project will also finance technical assistance and capacity building of key stakeholders in the geothermal sector. *Global Geothermal News*......

In associated news, the Directorate General of New and Renewable Energy and Energy Conservation (EBTKE) of the Ministry of Energy and Mineral Resources (SDM) has prepared three exploration drilling programs in three Geothermal Working Areas (WKP) this year. The three WKPs are located in Waesano (East Nusa Tenggara), Jailolo (North Maluku), and Nage (East Nusa Tenggara). *Global Geothermal News......* 

### State Investment to Help Develop 110 MW from Geo Dipa Geothermal Power Plants

The Indonesian government is set to inject **Rp 700 billion (USD 49.83 million)** into state-owned geothermal company **Geo Dipa Energi** next year to develop a 55 MW geothermal power plant in **Patuha, West Java** province, and another 55 MW plant in **Dieng, Central Java**. The plants are expected to be operational by 2023.

Geo Dipa president director **Riki Firmandha Ibrahim** said the company was focusing this year on procuring equipment and inking contracts."Next year, we will begin drilling and constructing the plants jointly financed by the multilateral lender **Asian Development Bank**," he added. *Global Geothermal News*......

### **AFRICA**

### Steam Production Reported at Baringo-Silali Geothermal Power Project

Steam has been produced at the surface of the Paka Well at the **Baringo-Silali geothermal power project**. According to the **Geothermal Development Company (GDC)** Managing Director **Johnston Ole Nchoe**, the six wells at the Baringo-Silali geothermal power project are expected to considerably help lower power bills in the country and improve access to electricity. *Global Geothermal News*......

### Contract Signed for Steam from 105 MW Menengai Geothermal Project

GDC and Kenya Power have signed a *Steam Payment Agreement* for the 105 MW to be produced by Independent Power Producers (IPPs) at the Menengai Geothermal Project. *Global Geothermal News......* 

### **EUROPE**

Project will Create Social Acceptance Model for Geothermal Energy

# **CRow DTHERMAL**

The **Crowdthermal project** aims to empower the European public to directly participate in the development of geothermal projects with the help of alternative financing schemes (**crowdfunding**) and social engagement tools. In order to reach this goal, the project will first increase the transparency of geothermal projects and technologies by creating one to one links between geothermal actors and the public so that a *Social Licence to Operate* (SLO) can be obtained.

Crowdthermal will create a social acceptance model for geothermal energy that will be used as baseline in subsequent actions for inspiring public support for geothermal energy. Parallel and synergetic with this, the project will work out details of alternative financing and risk mitigation options covering the different types of geothermal resources and various socio-geographical settings. The models will be developed and validated with the help of three case studies in Iceland, Hungary and Spain and with the help of a trans-European survey. *Global Geothermal News......* 

#### Drilling at 40 MWth Espoo Geothermal District Heating Project Scheduled for Completion in November

The final drilling phase of energy company **St1**'s pilot geothermal district-heating project has begun in **Otaniemi, Espoo**, near **Helsinki, Finland**.

The first **6.4 kilometre-deep** geothermal heat well was completed last year, and the second well to a depth of **3.3 kilometres** awaits the results of water stimulation modeling. The drilling plan for the remaining part of the second well has been determined according to modeling and the actual **drilling was scheduled to start in September.** 

Once complete in 2020, the plant will be the world's deepest geothermal heat production plant. *Global Geothermal News......* 

#### **Cornish Lithium Begins Exploration Drilling**

British mining company **Cornish Lithium** is gearing up to drill its first exploration holes to test whether it is possible to **exploit lithium from geothermal waters** that occur naturally and circulate beneath historic mine workings in Cornwall.

The company has successfully raised **GBP 1.4-million** in crowdfunding, welcoming 1,200 new investors, and was **preparing to proceed with drilling in October**.

Cornish Lithium has stated in the past that they would also like to investigate the possibility of combining geothermal energy production and lithium extraction. *Global Geothermal News*......



#### **UK Geothermal District Heating Network Expands**

The second phase of **Stoke-On-Trent**'s geothermal district heating network has begun to install another 1.4km of flow and return pipework.

**Councillor Carl Edwards**, said: "Careful mapping of our city's geology has shown us that there is geothermal energy under Stoke-on-Trent, and the deep seam coal-mining of the past has helped us to identify its source. It is serendipitous that our energy source of the past could help us in powering our city for the future. Our plans for the network are that it will eventually go on to be powered by these hot underground rocks."

"We're thrilled to be launching this latest phase of works. It is the next stage of a total 18km of pipes that will be installed over the next four years stretching across the city." *Global Geothermal News......* 

### Drilling Completed at United Downs Deep Geothermal Power Project Wells

Geothermal Engineering Ltd (GEL) reports that the deep drilling work at the United Downs Deep Geothermal Power Project in Cornwall, England, begun in November 2018, is now complete with the injection well reaching over 2,000m and the production well going to a depth in excess of 5,000m. Both wells intersected the fault at the predicted depth and the temperature at the bottom of the deeper well is around 190°C, which is also as expected.

Downhole measurements have confirmed that there are **lots of natural fractures** and early indications are that **the permeability is promising**.

GEL is now ready to begin the **evaluation stage** of the project. During this stage, a series of measurements and hydraulic tests to evaluate the fault structure will be undertaken to make sure the wells are in good condition, and to evaluate the amount of geothermal energy that can be sustainably harnessed.

At the start of September, the first part of this work begun with the removal of a temporary downhole packer from well UD-1. This allowed the onsite team to carry out some more downhole 'logging' measurements and to collect some sidewall cores. *Global Geothermal News......* 

(Courtesy Cornish Lithium)

### Inside Geothermal

### Twelve Boreholes to Be Drilled at Glasgow Geothermal Research Observatory

An innovative project in **Scotland** is investigating the potential for **untapped mine water** to be harnessed as geothermal energy that could be used to help heat millions of homes in the UK.

The **Glasgow Geothermal Research Observatory** will explore underground mine workings via **12 boreholes** drilled to varying depths in **Dalmarnock** and **Rutherglen's Cuningar Loop** in **Glasgow**'s east end.

So far, scientists have drilled four boreholes with the remaining eight partially drilled exploratory channels to be completed by the end of this year. *Global Geothermal News......* 

#### Irish Offshore Geothermal Resource Project Put on Hold

Irish exploration company **Providence Resources** has announced it has no plans to further develop a geothermal energy project in the foreseeable future.

Earlier this year Providence formed an affiliate business **Providence Renewables DAC** to look at geothermal energy projects, in particular **a possible 260°F resource** in the offshore **Porcupine Basin**.

Chief executive **Tony O'Reilly Jr** said while the group is planning a strategic review of all its assets and divisions, development of the renewables arm remains some time off, and not just due to the overall company's current financial restrictions.

"Geothermal energy is really interesting. The problem is there's got to be some legislative frameworks put in place to be able to do things like that; likewise around carbon sequestration. *Global Geothermal News......* 

### Trias Westland to Expand Geothermal District Heating Network

The **Trias Westland** geothermal greenhouse heating network in the Netherlands is expanding with an second geothermal heat source.

The first construction work started in September and over the next six months, two kilometers of heat pipelines will be installed in stages. Preparatory work for installing the second geothermal heat doublet at **Lange Broekweg** in **Naaldwijk** will start in the first quarter of 2020. It will become operational in the second half of 2020. *Global Geothermal News......* 

### Belgium Geothermal Project Paused for Investigation

The **Vito**-led **Balmatt geothermal project** in Mol-Donk in the province of Antwerp, suffered a serious setback at the end of June when a power failure was followed by an **earthquake measuring 2.1** on the Richter scale. The earthquake was the result of a sudden release of pressure that had been increasing **as cooled water was re-injected**.

Vito paused the project to make thorough investigations, fine-tune its monitoring system to limit seismic risks and reduce the pressure resulting from the re-injection of water. The analysis will help Vito's board of directors decide on which way to proceed. *Global Geothermal News*......

### Fifth Well Drilled at Munich Geothermal District Heating Project

Stadtwerke München (SWM) has announced they have drilled the fifth of six drill holes for the geothermal plant at the southern heating plant in Munich.

Subsequent pumping tests should then confirm the yield and temperature of the geothermal resource. SWM is confident that the **actual capacity of the plant will exceed the planned 50 MW**. By mid-2020, work on all six wells will be completed.

Meanwhile, SWM will build the heating plant planning to **go on stream by winter 2020/21**. Munich is planning to be the first major German city to generate 100 percent of its district heating using CO<sub>2</sub>-neutral sources by 2040. *Global Geothermal News......* 

### Garching Geothermal Plant Plans Summer 2020 Start

Construction of the **Silenos Energy** geothermal power plant in **Garching an der Alz**, east of **Munich** in **Bavaria**, **Germany**, started in mid-August.

The turbine is expected to be installed in spring 2020 and the plant is planned for commercial operation in the summer of 2020. *Global Geothermal News*......

### Swiss Government to Help Fund Exploration for Haute-Sorne Geothermal Project

The **Swiss Federal Office of Energy** has announced that the federal government will support the geothermal project in **Haute-Sorne in Jura**, with a "reconnaissance contribution" of **64.1 million Swiss Francs**. The first exploration well can now be drilled. *Global Geothermal News*......

### **Exergy Auctioned Off to Chinese Company**

Italian geothermal ORC turbine manufacturer Exergy Spa, a subsidiary of the Maccaferri Group has been sold in an auction to a Chinese company, Tica Thermal Solution Co. Ltd, based in Nanjing. *Global Geothermal News......* 

### Construction on New Geothermal Plant in Umbria to Start in November

**Diego Righini**, manager of **ITW LKW Geotermia Italia S.p.a.**, has announced construction of a geothermal power plant in **Castel Giorgio** in the Italian region of Umbria will start in November. *Global Geothermal News*......

### Polish Geothermal District Heating Network to Expand

The President of **Geotermia Podhalańska**, **Wojciech Ignacok**, announced that another 150 homes are to added to the **Podhale geothermal district heating network** in the far south of Poland. 120 homes are already being served. *Global Geothermal News*......

### Construction Begins at Torun Geothermal District Heating Project

The Polish government has announced the backing of Catholic priest **Tadeusz Rydzyk**'s plans for a geothermal district heating network for **Toruń** in northern **Poland**. Construction work started in January and the final networkwill be operated by a subsidiary of **Lux Veritatis** called **Geotermia Toruń**. The project will be financed partly from EU funds, as well as an 8.5 million złoty government loan and a 19.5 million złoty subsidy from the government's environmental fund.

The network will heat Rydzyk's media university, his church of the Sanctuary of the Blessed Virgin Mary Star of the New Evangelization and St. John Paul II, as well as parts of the city. *Global Geothermal News*......

### Turkish Company to Build Another ORC Geothermal Power Plant in Croatia

Zagreb-based **MB Geothermal**, part of Turkey's **MB Holding**, has signed a deal with Croatian project design firm **Ekonerg** for the design of a **19.9 MW geothermal power plant**.

The **Organic Rankine Cycle (ORC)** plant will be built in **Legrad**, close to the city of **Koprivnica** in the north of **Croatia**. This will be the second geothermal power plant in Croatia after MB Holding's **17.5 MW Velika Ciglena plant**. *Global Geothermal News*......

### **SCIENCE & TECHNOLOGY**

### HIGHER Project Looks Into Exploiting Supercritical Geothermal Resources in the Ductile Crust

Scientists at the **TU Bergakademie Freiberg**, the **Helmholtz Centre for Environmental Research** (UFZ), both in Germany, and the **Consejo Superior de Investigaciones Científicas (CSIC)** in Spain have announced a project to research exploiting supercritical geothermal resources in the ductile crust of volcanic regions.

The research project, named HIGHER, could result in a system of geothermal power production that could exceed conventional geothermal energy systems by a factor of ten. *Global Geothermal News*.....

The team published a paper in *Nature Communications* outlining their initial research:

"Supercritical geothermal systems are appealing sources of sustainable and carbon-free energy located in volcanic areas. Recent successes in drilling and exploration have opened new possibilities and spiked interest in this technology. Experimental and numerical studies have also confirmed the feasibility of creating fluid conducting fractures in sedimentary and crystalline rocks at high temperature, paving the road towards Enhanced Supercritical Geothermal Systems.



### Inside Geothermal

Despite their attractiveness, several important questions regarding safe exploitation remain open. We dedicate this manuscript to the first thermohydro-mechanical numerical study of a doublet geothermal system in supercritical conditions. Here we show that thermally-induced stress and strain effects dominate the geomechanical response of supercritical systems compared to pore pressure-related instabilities, and greatly enhance seismicity during cold water re-injection. This finding has important consequences in the design of Supercritical Geothermal Systems."

The risks of long-term re-injection in supercritical geothermal systems, by Francesco Parisio, Victor Vilarrasa, Wenqing Wang, Olaf Kolditz & Thomas Nagel. Nature Communications volume 10, Article number: 4391 (2019)

### Ultra-Low-Grade Geothermal Heat Engine Validated and Ready for the Market

**PwrCor, Inc.**, has announced the validation of an advanced technology that utilizes **low-grade and ultra-low-grade heat (150-212°F) to generate electrical power.** 

The company claims that the technology breakthrough exceeds cycle efficiencies of competing conventional power cycles and could now be applied in Data Centers, which previously could not effectively utilize their low temperature wasted heat, but now can economically convert that heat into useful power.

As **Tom Telegades**, CEO of PwrCor, stated, "The engineering enhancement that was developed, and that PwrCor is now exclusively commercializing, is truly an engineering and scientific breakthrough in thermodynamics. At the operating temperatures currently being addressed by PwrCor's technology, the efficiencies now exceed that of most thermodynamic power cycles, including the Rankine Cycle, used in many applications, as well as the Organic Rankine Cycle used in Waste-Heatto-Power, Geothermal, and Solar Thermal power applications." *Global Geothermal News*......

### Geothermal Power Plant By-Product Can be Used to Decontaminate Engine Exhaust Fumes

A geothermal power waste product that is similar to limescale can be used to **decontaminate engine exhaust fumes**, university chemists have discovered.

The team at **Manchester Metropolitan University** in the **United Kingdom** found that a **silica**-based solution – extracted from fluid used to generate renewable geothermal electricity in New Zealand – could **be re-purposed as a catalyst** that turns toxic pollutants into less harmful compounds.

Such catalysts are most commonly found in motor engines where they convert carbon monoxide into carbon dioxide in the exhaust gases.

The silica could be used to replace the 'much higher carbon footprint of industrially made products' with one that is naturally produced from a renewable source.

The waste material came from a **New Zealand** company, **Geo40 Ltd**, which has developed a world first technology for extracting the silica and further processing it into green alternatives to conventional industrial products. *Global Geothermal News*......

See also "Plant for Commercial Extraction of Silica & Lithium from Geothermal Brine Begins Construction" on page 23.

### III GEOTHERMAL LIBRARY

The GRC Library can be accessed at: www.geothermal-library.org

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### A New Boost for the Geothermal Industry In British Columbia? - New insights from the past could re-ignite the South Meager Geothermal project

By members of the GRC Student Committee: Antonina Calahorrano-Di Patre, Garen Thomas, Zachary Zody, Lakshman Ravi Teja Pedamallu, and Zahratul Kamila



Jeff Witter, Principal Geoscientist at Innovate Geothermal Ltd. Recently uncovered data by Geoscience BC answers a three decade-old question: Why was a very high temperature geothermal system explored but abandoned multiple times over the years? Dr. Jeff Witter (Innovate Geothermal Ltd. and a GRC Board Member) tells the story to the Geothermal Resources Council student committee.

The province of British Columbia (BC), host to the majority of potentially active volcanic areas in Canada, has been at the forefront of geothermal energy development in the country. According to province utility BC Hydro, 18 prospective geothermal sites have been identified. One particular initiative, the South Meager Geothermal project, has been explored multiple times; first in the early 1980s and later on in 2006. For reasons unknown to the general public at the time, the South Meager Geothermal project came to a halt in 2008 causing it to be labeled as a failure by the energy community. However, proprietary data recently made public by Geoscience BC has helped to shed new light on this story. Dr. Jeff Witter, Principal Geoscientist at Innovate Geothermal Ltd., kindly agreed to shed some light on past, current, and future research and development at the site.

Dr. Witter, you recently wrote a short report for Geoscience BC regarding the Mount Meager project and how it has evolved through time. When and how did you first hear about the project? What did you think about it at the time?

I heard about the Mount Meager project probably for the first time in 2008 when I moved to Canada and started working for a geothermal energy company. I thought it was very exciting, since it is a volcanic hosted geothermal system that is very high temperature. The project is located in the lower mainland of British Columbia near "load centers", which are the parts of the province where most people live and use lots of electricity. Proximity to population centers is really helpful to this sort of project.



The Mount Meager Volcanic Complex (MM) pictured inside the red circle, alongside other features of British Columbia. In the figure BR refers to Bridge River, EV to Elaho Valley, CC to Mount Cayley, MG to Mount Garibaldi, MC to Monmouth Creek, and WP to Watts Point. Modified from Russell et al. (2006).

Did you have any type of expectations for this Project? Did you know if it was going to be profitable or not?

In 2008 and up through 2010, I think all of us in the geothermal community in Vancouver were confident that this project would be successful. Some of the uncertainty with the project was, of course, whether they would be able to build a transmission line that would go from the site at Mount Meager all the way down a valley to connect to the existing transmission line. It was a long distance, tens of kilometers, and running those transmission lines would have been very expensive. That issue was finally not addressed at the time (2008 to 2010), since the project never got to that point.

So the project was abandoned several times since it started in the 80s. How did this affect the geothermal industry at the time, especially in BC?

As is the case in other parts of the world, the geothermal industry in British Columbia has certainly experienced ups and downs: these ups and downs are really controlled by external forces. For example, the availability of fossil fuels and the oil embargo had an immense impact in the 1980s, while the small crisis the geothermal industry experienced in the early 2000s in Canada had more to do with investors' sentiment towards these types of high-risk natural resource projects. When the financial crash of 2008 hit, the investment community had much lower tolerance for these sorts of higher-risk natural resource projects: this led to a lack of investment, which then led to a lack of incentive to move ahead projects like the one at South Mount Meager. Since that time (2010) the geothermal energy industry in British Columbia has really not been moving forward.

Even though the data from the 2008 geothermal project was made public in recent years, it was almost non-discoverable before you wrote the report... What did you think when you first saw the data? What surprised you the most?

What surprised me the most, is that the generally accepted narrative about the Mt Meager geothermal project was incorrect: there were doubts about whether or not the project was viable, whether there was a good resource there or not. I was therefore pleased that when I actually looked at the data, which had been proprietary up until the date it was released by Geoscience BC, I found that there was a lot of evidence for a very good geothermal resource at Mount Meager. This struck me as an important story that needed to be told so that the reality of the Mount Meager project could be understood by other scientists, by people in the geothermal community, and by the public. Having this new information really shed a lot of new light on this project and its viability. The real story could be better understood, rather than the prevailing narrative, which was incorrect because it was based upon old information.

So you just mentioned that the common knowledge about this project was based on old information... Are you referring to the information that came from the 1980s exploration work?

Yes, during that time (the 1980s) they put a lot of good effort into doing good science and doing some exploratory drilling at the South Meager project. That was all very, very good work, but only a limited number of wells were drilled with the majority of them not being very permeable. Flow rate tests were conducted, but commercial levels were not achieved. That is why in the 1980s, as I understand it, the project did not move forward. In the early 2000s, Western GeoPower had a second attempt at developing the South Meager Geothermal project, and obtained a lot of data from newly drilled wells. This is the data that had been proprietary up until the Geoscience BC data release.



Flow test of well MC-6 at the South Meager geothermal project (Source: Western GeoPower)

Now the project at Mount Meager seems to be starting again: geothermal exploration was carried out in the Mt Meager area during the last summer. What are your expectations for the project? Do you think it is going to jump-start the BC geothermal industry? Do you think the project itself is going to move forward? Are you just waiting for new data?

I am very excited about this new Natural Resources Canada (NRCan), Geological Survey of Canada (GSC), and Geoscience BC project focused on the Garibaldi volcanic belt! I think that in the next year, with all of these new data sets and analysis being conducted in large part focused on the Mount Meager volcanic complex, there is going to be a new and deeper understanding of the geological controls on the geothermal systems in and around Mount Meager. I am hopeful that all of this new information, and the analysis and understanding that comes out of it, will help to spur future efforts by developers and geothermal companies to do more exploration drilling at Mount Meager. Hopefully this will move the [project] forward to develop the geothermal resources into electricity generating power plants.

You mentioned that Western GeoPower drilled a new set of wells in the early 2000's. One of the main hurdles for the project to move forward at the time was the ability to make these wells flow. In your report, you mentioned that one proposed solution would be to drill deep production wells from the valley-floor. Would this increase the costs and eventually make the project prohibitively expensive, or is it still within the limits?

That is a good question, and I cannot really comment much on the costs of the drilling program because all those numbers are outside of my area of expertise. However, in my report about Mount Meager, I referred to an analysis made in 2009 by the consulting firm GeothermEx, in which they did the math to test the idea of drilling a well from the valley floor to a spot that intersects the known location of permeability. This location was discovered in some of the other wells, drilled from much higher up the slope. The calculations showed that a well at that lower elevation on the valley floor should be able to successfully flow the geothermal fluids from the permeable

zone deep in the subsurface. Pumping the geothermal fluids up and out of the ground is what they were unable to do from the well that was positioned much higher on the mountain side! So, whether or not a well drilled at that lower elevation will be low-cost enough in order to make the project economic, will likely depend on the costs of a drill rig, of the steel for casing, and all those other factors that will ultimately determine the overall well cost. However, a well drilled from the valley floor appears to be have the highest likelihood of being able to sustain the high flow rates that are needed in order to make the project viable. A large number of wells that can only produce a couple of hundred gallons per minute of geothermal fluid would not get anywhere: the project would not be viable because there are too many wells for too little production. That is why the aim would be to have very high production wells that can produce thousands of gallons per minute from a single well.

We are speaking about the Permeable Zone, its location, and its properties. How does the data point to this Permeable Zone location? Do we know about this permeable zone only from the exploration wells?

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Yes, that is correct. One of the wells, MC-8, was drilled through a section very deep inside the Mount Meager complex, and encountered what is called a lost circulation zone: a short interval in the well where the surrounding rocks must be an extremely permeable since all of the drilling mud, which fills the well bore, is lost out into the rock formations. That is the key piece of evidence that tells us the exact location of this permeable zone, [...] and that is what was discovered in the subsurface of Mount Meager.

I assume that new data that was collected this summer will relay more information about the lost circulation zone and the permeability of the area?

Well, drilling is ultimately the best way to test whether a specific location in the subsurface is permeable or not, but what the scientific data that was collected this summer can do is hopefully identify more information - obtain a better understanding - about the geologic framework and the structural controls in the region where the drilling showed some zones of very high permeability. If, for example, the scientific studies this last summer conclude that there is a significant fault contact, or a different lithologic contact which spatially agrees with the location of the lost circulation zone in the well, then we are starting to fit together the pieces of the jigsaw puzzle. If the studies suggest multiple lines of evidence all saying that this is a zone of high permeability, then that is what we want to achieve.



Helicopter overflying surveying stations on the Mt Meager Volcanic Complex, July 2019. Geophysical measurements were performed around the Mt. Meager volcanic complex during the summer of 2019, and aim to shed light on the internal structures and geothermal systems around Mt. Meager. Photo courtesy of Dr. Martyn Unsworth, University of Alberta.

It sounds like MC6 and MC8 (the two successful wells of the 2008 project) could be good candidates as injection wells... Is that a long-term hope for the project, or would it be best to just move on and drill new wells from the valley floor, maybe start doing injection there?

That is a really good topic to bring up because injection management in geothermal fields is really important, and it can make or break a project: if you have all kinds of production of geothermal fluids, but you don't have any place to put them (such as in injection wells), then the project is not going to move ahead.



Helicopter view of a fumarole (marked with a red arrow) on Job Glacier, Mount Meager, as seen on July 2019. Photo courtesy of Dr. Martyn Unsworth, University of Alberta.

The challenge of using MC6 and MC8 as injection wells is that the wellheads for both are located very high up on the mountain slope. Therefore, after the cooled geothermal fluids come out of the power plant and heat is extracted from them, you would have to pump those fluids all the way up the mountain side, to the wellhead, to put them back in MC6 and MC8. I think it is unlikely that MC6 and MC8 would be used as injection wells, as you would have to use so much of what is called a parasitic load, all kinds of extra electricity, in order to pump those fluids up the hill.

The geothermal community in Canada will, without any doubt, monitor the information about this project very closely, but only time (and data!) can tell for now if this initiative will move forward. Our gratitude goes to Dr. Witter for the insight given by this interview, and for bringing attention to the potential of this project, upto now hidden in plain sight.

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Contact Chi-Meng at cmoua@geothermal.org or 530.758.2360 ext 105.



Nearly 1,000 attendees gathered at the world's largest annual geothermal energy event, the GRC Annual Meeting and Expo, September 15 to 18 at the Palm Springs Convention Center, Palm Springs, California, USA.

The Palm Springs Convention Center and adjacent Renaissance hotel proved to be an excellent location for speeches, workshops, technical presentations, exhibits, and parties! Downtown Palm Springs offered many cultural and culinary pleasures and the beautiful surrounding scenery set the scene for some amazing fieldtrips and a bit of golf.

The Annual Meeting & Expo once again offered a superb setting for a networking extravaganza!







4



1. The participants at the pre-meeting New Frontiers in EGS Technology workshop. Thanks to Geothermal Resource Group for their support. Photo by Ian Crawford.

2. GRC Executive Director **Will Pettitt** leads a panel discussion to round up the EGS Technology workshop. Photo by Ian Crawford.

More photos from the Workshops can be seen on the flickr GRC Flicker website: https://flic.kr/s/aHsmGZsPaA

3. The Jeep tour folk squeeze through a slot canyon...just! Photo by Mike Krahmer

4. Before the start of the main event some hardy souls set out on a Jeep tour to the San Andreas fault. Photo by Mike Krahmer

More photos from the **San Andreas Fault** Jeep Tour can be seen on the **GRC Flicker** website: https://flic.kr/s/ aHsmHhipdr

5. Another pre-meeting fieldtrip visited the beautiful Palm Canyon. Photo by Mike Krahmer

More photos from the **Palm Canyon** fieldtrip can be seen on the **GRC Flicker** website: https://flic.kr/s/ aHsmHhkWBL







6. GRC President **Andy Sabin** and GRC Executive Director **Will Pettitt** (far right) check in at the Annual Charity Golf tournament at the Indian Wells Golf Resort. Photo by Ian Crawford.

7. Setting off on the long drive to the first tee! Photo by Ian Crawford.

8. Hitting some practice balls in the early morning light. Photo by Ian Crawford.

More photos from the Golf Tournament can be seen on the GRC flickr Flicker website: https://flic.kr/s/aHsmGZrN6t





9. Attendees line up to pick up their registration packets at the Palm Springs Convention Center. Photo by Ian Crawford.

10. Charlene Wardlow of

the Division of Oil, Gas, and Geothermal Resources at the California Department of Conservation greets visitors to her booth at the Opening Reception. Photo by Ian Crawford.

11. The GRC showed off a new booth design. The space became a popular spot for networking. Photo by Ian Crawford.

12. **Marcelo DeCamargo** (center) and friends enjoy the Opening Reception. Photo by Ian Crawford.

More photos from the flictr Opening Reception can be seen on the GRC Flicker website: https://flic.kr/s/ aHsmGZtqFL





13. GRC President **Andy Sabin** welcomes the international geothermal community to the Opening Session. Photo by Ian Crawford.

14. A large audience was in hand to hear special guests and energy experts covering many aspects of geothermal and other renewable energy development. Photo by Ian Crawford.

15. GRC Policy Committee Chair **Paul Thomsen** gave a rousing talk on "The Increasing Value of Geothermal Energy". Photo by Ian Crawford.

16. V. John White (left) led a panel discussion on the "State of the Industry" with (from left to right) Ryan Kelley, Jonathan Weisgall, Karen Christopherson, Prijandaru Effendi, and Paul Thomsen.

More photos from the Opening Session can be seen on the GRC Flicker website: **flickr** https://flic.kr/s/aHsmGZDaHP





17. On a warm Monday evening attendees gathered at the Palm Springs Air Museum for a fun party. Photo by Ian Crawford.

18. GRC Board Member **Jim Lovekin** enjoys a cocktail with Event Manager **Estela Smith**. Photo by Ian Crawford.

19. Members of the band "**The Flusters**" surrounded by some of their new fans! Photo courtesy The Flusters.

20. Past GRC President **Paul Brophy** examines one of the many second world war aircraft on display at the Air Museum. Photo by Ian Crawford.

21. Much fun was had on the dance floor! Photo by Ian Crawford.

More photos from the #¤µ¼¤ ·«¨ ¬µž , ¶`,° can be seen on the GRC Flicker flickr website: https://flic.kr/s/aHsmH1KHpm









24. **Xiaobing Liu** of Oakridge National Laboratory won the award for the Best Professional Poster. Photo by Chi-Meng Moua.

More photos from the Poster Reception can be seen on the GRC Flicker website: flickr https://flic.kr/s/aHsmHhgKDF





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25. Maria C. Richards is the worthy winner of the Joseph W. Aidlin Award - for transcendent service as Board President in supporting the Geothermal Resources Council Staff and guiding the Board during a time of expansion. Presenting the plaque is Patrick Walsh (right) as awards committee chair Marcelo DeCamargo looks on at left.

26. The Geothermal Pioneer Award is presented to Leland "Roy" Mink (center) - for 40 years of outstanding leadership, creative vision, and strategic planning for the advancement of geothermal resources and for being a mentor to the next generation. Jim Lovekin (left) and Marcelo DeCamargo (right) look on.

27. Dennis Kaspereit (right) receives the Henry J. Ramey Jr. Award from Jim Lovekin (left) - for unstinting devotion to innovative reservoir engineering and detailed modeling; leading to near-term reservoir management improvements, lowered field development and maintenance costs, and accurate predictions of long-term reservoir performance. Photo by Chi-Meng Moua.

28. Dr. William Harvey receives the Ben Holt Award - for his significant contribution to geothermal engineering and more importantly, sharing this knowledge and passion with his many students and fellow engineers. Photo by Chi-Meng Moua.

29. Jon Trujillo (left) presents Vincent J. Signorotti (center) a Geothermal Special Achievement Award – for 39 years of gracious dedication to the growth and development of geothermal projects through the acquisition, packaging, leasing and financing of real property and mineral rights. Marcelo DeCamargo looks on at right. Photo by Chi-Meng Moua.

30. Nick Goodman (right) accepted a Geothermal Special Achievement Award on behalf of his colleague, the late **Bruce Levy** – for his lifelong passion for power generation, the development of new power plants, and his love of all the wonderful, diverse personalities in the geothermal industry. Photo by Chi-Meng Moua.

31. GRC Scholarship winners: (From left to right) Omar Rodríguez Villarreal, GRC Executive Director Will Pettit, Sharon Best, Maria Alejandra Taborda and Kevin Mendoza. Photo by Chi-Meng Moua.

More photos from the '° ¤§¶ Ž, ±¦«"<sup>2</sup>± can be seen on the GRC flickr Flicker website: https://flic.kr/s/ aHsmHhgztR



32. Getting up close to a geothermal power plant on the Imperial Valley fieldtrip. Photo by Mike Krahmer.

33. On the Imperial Valley fieldtrip attendees venture into the Painted Canyon. Photo by Sam Abraham.

More photos from the **ft**  $3^{"}\mu^{\mu}$   $3^{"}\mu^{\mu}$  an be seen on the GRC Flicker website: https://flic.kr/s/aHsmHhi3Lp

# Thanks to the following companies for their support of the GRC Annual Meeting & Expo:

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# **Geothermal Photo Contest**



FIRST PLACE Salton Sea Infrared By Janet Harvey, Ladenburg, Germany

SECOND PLACE Cathedral By Fabio Sartori, Massa Marittima (Grosseto), Italy

THIRD PLACE **Powered By Light** By Thomas Ratouis, Reykjavik, Iceland

HONORABLE MENTION (H1) **Geothermal Drilling** By Vilhjálmur Guðmundsson, Reykjavik,

HONORABLE MENTION (H2) (For excellent representation of the community and its utilization of geothermal) The famous "cozido" cooked by geothermal heat By Jose Manuel Vaz Velho Barbosa Marques, Lisbon, Portugal



 $= \underbrace{\mathsf{M}}_{\mathsf{flickr}} \text{All the entries from the} \quad \cdot \ll / \overset{\circ}{}_{-\ast} \cdot \overset{\circ}{}_{+} \overset{\circ}{}_{\pm} \cdot \overset{\circ}{}_{\bullet} \cdot \overset{\circ}{}_{\bullet}$ 





# **On the Road: GRC Coso Geothermal and GreenFire Energy Field Trip**

By Hollis Chin, GreenFire Energy

On the last day of the recent GRC Annual Meeting & Expo in Palm Springs, California, 52 GRC attendees boarded a bus for a GRC field trip to visit the Coso Geothermal Fields and the GreenFire Energy closed-loop geothermal demonstration project.



Andy Sabin (standing facing the camera at center-right) explains the geology of the Coso geothermal field including a rhyolite volcanic dome named Sugarloaf Mountain in the distance. Photo By Ian Crawford.

The Coso Geothermal Field is located in the central Coso Range, approximately 160 miles north-northeast of Los Angeles and bounded by the Sierra Nevada Range to the west and the Mojave Desert to the southeast. This trip was particularly intriguing because the Coso Geothermal Field lies within the boundaries of the U.S. Naval Air Weapons Station (NAWS), China Lake, where access is extremely limited as it serves as a research and development facility for air-to-air and air-toground testing. The military geothermal program is managed by the Navy Geothermal Program Office and has the broad function of geothermal resource development and resource management on land that the military services.

On the first evening of the trip, a dinner was held and Andrew Sabin, Ph.D., of the Navy Geothermal Program Office, Naval Air Weapons



Andy Sabin explains the geology of the Coso Geothermal Field. Photo By lan Crawford.

Station (NAWS) and current President of the GRC gave a presentation on the geology of the Coso area. Joseph Scherer, CEO, GreenFire Energy Inc., gave a brief technical overview of the company's demonstration project and the initial testing results.

The early morning bus ride from Ridgecrest, California to the Coso Geothermal Field was fascinating. Andrew Sabin described the sites along the way including Fossil Falls, the Red Hill comprised of volcanic cinder, and the location of more than 6,000 petroglyphs in the nearby canyons. Kelly Blake, Director of the Navy Geothermal Program Office, also accompanied us. The bus traveled north on scenic Highway 395 and then turned off onto a non-descript road to arrive at the secured gates of the Coso Geothermal Field.

The Coso Geothermal Field has 4 power blocks comprising a total of 9, 30 MW turbine-generator sets for a total of 270 MW of rated capacity. Most of the power is sold to the local utility and powers much of the Naval Air Weapons Station. The power blocks were developed between 1987-1990 and have been in production ever since. Coso serves as a model for industry and military cooperation in the development of power operations. Mountain, the largest rhyolite dome in the volcanic field amidst the reddish domes in the range. We then viewed the Navy 1 power block, which has 3 wells, 2 turbines, and a net production of about 140 MW. The Coso Operating Company engineer, Cliff Buck, was at the site to explain the power block layout and answer questions about how Navy 1 operates.

A highlight of the tour was access to the Control Room where the operations of all 4 geothermal power blocks are managed. The focal point is a row



Eric Olson, DCS Technician, demonstrates the monitoring system at the Coso Operating Company control room. Photo By Ian Crawford.



Some of the equipment at the Navy 1 power block at Coso Geothermal. Photo By Ian Crawford.

The first stop in Coso was to admire the expansive and desolate Coso Volcanic Fields with 38 rhyolite lava domes and basaltic cinder cones. The most prominent sight is named Sugarloaf of monitors where operators continually watched flow diagrams of wells, separators, and many other system components. Participants were particularly interested in the monitor displaying process data from the GreenFire Energy demonstration.

At the GreenFire Energy demonstration project site, Joseph Scherer explained that an inactive well was used to demonstrate the technical and economic feasibility of closed-loop geothermal in a hot geothermal resource using both water and supercritical CO2.

This "first of its kind" project verified GreenFire Energy's modeling of closed-loop geothermal in hot dry rock, proved that a closed-loop retrofit could make unproductive hydrothermal wells productive, identified technical and economic challenges to be addressed before full scale implementation, and



The wellhead of well number 34A-20 at Coso Geothermal, being used to demonstrate the GreenFire Energy closed-loop technology. Photo By Ian Crawford

provided valuable knowledge to guide the upcoming commercial development of closed-loop geothermal technology.

Seeing the GreenFire Energy project was particularly exciting for the GreenFire Energy team and representatives of funding partners including the California Energy



The visitors were impressed by the sight and sounds at the GreenFire Demonstration site. The closed loop water holding tank on the left and the well silencer, in the background, both were emitting loud, healthy flows of steam. Photo By lan Crawford.

Commission, the Shell GameChanger program, and J-POWER of Japan. Roy Mink Ph.D., former Program Director, Geothermal Technologies Office at the U.S. Department of Energy said, "The demonstration by GreenFire Energy has provided a critical step in proving the down hole closed-loop technology to be a major component in developing a geothermal resource."

"GreenFire Energy's successful demonstration at Coso offers an incredible opportunity for geothermal developers to recover resources, which were previously unproductive. It was incredible to see a thermosiphon produce power during the GreenFire Energy tour." - Seth Champness, Engineer, Drill Cool Systems Inc.

The GRC fieldtrip to the Coso Geothermal Field and the GreenFire Energy demonstration was a great trip for geologists and non-geologists alike. "Being on the field trip with other likeminded professionals was a great learning experience and an exceptional networking opportunity. Thank you GRC and GreenFire," said Rob McConnell, Sales Consultant, Heat Source Energy. Participants witnessed the natural wonder of the Coso volcanic region, gained insight into the day-to-day operations of one of the least accessible geothermal fields, and got a glimpse of the future of geothermal at the GreenFire Energy demonstration.

More photos of the /%  $1 - 5 \cdot \mu^3$ .<sup>2</sup>  $^2 \P^2 / ^2 \cdot ^{\mu} \mu^{\mu}$  can be seen on the GRC Flicker website: https://flic.

kr/s/aHsmHhk54g



The GRC Fieldtrip group at the GreenFire demonstration site. Photo by GreenFire Energy

### **CHATTING GEOTHERMALLY WITH...**

by Susan Fox Hodgson cosmos@dcn.org

Nicole Lautze, Advocate: I initially worked on the National Geothermal Data System project. After that I wrote a proposal with a team for the Play Fairway project in Hawaii, where I am principal investigator. We have been working on this 3-phased project since 2014 and we're still going.



Now we are in Phase 3 and so we have deepened a well on the island of Lanai. It was initially 1,400 feet deep and we are roughly at 3,500 feet. This was challenging, as it took us about a year and a half to get to the point of actually drilling. We did an environmental assessment that took a while to write. Then there was the waiting period for public comments, the response to public comments, and waiting to see if anything happens after that.

I live on Oahu and fly to Lanai. I had no initial expectations about the drilling. I work with Don Thomas, who drilled the other two wells on Hawaii, so I'm learning from him. And I had visited his active drill sites in the past, so the drilling activity was along the lines of what I had expected.

I have two small children and so wasn't living on Lanai during drilling, and the drilling was 24/7. But I would get texts or a phone call early every morning. Don would get out to the site at about 7 a.m. He would tell me what had happened overnight, and I would get an evening report, too. It was really fun.

During drilling we held an open house for the Lanai community, so I went over that weekend. Both the community and I loved it, which is great. They have embraced the project.

The Lanai drill core was different from any other core we had worked on in the states. Excited, I am pursuing funding to analyze it.

The core looks like lava flows that have been crushed up and re-cemented rather than lava flows that have simply been compacted, which is what we have seen in the other drill cores. I think there's a story there with respect to how Hawaiian volcanic calderas evolve over time. We were drilling on the rim of a caldera on Lanai volcano. The basin that is the physical manifestation of the caldera is the Palawai Basin.

One unhappy surprise is how quickly the money goes. We only drilled for about four weeks in the month of June. We don't have funding available to embrace the risks associated with further deepening the well. Unless more money can be found, we will stop at this step. I really hope somebody comes up with funding so that we can keep going.

Overall, I very strongly believe the State of Hawaii should understand what its geothermal resource is and very little is known. Outside of Kilauea, we have very little data and little understanding of how the Hawaiian volcanoes cool over time or of the residual magma in the subsurface.

I studied active volcanoes in Italy—when you work on a volcano, you start to feel like you know it personally and that's fun. Hawaiian volcanoes are very well studied. Similar to the volcanoes I worked on in Italy, the Hawaiian Volcanoes are a pseudo-natural laboratory.

The State of Hawaii imports oil to produce about 75 percent of its electricity, has the highest electricity cost in the nation, and has a 100 percent renewable goal in a 2025 policy objective. I believe it is sad that geothermal isn't talked about more frequently. And it is quite challenging to find funding to work on geothermal in Hawaii. The state should take it more seriously.

But *geothermal* is not a popular word here. There is a strong vocal minority with a disproportionate influence in Hawaii—and some sensitivity around geothermal development.

These days on the side, I'm trying to talk more honestly and openly about geothermal. If I could get some funding for outreach, I would like to do a more organized outreach campaign, go into classrooms and that kind of thing—spreading the message. That's the thing about Lanai. If we could get a small production plant on Lanai, powering Lanai with community acceptance, it could be part of a geothermal tipping point for the state. Geothermal makes so much sense for the islands of Hawaii.

I want to add that we have found groundwater anomalies on Kauai, suggesting there might be geothermal on the island—residual magmatic heat, let's call it. My group, I believe, is the only one looking into this issue.

**Reach** Nicole Lautze, Ph.D., Associate Specialist at the University of Hawai'I,  $M\bar{\alpha}$ noa, at: lautze@ hawaii.edu

### Brandon Curkan, Innovator: I

work for C-FER Technologies and we entered geothermal in an odd way. The company mostly does oil and gas research. We work out of Alberta, Canada, and at one time had very little exposure to geothermal. I'm a fluid



dynamics specialist at C-FER, mostly working on experimental flow loops.

In Canada, as the oil industry went through a downturn, we began looking for diversification such as renewable energy projects. When I came across a couple of articles on geothermal that were actually from a GRC meeting, I started reading about it. It just made sense to me and was so similar to the oil and gas industry: there was a reservoir and a resource that you were trying to produce. I just saw all the parallels and did an analysis for our company. Management sent a few of us to the GRC for the first time around five years ago. We've found some projects here and have gotten involved. I see geothermal realistically as a key way forward through renewable energy.

As far as my work in geothermal, it's been at a fairly high level. We've done a few projects on specific issues, and we're looking to get more involved. I've written papers on some oil and gas practices that would benefit geothermal. In a push to get really collaborative, we are trying to bring over some of the oil and gas people to transfer some of their knowledge to geothermal.

I feel a little bit more passionate about the idea of trying to make geothermal work. I'm Canadian and live in Alberta, which is potentially the worst place in the world for geothermal. I'm specifically interested in EGS. The concept that you can drill anywhere is very exciting to me, as is the idea that even without hydrothermal resources, you can still make geothermal work—even in Alberta with a horrible temperature gradient. And if you can actually get EGS to work in Alberta, well, it is going to work anywhere.

On a personal level, I'm a huge nature fan. I do a lot of camping, snow-boarding, and outdoor activities. I do feel a little bit responsible for the environment. In Alberta I've grown up in a society that primarily uses fossil fuels for power. Since fuels like natural gas are so cheap, it's really hard for renewable energy to get a footprint in Alberta. I'd really like to see something like geothermal begin providing power there.

I thought geothermal really would have no place in Alberta for a long time, or even in Canada for that matter. But we're seeing some very exciting projects get funded, along with a lot of really interesting ideas. For example, one idea we've talked about with some companies—and find they are quite interested in—is using geothermal as a way to produce hot water to reinject as steam. In my mind this has moved the time table up quite a bit. If you can get the oil and gas companies on board, you'll really have the motivation to get EGS working. Those are the guys who have the resources to make it happen. I thought that geothermal would be really far out for Alberta, but now that I see it as a possibility it feels a lot closer.

Companies needing to inject steam to produce the heavy oil use a lot of energy. They take cold water, bring it up to temperature, and then inject it into the ground. This takes a huge amount of energy and, of course, creates greenhouse gas emissions.

If instead you can start with hot feed water, you

have to add less energy to reach the temperature you need to flash the water to steam and to inject that into the ground. You will save a huge amount of energy and reduce greenhouse gas emissions.

This would be a little bit of a hybrid project. It's not exactly renewable energy, but you would at least reduce the carbon footprint of oil production. To me, the stepping stone for geothermal in Alberta is that when you can prove the geothermal concepts in these daily operations, then, maybe, they will start taking on a life of their own after a while. In summary, an EGS project could provide hot feed water for heavy oil production.

If you can prove geothermal energy in Alberta and start doing research on it, you can start bringing the economics closer to that of oil and gas. I believe EGS is technically feasible, just not economically feasible right now. And the more research we do to reduce things like drilling costs, for example, it will just push EGS to be more realistic. The fact that it's technically feasible is really encouraging. This is something we could do. The only reason we don't is the price.

Yes, I like to call myself an innovator. I like to imagine what can happen in the long run and then try to see the steps it will take to get there.

**Reach** Brandon Curkan, PEng, Senior Research Engineer Experimental Fluid Mechanics, C-FER Technologies, at: b.curkan@cfertech.com

Jason Fisher, *Geo-Blogger*: I was born in Jamaica and worked in gold and copper exploration before going to work as a consulting geologist in Belize. Here I worked on a variety of projects including oil and gas exploration, environmental impact assessments, and hydrogeology



while lecturing in hydrogeology and physical geology at Galen University. After moving to the US and earning my second graduate degree, a *Masters in Geology* at Auburn University, I ended up getting interested in geothermal energy. This happened because I was offered a job logging wells. Because of my background in gold and copper exploration, my first assignment turned out to be a geothermal well with a granitoid reservoir with the all too familiar mineral alterations representing specific temperature regimes and hydrothermal fluids. I said, OK, it would be great to log some geothermal wells in Zuñil, Guatemala—all granite, rhyolite, and dacite. The Zuñil Field was my first dive into geothermal. And that was it. I never looked back.

My hotel in Zuñil was great, built around a series of fumaroles. Steam vents were located in specific rooms with a public sauna open to all. You could open the vents and a section of the room turned into a sauna, filling in five minutes with hot steam—250°F steam and you are cooked. Everybody loved the hotel, including me. Every night, every morning, you would open the vents and in minutes you had your own personal sauna.

Still in Guatemala, I became interested in finding information about geothermal development for non-geologists and for beginners. In a few months, I went to El Salvador to study geothermal reservoir characterization through the UN Geothermal Training Program.

Here I realized some of my fellow classmates couldn't understand some parts of our materials. I wanted to fill the communication gap between experts, non-experts, and experts who don't know but would like to. So I started a geothermal blog and posted many articles about geothermal energy (IG@isleofrocks30). The topics include tracers, risks, desalination, and a glossary updated weekly and posted every Monday on linked in (linkedin.com/ in/Jason-fisher-geo) and on my website (isleofrocks. com).

As for the future, I want to continue developing as a geothermal writer, combining this with GIS mapping experience. I lean toward lowtemperature resource projects, with an end goal of seeing the full use of this globally widespread geothermal resource. *Reach* Jason Fisher, Geologist, Geoscience Writer, Geothermal Resources, at: isleofrocks@gmail.com

**Brett Peterson**, *Stick Shifts:* Yes, my geothermal life has led

me to foreign countries, including Indonesia, Singapore, New Zealand, and Turkey—where I've been several times. I've worked in geothermal for 10 years. It was my first real job out of college, and I



got my degree in civil engineering at the University of Washington. But I've been traveling less of late.

Many experiences have come my way while living in different cultures. One time I stayed in Istanbul for an extra week. The day when I walked around Auckland, I felt as though I was in San Francisco or Seattle. Indonesia was great, and I found Singapore to be a modern and very clean city.

Once in a Turkish geothermal field, I was assigned to work with the same people every day. I ended up spending a week with them and friendships developed between us, as we were all about the same age. Normally the people I have worked with in the field are employees of construction and maintenance companies.

So here is my adventure. Usually on landing in a large airport, I would fly to a smaller one, rent a car, and drive for a few hours to a geothermal site and a hotel. One memorable day in a Turkish airport, when I went to pick up my rental car, one I'd reserved with an automatic transmission, the only car available had a stick shift.

I grew up driving an automatic car and probably had used a stick shift just once or twice. But then given no choice, I had to learn how to do it right away. I began by driving the car down the highway going away from the airport. For the first mile I was stalling it the entire way. And people driving by were slowing down and looking over to see if I was OK. I knew what to do, but it just wasn't working. I stalled the car every time I hit a stop light. That was a very frustrating evening, plus you know you

get to the hotel late at night after driving two hours. That was an evening I don't need to experience again.

*Reach* Brett Peterson, Design Engineer, Veizades & Associates, Inc., at: BAPeterson@veizades.com

Julia Diessl, *The Heat:* I am Austrian and my interest in geothermal basically started from working with oil and gas. Seeing how oil, gas, and heat are found in the subsurface, I thought, this is interesting but why not make more use of the heat?



Of course, Austria does have a history of balneology with thermal waters, mostly found at the edge of the Alps to the north and in the southern, ancient volcanic areas. Vienna itself lies on a sedimentary basin. The city is currently exploring heat resources down to bedrock for geothermal heat. Some of this bedrock extends into Hungary.

Working in geothermal fields, the footprint on the surface is small compared with other energy sources and this makes it interesting to me—as do the lithium and other minerals, and reservoir management policies. We create models from seismic and well data and study risks. The models support the development of the operators. I like that geothermal can learn from other industries like oil and gas, and *vice versa*. And I like seeing it happen in Austria.

An Austrian geothermal association is starting to form and I've come to know some of the members. We are working to getting the idea out there. Good information is important, like understanding stress and strain in the subsurface and how these can influence our life on the surface. As you know, people worry about induced seismicity. We must share our information with them, explaining and applying ways to reduce the risks and also the regulations hindering projects. As soon as I discovered geothermal—and realized what I could do with my knowledge and understanding, this has given me focus and kept me motivated. I like seeing how many more plans are underway.

*Reach* Julia Diessl, President and Senior Research Engineer for GeoMechanics Technologies, at: juliad@geomechanicstech.com

**Ryan Seward, Places & People:** I've worked in geothermal for four and a half years and kind of fell into it. As an undergrad, I studied geophysics and began working in geothermal modeling with Professor Mark Reed of the University of Oregon—and really liked it. He asked if I wanted



to stay on for a Masters and I said, yes. I really like geothermal and that's how I started in the geothermal industry. Actually I enjoy working on geological and geochemical projects for the greater good, for something that I hope benefits humanity instead of causing its demise.

I like being able to use my work to go all over the world. The geothermal areas are volcanically active, mountainous, and beautiful, and I've seen many of them. I've worked in the Philippines, Kenya, Guatemala, Turkey, Indonesia, and all over the Western US and Hawaii.

The geothermal community is pretty global and everyone approaches things a little bit differently, though safety standards may differ from one plant to the other. We all are doing the exact same thing. It's fun. We might not speak the exact same language, but we have similar skill sets. We can work side by side and help each other out. This is a neat way of experiencing another culture. Instead of just going to travel, you get to go and work alongside your colleagues. I have found geothermal workers to be incredibly skilled and intelligent all over the world. My favorite experiences have been working alongside with people from other cultures and their excitement to show me their cultures. After work, I have gone fly fishing in New Zealand, on a safari in Kenya, to a beach in Guadalupe, and to a glacier or geyser in Iceland.

Sometimes people ask me about where I live or what geothermal power plants are like in the US and how their operation compares with other operations around the world. It mainly all comes down to just being able to work alongside them. I've been pretty lucky. I've felt safe in every country I've ever been in and have had great experiences.

I try to take each day as it comes. We run into issues all the time with equipment not showing up. I work with the people in customs, trying to get our equipment released. In Turkey, we got done with a job a few days early and my Turkish co-workers made a list of things to see. We were able to get a car from the plant and drove around the country. We explored ancient Roman ruins, the travertine terraces at Pamukkale, and sat on the beach at Kusadasi.

Geothermal not only has been my career, but a way to enjoy the pleasures of the world. Of course, I've missed flights and a lot of little things like that. But I just take them as they come.

*Reach* Ryan Seward, Field Geologist, THERMOCHEM®, at: ryan@thermochem.com

### **Catherine Hickson**, *Volcanic*

*Adventuress:* I've actually been doing geothermal since I was an undergraduate at the University of British Columbia. In 1981, I started logging temperature gradient wells in the wilds of British Columbia. From there I mapped the Wells



Gray-Clearwater Volcanic Field in east central British Colombia, a place then thought to have geothermal potential. My professional career involved mapping and spending a lot of time in the "bush," as we geologists call it, away from roads and people for many months. After my Ph.D., I became a research scientist with the Geological Survey of Canada (GSC) and for the next few years continued with geothermal work, particularly on the geothermal potential of British Columbia. While keeping the geothermal torch glowing in Canada, I kept in touch with colleagues who were working in geothermal elsewhere in the world.

My original specialty is phreato-magmatic and sub-glacial volcanism, and I am around volcanoes a lot. It all started with an early fascination with hot springs and thermal features associated with the volcanoes—a theme I have continued throughout my career. In 2013 I added lithium brine exploration to the list because the brines occur in closed basins often associated with volcanism.

While working for the GSC, my work evolved from a geothermal-specific focus to one dealing with volcanic hazards. I worked on an alerting protocol for Canadian airspace, one especially focused on eruptions in the Aleutians and the Cascades. Since the prevailing winds blow the ash clouds from these volcanoes over Canada, the Canadian people and international aviators who use the airspace have a significant need for the information. I left the GSC in 2008 to join a start-up, pure-play geothermal company.

Being a field geologist, as I am, means experiencing all sorts of exciting things like crossing creeks in floods, encounters with wild animals (including a charge by a grizzly) and lots of helicopter rides in storms. A slightly different event that kind of sticks out in my memory—one not traumatic, but one that managed to combine my personal interests with a huge, geological event—was my trip around the world. It began at a time when I was in Italy, doing exploration and working on setting up a geothermal company, Magma Energy Italia. This was in 2010, the very year when Eyjafjallajökull, the Icelandic volcano, erupted, sending significant ash plumes for multiple days over Northern and Central Europe. My mother alerted me about the eruption, asking me (via email) how I planned to get back to Canada.

So I called my former Canadian colleagues. When they told me where the ash plumes were headed and which air spaces would be closed, I realized I wouldn't get home any time soon. This was the same year the World Geological Conference was in Bali, and I'd made plans to attend and do some assessments in a few Indonesian geothermal fields. So instead of flying back to Canada and from there on to Indonesia, I took a train to Rome, worked in the morning, and had a fabulous time exploring the city in the afternoon. However, each day I heard the growing anger of those stuck in place by the event—with no one but the Canadian press back home knowing the role I had played in the International Flight Safety and Volcanic Ash Protocols. Knowing my only way back home was to fly east, I flew to Turkey and then on to Bali, enjoyed the conference, looked at the geothermal prospects, and returned to Canada. Around the world; it took two weeks.

One of the most terrorizing and hair-raising things that really got me into volcanology in the first place is that I was an eye witness—on May 18, 1980, at 8:32 a.m., Sunday morning—when Mount St. Helens erupted. I was nine miles away, directly east of the volcanic summit. That event was both life and career changing for me. I was a geology student at the time, planning to go into sedimentology. Originally from Alberta, I thought sedimentology would be interesting, working in the oil patch.

I was working as a student in the geology department at the University of British Columbia that summer and we had taken a sequence of photos of the initial eruption. My professors put me in touch with the US Geological Survey (USGS), which was very interested in the photos and the sequence of events we had documented. These covered everything from the directed blast (technically called the pyroclastic surge), which is actually what almost killed us; a rain of accretionary lapilli (mud blobs that fall like hail); and a bridge washed out in front of us by a lahar. So we had time points for the three hours it took us to get out of harms way, away from these events. Basically the USGS put ours and other eyewitness reports together, coming up with a very detailed account of the events.

What is critical about Mount St. Helens is that at that time, the study of volcanology was in its infancy. Because of the number of people involved, the instrumentation, and all the work focused on Mount St. Helens, the study of volcanology took a huge leap forward. Among the specific events documented at Mount St. Helens was the "sector collapse", when a huge piece of the volcano became the world's largest, witnessed landslide. We got to see this unfold in incredible Technicolor. Back then, a pyroclastic surge was not an unknown event, but one basically unappreciated as to how extensive it could be. It destroyed over 230 square miles, extended out over 20 miles to the north of Mount St. Helens, and really was what created the most damage and loss of life.

So that is what I focused my undergraduate thesis work on—and with the help of my USGS colleagues, was able to work at a level higher than a normal for a third-year geology student. And so I entered volcanology. Then funding for volcanology on the Canadian landscape came through our geothermal energy program. So, as I said earlier, I hired on as a student doing temperature logging and my thesis work was funded through the geothermal program.

As a field geologist there are moments of horror and terror. One time, two field assistants and I were crossing a rain-swollen, flooded river, almost drowned, and when we did get to the other side safely, it was like, "What are we doing here?" Sometimes after a few days of rain when the rain has become snow and sleet, you do kind of wonder, "Why am I here?" But I am always passionate about the out-of-doors, and whether in the tropics or the frigid arctic ... you wake up the next day and you see a wolf, or you see caribou, or a moose, or the leaves are starting to turn color and the physical landscape around you is so beautiful you kind of forget that part before and just continue on.

I've just always tried to do my best and move forward on my own abilities. If there is a failure, I review what I have done. Usually the answer is not other people, either male or female. Usually I didn't do enough, or didn't focus enough, or didn't have the right background. A lot of it is taking personal responsibility for your actions and not blaming others.

To young geologists entering the profession, whether male or female, I would say, follow your passions. This gives you a good work ethic. Don't blame others for your shortcomings. For the females, don't blame the men and *vice versa*. Take personal responsibility.

Whether your senior is male or female, you need to be clear and transparent in terms of your intentions. If you're in a situation you find uncomfortable, remove yourself from it. It may be difficult in places like isolated field camps. But in today's world if you have the courage to get on the radio and say, "I need to get out of here for whatever reason," someone will help you do that. Don't internalize, don't blame yourself. Just put out that call for help. And whether male or female, I believe you should choose your battles. Save your energy for the things most important to you. Following your passions helps you here, showing you the battles you need to win to move on.

*Reach* Dr. Catherine Hickson, PGeo, DT hc, President, Geothermal Canada, at: president@geothermalcanada.org

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### **AND THEN....Geothermal Moments!**

by Susan Fox Hodgson cosmos@dcn.org

### Arctic Antics, by Greg Shore

In 1984 I undertook an Arctic geophysical project on Unalaska Island. One day while walking downstream from a geothermal discovery well on the flanks of Mt. Makushin, I felt something pulling at my backpack. I turned only to see an Aleutian fox, of about 20 pounds, assisting me by removing the electrical tape from an E-SCAN survey switch box. Foxes have no predators on the island and are too big for eagles, explaining their lack of fear.



An Aleutian fox continues pulling at the electrical tape with a paw. Photo by Greg Shore

My job was to create a 10 square mile, 3D resistivity map of the valleys downstream from the well. The program goal was to identify an extension of the geothermal resource that could be developed at a lower cost in areas already accessed by roads. We were looking for power for the town of Unalaska and Dutch Harbor, the center of the king crab fishery in the area, to replace costly diesel generation.

My company at the time was Premier Geophysics Inc., contracted by Gerry Huttrer with Republic Geothermal, for clients Alaska Power Authority and the Alaska Department of Geological & Geophysical Surveys.

Greg Shore, P.Ĝeo, Crone Geophysics & Exploration Ltd. ■



Unalaska Island and the town of Unalaska. Courtesy of Google maps

**To Our Readers:** Share your geothermal adventures right here - just describe them in a few short paragraphs. Photos are great but not necessary. *Susan* 

### **Calendar of Events**

### 7th London Geothermal Symposium (Geological Society)

**5 November, Burlington House, London, United Kingdom** https://www.geolsoc.org.uk/GSL-7th-London-Geothermal-Symposium

IGC Turkey Geothermal Congress & Expo 6-8 November, Izmir, Turkey

https://www.igc-turkey.com/

### Costa Rica Geothermal Workshop

**11-12 November, San Jose, Costa Rica** http://iea-gia.org/costa-rica-geothermal-workshopregistration/

#### 12th Annual Energy Africa Conference (The Global Commerce Forum) 14-15 November, Denver, Colorado, USA https://www.energyafricaconference.com/

#### Der Geothermiekongress 2019

**19-22 November, Munich, Germany** https://www.der-geothermiekongress.de/kongress-2019/ der-geothermiekongress.html

**1st Canadian Geothermal Students Day 21-22 November, Québec City, Québec, Canada** https://canadiangeothermal.wixsite.com/cgsd

#### Joint EAGE/BVG/FKPE Workshop on Borehole Geophysics and Geothermal Energy 22 November, Munich, Germany

https://eage.eventsair.com/boreholegeophysics2019/ event-overview

### 41st New Zealand Geothermal Workshop (NZGW)

25-27 November, University of Auckland, Auckland, New Zealand https://nzgeothermal.org.nz/

#### 4th National Geothermal Conference -RENAG - Colombian Geothermal Association (AGEOCOL)

**25-28 November, Medellin, Colombia** https://renagcolombia.wixsite.com/2019

#### Global Geothermal Energy Summit 2019 (ACI) 27-28 November, Florence, Italy

https://www.wplgroup.com/aci/event/globalgeothermal-energy-summit/ **COP 25 - Climate Change Conference 2-13 December, Santiago, Chile** https://unfccc.int/santiago

### American Geophysical Union - Annual Fall Meeting

**9-13 December, San Francisco, California, USA** https://www2.agu.org/en/Fall-Meeting

### GT'2020 Türkiye Jeotermal Kongresi

**5-6 February, 2020, Ankara, Turkey** https://geothermalturkey.org/

Stanford Geothermal Workshop - 45th Annual 10-12 February, 2020, Stanford, California, USA https://geothermal.stanford.edu/events/workshop

**GEMex Final Conference (GEMex Project) 18-19 February, 2020, Potsdam, Germany** http://www.gemex-h2020.eu/

### GeoTHERM - Expo & Congress

**5-6 March, 2020, Messe, Offenburg, Germany** https://www.geotherm-offenburg.de/de/geotherm\_ messe\_kongress\_geothermie

#### Joint GRC-SPE Workshop - High Temperature Well Cementing "Exploring Geothermal and Oil and Gas Synergies"

30 March - 1 April, 2020, San Diego, California, USA *Website......* 

#### 9th ITB International Geothermal Workshop 2020

**1-2 April, 2020, Bandung, Indonesia.** https://geothermal.itb.ac.id

### World Geothermal Congress 2020

27 April - 1 May, 2020, Reykjavik, Iceland www.wgc2020.com/

### Geothermal Resources in Sedimentary Basins Conference

9-10 September, 2020, Edmonton, Alberta, Canada http://gssb2019.com/

#### 44th GRC Annual Meeting & Expo

**18-21 October, 2020, Reno, Nevada, USA** www.geothermal.org/meet-new.html

### Eighth Africa Rift Geothermal Conference (ARGeo-C8)

26 October-1 November, 2020, UNEP headquarters, Nairobi, Kenya http://theargeo.org/

#### **45th GRC Annual Meeting & Expo 3-6 October, 2021, San Diego, California, USA** http://www.geothermal.org/meet-new.html



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