GEISER Geothermal Engineering Integrating Mitigation of Induced Seismicity in Reservoirs

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Editorial

The first year of the project is over, and we can look back to an eventful 2010, with several work-package meetings in Reykjavík, Orléans and Zürich. The GEISER top event was probably our first annual meeting in October, which was part of the "geothermal week" hosted by our project partner ÍSOR at Reykjavík. The workshop preceding the project meeting was very well attended and jointly organised by GEISER and the US DoE geothermal programme. The DoE co-sponsorship led to the participation of US experts in all topics addressed at the workshop. Extra-European participation also included an Australian delegation as well as experts from New Zealand, Japan and Canada. The almost 100 participants contributed to high-level discussions on the various aspects of induced seismicity in geothermal engineering. The work-shop gave us the opportunity not only to meet each other but also to receive first-hand accounts about the work performed in the various parts of the world and how the issue of induced seismicity is dealt with. By the end of the workshop participants agreed that an exchange of information and data should follow to address the issue internationally.

The workshop also gave the GEISER partners the opportunity to discuss collaboration with US partners in the context of a DoE funded partner-project, which involves analysis and inter-pretation of the extensive dataset from The Geysers.

For 2011, several workshops are planned and will be held at the workpackage level again. Those workshops that are already fixed are briefly mentioned in a separate section of this Newsletter. At the meeting in Reykjavík we also agreed to have a second general meeting in autumn of 2011. The host of the meeting has yet to be decided. GEISER partners also decided to invite international contributions again. So it will be an important decision to make in the coming weeks: Where will we meet for our second GEISER general assembly?

The GEISER management team wishes you all the best for 2011!

The U.S. DOE promotes partnership with Europe

The U.S. Department Of Energy's Geothermal Technologies Program (GTP) addresses induced seismicity by establishing and updating clear protocols and best practices, performing R&D, and collaborating both domestically and internationally to build a strong knowledge base. The program has developed an interim induced seismicity protocol that all DOE-funded EGS demonstration projects must follow, including collecting background seismicity and stress data, predictive modeling and ongoing monitoring during stimulation. An updated version of this protocol and a best practices document will be released for public review in early 2011.

Many other countries including those in the GEISER consortium and Australia are addressing induced seismicity in similar ways. Working together helps all those involved to better understand induced seismicity and develop potential mitigation strategies and proper policies. Additionally, there is value in developing a unified international stance that induced seismicity can be used as a tool, and can be properly monitored and mitigated.

Under an award through the American Recovery and Reinvestment Act of 2009, Array Information Technology is collaborating with 11 European partners, the University of California Berkeley, Helmhotlz Centre Potsdam, and Lawrence Livermore National Laboratory to address and mitigate problems associated with induced seismicity in EGS. The project is developing a system of techniques designed to answer the following: how enhanced geothermal activity changes the local and regional stress field; whether these activities can induce medium sized seismicity (M>3), and if so, how these events are correlated to geothermal activity in space and time; and what is the largest possible event and strongest ground motion (as well as associated potential hazards). If successful, this project will more accurately model the relationship between injection and production and larger magnitude events creating an opportunity to mitigate issues and/or hazards rather than abruptly halting or suspending the generation of energy at EGS reservoirs during the onset of seismic activity. In order to perform this work, a number of data sets will be required to provide different physical measurements distributed in space and time. Additionally, through the collaboration with European partners, a database of compiled data from 11 EGS sites worldwide will be made available to DOE.

DOE has awarded this project $1,164,143. Array is currently working with UC Berkeley and Potsdam to finalize their contracts.

The Australian approach for induced seismicity

The deployment of practical methods to attain reliable, trustworthy predictions of induced seismicity will underpin trusted land access for engineered (enhanced) geothermal systems (EGS) operations. In addition, regulators must be prepared to just say 'no' to projects where induced seismicity hazards pose unmanageable consequential risks for the public. To do otherwise can easily create mistrust of EGS operations in general.

Thus far in Australia, Geodynamics Limited has safely hydraulically stimulated high heat-producing, naturally fractured granites in Habanero

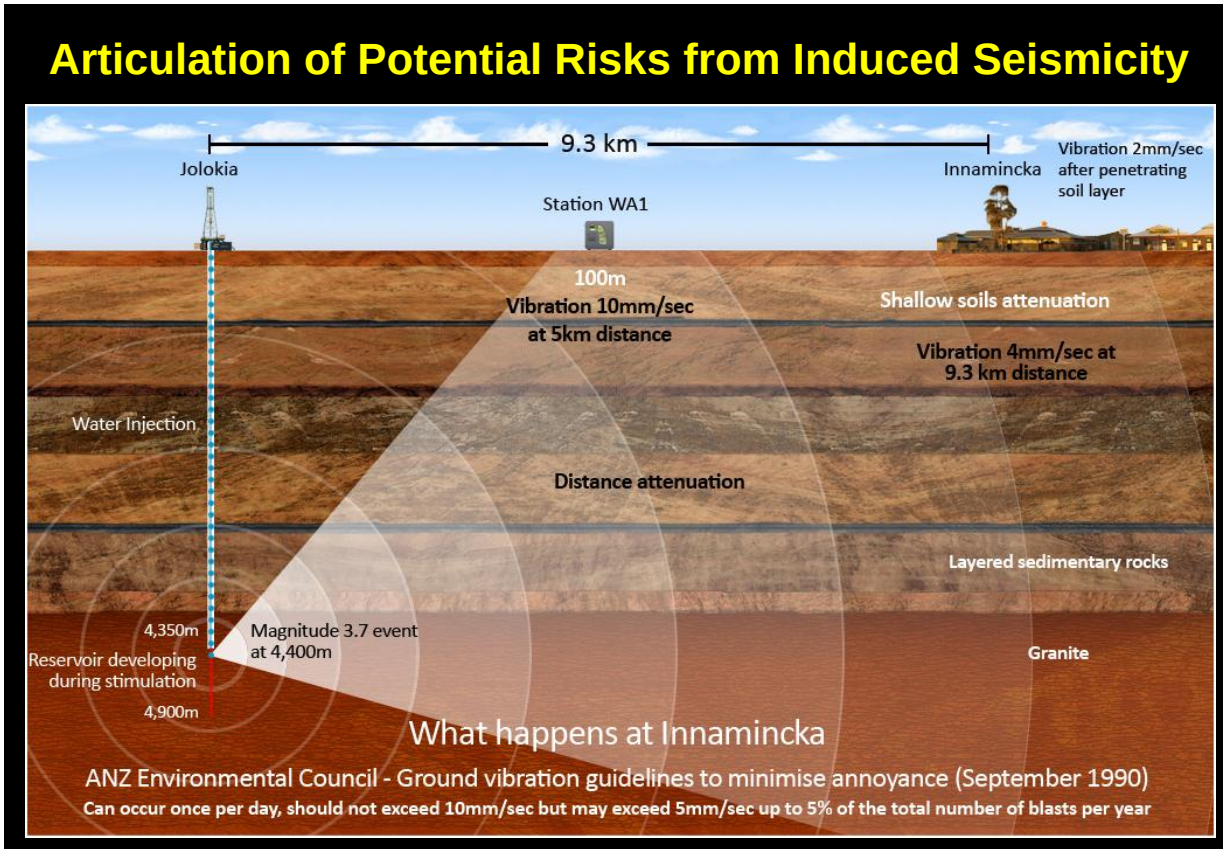
-1, 2 and 3 and Jolokia -1, and undertook injection/production of an EGS between Habanero 1 and 2 in the Cooper Basin in South Australia. Best practice risk management principles were applied throughout the planning, stakeholder engagement, regulatory approval and implementation stages of these EGS projects. The following illustration of induced seismicity expected from (pre-activity) EGS operations at Jolokia 1 was effective way to explain expected ground movement to potentially affected people.

The sharing of information from successive EGS operations will inevitably provide valuable experience and calibration for progress towards:

- pre-stimulation and pre-production models that are predictable and trustworthy; and
- methods that predictably and effectively improve geothermal reservoir quality.

Australian industry specialists and regulators are participating in focused national and international fora to foster fast progress towards practical, effective methods that both optimise and build public trust in EGS operations. These fora include:

- The Australian Geothermal Energy Group's (AGEG's) Technical Interest Group (TIG) for Induced Seismicity;
- The International Energy Agency's (IEA) Geothermal Implementing Agreement (GIA) under which international protocols for induced seismicity have been developed;
- The International Partnership for Geothermal Technologies (IPGT) which added a working group to cover induced seismicity in late 2010; and
- Conferences and workshops such as the one in Reykjavik 3-5 March 2010, jointly supported by participants in GEISER, the US DoE and the IEA.



News from the Reykjavik meeting, 03-05/10/2010

The first annual meeting of the GEISER consortium was held at ÍSOR (Iceland GeoSurvey) headquarters in Reykjavík, Iceland, during Octorber 3rd to 5th 2010. The meeting was planned as a workshop, jointly organised by GEISER and the US Department of Energy (DoE). The idea of the joint workshop was particularily to connect and coordinate efforts that are ongoing on both sides of the Atlantic as well as elsewhere in the world. The goal of the workshop was to develop strategies to address common challenges in a more effective manner and measure progress toward common goals in understanding and mitigation of induced seismicity in geothermal engineering.

The workshop was held among other events under the heading Geothermal Week in Reykjavík, during October 3rd to 9th 2010. The following meetings took place that week:

- General meeting of the GEISER geothermal project;
- A joint GEISER/DoE (US Department of Energy) workshop on induced seismicity;
- 6th meeting of the EERA (European Energy Research Alliance) Joint Programme on Geothermal Energy;
- IPGT (International Partnership for Geothermal Technology) activities;
- IEA-GIA (International Energy Agency, Geothermal Implementing Agreement) meetings.

Participants to the workshop in front of the headquarters of ÍSOR (Iceland).

More than hundred participants attended the Geothermal Week and the majority or eightyfive participants attended the workshop from 4 continents (Europe, Asia, Australia and North America) and from 17 countries. Geothermal experts where invited from the USA, Australia, New Zealand and Japan. Such invitations where made possible by a grant from the International Energy Agency (IEA) and by the funds made available to the GEISER consortium by Statoil to strengthen overseas interaction.

Participants of the workshop discussed major issues in induced seismicity, subdivided into five topic groups

- seismic analysis
- mechanical understanding
- hazard assessment
- mitigation strategies
- policy issues

Discussions in these groups were lively, sometimes controversial and generally showed that

- an improved understanding of the physical process is required to better

understand and mitigate induced seismicity,
- (more) reliable data are needed for hazard and risks analysis,
- model validation is needed to develop more accurate risk assessment models,
- generally a geo-scientific base needs to be developed to improve mitigation efforts,
- some sites should not be developed if there is not sufficient knowledge about the local seismic risks.

One of the five topic groups
at the workshop on
induced seismicity in Reykjavík.

The second day participants re-convened to form three new groups addressing cross-cutting issues from the previous day. Topic headers for these groups were
- Model Validation
- Monitoring and Communication
- Physical Processes

After the workshop, all participants agreed that communication and exchange of information at the international level, as practiced during the workshop shoul be continued and intensified. An exchange of data could accelerate progress, as the databse for well-documented induced seismicity in geothermal engineering is still rather small. There was also a consensus that communication of EGS projects to the public, of their objectives, consequences, and benefits, must be trustworthy and reliable. For all to accept EGS there needs to be a solid technical basis that is understood by all.

Most of the workshop participants joined a field trip on October the 3rd to the Reykjanes peninsula. A opportunity was given to visit the Svartsengi power plant and a new geothermal power plant at Reykjanes. (Guides during the field trip were Haukur jÓhannesson , ÍSOR, and Guðmundur Ómar Friðleifsson at HS-orka which invited the participants to a lunch at the Blue Lagoon).

It was a general opinion that the GEISER workshop and in general the geothermal week was successful. Thank you all for the participation and thank you very much to the Icelandic host for their perfect organization.

More information such as the workshop material is available on the GEISER Web site, http://www.geiser-fp7.eu, meetings section.

The field trip bus drove participants
to the end of the Reykjanes peninsula
on the 3rd of October.
Picture courtesy to A. Genter.

Feed-back from the USA group

The U.S. DOE's Geothermal Technologies Program was represented at the October 2010 meeting by JoAnn Milliken (Acting Program Manager) and Jay Nathwani (Lead for Geothermal R&D and Demonstration). Additionally, several experts were selected from National Laboratories, the US Geological Society (USGS) and from the geothermal industry to co-lead breakout sessions with GEISER participants. This group included Ernie Majer of Lawrence Berkeley National Laboratory, Art McGarr of the USGS, Herb Wang of the

University of Wisconsin, Ann Robertson-Tait of GeothermEx , Mike Fehler of MIT and Bill Foxall of Lawrence Livermore National Laboratory. As a result of this meeting, it was generally agreed that: induced seismicity is a real but manageable risk, honest communication with stakeholders including access to data is essential, there is a need for both deterministic and probabilistic models, higher quality data are needed, and international collaborations should be strengthened.

Feed-back from the Australian group

The Australian geothermal sector was represented at the Reykjavik meeting by: Barry Goldstein – PIRSA, IEA GIA Executive Committee Vice Chairman and AGEG Chairman; Dr Anthony Budd – Geoscience Australia, Australian IPGT representative, and AGEG TIG leader for Information Management; Michael Malavazos – PIRSA, AGEG TIG leader for Induced Seismicity, and Australia's IPGT convenor for Induced Seismicity; Dr Betina Bendall – PIRSA, Australian representative to the IEA GIA and AGEG TIG leader for Outreach; David Love – PIRSA, seismologist; and Dr. David Jepsen – Geoscience Australia, geophysicist.

The Australian participants in the Reykjavik Workshop believe consensus has been reached amongst experts; industry and regulators should cooperate in the development of practical and predictably trustworthy models and methods to effectively manage risks of induced seismicity associated with geothermal energy projects.

Forthcoming meetings

GEISER WP3

WP3 participants will meet on 30-31 May, 2011 in Potsdam, Germany.
More information about contents and logistics will be available in the forthcoming weeks.
Should you have any question regarding that WP3 meeting, feel free to contact Arno Zang (zang@gfz-potsdam.de).

GEISER WP4

A WP4 meeting, focussed on WP4 topics and progress, is planned to be held in April, 2011 in Paris, France. This meeting is open to interested members from other work packages. Participants will get more information in the forthcoming weeks. Contact:
Xavier Rachez (x.rachez@brgm.fr).

GEISER WP5 & WP6

A joint GEISER WP5 & WP6 meeting will be held on 10 and 11 March, 2011 at the TNO premises in Utrecht, Princetonlaan 6, Utrecht, The Netherlands. The meeting will start at 10.30 h on Thursday and will end on 13.00 h on Friday.
Utrecht Central train station can be easily reached from Schiphol airport. Trains depart every 30 minutes and the the trip takes about 30 minutes. From the Central station partipants can either take bus or taxi.
The agenda for the meeting will be provided in due time.

The WP5 & WP6 meeting will be host at the TNO building in Utrecht (The Netherlands).

Please contact Alexander Kronimus (alexander.kronimus@tno.nl) for any questions or request you might have in relation to the WP5 & WP6 meeting.