4.5.4 Development of an Updated Induced Seismicity Protocol for the Application of Microearthquake (MEQ) Monitoring for Characterizing Enhanced Geothermal Systems

Presentation Number: 024
Investigator: Majer, Ernie (Lawrence Berkeley National Laboratory)
Objectives: To develop an updated protocol/best engineering practices to address public and industry issues associated with induced seismicity; to identify critical technology and research needs/approaches to advance the understanding of induced seismicity associated with deep well injection and production; and to perform community outreach and education.
Average Overall Score: 2.8/4.0

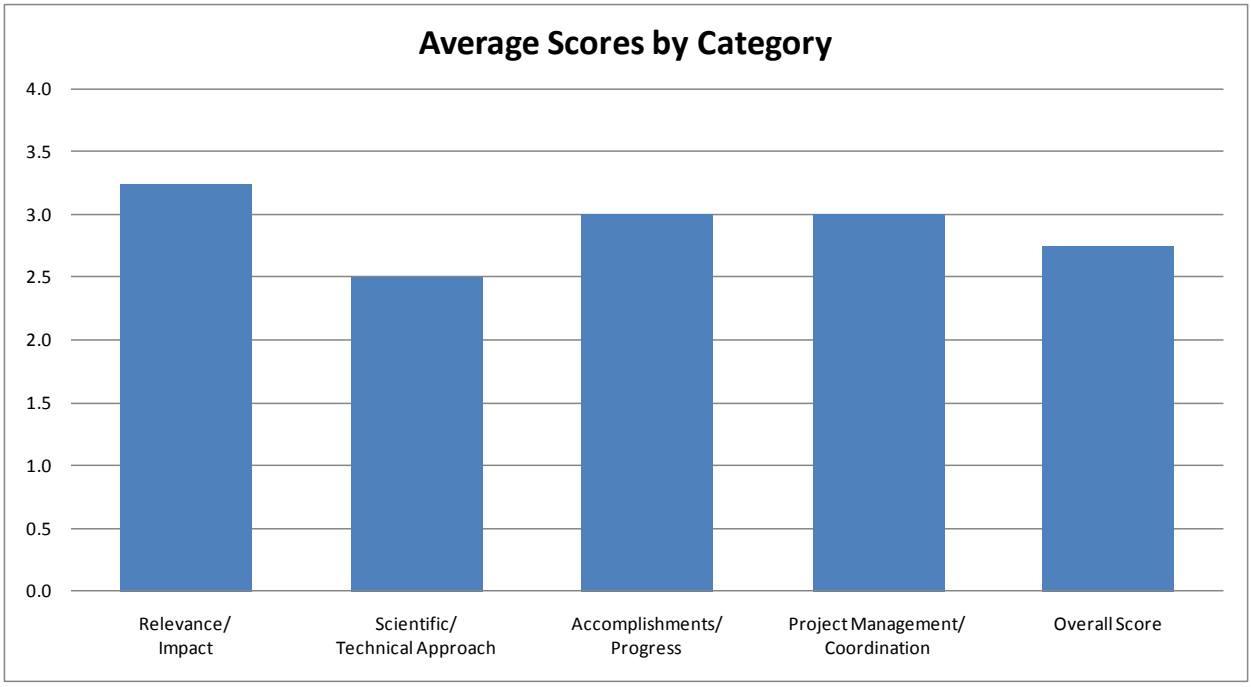

Figure 32: Development of an Updated Induced Seismicity Protocol for the Application of Microearthquake (MEQ) Monitoring for Characterizing Enhanced Geothermal Systems

4.5.4.1 Relevance/Impact of the Research

Ratings of Four-member Peer Review Panel: Good (3), Good (3), Outstanding (4), Good (3)

Supporting comments:

- The issue of induced seismicity is clearly paramount for geothermal operations, especially in or near populated areas. The use of best available science is necessary to address the associated risks. This project is developing guides and protocols to identify and evaluate seismic hazards associated with geothermal production through a series of workshops and discussions with a broader community. The problem is complicated by the fact that the occurrence of "natural"

earthquakes is far from being understood, and separation of "induced", "triggered" and "background" seismicity is not straightforward.

- The project seems to be important but I am not sure how this mission is best pursued and I was not convinced by the presentation that the direction is correct.

- This project is extremely important for DOE's goals. It has made excellent progress.

- This induced-seismicity protocol development project, if successfully completed, will make an extremely important contribution to the Geothermal Program EGS mission. The project activities will enable approaches to barriers, such as, siting, leasing, and permitting issues and technical barriers such as reservoir validation. If this project is successfully completed, this reviewer is certain that the EGS program will benefit and that the results will surely enable future EGS projects.

4.5.4.2 Scientific/Technical Approach

Ratings of Four-member Peer Review Panel: Good (3), Fair (2), Fair (2), Good (3)

Supporting comments:

- Issues of induced seismicity are not new, and general relationship between fluid injection and earthquakes is fairly well understood in the context of the effective stress and the Mohr-Coulomb failure theory. The goal of "mitigation" of seismic risks due to fluid injection is, however, rather tenuous. It is not clear what is meant by "mitigation". Fluid injection is known to stimulate seismic activity, and the level of that activity depends on a local tectonic regime.

- They need a sociologist on the project to try to estimate if the connection between the stated goals and progress towards achieving those goals is actually converging. Has there been a real raising of awareness by the public? How can one know if the goals are being achieved? By what measure can we know if the connection to the public is being made?

- Here is where I am concerned: this project seems to assume that the scientists and engineers are capable of determining, and will determine, just what it is that the public needs, and then will engage the public in forums where the scientists and engineers will tell them what they have been determined to need to know. This is the wrong approach. While scientists and engineers need to get their house in order, and this project is accomplishing this goal extremely well, at some point PRIOR to issuing protocols, there must be a genuine ENGAGEMENT in DIALOG with the social scientists, public figures, land-use planners, insurance companies, emergency management planners and first responders, and so on. Only through this dialog will we be able to ensure that appropriate aspects are incorporated, from the end-user's point of view, and the end-users are the companies involved and the public they deal with. The

investigators seem to think that the end users are the scientists who will then explain this stuff to the ignorant masses. That approach will not work well.

- The overall technical approach is good. Developing an induced seismicity protocol and identifying R&D needs is probably the most important project that needs to be done or otherwise EGS is doomed. It looks like there are adequate resources and more than sufficient scientific rigor of the work elements, procedures and methods that, if followed, will achieve the project objectives. The design of the project is straightforward and deemed reasonable and the technical approach is adequately described and clearly laid-out in the tasks provided and in the project timeline.

4.5.4.3 Accomplishments, Expected Outcomes and Progress

Ratings of Four-member Peer Review Panel: Fair (2), Fair (2), Outstanding (4), Outstanding (4)

Supporting comments:

- There is a need for a deeper and broader involvement and education of the general public in this process.

- Meetings were convened and protocols were discussed but I could not figure out how they would tell if they were progressing.

- The team has been extremely productive and efficient.

- The overall quality of the research team, equipment and facilities is outstanding given the PI and list of participants. Many of the participants are known to this reviewer and are world-class. Relevant experience and the balance of appropriate skills of the remainder of the participants are very good. There are several accomplishments to date, the results look promising, and the project seems to be on schedule. I was not able to ascertain the accomplishments as compared to costs to date since current costing was not given.

4.5.4.4 Project Management/Coordination

Ratings of Four-member Peer Review Panel: Good (3), Good (3), Good (3), Good (3)

Supporting comments:

- The PIs were fairly effective in organizing workshops, establishing a dedicated website and building a scientific community (both in the US and internationally) to address the project goals.

- Management seems to be reasonable. More interaction with the public may be useful. Perhaps a means to assess progress would be helpful too.

- This is difficult to judge. The project seems to be managed well.

- The technical, policy, business, and spend plans for the project are well thought-out, make sense and are, at least logistically on track. At the panel review a reviewer recommended greater public interaction and this reviewer agrees. Moreover, in this reviewer's experience as Superfund manager at LLNL for 10 years, experts cannot tell the public what needs to be done, the experts need to listen to the concerns of the public and address those concerns directly and in person, otherwise, this will not convince them the induced-seismicity is not a problem.

4.5.4.5 Overall

Ratings of Four-member Peer Review Panel: Good (3), Fair (2), Good (3), Good (3)

Supporting comments:

- Development of a science-based protocol and/or engineering guide for dealing with induced seismicity issues is critical for a successful operation of a geothermal plant. This project provides a necessary framework for developing such a protocol, although some issues (such as the mitigation strategy and procedures for interaction with the general public) need to be addressed in a more explicit fashion.

- I could not understand how the progress of this project was going to lead to a deeper understanding of the mission as stated.

- For accomplishing a forum of scientists and engineers to discuss technical issues, this project has been amazing and the best in the world. For accomplishing the goal of evaluating needs of the public and trying to meet those needs, it is falling short due to the lack of engagement of non-scientists.

- Overall, this reviewer enthusiastically recommends that the project proceed with the modification of increased public interaction. In the reviewer's opinion this project must be successful if EGS is going to move forward and should be funded as a high-priority project if funds are limited.

4.5.4.6 PI Response

No response.