

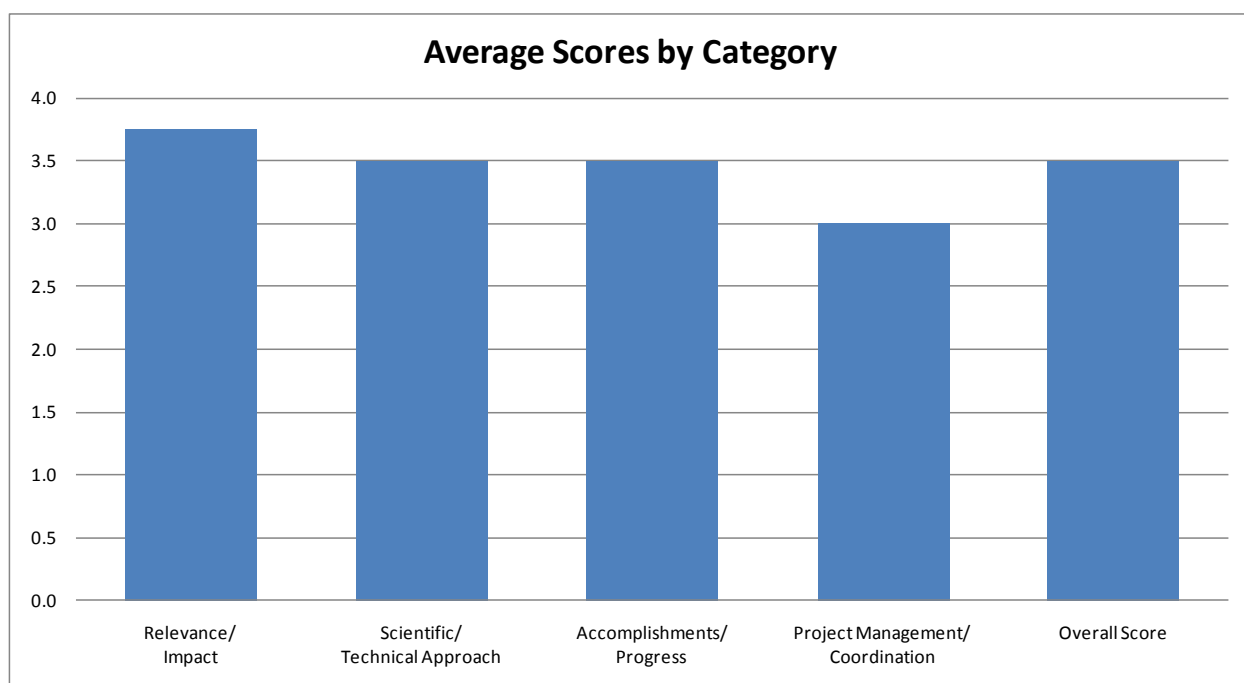
### 4.5.3 Microseismic Study with LBNL - Monitoring the Effect of Injection of Fluids from the Lake County Pipeline on Seismicity at The Geysers, California, Geothermal Field

**Presentation Number:** 023

**Investigator:** Majer, Ernie (Lake County)

**Objectives:** Upgrade and continue operation of a high resolution seismic array for five years at The Geysers as well as expand the array to record seismicity from any new additional DOE EGS sites at The Geysers as they come on line; to use microearthquake monitoring to understand and intelligently manage the effects of fluid injections and stimulations to aid in the optimization of EGS.

**Average Overall Score:** 3.5/4.0



**Figure 31: Microseismic Study with LBNL – Monitoring the Effects of Injection of Fluids from the Lake County Pipeline on Seismicity at The Geysers, California, Geothermal Field**

#### 4.5.3.1 Relevance/Impact of the Research

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

**Supporting comments:**

- The first phase of the project was to upgrade the existing seismic network at The Geysers geothermal field in northern California, including an addition of 6 new stations, and strong motion instruments. The instrument deployment seems to be on track.

- The seismic array at The Geysers is critical to our understanding of geothermal processes. We must support this work and use The Geysers as a laboratory for comparison with all other studies of seismicity in geothermal settings.
- This project is essential. But it is not really RESEARCH in a basic sense, nor will it create new information except for details of one site. It does, however, demonstrate an excellent way to deal with public perceptions and to maintain baseline monitoring for EGS studies. It is an excellent demonstration project.
- This microseismic injection-monitoring R&D project at The Geysers, if successfully completed, will make a very important contribution to the Geothermal Program mission. The project activities could solve known technical barriers, such as reservoir validation, scale up, and long-term sustainability as well as illuminate scientific issues including how fractures migrate when fracturing the rock and under what conditions. If this project is successfully completed, this reviewer is confident that the EGS program will benefit and that the results will surely add to the knowledge base.

#### ***4.5.3.2 Scientific/Technical Approach***

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

#### **Supporting comments:**

- Analysis of high-quality seismic data from a large active production site are clearly warranted for better understanding of the nature of injection-related seismicity. The PI team is capable of performing the tasks outlined in the proposal.
- I did not see significant "new" technical innovations in the technical report. Hypocenter locations were shown, although little discussion of the error or variation over time was discussed. What is the meaning of the donut hole in seismicity? How did earlier seismicity maps show that region? I would have expected to see some of that information presented if the researchers are going to focus on that as a major goal of this research.
- The approach is excellent, but there should also be a Broadband instrument (or two or three) involved.
- The overall technical approach is outstanding. Monitoring, locating and performing MEQ source mechanism calculations and correlating these with The Geysers injection/production data are very exciting and important tasks. 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.

#### ***4.5.3.3 Accomplishments, Expected Outcomes and Progress***

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

##### **Supporting comments:**

- The project is in the initial stages, so little data are available for analysis and evaluation. The data that do exist clearly show a causal relationship between the injection rates and the overall seismic activity. Further work will refine the spatiotemporal patterns of the induced seismicity and geothermal production.
- Still too early to know what the results of this effort are going to be.
- The team is amazingly productive and focused.
- The overall quality of the research team, equipment and facilities is outstanding given the PI and list of partners. Many of the researchers are known to this reviewer and are top-notch. Relevant experience and the balance of appropriate skills of the remainder of the research team seem to be very good. There are several accomplishments to date, the results look promising, and the project is, according to my rough calculations, on schedule (10% scope done so far in 0.6 years out of a total of 5 years or 13% schedule consumed = behind schedule by 3%). I was not able to ascertain the accomplishments as compared to costs to date since current costing was not given.

#### ***4.5.3.4 Project Management/Coordination***

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

##### **Supporting comments:**

- The project involves a productive collaboration between seismologists at Livermore and UC Berkeley. The work plan is carefully outlined and so far appears to be executed in a timely manner.
- I am not sure - there were many unanswered questions - the lead PI was not here and the presenter could not answer some of the critical questions.
- It is difficult to judge the project management. The PI was unable to present, and the presenter was unfamiliar with some aspects. Perhaps the rating should be higher, or perhaps lower; I cannot really tell.
- The technical, policy, business, and spend plans for the project are well thought-out, make sense and are, at least logistically, on track. However, project decisions points were not discussed.

#### **4.5.3.5 Overall**

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

#### **Supporting comments:**

- The Geysers is an excellent target for understanding relationships between the induced seismicity and geothermal production. This project will provide important insights into our understanding of microearthquakes, as well as potential for larger events, in an actively developed geothermal field (largest in the US).
- Overall the project is progressing in a reasonable manner. I strongly support the continuation of The Geysers project.
- This project is an excellent demonstration project, accomplishing (apparently) all that it set out to do.
- Overall, this reviewer enthusiastically recommends that the project proceed ahead. In the reviewers opinion this project is one of the best in all the projects reviewed and should be funded as a high-priority project if funds are limited. This microseismic injection-monitoring R&D project at The Geysers will solve known technical barriers that should provide insightful data and information to the EGS program.

#### **4.5.3.6 PI Response**

No response.