Development of microBayesloc Location Method

Award Number: FWP-FEW0193

Project Summary:

The main objective of this project was to characterize the temporal, spatial, and source-property evolution of the microseismicity associated with the stimulations at the Newberry EGS. An adaptation of Google's PageRank method to cluster the microseismic events in the catalog was used for data analysis. Cross-correlation was then used to compute differential arrival times of seismic phases associated to each event in a cluster to determine precise event relocations. Event relocations were determined using a modified version of Bayesloc, which incorporates differential-time measurements into a multiple-event location algorithm. Adding this extra information into the location scheme results in a more robust analysis, more accurate event locations, and improved microseismic characterization. After relocation, fault orientation and slip direction (focal mechanisms) were determined.

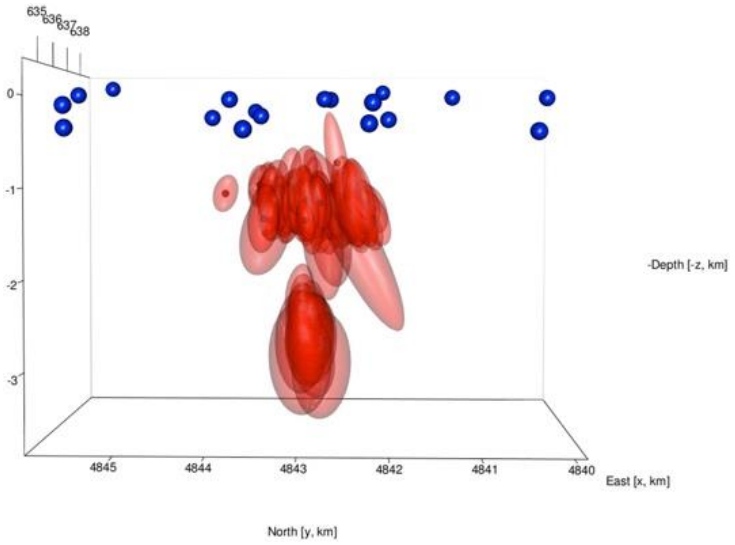

Figure 1: In the field, seismic sensors, indicated by the blue circles in the figure, are used to measure microseismic events and infer location. The microBayesloc algorithm produces an estimate of location uncertainty, an essential feature to help distinguish real from phantom faults. MicroBayesloc-determined microseismic event location uncertainty estimates are indicated by the red ellipsoid clouds.

Prime Performer:
Lawrence Livermore National Laboratory

Principal Investigator:
Stephen Myers

Project Duration:
10/01/2014 – 09/30/2017

Performer Location:
Livermore, California

Field Sites:
Frontier Observatory for Research in Geothermal Energy (FORGE) - Milford, Utah

Newberry Enhanced Geothermal System (EGS) Site - Oregon

Program:
Carbon Transport & Storage

Project Outcomes:

1) Relocations of Newberry microseismicity outline distinct faults, as opposed to nondescript clouds of seismicity that are reported in published event catalogs.
2) Hydroshearing during the 2014 stimulation affected a smaller fracture network than previously thought, which is consistent with the limited increase in fluid flow after the stimulation.
    a. The cloud of seismicity listed in a published 2014 catalog defines a volume of approximately 0.5712 km^3.
    b. The summed volume encompassing each of the relocated event clusters in our study is 0.014 km^3, over an order of magnitude smaller in volume.
3) Focal mechanisms determined in this study, combined with published assessments of regional stress, suggest that stresses generated by stimulation worked against ambient tectonic stress. As a result, far greater fluid injection pressure was needed to generate seismicity and the resulting fracture network was smaller in volume than anticipated.