

FINAL REPORT

**EVALUATIONS OF INDUCED SEISMICITY /
SEISMIC HAZARDS AND RISK**

**FOR THE
NEWBERRY VOLCANO EGS DEMONSTRATION**

Prepared for
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AltaRock Energy Inc., as part of the Newberry Volcano Engineered Geothermal System (EGS) Demonstration Project, will develop an EGS reservoir in the high temperature, low permeability rock on the northwest flank of Newberry Volcano. AltaRock intends to quantitatively demonstrate that hydroshearing techniques can successfully induce and sustain fluid flow and heat extraction from one injection well and two production wells for the conceptual design of a commercial-scale wellfield and power plant.

In the first phase of the project, we have evaluated the potential EGS induced seismicity and seismic hazards in the Project Area and analyzed the seismic risk as part of the submittal of an environmental document to the governing regulatory agencies and stakeholders. The specific objectives of the study are to: (1) evaluate the baseline seismic hazards in the Project Area including at La Pine, the closest community to the site; (2) estimate the potential increase in seismicity rate and the maximum magnitude of an earthquake induced by the hydroshearing in the injection well NGC 55-29; and (3) evaluate the increased seismic risk imposed by the hydroshearing activities.

A priori estimates of the maximum induced earthquake and the rate of seismicity that might occur due to EGS activities at Newberry Volcano are difficult to predict prior to the undertaking of site-specific investigations including seismic monitoring and subsurface imaging of the pre-existing fault and fracture pattern in the affected rock volume. As a first-order characterization, estimates can be made based on global case histories of other EGS projects preferably in similar geologic and tectonic settings. Based on this approach, an upper-bound range of maximum magnitudes ranging from moment magnitude (**M**) 3.5 to 4.0 has been incorporated into the hazard analysis. A probably conservative range of rates of activity has been considered in the hazard analysis adopted from the observed induced seismicity at The Geysers, California.

The Project Area in central Oregon is characterized by a moderate level of tectonic and volcanic activity with a number of active faults and a low to moderate level of historical seismicity. In the probabilistic seismic hazard analysis performed in this study, active faults, volcanic sources of seismicity, and regional seismic source zones for background earthquakes were included. This included two local seismic sources associated with Newberry Volcano. The results of the probabilistic seismic hazard analysis indicate that there is no difference in hazard at La Pine, Sunriver, and the Project site (NGC 55-29) between the baseline conditions (which incorporates the hazard from both natural tectonic and volcanic seismicity) and the EGS induced seismicity. As a result, potential EGS induced seismicity poses no seismic risk to the residents in the neighboring communities.

Although there is no additional seismic risk due to EGS induced earthquakes, if events of **M** 3.0 and higher were to occur, and we judge the likelihood of their occurrence to be small, they will probably be felt in La Pine and Sunriver, but not at damaging levels of ground motions (> 0.10 g). Individual residents within 10 km of the Project site will feel the larger events. The strength of shaking will depend on the size of the event, and distance to and site conditions at each location. The effects of induced seismicity will be more of a nuisance than a hazard to the vast majority of local residents because of the small size of the events and distances to centers of population.