Detection of earthquakes at geothermal fields by Distributed Acoustic Sensing Arrays using beamforming

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ABSTRACT

Distributed Acoustic Sensing (DAS) has considerably advanced our capability to continuously record seismic waves over distances of tens of kilometers at meter-scale resolution for long periods of time using fiber-optic cables. Existing, unused fiber-optic cables deployed as part of regional telecommunication infrastructure (dark fiber) near geothermal fields can be leveraged for improved detection of small earthquakes occurring as part of background seismicity or in response to injection/production activities at the geothermal fields. We develop and test a methodology for detection of earthquakes occurring at The Geysers geothermal field, Northern California using data recorded by a DAS array as part of the LBNL FOSSA experiment in the Sacramento basin, California. The array consists of~22 km of dark fiber between the cities of Sacramento and Woodland. We apply phase-coherence weighted beamforming to increase signal-to-noise ratio of surface-waves from cataloged earthquakes in the frequency range 0.5-1.0 Hz. This technique is applied to ~1 km long sub-arrays sampled at 2 m. Sub-arrays of different orientations can be used to constrain the azimuth of the seismic waves to the direction of the geothermal field. While the DAS array is ~100 km away from the geothermal field, beamforming enables the detection of seismic waves from earthquakes down to magnitude ~2.2. We compare the resulting waveforms with waveforms from a nearby temporary broadband seismometer. We further apply the methodology to new DAS data collected on a dark fiber profile between Calipatria and Imperial in the Imperial Valley, Southern California. We show preliminary results for earthquakes occurring in the Brawley and Salton Sea geothermal fields.