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Microearthquake characterisation of an artificially stimulated hydraulic fracture at the Coso geothermal area, California

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The Coso geothermal area, California, has produced hot water and steam for electricity generation for more than 20 years, during which time intense microearthquake activity has occurred in the area, much of it induced by geothermal production. The seismicity is monitored by a high-quality permanent network of three-component digital borehole seismometers operated by the US Navy and supplemented by a ~ 14-station portable array of surface three-component digital instruments. The purpose of the portable stations is to improve seismic monitoring around wells in which fluid injection/hydrofracturing experiments are conducted. The first injection experiment was conducted in well 34-9RD2, on the East Flank of the Coso geothermal area. This well was re-drilled February – March 2005 with the intention of hydrofracturing it by injecting fluids under pressure. Instead, natural fractures were encountered at about 2,660 m depth. Drilling muds entered the fractures, obviating the need to stimulate the well. These mud losses induced a 50-minute swarm of 44 microearthquakes, with magnitudes in the range -0.3 to 2.6. Most of the largest microearthquakes occurred in the first 2 minutes. Accurate relative relocations and moment tensors for the best-recorded subset reveal fine details of the fracture stimulated. This comprised a fault striking at N 20 deg E and dipping at 75 deg to the WNW, which propagated to the NNE and upward. Co-injection focal mechanisms reveal combined crack-opening and shear motion. Stress release and mode of failure differed between the pre-, co- and post-swarm periods. Some post-swarm events involved cavity collapse, suggesting that some of the cavities opened by the fluid injection were quickly closed. Stress and mode of failure had not returned to pre-swarm conditions within 1 month following the injection, posing the question of how long stress perturbations persist following a stimulation experiment. This question may be answered by processing data spanning a longer post-injection period, work that is currently in hand and will be reported in this presentation. We will also report on progress in developing a Graphical User Interface to facilitate deriving moment tensors from microearthquakes using amplitude ratios.