Microseismic event relocation based on PageRank linkage at the Newberry Volcano Geothermal Site

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The Newberry Volcano has been stimulated two times using high-pressure fluid injection to study Enhanced Geothermal Systems technology. Several hundred microseismic events were generated during the first stimulation in the fall of 2012, showing events in two distinct depth ranges where microseismicity does not clearly outline subsurface structures due to large event location uncertainties (Foulger and Julian, 2013). From this stimulation we explore the spatial and temporal development of microseismicity, which is key to understanding how it modifies stress, fractures rock, and increases permeability. We use an application of Google's PageRank (Aguiar and Beroza, 2014) to assess signal-correlation topology for the micro-earthquakes. We create signal families and compare these to the spatial and temporal proximity of associated earthquakes. We relocate events within families using the Bayesloc approach (Myers *et al*., 2007) which show tight spatial clustering of event families, as well as changes in cluster affiliation for some events. We also find that signal similarity (linkage) at several stations, not just one or two, is needed in order to confidently determine that events are in close proximity to one another, suggesting the importance of good seismic station coverage. We show that indirect linkage of signals using PageRank is a reliable way to increase the number of events confidently determined to be similar to one another, suggesting an efficient and effective grouping of earthquakes with similar physical characteristics (ie. location, focal mechanism, stress drop). We will apply this analysis to the stimulation performed in 2014 and compare the results to clusters found in the initial stimulation. This will allow us to determine whether changes in the state of stress and/or changes in the generation of subsurface fracture networks can be detected using PageRank topology as well as aid in the event relocation to obtain more accurate subsurface structure. *Prepared by LLNL under Contract DE-AC52-07NA27344. LLNL-ABS-717421*