

## Complex Fault Structure Studies with Improved Earthquake Catalogs near the San Andreas Fault Observatory at Depth Borehole Array

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Increasing data volumes and waveform quality in recent seismic data acquisition efforts have underscored the utility of efficient and effective processing methods that require minimal operator direction. Higher quality data, combined with repeatable and automated event identification methods, will yield more complete earthquake catalogs, which provide a better picture of the subsurface fault structure. The San Andreas Fault Observatory at Depth (SAFOD) borehole was an EarthScope opportunity to explore the complex fault structure along the Parkfield segment of the SAF, an area where M6 earthquakes can frequently occur. This borehole was surrounded by surface seismic networks including the High Resolution Seismic Network (HRSN) and Parkfield Telemetered Array (PASO, PASO-2, PASO-3; *Thurber et al*, 2007) as well as the Northern California Seismic Network (NCSN).

From 29 April to 11 May 2005, Paulsson Geophysical Services (PGS) deployed a vertical seismic profile (VSP) array consisting of 80 three-component geophones in the SAFOD borehole in order to record active source shots and earthquakes. PGS placed the VSP array within the inclined portion of the SAFOD borehole at a depth interval between 878-1703 m below sea level (~1500-2000 m deep). The VSP sensors continuously recorded seismic data at 0.25 ms (4 MHz) and were spaced at 15.2 m (50 ft) along the length of the array, for a total length of ~1200 m.

In this work, we apply an automated waveform cross-correlation technique to waveforms recorded by the extended downhole geophone deployment at SAFOD and other nearby surface and borehole stations. Initially, we apply this template matching technique to waveforms recorded by HRSN and PASO stations, drawing templates from the relocated earthquake catalog compiled by *Waldhauser and Schaff* [2008]. An initial catalog of 100 earthquakes produced by PGS outlines three main fault strands, which is consistent with the inferred fault geometry at SAFOD.

We have applied a template matching technique to the surface array data, and initial results appear to have detected a number of events in excess of the 100 in the PGS catalog. Continued review of the template matching results will augment the size and resolution of our catalog of the time period in question, and will help with the understanding of the earthquake clustering behavior along the Parkfield segment of the SAF.