Improved Detection of Earthquake Signals Using Empirical Matched Field Processing

CASIS Workshop

May 22, 2013

Dennise C. Templeton, David B. Harris, Jingbo Wang

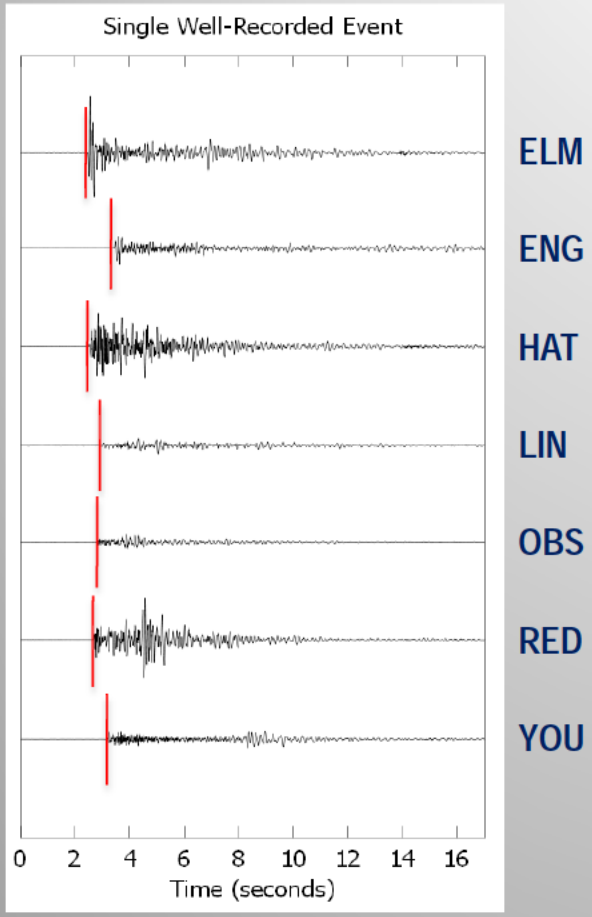
Lawrence Livermore National Laboratory

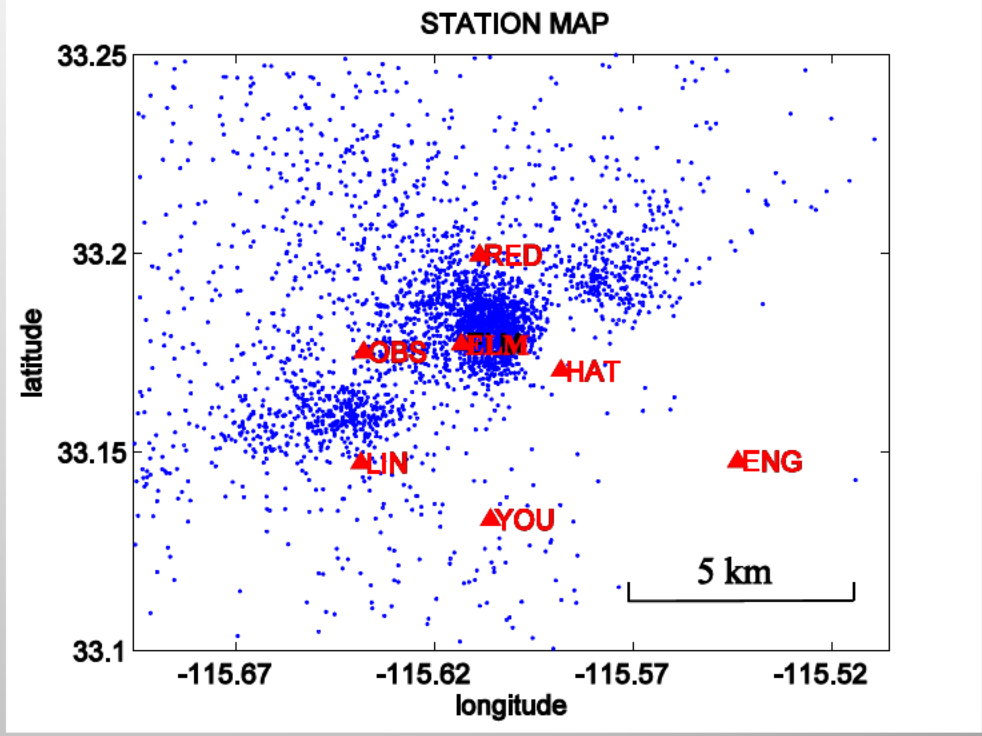
LLNL-PRES-637039

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344. Lawrence Livermore National Security, LLC

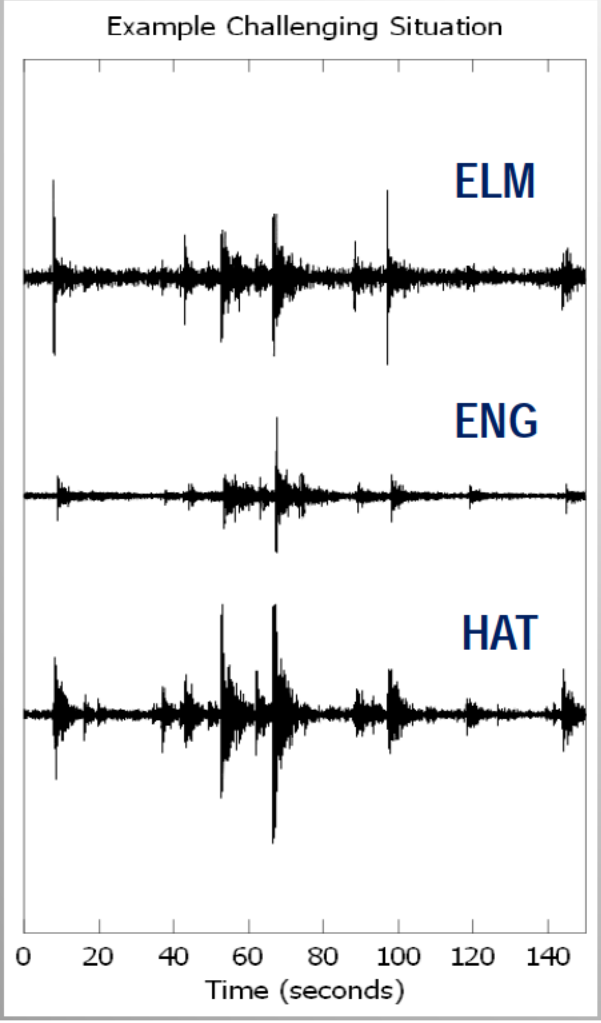
Source of Seismic Signals

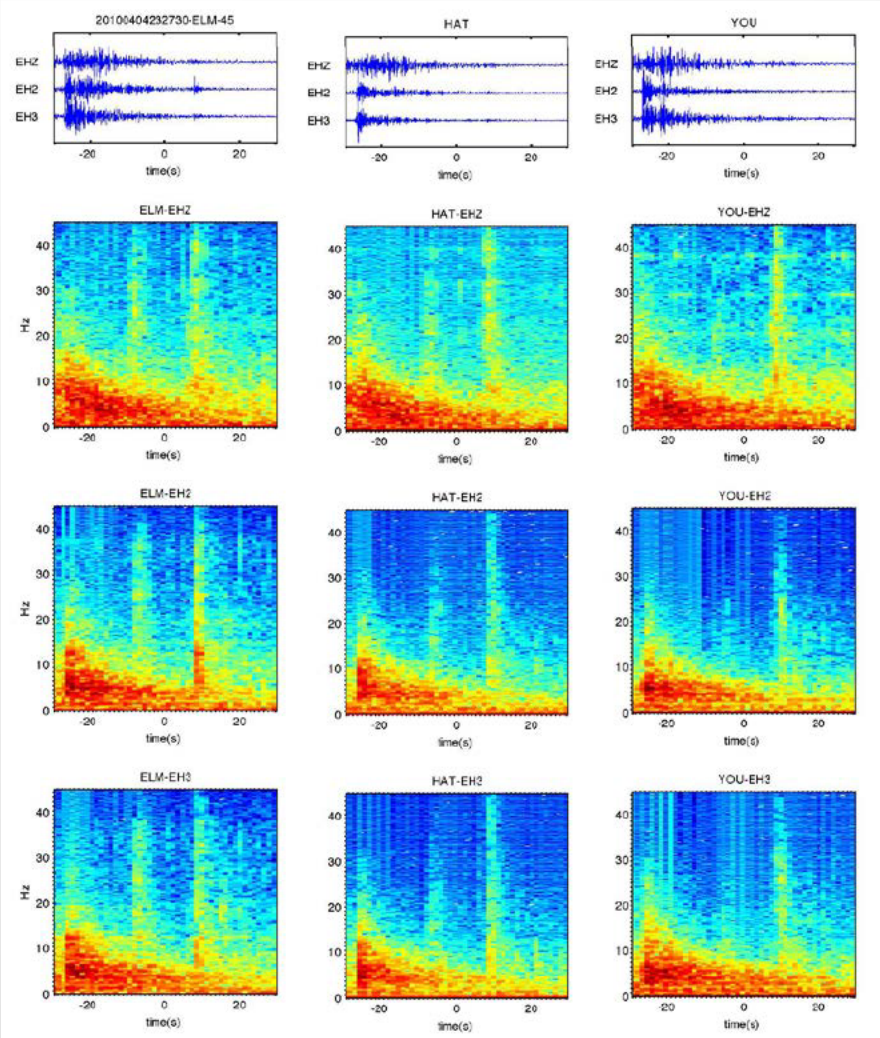
Earthquake Recording: Ideal Example





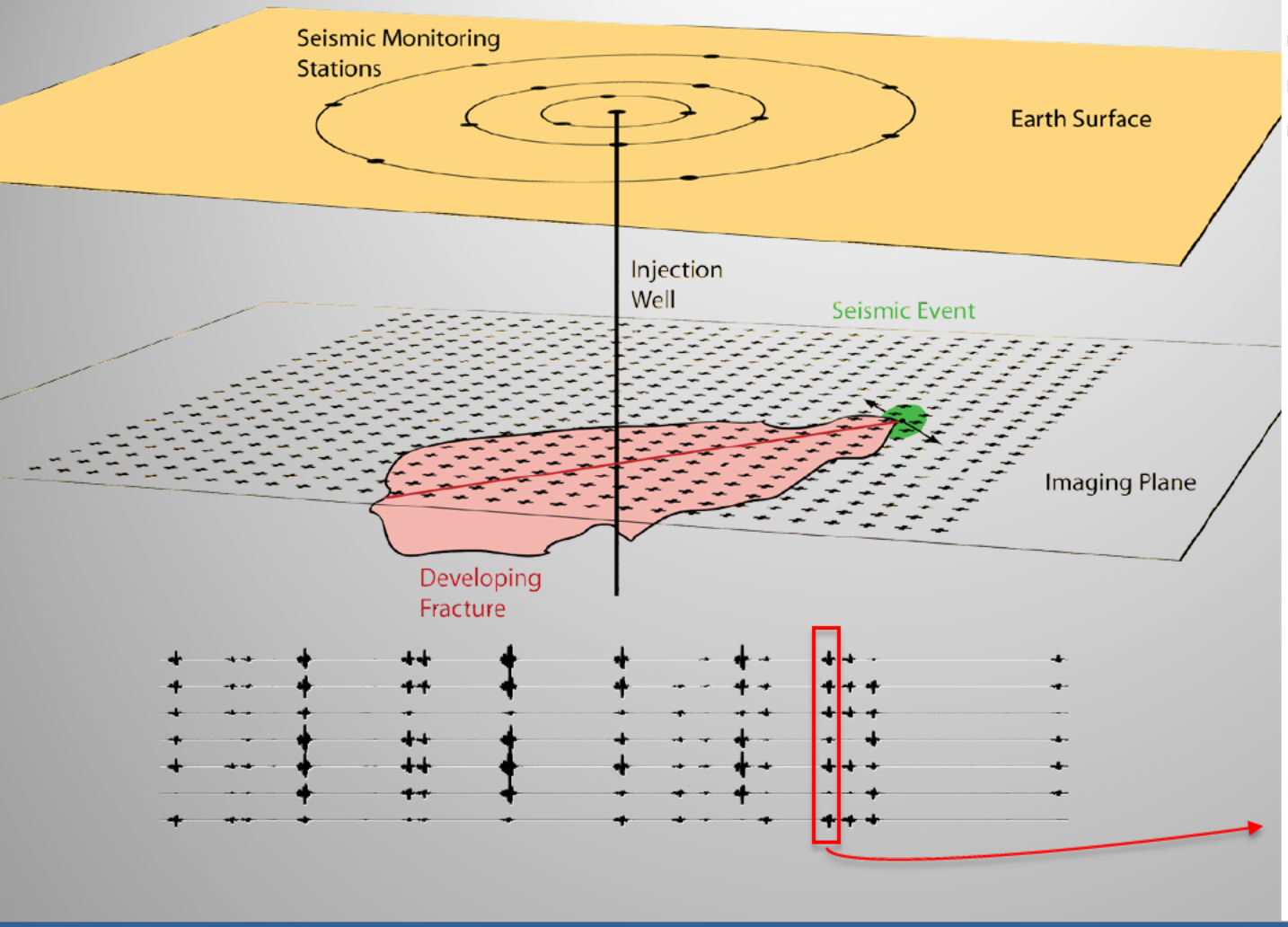
Earthquake Recordings: Challenging Examples

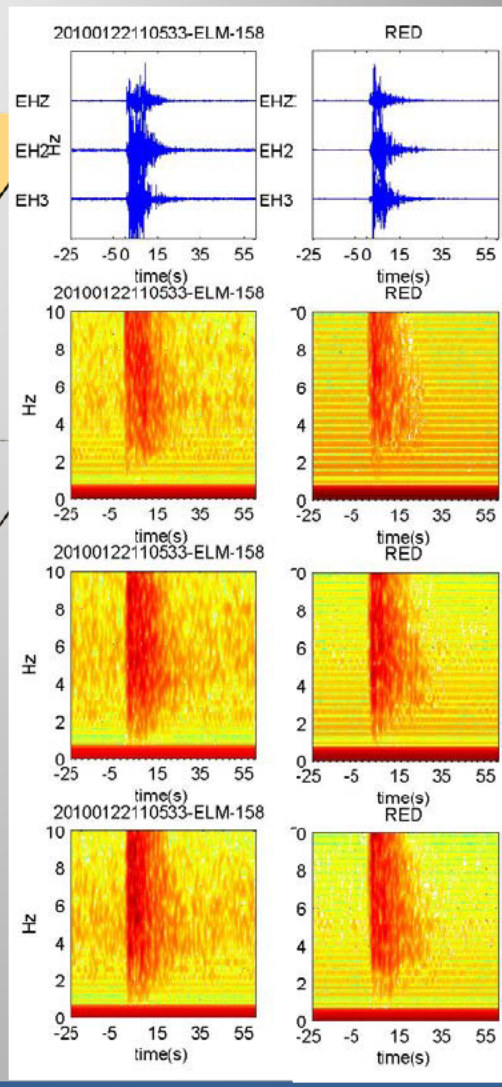




Matched Field Processing

Master Event

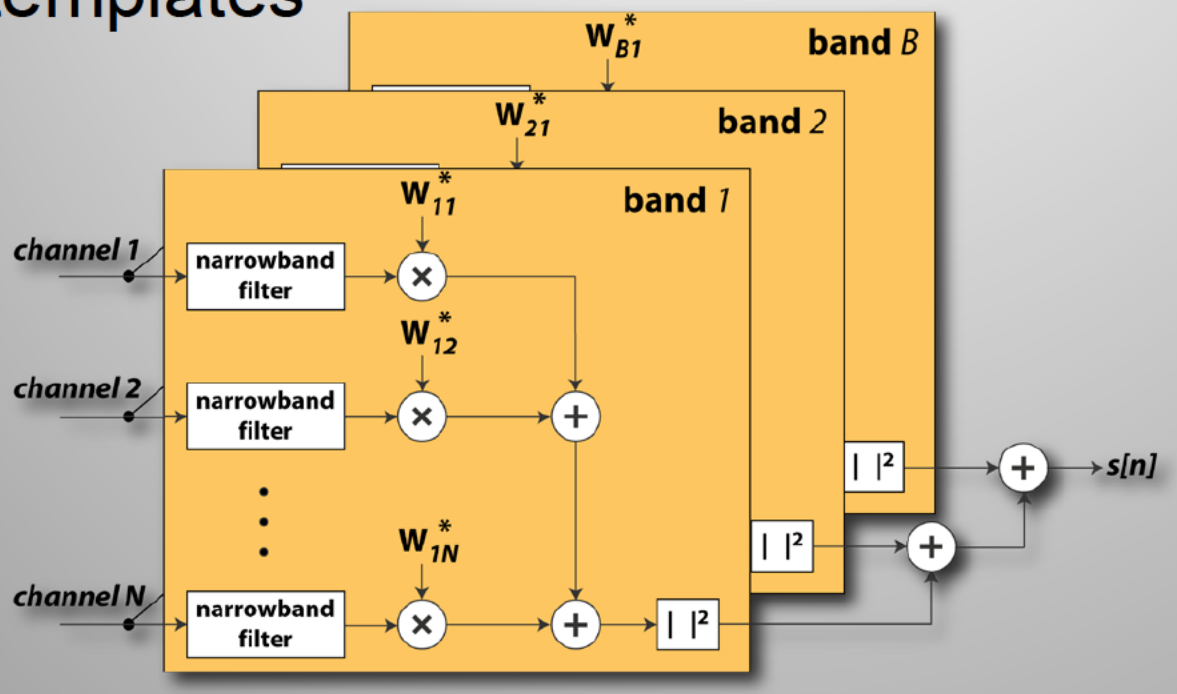


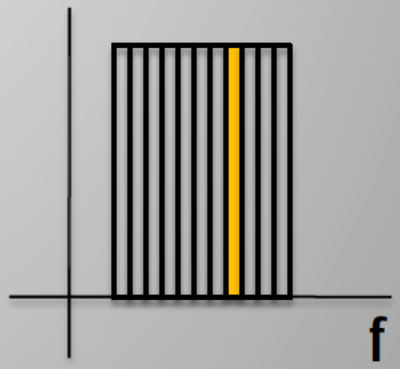


Cartoon of Matched Field Processing Theory

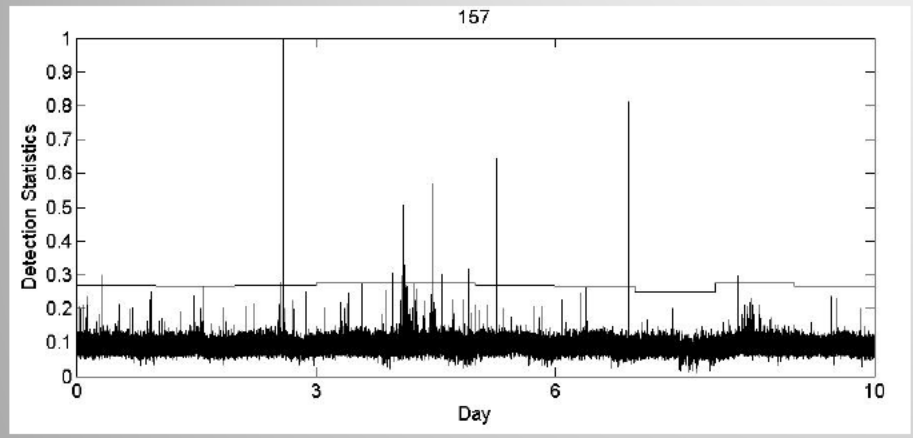
Comparing Master Templates to Continuous Seismic Data

- Compare amplitude and phase of continuous seismic data to pre-computed wavefield templates



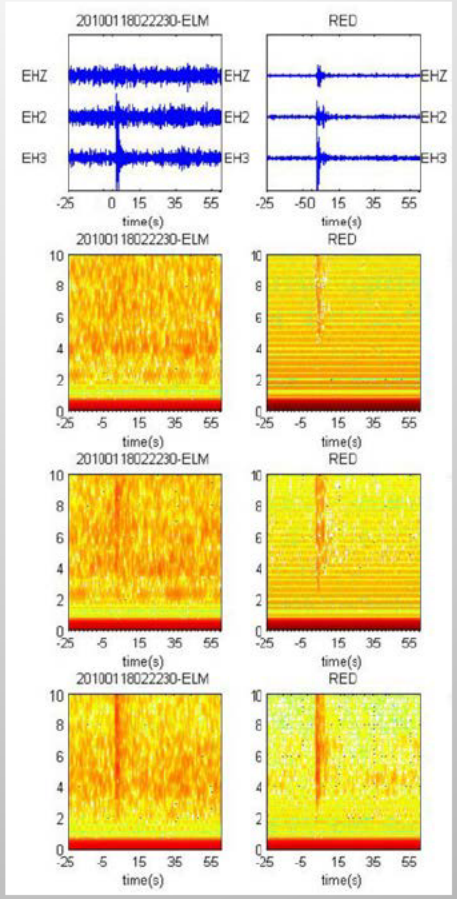


Detection Statistic and Verification

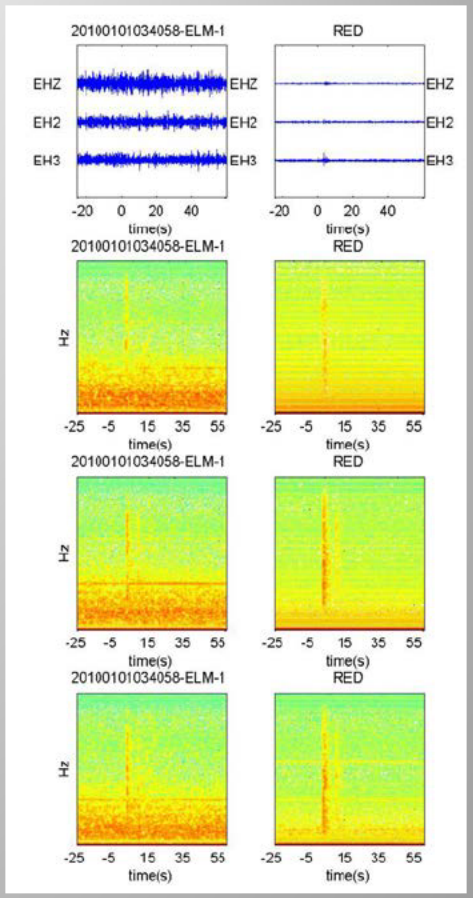


Detection Statistic values for a single master events over a 10 day period.

New Event A

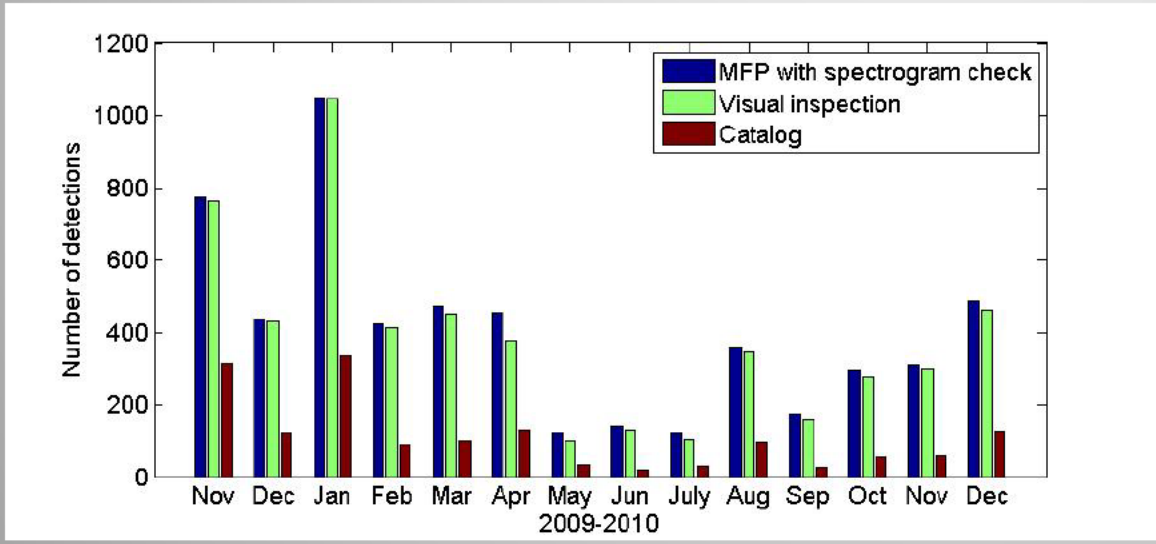


New Event B

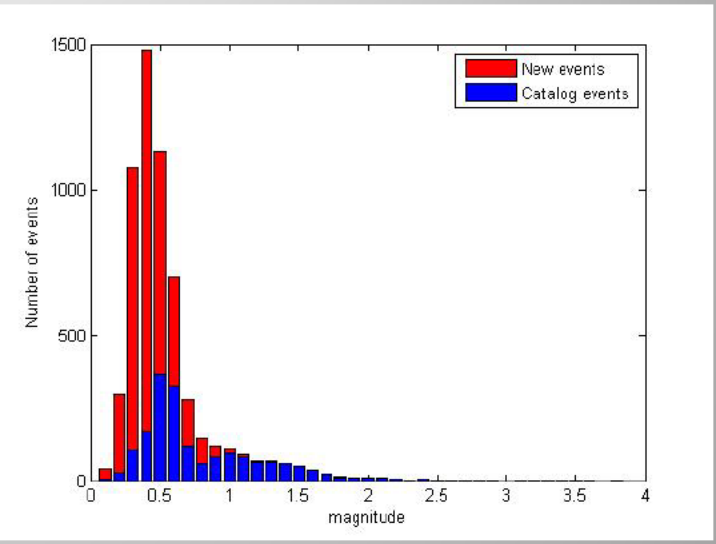


Verification of New Events

Comparison of New Events with Catalog Events: Salton Sea

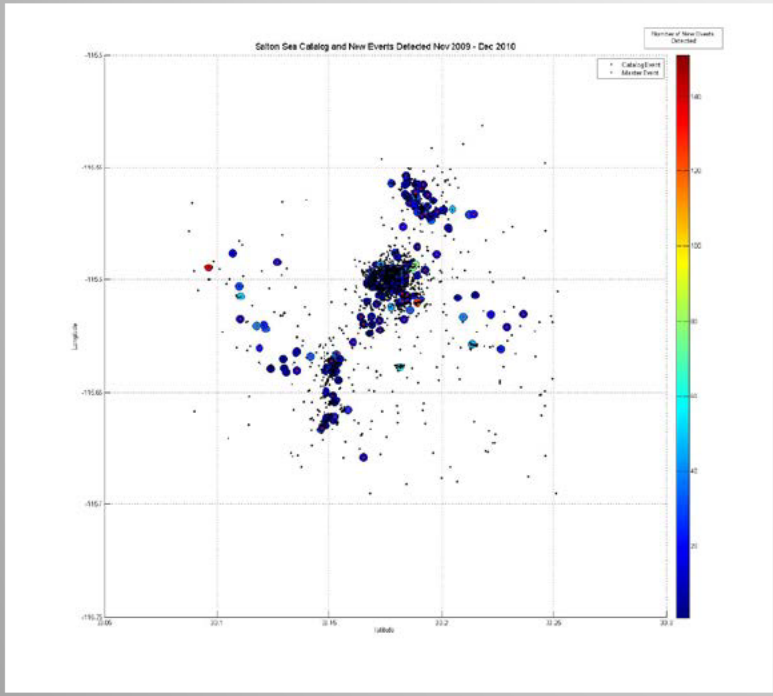


Comparing Number of Events Through Time

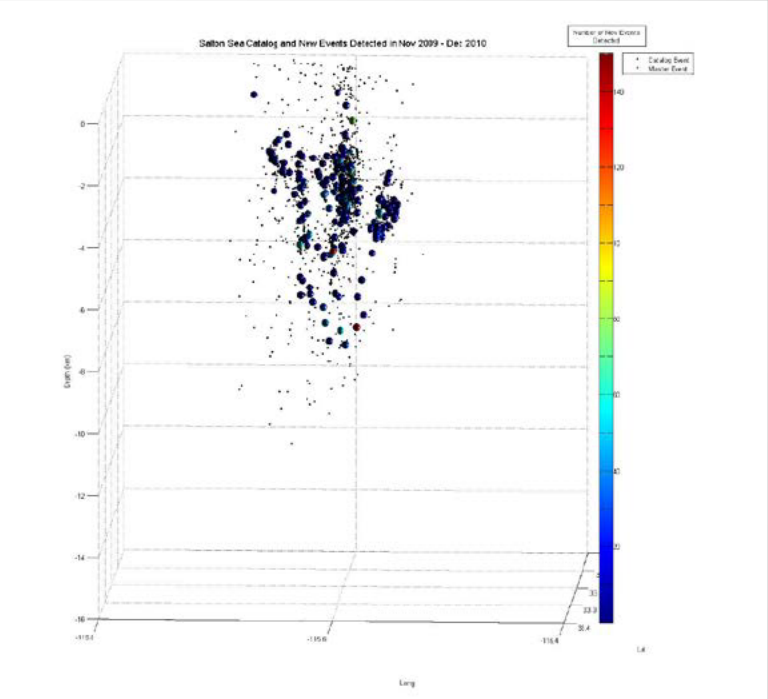


Comparing Size of Events

Location of New Events

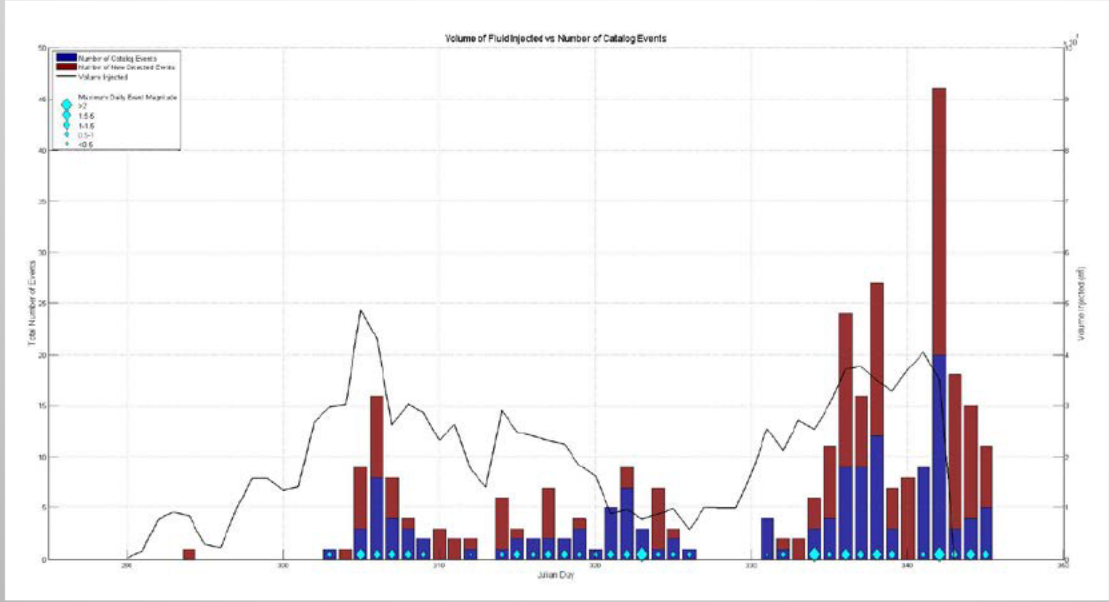


Map View



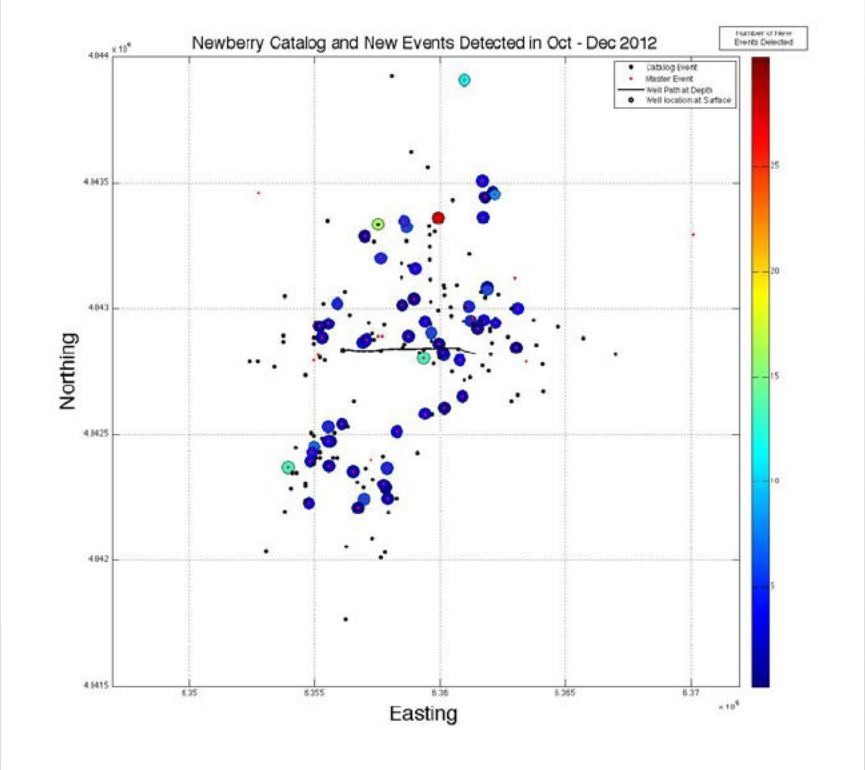
Depth View

Comparison of New Events With Catalog Events: Newberry EGS

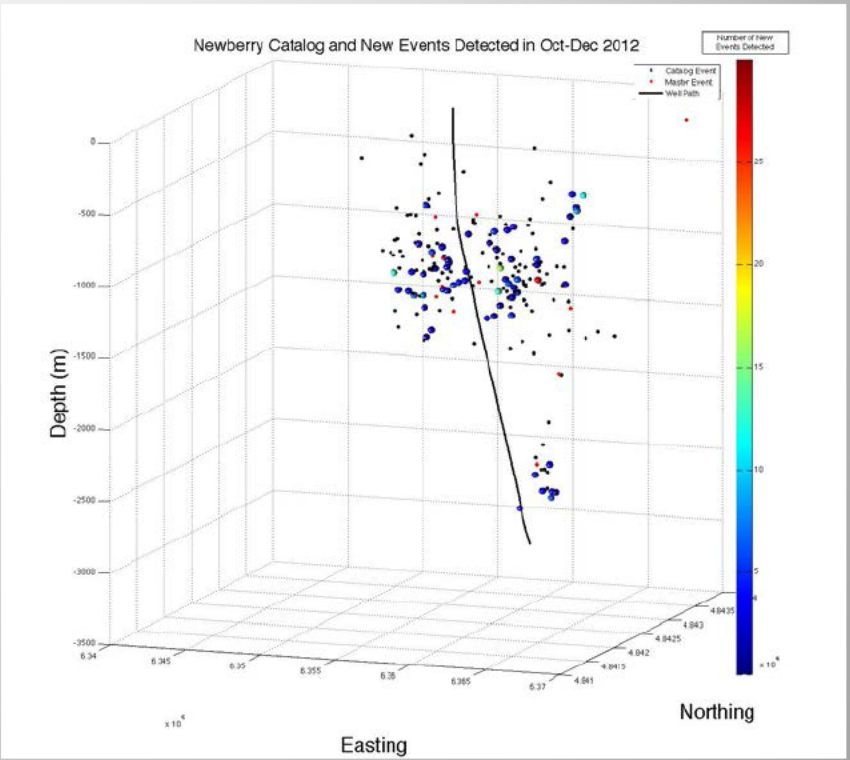


Comparing Number of Events Though Time With Fluid Injection Data

Location of New Events: Newberry



Map View



Depth View

Conclusions

- Empirical MFP can detect more seismic events than using only conventional earthquake detection techniques.
  - 250% more events at Salton Sea Geothermal Field
  - 115% more events at Newberry EGS site
- Can illuminate areas of the fault with extremely small events with poor signal-to-noise ratio which can elude traditional techniques.