Spatial/Temporal interdependence of aftershocks following the 10/31/2001 M5.1 Anza Earthquake

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1.0 Investigations undertaken

To date we have only used a small portion of our allotted funds (<10%), and therefore we have not fully completed this study. Of the three main tasks proposed that include using the ANZA seismic network data in investigations of: (1) Heterogeneous waveforms; (2) Bimodal magnitude distribution; and (3) The temporal delay between mainshocks and aftershocks, our efforts have focused on understanding the bimodal magnitude distribution (Figure 1). This distribution is not an artifact of the magnitude determination since we use the Richter magnitude M_L, as defined in Richter (1958), for the entire data set. We can also rule out recording artifacts because, on average, at least 6 stations recorded events below magnitude 0.5. Through this study we have found that the bimodal distribution of magnitudes in the ANZA seismic network catalog results from an artifact due to data sampling.

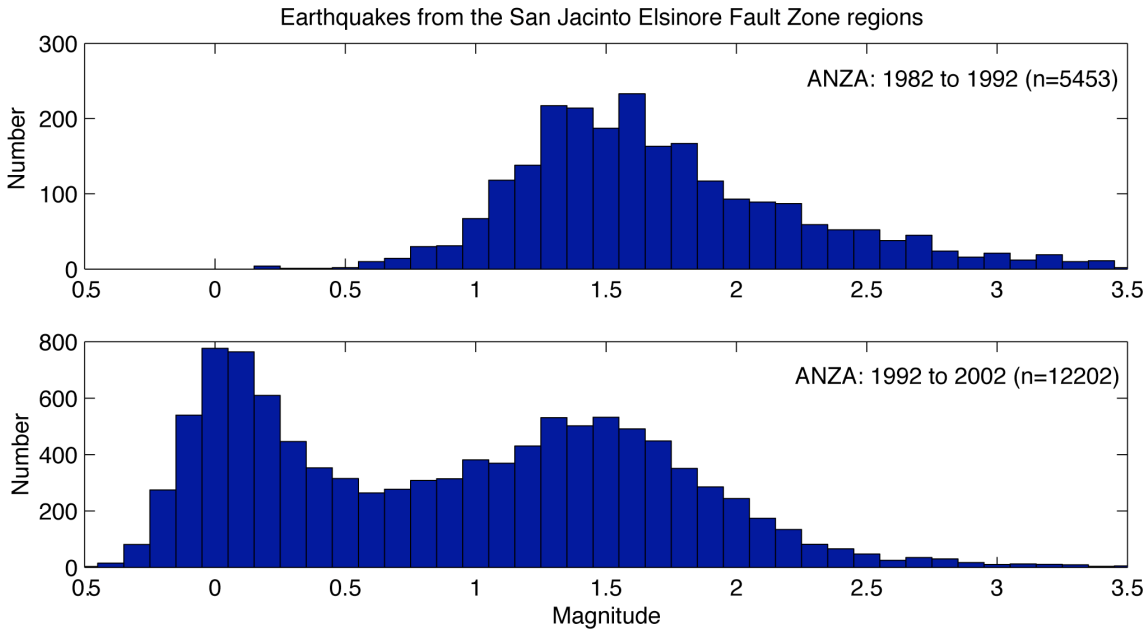

Figure 1. Magnitude histograms of data recorded by the Anza Seismic network for: (top) 5453 earthquakes recorded during 1982-1992 and (bottom) 12202 earthquakes recorded from 1992 - 2002.

2.0 Results

One of our goals was to compare the magnitude determinations in the ANZA seismic network database (http://eqinfo.ucsd.edu/deployments/anza.html) with those in the TRINET database (http://www.trinet.org), to quantitatively determine if there was a substantial difference in the catalog magnitudes. For earthquakes recorded by both networks (a sample of 1706 pairs identified in our study region) the variation in the cataloged magnitudes, on average, differ by 0.6 magnitude units. Larger differences are found for the smaller magnitude events (Figure 2). Because almost all of these small events are aftershocks of the M5.1 ANZA earthquake that occurred directly under the ANZA network, we expect these differences are likely due to the fact that the TRINET stations do not have a very good azimuthal distribution of this study area, and the source/station distances are typically much longer.

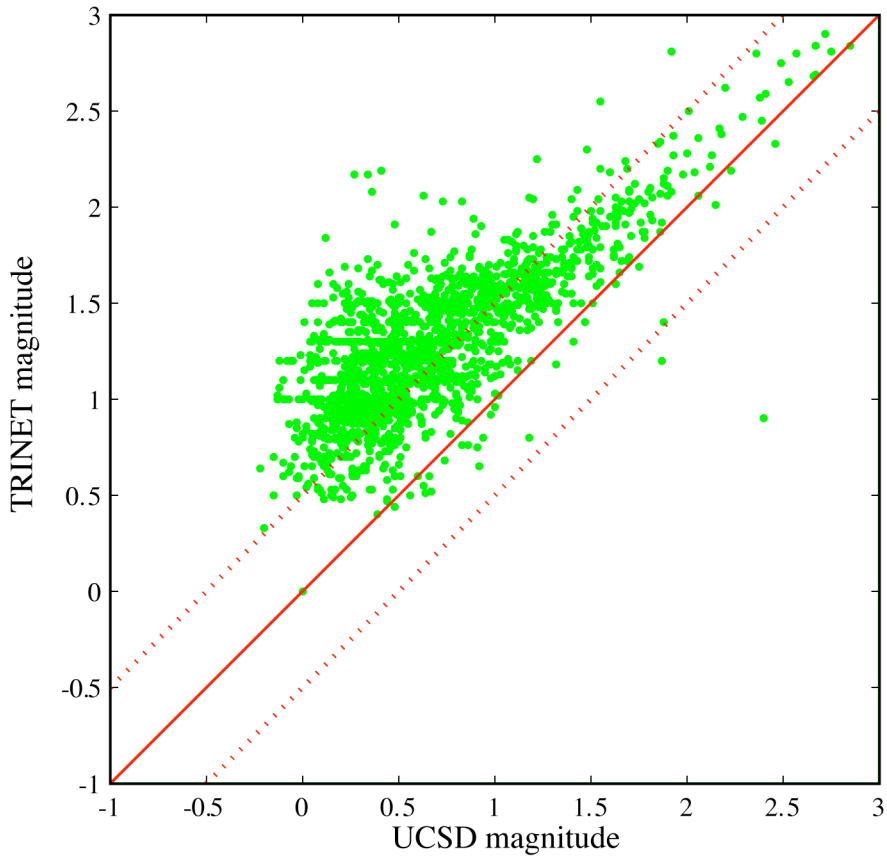

Figure 2. A comparison of local magnitudes listed in the TriNet catalog and those listed in the ANZA catalog. For reference, the solid line indicates perfect agreement of the catalog magnitudes and the dashed line indicates ±0.5 deviations.

We next test if the bimodal distribution is an artifact in the data sampling. Our concern is that small earthquakes that occur at locations sufficiently far from our network might not be detected. Examining the spatial extent of earthquakes of

different magnitude ranges (Figure 3) it is clear that the smallest earthquakes are only recorded when they are directly under our network: for the small magnitude events (≤0.5) note the minimal amount of earthquakes that appear in the edges of the sub-plots (Figure 3, top row). This is a result from the combination of our limited ability to detect small earthquakes at the outskirts of the network, and the prevalence of small magnitude earthquakes (< 0.5) in the aftershock sequence of the 10/31/2001 M5.1 Anza earthquake, which was directly below our seismic network.

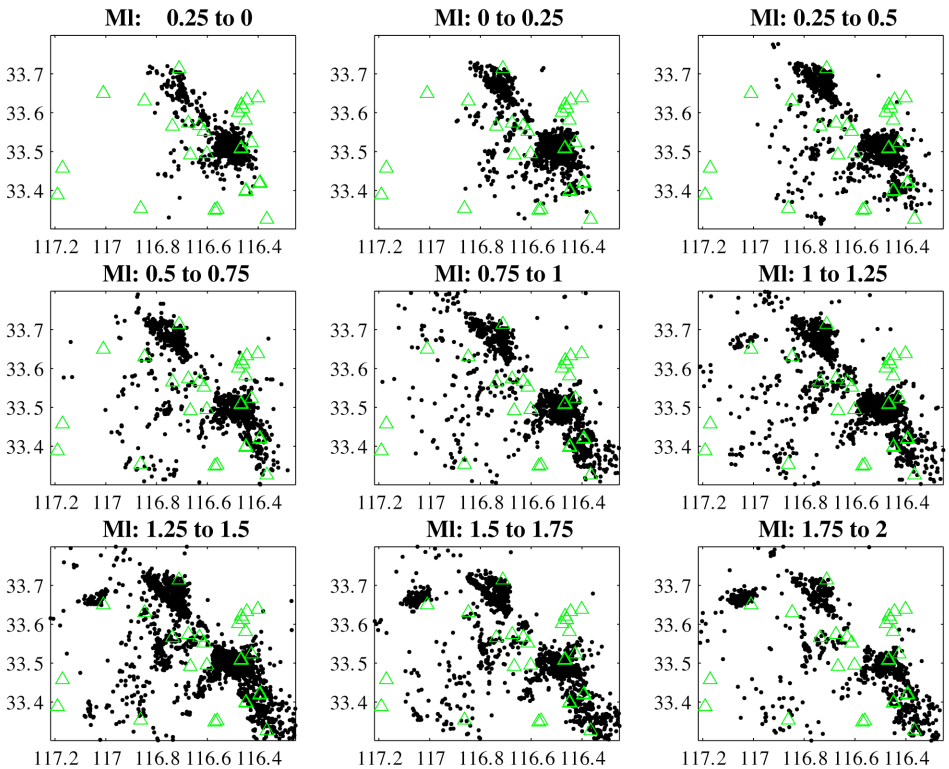

Figure 3. Location of earthquakes recorded by the ANZA seismic network, divided with respect to magnitude (from left to right & top to bottom, magnitudes are increasing as indicated in sub-titles).

Table 1. Regions of study.

Dataset Identifier	**Latitude**		**Longitude**	
	Minimum	**Maximum**	**Minimum**	**Maximum**
Full dataset	33.3	33.8	-117.25	-116.25
Northwest cluster of seismicity	33.6	33.75	-116.9	-116.6
Southeast cluster of seismicity	33.4	33.6	-116.6	-116.3

To eliminate the possibility of artifacts in data sampling we repeat our tests using two different data subsets: the first is the prevalent northwest cluster of earthquakes and the second is the prevalent southeast cluster of earthquakes (see Figure 3 & Table 1). We find that the bi-modal distribution of earthquakes is substantially reduced when the data is limited to the data subsets (Figure 4).

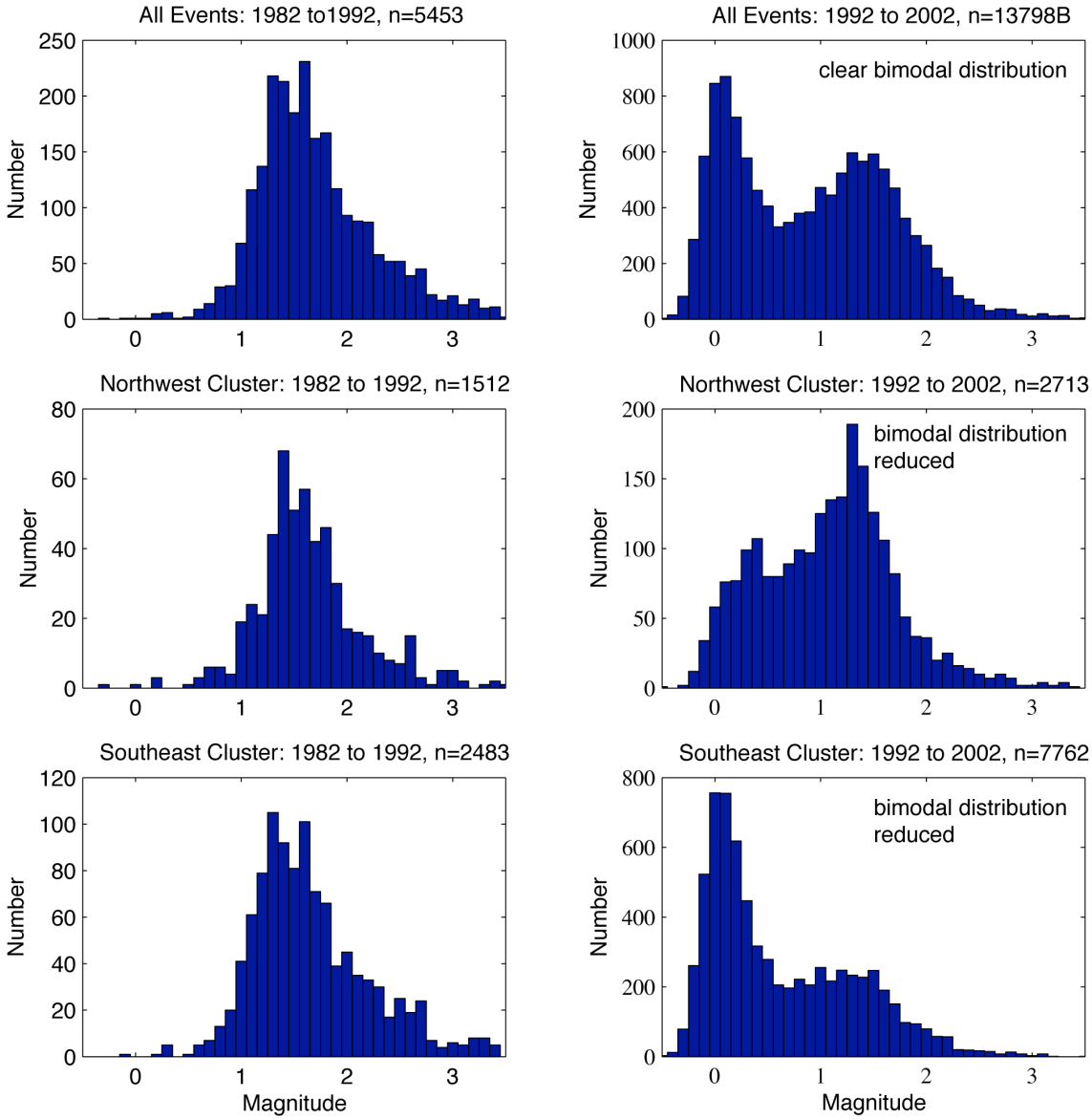

Figure 4. Magnitude histograms for three different datasets. The full dataset shows a bi-modal distribution of magnitudes (top row; right hand side); when the data is restricted to only that in the northwest cluster the bi-modal distribution is reduced (middle row; right hand side), a similar reduction is found when the data is restricted to only that in the southeast cluster (bottom row; right hand side).

3.0 Non-technical Summary

We have found that the bi-modal distribution of magnitudes (peaks at approximately 0.5 and 1.5) in the ANZA seismic network catalog, for events in the Elsinore and San Jacinto fault regions, is likely an artifact of data sampling. This is due to the fact that small magnitude earthquakes cannot be detected when they are sufficiently distant from the network. When we restrict the data to events directly under our network this bi-modal distribution is significantly diminished.

4.0 Reports published

These data were discussed in the paper: D.L. Kilb, R.L. Newman, F.L. Vernon, J.A. Eakins, L. Ziegler, J. Bowen, J. Otero, "Education and Outreach Based on data from the ANZA Seismic Network in Southern California" Seis. Res. Lett. V. 74, no. 5, p. 522-528, 2003.

5.0 Availability of seismic data

We have a world-wide-web home-page for the ANZA network, http://eqinfo.ucsd.edu, which provides maps and information about our database, stations, hardware configurations, including all network metadata in dataless seed volumes. We make special event web pages (http://eqinfo.ucsd.edu/special_events/index.html) for significant local, regional, and teleseismic events and maintain our *dbrecenteqs* webpages showing the latest seismicity on local, regional, and global scales (e.g., http://eqinfo.ucsd.edu/dbrecenteqs/anza/AZ_R2_map.html). The complete waveform data set of the ANZA network data, which consists of over 58,180 events, is stored on-line on a RAID mass storage. These data are stored in the standard CSS 3.0 format complete with instrument responses and they are accessible over the Internet. A data request is satisfied by placing the data in a directory for retrieval via the Internet or by sending a tape copy. Additional information can be obtained by sending email to anzanet@epicenter.ucsd.edu. At present we provide data in the following formats: CSS 3.0, SAC, or SEED. The IRIS Data Management Center is maintaining a complete copy of our data archive (updated in real-time) and ANZA data is integrated into their standard FARM database and BUD real-time data distributions. Researchers from academia and industry have complete access to all ANZA data and results directly through UCSD or can access data through the SCEC Datacenter or the IRIS DMC.