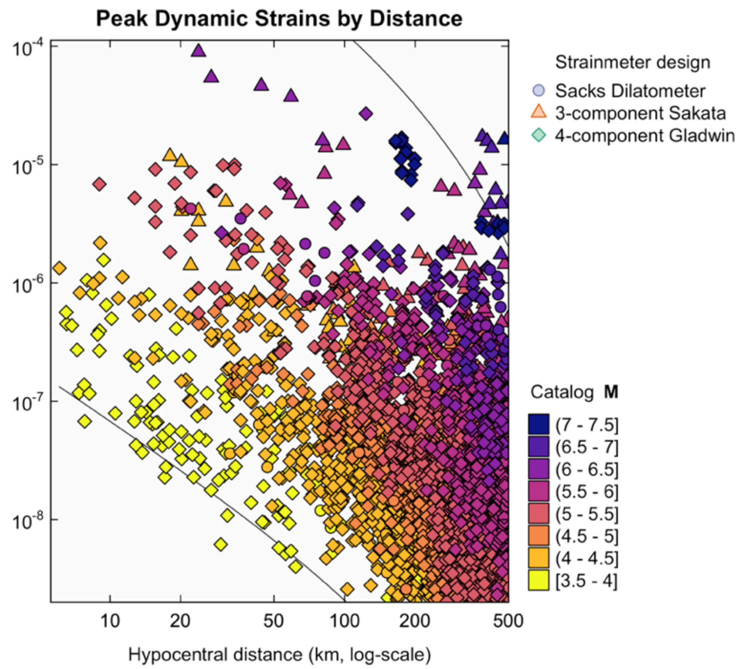
Earthquake Magnitudes from Dynamic Strain: the 2019 Ridgecrest Sequence

Andrew Barbour
United States Geological Survey, Menlo Park, CA

For decades strainmeters have been collecting high-frequency (≧ 20 Hz) strain data in seismically active parts of the Pacific/North American plate boundary, with signal detection capabilities that complement both geodetic (e.g., GNSS) and seismic networks. This opens the possibility that strainmeters may be used to investigate the attenuation and geometrical spreading characteristics of local earthquakes, and thus their magnitudes.



Farghal, Barbour and Langbein (*in prep.*) assembled a catalog of high-frequency strain data from all available Plate Boundary Observatory and USGS borehole strainmeters within 500 km of any earthquake with moment magnitude (Mw) greater than 3.5. In total their dataset includes 2962 records of dynamic strain. Using linear mixed-effects regression, they show that hypocentral-distance (R) decay terms for broadband root-mean-square strains (S) follow $\log S_o = -4.03 - 0.000757R - 1.46 \log R$. This expression is similar to the one used by the California Integrated Seismic Network to determine local magnitudes from seismometer displacements (M_L).

After adjusting S for S_o, the largest source of variability comes from lumped source properties – some combination of stress drop, apparent rupture velocity, fault geometry, and radiation pattern – but site effects also introduce a significant bias. After correcting for site effects, the magnitude inferred from strain is directly proportional to the catalog moment magnitude. Here I test this relationship with the 2019 M6.4 and M7.1 Ridgecrest earthquakes. Using recordings from three strainmeters located within 50 km of the mainshock hypocenter, we use the above relationship to determine $Mw = 6.32 \pm 0.28$ for the July 4 foreshock and 7.18 ± 0.18 for the July 6 mainshock.