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Supporting Information for

Stress- and structure-induced anisotropy in Southern California from two-decades of shear-wave splitting measurements

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Additional Supporting Information (Files uploaded separately)

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Introduction

Supporting information Figure S1 is a flowchart of fully automatic measurement of shear - wave splitting (SWS) parameters. Figure S2 shows an example of SWS measurement on station KNW to illustrate the MFAST procedure. Figures S3 and S4 show the temporal stability of SWS parameters on two nearby stations. Figure S5 shows the inconsistencies between average fast direction and maximum horizontal compressional stress (σ_{Hmax}) on geological map.

Large Tables S1, S2 compiles 232,000 raw SWS measurements and 90,000 high-quality measurements. Notice that Table S1 includes measurements from different channels of the same station. For example, if a station has both BH and HH channels, the measurements using both channels are included in Table S1. Table S2 rules out such cases by selecting the channel with highest signal-to-noise ratio (SNR), if more than one channel go through the quality control criteria described in the main text. Both Tables S1 and S2 follow the format of the MFAST output. Please refer to the MFAST user manual for details (http://mfast-package.geo.vuw.ac.nz, last accessed 7/2017).

Table S3 compiles average fast directions and delay times for individual stations using only high-quality measurements.

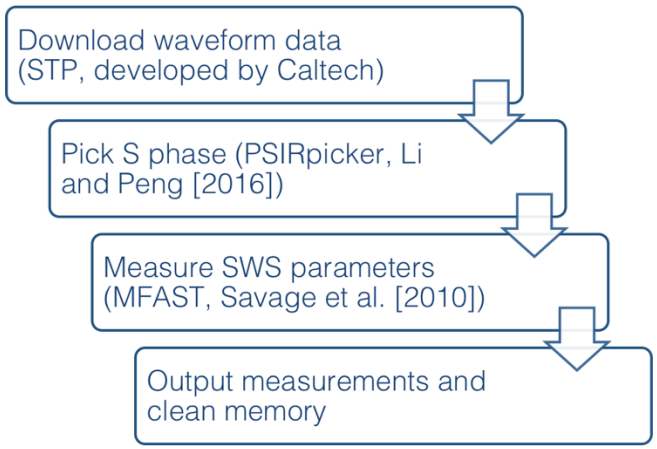

Figure S1. Flowchart of automatic measurement of SWS parameters.

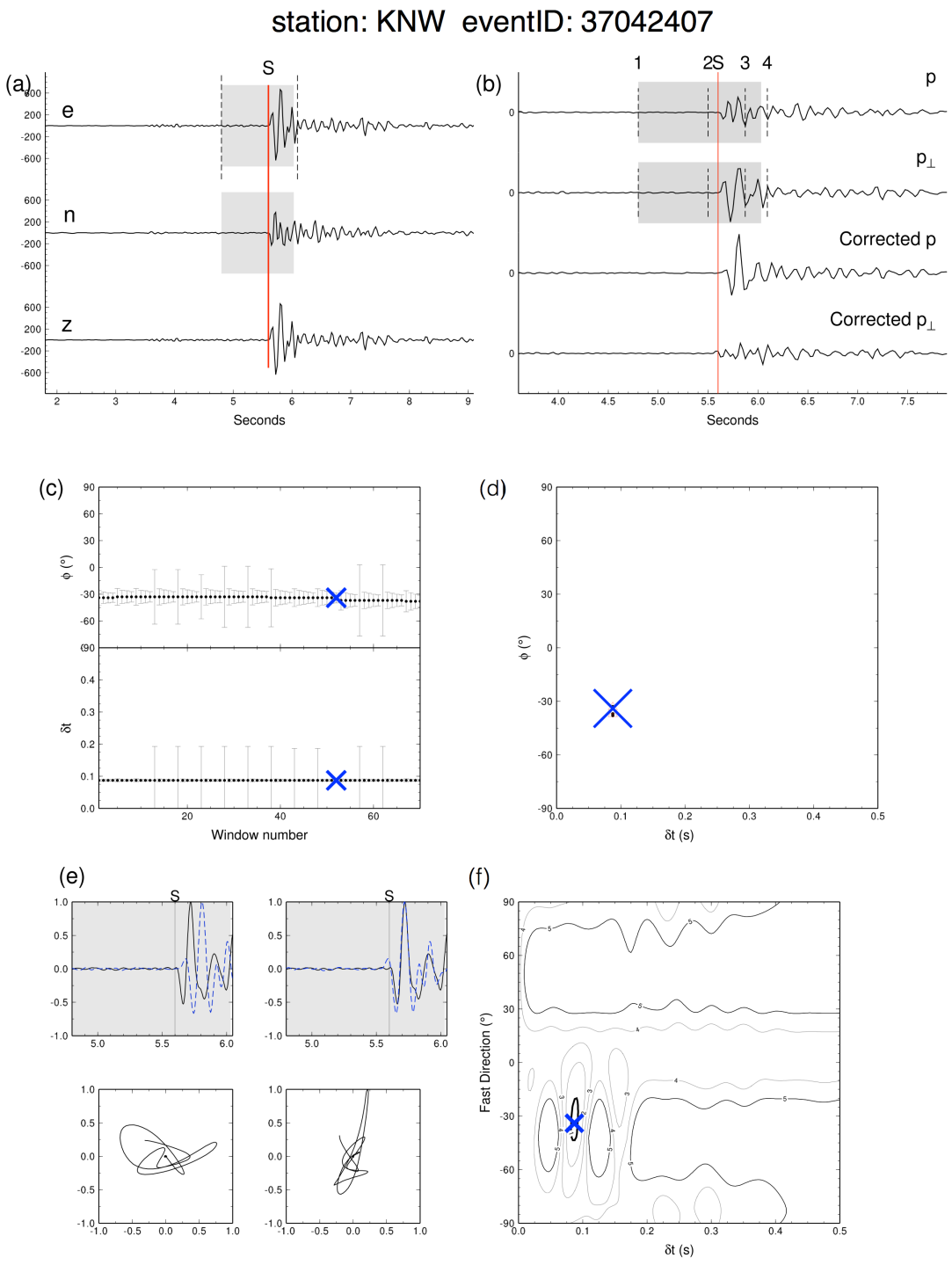

Figure S2. An example of automatic SWS analysis on an M 0.88 event (event ID 37042407) recorded at station KNW. (a) 1-15 Hz filtered waveform. Red line marks the S pick. The vertical dashed lines and the gray shading mark the time window used in the SWS analysis. (b) The top two components that are rotated to incoming polarization parallel (p) and perpendicular (q) direction. The bottom two are components corrected with the determined delay time and fast

direction. Dash lines mark the possible range for the starting (1, 2) and ending (3, 4) of the window. (c) The fast directions and delay times that are determined from 80 different time windows. (d) The distributions of fast directions and delay times determined from different time windows. The blue X marks the best cluster based on the criteria outlined in *Teanby et al.* [2004]. (e) Waveforms (top) and particle motions (bottom) for the original (left) and SWS corrected (right) waveforms. (f) Contours of the second eigenvalue of the covariance matrix for difference fast directions and delay times. The blue cross corresponds to the best-fitting parameters.

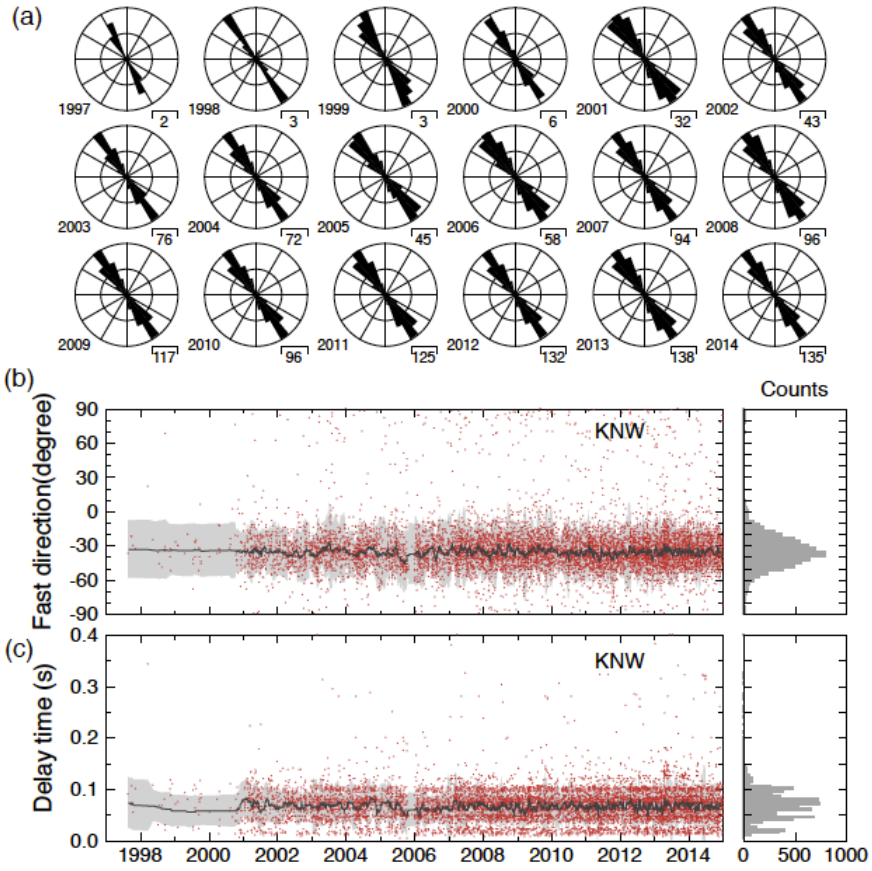

Figure S3. Temporal changes of fast directions and delay times at station KNW. (a) Rose diagram of fast directions at KNW in each year from 1997-2014. (b) Fast direction measurements at KNW. The black curve represents the running median for a 50-measurement window. The shaded area marks one standard deviation range. The right panel is a histogram of all the measurements. (c) Delay time measurements at KNW. Symbols are the same as those in (b).

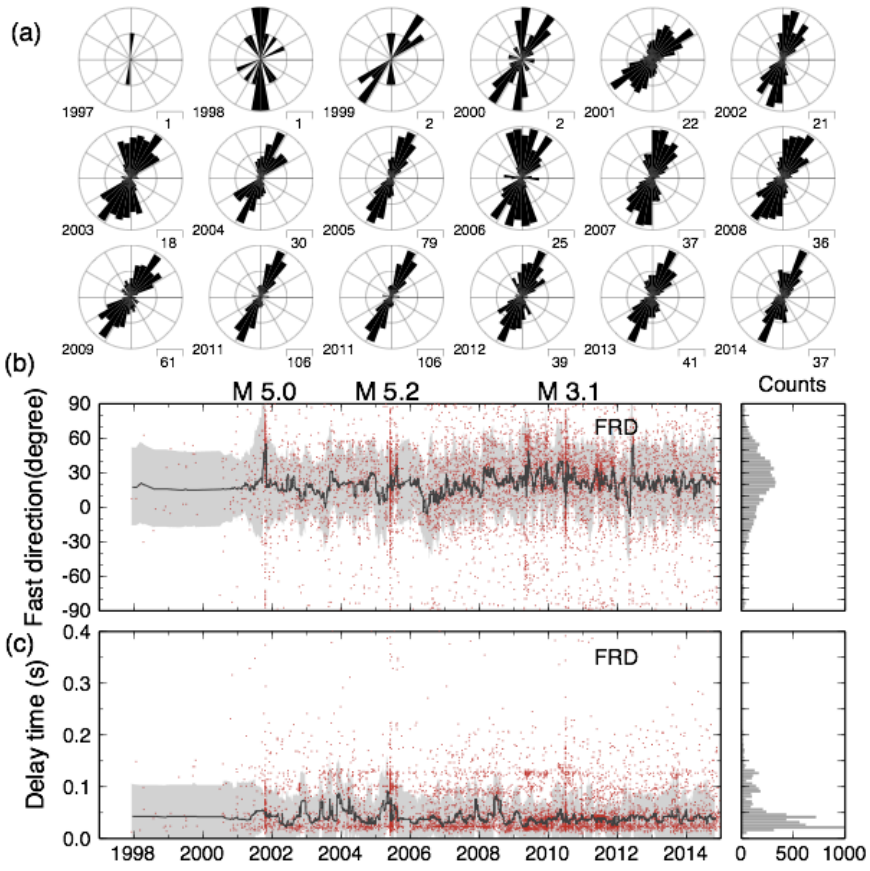

Figure S4. Temporal changes of fast directions and delay times at station FRD. Symbols are the same as those in Figure S3. Note that the patterns are apparently changed with M 5.0, M 5.2, and M3.1 events near this station.

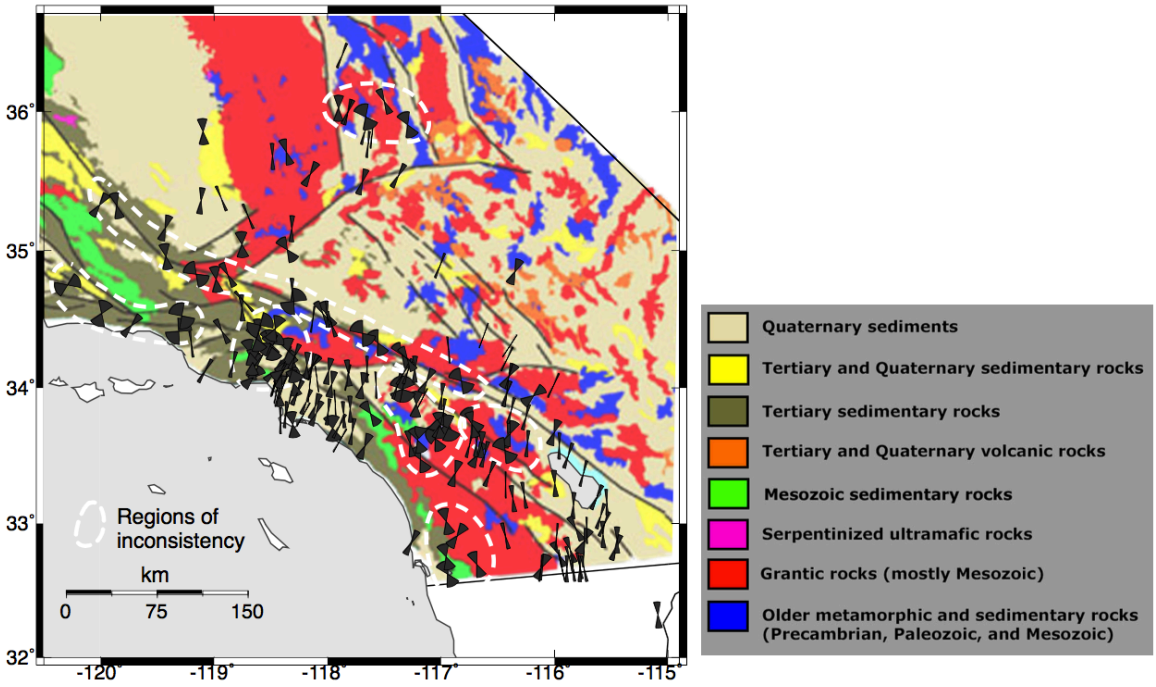

Figure S5. Comparison of fast directions and σ_{Hmax} superimposed on a simplified geological map in Southern California. The dashed circles mark the areas of significant inconsistencies between fast directions and σ_{Hmax}. Geological map are from Wikimedia Commons (https://commons.wikimedia.org/wiki/File:Geologic_map_California.jpg, last accessed 07/2017).

Table S1. A database of 232,000 raw SWS measurements, following the output format of the MFAST code.

Table S2. A database of 90,000 high-quality measurements as defined in the main text, following the output format of the MFAST code.

Table S3. Average fast directions and delay times for individual stations of Southern California Seismic Network.