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Kinematic Rupture Model for the 1966 Mw6 Parkfield Earthquake with Assessment of Resolution

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The Parkfield segment of the San Andreas Fault has ruptured in ~Mw6 earthquakes at least 5 times in the historical period. Based on similarity of waveforms from the 1922, 1934 and 1966 Parkfield earthquakes, Bakun and McEvilly (BSSA 1984) proposed the idea of characteristic earthquakes: a given fault segment would rupture repeatedly in earthquakes that would nucleate in the same hypocenter and generate slip on the same areas of the fault. Unlike previous Parkfield earthquakes, the 2004 mainshock did not nucleate near Middle Mountain and rupture to the SE, but rather nucleated near Gold Hill and ruptured NW. Despite these differences, do the 1966 and 2004 slip distributions look similar? We compute a kinematic rupture model for the 1966 event by inverting the scarce co-seismic dataset. Only five strong motion instruments were nearby at the time of the 1966 mainshock; all were located perpendicular to the fault, near its SE end. Because the data coverage of the fault is poor, the resolution of the rupture model becomes an important question. To estimate the resolution of the 1966 rupture model, we use 3 different approaches: 1) we use synthetic slip distributions to generate waveforms at the 5 stations, and then invert the synthetic waveforms to see how well the initial slip distributions can be recovered; 2) we invert seismograms of the 2004 earthquake recorded at 5 stations coincident or close to the stations that were in place in 1966; we then compare the obtained rupture model with one obtained by inversion of a more complete dataset (Custodio et al., GRL 2005; Liu et al., BSSA submitted); 3) we repeat step 2 using five stations located towards the NW end of the Parkfield segment; thus, for both the 1966 and 2004 mainshocks, the stations used in the inversions are located towards the end of the fault where directivity has a major effect. The resolution tests indicate that the 1966 rupture model is poorly resolved. However, the agreement between the 1966 rupture model and aftershock locations is good.

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