Constraints on crustal stress for South Island, New Zealand

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With an aim to investigate the crustal stresses on northern South Island, New Zealand, we use a Bayesian Markov chain Monte Carlo to determine posterior probability density functions of the orientations of tensorial stress consistent with the 2010 M_w7.1 Darfield and Feb 2011 M_w6.2 Christchurch, Canterbury Plains earthquakes, and the 2016 M_w7.8 Kaikoura earthquake of the Marlborough Fault System from coseismic slip models. In addition to indicating the likely orientations of seismogenic stresses, the posteriors provide a mechanism to interrogate the coseismic slip models on both a fault-segment and holistic level.

The orientations of the principal components of stress estimated from Kaikoura coseismic slip models are consistent with an Andersonian thrust regime, with a roughly east-west trending, near horizontal MCS, while those estimated from both of the Canterbury Plains earthquakes are consistent with a strike-slip regime, with a more SE-NW trending, near horizontal MCS. The trends of the MCS we infer are broadly consistent with past studies of focal mechanisms, borehole breakouts, and structural analyses, as well as the directions of maximum contraction inferred from GPS velocities. Inferences of S_{Hmax} for central South Island from past studies reveal a near uniformity in regional stress that is in agreement with our results for the Canterbury Plains earthquakes. In the north of South Island, our results from the Kaikoura slip models are consistent with past inferences that S_{Hmax} is rotated counterclockwise to more east-west orientations. We explore the effects of sediment load in the Canterbury Plains, topography, and tectonics on the inferred transition from a thrust regime in the Marlborough Fault System to a strike-slip regime in the Canterbury Plains.