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Award 16039: Validation of ground-motion simulations using precarious rocks

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In the period January-August 2016 we have developed ground motion simulations for the major Dunstan reverse fault in central Otago, New Zealand, and used the well-studied Cairnmuir Flat precariously-balanced rocks (PBR) to validate the simulations. This represents a geologically-based validation of simulations, rather than the standard approach of using instrumental strong motion records for validation. The Dunstan Fault, a 60 km long reverse fault, is responsible for the uplift of the Dunstan Mountains (1500-1600 masl). PBRs are abundant within a few km of the southwestern end of the fault, and are therefore conveniently located for validating simulated ground motions from $M \geq 7$ near-field Dunstan Fault earthquakes. The fragility (the peak ground acceleration or PGA required to topple the PBR, based on a simple field-based estimates) and fragility age (age since the PBR reached the present unstable morphology) were compared to the recurrence interval and simulated ground motions of Dunstan Fault earthquakes. Earlier studies showed cosmogenic Be^{10} exposure date for two of the PBRs to be in the range of 40,400 to 55,300 years B.P., and the Dunstan Fault to show a recurrence interval of about 8000 years. Therefore, the PBRs have experienced repeated large earthquakes in which ground-motions did not exceed their fragilities (i.e. PGAs no greater than 0.7-0.8 g). The fragilities generally fall within the range of permissible PGAs according to the PBRs, except for less than 20% of simulations which exceeded the PBR fragilities (Fig. 1). Our research for the remainder of the SCEC year will identify and evaluate the source parameters driving the high PGAs in the simulations. Our research represents the first effort at using PBRs to validate ground-motion simulations in New Zealand, and has been jointly supported by University of Otago, QuakeCoRE and GNS Science.

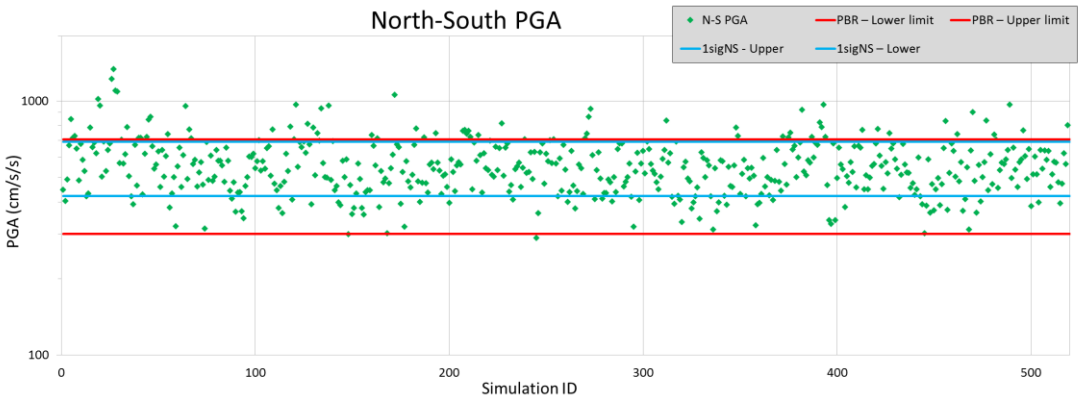

Figure 1: Simulated PGAs in the North-South (strike normal) sense of motion are shown as green dots, with 1-sigma bounds shown as the blue lines (0.4-0.7g). PBR dynamic fragilities are plotted as the red lines (0.3-0.7g). One-sigma range of PGAs.