DYNAMIC RUPTURE SIMULATIONS ON THE ALPINE FAULT, NEW ZEALAND: INVESTIGATING THE ROLE OF FAULT GEOMETRY ON RUPTURE SIZE AND BEHAVIOR OVER MULTIPLE EARTHQUAKE CYCLES

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The transpressional Alpine Fault is the primary plate boundary fault on the South Island of New Zealand. At a broad scale, its onshore surface trace between Milford Sound in the southwest and the Marlborough Fault System in the northeast consists of two planar sections connected by a major geometrical boundary, which is characterized by a dip change of as much as 40° over an along-strike length of only ∼5 km. Previous studies suggest that changes in dip along a strike-slip fault can affect rupture dynamics. It is therefore possible that this feature controls conditional earthquake segmentation on the Alpine Fault, as documented by the extensive paleoseismic record.

We simulate multiple cycles of dynamic ruptures on the southwestern ∼320 km of the Alpine Fault. We use dynamic rupture simulations for the coseismic period, then account for the interseismic period by incrementing shear stress based on time between events. For each dynamic simulation, we compare the modeled rupture length and surface slip to geologic and paleoseismic studies to ensure that we are producing physically-plausible simulations consistent with observations. We find that the dip change at the segment boundary is not inherently a barrier to rupture within single events, but that stress changes associated with rupture through this boundary in one earthquake can sometimes lead to segmentation in the next one. Our results suggest that rupture hazard on the Alpine Fault may depend both on the slip distribution of and the timing since the previous large earthquake. This also implies that both fault geometry in and of itself and long-term stress patterns resulting from that geometry are important considerations for hazard assessment on other geometrically-complex faults.