

Deep Fault Drilling Project, Alpine Fault, New Zealand

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The Alpine Fault is mature (>460 km offset), active (25 mm/yr), and late in its seismic cycle. It ruptured in AD 1717, has a 330 yr return time, and M8 earthquake probability is c. 30% in the next 50 yrs (Berryman et al. 2013). The objective of the Deep Fault Drilling Project (DFDP) is to collect materials, measure ambient conditions, and monitor at depth on the Alpine Fault, to understand earthquake processes and the formation of a continental orogen.

Pilot drilling (DFDP-1) was completed in 2011. Two boreholes were drilled, wireline geophysical loggings collected, and observatory installed. The followings were revealed as Initial results. A low-permeability alteration zone overprints the boundary between fault core and damage zone. The alteration zone significantly affects physical properties and likely evolves during the seismic cycle. There is a fluid pressure step of 0.53 MPa across the fault at 128 m depth, and probable greater difference at greater depth. Geothermal gradient is 63 +/- 2 C/km. Physical properties are highly asymmetric, suggesting a possible (northeastward) preferred rupture direction.

Planning is now underway for the next phase of drilling ("DFDP-2"), which is scheduled to start in 2014. The target total depth (TD) is 1.3 km, with contingency to reach 1.5 km. We drill, sample, and monitor the Alpine Fault to address fault zone evolution via brittle and ductile processes operating in the upper and mid-crust in this novel experiment.

Keywords: Fault zone drilling, the Alpine Fault, Earthquake processes, Brittle and ductile processes