Microseismicity adjacent to the locked, late-interseismic Alpine Fault, New Zealand.

*Calum John Chamberlain[1], Carolin M Boese[1], John Townend[1]

1. Victoria University of Wellington

New Zealand's Alpine Fault is the major on-land expression of the Australian-Pacific plate boundary, forming a dextral-reverse transpressional fault. The Alpine Fault is expected to fail in a great (M~ 8.0) earthquake in the coming decades, with a conditional probability of a large ground-rupturing earthquake in the next 50 years of 27%. The Deep Fault Drilling Project (DFDP) aims to study conditions on the Alpine Fault at depth prior to such a rupture. Motivated by the DFDP-2 drilling we conducted a focused study of microseismicity around the drill site, and subsequent real-time monitoring of seismicity during drilling. DFDP-2 was drilled in 2014-2015 in the Whataroa Valley, an area known to have low rates of seismicity, with few earthquakes above M_L 3.0.
To detect microseismicity in this seismically quiet region we used data from a dense local network of shallow borehole seismometers alongside data from the New Zealand national seismic network (GeoNet). We generated an initial catalog using standard energy-based detection techniques and manual phase-picks. From this initial catalog, 63 well recorded earthquakes within 20km of the DFDP-2 drill-site, and 14 explosions from a nearby quarry were selected for use as templates. These were used in a subsequent matched-filter detection routine through 2.25 years of continuous data. The resulting catalog contains 283 earthquakes of M_L<1.8 within 5km of the Alpine Fault surface trace. For all earthquakes, correlation pick-corrections were calculated to provide precise relative arrival times for use in double-difference hypocentre calculations. For highly similar earthquakes, precise magnitudes were calculated using the singular-value decomposition method. The resulting catalog of microseismicity is dominated by clustered, non-repeating seismicity in the vicinity of the main plane of the Alpine Fault, however the seismicity does not define a single fault structure. Based on evidence from this study and nearby geodetic studies, we infer that the Alpine Fault at the location studied is currently locked and accumulating stress throughout the seismogenic zone. Following this work we conducted real-time monitoring of seismicity around the DFDP-2 drill-site during drilling to study whether any changes in seismicity occurred during drilling. Little seismicity during drilling was detected around the borehole (4 earthquakes detected within 10km of the borehole), with no response observed due to drilling.

Keywords: Seismology, Deep-Fault Drilling Project, Alpine Fault

