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Cross-sectional structure of the southern sector of the Alpine Fault, New Zealand, from seismic reflection and gravity data

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The Alpine Fault, running for >400 km along the west side of the South Island of New Zealand, exhibits dextral strike-slip motion estimated at 23.1±0.8 mm/yr. It also accommodates ongoing uplift in the Southern Alps on the hanging wall of the fault with rates in the southern sector estimated at 5.9 mm/yr. For much of its length, scarps of earlier Alpine Fault ruptures are readily identifiable, even though there have been no ruptures since the arrival of Europeans in New Zealand. In the southern sector of the fault, previous paleoseismic work has characterised extensive fault scarps across the valleys of the Haast, Okuru and Turnbull rivers. However, these studies do not provide any direct evidence for the structure of the fault in the subsurface – a factor that is important in assessing earthquake hazard along the Pacific-Australian plate boundary here.

Early work, relying on poorly-constrained gravity and wide-angle seismic refraction interpretations, led to the proposal of a very shallowly-dipping plate boundary in this region. Assuming that this is the case, then the geometry of such a low-angle dip-slip reverse fault needs to be constrained in order to evaluate the magnitude, position and size of future surface ruptures of the Alpine Fault in this area. That said, the low-angle geometry of the Alpine Fault here is not universally accepted. The shallow-dipping model also contrasts with more recent work in the central and northern portions of the Alpine Fault that support a steeply dipping fault in those regions.

In January 2009, two seismic reflection profiles and associated gravity surveys were collected along the coastal plain of southern Westland adjacent to the Haast and Turnbull River valleys to provide higher-resolution images of the Alpine Fault at depth. The results of this work are presented here. The two seismic transects each cover $\tilde{4}$ km and are orientated perpendicular to the Alpine Fault. They extend inland as far as possible (i.e., until limited by the extreme topography of the Southern Alps) in order to maximise the coverage of the hanging wall. Due to the rugged topography and temperate rainforest vegetation of the Southern Alps and West Coast of the South Island, suitable locations for collecting seismic reflection and detailed gravity data across the Alpine Fault are rare. The combination of gravity and seismic data enables the development of a subsurface model that provide information to characterise the type of fault motion that will occur on the Alpine Fault during a future earthquake.