

## **The structural architecture of the Whataroa Valley and the Alpine Fault (New Zealand) from first-arrival seismic tomography and imaging using an extended 3D VSP survey**

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The New Zealand Alpine Fault is a major plate boundary that is expected to rupture in the next 50 years. A major effort has been made to characterise it so that we can learn about fault properties prior to rupture. Here we present a 3D seismic survey around the site where a drill penetrated to within a few 100 m meters above the fault surface. Within the glacial Whataroa Valley, we collected 3D seismic data to constrain valley structures that were obscured in previous 2D seismic data. The new data consist of a 3D extended vertical seismic profiling (VSP) survey using three-component and fibre optic receivers in the DFDP-2B borehole and a variety of receivers at the surface.

The data set enables us to derive a reliable 3D P-wave velocity model by first-arrival travel time tomography. We identify a 100-460 m thick sediment layer (mean velocity  $2200\pm 400$  m/s) above the basement (mean velocity  $4200\pm 500$  m/s). Particularly on the western valley side, a region of high velocities steeply rises to the surface and mimics the topography. We interpret this to be the infilled flank of the glacial valley that has been eroded into the basement. In general, the 3D structures implied by the velocity model on the upthrown (Pacific Plate) side of the Alpine Fault correlate well with the surface topography and borehole findings.

A reliable velocity model is not only valuable by itself but it is also required as input for prestack depth migration. We have performed the latter and have derived a structural image of the subsurface within the Whataroa valley. The top of the basement identified in the P-wave velocity model coincides well with reflectors in the migrated images. Additionally, faults and tectonic structures can be interpreted in detail at shallow depth (down to 1 km).

These data show the importance of 3D seismic data for investigating glacial valley structures in general and particularly in this region to facilitate the characterization of the Alpine Fault.