Analysis of microseismic activity detected by the WIZARD array, Alpine Fault, New Zealand

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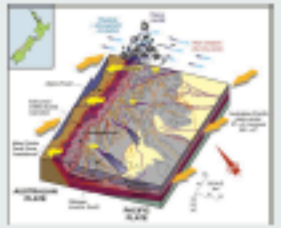
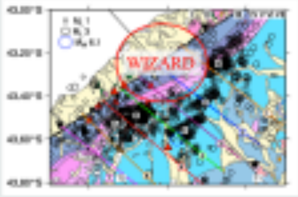
Introduction.

The Alpine Fault is an approximately 850 km transform fault through the South Island of New Zealand accommodating approximately 75% of the relative plate motion between the Hikurangi Trench in the North to the Puysegur Trench in the South (Boese et al., 2012). Motion occurs here as dextral-reverse shear slip on this obliquely converging plate boundary (Figure 1) at approximately 25 mm/yr. Seismicity along the central portion of the Alpine Fault to be diffuse, shallow, and low in magnitude (Boese et al., 2012). A number of studies indicate a gap in seismicity (Figure 2) along this central portion of the fault just northeast of Mount Cook (Boese et al., 2012; Leitner et al., 2001).

This study investigates the microseismicity of this "seismic gap" recorded on a temporary array of 20 seismic stations (WIZARD array). The primary goals of this investigation include (1) defining the geometry of the Alpine Fault and other active faults at depth through precise earthquake relocation, (2) provide data for seismic imaging, focal mechanisms, and shear-wave splitting, and (3) enable the assessment of possible changes in seismic activity induced by future fault zone drilling.





Methods.

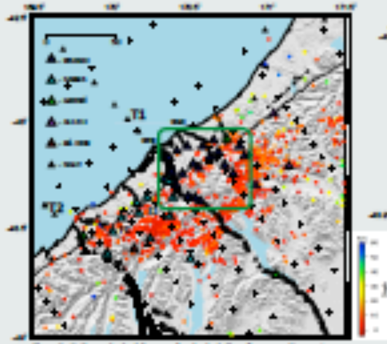
Earthquake data from the WIZARD, SAMBA, and ALFA12 arrays, and the GeoNet national seismic network were merged with shot and blast data from the SIGHT T1 and T2 transects

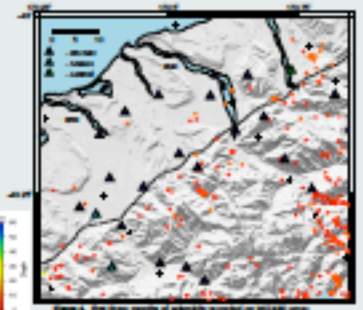
- ***Hypocenter relocation and tomography***: double-difference local earthquake tomography method after Zhang and Thurber (2006) using a 3D velocity model
- ***Magnitudes***: determined from waveform amplitudes and corrected for distance spreading according to $M_L = \log(A) + Q_x(\Delta)$, where A is the maximum amplitude, Q_x is the distance correction function, and Δ is the epicentral distance. Local magnitudes calculated from earthquakes recorded on the WIZARD array fit known magnitudes from the GNS catalog with $R^2 = 0.9$.
- ***Focal mechanisms***: P-wave first motion polarities were picked for events recorded on the WIZARD array with 7 or more observations

Data.

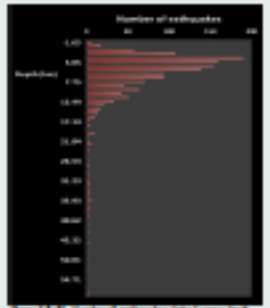
The dataset used in this study consists of 1724 earthquakes recorded on 35 stations in total.

SEISMICITY

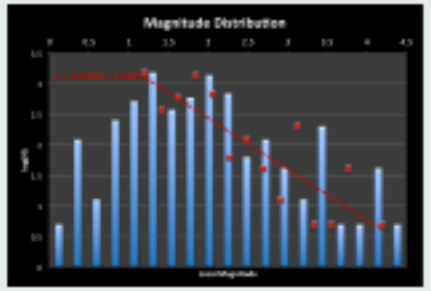




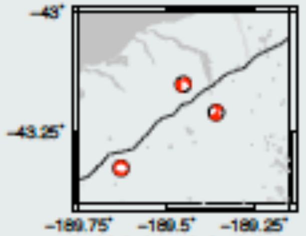
Seismogenic zone



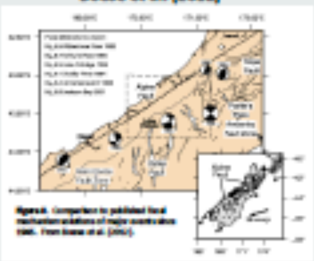
Magnitudes



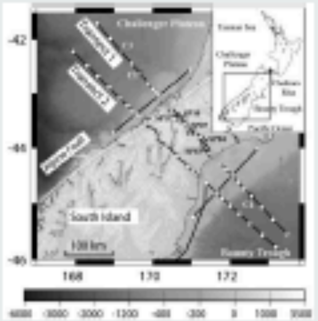
Focal mechanisms



Boese et al. (2012)

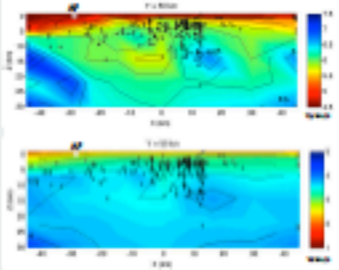


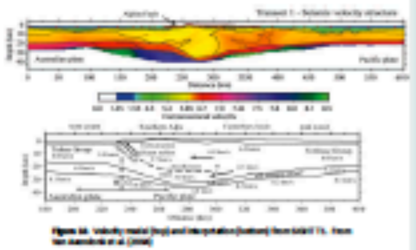
TOMOGRAPHY



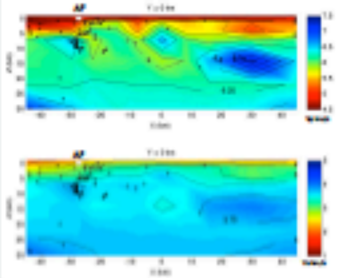
Model gridlines Y = 50 km and Y = 0 km (Figure 3) coincident with Transect 1 and Transect 2 of SIGHT, an active source wide angle refraction survey (Figure 9).

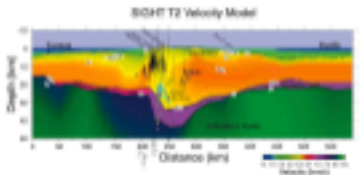
Transect 1





Transect 2





Preliminary Conclusions.

Earthquake hypocenter relocations show that seismicity is present along the central Alpine Fault at predominantly low magnitudes and shallow depths. Plots of earthquakes versus depth indicate that the depth of the seismogenic zone is at approximately 12-14 km, which agrees with published results (Boese et al., 2012; Leitner et al., 2001). Magnitudes calculated from earthquakes recorded on the WIZARD array are in good agreement with regional magntiude calculations. The Gutenberg-Richter plot for these event magnitudes suggests that the minimum magnitude event this array can reliably detect is M_L 1.

Velocity models are consistent with those produced from the SIGHT refraction survey and show finer scale anomalies not visible at the refraction level. Relocated earthquakes appear to define vertical faults approximately 40 km west of the Alpine Fault.

Next steps.

- Update earthquake database with data from WIZARD and SAMBA arrays as data is received
- Stack and add tunnel shot data
- Rotate and pick S arrivals for WIZARD and SAMBA events
- Shear wave splitting analysis

References.

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