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Mantle wedge anisotropy in North Island, New Zealand

A. Morely (1), G. W. Stuart (1), J-M. Kendall (2)

(1) School of Earth and Environment, University of Leeds, UK g.stuart@earth.leeds.ac.uk (2) Department of Earth Sciences, University of Bristol, UK

The mantle wedge above a subduction zone is the region where fluids from the subducted plate are mixed with convecting mantle to generate magmas. Observations of seismic anisotropy can be used to infer strain and flow patterns and physical processes in this region. In this study, we estimate seismic anisotropy using shear wave splitting observations from local subduction zone earthquakes along a profile of stations across the central North Island, New Zealand, and interpret it in terms of mantle wedge processes beneath the back-arc extension region of the Taupo Volcanic Zone (TVZ). North Island, New Zealand lies on the obliquely converging Hikurangi subduction zone between the overriding Australian and the subducting Pacific plate. The TVZ is the actively volcanic eastern section of the Central Volcanic Region (CVR) and marks the southern limit of back-arc extension in the Tonga-Kermadec subduction system.

We present shear-wave splitting measurements from 55 local earthquakes recorded on a 200 km profile of 19 stations, deployed as part of the CNIPSE experiment. The eastern fore-arc shows trench-parallel fast directions and low average delay time of 0.2s. The source of anisotropy is confined to the upper 60km and is likely to be deformation induced within the overriding Australian plate. Central western region of the North Island shows N-S trending fast anisotropy that may signify the presence of a viscous blanket of mantle material being entrained by the absolute motion of the Australian plate. Between these regions a dramatic switch to extension-parallel fast directions and delay times of 0.35s is seen across the back-arc in the Taupo Volcanic Zone (TVZ). These results suggest small-scale asthenospheric flow beneath the overriding plate with olivine a-axes oriented in the extension direction down to a maximum depth of 100km. This idea of return flow in the backarc upper-mantle is further supported by the observation of anomalous Vp/Vs ratios in this region.