Geophysical Research Abstracts
Vol. 15, EGU2013-4955, 2013
EGU General Assembly 2013

Seismic Evidence of Fault Structures in the Wadati-Benioff Zone of Northern Japan

Thomas Garth and Andreas Rietbrock
University of Liverpool, United Kingdom (tomgarth@liverpool.ac.uk)

It has been proposed that Wadati-Benioff Zone (WBZ) seismicity may be caused by the reactivation of outer rise normal faults, and that these faults may provide a pathway for the deep hydration of the subducting slab. Here we present seismic evidence that these serpenised fault zone structures are directly related to WBZ seismicity at depths of 100-150 km.

P-wave arrivals from intermediate depth events occurring in Northern Japan are analyzed. It has previously been proposed that P-wave arrivals in events below 150 km exhibit dispersion attributed to low velocity crust acting as a waveguide. We note that events at depths 120 – 150 km, that occur well below the top of the WBZ also show dispersion. As these events do not occur at the top of the slab they cannot reasonably be explained by a low velocity crustal waveguide. We propose that this dispersion arises from serpeninised fault zone structures that act as a waveguide.

2D finite difference wave propagation models show that fault like structures can explain the dispersive waveforms that are observed, when the event occurs directly on the fault. These dispersive P-wave waveforms give a constraint on individual fault zone structures. By constraining the relative arrival time of a given frequency using a spectrogram and the relative amplitude of a given frequency by comparing displacement spectra we characterize these dispersive waveforms. Comparing these signals with numerical models shows that the width of these faults to be approximately 3 km, with a P-wave velocity to be approximately 12 % slower than the surrounding mantle velocities. This velocity reduction is interpreted as areas of serpentinised slab material.

Arrivals from events in the WBZ are also associated with an extended P-wave coda. Analyses of the P-wave coda associated with these events gives a constraint on the broader structure of the WBZ, rather than the individual fault that a given event occurs upon. It is noted that the P-wave coda is strongest at stations closest to the trench, and the coda amplitude decreases with distance from the trench. We simulate this coda with orientated elongated scatterers, of variable velocity contrast, scale length, and aspect ratios.

These observations give further evidence that some intermediate depth seismicity occurs on outer rise fault zone structures. Furthermore these observations give some constraint on the hitherto unknown volume of water subducted in the slab mantle.