Thicker D double prime layer beneath the Antarctic Ocean

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We analyze seismograms from 68 deep earthquakes in Southeast Pacific and South American subduction zones from 1990 to 2003 recorded by 13 broad-band seismographic stations located in New Zealand, South America, Antarctica and Australia to study the anisotropy and velocity structure of shear waves in the D double prime layer beneath the Antarctic Ocean. We observe that transverse components (SH) arrive earlier than longitudinal components (SV) for S waves passing through the D double prime layer. The estimated anisotropy is up to 2.0%.

We systematically observed Scd phases due to the D double prime discontinuity that has been reported beneath circum Pacific regions. For 70~85 degree, Scd phase are observed between S and ScS arrivals in the transverse component, and SH waveforms show a double arrival at slowness near 9.0 s/deg while SV waves remain a single arrival. We perform waveform modeling and the differential travel time analysis among S, ScS, Scd and SKS phases to explain the observations. The optimum shear wave velocity structure is transversely isotropic. The SH velocity structures have a 2.0% velocity discontinuity at 300 ~350 km above the core-mantle boundary. The SV structures are similar to PREM.

The anisotropic D double prime layer, VSV smaller than VSH, beneath the Antarctic Ocean is significantly thicker than those beneath Alaska and the Caribbean Sea. It is expected that the temperature at the depths of post perovskite phase transition in this study areas are 500 K ~1000 K lower than those of beneath Alaska. The thick D double prime layer beneath the Antarctic Ocean can be possibly attributed to subducted material which began to accumulate ~180 Ma. The variation in the thickness of the D double prime layer can be interpreted to be controlled by the amount of paleo-slab material deposited.