Azimuthal anisotropy of surface wave propagation velocities at periods from 20 s to 30 s in the East Pacific ocean

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Large-scale anisotropy should be the key for understanding mechanism of mantle convection. Tanimoto and Anderson (1983) first mapped fast direction of Rayleigh wave propagation velocity of a period of 200s, which was very consistent with a pattern of mantle convection flow at depths of around 220 km by numerical simulations. However, statistical significance of the anisotropy mapping was not evident mainly due to poor quality and poor spatial coverage of broadband seismic records. In 1990s, quality and spatial coverage have been getting improved and mapping of anisotropy has been revitalized (e.g. Montagner (1998)).

The following is the procedure to obtain group velocities of surface waves in this study. (1) We select seismic events which occurred along the west coast of the north America continent, a plate boundary between the Pacific and the North American plates. (2) We band-pass-filter broadband seismic records at KIP (Kipapa, Hawaii) and RAR (Raratonga, Cook Islands) between 20 s to 30 s. (3) We obtain envelope seismogram by Hilbert transform to find arrival times of the surface waves.

Fundamental mode Rayleigh waves and Love waves sample information at depths from 20 km to 50 km and from surface to 150 km, respectively. Why we focus on pure path surface waves is that short period surface waves passing through over deep trenches and ocean-continent boundary are largely distorted.

Ocean floor ages are common to the pure paths from the west coast of north America to KIP and RAR and the effects of upper mantle heterogeneity and thickness of sea water should be the minimum on the Globe.

We calculate raypaths of the short period surface waves by SURFRAY of Yoshizawa and Kennett (2002) with group velocity distribution model of Larson and Ekstrome (2001) to find little distortion of raypaths.

Azimuthal variations of the group velocities at KIP and RAR are quite similar, suggesting that the azimuthal anisotropy is not dependent on wave propagation lengths and the regions. Overall group velocities of Rayleigh and Love waves are 3.95 km/s and 4.35 km/s in the east-west direction and 3.85 km/s and 4.4 km/s in the north-south direction, respectively. Q corrections to the group velocities is an order of 0.01 km/s and thus neglected. Rayleigh waves clearly display azimuthal anisotropy of two quadrant type of around 3 %. Love wave group velocities largely scatter and four quadrant type azimuthal anisotropy is unclear.

As suggested by Kawasaki and Tanimoto (1990), if there is azimuthal anisotropy in the oceanic uppermost mantle, group velocities of the 1-st higher mode Rayleigh waves are smaller than those of fundamental mode Love waves at periods between 20 s and 30 s in azimuths larger than 70-80 degree from plate spreading direction and thus coupling between the 1-st higher mode Rayleigh waves and the fundamental mode Love waves would occurs yielding anomaly of particle motion polarity. However, there are little deep earthquakes along the west coast which generate the 1-st higher mode Rayleigh waves and thus we could not find clear evidence of the coupling.