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Study of Division Layers of the Earth's Inner Core with EFO Modes Recorded by GGP Stations

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The inner core with a radius of 1221 km is an important deep structure in the Earth. Some geophysical phenomena are directly related with the inner core. Poupinet et al found the abnormal travel times of PKIKP waves and Masters & Gilbert observed the anomalous spectral splitting of EFO. To explain the abnormal travel times and anomalous spectral splittings, Morelli et al and Woodhouse et al pointed out the anisotropy of the inner core. Deuss discussed the discrepancy between seismic data and mineral physical values for the inner core shear wave velocity and considered that it may be explained as the existence of fluid inclusions in the inner core. Sun and Song provided a tomographic inversion for three-dimensional anisotropy of the Earth's inner core. Their model has strong hemispherical and depth variation.

Sumatra Andaman Large Earthquake on Dec. 26, 2004 generated not only the Indian Ocean Tsunami but also the Earth's free oscillations (EFO). The signals of Earth's free oscillations were perfectly recorded by the superconducting gravimeters in the globe. After the pre-treatment and spectral analysis on the observation data from the five stations, we obtained total of 147 EFO modes including 43 fundamental modes, 5 radial modes and 99 harmonic modes. We have checked 13 inner-core-sensitive modes consist of 8 shear-wave-sensitive modes (3S2, 2S2, 10S2, 5S1, 4S7, 5S10, 7S13 and 9S4) and 5 compressive-wave-sensitive modes (4S0, 3S0, 8S1, 13S2 and 13S3).

By analyzing the eight observed shear-wave-sensitive modes, the inner core may be divides into three layers, which include the upper inner core (UIC) with low-velocity, the middle inner core (MIC) with high-velocity and the inner inner core (IIC) with very-low-velocity. The low boundary of UIC is about at the position between the probe depth of 5S10 mode (1221km-1070km) and the probe depth of 4S7 mode (1221km-1030km), we adopted the average depth of 171 km below the boundary of the inner core, which agrees with the inner transition zone reported by Song & Helmberger. The top boundary of IIC is close to the position between the probe depth of 2S2 mode (1221km-760km) and the probe depth of 4S7 mode (1221km-880km), we accepted the the average depth of about 400 km below the boundary of the inner core, which is larger 220 km than the distinct inner inner core described by Sun and Song. The very low shear velocity of IIC may be related with the existence of fluid inclusions in the inner core advanced by Deuss. MIC has a high shear velocity related possibly to the anisotropy zone in the inner core pointed out by Sun & Song .

On the basis of the analysis of five checked compressive-wave-sensitive modes, the inner core may be divides into two layers, which include the upper layer and the lower later. The low boundary of the upper layer is about at the position between the probe depth of 3S0 mode (1221km-850km) and the probe depth of 8S1 mode (1221km-1221km), the average depth of which is about 185 km below the boundary of the inner core and is close to the boundary of UIC determined by the P wave sensitive modes. However the checked P wave sensitive modes can not provide a distinct between MIC and IIC.

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