Regional variation of PKP(DF) slowness observed by Hi-net

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Clear core phases are observed at the Hi-net (Okada et al., 2004) for six events which occurred beneath S. America. Three of the 6 events occurred in around 20 degrees south (called Bolivia events), and three reminders in around 31 degrees south (called Argentina events). The differential travel times of PKP(BC) or PKP(Cdiff) minus PKP(DF) for the Bolivia events are larger about 0.5 s at epicentral distance 155 degrees, and 1.0 s at 160 degrees than those for the Argentina events. To confirm the source of this anomaly, we examined the selected 2 Bolivia events and 1 Argentina event which are large enough to generate clear core phases at more than 50 stations, and calculated the slowness of PKP(DF) and PKP(Cdiff) from the travel times whose epicentral distance is between 153 and 158 degrees. The effect of heterogeneous structure beneath the stations is corrected using the travel time residuals for a California event, because the back-azimuth for the California event is close to those for the Bolivia events. The slownesses of PKP(Cdiff) for the three events are about 2.2 deg/s, which suggests lower velocity in the lowermost outer core compared with PREM. The slowness of PKP(DF) for the Bolivia events is about 1.4 deg/s. On the while, that for the Argentina event is about 1.3 deg/s. These results show that the cause of the differences of the differential traveltimes between the Bolivia events and the Argentina events is in the inner core. PREM is used for the reference model.

The back azimuths for the Argentina events are close to those for Hawaii events. We compared the residuals for a Hawaii event to those for the California event observed at J-array stations, because we cannot find clear arrivals for Hawaii events in Hi-net records. The differences of the residuals observed at the same stations do not show a distance dependence. This result shows that the station correction we used is appropriate. Next we analyzed the differential travel times of PKP(AB) minus PKP(DF) or PKP(Cdiff) for an Argentina event and a Bolivia event. The observed differentials of PKP(AB) minus PKP(Cdiff) for the Argentina event and of PKP(AB) minus PKP(DF) or PKP(Cdiff) for the Bolivia event are closed to the theoretical differentials. On the while, the observed differentials of PKP(AB) minus PKP(DF) for the Argentina event are larger than the theoretical ones, and become larger as the epicentral distance becomes large. This result supports our conclusion that the cause of the difference of the differential travel times between the Bolivia events and the Argentina events is in the inner core. We confirmed the 3.5 percent axisymmetric anisotropy of the inner core can be ruled out as the cause of the differences.

Our data sample the region at depths between 300 and 400 km. The distances between the turning points for the two events are about 400 km. Kaneshima (1996) showed the lateral heterogeneity of the uppermost inner core using the global waveform dataset and insisted the observed differential travel times are too large to be explained with models in which lateral variation is restricted within the peer 200 km of the inner core. Niu and Wen (2001) also showed the lateral variation of the velocity structure at the top of the inner core. Our and Kaneshima's results suggest that the lateral heterogeneous structure exists in the upper 1/3 of the inner core.

The value of 2.2 deg/s of the Cdiff slowness can be explained with the model which has a 150 km flat velocity zone at the lowermost outer core. This model is close to AK135, the models which Nakanishi (1990) and Souriau and Poupinet (1991) showed. The theoretical slowness is calculated from the synthesized waveform calculated by using the Direct Solution Model (Takeuchi et al., 1996).