

Tilted 220 km discontinuity beneath the Indian Ocean observed by the P'P' precursor

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P'P' precursors have been used to detect and quantify the 420 and 660 km seismic discontinuities (Nakanishi 1988, Benz and Vidale 1983). The sporadic appearance of the P'P' precursors has been a puzzle, some interpreted a false detection as a diminished discontinuity including the thickening of the boundary and a decrease of the velocity jump across the boundary, others tried to explain the change of the precursor amplitude by the 420 and 660 km boundary topography which causes focusing and defocusing of the reflected seismic rays (Davis et al., 1989).

USArray, a sub-continental scale seismographic array with well distributed more than 300 seismic sensors, had full fledged in the last few years and started strolling in North America. The array enabled us to measure the P'P' reflection points within an area of more than the scale of 1000 km by a single earthquake. It turned out that P'P' precursors from a cluster of earthquakes occurring in a small area are always recorded by USArray or local seismographic arrays in pre-USArray dates. The detected precursors have a slowness -4.5sec/deg , comparable to that of the P'P'ab phase and its timing relative to the surface reflection P'P'ab phase constrain the depth of the reflector. Earthquakes more than 300 km away from the cluster do not register 220 km precursors. The polarity of the precursors is the same to that of surface reflection, indicating a seismic velocity increase downward across the discontinuity. The amplitude of the precursors is about .3 of the P'P'ab surface reflection phase and its horizontal slowness significantly larger than that of P'P'ab by about 0.5sec/deg . The measured horizontal slowness and the traveltime of the precursors are explained that the precursors are reflected at about 170 degrees away from the seismic array.

Compared with the 660 km reflection cases, the large amplitude ratio between the 220 km precursors and surface reflections is explained by the seismic ray which focuses near the antipode of the epicenter, close to the triple junction in the Indian ocean, is reflected by a slightly tilted 220km discontinuity and changes its seismic ray angle. An analysis shows that the 220 km discontinuity forms a uniform slope in the area more than 500 km and consequently the topography of the 220 km discontinuity undulates by more than 20 km.

The ubiquity of the 220 km discontinuity in the oceanic arc has been argued (Gu, et al. 2001, Deuss and Woodhouse 2002). In these studies long-period SS waveform are collected and stacked to detect the precursors. If the discontinuity is uniformly tilted in a wide area larger than the seismic wavelength, the SS precursor would be difficult to detect in the area. This caution should be in mind in interpreting the discontinuity map revealed by the long-period SS precursors.