

Observed later phases for the aftershocks of the Tokachi-Oki earthquake, 2003 - 1. Reflection at the bottom of the Pacific slab

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Aftershocks of the Tokachi-Oki earthquake (M 8.0), 2003 are distributed over a rather large area (200 km x 150 km). We sometimes find a clear later phase between direct P and S waves on the waveforms recorded at NIED Hi-net stations. In this study, we investigate the characteristics of this later phase.

We select aftershocks with magnitude greater than 3.5 and occurred from September 26 to December 31, 2003. We divide NIED Hi-net stations in the Hokkaido and the Tohoku regions into 4 groups according to their locations: eastern and southern Hokkaido, and northern and southern Tohoku. From the line-up waveforms we find that the appearance of this later phase depends on both the source and station locations. We find a distinct later phase around 7 to 9 s after P arrival for stations in the Tohoku regions. For stations in the northern Tohoku region, the amplitude of this phase is larger than that of the direct P. For stations in the Pacific side of the southern Tohoku region, the amplitude is similar or smaller than that of the direct P. This phase can be also found for stations in southern Hokkaido region, but not for stations in the central and eastern Hokkaido region. The apparent velocity of this phase is 7.7 - 7.8km/s. At stations in the northern Tohoku region, the vertical component is the dominant for this phase. The spectral characteristics of it are similar to the direct P wave and its arriving time is earlier than S wave. We believe this later phase belongs to P wave group.

In the northern Tohoku region, the amplitude of this later phase is larger than that of direct P wave. In the Pacific side of the southern Tohoku region, its amplitude is similar or smaller than direct P wave one. In the Japan Sea side of the southern Tohoku region and the southern Hokkaido region, we can also find the later phase, but it is hard to detect the existence of this phase in the central and eastern Hokkaido.. At the stations in northern Tohoku region, the vertical component is dominant for this phase. Furthermore, the spectral characteristics are similar with the direct P wave. Therefore, this later phase is kinds of P wave.

This phase appears only for earthquakes located in the following areas. (1) The area corresponds to the southern edge of the Erimo spur at the location around 41.4N; 144.3E. (2) The area lies on 70 km from the trench axis to the Hokkaido side. (3) The area located in the eastern side of the Japan Trench (around 145E). For earthquakes occurred in the far-off of Kushiro, no later phase has been found at stations in the Tohoku region. Most of those earthquakes are located in the continental crust, with few of them distributed around the slab boundary. The CMT mechanism solutions are mainly reverse faults or strike-slip faults with SE-NW compression except that the event occurred in the eastern side of the Japan Trench shows normal fault with SE-NW extension.

We find that the above aftershock areas (1) and (3) are near the bending zone of the subducting Pacific slab. The later phase can be clearly identified at stations in Tohoku region but not for stations in the eastern Hokkaido region. The observed later phase may be considered as P waves reflected at the bottom boundary of the Pacific slab. However, the aftershock region is around the southwestern edge of the Hidaka collision zone. The geophysical condition there could be very complex. Further discussions on the cause of this later phase requires to consider the structures such as the discontinuity between the Kuril arc and the Japan arc and simulating, numerically how and where the later phases should be excited.