THE DESCENDING SLAB BENEATH THE KURILE-KAMCHATKA ARC AND ITS INFLUENCE ON RAY PATHS OF BODY WAVES

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An understanding of the effects of a subducted plate on seismic wave transmission is crucial for improving seismological analysis, which will lead to a better understanding of the subducted zone. By far, seismological methods are the most powerful tool for probing this part of the lithosphere where most earthquakes occur. In this investigation, we determine the geometry of the slab appropriate to the Kurile-Kamchatka arc and its influence on the emergence points of the rays (and thus on focal mechanisms), the amplitudes and the travel times of P waves. The Hypocenter File of the NOS for the 1961-1971 decade offers a data base for determining the orientation and character of the sub-Kurile slab from seismicity data.

To obtain the geometrical shape of the slab, we examine the distribution of foci both on a horizontal projection as well as on 17 vertical sections, each of 5° angular spread, normal to the arc. Hypocenters for each vertical section are taken from epicenters within each of 17 radial sectors. The sectors are defined by the circular property of the island arc. The required shape in planar form is realized by fixing the (focal) plane through the densest part in the vertical sections of the hypocenters. As a restraint this surface is made to pass through the trench axis at zero depth as our reference. Some contortions, resulting from changes in the dip both with depth and laterally, are noted. These are most pronounced around the Kurile-Hokkaido junction. For the purpose of three-dimensional ray tracing, the velocity inside the slab is taken to be 7 per cent higher than

that of the surrounding medium at comparable depth.

Six earthquakes were selected, with careful considerations given to the signal qualities, the azimuthal distribution of stations, and the hypocenter locations along the extent of the arc and with respect to the slab. All foci are close to or above the upper boundary of the slab. Three are of intermediate focal depth, whereas the other three are shallow shocks. The focal mechanisms are well determined in all cases by the use of P polarity and S polarization data.

Emergence-point-corrections of the station positions do not indicate significant changes caused by the distortion of the ray paths by the slab. The original focal mechanism solutions are thereby reaffirmed.

The observed amplitudes, corrected for the instrument, the crust below the station, the absorption in the mantle, and the source mechanism, indicate a possible effect of the slab in the southwest (enlarged amplitudes), in the northwest (reduced amplitudes), and to the north (enlarged amplitudes), while they are inconclusive to the northeast and south. An interesting correlation of the azimuthal aperture of the amplitudes to the southwest with the source positions along the arc is noted; the window increases in aperture for epicenters moving from the southwest to the northeast.

The hypothetical slab-model travel-time residuals are compared with the observed travel-time residuals. Good agreement is achieved within about 1 second (arrivals are late) at most azimuths, and to the south within about 2 seconds (arrivals are early).

Attempts to correlate amplitudes and travel-time residuals are partly successful, but more rigorous methods are needed for this.

Future studies may focus on well-controlled stations and well-distributed foci rather than using any and all available stations. This selection, if possible, will allow more direct comparisons, thus attaining better resolving power.