Seismic reflectivity of the Hidaka crust

Kentaro Yasunaga[1], Mamoru Takanashi[1], # Kyuichi Kanagawa[2], Tanio Ito[3], Osamu Nishizawa[4]

[1] Grad. School Sci. & Tech., Chiba Univ., [2] Dept. Earth Sci., Chiba Univ., [3] Dept. Earth Sciences, Fac. Sci., Chiba Univ., [4] GSJ

The Main Zone of the Hidaka metamorphic belt represents a partial section through the ancient Kuril arc crust referred here to the Hidaka crust, whose upper 23 km is estimated to be exposed at the surface along the Hidaka Main Thrust by collision of the Kuril arc against the Northeast Japan arc since middle Miocene (Komatsu et al., 1983). We compare a combined seismic reflection profile across the Hidaka collision zone with a synthetic seismogram based on laboratory-measured densities and acoustic velocities of the Main Zone rocks, and discuss the seismic reflectivity of the Hidaka crust.

A series of recent seismic reflection profiling across the Hidaka collision zone consists of 94 Hidaka (Arita et al., 1998), 96 Hidaka (Ikawa et al., 1997) and 97 Hidaka (Tsumura et al., 1999). A combined seismic reflection profile of these three experiments reveals a strongly reflective and laminated feature of the Hidaka lower crust as well as a relatively transparent feature of the Hidaka upper crust, as commonly observed in other seismic profiles of continental crusts. The upper part of the Hidaka lower crust characterized by numerous east-dipping reflectors and its lower part dominated by west-dipping reflectors suggest a delamination-wedge structure of the Hidaka crust, with its upper lower crust and upward being thrust up along the Hidaka Main Thrust, while its lower lower crust descending downward (Tsumura et al., 1999).

The Hidaka metamorphic Main Zone is composed of greenschist- and amphibolite-facies felsic metamorphic rocks and tonalite with migmatite in its upper main part, while it is dominated by granulite-facies amphibolite frequently intercalated with 5-200 m thick layers of felsic granulite and tonalite. Felsic metamorphic and igneous rocks have densities of 2.7-2.8 g/cm^3, and P-wave velocities of 5.4-5.8 km/s in the foliation-normal direction at 150 MPa confining pressures where the effects of cracks are negligible. In contrast, amphibolites have densities of about 3.0 g/cm^3 and P-wave velocities of 5.9-6.2 km/s.

We have used acoustic impedance values of samples in the foliation-normal direction to simulate near-vertical ray propagation through the Hidaka crust with horizontal lithologic layering. Because the seismic reflection data of the 94-97 Hidaka show dominant frequencies of 5-35 Hz, a zero-offset synthetic seismogram was generated by convolving the time series of reflection coefficients with a zero-phase band-pass filtered wavelet of 5-35 Hz. The resulting synthetic seismogram shows scarce and weak reflections in the upper main part while many strong reflections in the basal part, indicating the rather transparent upper main part and the strongly reflective basal part of the exposed Hidaka crust.

The seismic reflectivity of the exposed Hidaka crust expected from 1-D seismic reflection modeling is well correlatable with that of the Hidaka crust above the Hidaka Main Thrust revealed by the recent seismic reflection profiling, which supports that a partial Hidaka crust above the uppermost part of its seismically laminated lower crust is exposed at the surface. Our 1-D seismic reflection model for the exposed Hidaka crust shows that the transparent upper main part results from the overall similarity in acoustic impedance values of felsic rocks, as well as that the interlayering of amphibolite and felsic rocks with large contrasts in acoustic impedance produces strong reflections in the basal part.