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Seismological structure around Moho discontinuity: A view of an exposed crustal section of the Kohistan arc

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Interpretation of seismic structure around Moho discontinuity in island arc is important to understand the nature and growth of island arc. Seismic experiments have been carried out at a number of oceanic island arcs, such as the Aleutian, and Izu-Bonin-Mariana arcs. However, experimental investigations of Vp and Vs of rocks are often limited to shallow part (upper to middle crust and/or upper part of lower crust) because of limitation of the exposure of deep crustal rocks. The Kohistan arc, northern Pakistan, shows broad exposure of lowermost crustal rocks. Vp and Vs measurements for the Kohistan arc lowermost crustal rocks have been carried out by some studies (Burlini et al., 2005; Chroston and Simmons, 1989; Miller and Christensen, 1994; Kono et al., 2004; 2007; 2009). Here I show the seismic structure of the exposed lowermost crustal sections of the Kohistan arc, based on Vp and Vs measurements of various rock samples at room temperature (Miller and Christensen, 1994) coupled with high pressure and high temperature Vp and/or Vs results reported by Kono et al. (2004; 2007; 2009).
The lowermost part of the Kohistan arc mainly consists of garnet-free and garnet-bearing high-grade metamorphic rocks, and ultramafic rocks (pyroxenite and dunite). The upper part is composed of two-pyroxene granulite, garnet granulite, and garnet pyroxenite (or garnet hornblendite). High-pressure and room temperature measurements showed that garnet granulite had higher Vp and Vs (~0.3 km/s) than two-pyroxene granulite. Vp and Vs increased with increasing volume fraction of garnet. In contrast, plagioclase-free garnet pyroxenite showed significantly higher Vp and Vs than plagioclase-rich garnet granulite mainly due to the low Vp and Vs of plagioclase. High Vp and Vs of the garnet pyroxenite is relatively close to dunite. The significantly high Vp and Vs of the garnet pyroxenite yielded high reflection coefficients between the garnet granulite and garnet pyroxenite of up to 0.13 for P-waves and 0.14 for S-waves, comparable to values expected for Moho reflection. In addition, high-temperature Vp and Vs measurements have indicated strong Vp and Vs reductions in plagioclase-rich granulites and plagioclase aggregates above 400 ?C (Kono et al., 2004; 2006; 2008), while garnet pyroxenite showed markedly lower temperature dependence of Vp. Therefore, the difference in the Vp and Vs between garnet granulite and garnet pyroxenite would be enhanced under high-temperature conditions in the arc lowermost crust by the differences in the temperature derivatives of Vp and Vs. We conclude that the boundary between plagioclase-rich garnet granulite and plagioclase-free garnet pyroxenite yield the strongest seismic discontinuity in the Kohistan arc, which would correspond to Moho discontinuity. In addition to the strongest reflection coefficient between garnet granulite and garnet pyroxenite, we also found a relatively large reflection coefficient between garnet pyroxenite and pyroxenite. Such reflection might be observed in the underlying upper mantle.

Keywords: Moho, island arc, Kohistan, Seismic wave velocity