High pressure P-wave velocity measurement in Ichino-megata ultrabasic xenoliths: Petrologic model of NE Honshu arc

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P-wave velocity of lower crust beneath Northeast Japan mainland (NE Honshu) is 0.3 - 0.5 km/s lower than that of the Izu-Bonin, the Aleutian arcs and the average continental crust. In order to identify lithological and chemical characteristics of the lower crust of the NE Honshu arc, we measured compressional wave velocity (Vp) of crustal and mantle xenoliths incorporated in Quaternary volcanics in Ichino-megata at high pressure up to 1.0GPa. These xenoliths subjected to ultrasonic measurements were hornblende gabbros (38.6, 41.3 wt.% SiO2), amphibolites (36.1, 36.3, 43.8 wt.% SiO2), spinel lherzolites (46.2, 47.2 wt.% SiO2) and biotite granite (72.1 wt.% SiO2). Core rock samples of 12 mm in length and 14 mm in diameter were pressurized in a piston-cylinder apparatus with 34 mm internal diameter from 0.1 to 1.0 GPa at temperatures from 25 to 400 degree C.

Vp rapidly increased from 0.2 to 0.4 GPa, gradually increased from 0.4 to 0.7 GPa and was nearly constant from 0.7 to 1.0 GPa during pressurizing process. During depressurizing process, a slight decrease in Vp was observed until 0.4 - 0.5 GPa and subsequently Vp dropped rapidly at lower pressure than 0.4 GPa. Experimental results at 25 degree C and 1.0 GPa are summarized as follows. Vp of hornblende gabbros (38.6, 41.3 wt.% SiO2) and amphibolites (36.3, 38.1, 43.8 wt.% SiO2) were determined 6.71 km/s, 7.22 km/s and 7.04 km/s, 6.85 km/s, 7.24 km/s, respectively. Vp of 8.12 km/s and 8.03 km/s were obtained for spinel lherzolite samples (46.2, 47.2 wt.% SiO2), respectively. Vp of biotite granite (72.1 wt.% SiO2) was 6.30 km/s.

Vp of hornblende gabbro is nearly constant at temperature from 25 to 400 degree C. Similar results were also obtained in spinel lherzolites. However the Vp of amphibolites (36.3, 43.8 wt.% SiO2) at 400 degree C is 0.10 - 0.21 km/s lower than that at 25 degree C.

In relationships between measured Vp and SiO2 contents, we paid attention to a relation in amphibolites (HG-01, 05, 21) and hornblende gabbros (HG-08, 11) especially. The well-known silica-velocity trend of Rudnick and Fountain (1995) is shown for comparison. In generally it is believed that P-wave velocity increase as SiO2 content decreases (e.g. Rudnick and Fountain, 1995; Vp = -0.038*SiO2 wt.% + 8.91). However P-wave velocities for Ichino-megata lower custal xenoliths are much lower than those estimated from the relation above which give velocity of 7.24 km/s, 6.85 km/s, 7.04 km/s and 7.22km/s, 6.71km/s for amphibolites (HG-01, 05, 21) and hornblende gabbros (HG-08, 11). On the other word, it is clear that P-wave velocity increases as SiO2 content increases, that is, has a positive liner correlation, for Ichino-megata lower custal xenoliths.

We compared Vp of these xenoliths with the seismic profile in the NE Honshu arc of Iwasaki et al. (2001). Vp of hornblende gabbro (41.3 wt.% SiO2) and amphibolite (43.8 wt.% SiO2) are comparable to the lowermost crust and Vp of low silica hornblende gabbro (38.6 wt.%) and amphibolites (36.3, 38.1 wt.%) is nearly equivalent to velocity of the upper-lower crust. Relatively slow P-wave velocity in the lower crust of the NE Honshu arc is probably attributed to high hornblende abundance. We conclude that ultrabasic or basic lower crust of 12 km thickness exists beneath the NE Honshu arc. If it takes into account that the upper crust is mainly composed of granite, the crust of NE Honshu arc is likely basaltic in its average composition.