Seismic wave velocity at 1.0 GPa and up to 1000 C

Yoshio Kono[1], Masahiro Ishikawa[2], Makoto Arima[3]

[1] Environment and Information Sciences, Yokohama Nat. Univ., [2] Graduate School Environment & Information Sci, Yokohama National Univ, [3] Geolo. Instit. Yokohama Natl. Univ.

Laboratory measurements of seismic velocities of various rocks at high temperatures and high pressures corresponding to the lower-middle crustal conditions give important constraints for evaluation of structure of the continental crust (ex. Rudnick and Fountain, 1996). We are developing a new experimental method, which enable us to make precise measurement of P- and S-wave velocities of rock samples under lower crust to upper mantle conditions. In our previous experiments, seismic velocities could not be detected at higher temperatures than 400 C. In the new experimental method, we placed Pt buffer rod (20mm length) between the rock sample and the transducer (LiNbO3) in order to deduce temperature at the top of the transducers. Temperature at a top of the transducer is less than 400C when that of the rock sample is 1200C. P-wave velocity were measured for a cylinder-shaped rock sample of 6 mm in diameter and 6 mm in length. Rock sample used in this study is a garnet clinopyroxenite from Kohistan terrane, northern Pakistan. The rock sample was loaded in a BM sleeve then placed into a talc sleeve. The sample is a medium grained homogeneous rock and mainly composed of garnet and clinopyroxene. We used a piston-cylinder apparatus (34mm borehole) with the talc-BN-graphite cell assemblage. Seismic wave velocities were measured using the pulse transmission technique. To obtain the travel time through Pt buffer rods without rock sample, dummy experiments were carried out at various temperatures and pressures, in which two Pt rods were in direct contact each other at the center of the high-pressure cell.

The travel time through the rock sample slightly decreases with increasing pressure at the room temperature. At 1.0 GPa, it slightly increases with increasing temperature up to about 700C but it showed an abrupt increase at temperatures above 700 C. After the run at 1.0 GPa and 1100C, the length of Pt buffer rod was shortened less than 1 %. Rock sample and pressure medium were examined with optical microscope and EPMA. In the run product at 1.0 GPa and 1100C, glasses and newly formed minerals were identified around the rock sample. The newly formed mineral (Mg-oxide) is composed mainly of MgO with moderate FeO. The glass around the new minerals contains SiO2 (more than 70%) with moderate Al2O3, FeO and CaO. Comparing to the composition before the run, the garnet in the run product has slightly higher Al2O3 and lower Fe, and the clinopyroxene exhibits significantly lower Al2O3, FeO and CaO contents. Enstatite, glasses and rare quartz are observed around the BN sleeve suggesting the talc breakdown reaction (cf. talc=3enstatite+quartz+H2O at 1.0 GPa and about 700C, Chernosky, 1985). The results suggest that the rock sample was not in the closed system during experiment and dehydration reactions in both rock sample and pressure transmitting medium give considerable effect on the velocity measurement at high temperatures (above 700C). The abrupt increase in travel time above 700C was probably due to the dehydration reaction of the talc sleeve. For measurements of elastic velocity at high temperatures above 700C, we are developing new experimental techniques employing a sealed platinum capsule. This technique enables us to obtain precise seismic properties of hydrated rocks, partially melted rocks, and rocks under fluid-present condition.