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Seismic velocities of crustal rocks and minerals

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Recently, seismologists obtain high-resolution data of crust and mantle on distribution of seismic wave velocities (e.g., Nakajima et al., 2001). For interpretation the origin of distribution of seismic wave velocities, we have to know the relation between chemical variation and its seismological signature. There are two methods to obtain the relation. The first is direct seismic velocities measurement of bulk rock (multi-phases sample) by using high-pressure apparatus (e.g., Nishimoto et al. 2008; Kono et al. 2009). The second is theoretical calculation by using the data of well-defined thermoelastic parameters of minerals and modal composition. We can calculate the seismic velocities of rocks at various temperatures and pressures in the Earth's interior if some important thermoelastic parameters of constituent minerals, such as bulk modulus, its pressure derivative, density, Debye temperature, Gruneisen parameter, shear modulus and its pressure derivative at room pressure and temperature are obtained. Recently, we can obtain reliable thermoelastic parameters of upper mantle minerals by literatures in wide pressure and temperatures range, which cover the whole upper mantle of the Earth (e.g., compiled by Matsukage et al., 2005). Therefore the calculated seismic velocities of mantle rocks such as lherzolite and harzburgite can be compared directly with the seismic velocities profiles observed by seismologists (e.g. PREM, AK135).

On the other hand, the thermoelastic parameters of crustal minerals (e.g., amphibole and plagioclase) are not determined very well because of at least two experimental difficulties. The first problem is the low symmetric crystal structure of crustal minerals. The second problem is the narrow stability field, less than ˜3GPa and ˜1300 K. In this study, we try to calculate the thermoelastic parameters of crustal minerals by using the P-V-T equation of state data and heat capacity measured by previous studies, and estimate the seismic velocities of gabbroic and eclogite rocks with various chemical compositions at high-pressure and high-temperature. We also try to measure the elastic wave velocities and density (P-V-T data) of plagioclase and amphibole by using the multi-anvil apparatus with synchrotron X-ray in SPring-8. In this presentation, we are going to discuss the reliability of the calculation and show the relation between chemical variation of crustal rocks and its seismological signature.

Keywords: seismic velocity, gabbro, eclogite, plagioclase, amphibole, pyroxene