# Changes in seismic wave velocity during brittle deformation of gabbro and peridotite

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The Moho is defined as a discontinuity of seismic wave velocity and often interpreted to be the crust-mantle boundary. The oceanic crust is continuously created by magma system at the mid ocean ridge; consequently, the discontinuity of seismic wave velocity and/or sharp seismic reflection at the Moho is expected to be laterally uniform. However, recent seismic observations reported regional variations of the Moho reflectivity (e.g., Mutter and Carton, 2013; Ohira et al., 2018). As seismic wave velocity is greatly influenced by nucleation and growth of microcracks, such seismic anomaly at the Moho can be influenced by microcracks. We found that minor amounts of dilatancy in peridotite relative to mafic rocks based on strain measurements during triaxial deformation tests using these rocks (Akamatsu et al., 2019). This contrasting dilatant behaviors possibly lead to different evolution of seismic wave velocity between crust and mantle, and potentially cause the regional seismic anomaly in the oceanic plate. In this study, we measured elastic wave velocities of gabbro and peridotite during triaxial deformation experiments, and discussed how brittle deformation influences on the seismic velocity and reflectivity.

We used gabbro collected from the Oman ophiolite, and peridotite collected from the Horoman Complex. Triaxial deformation experiments were performed with intra-vessel deformation and fluid flow apparatus at room temperature, a constant strain rate of ~$10^{-6}$ $s^{-1}$, and a constant confining pressure of 20 MPa. Compressional and shear waves traveling in a direction normal to the loading axis were measured during deformation, where shear waves were polarized normal and parallel to the loading axis. Seismic wave velocities were determined by a pulse transmission method, in which travel times of seismic waves through the sample were measured.

In gabbros, both Vp and Vs markedly decreased (Vp: ~40%, Vs: ~30%) as the samples approache failure. Crack density inverted from the velocities showed anisotropic crack orientation, where microcracks parallel to the loading axis (axial microcracks) were dominantly created. These results correspond to strain data and microstructural observation of recovered samples after deformation (Akamatsu et al., 2019). On the other hand, in peridotites, a small decrease in Vp and Vs (<20%) were observed up to the maximum stress, and inverted crack density showed no significant increase in axial microcracks. This indicates that microcracks developed in peridotites were mainly "mode II" shear microcracks, corresponding to strain data and microstructural observation. These contrasting evolutions of seismic wave velocity and crack density between gabbro and peridotite during brittle deformation can modify the seismic discontinuity and reflectivity at the Moho, and contribute to the variation of the Moho in the oceanic plate.

Keywords: Peridotite, Gabbro, Seismic wave velocity, Brittle deformation, Dilatancy, Microcrack

 