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Seismic Velocities of Serpentinized Peridotites from the Higashi-Akaishi Body

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Serpentines play key roles in subduction zone processes including transport of water and slab-mantle coupling. Seismic properties of serpentinized peridotites are critical for seismological mapping of serpentinized regions, which leads to our good understanding of subduction zone processes. In order to understand the influence of serpentinization on seismic properties of peridotites, compressional and shear wave velocities of serpentinized peridotites were measured, and petrofabrics were examined by optical microscopy and SEM-EBSD.

Rock samples were collected from the Higashi-Akaishi Body (HA), Southwest Japan. HA is an olivine dominated kilometer-scale sliver of forearc mantle that preserves subduction deformation fabrics that locally include serpentines. We selected samples with antigorite content of 10, 14, and 39 vol%. They also contain small amounts of lizardite (<4 vol%). Olivine grains are almost randomly oriented. This is likely to be caused by grain boundary rotation of olivine grains assisted by sliding along the boundaries with antigorite. Major axes of antigorite grains are parallel or subparallel to the foliation. CPO data shows that b-axes of antigorite are well aligned parallel to the lineation and c-axes normal to the foliation.

Velocity measurements by the pulse transmission technique (Central frequency=2 MHz) were conducted at room temperature and confining pressures of up to 180 MPa, at which the influence of pores on velocities is sufficiently small. The fastest compressional wave velocity is observed in the direction parallel to the lineation, and the slowest in the direction normal to the foliation. The shear wave oscillating parallel to the foliation has higher velocity than that oscillating normal to the foliation. As the antigorite content increases, the mean velocity decreases and both azimuthal and polarization anisotropies are enhanced. The compressional wave velocity increases in the direction parallel to the lineation, while it decreases in the direction normal to the foliation.

Measured velocities are primarily controlled by the amount of antigorite. Olivine grains are almost randomly oriented, and most of antigorite grains have the same orientation. The b-axes are parallel to the lineation, and the c-axes normal to the foliation. The compressional wave velocity of antigorite is slowest in the c-axis direction (~5.6 km/s), and fastest (~8.9 km/s) in the a- and b-directions (Bezacier et al., 2009). As the amount of antigorite increases, the compressional wave velocity increases in the direction parallel to the lineation, whereas it decreases in that normal to the foliation. This leads to the decrease in mean velocity and the enhancement of anisotropy. A serpentinized layer on the top of subducting slab works as a reflector to a normally incident compressional wave, though it cannot make a significant splitting of shear waves.

Keywords: seismic velocity, serpentinite, antigorite, water, wedge mantle