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Elasticity of antigorite and glaucophane: anisotropy in the subduction zones

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Subduction zones are known for their recycling of hydrated materials (sediments, hydrated oceanic crust and upper mantle) that are subjected to metamorphic processes and deformation at depth. In order to detect these materials by seismology, knowledge of the elastic properties of these rocks is required. We studied serpentinites, blueschists and eclogites deformed in the high-pressure low-temperature context of subduction zones. To model the anisotropy of deformed rocks, single-crystal elastic properties of antigorite and glaucophane were measured using Brillouin spectroscopy under ambient conditions. In addition, lattice preferred orientations of antigorite and glaucophane were determined using an electron back-scattering diffraction (EBSD) technique. Antigorite and deformed serpentinites have a very high seismic anisotropy and remarkably low velocities along particular directions. $V_P$varies between 8.9 and 5.6 (46% anisotropy), and 8.3 and 5.8 (37%), and $V_S$between 5.1 and 2.5 (66%), and 4.7 and 2.9 km.s^{-1}(50%) for the single-crystal and aggregate, respectively. Deformed serpentinites can present seismic velocities similar to peridotites for wave propagation parallel to the foliation or lower than crustal rocks for wave propagation perpendicular to the foliation. For glaucophane, the mean P- and S-wave velocities are high (7.8 and 4.6 km.s^{-1}respectively), as well as anisotropy of 38.1% (AV_P) and 27.3% (AV_S). Although glaucophane-bearing eclogite seismic anisotropies are very weak (AV_P=2.9% and AV_S=1.7%), they are characterized by a maximum P-wave velocity sub-parallel to the lineation and by a minimum velocity normal to the foliation. The mean P- and S-wave velocities are high (7.9 and 4.7 km.s^{-1}, respectively). Blueschists present stronger anisotropies than eclogites (AV_P=15.7% and AV_S=10.3%) and velocity patterns are similar.
These properties can be used to detect serpentinite, blueschist and eclogite and discuss the relationships between seismic anisotropy and deformation in the mantle wedge and in the subducting plate. The shear wave splitting up to 1-1.5s for serpentinite can be explained with moderately thick (10-20km) serpentinite bodies. The calculated delay times for a 7-km thick layer of eclogite or blueschist are low for eclogite (<0.03s), but significant for blueschist (0.16s).

Keywords: elasticity, antigorite, glaucophane, anisotropy, shear wave splitting