CRYSTALS, GRAINS OR CRACKS? CAUSES FOR SEISMIC ANISOTROPY IN ROCKS FROM THE ECLOGITE ZONE, TAUERN WINDOW, AUSTRIA

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Crystallographic preferred orientations (CPO) and microcracks are major causes for seismic (P- and S-wave) anisotropy in rocks. To assess their relative importance we experimentally determined compressional (Vp) and shear wave (Vs) velocities on cubic samples with edge lengths of 43 mm in a triaxial multianvil apparatus using the ultrasonic pulse transmission technique. Investigated metasediment and variably retrogressed eclogite samples come from the Eclogite Zone in the Tauern Window, Austria. At successive isotropic stress states up to 600 MPa and room temperature measurements were related to the three principal fabric directions (X, Y, Z) representing the foliation (XY plane), the foliation normal (Z-direction) and the stretching lineation (X-direction). Progressive volumetric strain was logged by the individual piston displacements. Cumulative errors in Vp and Vs are estimated at <1%.

Microcrack closure contributes massively to increases in acoustic velocities and decrease of anisotropies up to 50 MPa (metasediments) and 150 MPa (eclogites), suggesting preferred orientations of cracks, and mineralogy and grain fabric influence on the mode of closure. Residual Vp anisotropies of about 6-16 % are attained at 300-400 MPa in eclogites (maximum Vp = 8.0-8.1 km/s, Vs = 4.4-4.6 km/s), about 5% at 300 MPa in a strongly retrogressed eclogite (maximum Vp = 7.4 km/s, Vs = 4.2 km/s), and about 6-17% at 200-250 MPa in the quartz-rich metasediments (maximum Vp = 6.1-6.5 km/s, Vs = 4.0-4.3 km/s). In the latter, white mica content and CPO mainly control anisotropy. Maximum wave velocities are parallel to the lineation and minimum velocities are perpendicular to the foliation in all samples. Shear wave splitting is strongest in the metasediments, and less pronounced in the eclogites. Seismic velocities and residual anisotropies in the metasediments correlate well with those computed from complete CPO measured by neutron diffraction. In the eclogites, however, experimentally determined seismic anisotropies are distinctly higher than those computed from CPO. This indicates a hitherto ignored but important contribution to seismic anisotropy, probably induced by the shape fabric of high-pressure silicates.