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Crystallographic preferred orientation and elastic anisotropy of high-pressure rocks from the Eclogite Zone of the Tauern Window, Austria

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High-resolution seismic imaging of the internal structures in subduction channels has so far not been possible. In part, this is due to a lack of knowledge regarding elastic wave velocities and their anisotropy, and textures (crystallographic preferred orientation, or CPO) of the rocks making up subduction channel fills. These are likely metabasalts of oceanic origin, and metamorphosed deep-sea sediments. All these rock types contain polyphase mineral assemblages, and CPO is difficult to obtain when dealing with polyphase rocks, which are the common case in subduction channels. In this study, the mineral CPO of high pressure rocks was determined from time-of-flight neutron spectra applying full pattern fit method ('Rietveld texture analysis'). With this method, it is possible to investigate polyphase samples, since the CPOs of all mineral phases can be determined simultaneously despite overlapping Bragg reflections in the spectra. From the CPO, 3D models for P-wave velocity anisotropies were calculated. This was done using the Christoffel equation, which considers the measured CPO and the single crystal elastic constants and density of the constituent phases.

Since subduction channels are not directly accessible, samples were collected in the Eclogite Zone of the Tauern Window, Austria. This is a paleo-subduction channel of the Alpine orogen, which originally formed in the Tertiary during subduction of the Penninic ocean beneath the Adriatic continent. It comprises eclogites, blueschists and greenschists, as well as micaschists, marbles and quarzites. The rocks have been exposed to P-T-conditions of 20-25 kbar and 600 +/- 30°C, and were exhumed in a very short time span of 1-2 Ma. A set of metasediments and metabasites with well-developed foliation were chosen for the study.

Here, we present the results of CPO analyses and bulk rock elastic anisotropies predicted from the CPO. In the eclogites, the CPO of omphacite, which is the main constituent phase (~40%), is well pronounced. Omphacite likewise determines the maximum P-wave velocity of the eclogites, leading to a maximum anisotropy of about 3%. The CPOs of micaschists display a clear foliation and lineation. Accordingly, slowest velocities are normal to the foliation plane. Maximum velocity anisotropy of the micaschists is about 7%. These results allow conclusions on seismic properties of rocks in subduction zones, as well as deeper structural levels of the Alps.