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Correlation of core and downhole seismic velocities in high-pressure metamorphic rocks: A case study for the COSC-1 borehole, Sweden

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Deeply rooted thrust zones are key features of tectonic processes and the evolution of mountain belts. Exhumed and deeply-eroded orogens like the Scandinavian Caledonides allow to study such systems from the surface. Previous seismic investigations of the Seve Nappe Complex have shown indications for a strong but discontinuous reflectivity of this thrust zone, which is only poorly understood. The correlation of seismic properties measured on borehole cores with surface seismic data can help to constrain the origin of this reflectivity. In this study, we compare seismic velocities measured on cores to in situ velocities measured in the borehole. The core and downhole velocities deviate by up to 2 km/s. However, velocities of mafic rocks are generally in close agreement. Seismic anisotropy increases from about 5 to 26 % at depth, indicating a transition from gneissic to schistose foliation. Differences in the core and downhole velocities are most likely the result of microcracks due to depressurization of the cores. Thus, seismic velocity can help to identify mafic rocks on different scales whereas the velocity signature of other lithologies is obscured in core-derived velocities. Metamorphic foliation on the other hand has a clear expression in seismic anisotropy. To further constrain the effects of mineral composition, microstructure and deformation on the measured seismic anisotropy, we conducted additional microscopic investigations on selected core samples. These analyses using electron-based microscopy and X-ray powder diffractometry indicate that the anisotropy is strongest for mica schists followed by amphibole-rich units. This also emphasizes that seismic velocity and anisotropy are of complementary importance to better distinguish the present lithological units. Our results will aid in the evaluation of core-derived seismic properties of high-grade metamorphic rocks at the COSC-1 borehole and elsewhere.