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Persistence of initial lithological heterogeneity to deep subduction conditions: Implications for the rheology of the subduction zone interface

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The subduction zone interface is a shear zone of varying thickness that defines the boundary between the subducting slab and overriding plate. The rheology of this shear zone controls several important aspects of subduction dynamics, but accurately estimating its rheology can be complex due to the wide range of subduction materials and their varying rheological properties. Of particular importance is the relative strengths of metasedimentary and metabasic rocks at various temperature and pressure conditions. To better understand these rheological contrasts in naturally deformed rocks, we are conducting field and microstructural work in the Eclogite Zone in the Tauern Window, Austria. The eclogite zone preserves intercalated metamafic (metabasalt and metagabbro) and metasedimentary (quartzite, garnet mica schist, marble and calc-schist) rocks that were subducted and exhumed to the surface as a single structural unit. Using high resolution drone imaging, 2D structural mapping, and 3D structural modeling, we have documented map-scale relationships between metamafic and metasedimentary rocks in the Eissee region near Matrei. Our mapping demonstrates that the mafic eclogites consistently define slabs, lenses and boudins of up to 2 km in along-strike length and 0.2 km in thickness, embedded within the metasedimentary units, all of which are relatively uniformly deformed to very high strain. This suggests that eclogitized metamafic rocks persisted as rheological heterogeneities within the subduction channel through both the subduction and exhumation paths. Additionally, we are using microstructural observations to document the deformation mechanisms of individual rock units and to understand the weakening mechanisms that allowed some of the eclogites to break down from boudins to strongly foliated layers intercalated with the metasediments. At the interface between select metasedimentary and eclogite units there is a marked rheological change in eclogite rheology, likely due to fluids leached from the metasedimentary rocks, resulting in strain localization and increased foliation development within eclogite layers from meter to micron length scales. Integration of our mapping, outcrop, and microstructural observations will provide insights into the length scales of rheological heterogeneity on the deep interface and large-scale geodynamics of subduction through influencing the bulk viscosity of the interface.