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Combined natural and numerical-modeling constraints on subduction interface strength at deep metamorphic conditions

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The integrated stress magnitude or bulk effective viscosity of subduction interface shear zones is a key component of both long- and short-term subduction dynamics. Current constraints on average subduction interface viscosity come from laboratory flow laws for subduction-related rock types and range from 10^{18} Pa.s (quartz-rich lithologies) to 10^{23} Pa.s (metabasaltic lithologies) for typical subduction strain rates and viscous subduction interface conditions (e.g. T between 400-900 °C). However, this viscosity range is based on end-member flow laws, which means it likely overestimates the true range in viscosity that is possible along the subduction interface. In nature, subduction shear zones are commonly a mixture of multiple rock types in various distributions (e.g. clast-matrix melanges); and furthermore, natural shear zones show a range in width from place to place, suggesting varying strain rates. Our goal in this study is to place more precise bounds on the global range of shear zone viscosity (or integrated shear stress) for natural subduction shear zones at deep subduction conditions. To do so, we curated a set of 9 geologic maps of eclogite facies shear zones from existing literature, focusing on those that a) show minimal retrogressive overprint, b) have defined shear zone widths, and c) have well-constrained PT conditions. These maps were digitized and implemented in a simple shear visco-elasto-plastic numerical model with constant strain rate (10^{-12} s^{-1}) boundary conditions and experimentally constrained flow laws assigned to each rock type, including eclogite (eclogite mafic blocks), wet quartz (quartz-rich blocks, schists, gneisses), blueschist (blueschist mafic blocks), wet olivine (peridotites), antigorite (serpentinites), and aragonite (calcareous blocks). Numerical experiments ran for a restricted amount of time steps to assure steady-state stress/viscosity (<10 ky). Resulting integrated shear stresses and viscosities were then compared for the different example shear zones. Initial results indicate that natural shear zones should exhibit effective viscosities that vary by at least 1-2 orders of magnitude at a specific temperature, depending on the distribution of weak vs. strong blocks and the matrix rheology. Additional results and statistical analysis of all of the shear zones will be presented at the meeting.