Shear heating in subduction zones resolves the hot rocks vs. cold models debate

Accurately inferring subduction zone thermal structure is crucial for predicting numerous chemical and physical phenomena. At present a 200-300 °C disparity occurs at depths of ~50 km between typical (cold) models vs. (hot) exhumed rocks. Fore-arc heat flow in modern subduction systems requires a heat source – inferred to be shear heating – with a typical friction coefficient of ~0.05. Adding such shear stresses to thermal models increases temperatures by 100-300 °C at depths of 30-80 km and reproduces the pressure-temperature conditions recorded by exhumed metamorphic rocks. Weakening of rocks (decreasing friction) above a specified temperature causes slab-top geotherms to steepen in P-T space (temperatures increase more slowly down the subduction interface). Hotter and drier rocks are denser than colder rocks, and harder to exhumate through buoyancy. Conceivably, exhumed metamorphic rocks might overrepresent old-cold subduction where rocks at the slab interface are wetter and more buoyant than in young-hot subduction zones.