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Forming a talc-rich slow slipping subduction interface: P-T-t-X history of metasomatic rocks

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The interface between subducting and overriding plates is fluid-rich, chemically dynamic, and seismogenic. Constitutive relationships and microstructural evidence suggest talc-rich rocks produced by metasomatism at this interface host episodic tremor and slow slip (ETS), but the chemical pathways producing talc and other metasomatic minerals remain unclear. Constraining the pressure-temperature-time-chemical evolution of such metasomatic rocks can reveal the full extent of their rheological impact. We apply field mapping, geochemistry, geochronology, and thermometry to a suite of talc-, chlorite-, and amphibole-rich metasomatic rocks from the Catalina Schist (California) that record evidence of episodic slow slip. These rocks compose the matrix of an exhumed subduction interface shear zone stratigraphically overlying coherent oceanic crust. Metasedimentary protoliths are converted to chlorite and actinolite schists and mantle wedge ultramafic rocks are converted to talc and actinolite schists. This metasomatism resulted from the local exchange of Na, LILE and REE from metasedimentary to ultramafic rocks, and Mg, Fe, Cr, and Ni from ultramafic to metasedimentary rocks. Magnesium isotopes record the extent of Mg loss and the role of CO_2-bearing fluids in producing large volumes of talc. All metasomatic rocks record infiltration of Ca-rich fluids from dehydration of underlying metabasalts. Raman spectroscopy of carbonaceous material and Zr-in-rutile thermometry of the metasomatic rocks indicate syn-kinematic metasomatism began during prograde subduction and continued through peak conditions comparable to those of modern ETS. Petrochronology of rutile and titanite overgrowths suggests the rutile-to-titanite reaction was catalyzed by metasomatism and constrains the timing of metasomatism to ~100 Ma, consistent with subduction of this portion of the Catalina Schist. Both local exchange between juxtaposed lithologies and external fluid infiltration were key in driving metasomatism of the subduction interface during prograde through peak subduction. The loss of Mg represents a new pathway for forming large volumes of talc at the subduction interface and suggests that juxtaposition of metasedimentary and ultramafic rocks at the subduction interface can produce the host lithology for slow slip. The source region of ETS is chemically dynamic and evolving and metasomatism plays a fundamental role in interface rheology and seismicity across a broad range of depths.