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Record of fluid-rock interaction in a long-lived subduction channel

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Subduction zones are the primary location for element recycling from the Earth's surface into the mantle. Subducting plates release slab-derived fluids that play a crucial role in generating intraslab earthquakes and serpentinization of the mantle wedge or flux melting of the mantle wedge to yield arc volcanism. Exhumed remnants of slab-mantle interfaces represent our only record, albeit incomplete, of the history of dehydration and fluid-rock interaction. Highly-retrogressed eclogites within the North Motagua Mélange in central Guatemala preserve extensive chemical alterations that record rehydration reactions at the plate interface at depths of ~80-30 km. Our new results suggest that these rocks reached peak burial at eclogite-facies conditions (550-600°C, 2.0-2.5 GPa) and were sliced off the slab at 114-113 Ma. These rocks also preserve two fluid-related retrogression events. An initial rehydration event at blueschist-facies conditions (500-550°C, 1.5-2.0 GPa) at 100-89 Ma is characterized by significant enrichments of fluid-mobile elements (e.g., K, Ba, Pb). At 82-73 Ma, the second retrogression stage occurred at epidote-amphibolite-facies conditions (450-500°C, 0.8-1.0 GPa) and was associated with Ca-Na-rich superimposed influx fluids. These two retrograde phases occurred during ~40 Ma of storage-decompression within the subduction interface prior to a final exhumation stage. Throughout this residence time, slab-derived fluids infiltrated the subduction interface, triggering mantle serpentinization, fluid-related vein crystallization, and chemical alteration of ascending eclogites. Our results suggest that retrograde eclogites and fluid-related rocks (e.g., jadeitites) in serpentinite matrices (frequently ignored due to their complexity) contain critical clues to reconstruct the record of physicochemical conditions of fluids migration in subduction zones and the timing of these fluid-rock interactions.