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MULTIPLE FLUID EVENTS DURING EXHUMATION OF THE TSO MORARI UHP ECLOGITE, NW INDIA: CONSTRAINTS FROM MINERALOGY, GEOCHEMISTRY, AND THERMODYNAMIC MODELLING

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The ultra-high pressure (UHP) metamorphism of Tso Morari eclogite in NW India has been intensively studied petrologically, mineralogically, and geochemically over the past several decades. Despite the wealth of literature on Tso Morari, its fluid history (e.g., fluid compositions and sources, pressure-temperature conditions of hydration/dehydration reactions, etc.) is still unconstrained. In this study we use microscopic and chemical mineralogy, whole-rock geochemistry, Mössbauer spectroscopy, and thermodynamic modelling to identify and characterize fluid events at Tso Morari. Two major fluids were identified during exhumation of the terrane: Fluid Event 1 occurred in the eclogite boudin core involving internally-generated fluids, and Fluid Event 2 occurred at the boudin rim involving an external infiltration of fluids at amphibole-facies conditions. Specifically, Fluid Event 1 consisted of a series of four distinct mineral dehydration reactions taking place in the eclogite matrix: (1) Epidote poikiloblasts formed at ~23.5 kbar and ~610 °C with ~3.1 mol % fluid expulsion mainly induced by the breakdown of lawsonite; (2) amphibole cores formed at ~19.0 kbar and ~610 °C as a result of destabilization of omphacite and talc and (3) amphibole rims formed at ~14.5 kbar and ~610 °C; and (4) symplectite association surrounding the omphacite grains formed at ~8.7 kbar and ~625 °C due to the break-down of phengite. Fluid Event 2 caused amphibolization at the eclogite boudin rim as a result of external fluid infiltration (>2.6–3.1 mol % H_2O) at 9.0–12.5 kbar at ~608 °C. This infiltrated fluid caused increased K_2O and CO_2 concentrations and higher bulk-rock $Fe^{3+}/\Sigma Fe$ ratio for major minerals; as well as increased LILE (e.g., K, Rb, Cs, Sr, Ba) and ratios of Ba/Rb and Cs/Rb in the amphibolized eclogite at the boudin rim. This phase of fluid most likely derived from the mixing of dehydrated host orthogneiss and/or metasediments during exhumation through the amphibolite-facies zone in the subduction channel. This study demonstrates the need for using careful petrographic observations in parallel with thermodynamic modelling to achieve realistic results.

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