Multistage Exhumation History of Ultra-cool Oceanic (U)HP eclogites: New evidence from the Nagaland Ophiolite Complex (NOC), NE India

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Despite significant progress in our understanding of the thermal history of ultra-high pressure (UHP) metamorphosed oceanic eclogite, the mechanisms of detachment and exhumation of these rocks in the subduction channel are still debatable. Opinions vary from their exhumation as detached blocks due to circulation in a weak and loose serpentinite mélange to coherent bodies in large-scale imbricated slices. In this study, we integrate published metamorphic P-T path and peak P-T data with new metamorphic reconstruction of oceanic eclogites from two locations in the Nagaland Ophiolite Complex (NOC), NE India to establish its UHP signature and complicated multistage exhumation history. Previous studies reveal the NOC to be the largest exposed remnant of an array of HP/LT metamorphic rocks within the eastern Neo-Tethys with the subduction burial-exhumation cycle of eclogites being bracketed between ca. 205 and 172 Ma. In both the locations near Thewati and Mokie villages, the eclogites occur as ~5 to ~50 m long and ~2-5 m wide tectonic lenses within a lawsonite blueschist facies metamorphosed package of oceanic basalt-limestone-radiolarian chert (peak P-T at ~11.5 kbar, ~340°C). The Thewati eclogite records a clockwise (CW) P-T path of evolution with an epidote blueschist facies prograde burial at ~18.8 kbar, 555°C, peak epidote eclogite facies metamorphism at ~25–28 kbar, ~650°C and a two stage exhumation: an early one along a steep dP/dT gradient in amphibole-eclogite facies at ~18.3 kbar, 630°C and a later one along a gentler dP/dT gradient through epidote blueschist facies to the transitional lawsonite blueschist and greenschist facies metamorphic conditions at ~6 kbar, 300°C. In the Mokie locality, thin discontinuous stringers of highly magnesian (Mg# = 73) and eclogite facies altered basaltic crust (peak P-T at ~23.8 kbar and ~555°C) separate the eclogitic core (Mg# = 44) from the blueschist host. The Mokie eclogite core records an epidote blueschist facies prograde burial at ~12.5 kbar, ~510°C, peak UHP epidote eclogite facies metamorphism at ~32.0 kbar, ~700°C, an initial, eclogite facies exhumation at ~17.3 kbar, 560°C that retraces the prograde burial path, but at a higher temperature, a subsequent phase of eclogite facies prograde heating and the final exhumation and cooling at metamorphic conditions transitional between lawsonite blueschist and prehnite-pumpellyite facies. We interpret the P-T history of the Nagaland blueschists and eclogites in terms of a Jurassic-aged ultra-cool (thermobaric ratio at metamorphic peak between ~220°C/GPa and ~300°C/GPa) intra-oceanic subduction system within the Neo-Tethys, subduction burial of the Mokie eclogite core to ~100 kms of depth, putting it in the select category of rare global UHP oceanic eclogite facies metamorphism during the cold mature stage of
subduction and a change in its exhumation style from an initial buoyancy-driven material transport in a rheologically weak and fluidised subduction channel, often involving prograde heating of partially exhumed rocks to later thrust stacking and tectonic mixing of the eclogites from different crustal levels with the cooler, prograde blueschists at shallower crustal levels ($P \approx 5-6$ kbar). This stage two exhumation led to the assembly of the Nagaland Accretionary Complex.