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Evidence for Extremely Rapid (sub-Myr Timescales) UHT Metamorphic Sole Formation during Spontaneous Subduction Initiation in Nagaland – Manipur ophiolite belt, Indo-Myanmar Ranges

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The origin of ultra-hot (T_{Max} ≥ 900 °C) metamorphic sole rocks at mantle depths (~35-45 kms) and the thermal and dynamic history within the first few million years of subduction infancy are not well understood. In this study, we establish the details of subduction dynamics under such extreme thermal conditions, using newly discovered metamorphic sole rocks of mafic granulite compositions, immediately beneath mantle-wedge peridotites from the Nagaland-Manipur Ophiolite Belt, NE India. We have integrated observations on metamorphic reaction textures, mineral compositional zonation, kinetically-controlled thermobarometry and calculated pseudosections in the mafic granulites to constrain two cycles of prograde heating-cooling and burial-exhumation at UHT-HT metamorphic conditions (cf. M_1-M_2 metamorphic cycles). The M_1 cycle is marked by the prograde reaction, hornblende$_1$ + plagioclase$_1$ + ilmenite$_1$ → garnet + aluminous clinopyroxene + rutile ± quartz + melt at ~14-15 kbar, 900-950 ^oC. The retrograde path of this cycle is marked by the formation of Ti-hornblende + plagioclase$_2$ + titanite at ~12 kbar, 730-750 ^oC. This is followed by renewed heating and minor burial to ~12.5 kbar 850-875 ^oC as part of the M_2 cycle, and producing clinopyroxene$_2$ + plagioclase$_2$ + ilmenite$_2$. Formation of low-Ti hornblende$_3$ + plagioclase$_3$ at ~10 kbar, 730-770 ^oC marks the retrograde path of this cycle. This sequence is consistent with initiation of subduction by a spontaneous process at oceanic transform faults / fracture zones (after Stern, 2004), followed by UHT metamorphic soling during the start of true subduction. The repeated exhumation-cooling and intervening heating pulses could be produced by subduction advancement and retreat in the adjustment phase. Sequential kinetic modeling of compositional zoning in garnets and clinopyroxenes constrains the short-lived nature of the two metamorphic cycles: 0.1-0.4 myrs for the M_1 cooling, followed by rapid heating (~1000-4000 ^oC/myr) and cooling (~500-7000 ^oC/myr) with a duration of 0.05-0.33 myrs for the combined M_2 heating and cooling stages. Such high-resolution timescales of repeated subduction burial and exhumation within the first million year of subduction initiation has not been accessible from the metamorphic rock record yet.

[1] Goldschmidt, Stern, R. J. (2004), *Earth and Planetary Science Letters 226*, 275–292.