Timescales of subduction initiation and evolution of thermal regimes: insights from the Oman metamorphic sole

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Subduction zones are first-order features of plate tectonics on Earth, yet the mechanisms by which subduction initiates remains enigmatic and controversial. In this study, we reappraise the timing of formation of the first fragments detached from the leading edge of the down-going slab during subduction initiation preserved in the Semail metamorphic sole; Oman–United Arab Emirates. Based on petrochronology and phase equilibrium modeling, we demonstrate that subduction initiated prior to 102-100 Ma at a slow rate (< 1 cm/yr). Subduction stagnated at relatively warm conditions (15–20°C/km) for > 5 Myr before evolving into a faster (≥ 2–5 cm/yr) and colder (~7°C/km) self-sustained regime. Subduction unlocking at 96-95 Ma, through the progressive change of the inter-plate thermo-mechanical structure, triggered the onset of slab retreat, large-scale corner flow and fast ocean spreading in the overriding plate. This study reconciles, therefore, conflicting analogue and numerical subduction initiation models and reveal the thermal, mechanical and kinematic complexity of subduction initiation.

Keywords: Metamorphic sole, Ophiolite, Subduction initiation, Interplate thermo-mechanical evolution

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