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Deep subduction of hot young oceanic slab required by the Syros eclogites

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The Cycladic islands of Syros and Siphnos, Aegean Sea, Greece, represent subducted IAT and BABB remnants of the Neotethyan Pindos Ocean. Garnet porphyroblasts (Ø=1mm) in a glaucophane-zoisite eclogite from Kini locality on Syros are compositionally zoned and display a unique prograde heating path from a high-pressure greenschist-facies core with high XSps and low Mg# via a blueschist-facies mantle with moderate XSps and Mg# to an eclogite-facies rim with low XSps and high Mg#. The outermost 35 μm of the garnet rims show flat XSps with rapidly increasing outwards Mg#. Na-Act-Chl-Ph rimmed by Gln mark the greenschist-blueschist facies transition, whereas Pg rimmed by Omp and the incoming of Rt at the expense of Ttn signify the blueschist-eclogite facies transition.

Raman barometry of quartz inclusions in the eclogitic garnet rims coupled with elastic modelling of the garnet host [1], and Zr-in-Rt and Grt-Cpx-Ph thermobarometry revealed near-UHP P-T conditions of the order of 2.6 GPa/660°C (maximum residual pressure was 0.8-0.9GPa). By contrast, the greenschist-blueschist transition lies at ∼0.75 GPa/355°C. This pressure is in excellent agreement with the position of the albite = jadeite + quartz boundary calculated at 350°C using the observed omphacite composition corrected for jadeite activity (Koons & Thompson, 1985) [2]. As a result, Cpx inclusions in garnet core signify the early entrance of garnet in the subduction zone history of the slab. Furthermore, the early growth of garnet (in lower pressures) observed in eclogites from Syros lies in great agreement with published slab-geotherms that indicate hot subduction and show a precocious garnet growth (Baxter and Caddick, 2013) [3]. The complete absence of lawsonite and the great abundance of zoisite crystals, based on the stability fields of both minerals (Poli et al., 2009) [4], further constrain the P-T trajectory of the slab.

Our new P-T estimates match published T distributions on the slab surface calculated for a subduction velocity of 3 cm/yr, a subduction angle of 30° and an age of incoming lithosphere of ∼20 Ma with a shear stress of 80 MPa at the slab-mantle interface [5]. The above are in excellent agreement with published isotopic work on zircons and garnets from Syros eclogites suggesting crystallisation from magmas derived from a depleted mantle at ∼80 Ma and constraining the event of eclogitic metamorphism at ∼55 Ma. Diffusion modelling of the garnet outermost rims suggests a brief heating pulse of only ∼1,000 years at peak T.

[1] Van der Molen (1981) Tectonophysics 73, 323-342 .[2] Koons and Thompson (1985) Chemical Geology 50, 3-30. [3] Baxter and Caddick (2013) Geology 41, 6, 643-646. [4] Poli et al. (2009) Earth and Planetary Science Letters 278, 350–360. [5] Peacock (1993) Geol. Soc. Am. Bull. 105, 684–694 .