A record of burial and rapid exhumation in an eclogite-facies black smoker from the W. Alps paleo-subduction zone

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The Zermatt-Saas Ophiolite (ZSO) is composed of dismembered slices derived from a 60-km wide coherent fragment of Tethyan oceanic lithosphere [1]. Sub-seafloor hydrothermally-altered basalts of the ZSO record lawsonite eclogite-facies metamorphism at depths of ~80 km (c. 2.4 GPa) and 540°C [1,2].

Here we present the results from a study combining zoned Sm-Nd garnet geochronology, mineral trace element geochemistry, phase equilibiria and diffusion modeling of a pyrite-rich chlorite-talcschist from the Servette locality (St. Marcel Valley, Italy), further constraining parameters for subduction in the Western Alps. Several cm-sized garnets from the sample were microdrilled to separate core and rim growth generations and were analyzed via thermal ionization mass spectrometry (TIMS) in order to determine the overall duration of garnet growth. Spessartine-rich garnet cores were dated to 50.6 ± 0.8 Ma, signifying an approximate age for the initiation of garnet growth. Garnet rims were dated to 46.9 ± 1.1 Ma. This growth duration (3.7 ± 1.4 Ma), when coupled to phase equilibria modeling, suggests that subduction occurred along a ~7˚C/km geothermal gradient at a burial rate of ~2 cm/yr (assuming a 18-20˚ slab angle).

Major and trace element zoning in garnet suggests two distinct growth generations. Garnet cores display evidence for significant reaction overstepping and rapid nucleation and growth. Zoning in garnet crystal rims (Ca and Mn-rich annuli) suggest that rim growth was both relatively slow and underwent several distinct resorption/growth episodes of minor amplitude. Through modeling of intra-crystal diffusive relaxation of these garnet growth annuli, constraints are made on the rate of subsequent (isothermal) exhumation, and are compared to those from previous studies from the ZSO [3].

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