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Zoned Sm-Nd Geochronology Reveals Rapid Garnet Megablast Growth in Dora-Maira Whiteschists

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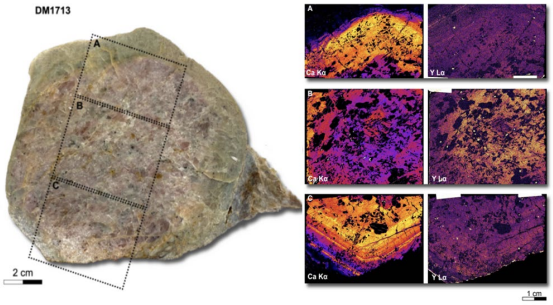

Figure 1: Garnet megablast (c. 10 cm) and associated wavelength dispersive spectroscopy (WDS) maps of Calcium and Yttrium showing zoning from rim to rim.

The subduction of continental material into the mantle is a major branch in the Earth's long-term geochemical evolution as it acts as a transport medium for H_2O and CO_2-rich fluids. Due to a variety of exhumation processes including buoyancy, these materials are commonly returned to the surface from shallow depths. Localities where continental materials are exhumed from ultra-high pressure (UHP) conditions (>2.7 GPa) are rare and provide a special opportunity to investigate the behavior of continental crust in a deep subduction system. Dora-Maira (DM), located in Northwestern Italy, is famously known for exposure of an UHP continental slice in which a metasomatic whiteschist assemblage was created with two distinct garnet populations: sparse megablasts (c. 10-20cm) and more abundant mesoblasts (2 – 5 cm)[1]. Garnet can record evolving metamorphic conditions and processes and can precisely and accurately date these changing conditions[2], making it a useful mineral for understanding deep subduction processes.

Compositional maps of sample DM1713[3], a 10 cm diameter megablast reveal concentric zoning in the core and vivid oscillatory zoning in the rim (Fig. 1). Zoned Sm-Nd chronology of five narrow concentric growth zones from core to rim show a distinctive growth pattern: (1) slow growth in the core; (2) a rapid burst during which most of the garnet crystallized; and (3) slower growth in the oscillatory zoned outermost rim. Eighty-five percent of the megablast volume grew in 0.86 ± 0.68 Myrs, between 38.36 ± 0.54 and 37.50 ± 0.41 Ma. The core (39.2 ± 1.5 Ma) and rim (35.0 ± 3.8 Ma) dates have high MSWD (21 and 31, respectively) reflecting a prolonged span of growth before and after the rapid growth pulse. The core could have begun growing as early as ca. 44 Ma. Smaller garnet mesoblasts dated in bulk yielded a date of 33.4 ± 2.3 Ma (n=7, MSWD=11) indicating further prolonged growth during early stages of exhumation. These results demonstrate the utility of zoned garnet Sm-Nd geochronology from Dora-Maira, opening up possibilities for further interrogation of this remarkable archive of UHP processes.

[1]Chopin, 1984 [2]Baxter et al. 2017 [3]Campomenosi et al. 2021