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

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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 H2O and CO2-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 conditions2, making it a useful mineral for understanding deep subduction processes.

Compositional maps of sample DM17133, 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.