Investigating the timing of sediment incorporation and metamorphism within the Ross Lake Fault Zone of the North Cascades Continental Magmatic Arc, Washington, USA

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Sediment incorporated into the mid and lower crust of magmatic arcs can greatly influence arc rheology, composition, and magmatism. The North Cascades of Washington, USA is a Cretaceous-Eocene continental magmatic arc that provides an ideal natural laboratory for studying arc sediment incorporation, as a range of crustal levels and metasedimentary lithologies are exposed within the crystalline core of the arc. In the Cretaceous and Eocene, three high-magma flux events are recorded within the North Cascades spanning 96-84 Ma, 78-59 Ma, and 50-45 Ma[1]. In this study we focus on the Ross Lake Fault Zone, which bounds and separates the arc from the unmetamorphosed clastic rocks of the Methow Terrane to the east. Within the fault zone are slices of metamorphosed sediment that we analyzed as part of this study (sample SK19-09A).

Sample SK19-09A is a garnet-bearing metapelite that was metamorphosed at peak conditions of 620-650 °C and 8.8-9.3 kbar[2]. Garnets preserve euhedral cores and display sharp discontinuous core-rim elemental zonation in Ca, Fe, and rare earth elements, suggesting two distinct episodes of garnet growth. The preservation of this sharp zoning suggests that the garnets experienced peak temperatures for less than ~5-10 million years[3]. We used zoned garnet Sm-Nd geochronology to determine the timing of garnet core and rim growth, allowing us to investigate the sediment incorporation history of the fault zone and temporal relationship to magmatic activity. Bulk garnets and rims were isolated using handpicking and microdrilling, respectively. A partial dissolution procedure was used to remove garnet inclusions, and then ID-TIMS was used to obtain a bulk garnet Sm-Nd isochron age of 65.1 ± 5.1 Ma (2SE; n = 6, MSWD = 1.6) and a garnet rim age of 59.7 ± 2.7 Ma (2SE; n = 6, MSWD = 1.7). We used the bulk and rim garnet ages with Sm zonation profiles to obtain a garnet core model age of ~85-90 Ma. This preliminary age suggests two distinct periods of garnet growth coinciding with the first and second high-magma flux events. Future work will include thermodynamic pseudosection modeling to determine the P-T conditions of garnet core and rim growth, and Sm-Nd geochronology to better constrain our core model age and metamorphism throughout the fault zone.