Partial Melting of Metasedimentary Rocks in the Deep Levels of Continental Arcs: Insight from the Late Cretaceous–Eocene North Cascades Arc, Washington, USA

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The incorporation and burial of metasedimentary rocks into the mid to deep crust of collisional orogenic belts and arcs can provide fertile material for the production of small, outcrop-scale partial melts to orogen-scale, leucogranite units and potentially flare-up events in continental magmatic arcs. In exhumed mid to lower crustal terranes, migmatitic paragneisses and orthogneisses are common, but it is not always clear if the leucocratic material formed *in situ* or whether it was generated at a deeper level and emplaced and subsequently deformed at its present position. The crystalline core of the Late Cretaceous–Eocene North Cascades continental arc, Washington, exposes upper-amphibolite-facies metasedimentary rocks and orthogneisses in addition to arc plutons. The ~9–12 kbar Swakane and ~8–10 kbar Skagit gneisses include metasedimentary rocks that are interpreted to have originated as forearc sedimentary rocks that were underthrust into the active arc system. The origin of migmatites within these two deeply exhumed units have been the focus of debate. To better understand the partial-melting history of metasedimentary rocks within the crystalline core of this ancient arc, seven ~5–35 cm thick, layer-parallel leucosomes and 6 dikes and other felsic intrusive material were collected for bulk chemistry analysis and split-stream, LA-ICP-MS U-Pb zircon geochronology and trace-element chemistry. Hf-isotope compositions were then obtained from a subset of zircons. The studied layer-parallel leucosomes were all strongly deformed and, based on their textures and shared deformation and interlayering with the host metasedimentary rocks, were interpreted as likely *in situ* melts. Crystallization ages of layer-parallel leucosome samples of the Skagit Gneiss range from ca. 69 to 48 Ma. In comparison, similar samples from the Swakane Gneiss have dates clustered tightly from ca. 73–66 Ma. The dikes and larger bodies of late felsic material that intrude the Swakane Gneiss crystallized from ca. 74–68 Ma. Many of the crystallization ages from the leucosomes and dikes from both units overlap with the timing of sediment incorporation. Two of the Skagit layer-parallel leucosomes yielded radiogenic zircon εHf_i values ranging from +11.9–+8.8. Zircons from one of the Swakane leucosomes also yielded a very limited range of εHf_i values of +6.1–+3.4, despite grains from the metasedimentary rocks yielding more variable εHf_i values. Conversely, zircons from small bodies of non-deformed felsic material that intrude the Swakane had a wide range of εHf_i values from +12.3 to -15.6, suggesting some sediment-source melt. The majority of the leucosomes did not contain apatite or monazite and overall had low P_2O_5 amounts (≤ 0.01 wt. %) despite the abundant apatite in Swakane and Skagit metasedimentary rocks. These results suggest that many of the strongly deformed leucosomes within the gneisses were not *in situ* melts from the host metasedimentary rocks, but likely were derived from a deeper, more radiogenic source. In this arc setting, the incorporation of the metasedimentary rocks to deep crustal levels with temperatures >650–800 °C did not result in significant partial melting and thus likely did not contribute to the observed arc flare-up magmatism.