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The subduction, exhumation, and deformation history of the Vaimok Lens, Seve Nappe Complex, Scandinavian Caledonides

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The Seve Nappe Complex (SNC) of the Scandinavian Caledonides represents portions of the Baltican margin that were subducted to mantle depths. Eclogite-bearing sub-units of the SNC provide a record of this important step in orogen development. One such sub-unit is the Vaimok Lens of the SNC in southern Norrbotten. The Vaimok Lens constitutes eclogites hosted within metasedimentary rocks that reached ultra-high pressure (UHP) conditions in the Cambrian/Early Ordovician period. The metasedimentary rocks are typically composed of quartz, white mica, garnet, plagioclase, biotite, clinozoisite, apatite and titanite, and show a pervasive 'S2' foliation that developed during exhumation. Garnet is recognized as a relic of prograde metamorphism during subduction, whereas the other minerals represent retrogressive metamorphism during exhumation. To resolve the timing of prograde metamorphism, Lu-Hf geochronology was conducted on metasediment-hosted garnet that preserves prograde, bell-shaped Mn-zoning with a chemical formula of $Alm_{69\text{-}59}Grs_{32\text{-}24}Sps_{13\text{-}2}Prp_{5\text{-}2}$. The results indicate garnet growth at 495.3 ± 2.6 Ma. Quartz-in-garnet (QuiG) elastic geobarometry was also conducted on garnet from the same sample, providing pressures of 0.9-1.3 GPa, calculated at 500-700°C. Six samples were obtained for in-situ $^{40}Ar/^{39}Ar$ geochronology, targeting white mica defining the S2 foliation. Samples can be classified as: 1) low-strain (n: 3), with large (>400 µm width), undeformed micas that are chemically homogeneous (X_{Cel}: 0.24-0.35), which yielded a weighted average $^{40}Ar/^{39}Ar$ population of 470.5 ± 5.9 Ma; 2) high-strain (n: 3), with small (<300 µm width) mica fish with heterogeneous chemistry (X_{Cel}: 0.03-0.27), which provided weighted average $^{40}Ar/^{39}Ar$ populations of 447.6 ± 2.6 Ma and 431.1 ± 4.1 Ma. An additional sample from the basal thrust of the lens that contains large (>300 µm width), homogeneous (X_{Cel}: 0.24-0.34) mica was also dated, yielding a population of 414.1 ± 5.8 Ma. Altogether, the data indicates that the Vaimok Lens was subducting by c. 495 Ma. The lens underwent post-decompression cooling at c. 470 Ma, possibly decompressing to 0.9-1.3 GPa by this time. This would equate to an exhumation rate of 3-9 mm/yr. Imbrication of the SNC in southern Norrbotten is taken to be c. 447 Ma. Scandian deformation was active by c. 431 Ma and led to overthrusting of the SNC onto subjacent nappes by latest c. 414 Ma. Both the timescale for

subduction and the rates of exhumation for the Vaimok Lens reflect subduction-exhumation dynamics of large UHP terranes. Furthermore, the timing of imbrication and Scandian deformation in southern Norrbotten is similar to estimates along strike of the SNC. These results indicate that the SNC acted as a large UHP terrane that underwent a ~25 Myr cycle of subduction and exhumation during the late Cambrian/Early Ordovician, before being deformed and partially dismembered in subsequent accretionary and collisional events.

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