Exhumation of the Seve Nappe Complex, central Scandinavian Caledonides: Insights from $^{40}Ar/^{39}Ar$ and AFT thermochronology

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The Seve Nappe Complex is the highest metamorphic grade unit within the Swedish Caledonides, spanning over 1000 km along the strike of the orogen. In west-central Jämtland, this allochthonous unit is further divided into the Middle and Lower Seve nappes, with ultra-high-pressure (UHP) rocks found in the Middle Seve Nappe (MSN). The tectonically lower unit, the Lower Seve Nappe (LSN), experienced high-pressure (HP) metamorphic conditions. Detailed pressure-temperature-time paths constrain late Cambrian to early Ordovician deep subduction followed by exhumation to mid-crustal levels in the Silurian. We present *in-situ* laser ablation and step-heating $^{40}Ar/^{39}Ar$ geochronology of micas, combined with apatite fission track (AFT) thermochronology to constrain the timing of exhumation of these deeply subducted rocks to the Earth's surface.

Samples were collected from the Åreskutan Mt. (MSN) and the COSC-1 drill core (LSN), providing a composite ca. 3 km vertical profile. The oldest $^{40}Ar/^{39}Ar$ apparent ages are recorded by biotite in the UHP gneisses, migmatites, and mylonites from the MSN. *In-situ* laser ablation of biotite texturally associated with the HP phases yielded 453-451 Myr ages. Relatively younger apparent ages were obtained from biotite that occurs within the main foliation (440-437 Ma) and the deformed biotite records an apparent age of ca. 428 Ma. $^{40}Ar/^{39}Ar$ step heat experiments on biotite reveal complex spectra, with apparent ages in general ranging from 447-438 Ma. Within the migmatite, *in-situ* ablation of phengitic white mica defining the main foliation yielded apparent ages of ca. 443 Ma and a range of relatively younger ages of 430-422 Ma. The latter agrees with the step-heating results obtained for the phengitic white mica which yielded an apparent age gradient from ca. 427 Ma to c. 375 Ma. Biotite and white mica within the LSN rocks yield *in-situ* ages ranging from 434-424 Ma for both undeformed and deformed grains. These ages agree with those obtained from the step heat experiments (430-427 Ma). A complex age spectrum with the oldest $^{40}Ar/^{39}Ar$ apparent ages (ca. 444 Ma) was obtained on white mica from the deepest part of the borehole. AFT ages from the MSN range from 240-190 Ma, in contrast to AFT ages from the LSN 190-70 Ma (COSC-1; including data by Green et al. 2022). Multi-kinetic inverse models (using HeFTy) indicate two episodes of rapid cooling in the Late Triassic and the Late Jurassic, with the latter also revealed in the AFT age vs. elevation plot.

In summary, in the MSN, the oldest biotite $^{40}Ar/^{39}Ar$ apparent ages apparently preserve a record of Ordovician-Silurian UHP-HT subduction-exhumation events. Both biotite and white mica in rocks from the MSN and LSN provide insights into the timing of Silurian thrusting and exhumation of these nappes. The substantial time gap of ca. 170 Ma between the youngest $^{40}Ar/^{39}Ar$ ages and the AFT data suggests that final exhumation of the SNC to shallow depths was not related to the Caledonian subduction cycle that led to the formation of the UHP unit but rather final exhumation from shallow crustal levels to the surface occurred during the Triassic-Jurassic.

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References

Green, P. F., Japsen, P., Bonow, J. M., Chalmers, J. A., Duddy, I. R., & Kukkonen, I. T., 2022: The post-Caledonian thermo-tectonic evolution of Fennoscandia. *Gondwana Research 107*, 201-234.