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Age and metamorphic conditions of the Tjeliken garnet – phengite gneiss (Swedish Caledonides)

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Eroded down to mid-crustal level the Scandinavian Caledonides offer a unique opportunity to study the interior of a mountain chain and provide insight of processes active during orogenesis. The Seve Nappe Complex (SNC) is a key allochthon for understanding the evolution of the Scandinavian Caledonides. Several recent studies of the Ordovician metamorphic rocks in the SNC in Jämtland have revealed higher pressures than previously known suggesting a deeper subduction of the Baltoscandian margin (Janák et al. 2013, Klonowska et al. 2014, Majka et al. 2014a, b, Rosén 2014). Geochronological data indicate that the (ultra)-high pressure event occurred at c. 460 Ma (Brueckner & Van Roermund 2007). Together the two data sets may suggest an earlier Scandian subduction and collision than at the moment accepted.

Target area for this study is the Tjeliken Mountain in the Blomhöjden – Stor Jougdan area in northern Jämtland. A recent study of the Tjeliken eclogite resulted in increased inferred pressure-temperature (P-T) conditions (Majka et al 2014a). Of particular interest for the area is that there currently are two contrasting tectonic interpretations, locating the Tjeliken Mountain in separate thrust sheets within the Seve Nappe Complex that differs in metamorphic grade (Strömberg et al. 1984; Zachrisson & Sjöstrand 1990). To further unravel the metamorphic evolution of the SNC, P-T conditions for the garnet – phengite gneiss hosting the Tjeliken eclogite is constructed. Also new U-Pb zircon data is presented to further construct the timing of the high-pressure event.

Studied samples contain the main mineral assemblage garnet + quartz + phengite + clinozoisite – epidote ± feldspars ± carbonates with accessory zircon + titanite + apatite. Preliminary results from line-step profiles reveal oscillatory zoned garnets with respect to almandine (42–62%) and grossular (29–50%) components. Spessertine and pyrope components are substantially lower, 1.6–8% and 0.8–6% respectively. Spessertine component decreases towards the rim and pyrope component increases. Garnet porphyroblasts are rare and occur as various textural varieties. Of particular interest are the rare but large skeletal garnets, indicating a complex growth pattern.

Also the epidote group minerals present in the studied samples show chemical zoning with two or three different zones. Ca component increases from core to rim whereas allanitic component decreases. Epidotes occur both in matrix and as inclusions in garnets. Phengites (Si = 3.1–3.4 a.p.f.u.) and feldspars (anorthite, albite, microcline) are also present both in matrix and in garnets. Albite-anorthite symplectites occur in matrix.

Zircon crystals are euhedral. CL images reveal a core-mantle-rim zircon texture. Many cores show oscillatory zoning visible to various degree, whereas rims are plain. Th/U ratios for rims are 0–0.47. Secondary ion mass spectrometry performed by a Cameca 1280 ion microprobe on the rims yields concordant age at c. 460 Ma for high-pressure metamorphism.

There are several ways of explanation of the garnet oscillatory zoning. Obtained data might suggest following as causes: (1) chemical reactions

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between calcium-rich inclusions i.e. epidotes and feldspars during the formation of the garnet consuming the inclusions; (2) competition for calcium (Ca) between co-existing matrix phases; (the chemical zoning of epidote group minerals together with the zoning of garnet suggests that the two phases possibly competed for the Ca present in bulk rock causing the oscillatory zoning); (3) the skeletal garnets indicate a garnet growth path starting at rim and moving inwards during consumption of other phases (the high levels of Ca and corresponding low levels of Fe could be due to consumption of Ca-rich phases during growth); (4) open system behaviour with periodic supply of Ca by fluid.

Further analysis is required to establish which process or combination of processes are responsible for the observed garnet zoning. Additional studies are also needed to establish the P-T evolution of the rock. The observed mineralogy indicate (U)HP metamorphic conditions. Phase equilibrium modelling will be performed to further unravel the P-T evolution of the garnet – phengite gneiss. The obtained U-Pb concordia age is in line with Brueckner & Van Roermunds' (2007) ages for the (U)HP rocks in the area, arguing for a Late Ordovician high-pressure event affecting the Baltoscandian margin.

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