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Two distinct high grade metamorphic events at c. 500 Ma and 450 Ma recorded in zircon from the Snasahögarna diamond-bearing gneiss, Scandinavian Caledonides

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The Seve Nappe Complex (SNC) of the Scandinavian Caledonides represents a deeply subducted portion of the Baltoscandian rifted margin. Previous age determinations of (ultra)high-pressure (HP-UHP) metamorphism yielded ages from c. 500-480 Ma in northern parts of the SNC in Norrbotten to c. 460-450 Ma in more southern locations in Jämtland. Here we present preliminary zircon dating results from the Snasahögarna Mts., the first metamorphic diamond locality discovered in the SNC in Jämtland.
Zircon grains from a diamond-bearing gneiss (Majka et al. 2014) of the Snasahögarna Nappe were dated using both classical SIMS and LA-ICP-MS depth profiling techniques. Trace elements were also measured in zircon during LA-ICP-MS depth profiling analyses. High resolution of the depth profiling technique allowed us to uncover three distinct domains in the zircon. The innermost domains, corresponding to cores of zircon grains, are characterized by HREE enrichment with respect to MREE, high Th/U ratios and large Eu anomalies. U-Pb zircon dates obtained for the cores range from c. 1560 to c. 820 Ma. The cores can be rimmed by two different types of zircon overgrowths. The first type (1) displays a very weak Eu anomaly, low Th/U ratios and strong HREE enrichment. The second type (2) of is also characterized by low Th/U ratios, but it differs from (1) substantially as it shows a strong Eu anomaly and no HREE/MREE enrichment. The average crystallization temperatures calculated from Ti content in zircon for overgrowths (1) and (2) are 824±38°C and 770±36°C, respectively. U-Pb zircon ages of 495.8 ±3.6 Ma and c. 450.2±4.4 Ma were obtained for zircon overgrowths (1) and (2).
Due to low Th/U ratio, weak Eu anomaly and high crystallization temperature overgrowth (1) is interpreted as high pressure and high temperature metamorphic zircon. Overgrowth (2) is c. 50 Ma younger than (1) and depleted in HREE with respect to (1). Relative depletion of HREE in overgrowth (2) results from retention of HREE in older zircon and most probably also in garnet. Thus, we interpret overgrowth (2) as crystallizing in lower pressure, but still in high temperature conditions.
Interestingly, the diamond-bearing gneiss from Snasahögarna revealed unequivocal evidence for HP (perhaps UHP) metamorphism already at c. 500 Ma. The younger age of c. 450 Ma is linked to high temperature, relatively lower pressure metamorphism (granulite facies conditions). Together, this data suggests either protracted residence of this part of the SNC at mantle depths (lasting about 50 Myr) or polymetamorphism. The latter may be an effect of double-dunking of the SNC, but overgrowth (2) does not show a pattern typical for HP-UHP zircon. This may be an effect of limited availability of Zr during the prograde-to-peak part of the second metamorphic event, or the studied rock did not experience HP metamorphism at c. 450 Ma. However, the latter scenario seems unlikely given the number of independent lines of evidence for a major UHP event at that time. These speculations notwithstanding, the Snasahögarna gneiss has delivered yet another interesting puzzle piece to the Caledonian jigsaw.
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