Titanite record of UHP exhumation from the upper plate of the Caledonian collision, North-East Greenland

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UHP eclogite and gneiss is exposed on a small island in North-East Greenland at 78° N, which lies within a much larger region (~50,000 km^2) of Laurentian HP continental crust formed in the upper plate of the collision with Baltica. Coesite-bearing zircon dated from both lithologies shows that UHP conditions were reached from 365–350 Ma at the end of the Caledonian collision. Rutile is the stable Ti-bearing phase in the best preserved UHP rocks, while titanite ± ilmenite forms on the retrograde path. Titanite in quartzofeldspathic gneiss records a textural progression from overgrowths on matrix rutile to total replacement by polycrystalline grains to euhedral porphyroblasts. Trace elements and U-Pb have been analyzed by SHRIMP-RG in titanite grain or *in situ* thin section mounts for 6 gneisses. Titanite forms on the isobaric part of the PT path at ~1.2 GPa (Cao *et al.*, 2019) in the range of 755–821°C, where Zr-in-titanite temperatures were calculated for $aSiO_2$=1 and $aTiO_2$=1 or 0.7. The temperature range fits with the Ti-phase stability fields determined by thermodynamic modeling of common bulk compositions from tonalitic gneisses. Trace elements in titanite are dominated by concave-down curves with or without a negative Eu anomaly. This pattern is similar to igneous titanite and we interpret it as forming during partial melting – indeed three of the samples contain thin, wispy leucosomes. Large (>600 µm), zoned subhedral titanite preserves three distinct trace element patterns that may be due to melting, metamorphism/recrystallization and garnet breakdown. Weighted mean $^{206}Pb/^{238}U$ dates, calculated with data-defined common Pb values, range from 347±6 to 321±7 Ma and variation cannot be correlated with the trace element domains. The combined dates from all samples define a lower intercept age of 331±4 Ma (MSWD = 2.6), which signals the timing of the rutile to titanite conversion.

Titanite from the UHP gneisses records a prolonged period of exhumation through 320 Ma that is also seen in the zircon record (Gilotti *et al.*, 2014), where (1) Phengite decompression melting started at ~347 Ma near the coesite to quartz transition, (2) Leucosome emplacement accompanied granulite- to amphibolite-facies retrograde metamorphism from 350–340 Ma, and (3) titanite grew during isobaric amphibolite facies exhumation from 330–320 Ma. This protracted exhumation contrasts with the Western Gneiss Region of Baltica where titanite forms within <4–15 million years of peak P. Slow exhumation in Greenland is consistent with a tectonic setting at the base of the overthickened, overriding plate. UHP metamorphism occurs late in the Caledonian collision by intracontinental subduction along major strike-slip faults that break the lithosphere (Gilotti and McClelland, 2007). The same transform faults also play a significant role in the exhumation of the UHP rocks to the lower crust (*i.e.*, to 1.2 GPa).

Cao, W., Gilotti, J.A., Massonne, H.-J., Ferrando, S., Foster, C.T., 2019. Partial melting due to breakdown of an epidote group mineral during exhumation of ultrahigh-pressure eclogite: an

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Gilotti, J.A., McClelland, W.C., Wooden, J.L., 2014. Zircon captures exhumation of an ultrahigh-pressure terrane, North-East Greenland Caledonides. *Gondwana Research* 25, 235-256.