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Monazite geochronology of UHP and HP metamorphism, deformation, and exhumation, Nordøyane, Western Gneiss Region, Norway

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ABSTRACT

U-Th-Pb monazite geochronology is combined with previous structural analysis and quantitative estimates of metamorphic conditions to date the thermotectonic evolution of UHP and HP plates (820 °C, 39 kbar; 780 °C, 18 kbar) metamorphosed during the Late Silurian-Early Devonian collision between Baltica and Laurentia. The Upper Plate contains a microdiamond-bearing, kyanite-garnet-graphite gneiss and associated kyanite eclogites, independently indicating probable diamond-forming conditions. In situ dating of monazite in the microdiamond sample, using the SHRIMP II at the Geological Survey of Canada, yielded ages of 415 ± 6.8 Ma for those included in garnet and 398 ± 6 Ma for those in the matrix. These ages compare to 408.0 ± 5.6 and 397.5 ± 4.4 Ma determined using the electron microprobe at the University of Massachusetts. Both methods also identified complexly zoned detrital cores up to 150 micrometers in diameter with ages of 1100–950 Ma and scattered grains with ages of 900–500 Ma, but no ages of 1680–1650 Ma equivalent to the local Baltica basement were found. Agreement between the two techniques allowed evaluation of monazite age domains (198 analyses) from the microdiamond rock and a kyanite-garnet-sillimanite mylonite produced from it, using a combination of high-resolution element imaging and trace-element analysis of U, Th, Pb, and Y. This comparison yielded three mean ages of 407.0 ± 2.1 Ma, 394.8 ± 2.3 Ma, and 374.6 ± 2.7 Ma.

Combining this geochronology with previous *P-T* estimates, we propose that the UHP unit reached its maximum depth of 125 km, at a maximum age of 407 Ma when monazite was included in garnet, and experienced 65 km of exhumation at an average rate of 10.9 mm/year during top-southeast thrusting that brought it into contact with the HP unit. Following these events, both units were exhumed together at an average rate of 3.8 mm/year until reaching a depth of 37 km at 395 Ma, where these rocks experienced extensive re-equilibration, and top-west and left-lateral shearing. After 395 Ma, these units continued to be exhumed at an average rate of 0.8 to 1.4 mm/year until 375 Ma, the time of last equilibration of asymmetric monazite porphyroclasts in the mylonite. The exhumation histories of these units record a change in mechanism from syncollisional exhumation through late- to post-orogenic collapse that was a consequence of plate reorganization.