Did melting at ultra-high-pressure trigger exhumation of the Western Gneiss Region, Norway? Field testing a controversial hypothesis

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During the Scandian Orogeny (415–400 Ma), collision between Laurentia and Baltica resulted in the subduction of Baltican continental crust to mantle depths. The mechanism behind the subsequent exhumation of the Baltican margin is debated, with one hypothesis positing that melting at peak ultra-high pressure (UHP) conditions (≥3.5 GPa, 750–850°C) led to the detachment of buoyant upper crust from the down-going Baltica plate, thereby triggering the exhumation. This hypothesis requires the presence of fluids to lower the solidus temperature sufficiently to allow melting at the PT conditions reached at peak subduction depth. We present preliminary results of a field-based study to test this hypothesis in the Nordøyane UHP domain, the hottest and deepest part of the Western Gneiss Region (WGR), a tectonic window into subducted Baltican crust. Mapping at a scale of 1:2000 in two low-strain regions on the islands of Haramsøya and Flemsøya demonstrated that eclogite facies structures are well preserved, and that crosscutting relationships between various generations of fabrics and leucosomes can be distinguished. Multiple generations of leucosomes are present within the orthogneisses that host the eclogite bodies. These leucosomes locally cut the eclogites, but no clear field or petrographic evidence has yet been found for leucosomes generated within eclogite bodies themselves. Although xenocrystic garnet and pyroxene are common, the dominant mafic phase that crystallised from host rock leucosomes was hornblende, indicating that most partial melts crystallized at amphibolite facies. Throughout the study area, an enigmatic suite of granodioritic intrusions envelops, disaggregates, and partially assimilates the main eclogite bodies. These intrusions are associated with zircon-bearing, pegmatitic, scapolite-hornblende leucosomes which are being investigated to constrain the compositions and source of fluids present during crystallisation of late-stage melts. Results to date show that most scapolite is meionitic (Me 63-80), with significant Na (0.86–1.31 apfu), C (0.53–0.72 apfu) and S (0.21–0.41 apfu), but low Cl (0.01 to 0.11 apfu). Future work will include stable isotope analysis of C, S, and O in scapolite to characterize the composition and source of late-stage fluids, and U-Pb zircon geochronology to determine the time of melt crystallisation. The results will be used to test the hypothesis, based on our own field observations, that melting in the Nordoyane domain orthogneisses accompanied decompression of the UHP eclogites and thus cannot have triggered exhumation.

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