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Oblique divergence and exhumation of giant ultrahigh-pressure terrains (Western Gneiss Region, Norway)

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The subduction of continental rocks to ultrahigh-pressure (UHP) conditions is an integral part of the evolution of many orogens, but the processes that exhume these rocks are still highly debated. Syn-convergence exhumation can explain the forced and/or buoyant return of relatively small UHP bodies in a subduction channel. However, we propose that the exhumation of giant UHP terrains, such as the Western Gneiss Region (WGR) of Norway, is consistent with oblique divergence, not convergence. Oblique divergence is expected to produce transtensional structures, including extension-parallel fold hinges and boudins as well as constrictional fabrics. The structural style of the WGR is dominated by transtension strain from UHP to low P conditions. We propose that the timing of exhumation of UHP rocks is tied to a large transform-detachment system along the western coast of southern and central Norway.

The UHP WGR is bounded to the north by the SW-NE trending Møre-Trøndelag Fault Zone (MTFZ), a ∼10 km wide transform shear zone that connects two extensional systems over a distance of several hundred kilometers. The extensional system to the S of the MTSZ consists of the W-directed Nordfjord-Sogn detachment that exhumed the UHP terrain. The extensional system on the northern side of the MTFZ is defined by the SW-directed Høybakken and NE-directed Kollstraumen detachments that bound a bivergent extensional core complex, the Central Norway Basement Window (CNBW). South of the MTFZ, UHP and HP eclogite is dispersed in an extensively deformed gneissic and migmatitic host with strong linear fabrics, lineation-parallel folds, and variably oriented shear zones that accommodated strike-slip to normal sense (top-to-W) shear. Omphacite CPO in layered eclogite indicates that fabrics developed in constriction (consistent with transtension) at HP and possibly UHP conditions. U-Pb ICPMS dating of zircon from leucosome in the gneissic host of UHP eclogite reveals dates between 410 and 400 Ma, which overlap with reported ages of UHP metamorphism obtained from eclogite. North of the MTFZ transform the structurally deepest exposures of the CNBW are HP mafic granulite in migmatite of the Roan Peninsula. There, foliation is flat-lying and carries a prominent NE-SW lineation. An outcrop of extremely sheared migmatite gneiss shows variably transposed leucosome. We obtained U-Pb ICPMS zircon dates for five generations of these leucosome bodies, from totally transposed to partially crosscutting; dates are similar within error (405-409 Ma), indicating that intense shearing took place under partial melting conditions. These dates also indicate that deformation and crystallization of migmatite in the CNBW and UHP WGR were coeval a few hundred kilometers apart across the MTFZ. We propose that transform motion of 100-150 km on the MTFZ opened simultaneously two pull-apart domains at ∼410-400 Ma, during oblique divergence in the orogen; the northern domain developed like a metamorphic core complex, and the southern one exhumed previously subducted UHP continental crust. Both domains show transtensional strain, consistent with the oblique divergence setting of this detachment-transform system.