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Campaign-Style Titanite LASS: Implications for Crustal Flow, Phase Transformations and Titanite Closure

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LASS (laser-ablation split-stream ICP MS) U-Pb and trace-element data were measured in titanite from >250 samples of quartzofeldspathic gneiss and leucosomes across the ultrahigh-pressure (UHP) Western Gneiss Region of Norway to understand deformation and metamorphism of continental crust during subduction and exhumation. Titanite is unstable at pressures > 1.5 GPa, and, indeed, most yielded post-UHP dates, concommitant with titanite breakdown during subduction. A number of titanites sampled across large areas, however, have pre-UHP U-Pb dates, indicating that the titanites survived their excursion to and return from mantle depths metastably. Pre-UHP titanites have trace-element concentrations reflective of their host-rock composition and indicative of magmatic growth from an LREE-enriched melt. In contrast, re- and neocrystallized titanites that grew during exhumation have heterogeneous trace-element signatures and elevated fluorine concentrations, indicating that preservation of pre-UHP titanite was governed by reduced H_2O activity.

These U-Pb and trace-element data from titanite over a broad area have three important implications. Titanite grains can remain closed to complete Pb loss during regional metamorphism at temperatures as high as 750°C and pressures as high as 3 GPa, implying that thermally mediated volume diffusion was not the principal factor controlling resetting of the U-Pb system. Phase transformations in–and deformation of–quartzofeldspathic rocks can be inhibited at the same conditions; much of the WGR remained untransformed, drier, and stronger even as the rocks were subducted to and exhumed from mantle depths.