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Dual origin and evolution of cratonic mantle garnet websterite from the Western Gneiss Region, Norway

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We investigated mineral microstructures and the whole-rock chemistry of 10 websterite layers in 5 orogenic peridotite bodies (Almklovdalen, Gurskebotn, Kalskaret, Nogvadalen and Raubergvik) exposed across the Western Gneiss Region (WGR), Norway. These bodies are believed to represent lithospheric mantle identical to that of eastern Greenland. All websterite layers contain garnet besides ortho- and clinopyroxene. Some samples include olivine and oxides as accessory minerals or amphibole partially replacing clinopyroxene. The common texture is characterized by porphyroclastic garnet and pyroxene, which host different types of acicular to lamellar shaped or short-prismatic silicates and oxides, except the Kalskaret websterite sample that shows lamellar inclusions in pyroxene only. These inclusions are either regularly distributed within crystal cores or occur concentrated along planar, crystal-transecting structures. Primitive mantle (PM) normalised REE concentrations of the websterites vary by two orders of magnitude, from sub- to supra-PM values. These REE patterns show either increasing or decreasing numbers towards the light REEs or "U"-shaped slopes, which suggest that the websterites experienced variable degrees of metasomatism including LREE enrichment. The latter is depending on the sample location: websterites from the orogenic hinterland (Kalskaret and Raubergvik) show no or minor LREE enrichment, whereas websterites from the coastal area (Almklovdalen, Gurskebotn and Nogvadalen) are characterized by a clear chemical overprint. Inclusions along crystal-transecting planes are absent in the former, but abundant in the latter websterites. This relationship suggests that the lined-up precipitates were formed from a metasomatising agent in contrast to the regularly distributed precipitates that may have formed earlier by solid-state exsolution.
The largely primary whole-rock chemistry of the hinterland websterites varies. Raubergvik websterites show sub-PM M&HREE abundances, Al/Cr of 9–19 and Zr contents of 0.7–1.8 ppm as typical for Otrøy garnet websterites and South African Al-enriched komatiites (Spengler & Alifirova, 2019). Kalskaret websterite differs by supra-PM M&HREE abundances, Al/Cr of 26 and Zr contents of 12.2 ppm. The latter data are similar to those of basaltic cumulates.
Our finding that coastal mantle fragments are more intensely metasomatised than those landwards is consistent with previous studies on garnet pyroxenites from other WGR localities (Fjørtoft vs. Otrøy; Brueckner et al., 2002). A dual evolution of mantle bodies exposed in the western peripheral and central parts of the WGR is implied. The finding of contrasting primary whole-rock chemistry is consistent with earlier propositions for a dual origin (basaltic vs. komatiitic) of pyroxenites in the mantle bodies (Brueckner et al., 2010; Spengler et al., 2018), although the type with komatiitic chemistry seems to occur across the whole WGR. We conclude that the lithospheric mantle underneath eastern Greenland has been re-fertilised twice.

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