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Fluid-induced crystallization of majoritic garnet during Scandian continental subduction, Western Gneiss Region, Norway

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Garnets containing crystallographically-oriented pyroxene needles, found in ultrahigh pressure (UHP) orogenic rocks, form the breakdown products of majorite crystallized at depths $>$ 200 Km. Presence of microdiamonds in some of these rocks[1] may suggest a deep (fluid-bearing?) subduction environment for the genesis of majorite. The (dm-scale) majoritic garnets in the UHP mantle rocks of the Western Gneiss Region (Norway) are unrelated to subduction and represent uprisen Archean transition zone mantle (M1 stage), cooled after accretion to deep cratonic roots (M2 stage)[2]. The Light Rare Earth Element (LREE) depletion of these WGR garnets (La/Yb= 0.004) and of the associated pyroxenes (cpx, opx; La/Yb=0.11) suggests derivation from a refractory mantle source after extraction of picritic melts[3]. This Archean-mid Proterozoic story is overprinted by the 425-390 Ma old Scandian continental subduction, with formation of new garnet (grt) + cpx + opx + phlogopite (phl) $\pm$ spinel (sp) (M3 stage) that contain diamond-bearing micro-inclusions witnessing deep influx of crustal COH subduction fluids[4]. Here we document the occurrence of new majoritic garnet in the M3 assemblage and in veins. This textural recognition, together with the LREE enrichment of the M3 minerals (majorite included), enables us to link majorite formation with the flow of subduction fluids during burial, again, towards sub-lithospheric depths. We investigated garnet websterites from Bardane (FjØrtoft island, W Norway), showing early megacrystic M2 opx, grt, cpx, $\pm$.sp (Cr# 70) The new M3 assemblage (grt, opx, cpx, phl, sp (Cr# 50) crystallized interstitially along the boundaries of M2 megacrysts. The M3 grt contains diamond-bearing polyphase inclusions related to incoming COH fluids[4]. In addition, cpx and grt exsolutions parallel the cleavage of the M2 opx and are associated with microcrystals of phl and carbonate. The following features of the M3 assemblage need to be emphasized: 1) carbonates in M2 opx display dolomite (dol) cores replaced by rims of magnesite (mag) and cpx, due to reaction dol + opx = mag + cpx at rising P-T; 2) the interstitial M3 grt has crystallographically oriented px needles; 3) veins of M3 phlogopite and garnet cut the M2 opx, this garnet also has px needles. These features indicate that new majorite formed during prograde metamorphism as the result of fluid infiltration along grain boundaries and in fractures, possibly at P-T conditions of 6-7 GPa/900-1000 ˚C. The laser-ablation ICPMS analysis of the trace element compositions of M3 minerals helps constraining the nature of the incoming fluid phase. The LREE-enrichment of cpx and opx (cpx La/Yb = 220) and the appreciable Li, B, Rb, Ba, Pb, U, Th of cpx and phl suggest addition of crustal components. The data for the interstitial and vein M3 grt + its px needles show that the pre-exsolution M3 majorite has flat REE patterns (La ca 1xChondrite; La/Yb= 0.35) and lacks the LREE depletion characteristic for grt. The px component of majorite thus allows LREE and LILE storage in this mineral, which becomes a relevant trace element repository in the deep mantle. The REE enriched signature of M3 majorite is at odds with the depleted nature of M1 (+ M2) grt, confirming the presence of two generations of majorite in these rocks. The REE compositions of the Norwegian majorites encompass the whole range reported for majorite inclusions in diamonds worldwide[5]. This shows that re-enrichment of depleted mantle by subduction-related fluids is a viable process, potentially monitored by the variabilty of majoritic garnet compositions.

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