Associations of högbomite + spinel and spinel + quartz in pegmatitic magnetite megacrysts from West Ongul Island, Lützow-Holm Complex, East Antarctica

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We report the mode of occurrence of the mineral associations including högbomite + spinel and spinel + quartz (**Fig. 1**) in magnetite megacrysts (3 cm × 5 cm) in pegmatite cutting the medium-grained quartzo-feldspathic garnet–biotite gneiss at West Ongul Island, Lützow-Holm Complex, East Antarctica.

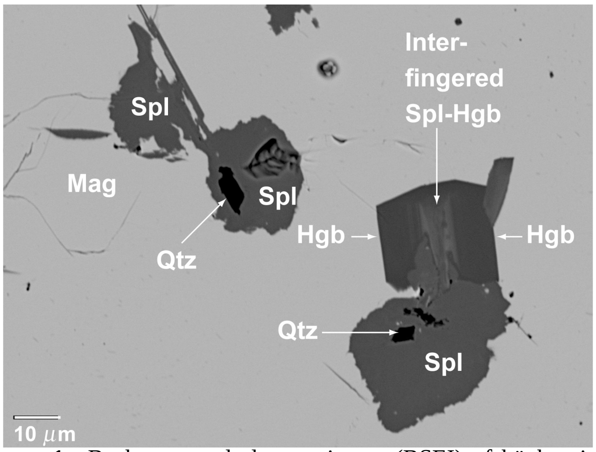

Figure 1. Back scattered electron image (BSEI) of högbomite + spinel + quartz and spinel + quartz associations trapped within magnetite megacrysts in pegmatite from West Ongul Island, Lützow-Holm Complex, East Antarctica.

Högbomite is a complex Fe–Mg–Al–Ti hydroxide mineral related to the spinel group (Hejny Armbruster 2002). Retrograde högbomite has been found in the amphibolite- to granulite-facies metamorphic rocks from Antarctica (Lützow-Holm complex: Grew et al 1990; Sør Rondane Mountains: Grew et al 1989, Shimura et al 2011), in the ultrahigh-temperature ganulites (Madagascar: Rakotonanrasana et al 2010; south India: Tsunogae Santosh 2005) and in the high-pressure eclogite (Kyrgyzstan: Orozbaev et al 2011). Some prograde högbomite is also reported in the ultrahigh-temperature Mg-Al rock (Nishimiya et al 2009).

West Ongul magnetite contains numerous fine inclusions of a monophase or multiphase assemblages comprising combinations of högbomite, spinel, quartz, sillimanite, andalucite, corundum, diaspore, muscobite, biotite, plagioclase, ilmenite, hematite, rutile, anatase, monazite and zircon. These occur as (1) isolated inclusion and (2) seam, are found at (3) ilmenite–magnetite boundary, and (4) partly replace the ilmenite seam (**Table 1**).

Table 1. Mineral inclusions within magnetite megacrysts in pegmatite from West Ongul Island, East Antarctica.

1. Isolated inclusions in magnetite
Hgb + Spl, Spl + Qtz, Hgb + Spl + Qtz, Fe-rich And + Crn, Ms + Pl, Ant, Spl, Sil, Bt, Mnz, Zrn
2. Seam
Spl + Hgb, Spl + Hgb + Ilm, Spl
3. Ilmenite–magnetite boundary
Spl + Hgb, Spl + Qtz, Dsp, Crn, Sil, Spl, Bt, Rt, Ilm, Mnz, Zrn
4. Replacement of ilmenite seam
Spl + Hgb, Dsp, Crn, Rt

Högbomite, assigned as the 2N2S type, forms small grains (5–20 μm) along the magnetite–ilmenite grain boundary or less commonly enclosed in spinel and magnetite. Electron microprobe analyses of högbomite yield 2.6–7.9 wt% TiO_2, 60–64 wt% Al_2O_3, 0–0.1 wt% Cr_2O_3, 18–25 wt% Fe (as FeO), 0.3–0.6 wt% MnO, 2.9–4.4 wt% MgO, 3.5–10 wt% ZnO, 0.61–0.01 wt% SnO_2, and 0.196–0.302 X_{Mg}^{Hgb}. Spinel varies 4.45–26.55 wt% ZnO and 0.221–0.362 X_{Mg}^{Spl}. Spinel and högbomite plot in the FeO–MgO–ZnO–TiO_2 tetrahedron (**Fig 2**).

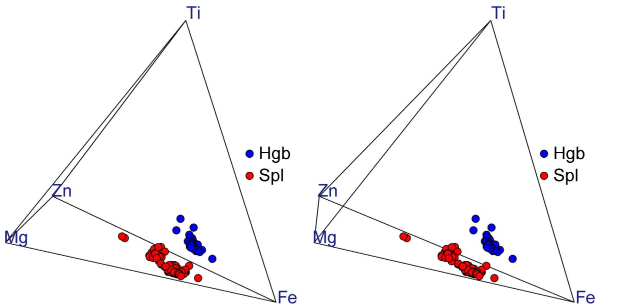

Figure 2. Stereographic FeO–MgO–ZnO–TiO_2 plot of högbomite and spinel included within magnetite megacrysts in pegmatite from West Ongul Island, Lützow-Holm Complex, East Antarctica.

From mineral associations of spinel + quartz, andalucite + corundum, muscovite + plagioclase, sillimanite, anatase and diaspore, the metamorphic $P-T$ path of West Ongul Island can be drawn as **Fig. 3**.

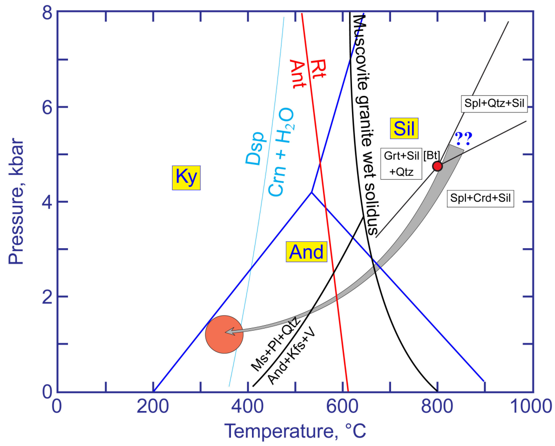

Figure 3. Probable $P-T$ path of West Ongul Island. Invariant point [Bt] in the KFMASH system is after Shimura et at 2002. Solidus of muscovite granilte, Ms + Pl + Qtz ⇌ And + Kfs + V: LeBreton Thompson 1988; Rt–Ant phase boundary: Dachille et al 1968; Crn–Dsp phase boundary: Fockenberg et al 1996, Perkins et al 1979.

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