European Mineralogical Conference
Vol. 1, EMC2012-640, 2012
European Mineralogical Conference 2012
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Pressure-temperature evolution of osumilite-bearing sapphirine granulite from Bunt Island in the Napier Complex, East Antarctica

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Sapphirine-bearing mineral assemblages in Mg-Al-rich and pelitic rocks have been the focus of many petrologists because of their preservation of various mineral assemblages and reaction textures useful for determination of peak $P-T$ condition as well as construction of $P-T$ path. Particularly, sapphirine + quartz assemblage in ultrahigh-temperature (UHT) metamorphic rocks has been regarded as a robust evidence for extreme temperatures, above 950 ˚C, and sometimes exceeding 1000 ˚C (e.g. Kelsey 2008). Recently, lowering of the stability temperature of sapphirine + quartz assemblage in highly oxidized states has been reported (Taylor-Jones and Powell, 2010; Korhonen et al., 2011), which pointed out that the estimate of Fe^{3+} content in sapphirine + quartz-bearing rocks and application of Fe_2O_3-bearing system is necessary for calculating precise peak conditions. In this study, we thus adopted pseudosection analysis considering the effect of Fe^{3+} content for the first time on osumilite-bearing sapphirine granulite from Bunt Island of Amundsen Bay, Enderby Land, in the Napier Complex, which is underlain by various Archean UHT (>1000 ºC) granulites. The calculations have been done in Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O-TiO_2-Fe_2O_3 (NCKFMASHTO) system using THERMOCALC 3.33 with the internally consistent data set. The sapphirine granulites from Bunt Island are characterized by some unique mineral assemblages such as sapphirine + quartz, osumilite + garnet, and aluminous orthopyroxene (Al_2O_3 = 11.0 wt.%; Osanai et al., 2001). Osanai et al. (2001) estimated the peak UHT condition for Bunt Island as $T > 1030$ ºC and $P < 9.8$ kbar and constructed clockwise $P-T$ path based on a KFMAS petrogenetic grid. Tsunogae et al. (2008) reported CH_4 in carbonic fluids suggesting that oxygen fugacity conditions during high-grade metamorphism were probably low. Osumilite-bearing sapphirine granulite from Bunt Island is composed by sapphirine, garnet, osumilite, plagioclase, orthopyroxene, quartz, and rutile with minor sillimanite, ilmenite, and zircon. Symplectite textures of K-feldspar + cordierite around osumilite and orthopyroxene + cordierite around garnet are assumed to have been formed during retrograde metamorphism. T-Mo (=Fe_2O_3/[FeO+Fe_2O_3] in mole) pseudosections, constructed to infer Fe^{3+} content of the rock, suggest Mo values of 0.05 at the peak of metamorphism. $P-T$ pseudosection inferred from the stability of garnet + orthopyroxene + plagioclase + sapphirine + ilmenite + rutile + quartz + liquid assemblage contains the peak metamorphic condition of Bunt Island at 8.8-9.5 kbar, 1020-1070 ºC, which was followed by cordierite-bearing lower-pressure stage probably along a clockwise $P-T$ trajectory. The mineral equilibria modeling of this study indicated low Fe^{3+} content of the rock, which is consistent with the absence of magnetite and low Fe^{3+} content in minerals, and confirmed that Bunt Island underwent extreme metamorphic condition of T >1000 ºC.