Ominelite, (Fe,Mg)Al$_3$BSiO$_9$ (Fe$^{2+}$ analogue of grandidierite), a new mineral from porphyritic granite in Japan

YOSHIKUNI HIROI,1,* EDWARD S. GREW,2 YOICHI MOTOYOSHI,3 DONALD R. PEACOR,4 ROLAND C. ROUSE,4 SATOSHI MATSUBARA,5 KAZUMI YOKOYAMA,5 RITSURO MIYAWAKI,5 JAMES J. MCGEE,6 SHU-CHUN SU,7 TOMOKAZU HOKADA,3 NOBORU FURUKAWA,1 AND HIROSHI SHIBASAKI8

1Department of Earth Sciences, Chiba University, Yayoicho, Inage-ku, Chiba 263-8522, Japan
2Department of Geological Sciences, University of Maine, Orono, Maine 04469, U.S.A.
3Department of Crustal Studies, National Institute of Polar Research, Kaga, Itabashi-ku, Tokyo 173-8515, Japan
4Department of Geological Sciences, University of Michigan, Ann Arbor, Michigan 48109, U.S.A.
5Department of Geology, National Science Museum, Hyakunincho, Shinjuku-ku, Tokyo 169-0073, Japan
6Department of Geological Sciences, University of South Carolina, Columbia, South Carolina 29208, U.S.A.
7Hercules Research Center, 500 Hercules Road, Wilmington, Delaware 19808, U.S.A.
8Overseas Activities Department, Metal Mining Agency of Japan, Toranomon, Minato-ku, Tokyo 105-0001, Japan

ABSTRACT

Ominelite, (Fe,Mg)Al$_3$BSiO$_9$, is the Fe$^{2+}$ analog of grandidierite. The mineral occurs as elongated and euhedral grains in close association with sekaninaite (Fe-dominant analogue of cordierite), garnet, biotite, andalusite, topaz, alkali feldspar, plagioclase, muscovite, quartz, dumortierite, schoorl, zircon, ilmenite, apatite, monazite, and pyrite in a porphyritic granite of Miocene age exposed along the Misen River in Tenkawa, Yoshino, Nara Prefecture, Japan (34°12’40”N, 135°53’40”E). Temperatures <700 °C and pressures below 4 kbars are suggested for the formation of ominelite and associated sekaninaite, topaz, andalusite and dumortierite. The Al-rich minerals could be either magmatic or restitic in origin. A representative electron microprobe analysis of ominelite is SiO$_2$ 19.34, TiO$_2$ <0.01, Al$_2$O$_3$ 48.85, FeO 19.37, MnO 0.43, MgO 1.33, CaO <0.01, P$_2$O$_5$ 0.13, B$_2$O$_3$ 10.91 wt%, total 100.36 wt%, corresponding to Fe$_{0.85}$Mg$_{0.10}$Mn$_{0.02}$Al$_{3.01}$B$_{0.99}$P$_{0.01}$Si$_{1.01}$O$_{9}$. Mohs’ hardness is about 7. No cleavage is observed. Its color is blue, and the streak is pale blue. It is pleochroic X = Z = pale blue-green and Y = colorless. Optically, it is biaxial (−) and, at λ = 589 nm, has α = 1.631 (1), β = 1.654 (1), γ = 1.656 (1), 2V$_X$ (meas.) = 31.5 (6)°, Y = e (prism elongation direction). Dispersion is υ >> r. Major lines in the powder pattern [d in Å, (hkl)] are 5.57(m)(200), 5.21(vs)(200), 3.73(m)(121), 3.51(m)(130), 2.97(s)(101), 2.79(s)(040), 2.18(s)(150, 421, 312). Space group is Pbnm. Lattice parameters are a = 10.343 (2), b = 11.095 (1), c = 5.7601 (8) Å and V = 661.0(2) Å$^3$, Z = 4, D$_{ab}$ = 3.169 g/cm$^3$. Refinement of the structure confirms that ominelite is isostructural with grandidierite with no detectable substitution of Al by Fe$^{2+}$.

INTRODUCTION

Since its discovery some 100 years ago at Andrahomana, Madagascar (Lacroix 1902), grandidierite, (Mg,Fe)Al$_3$BSiO$_9$, has been described from about 40 localities worldwide in regionally and contact metamorphosed pelitic and calcareous rocks, migmatises, and granulite-facies pegmatite (e.g., Grew 1996; Grew et al. 1998). McKie (1965) was the first to determine the presently accepted formula, which was confirmed by Stephenson and Moore’s (1968) crystal structure refinement. The first analyses carried out by Pisani (Lacroix 1903) and Raoult (Lacroix and de Gramont 1919) on material from the type locality in Madagascar gave Mg > total Fe, but the reported presence of CaO, alkalis and water implies that the analyzed material must not have been pure. Subsequent analyses of samples from the type locality gave Mg > Fe$^{2+}$, i.e., $X_Fe = Fe^{2+}/(Fe^{2+} + Mg) = 0.45–0.49$ (Grew et al. 1998) as do most analyses of material from other localities (e.g., Herd et al. 1984; Grew 1996), including McKie’s (1965) magnesian sample from Sakatelo, Madagascar. Consequently, grandidierite is generally considered to be the Mg-dominant end-member (e.g., Mandarino 1999). Compositions with Fe$^{2+}$ > Mg have been reported from Almgjotheii, Norway ($X_Fe = 0.50–0.81$, Huijsmans et al. 1982; Grew et al. 1998), Morton Pass, Wyoming (0.58, Grant and Frost 1990), possibly Bellerberg, Eifel, Germany (0.5, Blass and Graf 1994), and Mt. Stafford, Australia (0.50–0.55, calculated from Greenfield et al. 1998). However, this Fe$^{2+}$-dominant material was sparse, fine-grained and not well suited for describing Fe-dominant grandidierite as a distinct species.

Andalusite-sekaninaite-biotite porphyritic granite cropping out in the Misen pluton, Omine Mountains, Nara Prefecture, Japan, is noteworthy for extreme enrichment of Fe$^{2+}$ relative to Mg and in containing the borosilicate minerals dumortierite,