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# Synthesis of beryllian sapphirine in the system MgO-BeO-$Al_2O_3$-$SiO_2$-$H_2O$ and comparison with naturally occurring beryllian sapphirine and khmaralite. Part 1: Experiments, TEM, and XRD

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## ABSTRACT

Beryllian sapphirine $Mg_{4-x}Al_{4+x}[Al_{4+x-2y}Be_ySi_{2-x+y}O_{18}]O_2$ has been synthesized from starting compositions with $y \leq 1$ at $x = 0$ and $y \leq 0.5$ at $x = 0.5$, $P = 0.1$–$1.3$ GPa, $T = 700$–$1350$ °C. Electron diffraction shows the sapphirines are dominantly the 1*A* polytype but lamellae of a 2*M* phase are consistently present. This is the first 2*M* sapphirine synthesized in the laboratory, and the first known to be devoid of $Fe^{2+}$. No superstructure reflections corresponding to the doubled tetrahedral chain repeat of khmaralite were observed, probably due to insufficient annealing time. Cell parameters of the synthetic sapphirine decreased strongly and linearly with Be content (2.7 vol% decrease from $y = 0$ to $y = 1$). In agreement with crystal-chemical considerations, experiments with starting compositions of $y > 1.0$ resulted in additional crystalline phases either coexisting with the limiting sapphirine ($y = 1$) or without it. At 900 °C, 1.3–2.0 GPa, the saturating assemblage is surinamite + chrysoberyl + forsterite, which is chemically equivalent to sapphirine with $y = 1.5$. The current lack of natural khmaralite with Be > 0.78 cations per formula unit (pfu) is likely due to the bulk composition of the host rocks being too rich in $SiO_2$ and $Al_2O_3$ for forsterite to be stable. Addition of BeO to the MgO-$Al_2O_3$-$SiO_2$ system evidently enlarges the stability field of sapphirine + forsterite relative to its restricted range in the BeO-free system.