

Merwinite as a host of alkalis in the mantle: Synthesis and X-ray characterization

LUCA BINDI¹ AND OLEG SAFONOV²

¹Dipartimento di Scienze della Terra, Firenze, Italy; luca.bindi@unifi.it

²Institute of Experimental Mineralogy, Chernogolovka, Russia; oleg@iem.ac.ru

Merwinite, $\text{Ca}_3\text{MgSi}_2\text{O}_8$, stable up to 20 GPa at 1000°C and 16 GPa at 2000°C, shows the most dense anion packing among Ca-silicates. This phase may be an efficient candidate to induce geophysical anomalies in the mantle locally enriched in CaO and depleted in SiO_2 [1] [2], as well as a good trap for various trace elements and alkalis [3].

We report a synthesis of the Na and K-bearing merwinite-like phases $(\text{Ca}_{3-2x}\text{Na}_{2x})(\text{Mg}_{1-x}\text{Si}_x)\text{Si}_2\text{O}_8$ (with x up to 0.44) in the model CMAS Iherzolite (65% Fo, 30% En, 2% Di, 5% Prp) interacted with the $\text{CaCO}_3+\text{Na}_2\text{CO}_3+\text{KCl}$ melt at 5.5 and 7 GPa and 1370-1510°C [4]. Alkali content of the phase increases with increasing pressure and decreasing temperatures, reaching 8.7-9.3 wt% Na_2O and 2.6-3.0 wt% K_2O at 7 GPa and 1370°C. Nevertheless, some alkali-rich crystals were detected at higher temperatures, as well. Merwinite-like phases show negative correlation of Ca with Na+K. The Si content in the phase reaches 2.4-2.5 a.p.f.u. At $\text{Na}+\text{K} < 0.3$ a.p.f.u., alkali content shows a positive correlation with Si, whereas no correlation is present for varieties with $\text{Na}+\text{K} > 1$ a.p.f.u. A crystal fragment with composition $(\text{Ca}_{2.08}\text{Na}_{0.86}\text{K}_{0.08})(\text{Mg}_{0.53}\text{Si}_{0.45}\text{Al}_{0.03})\text{Si}_2\text{O}_8$ synthesized at 7 GPa and 1510°C has been picked up for the single-crystal X-ray characterization. It shows the merwinite structure ($R_1 = 0.031$), space group $P2_1/a$, $a = 12.987(2)$, $b = 5.101(1)$, $c = 9.130(2)$ Å, $\beta = 92.36(1)^\circ$, $V = 604.3(2)$ Å³, $Z = 4$. Na is hosted at the Ca sites, Si both replaces Mg at the octahedral coordination (similar to UHP silicates) and occurs in tetrahedral coordination. Ordering induces distortion, which modifies coordination of the Ca and Na atoms with respect to usual merwinite.

The present data prove that merwinite as a mineralogical indicator of the mantle peridotite interaction with alkaline carbonatitic liquids [5] [6] is an efficient host for alkalis. Merwinite is another example of the phase hosting Si on the octahedral coordination at relatively low pressures.

[1] Moore, Araki (1972), *Am. Min.*, **57**, 1355-1374; [2] Liu (1979), *Phys. Earth Planet. Int.*, **20**, 25-29; [3] Moriyama et al. (1992), *Geoch. J.*, **26**, 357-382; [4] Safonov (2011), *Dokl. Earth Sci.*, **440**, 1276-1281; [5] Zedgenizov et al. (2014), *Am. Min.*, **99**, 547-550. [6] Safonov et al. (2009), *Lithos*, **112S**, 112-128.