

Phase relations and chemistry of richteritic amphiboles in the system $K_2O-Na_2O-CaO-MgO-Al_2O_3-SiO_2-H_2O$ (KNCMASH)

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Introduction

Knowledge of alkali-amphibole and phlogopite stability plays a key-role in the understanding of water storage and recycling in the upper mantle. The few experimental data so far available at $P > 5.0$ GPa yield an upper pressure stability of < 9 GPa at 1200°C for pure phlogopite and 13–14 GPa at 1200°C for pure KNaCa-richterite $KNaCaMg_5Si_8O_{22}(OH)_2$ (Trønnnes 1990). In phlogopite-bearing natural peridotites Trønnnes *et al.* (1988) observed growth of KNaCa-richterite at the expense of phlogopite at about 10 GPa and 1000 – 1200°C . Sudo & Tatsumi (1990) stabilized pure $K_2CaMg_5Si_8O_{22}(OH)_2$ at 13 GPa and 1000°C . The present study has been undertaken to better understand phase relations of richterite in the presence of Na in P, T and composition space as this may reduce the upper stability limit of

richterite (Sweeney *et al.* 1993). We also investigate any PT-dependent changes in chemistry of amphibole and coexisting phases.

Methods

Experiments were carried out with a Boyd & England-type piston cylinder at $P \leq 3.0$ GPa and a Walker-type multi anvil device from 3.5 to 8.0 GPa. Mineral/phase transformations used for calibrations include α -quartz-coesite, coesite-stishovite, fayalite- γ -spinel, garnet-perovskite in $CaGeO_3$ and garnet-ilmenite in $CdGeO_3$. For cold calibration Bi phase transitions were used. Pressure accuracy is believed to be ± 0.2 GPa between 3.0 and 8.0 GPa and T-precision to be $\pm 20^\circ\text{C}$ at 1250°C .

Two different starting compositions were used: An oxide-mix with $Na_2O + K_2O/Al_2O_3 = 1.71$ representative of MARID (Dawson & Smith 1977) and metasomatic phlogopite-K-richterite perido-

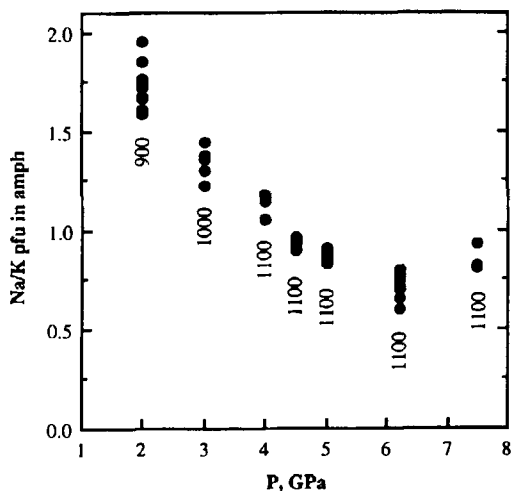


FIG. 1a. Na/K ratio of amphiboles from 2.0 to 7.5 GPa data points are individual amphibole analyses normalized to 24 O and 2 OH. Numbers below data-points refer to experimental temperatures.

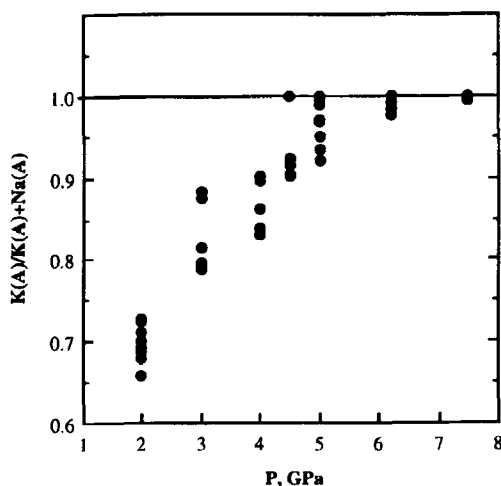


FIG. 1b. Alkali-ratio on A-site of amphiboles from 2.0 to 7.5 GPa. Experimental temperatures as in fig. 1a.

tites (mix1) and a mix of pre-synthesized phlogopite + omphacite + diopside + orthopyroxene with $\text{Na}_2\text{O} + \text{K}_2\text{O}/\text{Al}_2\text{O}_3 = 1.0$ which is thought to represent slightly metasomatically altered peridotites (mix2). These bulk systems are labelled peralkaline and subalkaline respectively.

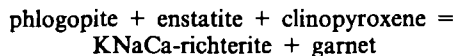
Results

Preliminary results show KNaCa-richterite stability to be critically dependent on the alkali-alumina ratio. In the peralkaline starting composition (mix1) amphibole is stable from 2.0 to 7.5 GPa at 1100°C and coexists with phlogopite + clinopyroxene ± olivine. At 6.2 to 7.5 GPa Ca-rich garnet appears as an additional phase stable with KNaCa-richterite. At 4 GPa amphibole disappears at 1200°C slightly below the solidus; melting starts between 1200°C and 1225°C, at 1250°C 30–50 % strongly peralkaline melt is present as extremely fine-grained quench. Broad-beam analyses yield approx. 7 wt.% Al_2O_3 , 15 wt.% K_2O , 5 wt.% Na_2O and 42–46 wt.% SiO_2 .

Amphibole and coexisting phases show systematic changes in chemistry throughout the pressure-interval investigated: most obvious is a decrease in Na/K ratios of amphiboles from > 1.5 at 2.0 GPa to < 0.85 at 6.2 GPa (Fig. 1a); with the incoming of garnet at 6.2 GPa Na/K increases slightly. With increasing pressure Na is continu-

ously replaced by K on the A-site (Fig. 1b) with K also entering the M(4)-site at 6.2 GPa. With increasing pressure coexisting phlogopite shows a systematic decrease in Na and a slight increase in total Al, clinopyroxene exhibits an increase in jadeite-component.

In mix2 KNaCa-richterite first appears at 6.0 GPa/1100°C. At $P < 6.0$ GPa the stable assemblage is phlogopite + clinopyroxene + orthopyroxene + garnet. Amphibole is formed by phlogopite-breakdown according to



Preliminary data yield a negative slope for this reaction which is in accordance with results from Sudo & Tatsumi (1990).

References

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