

## The lower-pressure stability of glaucophane in the presence of paragonite and quartz in the system $\text{Na}_2\text{O-MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$

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### ABSTRACT

Although the transition of the blueschist to greenschist facies has been modeled by the reaction glaucophane (Gln) + paragonite (Pg) + water (V) = clinocllore (Chl) + albite (Ab) + quartz (Qtz), we have found in the system  $\text{Na}_2\text{O-MgO-Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$  that smectite (Smec) forms repeatedly and persistently through the approximate reaction  $\text{Gln} + \text{Chl} = \text{Smec} \pm \text{Ab}$ . The reaction was verified using both synthetic and natural Gln and Chl, where in all cases complete reaction of Chl occurs in the presence of Gln to yield Smec. We have, therefore, investigated the reaction  $\text{Gln} + \text{Pg} + \text{Qtz} \pm \text{V} = \text{Smec} + \text{Ab}$ , as a possible alternative to the first reaction. The reaction  $\text{Gln} + \text{Pg} + \text{Qtz} \pm \text{V} = \text{Smec} + \text{Ab}$  was studied over the  $P$ - $T$  range of 600–800 °C and 1.4–2.0 GPa keeping the water content in the range of 0–4 wt% to avoid the direct reaction of Gln to Smec + Ab at water contents above 4 wt%. The reaction was experimentally reversed at 600 °C and 1.60(5) GPa, 700 °C and 1.70(5) GPa, and at 800 °C and 1.90(5) GPa (at 0 wt% water content), but with partial melting at 800 °C and pressure  $\leq 2.0$  GPa with water  $\geq 3$  wt%. The compositions of the phases and the state of Al-Si disorder in the albite were determined. The amphibole showed minor increase in Al and decrease in Mg and Si relative to the glaucophanic amphibole starting material, whereas paragonite showed minor enrichment in Mg and Si at the highest temperatures, complementary to the change in amphibole composition. Albite showed only limited ordering with decrease in temperature. Smectite at 600–700 °C has the average composition  $\text{Na}_{0.25}\text{Mg}_{2.21}\text{Al}_{1.19}\text{Si}_{3.44}\text{O}_{10}(\text{OH})_2 \cdot n\text{H}_2\text{O}$  and shows slight Mg depletion and Al enrichment at 800 °C. Evidence for at least some Mg enrichment in the interlayer cation sites was supported by powder X-ray diffraction with in situ heating stage analyses using changes in the  $d_{001}$  reflection at 200 °C as an approximate indication of Mg for Na substitution. The composition of smectite formed in this study is quite similar to that of other natural trioctahedral phyllosilicates reported in the literature. This, together with the experimental reversibility of the reaction observed here, indicates that smectite can form as a progressive metamorphic mineral at greenschist- and amphibole-facies conditions, particularly at the expense of chlorite and glaucophane.

**Keywords:** Glaucophane, metamorphic smectite, chlorite, greenschist facies, blueschist facies