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Short Communications

Dry Melting of Muscovite + Quartz in the Range $P_s = 7$ kb to $P_s = 20$ kb

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Abstract. Experimental data obtained for dry melting of muscovite + quartz show that the stability field of this assemblage is extended to higher temperatures compared with the corresponding melting reactions with excess vapor which have been determined by Storre and Karotke (1971, 1972).

Recently Storre and Karotke have reported experimental data on melting reactions of muscovite+quartz in the range 7–20 kb water pressure using a natural and a synthetic muscovite (1971, 1972). If excess water is present, muscovite+quartz react at H_2O pressures exceeding 5.8 kb to form liquid+sillimanite, or liquid+kyanite, respectively:

$$\text{muscovite} + \text{quartz} + H_2O \rightleftharpoons \text{liquid} + \text{sillimanite}, \quad \text{(Ia)}$$

$$\text{muscovite} + \text{quartz} + H_2O \rightleftharpoons \text{liquid} + \text{kyanite}. \quad \text{(Ib)}$$

With no free water the stability field of the assemblage muscovite+quartz is extended to higher temperatures and the upper stability limit is realized by the dry melting reactions:

$$\text{muscovite} + \text{quartz} \rightleftharpoons \text{liquid} + \text{K-feldspar} + \text{sillimanite}, \quad \text{(IIa)}$$

$$\text{muscovite} + \text{quartz} \rightleftharpoons \text{liquid} + \text{K-feldspar} + \text{kyanite}. \quad \text{(IIb)}$$

In the present study experiments on the dry melting reactions (IIa) and (IIb) were carried out. A mixture of 50 wt.-% quartz+44 wt.-% synthetic muscovite (synthesized[1] at 10 kb H_2O pressure and 700° C for 10 days)+3 wt.-% sillimanite (from Custer, South Dakota, USA)+3 wt.-% kyanite (from St. Gotthard, Switzerland) was reacted in a piston-cylinder apparatus between 7 and 20 kb confining pressure for 1 to 11 days. The temperatures are considered accurate to ±7° C, the pressure to ±0.5 kb. Since no free water was added, the liquid formed by melting contains only the water in the initial muscovite, i.e. for the composition of the mixture used, approx. 2 wt.-%. Thus, the liquid formed is by no means saturated. The results of the experiments are plotted in Fig. 1A. At 7 and 10 kb confining pressure muscovite+quartz react to form liquid+K-feldspar+sillimanite (reaction (IIa)), while at 15 and 20 kb confining pressure liquid+K-feldspar+kyanite are formed (reaction (IIb)). The slope of the dry melting curve (IIa) is approx. 13.3° C/kb, that of reaction (IIb) approx. 10° C/kb. In addition to the present runs the dry melting curve of Segnit and Kennedy

1 Specpure oxides or carbonate, respectively, from Johnson Matthey, London, were used for the synthesis.

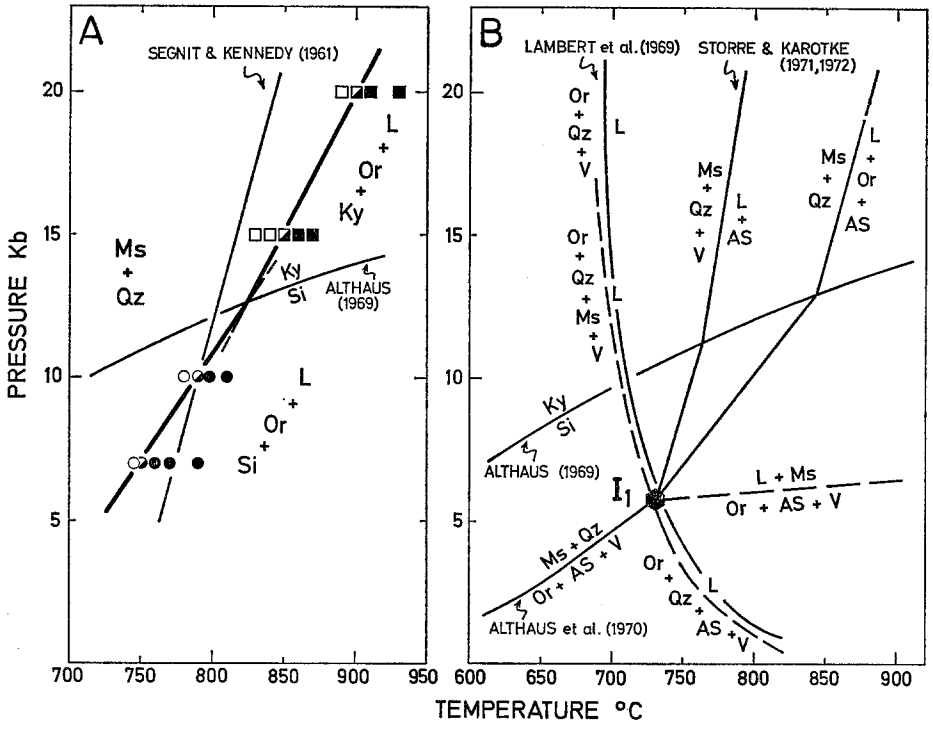

Fig. 1. A Experimental results for the dry melting of muscovite + quartz. Key for the run symbols: open symbols—no liquid, Ms + Qz stable; solid symbols—no Ms + Qz, L + Or + Si/Ky stable; half filled symbols—all phases observed; boxes (cycles)—Ky (Si) observed as stable Al_2SiO_5 modification. B Relations of all curves around the invariant point I_1 which was derived schematically by Lambert *et al.* (1969) and determined experimentally by Storre and Karotke (1971). For comparison the melting curve of Or + Qz + V which does not pass through I_1 is included. *Ms* muscovite; *Qz* quartz; *Or* K-feldspar; *Si* sillimanite; *Ky* kyanite; *AS* Al_2SiO_5 modification; *L* liquid; *V* vapor phase

(1961, p. 286, Fig. 3) is reproduced in Fig. 1A. But their data, using a piston-anvil apparatus, may not be relieable, because they obtained sillimanite even at 20 kb and, furthermore, they did not observe K-feldspar as a reaction product. Huang and Wyllie (1972) have worked on reaction (IIb) at 15 kb confining pressure and determined a temperature bracket of $930 \pm 20°C$, which is consistent, within limits of experimental error, with the bracket of $950 \pm 10°C$ derived in the present study.

Fig. 1B shows the relationship of all the reaction curves which are relevant to the upper stability limit of muscovite + quartz in the system K_2O-Al_2O_3-SiO_2-H_2O. They are governed by an invariant point I_1 which was derived schematically by Lambert, Robertson and Wyllie (1969) and determined experimentally by Storre and Karotke (1971). The present study of the dry melting reactions of the assemblage muscovite + quartz yields an independent confirmation of that experimental determination. A comparison of the vapor-absent dry

melting reactions (IIa) and (IIb) with the corresponding reactions with excess water (Ia) and (Ib) show that the stability field of muscovite + quartz is extended to higher temperatures: 10°C at 7 kb, 40°C at 10 kb, 80°C at 15 kb, and 90°C at 20 kb. Thus the curves for the dry melting curves (IIa) and (IIb) define the maximum temperature for the existence of the assemblage muscovite + quartz. These data are applicable to those high-grade metamorphic rocks in the lower crust and upper mantle in which no free water is present in the pores.

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