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Nano- to micro-scale decompression products in ultrahigh-pressure phengite: HRTEM and AEM study, and some petrological implications

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ABSTRACT

Samples of phengite-3*T*, $(K_{0.93}Na_{0.01})(Al_{1.44}Mg_{0.56}Ti_{0.02})(Si_{3.54}Al_{0.46})O_{10}(OH_{1.93}F_{0.07})$, which formed at about 3 GPa and 1000 K in ultrahigh-pressure metamorphic rocks of the Dora-Maira Massif (Western Alps, Italy), were investigated by HRTEM, AEM, EMPA, and SEM. The matrix of phengite-3*T*, which is almost free of stacking faults, contains single-crystal α-quartz platelets 100–700 Å thick that are confined by (001) planes of phengite. In the vicinity of quartz, the 30 Å period of the phengite-3*T* matrix is faulted by short sequences with about 19 Å periodicity, interpreted as talc-2*M*. The occurrence of these phases is not connected with any defects in the host phengite nor is their spatial distribution homogeneous on the TEM scale. The shape control exerted by phengite on the quartz crystals, the absence of deformation around them, and the nearby presence of an interlayered 19 Å phase, suggest that quartz and talc may have been produced within mica by a reaction of the type:

$$3 \text{ alumino-celadonite} + 2\,H^+ = 1 \text{ muscovite} + 1 \text{ talc} + 5 \text{ quartz} + 2\,H_2O + 2\,K^+$$

which leads to a less celadonite-rich phengite during decompression, after the rock had left the coesite stability field. In addition, examination by optical microscopy along [001] of "thick" sections of the Dora-Maira phengite and of phengite samples from other high-pressure terranes (Monte Mucrone and Sesia Zone in the Italian Western Alps, Dabie Mountains in central China), revealed the presence of micrometer-wide, amoeboid platelets of quartz interlayered at various depths parallel to (001) of micas. In spite of the different observation scale, these are interpreted as the same reaction product as identified by HRTEM. These new observations show that high-pressure white micas may not be homogeneous and should be examined more carefully. Some consequences for thermobarometry of such heterogeneity and intracrystalline re-organization during decompression are considered; they depend on the resolution of the analytical method employed. Implications for thermochronometry still have to be evaluated.