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Evolution of product phase assemblages during thermal decomposition of muscovite under strong disequilibrium conditions

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ABSTRACT

We investigated the thermal decomposition of muscovite in natural granite powders heated to 1175 °C for durations from 5 min to 68 h, at 1 bar, paying special attention to the early stages of decomposition. This study shows that muscovite is completely transformed after 5 min. Muscovite pseudomorphs consist of glass, mullite, and Al-rich oxides. For short durations (5 and 40 min), the Al-rich phase was identified by XRD, electron diffraction, and TEM microanalysis as γ-Al_2O_3 containing 4–8 wt% FeO (total Fe), probably a few weight percents of MgO, and possibly up to 10 wt% SiO_2. Faint superstructure spots and diffuse streaks observed in electron-diffraction patterns suggest vacancy or trace elements ordering in the γ-Al_2O_3 defect spinel structure. γ-Al_2O_3 displays an unexpected acicular morphology, elongated along three directions at 120° in the basal $(001)_{musc}$ planes and parallel to lateral faces of the former muscovite. Mullite forms rods elongated in the basal $(001)_{musc}$ planes along a direction at 90° from one set of γ-Al_2O_3 needles. The γ-Al_2O_3 structure appears to be a metastable phase that is replaced by corundum for longer durations.

Keywords: Crystal growth: mullite, Al-rich oxide, high-temperature studies, experimental petrology: granite, muscovite, electron diffraction, electron microscopy