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Prograde muscovite-rich pseudomorphs as indicators of conditions during metamorphism: An example from NW Maine

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Abstract

During metamorphism, evidence of the prograde path is commonly obliterated by continued recrystallization as temperatures increase. However, prograde pseudomorphs that are common in many terrains may provide insight into this portion of the metamorphic path if their mineralogy can be accurately interpreted. Seventeen sillimanite-zone metapelitic samples, each containing 2–5 muscovite-rich pseudomorphs, from the Farmington Quadrangle, Maine, U.S.A., were investigated to evaluate their use as indicators of conditions during prograde metamorphism. SEM-CL images, X-ray maps, image analysis, and electron microprobe analyses characterize the mineral distribution, modes, and compositions within the pseudomorph and the surrounding matrix. Based on modal mineralogy determined from image analyses, the muscovite-rich pseudomorphs are divided into four major types: muscovite-rich (>70% muscovite), quartz-muscovite (60–70% muscovite with 10–25% quartz), plagioclase-muscovite (58–72% muscovite with 10–20% plagioclase), and sillimanite-plagioclase-muscovite (50–60% muscovite with 10–20% each plagioclase and sillimanite). A biotite-rich, muscovite-poor mantle surrounds many pseudomorphs. All pseudomorphs are interpreted to be prograde, based on their texture, and are after staurolite because of the partial replacement of staurolite by coarse muscovite at lower grades.

Textural modeling of reaction mechanisms required to reproduce the observed mineralogy in the pseudomorphs indicates that each major pseudomorph type holds clues to the prograde path and represents a different mechanism of formation. Muscovite-rich and quartz-muscovite pseudomorphs formed by the breakdown of staurolite containing different modal amounts of poikiloblastic quartz. Quartz-muscovite pseudomorphs likely reflect a quartz-rich initial rock composition. Plagioclase-muscovite pseudomorphs require the infiltration of Na-bearing fluids. Sillimanite-plagioclase-muscovite pseudomorphs require a two-stage process; the infiltration of Na-rich fluids during staurolite breakdown followed by sillimanite growth. The subtle mineralogical differences recorded in the pseudomorphs studied here provide evidence of previously unrecognized controls along the prograde path during metamorphism.

Keywords: Pseudomorph, metamorphism, diffusion, metapelites, reaction mechanisms