

Stability of osumilite coexisting with spinel solid solution in metapelitic granulites at high oxygen fugacity

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ABSTRACT

Experiments were carried out in the quartz-saturated part of the system KFMASH at hematite-magnetite buffer conditions in a piston-cylinder apparatus using synthetic biotite, K-feldspar, quartz, and sillimanite₈₀-quartz₂₀ gel. Natural garnet and sillimanite were used as seeds. Three bulk compositions were used: $X_{Mg} = 0.81, 0.72, \text{ and } 0.53$, and the experiments were vapor absent. In the bulk composition with the highest X_{Mg} , dehydration-melting of biotite produced osumilite coexisting with spinel solid solution within the P - T window 7–8.5 kbar and 850–1000 °C. However, this mineral pair coexisted with cordierite at $P < 7.5$ kbar, and with sillimanite above 7.5 kbar. There is no appreciable change in the lower thermal stability of osumilite with lowering of X_{Mg} in the bulk composition, but both the upper pressure and upper thermal stabilities are reduced. With increasing pressure, osumilite + spinel breaks down to an orthopyroxene + sillimanite assemblage. There is no overlap of the stability fields of osumilite and sapphirine. Rather, sapphirine-bearing assemblages are produced at the expense of osumilite with increasing temperature. Sapphirine, however, did not appear in the bulk composition having $X_{Mg} = 0.53$. Instead, a wide stability field of spinel + cordierite + orthopyroxene + sillimanite is noted at $P > 7$ kbar and $T > 950$ °C. Garnet + orthopyroxene + sillimanite become stable at lower pressures with decreasing X_{Mg} in the bulk composition. The effects of additional components in natural assemblages, such as Zn in spinel and F and Ti in biotite, on the KFMASH equilibria are evaluated qualitatively. The experimental results were applied to six high-grade terranes, where osumilite + spinel coexistence at peak metamorphic conditions has been reported. The deduced P - T window for the osumilite + spinel association is entirely consistent with independent P - T estimates for the natural occurrences. It is argued that osumilite + spinel assemblage should be characteristic of metamorphism of highly magnesian pelites at high f_{O_2} along a prograde path of high dT/dP .