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High-grade contact metamorphism of calcareous rocks from the Oslo Rift, Southern Norway

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ABSTRACT

Shallow-level plutons caused extensive contact metamorphism of Lower Paleozoic shale and carbonate sequences in the Permian Oslo Rift. A >500 m long and 100 m wide shale-limestone xenolith embedded within monzonites belonging to the Skrim plutonic complex experienced high-grade contact metamorphism and generation of minerals and mineral assemblages rarely reported from metamorphic rocks. The peak metamorphic (Stage I) assemblages in calcite-saturated rocks include wollastonite, melilites, fassaitic pyroxenes, phlogopite, titanian grossular, kalsilite, nepheline, perovskite, cuspidine, baghdadite, pyrrhotite, and occasional graphite. Mineral reactions involving detrital apatite produced a series of silicate apatites, including the new mineral species $Ca_{3.5}(Th,U)_{1.5}Si_3O_{12}(OH)$. This assemblage equilibrated at T = 820–870 °C with a C-rich, internally buffered pore-fluid (20–40 mol% CO_2 + CH_4). During cooling the shale-limestone xenolith experienced infiltration of C-poor (< 0.1 mol% CO_2) fluids, triggering the formation of retrograde (Stage II) mineral assemblages comprising monticellite, tilleyite, vesuvianite, grandite garnets, diopside, and occasional hillebrandite. Rare potassium iron sulfides (rasvumite and djerfisherite) formed at the expense of primary pyrrhotite. These assemblages probably formed near 700 °C. Formation of diffuse sodalite-bearing veinlets was associated with breakdown of nepheline and the replacement of kalsilite and wollastonite by potassium feldspar. The sodalite-bearing Stage III assemblage formed by the infiltration of saline brines at a maximum temperature of 550 °C. Low-temperature (Stage IV) retrogression of the Stage I-III assemblage produced scawtite, giuseppettite, hydrogrossulars, phillipsite, thomsonite, and three hitherto undescribed mineral species.