Development of cordierite in medium to high grade metamorphic rocks in southwestern Nova Scotia

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Large porphyroblasts of andalusite, staurolite, and cordierite are associated with low-pressure regional metamorphism of the Meguma Group in southwestern Nova Scotia. The metamorphism was contemporaneous with the intrusion of the spatially associated Barrington Passage, Shelburne, and Port Mouton plutons at 377 to 366 Ma (U-Pb zircon and $^{40}Ar/^{39}Ar$ ages). However, it is not clear whether there was a direct relationship between the plutonism and the regional metamorphism.

The origin of the porphyroblastic cordierite has been controversial because of the patchy distribution of the mineral, its presence in rocks from biotite to sillimanite grade, and the large number of phases in the cordierite-grade rocks (e.g., andalusite-staurolite-cordierite-garnet-biotite-muscovite-plagioclase-quartz). Cordierite also exists as smaller grains in the migmatite zone surrounding the Barrington Passage Pluton.

TWEEQU multi-equilibrium thermobarometry was applied to cordierite-bearing rocks from throughout the area and indicates that these rocks had attained equilibrium. Pressure-temperature conditions range from 2500 to 4100 bars and 420 to 680°C. Isotherms are generally concentric around the plutons, except where they crosscut the eastern side of the Shelburne Pluton; this suggests a direct relationship between plutonism and regional metamorphism.

Thermobarometry, petrography and mineral chemistry indicate three mechanisms by which cordierite formed. Below ~520°C, idioblastic cordierite formed from matrix minerals. From ~520 to ~600°C, xenoblastic cordierite formed at the expense of andalusite and staurolite. Above ~600°C, migmatitic cordierite formed at the expense of sillimanite. The rarity of sector trilling in cordierite in the area, including in the migmatites, attests to the slow heating rate of the metamorphism and long thermal history.

The patchy distribution of cordierite cannot be explained by pressure-temperature conditions, nor can it be explained by water pressure, as calculations indicate that $P_{H2O}=P_{TOTAL}$ in some cordierite-bearing rocks, and $P_{H2O}<P_{TOTAL}$ in others. The main controls on cordierite formation in the area are therefore whole-rock Fe/Fe+Mg ratios and f_{O2}.