Amphiboles in A-type granites as indicators of complex magmatic systems: the Wentworth Pluton, Nova Scotia

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The Wentworth Pluton is one of several late Paleozoic A-type granite plutons in the Cobequid Highlands. The Wentworth granite has a bimodal abundance of Mg, and is, regionally, the only granite that contains both primary sodic and calcic amphiboles. This study investigates why the Wentworth granite has more geochemical and mineralogical diversity than other plutons. Microprobe analyses of amphiboles were compared to the modal and whole-rock composition, and Sm-Nd isotopic data, of the granites. Temperature (from zircon and amphibole), pressure (from amphibole), oxygen fugacity (from Fe-Ti oxides), fluorine and water-in-melt contents have been calculated, for the investigation of the magmatic conditions. The amphiboles include primary ferro-edenite, ferro-hornblende, ferro-richterite, and arfvedsonite and secondary ferro-actinolite, ferro-winchite, ferro-eckermannite, and riebeckite. The calcic amphiboles are hosted in granites with higher Mg and Ba concentrations compared to the sodic amphiboles. Furthermore, the granites with sodic amphiboles have higher ε_{Nd}, zircon-saturation temperatures, and initial F in-melt, compared to the granites with calcic amphiboles. The initial H_2O in-melt is higher for granites with calcic amphiboles. Sodic-calcic oikocrystic amphiboles are hosted in a fine-grained granite dyke that yielded the lowest pressure but high temperature. These differences between the granites indicate the presence of two magmatic systems in the Wentworth Pluton. A hydrous, Mg-rich magma with lower ε_{Nd} values and temperatures crystallized calcic amphiboles, whereas a relatively dry magma of higher temperarure and ε_{Nd} crystallized sodic amphiboles. The sample with interstitial development of both sodic-calcic and calcic amphiboles suggests that a hybridized granitic pulse rapidly reached the upper crust. This study shows that compositional variation in amphiboles of A-type granites can also result from the contribution of more than one magmatic source, not just from differentiation, and that the Wentworth magmatic system is more complex than previously proposed.

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