

The relationship between REE-Y-Nb-Th minerals and the evolution of an A-type granite, Wentworth Pluton, Nova Scotia

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ABSTRACT

The Wentworth Pluton in the Eastern Cobequid Highlands consists principally of metaluminous to peralkaline A-type granite (~362 Ma), a large part of which was remelted by a major gabbro intrusion (~357 Ma). Magmatic minerals like allanite-(Ce), chevkinite-(Ce), zircon, and hingganite-(Y) and post-magmatic mineral phases, such as REE-bearing epidote, samarskite-(Y), aeschynite-(Y), fersmite, thorite-like phases, and hydroxylbastnäsite-(Ce), were identified. The presence of fluorine in the parental magma, indicated by whole-rock geochemical data and the presence of fluorite, increased the solubility of monazite and xenotime and thus facilitated retainment of rare metals in the magmatic system. Fractionation of allanite-(Ce) and chevkinite-(Ce) led to a melt enriched in heavy rare earth elements (HREE), from which hingganite-(Y) crystallized during late magmatic stages. The remelting of the early granite led to fluorine and sulfur release in volatile phases, which circulated with hydrothermal fluids, thus mobilizing the REE and other rare metals. Reduction of fluorine activity during the late to post-solidus crystallization resulted in the precipitation of HREE and rare metals in samarskite-(Y), thereby enriching the residual hydrothermal fluids in light rare earth elements (LREE). Post-magmatic LREE minerals, such as hydroxylbastnäsite-(Ce), either replaced earlier minerals or precipitated from these hydrothermal fluids. Carbonate fluids involved in a late regional hydrothermal circulation event along the Cobequid-Chedabucto fault (320–315 Ma) promoted Ti mobility and the formation of TiO₂ minerals and probably of aeschynite-(Y). This mineralogical diversity, in addition to the complex geological history of the pluton, provides a unique opportunity to correlate the formation of individual rare-metal minerals to different stages of pluton evolution and thus provide an insight to the formation conditions of these minerals.

Keywords: A-type, geochemistry, Wentworth pluton, REE-minerals, anatexis