
**The REE and rare metal accessory minerals of the
A-type granite of the Late Paleozoic Wentworth
pluton, Cobequid Highlands, Nova Scotia**

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The Wentworth pluton comprises an early granite emplaced at about 362 Ma, intruded by a major gabbro (~354 Ma) that remelted large parts of the original A-type granite. The mineralogy and geochemistry of these rocks have been investigated by petrographic microscope, electron microprobe, and whole-rock geochemical analyses in order to determine the genetic links between the petrogenesis of the granite and the rare earth and rare metal element mineralization in the pluton.

The accessory mineral phases in the granite include magmatic phases like allanite, chevkinite, hingganite, and zircon and post-magmatic mineral phases like samarskite, aeschynite, yttracrasite-Y, Th-rich zircons, rutile, thorite, and bastnaesite. The early fractionation of magmatic allanite in the early granite and of chevkinite in syn- and post-gabbro granites indicates that magma was close to REE saturation. Presence of these minerals in the granite is significant, not only for establishing the magmatic origin of the mineralization, but for revealing several stages of REE and rare metal – mineral formation related to the magmatic evolution of the Wentworth pluton.

The early granites contain 200–600 ppm fluorine. The presence of F in the granitic magma resulted in the REE phosphates remaining in solution, so that monazite-xenotime saturation was never achieved, which would otherwise have removed LREE from the magma. When the early granites were emplaced, allanite crystallized. After the gabbro intrusion and granite melting, chevkinite crystallized. These minerals are major sinks for LREE, resulting in the granitic magma becoming enriched in middle and heavy REEs forming hingganite during late magmatic stages. Partial melting of the early Wentworth granite from the younger gabbro resulted in the release of F and Li in volatile phases. Fluorine started to circulate through late magmatic fluids, along with the REEs and rare metals like Nb, Y, Th, and U. Changes in fluorine activity led to the precipitation of Y and HREEs in samarskite, yttracrasite, and in

the fluid enrichment in LREEs. The enriched fluids leached yttracrasite and altered samarskite to aeschynite. Geochemical changes in the fluids resulted in the reduction of Zr mobility. This led to the precipitation of Th, forming Th-rich zircon overgrowths and thorite inclusions in magmatic zircons. The formation of the fluorine-bearing carbonate bastnaesite could be related to the 320–315 Ma hydrothermal circulation along the Cobequid-Chedabucto fault which is related to carbonate and sulphide-rich fluids.

It appears that parameters like the high temperatures from the coeval mafic magma, hydrothermal activity and the presence of fluorine both in the granitic magma and in late magmatic fluids were significant factors for the formation of the magmatic and post-magmatic minerals that appear to be significant hosts for REEs and rare metals. The identification of these factors could have significant applications in establishing magmatic models for REE enrichment for further investigation of prospective areas for the mining industry.