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Age, petrochemistry, and origin of a REE-rich mineralization in the Longs Peak-St. Vrain batholith, near Jamestown, Colorado (U.S.A.)

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Abstract

An unusual rare earth element (REE) mineralization occurs at a locality known as the "Rusty Gold" within the anorogenic 1.4 Ga Longs Peak-St. Vrain monzo- to syenogranite Silver Plume-type intrusion near Jamestown, Colorado (U.S.A.). Irregular-shaped centimeter- to decimeter-sized mineralized pods and veins consist of zoned mineral assemblages dominated by fluorbritholite-(Ce) in a gray-colored core up to 10 cm thick, with monazite-(Ce), fluorite, and minor quartz, uraninite, and sulfides. The core zone is surrounded by a black, typically millimeter-thick allanite-(Ce) rim, with minor monazite-(Ce) in the inner part of that rim. Bastnäsite-(Ce), törnebohmite-(Ce), and cerite-(Ce) appear in a thin intermediate zone between core and rim, often just a few hundreds of micrometers wide. Electron microprobe analyses show that the overall REE content increases from rim to core with a disproportionate increase of heavy REE (Σ_{HREE} increases 10-fold from 0.2 to 2.1%) compared to light REE (Σ_{LREE} increases twofold from 21.3 to 44.3%). The fluorbritholite-(Ce) contains minor U, Th, Fe, Mn, and Sr (total 0.10 apfu), with Al, Mg, Na, K, Ti, Pb, S, and Cl below instrument detection limits. Cerite-(Ce) is a minor constituent of the thin zone between the inner rim and the core. The cerite-(Ce) is Fe-rich with low Ca, and minor Al, Mg, and Mn, whereas törnebohmite-(Ce) is Al-rich and Ca-poor. Monazite-(Ce) and uraninite U-Th-Pb microprobe ages yield 1.420(25) and 1.442(8) Ga, respectively, confirming a co-genetic relationship with the host ca. 1.42(3) Ga Longs Peak-St. Vrain granite. We suggest the origin of the REE mineralization is a F-rich and lanthanide-rich, either late-magmatic hydrothermal fluid or residual melt, derived from the granite. This late-stage liquid, when becoming progressively enriched in REE as it crystallized, could explain the observed concentric mineralogical and geochemical zoning.

Keywords: Fluorbritholite-(Ce), cerite-(Ce), törnebohmite-(Ce), allanite-(Ce), REE-speciation, Rusty Gold, peraluminous granite, Silver Plume, Colorado