Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.33414

A petrological reappraisal of the prevailing paradigm for the Mountain Pass rare earth element deposit, USA

KATHRYN E. WATTS[1], ERIN K. BENSON[2], IAN W. HILLENBRAND[1] AND ALLEN K. ANDERSEN[1]

[1]U.S. Geological Survey
[2]Washington State University

A long-held view is that the Mountain Pass carbonatite REE deposit is igneous and related to rifting of the supercontinent Columbia during the Mesoproterozoic [1], but our recent studies provide abundant evidence for hydrothermal processes affecting mineralization and indicate the carbonatite stock and associated alkaline igneous rocks were emplaced in a transpressional environment inboard of a convergent plate margin. Paleoproterozoic subduction metasomatized the subcontinental lithospheric mantle via melting of C- and S-rich marine sediments [2, 3]. Partial melting of the modified mantle, combined with assimilation of Paleoproterozoic crustal rocks, generated the chemically unusual Mountain Pass magmas ca. 1.44–1.37 Ga [2-5]. Multi-mineral petrochronology of mylonitic rocks at Mountain Pass and in mountains tens of km from the mine site indicates deformation overlapped Mountain Pass magmatism and the Picuris orogeny in Laurentia ca. 1.47–1.35 Ga [6]. Virtually all mineral phases retain evidence for hydrothermal processes that overprinted primary igneous rocks of the Mountain Pass intrusive system, including zircon [4], titanite [5], phosphates [7], sulfates and sulfides [3], carbonates [8] and REE-bearing fluorcarbonates [9]. In the case of the carbonatite stock, major minerals (calcite, dolomite, barite) often retain igneous cores surrounded by fluid-altered rims and fluid-precipitated veins: for example, phenocrystic barite rimmed and crosscut by hydrothermal celestine [3]. Bastnäsite [$REE(CO_3)F$] typically occurs as a fine-grained mineral, often associated with celestine rims and veins, and is commonly interstitial and lining breccia blocks [9]. In carbonatite dikes that border the main carbonatite stock, phenocrystic cores of coarse bastnäsite are commonly rimmed by more Ca-rich REE fluorcarbonates (parisite, synchysite) that appear to have formed during melt evolution rather than secondary hydrothermal processes [9].

[1] Castor 2008, Can. Min., 46, 779-806; [2] Benson et al. 2025, Lithos, 508-509, 108060; [3] Benson et al. 2026, Mineral. Depos., in press; [4] Watts et al. 2022, Econ. Geol., 117, 1-23; [5] Poletti et al. 2016, J. Pet., 57, 1555-1598; [6] Hillenbrand et al. 2026, Geol. Soc. Lon., submitted; [7] Benson and Watts 2024, Econ. Geol., 119, 1611-1642; [8] Benson et al. 2026, Econ. Geol., in revision; [9] Watts and Andersen, 2026, Am. Min., 111, 11-28.