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A magmatic–hydrothermal model for REE–Cu fluorite breccias in the Gallinas Mountains, New Mexico

DR. ISSAC J. JACQUES, PHD AND MOSTAFA FAYEK
University of Manitoba

The Gallinas Mountains is a historic mining district in central New Mexico, mined for fluorite, REEs, Cu, Ag, Au, Pb and Fe. The most important deposits are fluorite breccias. Previous studies suggested they may be sourced from an unexposed carbonatite. New Nd and Sr isotope data for the fluorite, bastnaesite and subvolcanic rocks yield overlapping $^{87}Sr/^{86}Sr_i$ (0.706417–0.70878) and $\varepsilon Nd_{CHUR(T)}$ values (–3.7 to –2.1), indicating a genetic link between fluorite breccia deposits and the subvolcanic rocks. This is supported by the O and S isotope composition of primary barite ($\delta^{18}O_{VSMOW}$ = 0.0 to +5.6‰; $\delta^{34}S_{CDT}$ = +8.2 to +11.8‰) which plots between typical igneous rocks and the country rocks, and this reflects assimilation or water/rock interactions. Secondary barite exhibits higher and more variable $\delta^{18}O_{VSMOW}$ values (1.9 to 8.7‰), which reflects meteoric fluid overprinting. We present a new model for the formation of the Gallinas Mountains deposits. The deposits formed from two pulses of magmatic–hydrothermal fluids which are associated with the brecciation of the host rocks. Precipitation of bastnaesite was triggered by the introduction of CO_3 to the hydrothermal system via interaction with Yeso limestone while fluorite precipitation is due to increasing pH and decreasing temperature. Supergene processes remobilized Cu, Zn, Pb, Ag and As from the sulfides in the fluorite breccia deposit, and precipitated malachite, azurite, chrysocolla and adelite-descloizite group minerals above the REE ore. Our model suggests additional unexposed economic REE-bearing fluorite breccias may be found at depth where secondary Cu minerals occur at the surface.