# Lithogeochemical Vectors and Mineral Paragenesis of Hydrothermal REE-Bearing Fluorite Veins and Breccias in the Gallinas Mountains, New Mexico

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The Gallinas Mountains district in New Mexico showcase hydrothermal REE-bearing fluorite veins and breccias hosted in Permian sedimentary rocks and formed during the emplacement of trachyte/syenite sills, dikes and breccias ~30 Ma. Minor production of fluorite, REE, base, and precious metals has been recorded in the early 1900s. Gallinas Mountains is a prime location to study hydrothermal REE mobilization in an alkaline system because of the well exposed geology. REE are found in bastnäsite-(Ce), which is also the primary ore mineral of several important carbonatite REE deposits such as Mountain Pass in California and Bayan Obo in China. The aim of this study is to determine whether REE enrichment in the district can be vectored using fluorite and whole rock geochemistry.

Three REE-bearing fluorite vein types have been characterized using optical microscopy, BSE imaging, SEM-based automated mineralogy, and CL microscopy. These are: (i) barite-fluorite, (ii) bastnäsite-fluorite, and (iii) calcite-fluorite veins. Three distinct fluorite generations (Fl I-III) with unique CL signatures were distinguished in these veins. Of these, Fl II, found in type (ii) veins, appears to be most significant to REE deposition as it forms fine intergrowths with bastnäsite-(Ce) and these veins overprint Fluorite I in type (i) veins. Preliminary LA-ICP-MS analysis on fluorite indicates distinct REE chondrite-normalized profiles for each fluorite type. Fluorite I exhibits a LREE-enriched profile, Fluorite II a flat LREE profile depleted in HREE, and Fluorite III a LREE-depleted and HREE-enriched profile. Whole rock F and REE of the fluorite veins and breccias display a positive correlation with Ba, which indicates an increase in REE mineralization associated with the barite-fluorite veins. These new results indicate that F-metasomatism plays a key role in the hydrothermal mobilization and deposition of REE, which needs to be further investigated to develop geochemical vectors in this type of REE mineral deposit.