

Exploration for REE Mineralization in Pegmatites Using Aerospectrometric, Aeromagnetic, and Field Geology Techniques, West-Central Oaxaca, Mexico

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Rare Earth Elements (REE) have been extensive targets of geological exploration in the past two decades, due to their strategic and high commercial value, as well as the increased technological importance of rare REE alloys and compounds for sustainable energy devices, communications, computers, and many other electronic instruments. REE have been commonly found in very old igneous formations, such as in the Mesoproterozoic Grenvillian microcontinent Oaxaquia, which covers a vast area of south, central, north, and west Mexico. The Oaxacan Complex consists of a paragenetic sequence that concordantly overlaps an orthogneiss complex of gabbro-anorthosite composition; both were formed and metamorphosed together during the late Precambrian (1100–900 Ma). A northeastern part of Oaxaca state in Mexico is underlain by rocks of the Oaxaqueño Complex, where the area of study is located.

An airborne magnetometric and radiometric survey to define a geophysical signature associated with REE mineralization was carried out. The mineralization signature was established by integration of airborne gamma-ray spectrometric and magnetic data, in combination with field work, and subsequent petrographic and geochemical analyses through ICP-MS. Observed variations in the gamma-ray spectrometric data were used to visualize the topology of the distribution and determine the anomaly thresholds of the three radioelements, U, Th, and K, enriched in pegmatite suites. In the study area, pegmatitic rocks are common and are associated with a gamma ray response that includes the strongest U, Th, and K % anomalies, but it is divided in other dikes with a low radioactive response. Very close relationships exist between pegmatites, REE, and the magnetic and radioactive responses. Inside the anomalous area, despite the high K values, not all pegmatites contain high REE. The analytical signal revealed that some pegmatite dikes, mainly those in contact with gabbro, are the main sources of magnetic highs, particularly within a circular area. Anomalous zones of high U and Th counts were mapped and spatially coincide with the site where rock samples contain the highest REE concentrations. The magnetic data indicate a local high coincidence within this zone and highly complex magnetic patterns are evident in the area. Where elevated values of radiometric data, particularly within the uranium and thorium windows, are coincident with magnetic anomalies or are located along structural breaks, these areas should be considered as potential targets for ongoing exploration. The results from ICP-MS analyses and portable Geiger counter surveys confirm the relationship between radioactive elements and high concentrations (>2,000 ppm) of REE in the airborne survey area. These data are consistent with published preliminary results that suggest the Oaxaquia Formations may contain an economic concentration of REE.