

Heavy and Light Rare Earth Element bearing mineral phases in Hicks Dome and related igneous rocks, Southern Illinois

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The Hicks Dome crypto-volcanic structure, located in the Illinois-Kentucky Fluorspar District (IKFD) was a top producer of fluorite for much of the last century. Earlier Illinois State Geological Survey (ISGS) investigations of Hicks Dome in the 1960s identified Rare Earth Element (REE) bearing monazite alongside Uranium deposits. Continued exploration of Hicks Dome is necessary to secure the economic and energy future of the United States [1]. The ISGS is collaborating with the United States Geological Survey (USGS) on the Earth Mapping Resources Initiative (MRI) project that aims to map and investigate critical mineral occurrences within the United States. Previous researchers classified igneous samples from sites in the 'Midwest Permian Ultramafic District' as lamprophyres (alnöites) and carbonatites. Major and trace element analysis and petrographic work from newly drilled locations show variations in heavy REE (HREE) enriched versus light REE (LREE). In adjacent to Hicks Dome, Soward Diatreme samples show anomalous HREE/LREE enrichments. Xenotime and monazite (La and Ce rich) are found as fibroradial aggregates in dissolution cavities in fluorite and carbonate in Mississippian limestone samples [2]. However, the detailed mineralogy of the REE-bearing minerals requires further investigation.

Recently collected samples from the study area have been prepared for petrographic thin-section work and X-Ray Diffraction analysis to identify REE-bearing mineral phases and to constrain the depths of interest with high total REE abundances. Soward Diatreme samples from ~1000 ft depths come with a CaO wt% over 60% in Energy-Dispersive X-ray Spectroscopy analysis, and petrographically fit the definition of carbonatite. Morphology of the xenotime and monazite indicates these REEs bearing minerals are secondary phases, which indicates hydrothermal fluid alterations at these depths. Isotopic analysis in these minerals would further the understanding of the mechanism of the REEs mineral transit from primary/secondary sources. This research will lay the groundwork for future resource excavation and refinement of REEs in Illinois.

[1] U. S. Department of Energy, Critical Materials Rare Earths Supply Chain: A Situational White Paper (2020)

[2] Denny Brett et. al., Stratigraphy, Economic Geology, and Mineralogy of Hicks Dome, Hardin and Pope Counties, Illinois, ISGS Publication Catalog (2022)