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Hicks Dome: a view of a word-class REE deposit through fluid and melt inclusions.

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Critical minerals, including rare earth elements (REE) and fluorspar, are vital to the economic, technological, and energy independence of nations around the globe. Hicks Dome (HD) in southern Illinois represents a viable multi-commodity (REE-Nb-F) prospect to meet the growing demand for these critical metals. HD is also a geochemical anomaly that consists of a carbonatitic breccia (quartz + calcite + dolomite + fluorite + REE minerals) hosted in Paleozoic carbonates. The deposit is surrounded by a set of dikes and diatremes part of the Permian alkaline-ultramafic intrusive complex and also by a variety of fluorite Mississippi Valley-Type (MVT) deposits in what is known as the Illinois-Kentucky Fluorspar District (IKFD) of similar age. MVT deposits are low-temperature carbonate-hosted Pd-Zn-F-Ba-rich mineralizations that are formed by basinal fluid circulation, usually without a magmatic influence. Recently, a study from HD breccias and rocks from the alkaline-ultramafic intrusive complex suggests a strong correlation between the HREE enrichment in the HD breccias with brine-melts exsolved from a carbonatitic body at depth that could also be responsible for the alkaline-ultramafic intrusions in the region [1]. Regardless of these clear links, a comprehensive study correlating the fluid-melt compositions in HD, the surrounding alkaline-ultramafic intrusions, and the surrounding MVT deposits is missing. Here we show a systematic review of HD, the preliminary geochemical and petrological constraints on the intrusive rocks and the breccia, and how through a systematic study of the fluid-melt composition, we will be able to provide a more concise genetic model for the Hick's Dome hydrothermal-magmatic system. A growing number of studies [2, 3] show that some ore-stage mineral systems are dominated by sulfate, chloride, and carbonate melt inclusions that were previously confused with high salinity fluids or ignored and further underscores the need for detailed fluid-melt-solid inclusion work to understand better how each melt and/or fluid component contributes to the anomalous concentration of heavy REE at HD.

[1] Trela et al. (2024), Terra Nova https://doi.org/10.1111/ter.12712

[2] Bain et al. (2020), Nat. Geosci. 13, 751–757

[3] Xu et al. (2024), Geology https://doi.org/10.1130/G51887.1