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O, Fe, Cu and Zn Isotopic Characterization of New Jersey's Edison Iron Oxide Apatite Deposit

MICHAEL P DIMAIO[1], LINDA V. GODFREY[1], RYAN MATHUR[2] AND ILYA N. BINDEMAN[3]

[1]Rutgers University, Department of Earth and Planetary Sciences
[2]Geology Department, Juniata College, 1700 Moore Street, Huntingdon, PA 16652
[3]University of Oregon

Presenting Author: mpd147@eps.rutgers.edu

The Edison Mine in the New Jersey Highlands is an iron deposit in the northwest limb of the Reading Prong, made up of Appalachian Precambrian basement. Its origin is contested. There are numerous iron ore bodies in the Reading Prong, and various hypotheses describe their emplacement. These hypotheses include remobilized sedimentary deposits, metamorphosed sedimentary deposits, and ortho-magmatic fluid deposition. The Edison Mine shares many characteristics with other New Jersey and New York iron oxide apatite deposits and is exposed in multiple outcrops through late 19th century mining activities. The ore is adjacent to granitic pegmatite in multiple locations, and it hosts brecciated pegmatite xenoliths. Outcrops host abundant magnetite ore which have been analyzed for Fe-Cu-Zn-O isotopic characteristics, trace element, and textural patterns. Magnetite $\delta^{18}O$ data plot largely within ranges of known ortho-magmatic magnetite. $\delta^{56}Fe$ data show an affinity towards enrichment in lighter iron isotopes related to the evolution of the deposit's hydrothermal system or fluid-rock interaction during emplacement. Zinc isotopes fractionated by fluid exsolution, and copper isotopes through redox processes. Textural patterns and elemental distributions record distinct phases of precipitation of sulfides and 'oxy-exsolution' of Fe and Ti oxides. In combination, these tools reveal a magmatic-hydrothermal history of the Edison Deposit in a late Grenville orogenic setting (Ottawan), and we discount it as a metamorphosed sedimentary deposit.