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Allendeite ($Sc_4Zr_3O_{12}$) and hexamolybdenum (Mo,Ru,Fe), two new minerals from an ultrarefractory inclusion from the Allende meteorite

Chi Ma*, John R. Beckett and George R. Rossman

Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California 91125, U.S.A.

Abstract

During a nanomineralogy investigation of the Allende meteorite with analytical scanning electron microscopy, two new minerals were discovered; both occur as micro- to nano-crystals in an ultrarefractory inclusion, *ACM-1*. They are allendeite, $Sc_4Zr_3O_{12}$, a new Sc- and Zr-rich oxide; and hexamolybdenum (Mo,Ru,Fe,Ir,Os), a Mo-dominant alloy. Allendeite is trigonal, $R\bar{3}$, a = 9.396, c = 8.720, V = 666.7 Å^3, and Z = 3, with a calculated density of 4.84 g/cm^3 via the previously described structure and our observed chemistry. Hexamolybdenum is hexagonal, $P6_3/mmc$, a = 2.7506, c = 4.4318 Å, V = 29.04 Å^3, and Z = 2, with a calculated density of 11.90 g/cm^3 via the known structure and our observed chemistry. Allendeite is named after the Allende meteorite. The name hexamolybdenum refers to the symmetry (primitive hexagonal) and composition (Mo-rich). The two minerals reflect conditions during early stages of the formation of the Solar System. Allendeite may have been an important ultrarefractory carrier phase linking Zr-,Sc-oxides to the more common Sc-,Zr-enriched pyroxenes in Ca-Al-rich inclusions. Hexamolybdenum is part of a continuum of high-temperature alloys in meteorites supplying a link between Os- and/or Ru-rich and Fe-rich meteoritic alloys. It may be a derivative of the former and a precursor of the latter.

Keywords: Allendeite, $Sc_4Zr_3O_{12}$, hexamolybdenum, new alloy, new mineral, EBSD, nanomineralogy, Allende meteorite, CV3 carbonaceous chondrite