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Discovery, mineral paragenesis, and origin of wadalite in a meteorite

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Abstract

The mineral wadalite (ideal and simplified formula: $Ca_6Al_5Si_2O_{16}Cl_3$) has been discovered for the first time in a meteorite, specifically in coarse-grained, igneous type B calcium-aluminum-rich inclusions (CAIs) from the CV carbonaceous chondrite Allende. We report the results of electron microprobe, scanning electron microscopy, and transmission electron microscopy analyses of wadalite-bearing assemblages in the Allende CAIs and propose that wadalite formed by metamorphic reaction between åkermanitic melilite and anorthite, likely mediated by chlorine-bearing fluids. Petrographic relationships support the likelihood of multistage alterations by fluids of different chemistries interspersed or coinciding with thermal metamorphic episodes on the Allende parent asteroid. Fluid involvement in metamorphism of Allende CAIs implies that these objects experienced open-system alteration after accretion into the CV chondrite parent asteroid, which may have resulted in disturbances of their oxygen- and magnesium-isotope systematics.

Keywords: Wadalite, Allende, type B CAIs, aqueous alteration, fluid-mediated metamorphism