DISCOVERY OF A Mg-DOMINANT ANALOG OF KAMIOKITE, Mg₂Mo₃O₈. A NEW MINERAL FROM AN ALLENDE TYPE B1 CAI

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Introduction: During a nano-mineralogy investigation of the Allende meteorite, two occurrences of a new Mo-Mg oxide mineral, Mg₂Mo₃O₈, which we designate kamio-kite-(Mg) for the purposes of this abstract, were discovered in a Type B1 Ca-, Al-rich inclusion (CAI). The Mg analog of kamio-kite-(Fe₂Mo₃O₈) has a P₆₃mc structure and it occurs in the same CAI as a variety of other newly-observed meteoritic minerals described by [1].

Occurrence, Chemistry, Crystallography: One subhedral grain of kamio-kite-(Mg) [(Mg₁.₆Fe₀.₄)Mo₃O₈], ~1.0 µm wide, occurs within a 3 × 5 µm inclusion dominated by a single crystal of fcc Ni-Fe alloy (Ni₀.₄Fe₀.₆Pt₀.₂Rh₀.₁) wholly enclosed in MgAl₂O₄ spinel. The kamio-kite-(Mg) is in contact with the Ni-rich alloy. The other kamio-kite-(Mg) grain, in a different section of the same CAI, is 0.5 × 1.0 µm, roughly centered in a 3 × 4 µm phase assembly partially enclosed by spinel and partially enclosed by alteration material after melilite. Apatite is in contact with the alteration and Ni-Fe alloy, which contains inclusions of Ru-Os alloys and Mo-bearing oxides, is in contact with spinel.

Electron backscatter diffraction patterns of kamio-kite-(Mg) were matched to the P₆₃mc structures of kamio-kite and synthetic Mg₂Mo₃O₈. The best fit (MAD = 0.41) was achieved using structural data for Mg₂Mo₃O₈ [2], with a = 5.778 Å, c = 9.904 Å, V = 286.35 Å³, Z = 2.

Origin and Significance: Where present as part of phase assemblages predominately or wholly included in melilite, kamio-kite is Fe-rich (Mg/Fe molar <0.2) and coexists with or is in close proximity to a Ni-Fe alloy. Kamio-kite-(Mg) also coexists with Ni-Fe alloys but the assemblages are partially or wholly included in spinel and the high Mg/Fe (~4) may reflect local buffering of Mg by the surrounding Mg-rich spinel. Fe-Ni alloy compositions also reflect occurrence, with Ni/Fe highest (~5) in the assemblage wholly included in spinel, lower in the assemblage partially exposed to alteration (~3) and lowest in assemblages wholly included in melilite (~2). We observed P-rich phases in half of the kamio-kite (3 of 6) and kamio-kite-(Mg) (1 of 2) bearing phase assemblages. It is possible that all of these assemblages contain P-rich phases but that they are often absent in our samples due to sectioning effects.

A scenario for the formation of kamio-kite and kamio-kite-(Mg) is that a precursor consisting of a Mo ± P-rich alloy was oxidized during alteration to produce the observed suite of oxides and alloys ± phosphates. Both kamio-kite-(Mg)-bearing phase assemblages exhibit angular faces that intersect at high angles (~150°), possibly indicating that the current multi-phase assemblages are pseudomorphs after an original single crystal. Mo was preferentially oxidized with compositions of the resulting oxide(s) dictated by local constraints on Mg partial pressures. The formation of apatite reflects oxidation and an external source of Ca. The new Mo-Mg-Fe oxides provide new information on post-crystallization processes experienced by Allende CAIs.


DIFFUSION OF SOLAR WIND NOBLE GASES FROM GENESIS ALUMINUM COLLECTORS

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Introduction: The Genesis mission collected samples of solar wind (SW) over a two-year period and returned them to earth for high-precision laboratory measurements [1]. The exact temperatures that the collectors reached during exposure to the SW is unknown, however preflight simulations [2] and comparison of measurements from different target materials point to the potential for measurable losses due to thermally activated diffusion. We have conducted a diffusion experiment on a similar time scale as the Genesis mission to determine the diffusion parameters of the aluminum collector materials and to quantify the changes in the measured ratios due to diffusive losses. In this work we have studied the light noble gases: helium, neon, and argon.

Experimental: We baked individual pieces of two different bulk SW collectors—polished aluminum and aluminum on sapphire (AlO₅)—at six temperatures between 160 °C and 360 °C (with a reference group left at room temperature) for 322 days. Then we performed step-wise pyrolysis (200 to 850 °C, 45 min steps) to extract the gas from these samples, measuring the light noble gases released from each step. We analyzed He and Ne together in one mass spectrometer, and cryogenically separated Ar for analysis in a second one, each optimized accordingly.

Results: The measured isotopic ratios (total of all pyrolysis steps) of the unbaked AlO₅ reference sample are: ³He/⁴He = (4.52 ± .05) × 10⁻⁴, ²⁰Ne/²²Ne = 13.74 ± .02, and ³⁶Ar/³⁸Ar = 5.49 ± .01. There were significant losses of both ³He and ⁴He from the baked samples relative to the reference, with more ³He lost than ⁴He, leading to noticeable isotopic fractionation. Neon measurements show the same general trend as helium, but all measurements are within 3σ of the reference. There were no measurable losses of Ar within statistical errors, and the measured ³⁶Ar/³⁸Ar agrees very well with the previously reported value of 5.501 ± .005 [3].

The table below gives the estimated upper limit for losses of He and Ne at various temperatures from AlO₅ for the Genesis bulk collector exposure time (852 days).

Table 1.

<table>
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<th>Temp (°C)</th>
<th>³He loss</th>
<th>³He/⁴He decrease</th>
<th>²⁰Ne loss</th>
<th>²⁰Ne/²²Ne decrease</th>
<th>³⁶Ar/³⁸Ar decrease</th>
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