5424

N$_2$ SELF-SHIELDING IN THE SOLAR NEBULA: AN UPDATE
J. R. Lyons.   Institute of Geophysics and Planetary Physics, UCLA, Los Angeles, CA 90095-1567. E-mail: jimlyons@ucla.edu.

Introduction: The N$_2$ molecule is isoelectronic to CO, and exhibits a similar band system to CO in the VUV. The resolved rovibronic structure and very strong bands make N$_2$ a plausible candidate for self-shielding, even though it is an order of magnitude less abundant than CO in a gas of solar composition. The discovery of very large ^{15}N enrichment in lithic clasts in carbonaceous chondrites (e.g., [1–5]), in micrometeorites [6], and in comets [7] could be due to either low temperature ion-molecule chemistry that leads to NH$_3$ formation [8] or to N$_2$ self-shielding. Nitrogen isotopes in the solar system may also be enriched in ^{15}N as a result of N$_2$ self-shielding [9].

Previous Modeling: A preliminary assessment of N$_2$ self-shielding in the outer nebula [10, 11] suggests that although self-shielding does occur, it produces substantial ^{15}N enrichment in only a very small fraction of nebular material at 30 AU (δ^{15}N is about $+800‰$ in <1 ppm of total N, [11]). Also, the total enrichment in self-shielding product nitrogen (as HCN) is about $+100‰$ over $\sim10^6$ yr at 30 AU. This enrichment may not be large enough to distinguish Jupiter, with δ^{15}N $= -380 \pm 80‰$ [12], from the Sun, which has solar wind with δ^{15}N is about -450 $\pm$ 100‰ [13].

Modeling in Progress: The preliminary model ([10, 11]) used a reduced set of nitrogen reactions, and used an N$_2$ shielding function inferred from a Titan atmosphere photochemical model [14], with mean N$_2$ cross section representative of the 91–100 nm range applicable to the solar nebula. Present modeling includes (1) a more complete set of nitrogen reactions, and (2) a full integration over 911–100 nm of N$_2$ dissociation in the presence of H$_2$ absorption. The ^{28}N$_2$ and ^{29}N$_2$ cross sections are from a coupled-channel model description of measured N$_2$ cross sections, and were provided by A. Haeys and B. Lewis at ANU. These calculations are in progress.

Implications: As I pointed at the 2010 LPSC, the preliminary model results on nebular N$_2$ self-shielding have implications for CO self-shielding in the outer solar system. One criticism of outer solar nebula CO self-shielding has been that Jupiter would become more enriched in ^{15}N due to N$_2$ self-shielding than is observed [12]. However, with present uncertainties, a $\sim100‰$ increase in outer nebular δ^{15}N is not enough to rule out the occurrence of N$_2$ (and CO) self-shielding. Reduced uncertainties on solar wind δ^{15}N, as well as a quantitative assessment of fractionation during solar wind acceleration, could influence this conclusion.

References: [1] Sugiura et al. 2000. *Meteoritics & Planetary Science* 35:987–996. [2] Ivanova et al. 2008. *Meteoritics & Planetary Science* 43:915–940. [3] Briani et al. 2009. (Abstract #1642). 40th Lunar and Planetary Science Conference. [4] Bonal L. et al. 2009. (Abstract #2046). 40th Lunar and Planetary Science Conference. [5] Ishii et al. 2009. (Abstract #2467). 40th Lunar and Planetary Science Conference [6] Floss C. et al. 2009. (Abstract #1082). 40th Lunar and Planetary Science Conference. [7] Bockelee-Morvan D. et al. 2008. *The Astrophysical Journal Lett.* 679:L49–L52. [8] Rodgers S. D. and Charnley S. B. 2008. *MNRAS* 385:48. [9] Clayton R. N. 2002. *Nature* 415:860–861. [10] Lyons et al. 2009. *Geochimica et Cosmochimica Acta* 73, 4998–5017. [11] Lyons J. 2009. Abstract #5437. 72nd Metereological Society Meeting. [12] Owen T. 2001. *The Astrophysical Journal* 553:L77–L79. [13] Kallio A. et al. 2010. (Abstract #2481). 41st Lunar and Planetary Science Conference. [14] Liang et al. 2007. *The Astrophysical Journal* 664:L115–L118.

5134

DISCOVERY OF Cl-BEARING MAYENITE, Ca$_{12}$Al$_{14}$ O$_{32}$Cl$_2$, A NEW MINERAL IN A CV3 METEORITE
Chi Ma[1]*, Stuart A. Sweeney Smith[2], Harold C. Connolly Jr[3,4,5], John R. Beckett[1], George R. Rossman[1] and Devin L. Schrader[5]. [1]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125. [2]Department of Geology, Carleton College, Northfield, MN 55057. [3]Department of Physical Sciences, Kingsborough Community College of CUNY, Brooklyn, NY 11235 and Earth and Environmental Sciences, The Graduate Center of CUNY, New York, NY 10024. [4]Department of Earth and Planetary Sciences, AMNH, New York, NY 10024. [5]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721. E-mail: chi@gps.caltech.edu.

Introduction: A unique dmitryivanovite (CaAl$_2$O$_4$) -dominant Ca-, Al-rich refractory inclusion (CAI), named "Cracked Egg" by [1], was observed in the NWA 1934 CV3 carbonaceous chondrite. During our nano-mineralogy investigation of this CAI, Cl-bearing mayenite, Ca$_{12}$Al$_{14}$O$_{32}$Cl$_2$, was identified. Electron-microprobe, SEM, electron back-scatter diffraction (EBSD), and micro-Raman analyses have been used to characterize its composition and structure. Pyrometamorphic and natural Cl-bearing mayenites have been reported [2, 3] and synthetic Ca$_{12}$Al$_{14}$O$_{32}$Cl$_2$ is well known [4]. Here, we report the first occurrence of Ca$_{12}$Al$_{14}$O$_{32}$Cl$_2$ in a meteorite as a new alteration mineral in a CAI.

Occurrence, Chemistry, and Crystallography: Cl-bearing mayenite occurs as small (80–300 nm) crystals forming fine-grained aggregates (1–20 μm in size) along with Zn-bearing hercynite, gehlenite and perovskite in veins and inclusions within the dmitryivanovite-dominant CAI. The mean chemical composition is (wt%) Al$_2$O$_3$ 48.48, CaO 45.73, Cl 5.12, FeO 0.80, Na$_2$O 0.12, TiO$_2$, 0.03, O -1.16, sum 99.12. An empirical formula calculated on the basis of 34 O + Cl atoms is (Ca$_{11.93}$Na$_{0.06}$)$_{\sum11.99}$ (Al$_{13.91}$Fe$_{0.16}$Ti$_{0.01}$)$_{\sum14.08}$O$_{31.94}$Cl$_{2.11}$.

Synthetic Ca$_{12}$Al$_{14}$O$_{32}$Cl$_2$ has a cubic structure with a Ca-Al-O framework forming "cages" in which the Cl is located [4]. The meteoritic Cl-bearing mayenite showed no electron back-scatter diffraction pattern, due to small crystal sizes and, probably, poorly ordered structures but Raman microanalysis revealed a spectrum very close to that of synthetic Ca$_{12}$Al$_{14}$O$_{32}$Cl$_2$, confirming that the meteoritic phase has a similar structure.

Origin and Significance: Cl-bearing mayenite is not only a new meteoritic Ca-, Al-phase, but also a new Cl-rich phase, joining the Cl-rich meteoritic minerals sodalite (Na$_4$Al$_3$Si$_3$O$_{12}$Cl) and wadalite (Ca$_6$Al$_5$Si$_2$O$_{16}$Cl$_3$). Cl-bearing mayenite is a secondary alteration phase in "Cracked Egg". A simple scenario for its formation would be the parent body breakdown of dmitryivanovite in a Cl-, Fe-rich vapor or fluid to produce Cl-bearing mayenite and hercynite, although we have not yet ruled out the possibility that Cl-bearing mayenite formed during terrestrial alteration or that preterrestrial Cl-free mayenite was later chlorinated. Multiple-alteration events seem to have occurred in this CAI.

References: [1] Sweeney Smith S.A. et al. 2010. (Abstract #1877). 41th Lunar and Planetary Science Conference. [2] Zateeva S.N. et al. 2007. *Geology of Ore Deposits* 49:792–780. [3] Galuskin E.V. et al. 2009. *European Journal of Mineralogy* 21:1045–1059. [4] Iwata T. et al. 2007. *Journal of Solid State Chemistry* 181:51–55.