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], 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 ($CaAl_2O_4$) - 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_2O_3 48.48, CaO 45.73, Cl 5.12, FeO 0.80, Na_2O 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 $(Ca_{11.93}Na_{0.06})_{\sum 11.99}(Al_{13.91}Fe_{0.16}Ti_{0.01})_{\sum 14.08}O_{31.94}Cl_{2.11}$.

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 ($Na_4Al_3Si_3O_{12}Cl$) and wadalite ($Ca_6Al_5Si_2O_{16}Cl_3$). 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 LPSC*. [2] Zateeva S.N. et al. 2007. *Geology of Ore Deposits*, 49, 792-80. [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.