

DISCOVERY OF A NEW Cl-RICH SILICATE MINERAL, $\text{Ca}_{12}(\text{Al}_2\text{Mg}_3\text{Si}_7)\text{O}_{32}\text{Cl}_6$: AN ALTERATION PHASE IN ALLENDE. Chi Ma¹, Alexander N. Krot². ¹Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA; ²Hawai'i Institute of Geophysics and Planetology, University of Hawai'i at Manoa, Honolulu, HI 96822, USA. Email: chi@gps.caltech.edu

Introduction: During a nanomineralogy investigation of the Allende CV3 carbonaceous chondrite, a new silicate mineral, $\text{Ca}_{12}(\text{Al}_4\text{Mg}_3\text{Si}_7)\text{O}_{32}\text{Cl}_6$ with the $I\bar{4}3d$ wadalite structure, was identified in the Type B1 Ca-Al-rich inclusion (CAI) *Egg-3*. Field-emission SEM with EDS and electron back-scatter diffraction and electron microprobe were used to characterize its composition, structure, and associated phases. Synthetic $\text{Ca}_{12}(\text{Al}_4\text{Mg}_3\text{Si}_7)\text{O}_{32}\text{Cl}_6$ are not reported. The Allende $\text{Ca}_{12}(\text{Al}_4\text{Mg}_3\text{Si}_7)\text{O}_{32}\text{Cl}_6$ is the first natural occurrence of this phase. Here we discuss its origin and significance for understanding alteration processes on the CV chondrite parent asteroid. The mineral is currently under review by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA 2014-028). It is a new member of the wadalite group.

Occurrence, Chemistry, and Crystallography: This mineral occurs as small grains, 2 – 6 μm in size, with monticellite, grossular, wadalite, and newly-approved hutcheonite [1] in secondary alteration areas along some cracks between primary melilite, spinel and Al,Ti-diopside in the core area of the Allende CAI *Egg-3*, which is a Type B1 FUN (Fractionation and Unidentified Nuclear effects) inclusion [2]. Melilite with spinel, Al,Ti-diopside, anorthite and trace of Ni-Fe-rich metal occupies the mantle-core area of the CAI. *Egg-3* is surrounded by a Wark-Lovering rim consisting of Al,Ti-diopside and forsterite. The matrix around the inclusion consists of ferroan olivine, nepheline, diopside-hedenbergite pyroxenes, and minor troilite and pentlandite.

The mean chemical composition of this new mineral is (wt%) CaO 41.49, SiO₂ 27.49, Al₂O₃ 12.42, MgO 7.34, Na₂O 0.41, Cl 13.03, O=Cl -2.94, total 99.24, giving rise to an empirical formula of $(\text{Ca}_{11.69}\text{Na}_{0.21})(\text{Al}_{3.85}\text{Mg}_{2.88}\text{Si}_{7.23})\text{O}_{32}\text{Cl}_{5.80}$. The end-member formula is $\text{Ca}_{12}(\text{Al}_4\text{Mg}_3\text{Si}_7)\text{O}_{32}\text{Cl}_6$. Electron back-scatter diffraction patterns of this phase can be indexed nicely by the $I\bar{4}3d$ wadalite structure and give a best fit using the wadalite structure from [3] with unit cell dimensions: $a = 11.981 \text{ \AA}$, $V = 1719.8 \text{ \AA}^3$, and $Z = 2$.

Origin and Significance: This Si-dominant wadalite phase is a new secondary alteration phase, apparently formed by iron-alkali-halogen metasomatic alteration of the primary phases like melilite, anorthite, and Al,Ti-diopside in the CAI. Formation of the secondary Cl-rich minerals (normal wadalite and this Si-dominant wadalite phase) during the metasomatic alteration of the Allende CAIs by Cl-rich fluids suggests an open-system alteration of the CAIs on the CV chondrite parent body.

References: [1] Ma C. & Krot A.N. 2014. *Am. Miner.* 99, 667–670. [2] Wasserburg G.J. et al. 2012. *Meteor. Planet. Sci.* 47, 1980–1997. [3] Feng Q.L. et al. 1988. *Acta Crystallogr.* C44, 589–592.