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Adrianite, $Ca_{12}(Al_4Mg_3Si_7)O_{32}Cl_6$, a new Cl-rich silicate mineral from the Allende meteorite: An alteration phase in a Ca-Al-rich inclusion

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Abstract

Adrianite (IMA 2014-028), $Ca_{12}(Al_4Mg_3Si_7)O_{32}Cl_6$, is a new Cl-rich silicate mineral and the Si,Mg analog of wadalite. It occurs with monticellite, grossular, wadalite, and hutcheonite in altered areas along some veins between primary melilite, spinel, and Ti,Al-diopside in a Type B1 FUN (Fractionation and Unidentified Nuclear effects) Ca-Al-rich inclusion (CAI), *Egg*-3, from the Allende CV3 carbonaceous chondrite. The mean chemical composition of type adrianite by electron probe microanalysis is (wt%) CaO 41.5, SiO_2 27.5, Al_2O_3 12.4, MgO 7.3, Na_2O 0.41, Cl 13.0, O=Cl –2.94, total 99.2, giving rise to an empirical formula of $(Ca_{11.69}Na_{0.21})(Al_{3.85}Mg_{2.88}Si_{7.23})O_{32}Cl_{5.80}$. The end-member formula is $Ca_{12}(Mg_5Si_9)O_{32}Cl_6$. Adrianite has the $I\bar{4}3d$ wadalite structure with a = 11.981 Å, V = 1719.8 Å^3, and Z = 2, as revealed by electron backscatter diffraction. The calculated density using the measured composition is 3.03 g/cm^3. Adrianite is a new secondary mineral in Allende, apparently formed by alkali-halogen metasomatic alteration of primary CAI minerals such as melilite, anorthite, perovskite, and Ti,Al-diopside on the CV chondrite parent asteroid. Formation of secondary Cl-rich minerals sodalite, adrianite, and wadalite during metasomatic alteration of the Allende CAIs suggests that the metasomatic fluids had Cl-rich compositions. The mineral name is in honor of Adrian J. Brearley, mineralogist at the University of New Mexico, U.S.A., in recognition of his many contributions to the understanding of secondary mineralization in chondritic meteorites.

Keywords: Adrianite, $Ca_{12}(Al_4Mg_3Si_7)O_{32}Cl_6$, new mineral, wadalite group, alteration mineral, Ca-Al-rich inclusion, Allende meteorite, carbonaceous chondrite