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Hutcheonite, $Ca_3Ti_2(SiAl_2)O_{12}$, a new garnet mineral from the Allende meteorite: An alteration phase in a Ca-Al-rich inclusion

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Abstract

Hutcheonite (IMA 2013-029), $Ca_3Ti_2(SiAl_2)O_{12}$, is a new garnet mineral that occurs with monticellite, grossular, and wadalite in secondary alteration areas along some cracks between primary melilite, spinel, and Ti,Al-diopside in a Type B1 Fractionation and Unidentified Nuclear effects (FUN) Ca-Al-rich inclusion (CAI) *Egg-3* from the Allende CV (Vigarano type) carbonaceous chondrite. The mean chemical composition of type hutcheonite by electron probe microanalysis is (wt%) CaO 34.6, TiO_2 25.3, SiO_2 20.9, Al_2O_3 15.7, MgO 2.1, FeO 0.7, V_2O_3 0.5, total 99.8, giving rise to an empirical formula of $Ca_{2.99}(Ti^{4+}_{1.53}Mg_{0.25}Al_{0.17}Fe^{2+}_{0.05}V^{3+}_{0.03})(Si_{1.68}Al_{1.32})O_{12}$. The end-member formula is $Ca_3Ti_2(SiAl_2)O_{12}$. Hutcheonite has the $Ia\bar{3}d$ garnet structure with a = 11.843 Å, V = 1661.06 Å^3, and Z = 8, as revealed by electron backscatter diffraction. The calculated density using the measured composition is 3.86 g/cm^3. Hutcheonite is a new secondary phase in Allende, apparently formed by iron-alkali-halogen metasomatic alteration of the primary CAI phases like melilite, perovskite, and Ti,Al-diopside on the CV chondrite parent asteroid. Formation of the secondary Ti-rich minerals like hutcheonite during the metasomatic alteration of the Allende CAIs suggests some mobility of Ti during the alteration. The mineral name is in honor of Ian D. Hutcheon, a cosmochemist at Lawrence Livermore National Laboratory, California, U.S.A.

Keywords: Hutcheonite, $Ca_3Ti_2(SiAl_2)O_{12}$, new mineral, schorlomite group, garnet supergroup, Allende meteorite, carbonaceous chondrite, Ca-Al-rich inclusion