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Addibischoffite, $Ca_2Al_6Al_6O_{20}$, a new calcium aluminate mineral from the Acfer 214 CH carbonaceous chondrite: A new refractory phase from the solar nebula

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Abstract

Addibischoffite (IMA 2015-006), $Ca_2Al_6Al_6O_{20}$, is a new calcium aluminate mineral that occurs with hibonite, perovskite, kushiroite, Ti-kushiroite, spinel, melilite, anorthite, and FeNi-metal in the core of a Ca-Al-rich inclusion (CAI) in the Acfer 214 CH3 carbonaceous chondrite. The mean chemical composition of type addibischoffite measured by electron probe microanalysis is (wt%) Al_2O_3 44.63, CaO 15.36, SiO_2 14.62, V_2O_3 10.64, MgO 9.13, Ti_2O_3 4.70, FeO 0.46, total 99.55, giving rise to an empirical formula of $(Ca_{2.00})(Al_{2.55}Mg_{1.73}V^{3+}_{1.08}Ti^{3+}_{0.50}Ca_{0.09}Fe^{2+}_{0.05})_{\Sigma 6.01}(Al_{4.14}Si_{1.86})O_{20}$. The general formula is $Ca_2(Al,Mg,V,Ti)_6(Al,Si)_6O_{20}$. The end-member formula is $Ca_2Al_6Al_6O_{20}$. Addibischoffite has the $P\bar{1}$ aenigmatite structure with a = 10.367 Å, b = 10.756 Å, c = 8.895 Å, α = 106.0°, β = 96.0°, γ = 124.7°, V = 739.7 Å^3, and Z = 2, as revealed by electron backscatter diffraction. The calculated density using the measured composition is 3.41 g/cm^3. Addibischoffite is a new member of the warkite ($Ca_2Sc_6Al_6O_{20}$) group and a new refractory phase formed in the solar nebula, most likely as a result of crystallization from an ^{16}O-rich Ca, Al-rich melt under high-temperature (~1575 °C) and low-pressure (~10^{-4} to 10^{-5} bar) conditions in the CAI-forming region near the protosun, providing a new puzzle piece toward understanding the details of nebular processes. The name is in honor of Addi Bischoff, cosmochemist at University of Münster, Germany, for his many contributions to research on mineralogy of carbonaceous chondrites, including CAIs in CH chondrites.

Keywords: Addibischoffite, $Ca_2Al_6Al_6O_{20}$, new mineral, warkite group, refractory phase, Ca-Al-rich inclusion, Acfer 214 meteorite, CH3 carbonaceous chondrite