DISCOVERY OF BECKETTITE, Ca$_2$V$_6$Al$_6$O$_{20}$ A NEW ALTERATION MINERAL IN A V-RICH Ca-Al-RICH INCLUSION FROM ALLENDE. Chi Ma$^{1,3}$, Julie Paque$^1$, and Oliver Tschauner$^2$; $^1$Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA; $^2$Department of Geoscience and High Pressure Science and Engineering Center, University of Nevada, Las Vegas, NV 89154, USA; $^3$chi@gps.caltech.edu.

Introduction: During a nanomineralogy investigation of the Allende CV3 meteorite, we discovered the new mineral beckettite (IMA 2015-001; Ca$_2$V$_3^{+6}$Al$_6$O$_{20}$) in a V-rich, fluffy Type A Ca-Al-rich inclusion (CAI) $A$-$WP1$ in USNM 7617, which was previously studied by Paque and coworkers [1-3]. Electron probe microanalysis (EPMA), scanning electron microscopy, and electron backscatter diffraction (EBSD) were used to characterize its chemical composition and structure. Beckettite is a new vanadium aluminate mineral and a new member of the sapphireine supergroup. This phase was previously observed in $A$-$WP1$ based on EPMA [1]. Synthetic Ca$_2$V$_6$Al$_6$O$_{20}$ has not been reported. Here, we describe beckettite as a new alteration mineral in a CAI and consider its origin and implications for alteration processes. Beckettite is named in honor of John R. Beckett, a cosmochemist at California Institute of Technology. The new mineral and name have been approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association [4].

Occurrence, chemistry, and crystallography: Beckettite occurs as aggregates of crystals 4 to 8 μm in size within highly altered areas of $A$-$WP1$ (Figs. 1-4), along with secondary grossular, anorthite, coulsonite, hercynite, and corundum. Primary phases in the CAI are melilite, spinel, perovskite, grossmanite-davisite, hibonite, paqueite (Ca$_3$Ti$_2$(Al,Ti,Si)$_3$O$_{14}$) [5], burnettite (CaV$_{Al}$Si$_{O_6}$) [5], and refractory metal grains.

The mean chemical composition of type crystals by EPMA is given in Table 1. Beckettite shows an empirical formula (based on 20 oxygen atoms per formula unit apfu) of (Ca$_{1.99}$Na$_{0.01}$)(V$_{3.47}$Al$_{1.40}$Ti$_{0.57}$Mg$_{0.25}$Sc$_{0.08}$Fe$^{3+}$_{0.04}Mn$_{0.01}$)(Al$_{5.72}$Si$_{0.28}$)O$_{20}$. The general formula is Ca$_2$(V,Al,Ti,Al,Mg)$_6$Al$_6$O$_{20}$ and the end-
Beckettite grains are invariably in the central portions of alteration regions composed of fine-grained secondary corundum and grossular(?), often in contact with primary V-bearing hibonite and/or perovskite (Figs. 2-4). Similar regions of corundum + grossular(?) are centered by coulsonite \((Fe_{0.55}Mg_{0.45})(V_{1.18}Al_{0.82})O_4\) and hercynite \((Fe_{0.61}Mg_{0.44})(Al_{1.84}V_{0.15})O_4\). Coulsonite is exsolution in hercynite (Fig. 2). Spinel inclusions in melilite are relatively V-rich (~2 wt%) but the most V-rich refractory phase in this CAI is burnettite (a new V-clinopyroxene with 9.35 wt% \(V_2O_3\) and 6.89 wt% \(Sc_2O_3\)), occurring as one micro-crystal in melilite [7].

**Origin and significance:** Beckettite, \(Ca_2V_6Al_6O_{20}\), is not only a new mineral, but also a new material. It is a new member of the sapphirine supergroup and the \(V^3+\)-dominant analog of the recently described ultra-refractory phase warkite [8], \(Ca_2Sc_6Al_6O_{20}\).

Beckettite is apparently a secondary alteration phase, as indicated by its petrographic texture, probably formed in the parent body. Beckettite is likely formed by late-stage metasomatic reactions in which grossular, corundum, coulsonite and hercynite, replace primary phases such as melilite, hibonite, MgAl_2O_4 spinel, perovskite and burnettite.

V from primary phases like burnettite should have contributed to the formation of beckettite, coulsonite and hercynite. It seems that beckettite is in the middle of alteration and survives because it is a product of the destruction of what was a V-rich inclusion in melilite in that same spot. The V gets dumped out into beckettite or coulsonite because the V isn’t very volatile. Alternative, a simple scenario may also be breakdown of primary hibonite in a hot V-rich fluid to produce beckettite and corundum.