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Cabrerite, $NiMg_2(AsO_4)_2{\cdot}8H_2O$, a new old mineral: The ordered intermediate between annabergite and hörnesite

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Abstract

Cabrerite (IMA2023-123), $NiMg_2(AsO_4)_2{\cdot}8H_2O$, is a newly approved mineral species from the Nickel mine, Cottonwood Canyon, Table Mountain district, Churchill County, Nevada, U.S.A., that was originally described in 1863 from Sierra Cabrera, Almería, Andalusia, Spain. At the Nickel mine, cabrerite occurs in divergent groups of green blades up to 1 mm long. Blades are elongated and striated parallel to [001], flattened on {010}, and exhibit the forms {010}, {110}, and $\{20\bar{1}\}$. The mineral is transparent with vitreous luster and white streak. The Mohs hardness is ~2½. The mineral has moderately sectile tenacity, irregular and stepped fracture, and three cleavages: perfect on {010}, fair on {100}, and poor on $\{\bar{1}02\}$. The measured density is 2.93(2) g·cm^{-3}. The mineral dissolves slowly in RT dilute HCl. The mineral is optically biaxial (+), $\alpha = 1.609(2)$, $\beta = 1.633(2)$, $\gamma = 1.667(2)$ (white light); $2V_{meas} = 82(2)°$; slight $r < v$ dispersion; orientation $X = \mathbf{b}$, $Z \wedge \mathbf{c} = 37°$ in obtuse β; nonpleochroic. Electron probe microanalysis provided the empirical formula $(Mg_{1.46}Ni_{1.55})_{\Sigma 3.01}(As_{1.00}O_4)_2{\cdot}8H_2O$. Cabrerite is monoclinic, $C2/m$, $a = 10.2054(11)$, $b = 13.3772(13)$, $c = 4.7382(4)$ Å, $\beta = 105.057(7)°$, $V = 624.66(11)$ Å^3, and $Z = 2$. The mineral has a vivianite-type structure ($R_1 = 0.0353$ for 668 $I > 2\sigma_I$ reflections) in which $M1O_2(H_2O)_4$ octahedra and $M2_2O_6(H_2O)_4$ edge-sharing octahedral dimers are linked together via TO_4 tetrahedra (where T = P or As), and hydrogen bonds to form layers parallel to {010}; successive layers are linked by hydrogen bonds only. Cabrerite is the ordered intermediate between hörnesite and annabergite, with Ni dominant at $M1$, Mg dominant at $M2$, and T = As.

Keywords: Cabrerite, new mineral, hörnesite, annabergite, ordered intermediate, crystal structure, Nickel mine, Cottonwood Canyon, Nevada