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Carlfrancisite: $Mn_3^{2+}(Mn^{2+},Mg,Fe^{3+},Al)_{42}(As^{3+}O_3)_2(As^{5+}O_4)_4[(Si,As^{5+})O_4]_6[(As^{5+},Si)O_4]_2(OH)_{42}$, a new arseno-silicate mineral from the Kombat mine, Otavi Valley, Namibia

Frank C. Hawthorne[1,*], Yassir A. Abdu[1], Neil A. Ball[1] and William W. Pinch[2]

[1]Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada
[2]19 Stonebridge Lane, Pittsford, New York 14534-1800, U.S.A.

Abstract

Carlfrancisite, $Mn_3^{2+}(Mn^{2+},Mg,Fe^{3+},Al)_{42}(As^{3+}O_3)_2(As^{5+}O_4)_4[(Si,As^{5+})O_4]_6[(As^{5+},Si)O_4]_2(OH)_{42}$, is a new mineral from the Kombat mine, Otavi Valley, Namibia, and occurs as curved platy aggregates ~2 cm across on a matrix of Mn arsenates and oxides. It is yellowy orange to pale yellow with a very pale-yellow streak, translucent with a vitreous to opalescent luster, and does not fluoresce under ultraviolet light. Cleavage is micaceous on {001}, and no parting or twinning was observed. Mohs hardness is 3, and carlfrancisite is brittle with a hackly fracture. The calculated density is 3.620 g/cm^3. Optical properties were measured with a Bloss spindle stage for the wavelength 590 nm using a gel filter. The indices of refraction are $\varepsilon = 1.756$, $\omega = 1.758$, and it is non-pleochroic. Carlfrancisite is trigonal, space group $R\bar{3}c$, $a = 8.2238(2)$, $c = 205.113(6)$ Å, $V = 12\,013.5(4)$ Å^3, $Z = 6$, $c:a = 1:24.941$. The seven strongest lines in the X-ray powder-diffraction pattern are as follows: d (Å), I, (hkl): 2.826, 100, ($\bar{2}$ 2 44); 2.371, 88, ($\bar{2}$ 3 40, $\bar{1}$ 3 41); 1.552, 84, ($\bar{1}$ 5 0); 2.676, 63, ($\bar{2}$ 3 7); 3.243, 54, (0 1 56, $\bar{1}$ 2 39); 4.107, 48, ($\bar{1}$ 2 0); 2.918, 47, (0 2 40). Chemical analysis by electron microprobe and crystal-structure refinement gave As_2O_5 13.07, As_2O_3 3.18, P_2O_5 0.50, V_2O_5 0.74, SiO_2 8.96, Al_2O_3 0.78, FeO 0.22, MnO 53.25, MgO 9.37, H_2O(calc) 8.42, sum 98.49 wt%. The H_2O content and the valence states of As were determined by crystal-structure analysis. The empirical formula is $Mn^{2+}_{33.55}Mg_{10.39}Fe^{2+}_{0.14}Al_{0.68}As^{3+}_{1.44}(Si_{6.67}P_{0.32}V^{5+}_{0.37}As^{5+}_{5.08})O_{54}(OH)_{42}$ on the basis of 96 anions with (OH) = 42 apfu. The structure of carlfrancisite is closely related to that of mcgovernite and turtmannite.

Keywords: Carlfrancisite, new mineral species, arseno-silicate, Tsumeb mine, Otavi Valley, Namibia, electron microprobe analysis, optical properties, chemical analysis, mcgovernite, turtmannite