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Dellaventuraite, $NaNa_2(MgMn^{3+}_2Ti^{4+}Li)Si_8O_{22}O_2$, a new anhydrous amphibole from the Kajlidongri Manganese Mine, Jhabua District, Madhya Pradesh, India

KIMBERLY T. TAIT,[1] FRANK C. HAWTHORNE,[1,*] JOEL D. GRICE,[2] LUISA OTTOLINI,[3] AND V.K. NAYAK[4]

[1]Department of Geological Sciences, University of Manitoba, Winnipeg, Manitoba R3T 2N2, Canada
[2]Research Division, Canadian Museum of Nature, P.O. Box 3443, Station D, Ottawa, Ontario K1P 6P4, Canada
[3]CNR-Istituto di Geoscienze e Georisorse (IGG), Sezione di Pavia, via Ferrata 1, I-27100 Pavia, Italy
[4]H-21 Gitanjali Complex, Shanti Vihar Colony, Makronia Camp, P.O. Box Saugar 470-004, India

ABSTRACT

Dellaventuraite is a new amphibole species from the Kajlidongri manganese mine, Jhabua District, Madhya Pradesh, India. It occurs with leakeite, kornite, albite, braunite, and bixbyite associated with cross-cutting epigenetic veins that have reacted with regionally metamorphosed rocks containing Mn-rich minerals (braunite, bixbyite, jacobsite, spessartine) to produce Mn-rich amphiboles, Mn-rich pyroxenes, Mn-rich mica, piemontite, and manganophyllite. Dellaventuraite occurs as anhedral grains, the color of which varies from pink to red, depending on Mn content. It is brittle, $H = 5$, $D_{calc} = 3.184$ g/cm^3, has a pale pink streak, vitreous luster, and does not fluoresce in ultraviolet light; it has perfect cleavage on {110} and conchoidal fracture. In transmitted plane-polarized light, dellaventuraite is strongly pleochroic, X = pale mauve-brown, Y ~ Z = dark red-brown; Y ^ $a = 20°$ (in β obtuse), $Z = b$, with absorption $X < Y \sim Z$. It is biaxial positive, $\eta_\alpha = 1.688 \pm 0.003$, $\eta_\beta = 1.692 \pm 0.005$, $\eta_\gamma = 1.721 \pm 0.003$, $2V_{(obs)} = 49 \pm 3°$, $2V_{(calc)} = 41°$. Dellaventuraite is monoclinic, space group $C2/m$, $a = 9.808(1)$, $b = 17.840(2)$, $c = 5.2848(5)$ Å, $\gamma = 104.653(1)°$, $V = 894.6(2)$ Å^3, $Z = 2$. The strongest ten X-ray diffraction lines in the powder pattern are [d(*I*,*hkl*)]: 2.697(10,151), 2.542(9,–202), 3.127(8,310), 3.378(7,131), 2.154(7,261), 1.434 (7,–661), 4.450(6,021), 8.459(5,110), 2.727(5,–331), 2.328(5,–351). Analysis by a combination of electron microprobe, SIMS and crystal-structure refinement gives $SiO_2 = 54.22$, $Al_2O_3 = 0.81$, $TiO_2 = 5.45$, $Fe_2O_3 = 6.44$, $Mn_2O_3 = 7.57$, ZnO = 0.12, NiO = 0.16, MgO = 8.26, $Li_2O = 1.53$, CaO = 1.85, $Na_2O = 8.12$, $K_2O = 2.12$, $H_2O = 0.80$, Cr, V, F, Cl not detected, sum 97.41 wt%. The formula unit, calculated on the basis of 24(O,OH,F) is $(K_{0.40}Na_{0.61})(Na_{1.71}Ca_{0.29})$ $(Mg_{1.81}Zn_{0.01}Ni_{0.02}Li_{0.90}Fe^{3+}_{0.71}Mn^{3+}_{0.85}Ti^{4+}_{0.60}Al_{0.10})(Si_{7.96}Al_{0.04})O_{22}[(OH)_{0.80}\ O_{1.20}]$; the ideal end-member composition $NaNa_2(MgMn^{3+}{}_2LiTi^{4+})Si_8O_{22}O_2$.

The crystal structure of dellaventuraite was refined to an R index of 3.8% using Mo$K\alpha$ X-ray intensity data. The M1 site is occupied by Ti^{4+}, Mn^{3+}, and Mg in approximately equal amounts, the M2 site is occupied primarily by Mg and Fe^{3+}, and M3 is occupied by Li with minor Mg and Mn^{2+}. Local bond-valence considerations suggest that O^{2-} at O3 is linked to Ti^{4+}Mg or $Mn^{3+}Mn^{3+}$ at the adjacent M1 sites, and that OH at O3 is linked to MgMg at the adjacent M1 sites.