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Vladykinite, $Na_3Sr_4(Fe^{2+}Fe^{3+})Si_8O_{24}$: A new complex sheet silicate from peralkaline rocks of the Murun complex, eastern Siberia, Russia

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Abstract

Vladykinite, ideally $Na_3Sr_4(Fe^{2+}Fe^{3+})Si_8O_{24}$, is a new complex sheet silicate occurring as abundant prismatic crystals in a dike of coarse-grained peralkaline feldspathoid syenite in the north-central part of the Murun complex in eastern Siberia, Russia (Lat. 58° 22′ 48″ N; Long. 119° 03′ 44″ E). The new mineral is an early magmatic phase associated with aegirine, potassium feldspar, eudialyte, lamprophyllite, and nepheline; strontianite (as pseudomorphs after vladykinite) and K-rich vishnevite are found in the same assemblage, but represent products of late hydrothermal reworking. Vladykinite is brittle, has a Mohs hardness of 5, and distinct cleavage on {100}. In thin section, it is colorless, biaxial negative [$\alpha = 1.624(2)$, $\beta = 1.652(2)$, $\gamma = 1.657(2)$, $2V_{meas} = 44(1)°$, $2V_{calc} = 45(1)°$] and shows an optic orientation consistent with its structural characteristics (**X**^**a** = 5.1° in β obtuse, **Z**^**c** = 4.7° in β acute, **Y** = **b**). The Raman spectrum of vladykinite consists of the following vibration modes (listed in order of decreasing intensity): 401, 203, 465, 991, 968, 915, 348, 167, 129, 264, 1039, and 681 cm^{-1}; O-H signals were not detected. The Mössbauer spectrum indicates that both Fe^{2+} and Fe^{3+} are present in the mineral ($Fe^{3+}/Fe_\Sigma = 0.47$), and that both cations occur in a tetrahedral coordination. The mean chemical composition of vladykinite (acquired by wavelength-dispersive X-ray spectrometry and laser-ablation inductively-coupled-plasma mass-spectrometry), with Fe_Σ recast into Fe^{2+} and Fe^{3+} in accord with the Mössbauer data, gives the following empirical formula calculated to 24 O atoms: $(Na_{2.45}Ca_{0.56})_{\Sigma 3.01}(Sr_{3.81}K_{0.04}Ba_{0.02}La_{0.02}Ce_{0.01})_{\Sigma 3.90}(Fe^{2+}_{0.75}Fe^{3+}_{0.66}Mn_{0.26}Zn_{0.16}Al_{0.12}Mg_{0.05}Ti_{0.01})_{\Sigma 2.01}(Si_{7.81}Al_{0.19})_{\Sigma 8.00}O_{24}$. The mineral is monoclinic, space group $P2_1/c$, $a = 5.21381(13)$, $b = 7.9143(2)$, $c = 26.0888(7)$ Å, $\beta = 90.3556(7)°$, $V = 1076.50(5)$ Å^3, $Z = 2$. The ten strongest lines in the powder X-ray diffraction pattern are [d_{obs} in Å (I) (hkl)]: 2.957 (100) ($\bar{1}23$, 123); 2.826 (100) ($\bar{1}17$, 117); 3.612 (58) ($\bar{1}14$, 114); 3.146 (37) (120); 2.470 (32) (210, 01.10); 4.290 (30) ($\bar{1}11$, 111); 3.339 (30) ($\bar{1}06$, 115, 106); 2.604 (28) (200); 2.437 (25) (034); 1.785 (25) (21.10, $\bar{2}34$). The structure of vladykinite, refined by single-crystal techniques on the basis of 3032 reflections with $F_o > 4\sigma F_o$ to $R_1 = 1.6\%$, consists of tetrahedral sheets parallel to (100) and consisting of $(Si_8O_{24})^{16-}$ units incorporating four-membered silicate rings and joined into five- and eight-membered rings by sharing vertices with larger tetrahedra hosting Fe^{2+}, Fe^{3+}, Mn, Zn, Al, Mg, and Ti. Larger cations (predominantly Na, Sr, and Ca) are accommodated in octahedral and square-antiprismatic interlayer sites sandwiched between the tetrahedral sheets. Structural relations between vladykinite and other sheet silicates incorporating four-, five-, and eight-membered rings are discussed. The name vladykinite is in honor of Nikolay V. Vladykin (Vinogradov Institute of Geochemistry, Russia), in recognition of his contribution to the study of alkaline rocks. Holotype and co-type specimens of the mineral were deposited in the Robert B. Ferguson Museum of Mineralogy in Winnipeg, Canada.

Keywords: Vladykinite, new mineral, sheet silicate, peralkaline rocks, Murun complex, Yakutia, Russia