

Krasheninnikovite, $\text{KNa}_2\text{CaMg}(\text{SO}_4)_3\text{F}$, a new mineral from the Tolbachik volcano, Kamchatka, Russia

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ABSTRACT

A new mineral krasheninnikovite, ideally $\text{KNa}_2\text{CaMg}(\text{SO}_4)_3\text{F}$, is found in the sublimates of an active fumarole at the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka, Russia. It is associated with tenorite, thenardite, hematite, euchlorine, blödite, vergasovaite, and fluorophlogopite. Krasheninnikovite forms long-prismatic to acicular crystals up to 3 mm long and up to 20 μm thick. The crystals are combined in sheaf-like, radiating or open-work matted aggregates forming nests up to several cm^3 or crusts. Krasheninnikovite is transparent, colorless in individuals and white in aggregates. The luster is vitreous. The mineral is brittle; the thinnest needles are flexible and elastic. The Mohs hardness is 2½–3. Cleavage was not observed. D_{meas} is 2.68(1), D_{calc} is 2.67 g/cm^3 . Krasheninnikovite is optically uniaxial (–), $\omega = 1.500(2)$, $\epsilon = 1.492(2)$. The IR spectrum is unique. The chemical composition (wt%, electron microprobe data) is: Na_2O 15.48, K_2O 6.92, CaO 11.51, MgO 9.25, MnO 0.15, FeO 0.04, Al_2O_3 0.23, SO_3 53.51, F 3.22, Cl 0.16, $-\text{O}=(\text{F},\text{Cl})_2$ –1.39, total 99.08. The empirical formula, calculated on the basis of 13 (O+F+Cl) apfu, is: $\text{K}_{0.67}\text{Na}_{2.27}\text{Ca}_{0.93}\text{Mn}_{0.01}\text{Mg}_{1.04}\text{Al}_{0.02}(\text{SO}_4)_{3.04}\text{F}_{0.76}\text{Cl}_{0.02}\text{O}_{0.06}$. Krasheninnikovite is hexagonal, space group $P6_3/mcm$, $a = 16.6682(2)$, $c = 6.9007(1)$ Å, $V = 1660.36(4)$ Å³, $Z = 6$. The strongest reflections of the X-ray powder pattern [d , Å $I(hkl)$] are: 4.286 22(121); 3.613 24(040); 3.571 17(221); 3.467 42(131); 3.454 43(002); 3.153 100(140), 3.116 22(022), 2.660 39(222), 2.085 17(440). The crystal structure was solved on a single crystal and refined on a powder sample by the Rietveld method, $R_{\text{wp}} = 0.0485$. The krasheninnikovite structure is unique. It is based upon a heteropolyhedral pseudo-framework consisting of CaO_6 octahedra, MgO_3F octahedra, and SO_4 tetrahedra; K and Na cations are located in cavities. Krasheninnikovite is named in honor of the Russian geographer, ethnographer, and naturalist S.P. Krasheninnikov (1711–1755), one of the first scientists who researched Kamchatka. The type specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow.

Keywords: Krasheninnikovite, new mineral, sulfate, crystal structure, fumarole sublimate, Tolbachik volcano, Kamchatka