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Tumchaite $Na_2(Zr,Sn)Si_4O_{11}\cdot 2H_2O$—A new mineral from carbonatites of the Vuoriyarvi alkali-ultrabasic massif, Murmansk Region, Russia

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Abstract

Tumchaite, $Na_2(Zr,Sn)Si_4O_{11}\cdot 2H_2O$, is a new species from the Vuoriyarvi alkali-ultrabasic massif, Murmansk Region, Russia, where it occurs as colorless to white tabular monoclinic crystals associated with calcite, dolomite, a mineral of the serpentine group and pyrite in the late dolomite-calcite carbonatites. It is transparent to translucent; with vitreous luster; and perfect cleavage on (100). Mohs hardness is 4.5, D_{meas} is 2.78 (2) g/cm^3. Tumchaite is optically biaxial (-), with $\alpha = 1.570$ (2), $\beta = 1.588$ (2), $\gamma = 1.594$ (2), $2V_{meas} = 60$ (5)°, and elongation positive, $Y = b$, $c \wedge Z = 3°$. Pleochroism exists, with $Y = Z$ = colorless, X = greenish-gray. Electron microprobe analysis gave (wt%): Na_2O 13.72, CaO 0.15, SiO_2 52.71, TiO_2 0.35, ZrO_2 20.41, SnO_2 5.73, HfO_2 0.60, H_2O (computed assuming $2H_2O$ pfu.) 7.86, total 101.53. The X-ray study pointed to space group $P2_1/c$, $a = 9.144$ (4), $b = 8.818$ (3), $c = 7.537$ (3) Å, $\beta = 113.22$ (3)°, $V = 558.49$ Å^3, $Z = 2$. The strongest lines of the powder diffraction pattern [d in Å (I) (hkl)] are: 8.40 (10) (100), 5.38 (9) (11$\bar{1}$), 4.00 (8) (111), 3.401 (9) (20$\bar{2}$), 2.902 (9) (211), 2.691 (9) (13$\bar{1}$). The crystal structure of tumchaite was refined to $R = 0.043$ for 865 $F_o > 4\sigma(F_o)$. The mineral is isotypic with penkvilksite-1M. The structure is characterized by silicate sheets parallel (100), formed by alternating clockwise- and counterclockwise-growing spiral chains of corner-sharing SiO_4 tetrahedra. The sheets are connected by octahedra occupied by (Zr, Sn) at 0, 1/2, 0. The Zr/Sn ratio in the octahedra is 4. Water molecules and Na cations are placed in the cavities of the polyhedral framework. The ideal crystal-chemical formula is $Na_2(Zr_{0.8}Sn_{0.2})[Si_4O_{11}]\cdot 2H_2O$. The mineral is named tumchaite for the river Tumcha near Vuoriyarvi massif.