

## New Mineral Names\*†

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## IN THIS ISSUE

This New Mineral Names has entries for 9 new mineral species, including dmsokolovite, geschieberite, imayoshiite, palladosilicide, plášilite, raisaite, shchurovskyite, svornostite, and vanackerite.

## GESCHIEBERITE\* AND SVORNOSTITE\*

- J. Plášil, J. Hloušek, A.V. Kasatkin, R. Škoda, M. Novák and J. Čejka (2015) Geschieberite,  $K_2(UO_2)(SO_4)_2(H_2O)_2$ , a new uranyl sulfate mineral from Jáchymov. *Mineralogical Magazine*, 79(1), 205–216.
- J. Plášil, J. Hloušek, A.V. Kasatkin, M. Novák, J. Čejka and L. Lapčák (2015) Svornostite,  $K_2Mg[(UO_2)(SO_4)_2] \cdot 8H_2O$ , a new uranyl sulfate mineral from Jáchymov, Czech Republic. *Journal of Geosciences*, 60, 113–121.

Two new uranyl sulfates, geschieberite (IMA 2014-006), ideally  $K_2(UO_2)(SO_4)_2(H_2O)_2$  and svornostite (IMA 2014-078), ideally  $K_2Mg[(UO_2)(SO_4)_2] \cdot 8H_2O$ , were recently discovered in the Geschieber vein at the Svornost mine, Jáchymov (Joachimsthal), Western Bohemia, Czech Republic, and named for their type locality. The Jáchymov ore district is a classic example of the Variscan hydrothermal vein type of deposit, so-called five-element formation, Ag–Bi–Co–Ni–U. Both new minerals are the supergene products of the post mining alteration of the uraninite and sulfides of the primary ore. They occur in the close association with each another and with adolfpateraita, gypsum and mathiesiusite. Both minerals exhibit strong yellowish green fluorescence under both short- and long-wave UV radiation. Both are brittle, have an uneven fracture, and estimated Mohs hardness of ~2. Both are unstable under electron beam so the EDS mode was chosen for electron probe measurements.

**Geschieberite** forms bright green, compact crystalline aggregates composed of multiple intergrowths of prismatic {010} crystals elongated on [001] typically 0.1–0.2 mm across sometimes modified by {001}. The crystals are translucent pale green with greenish-white streak and a vitreous luster. The cleavage is perfect on {100}. The density could not be measured due to paucity of pure material;  $D_{calc} = 3.259$  g/cm<sup>3</sup>. Geschieberite is slightly soluble in cold H<sub>2</sub>O. It is optically biaxial (–),  $\beta = 1.596(2)$ ,  $\gamma = 1.634(4)$  (590 nm);  $X = a$ . In a plane-polarized transmitted light, the mineral is nearly colorless with no apparent pleochroism. The average of 7 electron probe EDS analyses is [wt% (range)]: Na<sub>2</sub>O 0.23 (0.12–0.59), K<sub>2</sub>O 14.29 (12.90–16.66), MgO 2.05 (1.77–2.52), CaO 0.06 (0–0.12), UO<sub>3</sub> 49.51 (47.23–51.64), SO<sub>3</sub> 27.74 (26.82–28.78), H<sub>2</sub>O 6.36 (by structure refinement), total 100.24. This gives the empirical formula  $(K_{1.72}Mg_{0.29}Na_{0.04}Ca_{0.01})_{\Sigma 2.06}(U_{0.98}O_2)(S_{0.98}O_4)_2(H_2O)_2$  based on 12 O apfu. The strongest lines in the X-ray powder-diffraction pattern [ $d$  Å ( $I\%$ ;  $hkl$ )] are: 6.882 (100; 200), 5.622 (53; 111), 4.589 (12; 211), 4.428 (16; 202),

3.681 (18; 311), 3.403 (12; 013), 3.304 (15; 401,  $\bar{1}$ 13), 3.006 (17; 122). The unit-cell parameters refined from powder-diffraction data are:  $a = 13.786(5)$ ,  $b = 7.278(3)$ ,  $c = 11.536(4)$  Å,  $V = 1157.4$  Å<sup>3</sup>. Single-crystal X-ray diffraction data collected on a crystal of size 0.19 × 0.11 × 0.09 mm refined to  $R_1 = 0.028$  for 1882 unique reflections with  $I \geq 3\sigma(I)$  shows geschieberite is orthorhombic,  $Pna2_1$ , with  $a = 13.7778(3)$ ,  $b = 7.2709(4)$ ,  $c = 11.5488(2)$  Å,  $V = 1156.92$  Å<sup>3</sup>,  $Z = 4$ .

**Svornostite** forms bright yellow aggregates of light yellow elongated by [001] and flattened on {100} crystals up to 0.2 mm. The crystals are transparent to translucent with a vitreous luster and very pale yellow streak. The cleavage is perfect on {100} and {010}. The density was not measured;  $D_{calc} = 3.268$  g/cm<sup>3</sup>. The mineral is optically biaxial (+),  $\alpha = 1.548(2)$ ,  $\beta = 1.556(3)$ ,  $\gamma = 1.585(2)$  (590 nm). The  $2V$  was not measured;  $2V_{calc} = 56^\circ$ ;  $Z = c$ . No dispersion was observed. The mineral is non-pleochroic; the color in transmitted light is not given. The average of 6 electron probe EDS analysis [wt% (range)] is: K<sub>2</sub>O 7.93 (7.34–8.31), MgO 3.11 (2.75–3.93), CuO 0.79 (0–2.40), SO<sub>3</sub> 28.13 (25.44–30.70), UO<sub>3</sub> 48.94 (44.99–51.72), H<sub>2</sub>O (by stoichiometry according structure model) 12.53, total 101.43. That yields the empirical formula  $K_{1.94}(Mg_{0.89}Cu_{0.11})_{\Sigma 2.00}(U_{0.99}O_2)(S_{1.01}O_4)_2(H_2O)_8$  based on 28 O apfu. The strongest powder X-ray diffraction lines are [ $d$  Å ( $I\%$ ;  $hkl$ )] : 8.279 (50; 010), 6.398 (100; 200), 5.060 (55; 210), 4.645 (40; 012), 4.610 (38; 211), 3.881 (34; 021), 3.318 (44; 221), 3.009 (44; 213). The unit-cell parameters refined from powder-diffraction data are:  $a = 12.787(3)$ ,  $b = 8.275(2)$ ,  $c = 11.222(3)$  Å,  $V = 1187.5$  Å<sup>3</sup>. Single-crystal X-ray diffraction data collected on a crystal 0.24 × 0.07 × 0.05 mm refined to  $R_1 = 0.023$  for 2745 reflections with  $I_{obs} > 3\sigma(I)$  shows svornostite is orthorhombic, space group  $Pnm2_1$ ,  $a = 12.7850(3)$ ,  $b = 8.2683(4)$ ,  $c = 11.2163(3)$  Å,  $V = 1185.68$  Å<sup>3</sup>,  $Z = 2$ .

The Raman spectra of both new minerals are similar and shows bands [geschieberite / svornostite (cm<sup>-1</sup>)]  $w =$  weak,  $vs =$  very strong] at: 3594 and 3506 / **3622**, **3545**, and **3496** ( $\nu$  O–H stretching vibrations of the hydrogen-bonded H<sub>2</sub>O molecules); 1216, 1126, and 1008 / **1220**, **1200**, **1155**, and **1110** [ $\nu_3$  (SO<sub>4</sub>)<sup>2-</sup> antisymmetric stretching]; 992 and 984 / **1028** and **989** [ $\nu_1$  (SO<sub>4</sub>)<sup>2-</sup> symmetric stretching]; 832vs / **854**vs [ $\nu_1$  (UO<sub>2</sub>)<sup>2+</sup> symmetric stretching]; 652, 606, and 584 / **643** and **610** [ $\nu_2(\delta)$  (SO<sub>4</sub>)<sup>2-</sup> bending]; 470, 456, and 426 / **458** and **438** [ $\nu_2(\delta)$  (SO<sub>4</sub>)<sup>2-</sup> bending]; 386 / **322** (libration mode of H<sub>2</sub>O or  $\nu$  U–O ligand vibration); ~350w (K–O stretching); 270s, 250s, and 230s / **268w** with a **207** shoulder [ $\nu_2(\delta)$  (UO<sub>2</sub>)<sup>2+</sup> bending]; 180, 154, 132, 100, 80 / **186**, **132**, and **75** (lattice modes). The structure of geschieberite consists of [(UO<sub>2</sub>)(SO<sub>4</sub>)<sub>2</sub>(H<sub>2</sub>O)]<sup>2-</sup> sheets based on the protasite anion topology and stacked perpendicular to **a**. Interlayer linkage is provided by K and one H<sub>2</sub>O, while the other H<sub>2</sub>O molecule is localized at the free vertex of the uranyl pentagonal bipyramid in the structural unit. The structure is identical to that of the synthetic compound  $K_2[(UO_2)(SO_4)_2(H_2O)](H_2O)$ .

\* All minerals marked with an asterisk have been approved by the IMA CNMMC.

† For a complete listing of all IMA-validated unnamed minerals and their codes, see <http://pubsites.uws.edu.au/ima-cnmmc/>.

In svornostite the structural unit  $[(\text{UO}_2)(\text{SO}_4)_2(\text{H}_2\text{O})]^{2-}$  is represented by infinite chains parallel to *c*. In the chains  $\text{UO}_7$  pentagonal bipyramids shares four of the equatorial vertices with  $\text{SO}_4$  tetrahedra with each tetrahedron is linked to two uranyl bipyramids. The free, non-linking equatorial vertex of the uranyl bipyramid is occupied by an  $\text{H}_2\text{O}$  molecule. The adjacent chains are linked through the Mg-octahedra sharing the apical O atoms of the  $\text{SO}_4$  groups of the chains and additionally by the K–O bonds and also H-bonds involving  $\text{H}_2\text{O}$  molecules. The structural formula of svornostite is  $\text{K}_2\text{Mg}[(\text{UO}_2)(\text{SO}_4)_2(\text{H}_2\text{O})]_2(\text{H}_2\text{O})_6$ . The uranyl sulfate chains are the same as found in the structures of bobcookite and several of synthetic uranyl sulfates. The type specimens of geschieberite and svornostite are deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **O.C.G. and D.B.**

### IMAYOSHIITE\*

D. Nishio-Hamane, M. Ohnishi, K. Momma, N. Shimobayashi, R. Miyawaki, T. Minakawa and S. Inaba (2015) Imayoshiite,  $\text{Ca}_3\text{Al}(\text{CO}_3)[\text{B}(\text{OH})_4](\text{OH})_6 \cdot 12\text{H}_2\text{O}$ , a new mineral of the ettringite group from Ise City, Mie Prefecture, Japan. *Mineralogical Magazine*, 79(2), 413–423.

Imayoshiite (IMA 2013-069), ideally  $\text{Ca}_3\text{Al}(\text{CO}_3)[\text{B}(\text{OH})_4](\text{OH})_6 \cdot 12\text{H}_2\text{O}$ , is a new mineral found at Suisho-dani, Ise City, Mie Prefecture, Japan. The mineral occurs in cavities of the altered gabbro xenolith in the exposed serpentinized dunite, where rims of the xenoliths suffered hydrothermal alteration. Plagioclase, a main constituent of the xenoliths, has been altered to hydrous calcium silicate minerals such as oyelite, hydrogarnet, xonotlite, tobermorite, bullfonteinite, apophyllite, and prehnite, all of which are associated with imayoshiite. Imayoshiite occurs as white aggregates of fibrous-to acicular crystals up to 2 mm across with silky luster. Crystals are colorless, transparent with a white streak and a vitreous luster. The mineral is brittle, has distinct cleavage on {100} and an uneven fracture. Mohs hardness is 2–3.  $D_{\text{calc}} = 1.79 \text{ g/cm}^3$ . No fluorescence was observed under long- or short-wave ultraviolet radiation. The mineral is optically uniaxial (–) with  $\omega = 1.497(2)$  and  $\epsilon = 1.470(2)$ . The main absorption bands of the IR spectrum ( $\text{cm}^{-1}$ ) are: 3600 and 3420 (O–H stretching vibrations), 1678 (H–O–H bending vibrations), 1417 and 882 (vibrations of the carbonate group), and 1207 [vibrations of  $\text{B}(\text{OH})_4$  tetrahedra]. DTA analysis shows a strong endothermic peak at 120 °C corresponding to loss of water. Weight losses were 50.02% and 7.49% from room temperature to 500 °C and from 500 to 900 °C, respectively; these are attributed to the evolution of  $\text{H}_2\text{O}$  and  $\text{CO}_2$ , respectively. The average of 5 electron probe WDS analyses is [wt% (range)]: CaO 28.20 (27.17–29.13),  $\text{Al}_2\text{O}_3$  7.60 (7.35–8.03),  $\text{SiO}_2$  1.17 (1.11–1.29),  $\text{SO}_3$  0.84 (0.80–0.93),  $\text{B}_2\text{O}_3$  5.47 (by stoichiometry),  $\text{CO}_2$  7.49,  $\text{H}_2\text{O}$  50.02, total 100.80.  $\text{CO}_2$  and  $\text{H}_2\text{O}$  were calculated from TG data. This gives the empirical formula  $\text{Ca}_3\text{Al}_{0.88}\text{Si}_{0.12}(\text{CO}_3)_{1.02}[\text{B}(\text{OH})_4]_{0.94}(\text{SO}_4)_{0.06}[(\text{OH})_{5.96}\text{O}_{0.04}]_{26} \cdot 11.71\text{H}_2\text{O}$  based on 3 Ca apfu. The strongest lines in the X-ray powder-diffraction pattern [ $d$  (Å) ( $I$ %;  $hkl$ )] are: 9.543 (100; 100), 2.525 (69; 213, 123), 4.636 (40; 102), 3.821 (33; 112), 2.729 (31; 302), 2.174 (30; 223), 1.768 (28; 006), 2.120 (23; 313, 133), 5.515 (18; 110). The unit-cell parameters refined from powder-diffraction data are  $a = 11.0264(11)$ ,  $c = 10.6052(16)$  Å, and  $V = 1116.6$  Å<sup>3</sup>. Single-crystal X-ray diffraction data collected on a crystal of size  $0.09 \times 0.07 \times 0.06$  mm refined to  $R_1 = 0.0235$  for reflections with  $I \geq 2\sigma(I)$  shows imayoshiite is hexagonal,  $P6_3$ ,  $a = 11.0459$ ,  $c = 10.6150$  Å,  $V = 1121.65$  Å<sup>3</sup>,  $Z = 2$ . The structure of imayoshiite is based on  $\text{Ca}_3[\text{Al}(\text{OH})_6(\text{H}_2\text{O})_{12}]$  columns that consist of  $\text{Al}(\text{OH})_6$  octahedra and a trimer of edge-sharing  $\text{Ca}(\text{OH})_4(\text{H}_2\text{O})_4$  polyhedron.  $\text{CO}_3$  and  $\text{B}(\text{OH})_4$  are independently located in channels that run parallel to the *c* axis. Imayoshiite is the first member of the ettringite group with both  $\text{CO}_3$  and  $\text{B}(\text{OH})_4$  anions. Imayoshiite is named in honor of the Japanese mineral collector, Takaharu Imayoshi (1905–1984), whose activities and specimens have undoubtedly made a significant contribution to mineralogy. The type specimen is deposited in the National Museum of Nature and Science, Japan. **O.C.G.**

### PALLADOSILICIDE\*

L.J. Cabri, A.M. McDonald, C.J. Stanley, N.S. Rudashevsky, G. Poirier, H.R. Wilhelmij, W. Zhe and V.N. Rudashevsky (2015) Palladosilicide,  $\text{Pd}_2\text{Si}$ , a new mineral from the Kapalagulu Intrusion, Western Tanzania and the Bushveld Complex, South Africa. *Mineralogical Magazine*, 79(2), 295–307.

Palladosilicide (IMA 2014-080), ideally  $\text{Pd}_2\text{Si}$ , is a new mineral found at the platinum-group element (PGE)-chromite horizon of the Kapalagulu Intrusion near the eastern shore of Lake Tanganyika, western Tanzania, as well as in the UG-2 chromitite, Bushveld Complex, RSA. Associated minerals include chromite, pentlandite, pyrrhotite/troilite, chalcopyrite, magnetite, along with gudmundite, arsenopyrite, zircon, galena, and anglesite. Thirteen grains of palladosilicide were found ranging in size from 0.7–39.1 μm, anhedral to subhedral habit, either free or attached to chromite. The new mineral is bright creamy with metallic luster, shows no cleavage, parting or fracture, and shows no twinning. Density and hardness could not be measured due to small grain size.  $D_{\text{calc}}$  varies between 9.562 to 9.753 g/cm<sup>3</sup> for 3 analyses. The mineral is weakly birefractant and displays no discernible pleochroism. It is weakly anisotropic, has weak extinction and rotation tints in shades of blue and olive green. Reflectance values were measured between 400 and 700 nm in 20 nm intervals. The values for COM wavelengths in air/oil [ $R_{\text{min}}$ ,  $R_{\text{max}}$  % ( $\lambda$  in nm)] are: 49.6/36.3, 52.7/38.6 (470); 51.2/27.6, 53.8/39.5 (546); 51.6/37.8, 53.7/39.5 (589); 51.7/37.9, 53.3/39.3 (650). The average of 8/12 electron probe EDS analyses on 2 crystals of palladosilicide is [wt% (range)]: Si 7.95/10.13 (6.83–8.58/8.49–10.76), Pd 70.03/68.77 (64.20–70.69/66.35–72.27), Ag 1.07/0.33 (0.17–2.64/0.18–0.64), Ni 4.59/5.16 (4.26–4.89/4.85–5.51), Te 0.32/– (0.00–1.16/–), Sb 0.36/0.11 (0.26–0.55/0.00–0.55), As 3.95/2.18 (3.15–6.76/0.82–5.37), Fe 0.64/0.35 (0.57–0.69/0.23–0.42), Pt 1.72/4.45 (1.17–1.96/1.57–6.30), Sn 1.79/3.08 (1.33–2.10/1.54–4.18), Cu 2.02/1.62 (1.96–2.67/1.17–2.45), Rh 2.39/3.76 (2.06–2.61/2.40–5.18), total 95.53/99.94 (89.50–98.44/99.43–100.50). This gives the empirical formula  $(\text{Pd}_{1.636}\text{Ni}_{0.199}\text{Cu}_{0.079}\text{Rh}_{0.061}\text{Fe}_{0.029}\text{Ag}_{0.042}\text{Pt}_{0.024}\text{Sn}_{0.039})_{22.123}(\text{Si}_{0.753}\text{As}_{0.121}\text{Sb}_{0.007}\text{Te}_{0.009})_{20.878}$  for crystal 1 and  $(\text{Pd}_{1.557}\text{Ni}_{0.212}\text{Cu}_{0.061}\text{Rh}_{0.088}\text{Fe}_{0.015}\text{Ag}_{0.007}\text{Pt}_{0.055}\text{Sn}_{0.063})_{22.058}(\text{Si}_{0.869}\text{As}_{0.07}\text{Sb}_{0.02})_{20.941}$  for crystal 2 based on 3 apfu. The small grain size and the presence of inclusions precluded the analysis of palladosilicide by standard powder X-ray diffraction (XRD) methods and the mineral was thus studied by electron backscattered diffraction. From the matching of Kikuchi patterns, palladosilicide is found to be isostructural with synthetic, metal-rich  $\text{Pd}_2\text{Si}$  and structurally, could be considered as the Pd–Si analog of barringerite ( $\text{Fe}, \text{Ni}$ )<sub>2</sub>P. Calculated cell data based on synthetic, metal-rich  $\text{Pd}_2\text{Si}$  shows the mineral is hexagonal, space group  $P6_2m$ , with  $a = 6.496(5)$ ,  $c = 3.433(4)$  Å,  $V = 125.5$  Å<sup>3</sup>,  $Z = 3$ . The strongest lines in the calculated X-ray powder-diffraction pattern [ $d_{\text{calc}}$  (Å) ( $I_{\text{calc}}$ %;  $hkl$ )] are: 2.3658 (100; 111), 2.1263 (37; 120), 2.1808 (34; 021), 3.240 (20; 110); 1.8752 (19; 030), 1.7265 (12; 002), 1.3403 (11; 122), 1.2089 (10; 231). Palladosilicide is named for its two essential chemical components, palladium and silicon. Part of the holotype has been deposited in the Canadian Museum of Nature, Gatineau, Québec, Canada. **O.C.G.**

### PLÁŠILITE\*

A.R. Kampf, A.V. Kasatkin, J. Čejka and Joe Marty (2015) Plášilite,  $\text{Na}(\text{UO}_2)(\text{SO}_4)(\text{OH}) \cdot 2\text{H}_2\text{O}$ , a new uranyl sulfate mineral from the Blue Lizard mine, San Juan County, Utah, USA. *Journal of Geosciences*, 60, 1–10.

Plášilite (IMA 2014-021), ideally  $\text{Na}(\text{UO}_2)(\text{SO}_4)(\text{OH}) \cdot 2\text{H}_2\text{O}$ , is one of a number of new uranyl sulfates recently discovered at the Blue Lizard mine, Red Canyon, White Canyon District, San Juan County, Utah, U.S.A. (37°33'26"N 110°17'44"W). The new mineral has a low-temperature supergene origin related to the post-mining oxidation of

primary ores containing uraninite, pyrite, chalcocopyrite, bornite, and covellite disseminated in lenses of organic matter. It occurs in and on sandstone matrix in close association with atacamite, blödite, brochantite, chalcantite, dickite, gerhardtite, gypsum, hexahydrate, johannite, manganoblödite, natrozippeite, and tamarugite. Other secondary minerals in the general assemblage include belakovskite, bluelizardite, boyleite, cobaltoblödite, copiapite, coquimbite, cyanotrichite, d'ansite (Mn), deliensite, ferrinatrite, halite, kröhnkite, lishizhenite, meisserite, metavoltine, pickeringite, pseudojohannite, rhomboclase, römerite, and sideronatrite. Plášilite forms greenish yellow, long, thin bladed crystals exhibiting the forms {100}, {010}, and {011}, elongated on [001], flattened on {100} and commonly twinned on {100}. It is transparent with vitreous luster and a white streak. The fluorescence is bluish white under both long- and short-wave UV. The Mohs hardness estimated as ~2–3. The mineral is brittle with an even fracture and two perfect cleavages on {010} and {001}. Plášilite is easily soluble in water at room temperature. The density was not measured due to solubility the mineral in Clerichi solution;  $D_{\text{calc}} = 3.726 \text{ g/cm}^3$ . The mineral is optically biaxial (+),  $\alpha = 1.556$ ,  $\beta = 1.581$ ,  $\gamma = 1.608$  (white light),  $2V_{\text{meas}} = 88(1)^\circ$ ,  $2V_{\text{calc}} = 89^\circ$ ;  $X = \mathbf{b}$ ,  $Y \wedge c = 4^\circ$  in obtuse  $\beta$ . Dispersion of optical axes is moderate,  $r < v$ . It is pleochroic with  $X =$  nearly colorless  $< Y =$  very pale yellow  $< Z =$  pale yellow. The Raman spectrum bands are ( $\text{cm}^{-1}$ ): 3600 (OH stretching vibration of the OH ions), 3530 and 3385 (OH stretching vibrations of water molecules), 1180, 1069 and 1035 (antisymmetric stretching of  $\text{SO}_4^{2-}$ ), 997 (symmetric stretching of  $\text{SO}_4^{2-}$ ) with a shoulder 986.5 ( $\delta\text{U-OH}$  bending vibration or the  $\text{SO}_4^{2-}$  symmetric stretching), 905 weak ( $\text{UO}_2^{2+}$  antisymmetric stretching), 838 strong ( $\text{UO}_2^{2+}$  antisymmetric stretching) with a shoulder 824 ( $\delta\text{U-OH}$  bending), 645, 603, 480, 445 ( $\text{SO}_4^{2-}$  bending), 349 (probably U-O stretching), 243 ( $\text{UO}_2^{2+}$  bending), 210, 186, 170, 137, 88, and 70 (lattice modes). Raman spectroscopy confirmed the absence of  $\text{CO}_2$ . The average of 9 electron probe EDS analyses is [wt% (range)]: Na<sub>2</sub>O 6.61 (5.42–7.63), UO<sub>3</sub> 65.15 (64.47–66.30), SO<sub>3</sub> 18.33 (17.63–19.19), H<sub>2</sub>O 10.24 (by stoichiometry), total 100.33. Attempts to use the WDS mode were unsuccessful due to rapid and significant decomposition under the electron beam. No other elements with atomic numbers higher than 8 were observed. The empirical formula based on 9 O apfu is  $\text{Na}_{0.94}(\text{UO}_2)(\text{S}_{1.01}\text{O}_4)(\text{OH})(\text{H}_2\text{O})_2$ . The strongest lines of the powder X-ray diffraction pattern are [ $d \text{ \AA}$  (I;  $hkl$ )]: 6.90 (100; 020), 5.85 (99; 011,  $\bar{1}11$ ), 4.024 (57; 200, 130), 3.492 (82;  $\bar{1}02, 220, 040$ ), 3.136 (40;  $\bar{1}22$ ), 2.690 (25; 141, 102,  $\bar{2}41, 032$ ), 2.618 (34; 240, 150,  $\bar{3}02$ ), 1.921 (30; multiple). Unit-cell parameters refined from the powder X-ray data with whole-pattern fitting are:  $a = 8.697(2)$ ,  $b = 13.827(2)$ ,  $c = 7.065(2) \text{ \AA}$ ,  $\beta = 112.118(7)^\circ$ ,  $V = 787.1 \text{ \AA}^3$ . Plášilite is monoclinic, with the space group  $P2_1/c$ . Unit-cell parameters obtained using single-crystal X-ray data are:  $a = 8.7122(6)$ ,  $b = 13.8368(4)$ ,  $c = 7.0465(2) \text{ \AA}$ ,  $\beta = 112.126(8)^\circ$ ,  $V = 786.89 \text{ \AA}^3$ , and  $Z = 4$ . The crystal structure of plášilite was solved by direct methods and refined to  $R_1 = 0.019$  for 1603  $F_{\text{obs}} > 4\sigma F$  reflections. In the structure the pairs of  $\text{U}^{6+}\text{O}_7$  pentagonal bipyramids share a common edge, forming dimers. The dimers are linked by sharing corners with  $\text{SO}_4$  groups, yielding a  $[(\text{UO}_2)_2(\text{SO}_4)_2(\text{OH})_2]^{2-}$  sheets parallel to (010) linked to one another in the [010] direction by the chains of edge-sharing  $\text{NaO}_2(\text{H}_2\text{O})_4$  octahedra parallel to [001]. The framework thereby created is further linked via relatively weak hydrogen bonds. The uranyl sulfate sheet is based on the phosphuranylite anion topology. The sheets in plášilite and deliensite are geometrical isomers. Plášilite (*plá: shil ait*) is named for Jakub Plášil (b. 1984), a researcher of the Institute of Physics, Academy of Sciences of the Czech Republic for his work on the crystal chemistry of hydrated oxysalts and hexavalent uranium compounds. He is author or co-author of the descriptions of 23 new mineral species. Of the six cotype specimens, five are deposited in the Natural History Museum of Los Angeles County, U.S.A., and sixth is housed in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **D.B.**

## RAISAITE\*

I.V. Pekov, E.A. Vlasov, N.V. Zubkova, V.O. Yapaskurt, N.V. Chukanov, D.I. Belakovskiy, I.S. Lykova, A.V. Apletalin, A.A. Zolotarev and D.Y. Pushcharovsky (2016) Raisaite,  $\text{CuMg}[\text{Te}^{6+}\text{O}_4(\text{OH})_2] \cdot 6\text{H}_2\text{O}$ , a new mineral from Chukotka, Russia. *European Journal of Mineralogy*, 28, 459–466.

Raisaite (IMA 2014-046), ideally  $\text{CuMg}[\text{Te}^{6+}\text{O}_4(\text{OH})_2] \cdot 6\text{H}_2\text{O}$ , was discovered at the Sentyabr'skoe deposit, Ilirney ore district, Western Chukotka, North-Eastern Russia. The new mineral (Cyrillic: Раисаит) was named after Raisa Aleksandrovna Vinogradova (b. 1935), a specialist in ore mineralogy. Raisaite is a secondary supergene mineral and occurs in minor amounts in the oxidation zone in quartz veins with calcite, dolomite, ankerite, muscovite, nacrite, chamosite, and ore minerals such as pyrite, chalcocopyrite, galena, sphalerite, acanthite, chlorargyrite, brucite, goethite, coronadite, paratellurite, xocomecatlite, and incompletely studied Cu, Mg, Mn, Zn, Fe, and Pb tellurite/tellurates. Raisaite forms prismatic, usually well-shaped crystals, which form radial groups, and crystal crusts. Individual crystals are up to  $0.15 \times 0.03 \text{ mm}$ , very rarely up to  $0.6 \times 0.1 \text{ mm}$ . Dense, roundish or spherical clusters up to 0.2 mm in diameter are also observed. Raisaite grows on dolomite, quartz, muscovite, chalcocopyrite, hessite, and petzite. In some cases, gypsum covers raisaite aggregates. The new mineral is transparent, light blue to bright sky blue, with a white streak and vitreous luster. Raisaite is brittle with a Mohs hardness ~2. It has an imperfect cleavage in (001), and uneven fracture.  $D_{\text{meas}} = 2.82(1)$ ,  $D_{\text{calc}} = 2.828 \text{ g/cm}^3$ . Raisaite is optically biaxial (+),  $\alpha = 1.626(3)$ ,  $\beta = 1.642(5)$ , and  $\gamma = 1.665(3)$  (589 nm);  $2V_{\text{meas}} = 80(10)^\circ$ ;  $2V_{\text{calc}} = 81^\circ$ . Dispersion of optical axes is weak,  $r < v$ . Pleochroism is weak:  $Z$  (bluish-grayish)  $> Y$  (pale bluish-grayish)  $> X$  (colorless). The extinction angle with  $Z$  is  $2(1)^\circ$ . IR spectrum shows the absorption bands in the range ( $\text{cm}^{-1}$ ) of 3000–3600 [O-H stretching vibrations of  $\text{H}_2\text{O}$  and (OH) groups], weak bands at 1865 and 2276 corresponding to acidic (OH) groups, 1577, 1653, and 1670 (non-degenerate H-O-H bending modes of the 3 independent  $\text{H}_2\text{O}$  molecules), and bands below 1150, which assignment is ambiguous. The absence of any bands in the range of 1150–1500  $\text{cm}^{-1}$  indicates the absence of the groups with C-O, N-H, N-O, and B-O bonds. The averaged 7 point WDS electron probe analyses gave [wt%, (range)]: MgO 10.68 (10.41–10.97), CuO 18.09 (17.19–19.01),  $\text{SO}_3$  0.44 (0.05–1.26),  $\text{TeO}_3$  41.19 (39.96–42.16),  $\text{H}_2\text{O}_{\text{calc}}$  (by difference) 29.60, total 100.00. The empirical formula of raisaite is  $\text{Cu}_{0.96}\text{Mg}_{1.11}\text{Te}_{0.99}\text{S}_{0.02}\text{O}_{4.20}(\text{OH})_{1.80} \cdot 6\text{H}_2\text{O}$  based on O = 12 atoms pfu. The strongest lines of the X-ray powder diffraction pattern are [ $d \text{ \AA}$  (I%;  $hkl$ )]: 7.088 (100; 110), 5.815 (35;  $\bar{1}11$ ), 5.690 (23; 111), 4.949 (91; 200, 002), 4.507 (50; 021), 3.533 (17;  $\bar{2}02, 022$ ), 3.358 (17; 221), 3.310 (21; 221), 2.694 (29;  $\bar{1}32$ ). The crystal structure of raisaite was solved by direct methods and refined to  $R = 1.86\%$ . The new mineral is monoclinic,  $C2/c$ ,  $a = 9.9078(2)$ ,  $b = 10.1325(3)$ ,  $c = 9.8375(2) \text{ \AA}$ ,  $\beta = 91.839(2)^\circ$ ,  $V = 987.09 \text{ \AA}^3$ , and  $Z = 4$ . Raisaite has a unique crystals structure that is based on heteropolyhedral zigzag chains built by alternating edge-sharing  $[\text{Te}^{6+}\text{O}_4(\text{OH})_2]$  and  $[\text{CuO}_4(\text{H}_2\text{O})_2]$  octahedra.  $[\text{Mg}(\text{H}_2\text{O})_6]$  octahedra are connected with the chains on both sides via common O vertices. Adjacent chains are linked by H-bonding forming “layers” that are connected with each other by a system of hydrogen bonds. The type specimen is deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

## SHCHUROVSKYITE\* AND DMISOKOLOVITE\*

I.V. Pekov, N.V. Zubkova, D.I. Belakovskiy, V.O. Yapaskurt, M.F. Vigasina, E.G. Sidorov and D.Y. Pushcharovsky (2015) New arsenate minerals from Arsenatnaya fumarole, Tolbachik volcano, Kamchatka,

Russia. IV. Shchurovskyite,  $K_2CaCu_6O_2(AsO_4)_4$  and dmisokolovite,  $K_3Cu_3AlO_2(AsO_4)_4$ . Mineralogical Magazine, 79(7), 1737–1753.

Shchurovskyite (IMA 2013-078), ideally  $K_2CaCu_6O_2(AsO_4)_4$ , and dmisokolovite (IMA 2013-079), ideally  $K_3Cu_3AlO_2(AsO_4)_4$ , are two new minerals discovered in the Arsenatnaya fumarole at the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka Peninsula, Russia. Shchurovskyite (Cyrillic: щуровскийит) was after Grigory Efimovich Shchurovsky (1803–1884), a prominent Russian geologist, mineralogist, and specialist in mineral deposits at Moscow State University. Dmisokolovite (дмисоколовит) was named after Dmitry Ivanovich Sokolov (1788–1852), a famous Russian mineralogist and geologist and Professor of Mineralogy and Geology at St. Petersburg State University and Academician of the Russian Academy of Sciences. Both new minerals occur in association with each other as well as with other arsenates such as johillerite, bradaczekite, tilasite, svabite, lammerite, lammerite- $\beta$ , urusovite, ericlxmanite, kozyrevskite, popovite, alarsite, hatertite, yurmarinite, pharmazincite, melanarsite, katarsite, and with tenorite, hematite, fluorophlogopite, aphythitalite, langbeinite, calcio-langbeinite, krashennikovite, steklite, anhydrite, As-bearing orthoclase, Cu-rich gahnite, corundum, wulfite, arcanite, palmierite, dolerophanite, alumoklyuchevskite, vanthoffite, sylvite, and OH-free fluoborite. The aforementioned minerals form incrustations up to 0.5 cm thick on the surface of basalt scoria. Shchurovskyite forms coarse tabular to prismatic crystals usually <0.03 mm, rarely up to 0.15 mm, and anhedral crystals. Dmisokolovite forms tabular, prismatic or dipyrarnidal crystals up to 0.2 mm, and equant to flattened grains. The new minerals are both transparent with vitreous luster. Shchurovskyite is olive-green to dark olive-green, typically with a gray hue, or olive drab, and has a pale greenish streak. Dmisokolovite is bright emerald-green to light green, occasionally with a bluish hue, and has a light green streak. Both minerals are brittle, with Mohs hardness of 3. Shchurovskyite has no cleavage or parting. Dmisokolovite shows one direction of imperfect cleavage. Both minerals have an uneven fracture. Density was not measured because of the paucity of the material.  $D_{\text{calc}} = 4.28 \text{ g/cm}^3$  for shchurovskyite and  $D_{\text{calc}} = 4.26 \text{ g/cm}^3$  for dmisokolovite. Shchurovskyite is optically biaxial (+),  $\alpha = 1.795(5)$ ,  $\beta = 1.800(5)$ , and  $\gamma = 1.810(6)$  (589 nm);  $2V_{\text{meas}} = 70(15)^\circ$ ;  $2V_{\text{calc}} = 71^\circ$ . Dispersion of optical axes was not observed. Pleochroism is weak:  $Z \geq Y$  (grass green) >  $X$  (yellowish green). Dmisokolovite is optically biaxial (-),  $\alpha = 1.758(7)$ ,  $\beta = 1.782(7)$ , and  $\gamma = 1.805(8)$  (589 nm);  $2V_{\text{meas}} = 85(5)^\circ$ ;  $2V_{\text{calc}} = 88^\circ$ . Dispersion of optical axes is strong,  $r > v$ . The mineral is pale green in transmitted light, non-pleochroic. In Raman spectra of both minerals strong bands in the region 750–950  $\text{cm}^{-1}$ , with a maximum at ~840  $\text{cm}^{-1}$  corresponding to  $As^{5+}$ -O stretching vibrations of  $AsO_4$  anionic groups. Bands with frequencies <700  $\text{cm}^{-1}$  correspond to  $As^{5+}$ -O bending vibrations and  $Cu^{2+}$ -O stretching vibrations. Strong bands with maxima at 486  $\text{cm}^{-1}$  (shchurovskyite) and 500  $\text{cm}^{-1}$  (dmisokolovite) presumably correspond to the  $Cu^{2+}$ -O stretching modes. An absence of bands with frequencies >950  $\text{cm}^{-1}$  indicates the absence of groups with O-H, C-H, C-O, N-H, N-O, and B-O bonds. The average of 4 electron probe WDS analyses of shchurovskyite is [wt%, (range)]:  $K_2O$  8.85 (8.03–9.41),  $Rb_2O$  0.11 (0.00–0.42),  $CaO$  4.94 (4.53–5.24),  $CuO$  43.19 (42.43–44.11),  $ZnO$  0.42 (0.00–0.66),  $Al_2O_3$  0.04 (0.00–0.10),  $P_2O_5$  0.59 (0.00–0.99),  $V_2O_5$  0.01 (0.00–0.05),  $As_2O_5$  40.72 (39.96–41.93),  $SO_3$  0.35 (0.00–1.39), total 99.22 wt%. The empirical formula calculated on the basis of 18 O atoms pfu is:  $K_{2.05}Rb_{0.01}Ca_{0.96}Cu_{5.92}Zn_{0.06}Al_{0.01}P_{0.09}S_{0.05}As_{3.98}O_{18}$ . The average of 4 electron probe WDS analyses of dmisokolovite is [wt%, (range)]:  $Na_2O$  0.83 (0.61–1.00),  $K_2O$  10.71 (10.51–10.91),  $MgO$  0.35 (0.29–0.47),  $CaO$  0.21 (0.00–0.50),  $CuO$  38.67 (37.96–39.07),  $ZnO$  0.20 (0.00–0.40),  $Al_2O_3$  4.68 (3.98–5.73),  $Fe_2O_3$  0.36 (0.00–0.60),  $P_2O_5$  0.78 (0.50–1.34),  $V_2O_5$  0.04 (0.00–0.12),  $As_2O_5$  43.01 (42.51–43.65), total 99.84 wt%. The empirical formula calculated on the basis of 18 O atoms pfu is:  $Na_{0.28}K_{2.36}Mg_{0.09}Ca_{0.04}Cu_{5.04}Zn_{0.04}Al_{0.95}Fe_{0.05}P_{0.11}As_{3.88}O_{18}$ . The strongest lines of shchurovskyite X-ray powder pattern [ $d \text{ \AA}$  (%;  $hkl$ )] are: 8.61 (100; 200,001), 5.400 (32;

110), 2.974 (32;  $\bar{3}12,510$ ), 2.842 (47; 003,020), 2.757 (63;  $\bar{6}01,511$ ), 2.373 (36; 512,420), 2.297 (31; 421,222,313); and of dmisokolovite X-ray powder pattern [ $d \text{ \AA}$  (%;  $hkl$ )] are: 8.34 (95; 002), 5.433 (84; 110), 2.921 (66; 510,314), 2.853 (58; 511,020), 2.733 (100; 006,512,602). Shchurovskyite is monoclinic, space group  $C2$ ,  $a = 17.2856(9)$ ,  $b = 5.6705(4)$ ,  $c = 8.5734(6) \text{ \AA}$ ,  $\beta = 92.953(6)^\circ$ ,  $V = 839.24 \text{ \AA}^3$ ,  $Z = 2$ . Dmisokolovite is also monoclinic, space group  $C2/c$ ,  $a = 17.0848(12)$ ,  $b = 5.7188(4)$ ,  $c = 16.5332(12) \text{ \AA}$ ,  $\beta = 91.716(6)^\circ$ ,  $V = 1614.7 \text{ \AA}^3$ ,  $Z = 4$ . The crystal structures of shchurovskyite and dmisokolovite were solved by direct methods and refined  $R_1 = 7.46\%$  and  $R_1 = 13.45\%$ , respectively. Their crystal structures are closely related in the topology of the main building units. They are based on a quasi-framework consisting of  $AsO_4$  tetrahedra and polyhedra centred by Cu in shchurovskyite or by Cu and Al in dmisokolovite. K and Ca atoms are located in channels of the quasi-framework. The type specimens of both new minerals are deposited in the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **Yu.U.**

### VANACKERITE\*

J. Schlüter, T. Malcherek and G. Gebhard (2016) Vanackerite, a new lead cadmium arsenate of the apatite supergroup from Tsumeb, Namibia. Neues Jahrbuch für Mineralogie-Abhandlungen Journal of Mineralogy and Geochemistry 193/1, 79–86.

A new member of the apatite supergroup, vanackerite (IMA 2011-114), ideally  $Pb_4Cd(AsO_4)_3Cl$ , was discovered in the second oxidized zone of the famous Tsumeb mine, a dolostone-hosted, polymetallic, hydrothermal ore deposit. It is a supergene mineral formed by alteration of polymetallic ore. The specimen with a new mineral was collected in 1980, but for a long time thought to be a mimetite. Vanackerite is Cd-substituted analog of mimetite. In the holotype specimen vanackerite crystals sitting on bluish-green thometzekite and are associated with anglesite and gypsum. Light yellow, thin, translucent adamantine pseudohexagonal tabular {001} crystals of vanackerite up to 5 mm form groups and rosettes. The streak is white. Minor crystal forms are {010}, {111}, and {101}. Twinning was not observed. Some of the large vanackerite crystals reveal a fine-grained domain structure under crossed polars. The mineral shows an orange fluorescence in UV light which is stronger at 366 nm. The indentation hardness  $VHN_{25} = 270 \text{ kg/mm}^2$  corresponds to ~4 of Mohs scale;  $D_{\text{calc}} = 7.28 \text{ g/cm}^3$ . No data on optical properties were obtained;  $n_{\text{calc}} = 2.04$ . Polarized Raman spectra are dominated by the bands in the area 850–750  $\text{cm}^{-1}$  with a most strong peak at ~830  $\text{cm}^{-1}$  ( $AsO_4$  stretching vibrations) and in the area 500–300  $\text{cm}^{-1}$  ( $AsO_4$  bending). The exact wavenumbers are not provided. IR and Raman spectroscopy do not indicate any relevant water content. The average of 45 point electron probe WDS analyses is [wt%, (range)]:  $PbO$  64.44 (63.02–67.36),  $CdO$  8.82 (7.72–9.48),  $As_2O_5$  23.59 (23.12–23.95),  $Cl$  1.51 (1.13–1.97),  $O=Cl_2$  0.34, total 98.02 wt%. The empirical formula based on 8 cations pfu is  $Pb_{4.10}Cd_{0.98}As_{2.92}Cl_{0.61}$ . The strongest X-ray powder reflections are [ $d \text{ \AA}$  (%;  $hkl$ ): 4.140 (10; 200), 3.290 (34; 102, 320), 2.982 (100; 211,112,300), 2.067 (16; 222), 1.944 (11; 313)]. The single-crystal X-ray diffraction data shows vanackerite is trigonal, space group  $P\bar{3}$  with  $a = 10.0279(3) \text{ \AA}$ ,  $c = 7.2965(2) \text{ \AA}$ ,  $V = 635.43 \text{ \AA}^3$ , and  $Z = 2$ . The crystal structure refined to  $R = 0.0326$  for 2249 observed  $I > 3\sigma(I)$  reflections and is obtained from the hexagonal mimetite structure by site splitting of one of the Pb positions, accompanied by rotation of the arsenate tetrahedra. The mineral is named in honor of Georges Vanacker (1923–1992) of Bruegge, Belgium, who built a magnificent systematic collection of minerals including many specimens of the Tsumeb deposit in one of which vanackerite was identified. He donated this collection to the Natural Sciences Institute (Institut Royal des Sciences Naturelles de Belgique) of Bruxelles (Belgium) in 1991. The type specimen has been deposited in the Mineralogical Museum of the University of Hamburg, Germany. **D.B.**