

New Mineral Names*†

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This New Mineral Names has entries for 5 new minerals, including cerchiarait-(Al), cerchiarait-(Fe), štěpíte, vysokýite, and yaroshevskite.

CERCHIARAITE-(Fe)*, CERCHIARAITE-(Al)*

A.R. Kampf, A.C. Roberts, K.E. Venance, C. Carbone, D. Belmonte, G.E. Dunning, and R.E. Walstrom (2013) Cerchiarait-(Fe) and cerchiarait-(Al), two new barium cyclosilicate chlorides from Italy and California, USA. *Mineralogical Magazine*, 77(1), 69–80.

Cerchiarait-(Fe) (IMA 2012-012), ideally $\text{Ba}_4\text{Fe}_3^{2+}(\text{Si}_4\text{O}_{12})\text{O}_2(\text{OH})_4\text{Cl}_2[\text{Si}_2\text{O}_3(\text{OH})_4]$, and cerchiarait-(Al) (IMA 2012-011), ideally $\text{Ba}_4\text{Al}_4(\text{Si}_4\text{O}_{12})\text{O}_2(\text{OH})_4\text{Cl}_2[\text{Si}_2\text{O}_3(\text{OH})_4]$, are new minerals described from different locations. For the cerchiarait-(Fe) type localities are the Cerchiarait mine, Liguria, Italy and the Esquire No. 7 and No. 8 claims, Big Creek, Fresno County, California, USA. Cerchiarait-(Al) was found at the Esquire No. 1 claim, Rush Creek, Fresno County, California, USA and at the Esquire No. 7 and No. 8 claims noted above. At the Cerchiarait mine, cerchiarait-(Fe) occurs as tan to brown thin prisms and matted fibers in small fractures and veinlets within the metacherts of a Jurassic ophiolitic sequence. It is associated with aegirine, calcite, Mn-bearing diopside (variety schefferite), hematite, K-feldspar, norrishite and quartz. The origin is related to re-equilibration of the ophiolitic sequences during tectonometamorphic overprinting (~80 Ma) in prehnite-pumpellyite facies conditions ($P = 2\text{--}3$ kbar, $T = 250\text{--}300$ °C). Cerchiarait-(Fe) and cerchiarait-(Al) from the Esquire No. 1, No. 7, and No. 8 claims occur in parallel-bedded quartz-sanbornite vein assemblages which formed as a result of fluid interaction along the margin of the vein. At the Esquire No. 1, No. 7, and No. 8 claims, both minerals occur as subparallel aggregates of blue to bluish green irregular prisms in subparallel crystal aggregates generally less than 1 mm across. Associated minerals at the Esquire No. 1 claim for cerchiarait-(Al) include bazirite, diopside, goethite, opal, quartz, sanbornite, titanaramellite, traskite, and witherite. At the Esquire No. 7 claim, cerchiarait-(Fe) and cerchiarait-(Al) are associated with bazirite, diopside, muirite, pyrrhotite, Ba-rich tobermorite, traskite and witherite. At the Esquire No. 8 claim, they are associated with bazirite, calcite, diopside, pyrrhotite, titanaramellite, and Ba-rich tobermorite. Crystals of both minerals are transparent with a colorless to tan streak (Cerchiarait mine) or pale green-blue streak (Esquire No. 1, No. 7, and No. 8 claims), have a vitreous

luster, brittle tenacity, irregular fracture, show no cleavage and have a Mohs hardness of ~4½. The density could not be measured for cerchiarait-(Fe) due to the fibrous nature of the crystals; $D_{\text{calc}} = 3.710$ g/cm³. For cerchiarait-(Al), $D_{\text{meas}} = 3.69(3)$ g/cm³, $D_{\text{calc}} = 3.643$ g/cm³. The new minerals do not fluoresce in long-wave or short-wave ultraviolet light. Cerchiarait-(Fe) is uniaxial (+), with $\omega = 1.741(2)$, $\epsilon = 1.768(2)$. It is weakly pleochroic with O (colorless) < E (yellow). Cerchiarait-(Al) is uniaxial (–), with $\omega = 1.695(2)$ and $\epsilon = 1.677(2)$. It is strongly pleochroic with O (colorless) < and E (blue). The average of 10 electron probe WDS analyses of the cerchiarait-(Fe) from the Cerchiarait mine is [wt% (range)]: Na₂O 0.05 (0.00–0.13), BaO 40.81 (39.13–42.08), CaO 0.17 (0.03–0.42), MgO 0.06 (0.00–0.13), Mn₂O₃ 0.22 (0.04–0.46), Fe₂O₃ 19.03 (18.25–20.26), Al₂O₃ 0.87 (0.74–0.94), TiO₂ 1.51 (0.52–2.25), SiO₂ 23.51 (23.26–23.83), Cl 5.47 (5.13–5.98), O=Cl –1.23, H₂O (by stoichiometry) 5.84. The empirical formula based on 27 anions pfu is $(\text{Ba}_{3.82}\text{Na}_{0.02}\text{Ca}_{0.04})_{\Sigma 3.88}(\text{Fe}_{3.42}^{3+}\text{Ti}_{0.27}^{4+}\text{Al}_{0.25}^{3+}\text{Mn}_{0.04}^{3+}\text{Mg}_{0.02})_{\Sigma 4.00}\text{Si}_{5.62}\text{O}_{15.47}(\text{OH})_{9.31}\text{Cl}_{2.22}$. The average of 11 electron probe WDS analyses on the cerchiarait-(Al) from the Esquire No. 1 claim is [wt% (range)]: BaO 44.82 (43.75–46.91), MgO 0.43 (0.35–0.59), MnO 0.30 (0.20–0.44), Fe₂O₃ (total) 7.27 (5.58–8.25), Fe₂O₃ 6.55 and FeO 0.65 (on the basis of bond-valence analysis), Al₂O₃ 8.94 (8.12–9.79), SiO₂ 25.38 (25.25–26.22), Cl 7.53 (7.35–7.94), O=Cl –1.70, H₂O (by stoichiometry) 5.76. The empirical formula based on 27 anions pfu is $\text{Ba}_{4.00}(\text{Al}_{2.40}^{3+}\text{Fe}_{1.12}^{3+}\text{Mg}_{0.15}\text{Fe}_{0.12}^{2+}\text{Mn}_{0.06}^{2+})_{\Sigma 3.85}\text{Si}_{5.78}\text{O}_{15.34}(\text{OH})_{8.75}\text{Cl}_{2.91}$. The strongest lines in the X-ray powder-diffraction pattern of cerchiarait-(Al) from Esq. 1 [d_{obs} (Å) ($I_{\text{obs}}\%$; hkl)] are: 3.009 (100; 411,002), 2.580 (93; 501,222), 3.316 (77; 321), 1.880 (68; 213,532,730,721,602), 1.4031 (54; 941,723,912,950). The unit-cell parameters refined from powder-diffraction data are: $a = 14.317(4)$, $c = 6.0037(18)$ Å, $V = 1230.6$ Å³. Single-crystal X-ray diffraction data collected on a crystal of cerchiarait-(Fe) from Esq. 8 of size $70 \times 40 \times 40$ μm refined to $R_1 = 0.0253$ for 329 unique reflections with $I \geq 4\sigma(I)$ shows the new mineral is tetragonal, space group $I4/mmm$, with $a = 14.3554(12)$, $c = 6.0065(5)$ Å, $V = 1237.80$ Å³, and $Z = 2$. The new minerals are isostructural with cerchiarait. Their structure consists of corner-sharing SiO₄ tetrahedra that form 4-membered rings that link via corner-sharing to an edge-sharing chain of Fe³⁺O₆ octahedra running parallel to c . A Cl site alternates along c with the Si₄O₁₂ ring. A large channel in the framework contains Ba atoms around its periphery and statistically distributed Si₂O₃(OH)₄ silicate dimers and Cl atoms. The names are after cerchiarait, where a

* 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/>.

suffix-based naming scheme is used and in which the original *cerchiaraita* is renamed *cerchiaraita*-(Mn). Five cotype specimens are deposited at the Natural History Museum of Los Angeles County, Los Angeles, California, U.S.A. **O.C.G.**

ŠTĚPITE*, VYSOKÝITE*

- J. Plášil, K. Fejfarová, J. Hloušek, R. Škoda, M. Novák, J. Sejkora, J. Čejka, M. Dušek, F. Veselovský, P. Ondruš, J. Majzlan, and Z. Mráek (2013) *Štěpíte*, $U(AsO_3OH)_2 \cdot 4H_2O$, from Jáchymov, Czech Republic: the first natural arsenate of tetravalent uranium. *Mineralogical Magazine*, 77(1), 137–152.
- J. Plášil, J. Hloušek, R. Škoda, M. Novák, J. Sejkora, J. Čejka, F. Veselovský, and J. Majzlan (2013) *Vysokýite*, $U^{4+}(AsO_2(OH)_2)_4 \cdot 4H_2O$, from Jáchymov, Czech Republic. *Mineralogical Magazine*, 77(8), 3055–3066.

Štěpíte (IMA 2012-006), ideally $U^{4+}(AsO_3OH)_2 \cdot 4H_2O$ and *vysokýite* (IMA 2012-067), ideally $U^{4+}(AsO_2(OH)_2)_4 \cdot 4H_2O$ are new natural arsenates of tetravalent uranium discovered at the intersection of the Geschieber and Geyer veins, 10th level of the Svornost (former “Einigkeit”) mine Jáchymov (St Joachimsthal) ore district, Krušné Hory Mountains (Erzgebirge), ~20 km north of Karlovy Vary, NW Bohemia, Czech Republic. The Jáchymov ore district is a classic example of Ag-As-Bi-Co-Ni-U hydrothermal vein-type deposit. The new minerals were found on the surface of native arsenic lens (with traces of arsenopyrite and pyrite and with no uraninite) weathered by post mining processes being exposed to a moist environment for more than 40 years. The supergene association includes arsenolite (abundant), běhounekite, claudetite, kaatialaite, scorodite, parasymplectite, gypsum, picropharmacolite, melanterite, native sulfur and a partially characterized phase $(H_3O)_2^+(UO_2)_2(AsO_4)_2 \cdot 6H_2O$. *Štěpíte* was originally reported from Jáchymov as an unnamed new phase $U^{4+}(HASO_4) \cdot 4H_2O$ (Ondruš et al. 1997) and it was subsequently codified as UM1997-20-AsO:HU at the IMA list of valid unnamed minerals.

Štěpíte forms crystalline crusts of tabular crystals with prominent {001} and {010} faces, up to 0.6 mm in size, commonly intergrown to form aggregates up to 6 mm across. It also occurs as blocky intergrowths of crystals and as minute radiating aggregates of thin platy crystals. Crystals of *štěpíte* are emerald-green with a gray to greenish gray streak and vitreous luster, have very good cleavage on (001), an uneven fracture, are brittle, and have a Mohs hardness of ~2. The density was not measured; $D_{calc} = 3.90 \text{ g/cm}^3$. *Štěpíte* is not fluorescent in either short-wave or long-wave ultraviolet light. It is nonpleochroic (color in transmitted light is not given), biaxial (–) with $\alpha = 1.636(2)$, $\beta = 1.667(3)$, $\gamma = 1.672(2)$, and $2V_{obs} < \sim 5^\circ$, shows anomalous interference grayish to pale yellow colors on the 001 plane. The wavenumbers of the main absorption bands of the IR spectrum (cm^{-1}) are: 3457 and 3392 (OH-stretching vibrations of H_2O and OH); 1652 [ν_2 (δ) bending vibration of H_2O]; 1402 and 1236 [δ (As-OH) bending]; 1076, 1035, and 1004 (probably overtones); 936, 869, 853, 830, and 815 [overlapping bands of $\nu(AsO_3OH)$ stretching vibrations (ν_1 symmetric and split triply degenerate ν_3 antisymmetric vibrations)]; 758 [ν (As-OH) stretching vibration]; 653 (possibly libration modes of H_2O molecules); 559 and 425

[$\delta(AsO_3OH)$ bending vibrations]. The wavenumbers of the main absorption bands of Raman spectrum (cm^{-1}) are: 3552 and 3484 (OH-stretching vibrations of H_2O and OH); 1641 [ν_2 (δ) bending vibration of H_2O]; 1490 and 1239 [δ (As-OH) bending]; 896, 844, and 811 [overlapping $\nu(AsO_3OH)$ stretching vibrations (ν_1 symmetric and split triply degenerate ν_3 antisymmetric vibrations)]; 760 [ν (As-OH) stretching vibration]; 420, 401, 377, 368, 351, 322, and 312 [$\delta(AsO_3OH)$ bending vibrations]; 287, 262, and 235 [ν (OH-O) stretching vibrations]; 180, 160, 139, 115, and 107 (lattice modes). The average of 6 electron probe WDS analyses is [wt% (range)]: Na_2O 0.13 (0.08–0.19), UO_2 (valence of U verified by XANES spectroscopy) 50.19 (49.71–50.63), SiO_2 0.12 (0.09–0.20), P_2O_5 0.46 (0.29–0.51), As_2O_5 38.64 (37.41–39.73), SO_3 1.95 (1.23–2.51), H_2O (calculated on the basis of $4H_2O + 2OH$ from the structure determination) 16.41. The empirical formula based on 12 O apfu is $(U_{1.01}Na_{0.02})_{\Sigma 1.03}[(AsO_3OH)_{1.82}(PO_3OH)_{0.04}(SO_4)_{0.13}(SiO_4)_{0.01}]_{\Sigma 2.00} \cdot 4H_2O$. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} Å ($I_{obs}\%$; hkl)] are: 8.190 (100; 004), 7.008 (43; 112), 5.475 (18; 200), 4.111 (16; 008), 3.395 (20; 312,217), 2.1543 (25; 419). The unit-cell parameters refined from powder-diffraction data are: $a = 10.9905(4)$, $c = 32.782(2)$ Å, and $V = 3959.7$ Å³. Single-crystal X-ray diffraction data collected on a crystal of size $0.16 \times 0.13 \times 0.08$ mm refined to $R_1 = 0.0353$ for 1434 unique reflections with $I \geq 3\sigma(I)$ shows *štěpíte* is tetragonal, space group $I4_1/acd$, with $a = 10.9894(1)$, $c = 32.9109(6)$ Å, $V = 3974.5$ Å³, and $Z = 16$. The structure of *štěpíte* consists of sheets of eight-coordinate uranium atoms and hydroxyarsenate “tetrahedra” perpendicular to [001], with the uranium being bonded to six oxygen atoms which belong to the hydroxyarsenate groups and two oxygen atoms from interlayer H_2O molecules. The UO_8 polyhedra are connected to five other U polyhedra via six AsO_3OH groups. The $[U^{4+}(AsO_3OH)_2]^{+0}$ sheets are linked by hydrogen bonds involving H_2O molecules in the interlayers and OH groups in the sheets. The new mineral is named in honor of Ing. Josef Štěp (1863–1926), a Czech mining engineer who played a leading role in the development of the Jáchymov mines, and the “father” of the world’s first radioactive spa at Jáchymov.

Vysokýite forms rich, radial aggregates, consisting of light-green very fine, exceptionally long fibers (up to 8 mm) elongated on [010]. Crystals of *vysokýite* are occasionally covered by small aggregates of green tabular *štěpíte* crystals or their hemispherical aggregates and are associated with prismatic green crystals of *běhounekite*. *Vysokýite* has an alabaster luster and a greenish-white to grayish streak. It is brittle with uneven fracture and perfect cleavage along (100) and (001); the Mohs hardness is ~2. Density was not measured due to fibrous nature of the crystals; $D_{calc} = 3.393 \text{ g/cm}^3$. The mineral does not fluoresce under short- or long-wave UV radiation. It is colorless in transmitted light (pleochroism not mentioned). The refractive indices could be only measured along and perpendicular to fibres: $\alpha' = 1.617(3)$, $\gamma' = 1.654(3)$ (589 nm). The estimated optical orientation is $\alpha' \sim X$, $\gamma' \sim Z$. The Raman spectrum covering the range 50–3150 cm^{-1} shows bands (cm^{-1}) at 2750 and 2230 (ν O-H stretching vibrations of As-OH and of hydrogen-bonded H_2O molecules; 1545 and 1435 (combination bands and/or overtones); highest intensity bands 920 and 816 (ν_3 antisymmetric and ν_1 symmetric As-O stretching); 769 (As-OH stretching); 595 and 559 (δ

As-OH bending vibrations); 427, 368 [ν_4 (δ) O-As-O bending], 324 [ν_2 (δ) bending]; 200, 184, 99, and 61 (lattice modes). The average of 5 electron probe WDS analyses is [wt% (range)]: SiO₂ 1.03 (0.70–1.05), UO₂ 29.44 (24.50–32.05), As₂O₅ 48.95 (46.29–50.99), SO₃ 0.12 (0–0.48), H₂O 15.88 (by stoichiometry 4H₂O+8OH from the crystal structure), total 95.42. The reason of the low total is not explained. The empirical formula based on 20 O apfu is U_{1.00}[AsO₂(OH)₂]_{3.90}(SiO₄)_{0.16}(SO₄)_{0.01}·4H₂O. The strongest lines in the X-ray powder diffraction pattern are [d_{obs} Å ($I_{\text{obs}}\%$; hkl)]: 8.872(100; 100), 8.067 (50; 002), 6.399 (7; 103), 4.773 (6; 104), 3.411 (10; 302), 3.197 (18; 313). Single-crystal X-ray diffraction data collected on a crystal of size 0.19 × 0.02 × 0.01 mm refined to $R_1 = 0.0595$ for 2718 unique reflections with $I \geq 3\sigma(I)$ shows vysokýite is triclinic, space group $P\bar{1}$, with $a = 10.749(2)$, $b = 5.044(3)$, $c = 19.1778(7)$ Å, $\alpha = 89.872(15)^\circ$, $\beta = 121.534(15)^\circ$, $\gamma = 76.508(15)^\circ$, $V = 852.1$ Å³, $Z = 2$. The crystal structure of vysokýite consists of UO₈ square antiprisms sharing all of their vertices with 8 As-tetrahedra to form infinite chains parallel to [010]. These chains are linked by hydrogen bonds involving terminal (OH) groups of the double-protonated As-tetrahedra and molecules of H₂O located between the chains. The new mineral is named in honor of Ing. Arnošt Vysoký (1823–1872), the former chief of the Jáchymov mines and smelters, chemist, metallurgist and specialist in technological processes of the ores.

The type specimens of štěpíte and vysokýite have been deposited in the collections of the Department of Mineralogy and Petrology of the National Museum in Prague, Czech Republic.

O.C.G., D.B.

Discussion: The calculated $2V$ for štěpíte is 43° . Thus one of the measured values: $2V$ or refractive index β are incorrect. The mineral could be anomalously biaxial.

References cited

Ondruš, P., Veselovský, F., Skála, R., Císařová, I., Hloušek, J., Frýda, J., Vavřín, I., Čejka, J., and Gabašová, A. (1997) New naturally occurring phases of secondary origin from Jáchymov (Joachimsthal). *Journal of the Czech Geological Society*, 42, 77–108.

YAROSHEVSKITE*

I.V. Pekov, N.V. Zubkova, M.E. Zelenski, V.O. Yapaskurt, Yu.S. Polekhovskiy, O.A. Fadeeva, and D.Yu. Pushcharovskiy (2013) Yaroshevskite, Cu₉O₂(VO₄)₄Cl₂, a new mineral from the Tolbachik volcano, Kamchatka, Russia. *Mineralogical Magazine*, 77(1), 107–116.

Yaroshevskite (IMA 2012-003), ideally Cu₉O₂(VO₄)₄Cl₂, in a new mineral found in sublimates of the Yadovitaya fumarole at the Second scoria cone of the Northern Breakthrough of the Great Tolbachik Fissure Eruption, Tolbachik volcano, Kamchatka, Russia. The sublimates were collected in an open cave

about 1.5 m wide and 2 m deep with an interior temperature of up to 340 °C with walls thickly encrusted by a diverse assemblage of minerals (dominantly sulfates). Yaroshevskite occurs very rarely on crusts that mainly consist of bright green euchlorine in association with fedotovite, hematite, tenorite, Cu-rich lyonsite, melanothallite, atlasovite, kamchatkite and secondary supergene avdoninite, belloite, and chalcantite. Yaroshevskite forms isolated prismatic crystals up to 0.1 × 0.15 × 0.3 mm. Crystals are black and opaque, have a reddish black streak, metallic to adamantine luster, are brittle, show no cleavage and an uneven fracture. The micro-indentation measurements VHN = 172 (165–179) kg/mm² corresponding to a Mohs hardness of ~3½. The density could not be measured due to the paucity of the material; $D_{\text{calc}} = 4.86$ g/cm³. Yaroshevskite is gray with a weak bluish hue in reflected light, shows no internal reflections or birefractance and a very weak anisotropy. The reflectance values (measured between 400 and 700 nm in 20 nm intervals) are [$R\%$ (λ nm)]: 15.8 (400), 16.2 (420), 16.3 (440), 16.2 (460), 16.0 (480), 15.8 (500), 15.5 (520), 15.3 (540), 15.2 (560), 14.9 (580), 14.7 (600), 14.5 (620), 14.4 (640), 14.2 (660), 14.0 (680), 13.8 (700). The average of 5 electron probe WDS analyses is [wt% (range)]: CuO 61.82 (60.8–62.4), ZnO 0.53 (0.4–0.8), Fe₂O₃ 0.04 (0.00–0.07), V₂O₅ 31.07 (30.5–31.7), As₂O₅ 0.32 (0.2–0.4), MoO₃ 1.56 (1.0–1.9), Cl 6.23 (6.0–6.6), O=Cl₂ –1.41, total 100.16. The empirical formula based on 20 (O+Cl) anions pfu is (Cu_{8.80}Zn_{0.07}Fe_{0.01})_{Σ8.88}(V_{3.87}Mo_{0.12}As_{0.03})_{Σ4.02}O_{18.01}Cl_{1.99}. The strongest lines in the X-ray powder-diffraction pattern [d_{obs} (Å) ($I_{\text{obs}}\%$; hkl)] are: 8.65 (100; 001), 6.84 (83; 0 $\bar{1}$ 1), 6.01 (75; 100), 5.52 (60; $\bar{1}$ 01), 4.965 (55; 011), 4.198 (67; $\bar{1}$ $\bar{1}$ 1), 4.055 (65; 110), 3.120 (55; 021), 2.896 (60; 2 $\bar{1}$ 1,003, $\bar{2}$ 20). The unit-cell parameters refined from powder-diffraction data are: $a = 6.4528(3)$, $b = 8.3121(5)$, $c = 9.1700(4)$ Å, $\alpha = 105.208(5)$, $\beta = 96.147(5)$, $\gamma = 107.881(5)^\circ$, $V = 442.16$ Å³, and $Z = 1$. Single-crystal X-ray diffraction data collected on a crystal of size 0.03 × 0.09 × 0.23 mm refined to $R_1 = 0.0737$ for 2026 unique reflections with $I \geq 2\sigma(I)$ shows yaroshevskite is triclinic, space group $P\bar{1}$, with $a = 6.4344(11)$, $b = 8.3232(13)$, $c = 9.1726(16)$ Å, $\alpha = 105.338(14)$, $\beta = 96.113(14)$, $\gamma = 107.642(1)^\circ$, $V = 442.05$ Å³, and $Z = 1$. The crystal structure of yaroshevskite is based on corrugated layers coplanar with ac . The layers are made up of chains of edge-sharing flat squares with central Cu²⁺ cations, with neighboring chains connected via groups of three Cu²⁺-centered squares. The neighboring layers are connected via pairs of CuO₄Cl fivefold-coordinated polyhedra and isolated VO₄ tetrahedra. The name is in honor of the Russian geochemist Alexei Andreevich Yaroshevskiy (b. 1934), professor in the Department of Geochemistry at the Faculty of Geology of Moscow State University. The type specimen of yaroshevskite has been deposited in the collection of the Fersman Mineralogical Museum of the Russian Academy of Sciences, Moscow, Russia. **O.C.G.**