

NEW MINERAL NAMES*

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Baiyuneboite-(Ce)

Pigqiu Fu, Xlanze Su (1987) Baiyuneboite—A new mineral. *Acta Mineralogica Sinica*, 7, 289–297 (in Chinese, English abstract).

Pingqiu Fu, Youhua Kong, Guohong Gong, Meicheng Shao, Jinzi Qian (1987) The crystal structure of baiyuneboite-(Ce). *Acta Mineralogica Sinica*, 7, 298–304 (in Chinese, English abstract).

Electron-microprobe analyses of ten grains, whose validity was checked by single-crystal X-ray methods prior to analysis, gave an average of Na₂O 4.73, CaO 1.04, BaO 20.38, Ce₂O₃ 24.21, La₂O₃ 10.92, Pr₂O₃ 0.62, Nd₂O₃ 10.04, Gd₂O₃ 0.13, F 2.50, CO₂ (by gas chromatography) 24.64, O = F 1.05, sum 98.16 wt%, corresponding to Na_{1.08}(Ba_{0.94}Ca_{0.13})_{Σ1.07}(Ce_{1.05}La_{0.48}Nd_{0.42}Pr_{0.03}Gd_{0.01})_{Σ1.99}F_{0.93}C_{3.97}O_{12.07}, ideally NaBaCe₂F(CO₃)₄. The mineral occurs as yellow, irregular grains 0.3 to 3 mm in size, frequently as thin hexagonal tablets. White streak, resinous to adamantine luster, transparent, nonfluorescent, brittle, conchoidal fracture, perfect {001} cleavage, H = 4.5, $D_{\text{meas}} = 4.30(11)$, $D_{\text{calc}} = 4.45 \text{ g/cm}^3$ with Z = 2. Uniaxial negative, $\omega = 1.7450(5)$, $\epsilon = 1.5990(5)$ at 589 nm; weakly dichroic, O = light greenish, E = pale brownish yellow. The DTA curve has a strong exothermic peak at 520 °C corresponding to evolution of CO₂. The infrared curve has absorption bands, attributable to CO₃ groups, at 1470, 1400, 1080, 878, 855, 716, and 687 cm⁻¹. Crystal-structure X-ray determination (R = 4.9%) showed the mineral to be hexagonal, space group *P6₃/mmc*, $a = 5.0875(15)$, $c = 23.1680(1) \text{ \AA}$. Strongest lines of the powder pattern (Fe radiation) are 3.840(70)(006), 3.510(90)(104), 3.200(100)(105), 2.547(80)(110), and 2.047(60)(1.0.10).

The mineral occurs in the Bayan Obo iron–niobium–rare-earth deposit in Inner Mongolia. Associated minerals are dolomite, fluorite, phlogopite, soda pyroxene, riebeckite, apatite, bafertisite, bastnaesite, and magnetite. Type material is in the Institute of Geochemistry of the Chinese Academy of Sciences, Guiyang, Guizhou Province, China. The new name alludes to the locality [with which there is some obvious difficulty in transliteration].

Discussion. Information provided by J. A. Mandarino, Chairman of the CNMMN, IMA, is that this mineral and name were approved, but it was learned subsequently that

the formula for cordylite-(Ce) requires revision such that cordylite-(Ce) and baiyuneboite-(Ce) may be identical. The Chairman therefore withdrew the approval and asked that the authors withhold publication of their description of baiyuneboite-(Ce) until the matter could be resolved. The request, unfortunately, was ignored. J.L.J.

Diaoyudaoite*

Shunxi Shen, Lirong Chen, Anchun Li, Tailu Dong, Qiu-huo Huang, Wenqiang Xu (1986) Diaoyudaoite—A new mineral. *Acta Mineralogica Sinica*, 6, 224–227 (in Chinese, English abstract).

The average of 13 electron-microprobe analyses gave Na₂O 4.54, Al₂O₃ 93.00, Cr₂O₃ 1.95, MgO 0.10, CaO 0.10, SiO₂ 0.23, K₂O 0.12, sum 100.04 wt%, corresponding to (Na_{0.87}K_{0.02}Mg_{0.02}Ca_{0.01})_{Σ0.92}(Al_{10.84}Cr_{0.15}Si_{0.02})_{Σ11.01}O₁₇, ideally NaAl₁₁O₁₇. The mineral occurs as colorless to light green, transparent, thin tabular crystals mostly 0.4 × 0.2 × 0.02–0.04 mm, but up to 0.5 × 0.3 mm. Cleavage well developed, rare conchoidal fracture, H₁₅ = 1392.8 kg/mm² (Mohs 7.6), $D_{\text{meas}} = 3.30$ (suspension), $D_{\text{calc}} = 3.21 \text{ g/cm}^3$ with Z = 2. Optically uniaxial negative, $\omega = 1.6876(2)$, $\epsilon = 1.6630(2)$, weak absorption. X-ray single-crystal study indicated hexagonal symmetry, space group *P6₃/mmc*, $a = 5.602(1)$, $c = 22.626(5) \text{ \AA}$. Strongest lines of the X-ray powder pattern (57.3-mm camera, Fe radiation) are 11.2(100)(002), 5.65(60)(004), 2.680(70)(017), 2.505(50)(114), 2.028(40)(026), 1.413(40)(0.2.13), and 1.400(60)(220). The results are in good agreement with data for synthetic β-NaAl₁₁O₁₇.

The new mineral occurs abundantly in the heavy-mineral (S.G. > 2.8) fraction that makes up about 1.4 wt% of the surface layer of sea-floor muds taken at about 1500-m water depth near the island of Diaoyudao, a few kilometers northeast of Taiwan. The new mineral contains native chromium inclusions, thus indicating a magmatic origin; a relationship to nearby high-alumina basalts is suggested. Associated minerals in the heavy fraction are mainly hornblende, epidote, dolomite, chlorite, and biotite. Type material is in the Museum of Geology, Beijing. J.L.J.

Fedotovite*

L.P. Vergasova, S.K. Filatov, Ye.K. Serafimova, G.L. Starova (1988) Fedotovite K₂Cu₃O(SO₄)₃—A new mineral

* Before publication, minerals marked with an asterisk were approved by the Commission on New Minerals and Mineral Names, International Mineralogical Association.

from volcanic sublimates. Doklady Akad. Nauk SSSR 299(4), 961–964 (in Russian).

Two chemical analyses gave Na₂O 1.48, 1.50, K₂O 13.97, 13.30, CuO 38.93, 38.81, ZnO 0.37, 0.21, PbO 0.70, 0.62, SO₃ 42.00, 41.79, H₂O, trace, not analyzed, insoluble residue, 2.80, 2.30, sums 100.25, 98.53, corresponding to (K_{1.65}Na_{0.28})_{Σ1.93}(Cu_{2.85}Zn_{0.02}Pb_{0.01})_{Σ2.88}S_{3.05}O₁₃ and (K_{1.72}Na_{0.28})_{Σ2.00}(Cu_{2.84}Zn_{0.03}Pb_{0.01})_{Σ2.88}S_{3.04}O₁₃. Soluble in weak nitric acid, unstable in air. The DTA curve shows two endothermic effects, the first at 692 °C with no weight loss and corresponding to breakdown with formation of tenorite, the second at 715 °C with a 20 wt% loss corresponding to desulfatization. The IR spectrum shows features at 600 cm⁻¹ and 1100 cm⁻¹ characteristic of (SO₄)²⁻ groups. The absence of features at 1600 and 3400–3600 cm⁻¹ indicates that no water or hydroxyl is present. Crystals of the mineral, which are up to 5 mm long and 0.1 to 1 mm thick, are flattened on {100} and irregular in outline, rarely rectangular from {010} and {001} or pseudohexagonal from {001} and {011}. Color emerald to grass-green, streak light grass-green, luster silky to vitreous, H = 2.5, perfect {100} cleavage, $D_{\text{meas}} = 3.205(3)$ (suspension), $D_{\text{calc}} = 3.17$ and 3.18 g/cm³ for the first and second chemical analyses, respectively, with Z = 8. Biaxial positive, straight extinction relative to cleavage, $\alpha = 1.577$, $\beta = 1.594$, $\gamma = 1.633$, $2V_{\text{calc}} = 68^\circ$, Z = b, Y \wedge c $\approx 0^\circ$. Transparent, pleochroic from green-yellow (Z, Y) to greenish-blue (X) with absorption Z > Y. X-ray study showed the mineral to be monoclinic, space group $P2_1/c$; the unit cell from powder data is $a = 19.06(3)$, $b = 9.47(1)$, $c = 14.18(2)$ Å, $\beta = 112.36(9)^\circ$. The strongest lines (39 given) are 8.83(100)(200), 6.59(4)(20 $\bar{2}$), 6.54(4)(002), 4.405(3)(400), 4.207(3)(21 $\bar{3}$), 2.943(12), and 2.844(5).

The mineral forms aggregates of poorly developed platy to micaceous crystals and fine-grained crusts 1 to 2 mm thick in incrustations around fumaroles of the second cone of the northern fracture of the Great Clefted Tolbachik eruption, Kamchatka, USSR. Associated minerals include dolerophanite, chalcocyanite, tolbachite, piypite, mel-anothallite, and tenorite. The name is for S. A. Fedotov (1931–). A sample is preserved in the museum of the Leningrad Mining Institute.

Discussion. The relation with the sodium-potassium-copper sulfate euchlorine, described in 1884, needs to be clarified. Euchlorine has compositions and optical properties similar to those of fedotovite and includes compositions with K > Na; the anhydrous character of fedotovite is a notable difference. E.S.G.

Françoisite-(Nd)*

P. Piret, M. Deliens, J. Piret-Meunier (1988) Françoisite-(Nd), a new uranyl and rare-earth phosphate: Properties and crystal structure. Bull. Minéral., 111, 443–449 (in French, English abstract).

The average and (range) of ten electron-microprobe analyses gave UO₃ 67.30 (66.70–68.02), Y₂O₃ 1.53 (0.78–

2.05), La₂O₃ 0.71 (0.23–1.03), Ce₂O₃ 1.00 (0.49–1.99), Pr₂O₃ 0.92 (0.63–1.29), Nd₂O₃ 4.60 (3.71–6.42), Sm₂O₃ 1.60 (1.40–1.91), Dy₂O₃ 0.79 (0.59–1.18), [ΣREE₂O₃ 11.15 (10.10–12.37)], P₂O₅ 10.15 (9.91–10.39), H₂O by gas chromatography 8.53, sum 97.13 (96.38–98.87) wt%, corresponding to the empirical formula 3.15UO₃·0.49(REE₂O₃)·0.96P₂O₅·6.3H₂O; X-ray crystal-structure study indicated a formula REE(UO₂)₃O(OH)(PO₄)₂·6H₂O. The mineral occurs as aggregates of yellow, translucent, nonfluorescent crystals up to 0.3 mm long, tabular (010), elongate [001], and showing also {100} and {10 $\bar{2}$ }. Twinned on (100), white streak, vitreous luster, H about 3, uneven fracture, easy {010} cleavage, $D_{\text{meas}} = >4.06$, $D_{\text{calc}} = 4.63$ g/cm³ with Z = 4. Optically biaxial negative, $2V_{\text{meas}} = 35^\circ$, $\alpha = 1.65$ (calc.), $\beta = 1.74(1)$, $\gamma = 1.75(1)$, X = b, Y \wedge c = 14.5°, Z \wedge a = 8.3°. X-ray study indicated monoclinic symmetry, space group $P2_1/c$, $a = 9.298(2)$, $b = 15.605(4)$, $c = 13.668(2)$ Å, $\beta = 112.77(1)^\circ$. Strongest lines of the powder pattern (114-mm camera, Cu radiation) are 7.79 (100)(020), 5.76(50)(120), 4.44(40)(21 $\bar{1}$), 4.33(40)(102), 3.88(50B)(040), 3.13(50)(12 $\bar{4}$), 2.874(40)(322), and 2.840 (40)(222).

The new name honors Dr. Armand François, geologist and former director of the Geology Department of Gécamine, a Zairian mining company. The mineral occurs in the Kamoto-Est copper-cobalt deposit, 6 km west of Kolwezi, Zaire, in association with uraninite, schoepite, uranophane, curite, schuilingite, and kamotoite-(Y). Type material is in the Institut royal des Sciences naturelles de Belgique, Brussels, Belgium. J.L.J.

Godovikovite*

Ye.P. Shcherbakova, L.F. Bazhenova, B.V. Chesnokov (1988) Godovikovite—NH₄(Al,Fe)(SO₄)₂ a new ammonium-bearing sulfate. Zapiski Vses. Mineralog. Obshch., 117(2), 208–211 (in Russian).

A chemical analysis, involving gravimetry (sulfate) complexometric methods (Al and Fe³⁺), chlorplatinate (NH₄ + K), and flame photometry (K), gave SO₃ 57.02, TiO₂ 0.66, Fe₂O₃ 7.70, Al₂O₃ 11.98, CaO 0.40, MgO 1.00, MnO 0.04, Na₂O < 0.05, K₂O 0.52, (NH₄)₂O 8.50, insoluble residue 12.49, sum 100.31 wt%. The insoluble residue is mostly finely dispersed quartz. After deducting this residue and normalizing to 100 wt%, the analysis corresponds to [(NH₄)_{0.92}Mg_{0.07}K_{0.03}Ca_{0.02}]_{Σ1.04}(Al_{0.66}Fe_{0.27}Ti_{0.02})_{Σ0.95}(SO₄)_{2.00}; or ideally (NH₄)(Al,Fe³⁺)(SO₄)₂ if Mg and Ca are assumed to be from admixed anhydrous Mg and Ca sulfates. The mineral is slowly soluble in water. The DTA curve has two endothermic peaks, one at 570 °C, corresponding to breakdown into simple sulfates and breakdown of (NH₄)₂SO₄, the other at 810 °C, corresponding to desulfatization of Al₂(SO₄)₃ and Fe₂(SO₄)₃. The loss of 9.1 wt% at 570 °C is attributed to loss of (NH₄)₂O. The mineral forms white, compact or porous chalky aggregates of fine hairs, 0.001 to 0.015 mm in size, in the burning dumps of coal mines near the town of Kopeysk in the

Chelyabinsk coal basin of the Southern Urals, USSR. The mineral is one of the main constituents of the sulfate crusts formed by reaction of sulfuric acid with the material in the dumps. Together with $(\text{Al,Fe})_2(\text{SO}_4)_3$, it occurs in the lower, hotter zones, which are up to 5 cm thick and up to 1 m² in area. Luster of the aggregates is dull, fracture uneven, $H = 2$, $D_{\text{meas}} = 2.53$ (suspension), $D_{\text{calc}} = 2.52$ g/cm³ with $Z = 1$. Uniaxial positive, $\epsilon = 1.581(2)$, $\omega = 1.572(2)$. Colorless. The powder X-ray pattern corresponds closely to that of synthetic $\text{NH}_4\text{Al}(\text{SO}_4)_2$ if allowance is made for an increase in d values because of substitution of Fe^{3+} for Al. Thus the mineral is assigned hexagonal symmetry and space group $P321$. Unit-cell parameters calculated from the powder data are $a = 4.75(1)$, $c = 8.30(1)$ Å, and strongest lines (18 given) are 8.30(90)(001), 3.69(100)(101), 2.921(90)(102), 2.764(70)(003), 2.374(80)(110), and 1.848(70)(104,202).

The name is for Aleksandr Aleksandrovich Godovikov (1927–). Samples are deposited in the Fersman Mineralogical Museum, Moscow. E.S.G.

Hydrotalcite-manasseite group

V.A. Drits, T.N. Sokolova, G.V. Sokolova, V.I. Cherkashin (1987) New members of the hydrotalcite-manasseite group. *Clays and Clay Minerals*, 35, 401–417.

The minerals were studied in three samples: one was from a clay lens within a boron-potassium-magnesium salt body in Lower Permian rocks of the pre-Caspian depression, and two were insoluble residues from a halite body and a sylvite body in Middle Asia. The size fractions >0.01 mm from the pre-Caspian rocks contain quartz, chalcedony, chlorite, biotite, oxylepidomelane [= ferrian biotite], zircon, garnet, sphene [= titanite], anhydrite, kieserite, langbeinite, and various borates, as well as minerals of the hydrotalcite-manasseite group; the <0.01-mm fraction contains "hydrated talc" (kerolite) [= talc], serpentinite, and disordered chlorite-swelling chlorite. Associated minerals in the Middle Asia salt bodies are authigenic quartz, chalcedony, anhydrite, and magnesite; the finest size fractions also contain Mg-rich chlorite and authigenic illite.

The minerals form pyramidal-prismatic crystals visible under the scanning electron microscope; crystals from lowest density fractions (1.83–2.09 g/cm³) display chiefly hexagonal or dihexagonal prismatic forms, whereas pyramidal-prismatic forms are more common in denser fractions. The trigonal-prism form is rare. Platy crystals cleave readily. Optically positive ($\epsilon \parallel c$), negative elongation. Refractive indices $\epsilon = 1.532$ – 1.528 , $\omega = 1.520$ – 1.513 on the pre-Caspian sample (mineral unspecified); $\epsilon = 1.546(2)$, $\omega = 1.534(2)$ on the 11-Å phase still enclosed in halite from Middle Asia, decreasing to $\epsilon = 1.508$ – 1.505 and $\omega = 1.489$ – 1.488 after dissolution of halite.

7.56-Å CO_3 -hydrotalcite-manasseite-2H

Chemical analyses of the $2.15 \leq D \leq 2.16$ and $2.14 \leq D \leq 2.15$ fractions (where $D =$ density in g/cm³) of the sample from the pre-Caspian are respectively, SiO_2 4.37,

3.12, TiO_2 0.20, 0.20, Al_2O_3 20.27, 21.28, Fe_2O_3 0.19, n.d. (not detected), FeO , P_2O_5 , CaO , MnO , n.d., MgO 31.38, 31.77, Na_2O 0.08, 0.08, K_2O 0.21, 0.12, H_2O^+ 32.13, 31.41, H_2O^- 0.84, 1.77, C n.d., 0.06, CO_2 , 7.08, 7.08, SO_3 1.84, 3.16, sums 98.59, 100.05 wt%, leading to a formula $[\text{Mg}_{3.95}\text{Al}_{2.05}(\text{OH})_{12}][(\text{CO}_3)_{0.91}(\text{SO}_4)_{0.12} \cdot 3\text{H}_2\text{O}]$. The SO_4 is probably contained in admixed 16.5- and 18.5-Å phases, and SiO_2 is probably from admixed quartz noted in the X-ray powder pattern. The X-ray powder data yield $a = 3.042$, $c = 15.12$ Å (hexagonal). Oriented samples yield prominent (00 l) (l even) lines of 7.56, 3.78 Å, etc. (17 lines up to (1.0.10) are given from an unoriented sample). For a layer thickness ($c' = c$) of 7.56 Å (observed range of c' is 7.56 to 7.61 Å), $D_{\text{calc}} = 2.147$ g/cm³, in accord with the $D_{\text{meas}} = 2.17$ – 2.18 g/cm³ of the fraction lacking detectable amounts of the 16.5-Å and 18.5-Å phases.

The name is based on a nomenclature for the hydrotalcite-manasseite group of minerals proposed in this paper. In this case, 7.56 Å refers to the interlayer spacing, CO_3 to the dominant anion accompanying H_2O molecules in the interlayers, hydrotalcite to the composition of the brucite layer (here Mg-Al), and 2H to the polytype.

8.85-Å SO_4 -hydrotalcite

No chemical analysis is given. The dominant series of d values in the least dense fractions (1.98–2.04 g/cm³) of the sample from the pre-Caspian, namely 8.85, 4.42 Å, etc., are attributed to a SO_4 -containing member of the hydrotalcite group. For a mineral of composition $[\text{Mg}_3\text{Al}_2(\text{OH})_{12}][(\text{SO}_4) \cdot 3\text{H}_2\text{O}]$, the calculated and observed XRD intensities correspond satisfactorily, and $D_{\text{calc}} = 1.962$ g/cm³, which is less than the observed densities because the mineral is overgrown with quartz.

The mineral is compared to the SO_4 -hydrotalcite reported by Lisitzina and Drits (*Litologiya Poleznykh Iskopyemykh*, 6, 20–39, 1985).

11-Å SO_4 -hydrotalcite-1H

Chemical analysis of the $2.10 \leq D \leq 2.12$ g/cm³ fraction of the residue from halite from Middle Asia gave SiO_2 3.03, TiO_2 0.09, Al_2O_3 15.71, Fe_2O_3 0.71, FeO , MnO n.d., CaO 0.08, MgO 24.61, P_2O_5 0.08, Na_2O 2.70, K_2O 0.11, CO_2 n.d., SO_3 15.86, H_2O^+ and H_2O^- 37.02 (by difference from 100 wt%), corresponding to a formula $[\text{Mg}_{3.96}\text{Fe}_{0.06}^{3+}\text{Al}_{1.98}(\text{OH})_{12}][(\text{SO}_4)_{1.02} \cdot 7.3\text{H}_2\text{O}]$ admixed with 3.03 wt% quartz and 6.10 wt% Na_2SO_4 . An alternative structural model, for which the calculated number of H_2O molecules per unit cell agrees better with the chemical analysis, is based on the assumption that the Na cations are present in the interlayers: $[\text{Mg}_{3.96}\text{Fe}_{0.06}^{3+}\text{Al}_{1.98}(\text{OH})_{12}][\text{Na}_{0.56}(\text{SO}_4)_{1.30} \cdot 7.3\text{H}_2\text{O}]$, cf. wermlandite. The X-ray powder data yield $a = 5.293$, $c = 11.16$ Å (hexagonal). Oriented samples yield prominent 00 l lines at 11.16, 5.58, and 3.72 Å, and d_{001} varies from 10.8–11.16 Å (a total of 22 lines up to 117 is given for the unoriented sample). For $c = 11.16$ Å, $D_{\text{calc}} = 1.90$ g/cm³, less than the observed range of $D_{\text{meas}} = 2.10$ – 2.12 g/cm³ because of quartz overgrowths.

The name is based on the nomenclature for the hydrotalcite-manasseite group of minerals proposed in this pa-

per. In this case, 11 Å refers to the interlayer spacing, SO₄ to the dominant anion accompanying H₂O molecules in the interlayers, hydrotalcite to the composition of the brucite layer (here Mg-Al), and 1H to the polytype.

16.5-Å mixed-layer CO₃-SO₄-hydrotalcite

Chemical analyses of the 16.5-Å phase (mixed with the 8.85- and 11.16-Å phases) in the 2.09 ≤ *D* ≤ 2.11 and 2.11 ≤ *D* ≤ 2.13 fractions from the residue in the Middle Asia sylvite are, respectively, SiO₂ 3.61, 4.07, TiO₂ 0.05, 0.05, Al₂O₃ 19.16, 18.95, Fe₂O₃ 1.04, 1.01, FeO n.d., MnO n.d., 0.01, CaO n.d., 0.03, MgO 30.16, 30.12, P₂O₅ 0.10, 0.18, Na₂O 0.36, 0.34, K₂O n.d., 0.56, CO₂ 2.84, 2.49, SO₃ 10.43, 10.49, H₂O⁺ and H₂O⁻ 32.35, 31.70 (by difference from 100 wt%), from which a formula is calculated to be [Mg_{3.96}Al_{1.97}Fe_{0.07}³⁺(OH)₁₂][(SO₄)_{0.68}(CO₃)_{0.34}·3H₂O]. X-ray patterns of oriented samples yield 7 00l reflections. For an ordered mixed-layer structure consisting of 7.56-Å CO₃-bearing layers and 8.94-Å SO₄-bearing layers, *D*_{calc} = 2.06 g/cm³, somewhat less than *D*_{meas} = 2.09–2.13 g/cm³ because the mineral is overgrown by quartz. The mineral occurs in the clay of the pre-Caspian deposits as well as in the sylvite body of Middle Asia.

18.5-Å mixed-layer CO₃-SO₄-hydrotalcite-3R

A complete chemical analysis was not done. Partial analyses of the low-density fractions (1.98–2.11 g/cm³) of the pre-Caspian clay in which this mineral occurs mixed with related phases, in particular for the 2.11–2.13 g/cm³ fraction, gave CO₂ 5.74 and SO₃ 4.63 wt%; for the 2.09–2.11 g/cm³ fraction, CO₂ 5.19 and SO₃ 5.70 wt%. These results, together with X-ray diffraction data, suggest two possible models for an ordered mixed-layer structure with an 18.5-Å spacing and consisting of alternating 7.56-Å and 10.84-Å layers. The corresponding formulas are [Mg₄Al₂(OH)₁₂][(CO₃)_{0.5}(SO₄)_{0.5}·6.5H₂O] and [Mg₄Al₂(OH)₁₂][(CO₃)_{0.5}(SO₄)_{0.64}Na_{0.28}·4.5H₂O]. *D*_{calc} = 1.99 g/cm³ for the second model, less than *D*_{meas} = 2.09–2.13 g/cm³, which is higher because the mineral is overgrown by quartz. X-ray diffraction data for an unoriented sample yield *a* = 3.046, *c* = 55.62 Å. This pattern has 21 lines (up to 119). Oriented X-ray patterns have 00l reflections at 18.5–18.4, 9.25–9.20, 6.17–6.15 Å, etc.

Discussion

7.56-Å CO₃-hydrotalcite-2H differs from an earlier-described hydrotalcite (7.6-Å CO₃-hydrotalcite-3R in the proposed nomenclature) in polytype, from an earlier-described manasseite (7.8-Å CO₃-hydrotalcite-2H) in interlayer spacing, and from both in content of molecular water. The proposed system of nomenclature and new names have not been approved and should not have been published. E.S.G.

Ulrichite*

W.D. Birch, W.G. Mumme, E.R. Segnit (1988) Ulrichite—A new copper calcium uranium phosphate from Lake Boga, Victoria, Australia. *Australian Mineral.*, 3, 125–134.

Electron-microprobe analysis gave CaO 9.23, CuO 11.02, UO₃ 46.36, P₂O₅ 22.09, H₂O (by CHN analyzer) 9.9, sum 98.60 wt%, corresponding to Ca_{1.09}Cu_{0.92}U_{1.07}P_{2.06}H_{7.3}O_{14.00}, ideally CaCu(UO₂)(PO₄)₂·4H₂O. The mineral occurs typically as radiating sprays of apple-green to lime-green acicular crystals up to 1 mm long and 0.05 mm thick, also as flat prisms, some twinned on {100} and with complex pyramidal terminations. Translucent to transparent, vitreous luster, white streak, *H* = 3.5, no cleavage, nonfluorescent, readily soluble in dilute HCl and HNO₃. Optically biaxial, negative(?), *α* = 1.622(2), *γ* = 1.634(2), length slow, nonpleochroic. X-ray crystal-structure study showed the mineral to monoclinic, space group *C2/m*; cell dimensions refined from a Gandofi pattern gave *a* = 12.79(3), *b* = 6.85(2), *c* = 13.02(3) Å, *β* = 91.03(7)°. *D*_{calc} = 3.71 g/cm³ with *Z* = 4. Strongest lines of the X-ray powder pattern are 6.389(100)(002,200), 5.602(14)(201), 4.498(15)(202,112), 3.480(14)(311), 3.193(45)(312,400), 2.879(20)(204), and 2.373(15)(024,511).

The new name is for George Henry Frederick Ulrich (1830–1900) in recognition of his contribution to the description of the minerals of Victoria. The new mineral occurs with turquoise and chalcociderite in miarolitic cavities in pegmatoidal granite in a granite quarry 10 km south of the township of Lake Boga in northwestern Victoria, Australia. Other associated minerals are fluorapatite, libethenite, cyrilovite, torbernite, saleeite, and an unidentified iron phosphate. Type material is in the Mineralogy Department, Museum of Victoria, Australia. J.L.J.

Zabuyelite*

Mianping Zheng, Wengao Liu (1987) A new Li mineral—Zabuyelite. *Acta Mineralogica Sinica*, 7, 221–226 (in Chinese, English abstract).

Wet-chemical analysis gave Li₂O 34.20, Na₂O 2.49, K₂O 0.75, MgO 1.81, CaO 1.24, Fe₂O₃ 0.88, MnO 0.017, CO₂ 52.70, H₂O⁺ 1.88, Cl 1.09, SO₃ 0.57, B₂O₃ 0.10, NO₃ 0.44, insol. 1.89, sum 100.057 wt%. Inclusions of gaylussite [Na₂Ca(CO₃)₂·5H₂O] and northupite [Na₃Mg(CO₃)₂Cl] were evident and probably account for the presence of Na, Ca, and Cl; the analytical results are considered to correspond to those for Li₂CO₃, the theoretical contents of which are Li₂O 40.44, CO₂ 59.56 wt%. The mineral occurs as crystals 1.5 to 20 μm long embedded in halite in rock-salt layers, and as doubly terminated crystals in precipitates on the periphery of a Li-rich salt lake at Nagri, Tibet. Crystal terminations are pyramids on prismatic crystals typically 0.1 to 0.5 mm long, 0.03 to 0.15 mm wide, and 0.02 to 0.5 mm thick; crystals up to 1.2 mm long have been observed. Colorless, transparent, vitreous luster, cleavages perfect {100} and moderate {011}, *H* = 3, brittle, twinned (100), slightly soluble in water, reacts vigorously with dilute HCl, nonfluorescent, *D*_{meas} = 2.09(1) by suspension, *D*_{calc} = 2.096 g/cm³ for the theoretical formula, and *Z* = 4. Optically biaxial negative, *α* = 1.4285(10), *β* = 1.5672(10), *γ* = 1.5743(10), 2*V* = 25°, *Y* = *b*, *Z* ∩ *c* = 10°. Monoclinic cell dimensions calculated from the X-ray powder pattern are *a* = 8.356, *b* = 4.964, *c* = 6.185

\tilde{A} , $\beta = 114.6^\circ$, space group $C2/c$ (by analogy with data for synthetic Li_2CO_3). Strongest lines of the powder pattern (57.3-mm Gandolfi camera, Cu radiation) are 4.15(80) (110), 2.92(80)(202), 2.811(100)(002), 2.481(40B)(020), and 2.42(40)(311) [indices from PDF 22-1141].

The mineral is named for the type locality, the Zabuye Salt Lake, Nagri, Tibet. Type material is in the Geology Museum, Beijing, China. **J.L.J.**

Zhanghengite*

Kuiren Wang (1986) Zhanghengite—A new mineral. *Acta Mineralogica Sinica*, 6, 220–223 (in Chinese, English abstract).

Six electron-microprobe analyses using metals as standards gave a range of Cu 50.46–53.68, Zn 45.83–49.32, Cr 0.00–0.25, Fe 0.11–0.16, Al 0.04–0.06, Ni 0.00–0.01, sums 99.98–99.99 wt%; the average corresponds to $\text{Cu}_{1.056}\text{Zn}_{0.935}\text{Fe}_{0.003}\text{Al}_{0.003}\text{Cr}_{0.003}$. The mineral occurs as granular, irregular grains and also as tabular, dendritic; grain size is 0.13×0.15 to 0.1×0.35 mm. Golden yellow color, bronze streak, metallic luster, no cleavage, $\text{VHN}_{10} = 140$ –150, $D_{\text{calc}} = 8.32 \text{ g/cm}^3$ with $Z = 1$; fresh surfaces darken readily in air. Bright yellow in reflected light, isotropic, no internal reflection; reflectance percentages (WTiC standard) are 405, 57.7; 437, 50.8; 480, 43.9; 549, 81.1; 591, 90.0; 645, 93.7. The X-ray powder pattern (57.3-mm camera, unfiltered Fe radiation) has only four $K\alpha$ lines: 2.089(100)(101), 1.470(50)(200), 1.201(80)(112), and 1.044 Å (60)(202). On the basis of these four lines, which were indexed on a cubic cell using the Bunn method, the space group is considered to be $Im\bar{3}m$, $a = 2.952(2)$ Å, with Cu and Zn disordered in the structure. A phase of equivalent composition is known in the system Cu–Zn.

The new mineral occurs in the matrix of a meteorite that fell on Boxian County, Anhui Province, China, on October 20, 1977. Associated minerals are olivine, orthopyroxene, clinopyroxene, plagioclase, orthoclase, whitlockite, quartz, biotite, dolomite, calcite, corundum, troilite, kamacite, taenite, chromite, ilmenite, magnesioferrite, pentlandite, graphite, wüstite, and copper. The new name is for Zhang Heng, a famous astronomer in ancient China.

Discussion. A repository for type material is not given. The authors consider zhanghengite to be distinct from synthetic CuZn with space group $Pm\bar{3}m$ (PDF 2–1231). **J.L.J.**

Zimbabweite*

E.E. Foord, J.E. Taggart, Jr., R.V. Gaines, P.L. Grubb, R. Kristiansen (1986) Zimbabweite, a new alkali-lead-arsenic tantalate from St Anns mine, Karoi District, Zimbabwe. *Bull. Minéral.*, 109, 331–336.

Composite wet-chemical, spectrographic and electron-microprobe analyses gave Ta_2O_5 46.5, As_2O_3 26.5, PbO 15.0, Nb_2O_5 4.8, Na_2O 3.1, K_2O 1.5, TiO_2 1.4, BaO 0.4, SrO 0.02, UO_2 0.3, Bi_2O_3 0.2, H_2O^+ 0.13, H_2O^- 0.06, SnO₂

0.1, F 0.04, less O = F 0.2, sum 100.03 wt%, corresponding to $(\text{Na}_{1.51}\text{K}_{0.48}\text{Ba}_{0.04})_{\Sigma 2.03}\text{Pb}_{1.01}(\text{As}_{4.03}\text{Bi}_{0.01})_{\Sigma 4.04}(\text{Ta}_{3.17}\text{Nb}_{0.55}\text{Ti}_{0.26}\text{U}_{0.02}\text{Sn}_{0.01})_{\Sigma 4.01}\text{O}_{18}$, simplified as $(\text{Na},\text{K})_2\text{PbAs}_4(\text{Ta},\text{Nb},\text{Ti})_4\text{O}_8$. The mineral occurs as honey yellow–brown euhedral to subhedral crystals, up to $1 \times 1 \times 2$ cm, showing {010}, {201}, and less prominent {100} and {111}. White streak, adamantine luster, brittle fracture, $H = 5$, perfect {010} cleavage, nonmagnetic, nonfluorescent in ultraviolet light, insoluble in common acids or bases, $D_{\text{meas}} = 6.20(3)$ by Berman balance, $D_{\text{calc}} = 6.16 \text{ g/cm}^3$ for the analytical formula, and $Z = 4$. Optically biaxial positive, refractive indices > 2.10 , $2V_Z = 80(4)^\circ$, strong dispersion $r < v$, $Z = a$, $Y = b$, $X = c$, moderately pleochroic with $X =$ pale yellow-brown, $Y =$ light reddish-brown, $Z =$ reddish-brown. TGA in air shows a loss of 22.5 wt% beginning at 840 °C and ending at about 900 °C due to loss of As_2O_5 . Single-crystal X-ray study showed the mineral to be orthorhombic, space group $Ccma$ or $Cc2a$, $a = 12.233(2)$, $b = 15.292(2)$, $c = 8.665(2)$ Å, and with a strong pseudocell of $a' = 1/4a$, $b' = 1/4b$. Strongest lines of the powder pattern (diffractometer, $\text{CuK}\alpha_1$ radiation) are 3.823 (55)(040), 3.242(45)(240), 3.195(100)(222,132), 3.033(60)(241), 2.990(70)(331), 2.882(70)(401), 2.548(50)(060), and 1.913(50)(080).

The mineral, which is named for the country of origin, occurs in the hydrothermally kaolinitized zone of a Precambrian granitic pegmatite, and in dumps at St Anns mine, Karoi District, Zimbabwe.

Discussion. No repository for type material is given. A subsequent crystal-structure determination (*Am. Mineral.*, 73, 1186–1190, 1988) gave $a = 12.245(2)$, $b = 15.287(4)$, $c = 8.684(1)$ Å, space group $Ccmb$, and $D_{\text{calc}} = 5.97 \text{ g/cm}^3$ for the formula $\text{Na}(\text{PbNa}_{0.5}\text{K}_{0.5})\text{As}_4(\text{Ta}_{3.17}\text{Nb}_{0.5}\text{Ti}_{0.5})\text{O}_{18}$. **J.L.J.**

Zincvoltaite*

Wanmao Li, Guoying Chen, Shurong Sun (1987) Zincvoltaite—A new sulfate mineral. *Acta Mineralogica Sinica*, 7, 307–312 (in Chinese, English abstract).

Wet-chemical analysis gave K_2O 4.11, CaO 0.69, ZnO 14.61, FeO 3.20, MnO 1.20, Fe_2O_3 11.21, Al_2O_3 2.50, SO_3 46.93, H_2O 15.69, sum 100.14 wt%, corresponding to $(\text{K}_{1.79}\text{Ca}_{0.25})_{\Sigma 2.04}(\text{Zn}_{3.69}\text{Fe}_{0.91}^{2+}\text{Mn}_{0.35})_{\Sigma 4.95}\text{Fe}_{2.89}^{3+}\text{Al}_{1.01}(\text{SO}_4)_{12.06} \cdot 17.92\text{H}_2\text{O}$, ideally $\text{K}_2\text{Zn}_3\text{Fe}_3^+\text{Al}(\text{SO}_4)_{12} \cdot 18\text{H}_2\text{O}$. The mineral occurs as single grains, typically 1 to 2 mm in size, and as granular aggregates scattered in secondary quartz aggregates; also as irregular veinlets in pyrite. Color green-black to oil-green, streak grayish-green, luster pitchy to resinous, vitreous on crystal surfaces, transparent to translucent, brittle, no cleavage, conchoidal fracture, hardness about 3, $D_{\text{meas}} = 2.756$ (by pycnometer), $D_{\text{calc}} = 2.767 \text{ g/cm}^3$ with $Z = 16$ and the chemical formula. Slowly soluble in water, readily soluble in HCl. Decomposes slowly in air. Crystals have the forms {111}, {100}, {110}, and {211}; octahedra, cubes, and combinations of these are common. Optically yellowish-green, isotropic, sometimes anomalously uniaxial, $n = 1.605(3)$ in Na light. Single-crystal

X-ray study indicated cubic symmetry, space group $Fd\bar{3}c$, $a = 27.180(1)$ Å from refinement of powder data. Strongest lines of the powder pattern (diffractometer, Co radiation, 76 lines listed) are 5.53(48)(422), 4.24(28)(620), 3.54(67)(731), 3.39(100)(800), 3.13(39)(751), 3.03(28)(840), and 2.84(32)(931).

The mineral, which is the zinc analogue of voltaite, occurs in the oxidation zone of a sphalerite-galena-pyrite deposit in an arid climate at Xitieshan, Qinghai Province, China. Associated sulfate minerals are r merite, melanterite, and gypsum. Type material is at the Geology Department, Lanzhou University, and at the Geological Museum of the Ministry of Geology, Beijing. J.L.J.

Unnamed phosphate

H.D. Gay, R. Lira (1987) Fluellite of Cerro Blanco, Tanti, Cordoba. *Revista Asoc. Argentina Mineral. Petrol. Sedimentol.*, 18, 27–32 (in Spanish, English abstract).

With fluellite and secondary phosphates derived principally from triplite are phosphosiderite, strengite, bermanite, torbernite, and an unidentified mineral proposed to be new and to have the formula $KTi(Mn,Fe,Mg)Fe_2(PO_4)_4(OH)_3 \cdot nH_2O$. It is suggested that the mineral may be isomorphous with paulkerrite. No analyses or other data are given. J.L.J.

Unnamed layered titanosilicate

Ye.V. Sokolova, Yu.K. Yegorov-Tismenko, A.P. Khomyakov (1987) The crystal structure of $Na_7Ca_3Mg(Ti, Mn)_4[Si_2O_7]_2[PO_4]_6O_2F_6$ —A new representative of the family of layered titanosilicates. *Doklady Akad. Nauk SSSR*, 294(2), 357–362 (in Russian).

Electron-microprobe analysis gave the empirical formula $Na_{16.09}Ca_{2.67}Mn_{1.42}Mg_{0.58}Ti_{2.71}Nb_{0.37}Zr_{0.25}Si_{4.00}P_{5.93}F_{1.5}O_{42}$ (only the formula is given). X-ray study showed the mineral to be triclinic, space group $P\bar{1}$, $a = 5.412(2)$, $b = 7.079(3)$, $c = 26.56(1)$ Å, $\alpha = 95.21(4)$, $\beta = 93.51(4)$, $\gamma = 90.10(3)^\circ$, $V = 1011.4$ Å³, $Z = 1$. $D_{meas} = 3.1$, $D_{calc} = 3.0$ g/cm³ for the formula calculated from the crystal-structure refinement ($Na_{17.04}Ca_{2.96}Mg_{0.64}Mn_{1.01}Ti_{2.69}Zr_{0.25}Nb_{0.36}Si_4P_6O_{40}F_6$). The mineral, referred to as mineral X5, is one member of a series that consists of a lomonosovite block (idealized formula $Na_2(Ti, Mn)_2F_2[NaTiO(Si_2O_7)]_2(Na_2MnPO_4 \cdot Na_2MgPO_4)$) alternating with a doubled sulfohalite block ($Na_9Ca_3[PO_4]_4F_4$). Another of this series is mineral T (see abstract following). Mineral X5 was discovered by A. P. Khomyakov in the ultra-alkaline rocks of the Lovozero massif, Kola Peninsula, USSR. The paper is largely a discussion of the mineral's crystal structure and the relation of the mineral to other members of layered titanosilicates. No other properties are given.

Discussion. The empirical formula does not balance with respect to charge (84.77 positive, 85.5 negative) and differs considerably in F content from the structural formula for which charge balance (85.82 positive, 86 nega-

tive) is better. The microprobe F value could be too low. E.S.G.

Unnamed layered titanosilicate

Ye.F. Sokolova, Yu.K. Yegorov-Tismenko, A.P. Khomyakov (1987) Features of the crystal structure of $Na_{14}CaMgTi_4[Si_2O_7]_2[PO_4]_4O_4F_2$ —A homologue of the structural types lomonosovite and sulfohalite. *Mineral. Zhurnal* 9(3), 28–35 (in Russian).

Electron-microprobe analysis gave the empirical formula $Na_{12.66}Ca_{1.42}Mg_{0.39}Ti_{2.44}Mn_{0.86}Zr_{0.46}Nb_{0.42}Si_{4.02}P_{3.84}O_{33}F_1$ (only the formula is given). X-ray study showed the mineral to be triclinic, space group $P\bar{1}$, $a = 5.415(2)$, $b = 7.081(3)$, $c = 20.34(1)$ Å, $\alpha = 86.85(4)$, $\beta = 94.40(4)$, $\gamma = 89.94(3)^\circ$, $V = 776.4(6)$ Å³, $D_{meas} = 3.1$ g/cm³, $Z = 1$. The crystal-structure refinement gave $Na_{12.41}Ca_{2.09}Mg_{0.5}Ti_{2.4}Mn_{0.8}Zr_{0.4}Nb_{0.4}Si_{4.0}P_{3.74}O_{32.5}F_2$. The mineral, referred to as mineral T, can be regarded as one member of a series. It consists of a lomonosovite block (idealized formula $Na_2Ti_2O_2[NaTiO(Si_2O_7)]_2(Na_3PO_4 \cdot Na_2MgPO_4)$) alternating with a sulfohalite block ($Na_9Ca[PO_4]_2F_2$). Another mineral in this series is mineral X5 (see preceding abstract). Mineral T was discovered by A. P. Khomyakov in the ultra-alkaline rocks of the Lovozero massif, Kola Peninsula, USSR. The paper is largely a discussion of the mineral's crystal structure and the relation of the mineral to other members of layered titanosilicates. No other properties are given. E.S.G.

New Data

Kulanite

Yeuqing Yang, Yunxiang Ni, Yongquan Guo, Yaping Zhang, Jiapin Liu (1986) First discovery of kulanite in China. *Yanshi Kuangwuxue Zashi*, 5(2), 119–127 (in Chinese, English abstract).

Kulanite occurs abundantly disseminated and as veinlets in a granitic pegmatite containing montebasite and other phosphates at Xiyuantou, Fujian Province, China. The chemical composition (wet-chemical and microprobe analyses) and the optical and physical properties are in good agreement with those for type kulanite. Single-crystal X-ray study gave monoclinic symmetry, space group $P2_1$, or $P2_1/m$, $a = 9.024(1)$, $b = 12.079(4)$, $c = 4.924(1)$ Å, $\beta = 100.462^\circ$.

Discussion. Kulanite is a member of the bjarebyite group in which bjarebyite (crystal structure described in *Am. Mineral.*, 59, 567–572, 1974) and perloffite are reported to be monoclinic, whereas kulanite and penikisite are considered to be triclinic. All of the members have similar cell parameters, but kulanite (*Can. Mineral.*, 14, 127–131, 1976) and penikisite (*Can. Mineral.*, 15, 393–395, 1977) were concluded to be only pseudo-monoclinic: although the single-crystal X-ray studies showed monoclinic symmetry, asymmetrical dispersion of the optic axes indicated triclinic symmetry. For kulanite from China the optical

dispersion is reported, but symmetry or asymmetry is not, and the authors opine that the space group determined by X-rays is more fundamental than optics in assigning the correct symmetry. **J.L.J.**

Wölsendorfite group

L.N. Belova, B.I. Ryzhov, O.V. Fedorov, G.V. Lyubomilova (1985) Typomorphism and isomorphism of the wölsendorfite group of uranium hydroxides. *Izvestiya Akad. Nauk SSSR, Ser. Geol.*, 2, 65–72 (in Russian).

Eight new chemical and four new microprobe analyses are reported for the wölsendorfite group, including wölsendorfite, calciouranoite (and the variety K-Sr calciouranoite), metacalciouranoite, and bauranoite. Ranges of some elements (exclusive of analyses extensively contaminated by silica, i.e., <4.20 wt% SiO₂) are UO₃ 52.41–74.53, CaO 1.91–6.46, PbO 0.94–27.33, BaO 0–13.68, K₂O 0–1.93, Na₂O 0.0–1.05, SrO 0–2.15, H₂O 6.98–9.26. In also considering 13 published analyses of these minerals (total 25), the ratios of U to other cations were found to range from 1.5 to 2.3, lower in bauranoite and closest to the ideal value 2 in calciouranoite. A plot of the compositions in terms of the three major cations shows nearly complete solid solution between Ca and Pb, but only a few com-

positions between Ca and Ba suggest possible solid solution. Only one composition is significantly along the join Ba-Pb, and two suggest only limited ternary isomorphism.

New X-ray powder data are presented for one wölsendorfite and one calciouranoite (considerable admixed quartz). Major lines (in Å) in the wölsendorfite pattern (22 given) are 7.707(30, broad), 7.029(30, broad), 3.400(70, broad), 3.088(100), 1.991(40), 1.906(40, broad), 1.723(30, broad); for calciouranoite major lines (12 given) are 3.435(20), 1.616(90), 1.2384(50), and 1.2369(50).

The four minerals form very fine grained to cryptocrystalline pseudomorphs of pitchblende in the oxidation zones of uranium mineralization in Mesozoic rocks of the USSR. Calciouranoite is the most widespread, whereas wölsendorfite is restricted to galena-pitchblende ores and bauranoite to ore associated with barite and fluorite mineralization. A later generation of calciouranoite forms aggregates with calcite and uranophane precipitated by percolating solutions.

Discussion. The X-ray patterns show considerable variation, and nonindexable diffraction lines (compare PDF 12–159) appear both here and in some of the patterns in the literature. In view of the large range of reported ratios of U to other cations, further study is needed to verify group status for these minerals. **E.S.G.**