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New Mineral Names*

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$(Be,\square)(V,Ti)_3O_6$

G. Raade, T. Balić-Žunić (2006) The crystal structure of $(Be,\square)(V,Ti)_3O_6$, a mineral related to kyzylkumite. Can. Mineral., 44, 1147–1158.

The unnamed mineral that was investigated is found at the Byrud emerald mine, in Eidsvoll, Akershus, southern Norway. The mineralization is associated with syenitic pegmatites that transect Cambrian black shales and Permian trachytic dikes. The mineral occurs as inclusions in feldspar and quartz with Ta- and Nb-rich rutile, as well as V-rich rutile. The crystals are prismatic, needle- or lath-shaped, up to 1 mm in length and are commonly striated as a result of polysynthetic twinning. The mean of six electron microprobe analyses gave BeO (calc for 1 Be pfu) 9.92, Al_2O_3 1.44, V_2O_3 37.86, Cr_2O_3 8.79, Fe_2O_3 2.66, TiO_2 38.36, sum 99.03 wt%, corresponding (on the basis of 6 O) to: $Be(V_{1.27}Ti_{1.21}Cr_{0.29}Fe_{0.08}Al_{0.07})_{\Sigma 2.92}O_6$. The presence of substantial Be and minor Li was verified but not quantified by analysis with an ion microprobe (SIMS). If the content of Be is reduced to 0.84 pfu, in accord with the results of the structure refinement, than the content of BeO is 8.04 and the sum is 97.15 wt%, with the empirical formula $(Be_{0.84}\square_{0.16})(V_{1.32}Ti_{1.25}Cr_{0.30}Fe_{0.09}Al_{0.07})_{\Sigma 3.03}O_6$, ideally $Be(V_2Ti)O_6$.

Single-crystal X-ray study ($R1 = 0.045$) of a twinned crystal, twin plane {210}, revealed the mineral to be orthorhombic, space group *Pnma*, $a = 9.982(1)$, $b = 8.502(1)$, $c = 4.5480(6)$ Å, $V = 385.97(9)$ Å^3, $Z = 4$, $D_{calc} = 4.38$ g/cm^3, and to be isostructural with norbergite, $Mg_3SiO_4F_2$. The structure refinement revealed the Be site to be partially occupied, 0.84(1), and crystal-chemical considerations suggest that V and Ti are not ordered over the two unique octahedral sites.

Powder diffraction data were collected with a Debye-Scherrer camera (9 cm diameter, Fe$K\alpha$ radiation) and yielded the strongest lines (*d* in Å, qualitative intensity) 4.15 (weak), 3.72 (medium), 2.96 (strong), 2.57 (weak), 2.48 (very weak), 2.32 (very weak), 2.17 (weak), 1.68 (strong, broad), and 1.43 (weak). Powder diffraction data were also calculated from the structure using Powder Cell 2.0 beta (Cu$K\alpha_1$ radiation), strongest lines [*d* in Å (*I*,*hkl*)] are 3.724 (69,111), 2.967 (100,121), 2.687 (19,301), 2.563 (47,311), 2.466 (31,230), 2.272 (21,321), 2.168 (31,231), 1.682 (33,402), 1.672 (72,232), 1.436 (24,630).

The authors state that the measured and calculated diffraction patterns are very similar to that of kyzylkumite, nominally $V_2Ti_3O_9$. The unit cell originally reported for kyzylkumite, $a = 33.80(5)$, $b = 4.578(5)$, $c = 19.99(3)$ Å, $\beta = 93.40(5)°$, $V = 3087.7$ Å^3, $Z = 18$, $D_{calc} = 3.77$ g/cm^3, is eight times larger than that of the mineral investigated, and is suspected to be a supercell resulting from twinning. Despite several requests, the authors have been unable to obtain holotype samples of kyzylkumite from the appropriate institutions in St. Petersburg, Russia. Material alleged to be kyzylkumite was obtained from individual and commercial sources; the results of electron- and ion-microprobe analysis yielded the empirical formula $(Be_{0.47}\square_{0.53})(Ti_{2.07}V_{0.82}Cr_{0.06}Fe_{0.04})_{\Sigma 2.99}O_6$. The authors' proposal to the IMA for a redefinition of kyzylkumite was weakened by the absence of new data on the type material and yielded divergent opinions, and is currently in abeyance (a final vote was not requested). It is the opinion of the authors that a new detailed chemical and structural investigation of type kyzylkumite is warranted. **A.J.L.**

FLUORO-MAGNESIOHASTINGSITE*

H-P. Bojar, F. Walter (2006) Fluoro-magnesiohastingsite from Dealul Uroi (Hunedoara county, Romania): Mineral data and crystal structure of a new amphibole end-member. Eur. J. Mineral. 118, 503–508.

Fluoro-magnesiohastingsite occurs as reddish-brown to yellowish idiomorphic, prismatic crystals up to 3 mm in length. The mineral is transparent in small crystals and has hematite, chondrodite, augite and fluorite inclusions in larger crystals. It has a vitreous luster, and Mohs hardness of 6. It shows a perfect {110} cleavage and is brittle. Electron microprobe analyses gave (average of 35 analyses) SiO_2 40.77, TiO_2 1.21, Al_2O_3 13.11, Fe_2O_3 6.44, MgO 18.7, CaO 13.99, Na_2O 1.79, K_2O 1.17, F 4.39, –O = F 1.84, sum 99.73 wt% corresponding to $(Na_{0.50}K_{0.22}Ca_{0.17})_{\Sigma=0.89}Ca_{2.00}(Mg_{4.03}Fe^{3+}_{0.70}Al_{0.13}Ti_{0.13})_{\Sigma=4.99}(Si_{5.89}Al_{2.11})_{\Sigma=8.00}O_{22.00}F_{2.00}$ based on 24 (O + F), ideally $(Na,K,Ca)Ca_2(Mg,Fe^{3+}Al,Ti)_5(Si,Al)_8O_{22}F_2$. The IR spectrum of the mineral has absorption bands at 1056, 950, 731, 691, 627, 515, 465, 434, and 467 cm^{-1}, no band were observed in the (OH)-streching region (3800–3600 cm^{-1}). Fluoro-magnesiohastingsite is biaxial (+), $\alpha = 1.642$, $\beta = 1.647$,

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

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γ = 1.662 , $2V_{obs}$ = 61°, no dispersion observed. It is pleochroic yellow-brown (α) to light brown (β and γ).

According to the work done with a Bruker Apex CCD diffractometer on a single crystal (0.31 × 0.05 × 0.05 mm) fluoro-magnesiohastingsite is monoclinic, *C*2/*m* with unit-cell parameters refined from powder X-ray diffraction data *a* = 9.871(1), *b* = 8.006(2), *c* = 5.314(1) Å, β = 105.37(1)°, *V* = 910.7(2) Å^3, *Z* = 2, D_{calc} = 3.18 g/cm^3. The crystal structure was refined to R_1 = 0.054 for 903 reflections with $F_o > 4\sigma(F_o)$. The strongest lines on the X-ray pwder diffraction pattern (D5000 difractometer, burker AXS, twin-Goebel mirrors, Cu*K*α radiation, 34 lines) include 9.008(27,020), 8.421(61,110), 4.502(15, 040), 3.377(44,131), 3.271(61, 240), 3.124(100, 310), 2.932(35,221), 2.805(28,330), 2.746(31,$\bar{3}$31), 2.700(54,151), 2.590(25,061), 2.557(31,$\bar{2}$02), 2.3801(12,400), 2.3445(26,$\bar{3}$51), 2.3339(23,$\bar{4}$21), 2.2969(18,$\bar{3}$21), 2.1565(25,261), 2.0409(10,202), 2.0323(11,$\bar{4}$02), 2.0114(11,351), 1.8933(15,$\bar{5}$10), 1.6458(26,461), 1.6130(22,1.11.0), 1.5864(10,600), 1.4413(23,$\bar{6}$61).

The mineral was found in small cavities in an altered hematite-rich xenolith in an abandoned trachyandesite quarry at Dealul Uroi, 10 km east of Deva, Hunedoara County, Romania. Dealul was an active volcano in the Apuseni Mountains 1.6 Ma ago. It is associated with titaniferous hematite, augite, phlogopite, enstatite, feldspar, tridymite, titanite, fluorapatite, ilmenite, and pseudobrookite. The mineral is named in based on the amphibole nomenclature scheme of the subcommittee on amphiboles of the IMA-CNMMN. The type material has been deposited at the Department of Mineralogy of the Landesmuseum Joanneum Graz (catalog no. 83854-83855). **R.R.**

GEORGBARSANOVITE*

A.P. Khomyakov, G.N. Nechelyustov, I.A. Ekimenkova, R.K. Rastsvetayeva (2005) Georgbarsanovite, $Na_{12}(Mn,Sr,REE)_3Ca_6Fe^{2+}_3Zr_3NbSi_{25}O_{76}Cl_2{\cdot}H_2O$, a mineral species of the eudialyte group: revalidation of barsanovite and the new name of the mineral. Zapiski Rossiyskogo Mineralogicheskogo Obshchestva, 134(6), 47–57 (in Russian, English abstract).

Georgbarsanovite (collected prior to 1963) came from boulders of nepheline-feldspar pegmatite in the upper reaches of the Petreliusa River valley, Khibiny alkaline massif, Kola Peninsula Russia. It and niobian eudialyte replace earlier eudialyte associated with cancrinite, albite, aegirine-augite, alkali amphibole, and biotite. Georgbarsanovite and eudialyte form irregular, multicolored aggregates to 8–10 cm, ranging from pink (earlier eudialyte) to reddish brown (niobian eudialyte) then yellow-green (georgbarsanovite). The georgbarsanovite consists of 1–2 cm thick branching veinlets in the reddish brown eudialyte, and shows both gradational and sharp contacts with this eudialyte. Georgbarsanovite is transparent to slightly translucent yellow-green with a vitreous luster and white streak. Brittle, no cleavage, uneven to conchoidal fracture, *H* 5, D_{obs} 3.05(2), D_{calc} 3.11 g/cm^3. Uniaxial (–) with anomalous biaxial character for some grains (2*V* to 10–15°), ω = 1.639(2) (bottle green), ε = 1.631(2) (pale yellow); non-fluorescent in UV light. Decomposes and gelatinizes in heated acids. Electron microprobe analysis and L.O.I. at 500 °C give the average composition Na_2O 11.03, K_2O 0.35, CaO 10.73, SrO 2.24, BaO 0.14, FeO 5.57, MnO 2.55, La_2O_3 0.87, Ce_2O_3 1.58, Nd_2O_3 0.65, Y_2O_3 0.43, ZrO_2 12.08, HfO_2 0.28, TiO_2 0.11, Nb_2O_5 3.72, SiO_2 46.03, Cl 1.20, F 0.35, H_2O 0.48, O = (F,Cl) –0.42, total 99.97 wt%. IR spectroscopy confirms the presence of (OH), H_2O, and minor CO_2. On a basis of 53 total cations (*Z* = 3), the empirical formula is $(Na_{11.73}K_{0.24})_{\Sigma 11.97}(Mn_{1.19}Sr_{0.71}REE_{0.63}Ca_{0.30}Y_{0.13}Ba_{0.03})_{\Sigma 2.99}Ca_6(Fe^{2+}_{2.55}Zr_{0.23}Ti_{0.05}Hf_{0.04})_{\Sigma 2.87}Zr_3Nb_{0.92}Si_{25.25}O_{76.48}Cl_{1.11}F_{0.61}{\cdot}0.88H_2O$, indicative of the ideal formula $Na_{12}(Mn,Sr,REE)_3Ca_6Fe^{2+}_3Zr_3NbSi_{25}O_{76}Cl_2{\cdot}H_2O$. The strongest lines in the X-ray powder diffraction pattern (DRON-3M diffractometer) are [*d* Å, (*I*%, *hkl*)]: 3.202, (100, 208), 2.975 (98, 315), 2.857 (44, 404), 3.155 (71, 217), 4.304 (62, 205), 6.42 (54, 104), 2.591 (54, 039), 3.176 (51, 306), 3.017 (51, 119). Refinement of the powder data gives *a* = 14.274(2), *c* = 30.02(1) Å, space group *R*3*m*. Single-crystal X-ray structure refinement (Ekimenkova et al. 2000, *Dokl. Ross. Akad. Nauk*, 370, 477–480) shows georgbarsanovite to be a new member of the eudialyte subgroup of the eudialyte group. It is an analog of ferrokentbrooksite with Mn dominant at *N*(4) instead of Na. The mineral was originally named "barsanovite" by Dorfman et al. (1963, *Dokl. Akad. Nauk SSSR*, 153, 1164–1167), but was discredited in 1969 due to erroneous assignment of monoclinic symmetry. However, the mineral warrants new species status vis-à-vis the recent classification scheme for eudialyte-group minerals (Johnsen et al. 2003, *Can. Mineral.*, 41, 785–794). Because the name "barsanovite" was affiliated with a species defined as monoclinic, a new name had to be chosen for this trigonal mineral; consequently, it was resurrected as "georgbarsanovite." As with barsanovite, the name honors prominent Russian mineralogist Georgiy Pavlovich Barsanov (1907–1991). The type sample resides at the A.E. Fersman Mineralogical Museum, Russian Academy of Sciences (catalog no. 61504). **T.S.E.**

MANGANIANDROSITE-(CE)*, VANADOANDROSITE-(CE)*

B. Cenki-Tok, A. Ragu, T. Armbruster, C. Chopin, O. Medenbach (2006) New Mn- and rare-earth rich epidote-group minerals in metacherts: manganiandrosite-(Ce) and vanadoandrosite-(Ce). Eur. J. Mineral., 18, 569–582.

Two new species of epidote-group minerals have been described from carbonate pods in Mn-rich metacherts.

Manganiandrosite-(Ce) was discovered in the Praborna Mn deposit, Saint-Marcel, Val d'Aosta, Italy, which belongs to the eclogitic facies ophiolitic Zermatt-Sasas Unit within the Western Alps. The deposits occur as quartz-rich lenses intercalated with quartz-phengite-almandine schist with calcschist and black metashale overlying serpentinite, metabasite, and ophicalciate bodies. Reduced boudins of Mn-carbonate-silicate assemblages are also present. The main minerals include quartz, braunite, hematite, spessartine, piemonite, locally ardennite, pyroxmangite, rhodonite, tephroite, friedelite, and humite-group minerals. The Praborna mine is the type locality for roméite, piemonite and strontiomelane. Manganiandrosite-(Ce) was collected on the dumps of the mine and occurs as elongated grains a few tens of micrometers in length associated with tephroite, Mn-pyroxenoid, hematite, and calderite, as well as isolated grains 100 μm in length associated with rhodochrosite, pyroxenoid, spessartine, calderite, hematite, and pyrophanite. Manganiandrosite-(Ce) is dark brown, has a reddish brown streak, is vitreous to adamantine, brittle, and has no discernable cleavage. It is transparent, not fluorescent under the electron beam, biaxial positive, $\alpha > 1.74$, $n_{calc} = 1.80$, strongly pleochroic with α light yellow, β orange-brown, γ red-brown, $2V_{meas} = 80.6(1.5)°$. A full optical characterization was not possible due to the strong absorption and high refractive index. Chemical analyses of manganiandrosite-(Ce) [WDS, 4 analyses, average (range)] gave SiO_2 29.04 (28.7–29.3), Al_2O_3 8.20 (7.6–8.5), TiO_2 1.26 (0.8–1.5), Fe_2O_3 2.98 (1.9–3.4), MnO 15.01 (14.0–15.8), Mn_2O_3 11.62 (11.4–12.9), MgO 0.28 (0.2–0.4), SrO 1.17 (0.4–1.7), CaO 3.82 (3.6–4.2), Ce_2O_3 12.22 (11.8–13.0), La_2O_3 6.08 (5.6–6.4), Nd_2O_3 3.24 (3.0–3.7), Sm_2O_3 0.18 (0–0.4), F 0.07 (0–0.14), H_2O_{calc} 1.45, sum 96.59 wt%. This corresponds to a structural formula, based on $Si_3O_{11}(O,F)(OH)$, of $[Mn^{2+}_{0.60}Ca_{0.40}]_{\Sigma=1.00}[(Ce_{0.46}La_{0.23}Nd_{0.12}Sm_{0.01})_{\Sigma REE\geq 0.82}Sr_{0.07}Ca_{0.02}]_{\Sigma\geq 0.91}[Mn^{3+}_{0.63}Fe^{3+}_{0.23}Ti_{0.10}Mg_{0.04}]_{\Sigma=1.00}Al_{1.00}[Mn^{2+}_{0.96}Mn^{3+}_{0.04}]_{\Sigma=1.00}Si_2O_7SiO_4O(OH)$, ideally $Mn^{2+}CeMn^{3+}AlMn^{2+}Si_2O_7SiO_4O(OH)$.

Vanadoandrosite-(Ce) was discovered in the Aure valley at the mine above the Vielle Aure village, central Pyrénées, France. These Paleozoic stratiform Mn ore deposits are known for their Mn-silicate assemblages (rhodonite, tephroite, friedelite, and spessartine). Vanadoandrosite-(Ce) occurs in millimeter-thick quartz-rhodochrosite-sulfide veins cross-cutting massive microcrystalline rhodochrosite ore, as well as in the ore itself, in millimeter-sized quartz grains rimmed by chalcopyrite. The mineral is dark brown to black, and forms isolated, stout prismatic grains (tens of micrometers in length), or as radiating aggregates. Associated minerals include quartz, vuorelainenite, rhodochrosite, chalcopyrite, vanadian spessartine, and friedelite. It has a brown streak, is vitreous to adamantine, brittle, and has no discernable cleavage. It is transparent, non-fluorescent under the electron beam, biaxial, $\alpha > 1.74$, $n_{calc} = 1.82$, strong pleochroism, yellow-brown < red-brown < dark greenish brown || *b*. The high birefringence and strong absorption did not allow for a full optical characterization. Chemical analyses [WDS, average of 8 analyses (range)] gave SiO_2 28.81 (28.8–29.5), Al_2O_3 9.65 (9.1–10.6), V_2O_3 5.30 (3.1–5.3), TiO_2 0.06 (0.03–0.07), Fe_2O_3 2.18 (1.6–3.2), MnO 17.78 (17.3–23.2), Mn_2O_3 1.75, MgO 1.22 (1.2–2.9), SrO 0 (0–0.07), CaO 2.57 (2.4–4.6), Ce_2O_3 16.14 (14.0–16.1), La_2O_3 8.29 (7.4–8.8), Nd_2O_3 0.84 (0.7–1.1), Sm_2O_3 0 (0–0.1), F 0.57 (0.6–1.5), H_2O_{calc} 1.44, sum 96.36 wt%. The structural formula of the most V-rich analysis, based on $Si_3O_{11}(O,F)(OH)$, is $[Mn^{2+}_{0.62}Ca_{0.38}]_{\Sigma=1.00}[(Ce_{0.39}La_{0.15}Nd_{0.10}Sm_{0.02})_{SREE=0.66}Ca_{0.21}Sr_{0.11}]_{\Sigma=0.98}[V^{3+}_{0.80}Al_{0.16}Mg_{0.03}Ti_{0.01}]_{\Sigma=1.00}Al_{1.00}[Mn^{2+}_{0.36}V^{3+}_{0.31}Fe^{2+}_{0.23}Fe^{3+}_{0.10}]_{\Sigma=1.00}Si_2O_7SiO_4O(OH)$, ideally $Mn^{2+}CeV^{3+}AlMn^{2+}Si_2O_7SiO_4O(OH)$.

Both new species are monoclinic, $P2_1/m$, in agreement with all other monoclinic epidote-group minerals. Unit-cell dimensions are $a = 8.901(2)$, $b = 5.738(1)$, $c = 10.068(2)$ Å, $\beta = 113.425(4)°$, $V = 471.81$ Å^3, for manganiandrosite-(Ce), and $a = 8.856(3)$, $b = 5.729(2)$, $c = 10.038(4)$, $\beta = 113.088(4)°$, $V = 468.5$ Å^3 for vanadoandrosite-(Ce,), respectively. Only calculated X-ray powder diffraction patterns are given for the two minerals (Cu*K*α radiation, Debye-Scherrer geometry, [*d*(*I*)manganiandrosite-(Ce), *d*(*I*)vanadoandrosite-(Ce), (*hkl*)]: 9.2382(8), 9.2340(25), (001); 8.1674(11), 8.1467(24), (100); 7.8639(28), 7.8159(19), $(10\bar{1})$; 5.1815(23), 5.1833(19), (101); 3.5141(41), 3.5004(43), $(21\bar{1})$; 2.9042(24), 2.8872(21), $30\bar{2})$; 2.8964(100), 2.8890(100), $(11\bar{3})$; 2.8690(35), 2.8645(41), (020); 2.7134(39), 2.7114(31), (013); 2.7069(39), 2.7023(34), (120); 2.6225(53), 2.6124(54), $(31\bar{1})$; 2.5908(28), 2.5916(26), (202); 2.1852(23), 2.1765(21), $(40\bar{1})$; 1.6217(23), 1.6142(21), $(42\bar{4})$. The structure refinements indicate that Mn occurs mainly in the divalent state in both species, and occupies both the large A1 site and the large octahedrally coordinated M3 site instead of Al or Fe^{3+}, charge-compensating the substitution of Ca by REE^{3+} in the largest A2 site. The two species are members of, and isostructural with, the androsite series, in accordance with the nomenclature scheme recently adopted for the epidote-group by the IMA (Armbruster et al. 2006, *Eur. J. Mineral.*, 18, 551–567). Type material is deposited at the Musée de Minéralogie, Ecole des Mines de Paris [reference no. 73951 ENSMP, manganiandrosite-(Ce), IMA CNMMN no. 2002-49, and 73952 ENSMP, vanadoandrosite-(Ce), IMA CNMMN no. 2004-15]. **P.C.P.**

SR-NA-REE TITANATES

A.Y. Barkov, M.E. Fleet, R.F. Martin, Y.P. Men'shikov (2006) Sr-Na-REE titanates of the crichtonite group from a fenitized megaxenolith, Khibina alkaline complex, Kola Peninsula, Russia: first occurrence and implications. Eur. J. Mineral., 18, 493–502.

Potentially new Sr-Na-REE enriched members of the crichtonite group from a fenitized megaxenolith in the Khibina alkaline complex, Kola Peninsula, Russia, have been studied by WDS electron-microprobe methods. Chemical analyses (WDS, N = 1408, n.d. = not detected) gave averages (ranges) of TiO_2 68.39 (64.66–73.28), ZrO_2 2.55 (0.74–4.71), FeO 17.53 (15.49–19.15), MnO 1.43 (0.28–2.23), MgO 0.47 (n.d.–0.78), ZnO 0.12 (n.d.–0.36), Cr_2O_3 0.52 (0.25–1.87), SrO 2.49 (n.d.–4.28), CaO 1.58 (0.90–2.53), BaO n.d. (n.d.–0.28), NiO n.d. (n.d.–1.56), V_2O_3 0.46 (0.32–0.60), Ce_2O_3 0.98 (n.d.–3.99), La_2O_3 0.80 (n.d.–0.35), Pr_2O_3 n.d. (n.d.–0.40), Y_2O_3 n.d. (Nb_2O_5 0.42 (0.12–1.06), ThO_2 0.13 (n.d.–0.99), total 98.89 wt%. These ranges correspond to atoms per formula unit (based on 38 oxygen) of Ti 14.81–15.65, Zr 0.11–0.66, Fe 3.86–4.76, Mn 0.07–0.56, Mg 0–0.34, Zn 0–0.08, Cr 0.06–0.45, Sr 0–0.75, Ca 0.29–0.80, Ni 0–0.02, Pb 0–0.04, K 0–0.11, Na 0–0.87, V 0.08–0.14, Ce 0–0.43, La 0–0.36, Nd 0–0.06, Nd 0–0.06, Sm <0.05, Pr <0.05, Nb 0–0.14, and Th 0–0.07. As a result, based on the general formula $ABC_{18}T_2O_{38}$, these potentially new crichtonite-group species can be described by one of four formulae:

1. $(Sr,Na,K,REE)(Ca,Zr,Mn)(Ti,Fe)_{18}Fe_2O_{38}$;
2. $(Sr,Na,K,REE)(Zr,Ca,Mn)(Ti,Fe)_{18}Fe_2O_{38}$;
3. $(Na,Sr,K,REE)(Ca,Zr,Mn)(Ti,Fe)_{18}Fe_2O_{38}$;
4. $(Na,Sr,K,REE)(Zr,Ca,Mn)(Ti,Fe)_{18}Fe_2O_{38}$.

Formulae 1 and 2 correspond to potentially new Ca- or Zr-dominant variants of crichtonite, whereas 3 and 4 correspond to potentially new Ca- or Zr-dominant variants of landauite.

The Sr-Na-REE titanate minerals are associated with fenitized megaxenoliths 0.2 km across, in sharp contact with syenite. Locally, these titanates are the principal oxide mineralization. They are associated with perthitic alkali feldspar, albite, nepheline, analcime, andalusite, corundum, topaz, phlogopite, quartz, rutile, ferroan freudenbergite, titanite, manganoan ilmenite, Na-rich phases related to loparite-(Ce), neighborite, monazite-(Ce), and fluorite. Sulfides include pyrrhotite, marcasite, chalcopyrite, ferroan alabandite, and an unusual wurtzite. The Na-rich composition of these potentially new crichtonite-group members are related to a high Na-activity associated with intense Na-metasomatism in the albitized area of the Khibina complex. The Cr-rich compositions (up to 1.87 wt% Cr_2O_3) of the crichtonite-phases suggests that mafic rocks are the most likely protolith for the mineralized megaxenolith and related xenolithic bodies. **P.C.P.**

NEW DATA

KIRKIITE

D. Pinto, T. Balić-Žunić, A. Garavelli, C. Garbarino, E. Makovicky, F. Vurro (2006) First occurrence of close-to-ideal kirkiite at Vulcano (Aeolian Islands, Italy): chemical data and single-crystal X-ray study. Eur. J. Mineral., 18, 393–401.

Kirkiite was originally described by Moëlo et al. (1985) from a deposit near Kirki (Greece) with a chemical composition of $Pb_{10.08}Bi_{2.55}Sb_{0.13}As_{2.91}S_{19}$. Even with the compositional differences it was described as the natural analog of synthetic $Pb_{10}Bi_3As_3S_{19.}$ The studied kirkiite is the second occurrence from the high temperature fumarole deposit of La Fossa crater, Vulcano islands, Aeolian archilepago, Italy. It forms as a mixed crust and aggregates of micro crystals covering brecciated and altered rocks. The first specimen described in 1998 gave an average composition of $Pb_{9.97}(Bi_{2.61}As_{3.35})_{\Sigma=5.96}(S_{18.65}Se_{0.42})_{\Sigma=19.07}$,whereas the newly described occurrence gave an average composition of $Pb_{10.00}Bi_{3.01}As_{3.01}(S_{18.47}Se_{0.44}Cl_{0.06})_{\Sigma=18.97}$ based on 35 atoms, which is closer to the ideal formula. The crystals were found to be homogeneous in composition. The main compositional differences between the type and the close-to-ideal kirkiite are the higher Bi content, the absence of Sb and the presence of trace Se and Cl in the later specimen.

The crystal-structure refinement of the close-to-ideal kirkiite was performed by single-crystal X-ray diffraction using Bruker AXS four-circle diffractometer equipped with CCD SMART1000 area detector, on a twinned (0.010 × 0.024 × 0.037 mm) crystal, to $R_1 = 0.074$ for 1443 reflections with $F_o > 4(F_o)$. The mineral is pseudo-hexagonal monoclinic, $P2_1/m$, $a = 8.774(3)$ Å, $b = 26.237(6)$ Å, $c = 8.774(3)$, $\beta = 119.653(4)°$, $V = 1740.2(9)$ Å^3. The c axis is shorter than for the type specimen whereas a and b are longer. These differences are related to a higher Bi/As ratio in the investigated kirkiite, based on the distortion their site occupancy causes on certain polyhedrons. In general the polyhedrons are more symmetrical and regular in the close-to-ideal kirkiite.

The mineral was associated with vurroite, galena, bismuthinite, galenobismutite, cannizzarite, lillianite, heyrovskýite, and less characterized sulfochlorides. The difference in composition of the two occurrences of kirkiite at Vulcano is due to the differences in composition of the gas phase coming from the fumaroles at the moment of crystallization. **R.R.**

ANTIMONPEARCEITE*, SE-RICH

M. Evain, L. Bindi, S. Menchetti (2006) Structure and phase transition of the Se-rich variety of antimonpearceite, $[(Ag,Cu)_6(Sb,As)_2(S,Se)_7]$-$[Ag_9Cu(S,Se)_2Se_2]$. Acta Crystallogr., B62, 768–774.

Single-crystal X-ray structure study of Se-rich antimonpearceite, $(Ag,Cu)_{16}(Sb,As)_2(S,Se)_{11}$, at 300 and 120 K ($R1 = 0.049$ for the refinement at 300 K, $R1 = 0.069$ at 120 K), indicated that at room temperature it is isotypic with pearceite: trigonal, space group $P\overline{3}m1$, with cell parameters (at 300 K) $a = 7.5950(4)$, $c = 12.0731(6)$ Å, $V = 603.12(5)$ Å^3, $Z = 1$, $D_{calc} = 6.52$ g/cm^3. The average of ten electron microprobe analyses yielded the chemical formula on the basis of 29 atoms: $[Ag_{14.67(14)}Cu_{1.20(7)}Fe_{0.03(1)}Bi_{0.01(1)}Pb_{0.01(1)}Zn_{0.01(1)}]_{\Sigma15.93}[Sb_{1.86(9)}As_{0.19(2)}]_{\Sigma2.05}[S_{8.47(98)}Se_{2.550(6)}]_{\Sigma11.02}$, in fair agreement with that derived from the structural analysis at 300 K: $(Ag_{14.59}Cu_{1.41})_{\Sigma16}(Sb_{1.66}As_{0.34})_{\Sigma2}(S_{8.34}Se_{2.66})_{\Sigma11}$. Aside from Sb vs. As content, the room temperature structure of Se-rich antimonpearceite differs from that of pearceite (cf. *American Mineralogist*, 91, 1953–1954) mainly in the ordering of Se onto certain anion sites. In contrast to pearceite, Se-rich antimonpearceite undergoes a phase transition at low temperatures to a structural variant not previously observed in the polybasite group: monoclinic, space group $P2_1/c$, $a = 13.1426(14)$, $b = 7.5879(7)$, $c = 23.729(4)$ Å, $\alpha = 90$, $\beta = 90$, $\gamma = 90°$. **A.J.L.**

BILLIETITE*

R.J. Finch, P.C. Burns, F.C. Hawthorne, R.C. Ewing (2006) Refinement of the crystal structure of billietite, $Ba[(UO_2)_6O_4(OH)_6](H_2O)_8$. Can. Mineral., 44, 1197–1205.

Single-crystal X-ray study of billietite ($R1 = 0.034$), $Ba[(UO_2)_6O_4(OH)_6](H_2O)_8$, confirmed that it is orthorhombic, space group $Pbn2_1$ (non-standard setting of space group $Pna2_1$), $a = 12.0941(8)$, $b = 30.211(2)$, $c = 7.1563(5)$ Å, $V = 2614.7(4)$ Å^3, $Z = 4$, $D_{calc} = 5.25$ g/cm^3. The crystal studied was twinned by inversion with a highly asymmetric distribution of the enantiomorphic components: twin-scale factor 6(1)%. Billietite contains two symmetrically and stereochemically distinct structural sheets of uranyl polyhedra; one sheet is identical to that found in ianthinite, whereas the other is topologically identical to that found in becquerelite. The sheets are linked by Ba cations and H_2O groups. The data resolve previous uncertainties about the structure and composition of billietite. **A.J.L.**

LÉVYCLAUDITE*

M. Evain, V. Petricek, Y. Moëlo, C. Maurel (2006) First (3+2)-dimensional superspace approach to the structure of levyclaudite-(Sb), a member of the cylindrite-type minerals. Acta Crystallogr., B62, 775–789.

Single-crystal X-ray study of an untwinned crystal of the Sb end-member of synthetic lévyclaudite ($R1 = 0.074$), $(Pb_{0.701}Sb_{0.299}S)_{\Sigma=1.357}(Sn_{0.851}Cu_{0.299}S_2)$, $Z = 2$, $D_{calc} = 5.71$ g/cm^3, has shown that it is a misfit-layer compound of the cylindrite type, with a structure that results from the combination of two heavily modulated triclinic Q and H subcells with a common **q** wavevector and only one shared reciprocal axis (stacking direction). The Q layer, ~$(Pb_{0.7}Sb_{0.3}S)$, is derived from the NaCl archetype: $a = 5.8218(6)$, $b = 5.8645(5)$, $c = 12.1443(13)$ Å, $\alpha = 92.327(7)$, $\beta = 78.533(9)$, $\gamma = 90.019(8)°$; the H layer, ~$(Sn_{0.85}Cu_{0.3}S_2)$, is derived from the CdI_2 archetype: $a = 3.6661(3)$, $b = 6.3138(5)$, $c = 11.9028(10)$ Å, $\alpha = 92.490(7)$, $\beta = 90.590(8)$, $\gamma = 89.986(8)°$. The structure was refined with a superspace approach that accounts for the modulations in the two subsystems and uses the non-standard triclinic space group $C\overline{1}$.

Discussion. As the material studied is synthetic in origin, the use of the suffix –(Sb) for the composition $(Pb_{0.701}Sb_{0.299}S)_{1.357}(Sn_{0.851}Cu_{0.299}S_2)$ is in accord with the recommendations of the IMA for chemical analogs of minerals (cf. Bayliss et al. 2005, *Canadian Mineralogist*, 43, 1429–1433). The composition of natural lévyclaudite expressed in a similar fashion is: $(Pb_{0.72}Bi_{0.22}Sb_{0.06}S)_{1.36}(Sn_{0.80}Cu_{0.35}S_2)$. **A.J.L.**

TYCHITE*

G.R. Schmidt, J. Reynard, H. Yang, R.T. Downs (2006) Tychite, $Na_6Mg_2(SO_4)(CO_3)_4$: structure analysis and Raman spectroscopic data. Acta Crystallogr., E62, i207–i209.

Single-crystal X-ray study of tychite ($R1 = 0.023$), $Na_6Mg_2(SO_4)(CO_3)_4$, confirmed that it is isotypic with ferrotychite and a member of the northupite group: cubic, space group $Fd\overline{3}$, $a = 13.9038(2)$ Å, $V = 2687.82(7)$ Å^3, $Z = 8$, $D_{calc} = 2.58$ g/cm^3. A Raman spectrum of tychite with peak assignments is also presented. **A.J.L.**