

## New Mineral Names\*†

DMITRIY I. BELAKOVSKIY<sup>1</sup>, FERNANDO CÁMARA<sup>2</sup>, AND YULIA UVAROVA<sup>3</sup><sup>1</sup>Fersman Mineralogical Museum, Russian Academy of Sciences, Leninskiy Prospekt 18 korp. 2, Moscow 119071, Russia<sup>2</sup>Dipartimento di Scienze della Terra “Ardito Desio”, Università di degli Studi di Milano, Via Mangiagalli, 34, 20133 Milano, Italy<sup>3</sup>CSIRO Mineral Resources, ARRC, 26 Dick Perry Avenue, Kensington, Western Australia 6151, Australia

## IN THIS ISSUE

This New Mineral Names has entries for 6 new minerals, including, beusite-(Ca), graftonite-(Ca), graftonite-(Mn), hyrslite, magnesioeltrandoite-2N3S, and zincovelesite-6N6S.

## BEUSITE-(Ca), GRAFTONITE-(Ca)\* AND GRAFTONITE-(Mn)\*

F.C. Hawthorne, M.A. Wise, P. Černý, Y. Abdu, N.A. Ball, A. Pieczka, and A. Włodek (2018) Beusite-(Ca), ideally  $\text{CaMn}_2^{2+}(\text{PO}_4)_2$ , a new graftonite-group mineral from the Yellowknife pegmatite field, Northwest Territories, Canada: Description and crystal structure. *Mineralogical Magazine*, 82(6), 1323–1332.

A. Pieczka, F.C. Hawthorne, N. Ball, Y. Abdu, B. Gołębiewska, A. Włodek, and J. Żukrowski (2018) Graftonite-(Mn), ideally  $^{\text{Mn}}\text{Mn}^{\text{M2,M3}}\text{Fe}_2(\text{PO}_4)_2$ , and graftonite-(Ca), ideally  $^{\text{Mn}}\text{Ca}^{\text{M2,M3}}\text{Fe}_2(\text{PO}_4)_2$ , two new minerals of the graftonite group from Poland. *Mineralogical Magazine*, 82(6), 1307–1322.

Three new monoclinic minerals of the graftonite group, earlier considered as the “grafonite–beusite series” (Hawthorne and Pieczka 2018) were recently discovered: beusite-(Ca) (IMA 2017-051) ideally  $^{\text{Mn}}\text{Ca}^{\text{M2,M3}}\text{Mn}_2(\text{PO}_4)_2$ , graftonite-(Mn) (IMA 2017-050), ideally  $^{\text{Mn}}\text{Mn}^{\text{M2,M3}}\text{Fe}_2(\text{PO}_4)_2$ , and graftonite-(Ca) (IMA 2017-048), ideally  $^{\text{Mn}}\text{Ca}^{\text{M2,M3}}\text{Fe}_2(\text{PO}_4)_2$ . All new minerals occur in beryl–columbite–phosphate subtype of zoned rare-element pegmatites. Beusite-(Ca) was found in a small dike, which cuts an interlayered sequence of amphibolite and granodiorite in the Archean Yellowknife pegmatite field, located between Upper Ross Lake and Redout Lake, 75 km northeast of Yellowknife and 3.5 km east of the Redout granite, Canada (62°44′37″N, 113°6′26″W). Beusite-(Ca) occurs in a beusite–triphylite nodule ~6 × 5 × 3 cm. Graftonite-(Mn) and graftonite-(Ca) were found in phosphate nodules of two pegmatites at Lutomia and Michałkowa villages, respectively, in the Góry Sowie gneissic block, Lower Silesia, southwest Poland. This block is a product of multistage evolution culminated ~385–370 Ma by amphibolite-facies metamorphism and migmatization at temperatures of 775–910 °C and pressures of 6.5–8.5 kbar. The origin of the pegmatites thought to be related to anatectic melts, generated by partial melting of the metasedimentary–metavolcanics sequence. Phosphate nodules reaching 5 × 3 × 3 cm are sitting in blocky feldspar zones (with massive albite, some plagioclase, muscovite, and schorl–foitite tourmaline) and contain a large number of other phosphates e.g. monazite-(Ce), xenotime-(Y), graftonite-(Mn), graftonite-(Ca), beusite-(Ca), sarcopside, triphylite partly oxidized topotactically to ferrisicklerite and heterosite, wolfeite, triploidite, stanekite, hagendorfite, ferrohagendorfite, alluaudite, fluor- and hydroxylapatite, whitlockite, kryzhanovskite, phosphoferrite, ludlamite, vivianite, fairfieldite, hureaulite, earlshannonite, whitmoreite, strunzite, ferrostrunzite, be-

raunite, dufrénite, landesite, jahnsite-(CaMnFe), -(CaMnMn), and -(MnMnMn), and occasionally also malhmoodite and zigrasite. Fergusonite-(Y), gadolinite-(Y), allanite-(Ce), ilmenite, titanite, sillimanite, uraninite, pyrite, arsenopyrite, löllingite, chalcocopyrite, Cd-wurtzite or sphalerite, chalcocite or covellite, cuprite, native copper, goethite, and unidentified Mn oxides were found as tiny inclusions in the phosphates or in the rock-forming minerals. Thus graftonite-(Mn), graftonite-(Ca), and beusite-(Ca) are common primary phosphates in phosphate nodules, occurring as lamellar intergrowths with sarcopside ± triphylite/lithiophilite, products of exsolution from a (Li,Ca)-rich graftonite-like parent phase crystallized at high temperature from P-bearing hydrosaline melts. Beusite-(Ca) forms pale-brown lamellae 0.1–1.5 mm wide, epitaxially intergrown with triphylite. Pinkish brown graftonite-(Mn) and more brownish graftonite-(Ca) occur as lamellar intergrowths up to 0.5 mm wide with triphylite or products of its topotactic oxidation. All three minerals are transparent, have a vitreous luster, a good cleavage on {010} [for beusite-(Ca) it is also observed on {100}], no parting and irregular fracture. They are brittle with a Mohs hardness of ~5 and both are non-fluorescent. The densities were not measured;  $D_{\text{calc}} = 3.610, 3.793, \text{ and } 3.592 \text{ g/cm}^3$  for beusite-(Ca), graftonite-(Mn), and graftonite-(Ca) respectively. In transmitted light the minerals are colorless, non-pleochroic. They are optically biaxial (+), with  $\alpha = 1.685(2), 1.710(2), 1.690(2)$ ,  $\beta = 1.688(2), 1.713(2), 1.692(2)$ , and  $\gamma = 1.700(5), 1.725(2), 1.710(5)$ ;  $2V_{\text{meas}} = 46.0(5), 54(2)$ , and  $40.1(6)^\circ$  ( $\lambda = 589 \text{ nm}$ ), respectively, for beusite-(Ca), graftonite-(Mn), and graftonite-(Ca). Respectively the optical orientations are:  $X \parallel \mathbf{b}$ ;  $Y \wedge \mathbf{a} = 40.3^\circ$  in  $\beta$  obtuse (the dispersion of an optical axes is  $r < v$ , weak);  $Z \wedge \mathbf{a} = 49.7^\circ$  in  $\beta$  acute;  $X \parallel \mathbf{b}$ ,  $Y \wedge \mathbf{a} = 44.2^\circ$  (in  $\beta$  obtuse),  $Z \wedge \mathbf{c} = 35.0^\circ$  (in  $\beta$  acute);  $X \parallel \mathbf{b}$ ,  $Y \wedge \mathbf{a} = 41.4^\circ$  in  $\beta$  acute and  $Z \wedge \mathbf{c} = 32.1^\circ$  in  $\beta$  acute. The Raman spectrum of beusite-(Ca)/ graftonite-(Mn)/ graftonite-(Ca), in the range 100–1200  $\text{cm}^{-1}$ , shows the peaks at ( $\text{cm}^{-1}$ ; s – strong, m – medium, w – weak, vw – very weak): 961s/ 966s/ 968s, 1008s/ –/ 1013s, 1027s/ 1025m/ 1032s, 1054w/ –/ –, 1090m/ –/ 1098m, 1104m/ 1117w / 1106m (stretching vibrations of the  $\text{PO}_4$  groups); 592vw/ 587/ 590, 562m/ 566/ –, 548w/ –/ –, 473vw/ –/ 472, 458w/ 451/ 458, 416w/ 423/ – (bending vibrations of  $\text{PO}_4$  and stretching vibrations of  $\text{CaO}_8$  and  $\text{MnO}_6$  polyhedra). The peaks 347vw, 261w, 231vw, 212w, 182vw, 160vw, 140vw, and 115vw for beusite-(Ca) as well as multiple weaker peaks below 400  $\text{cm}^{-1}$  for graftonite-(Mn) and graftonite-(Ca) are assigned to an angular deformation of the  $\text{CaO}_8$  and  $\text{MnO}_6$  polyhedra. The averages of ten WDS electron probe analyses for beusite-(Ca)/ 20 spots for graftonite-(Mn)/ 2 spots for graftonite-(Ca) [wt%, (range)] are:  $\text{P}_2\text{O}_5$  41.63 (41.00–42.10)/ 40.02 (39.62–40.46)/ 41.52 (41.36–41.68), FeO 19.43 (19.00–19.80)/ 27.31 (26.07–28.83)/ 29.13 (27.81–30.44), MnO 23.63 (23.10–25.10)/ 26.06 (25.61–26.46)/ 12.14 (11.34–12.94), MgO nd/ 0.66 (0.57–0.74)/ 0.56 (0.09–1.03), CaO 15.45 (14.30–16.10)/ 4.74 (3.74–5.97)/ 16.17 (16.05–16.28), Zn bdl/ 0.29

\* 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/>.

(0.20–0.36)/ bdl, total 100.14/99.09/99.51. The empirical formulae based on 8O pfu are: respectively  $M^{(1)}(Ca_{0.94}Mn_{0.06})^{M(2),M(3)}(Mn_{1.08}Fe_{0.92})_{23.00}P_{2.00}O_8/M^{(1)}(Mn_{0.70}Ca_{0.30})^{M(2),M(3)}(Fe_{1.34}Mn_{0.60}Mg_{0.06}Zn_{0.01})_{23.01}P_{1.99}O_8/M^{(1)}(Ca_{0.98}Mn_{0.02})^{M(2),M(3)}(Fe_{1.38}Mn_{0.56}Mg_{0.05})_{22.99}P_{2.00}O_8$ . The Mössbauer spectra show that in beusite-(Ca) 86% of  $Fe^{2+}$  occurs at the  $M(2)$  site and 14% at the  $M(3)$  site while for graffonite-(Mn) Fe is completely disordered over the  $M(2)$  and  $M(3)$  sites, which leads to the structural formula  $M^{(1)}(Mn_{0.70}Ca_{0.30})^{M(2)}(Fe_{0.67}Mn_{0.27}Mg_{0.06}Zn_{0.01})^{M(3)}(Fe_{0.67}Mn_{0.33})(PO_4)_2$ . No Mössbauer data was obtained for graffonite-(Ca). No X-ray powder data were obtained since all minerals are intimately intergrown with triphylite. The strongest lines of the calculated powder X-ray diffraction patterns on the basis of single-crystal data are [ $d$  Å ( $h$ ;  $kl$ )]: 3.564 (97; 130), 3.030 (58;  $\bar{1}02$ ), 2.991 (76; 131), 2.932 (87; 040,  $\bar{1}12$ ), 2.904, (100; 230), 2.873 (86; 221), 2.718 (86;  $\bar{3}11$ ), 2.413 (37; 311) for beusite-(Ca); 3.506 (73; 130), 3.016 (35;  $\bar{1}02$ ), 2.952 (55; 131), 2.916 (53;  $\bar{1}12$ ), 2.899 (44; 300), 2.874 (100; 230,040), 2.858 (79; 221), 2.717 (79;  $\bar{3}11$ ) for graffonite-(Mn) and 3.654 (100; 130), 3.133 (56;  $\bar{1}02$ ), 3.097 (57; 131), 3.042 (76; 040,  $\bar{1}12$ ), 3.014, (77; 230), 2.979 (85; 221), 2.834 (68;  $\bar{3}11$ ), 2.542 (30; 311) for graffonite-(Ca). The crystal structures of beusite-(Ca), graffonite-(Mn) and graffonite-(Ca) were refined to  $R_1 = 1.55, 2.34$ , and 1.63%, respectively, for 1832, 1911, and 1793  $F_o > 4\sigma F$  reflections. All these species are isostructural with graffonite,  $M^{(1)}Fe^{M(2),M(3)}Fe_2(PO_4)_2$  (monoclinic system; space group  $P2_1/c$ ,  $Z = 4$ ). The unit-cell parameters, respectively, are  $a = 8.799(2)/8.811(2)/8.792(2)$ ,  $b = 11.724(2)/11.494(2)/11.743(2)$ ,  $c = 6.170(1)/6.138(1)/6.169(1)$  Å,  $\beta = 99.23(3)^\circ/99.23(3)^\circ/99.35(3)^\circ$ ;  $V = 628.3/613.5/628.5$  Å<sup>3</sup>. Chemistry and crystal-structure refinement indicate that the  $M(1)$  site is occupied dominantly by Mn in graffonite-(Mn) and by Ca in graffonite-(Ca) and beusite-(Ca). In the last, one  $Mn^{2+}$  is strongly ordered at the [6]-coordinated  $M(3)$  site, with its minor amount at  $M(1)$ . However ordering of  $Mn^{2+}$  and  $Fe^{2+}$  over the  $M(2)$  and  $M(3)$  sites is not part of the classification criteria for this group. In graffonite-(Mn) and -(Ca) the  $M(2)$  and  $M(3)$  sites are occupied by  $Fe^{2+}$  and  $Mn^{2+}$ , with  $Fe^{2+}$  dominant over  $Mn^{2+}$  at the aggregate  $M(2)+M(3)$  sites. The mineral names are given according current classification of the graffonite-group (Hawthorne and Pieczka 2018). Both minerals are common primary phosphates in phosphate nodules, occurring as lamellar intergrowths with sarcopsite ± triphylite/lithiophilite, products of exsolution from a (Li,Ca)-rich graffonite-like parent phase crystallized at high temperature from P-bearing hydrosaline melts. The holotype of beusite-(Ca) is deposited in the Department of Mineral Sciences, National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A. The holotype and cotype specimens of graffonite-(Mn) and graffonite-(Ca) are deposited in the Mineralogical Museum of University of Wrocław, Poland). Holotype of graffonite-(Ca) is also holotype for maneekiite. **D.B.**

## References cited

Hawthorne, F.C., and Pieczka, A. (2018) Classification of the minerals of the graffonite group. *Mineralogical Magazine*, 82, 1301–1306.

## HYRŠLITE\*

F.N. Keutsch, D. Topa, and E. Makovicky (2018) Hyršlite,  $Pb_8As_{10}Sb_6S_{32}$ , a new  $N = 3;3$  member of the sartorite homologous series from the Uchucchacua polymetallic deposit, Peru. *European Journal of Mineralogy*, 30(6), 1155–1162.

Hyršlite (IMA 2016-097),  $Pb_8As_{10}Sb_6S_{32}$ , monoclinic, is a new member of the sartorite homologous series of Pb-(As,Sb) sulfosalts. It was discovered at the Socorro section the Uchucchacua polymetallic deposit, Oyon district, Catajumbo, Lima Department, Peru. It is an Ag–Mn–Pb–Zn vein, replacement and skarn mineral deposit, hosted by limestones and surrounded by andesitic and dacitic volcanic intrusions of Late Oligocene age (~25 Ma) with which the formation of the deposit might be connected. Ores occur as fissure infill and replacement of adjacent limestone in a succession of antiforms and synforms. In the first stage, silicates of Mn, Fe,

and Ca (rhodonite, bustamite, etc.) were deposited. In Stage 2, friedelite, magnetite, Fe-sphalerite, Mn-wurtzite, alabandine, and pyrrhotite were deposited. Main gangue minerals were calcite, kutnohorite, rhodochrosite, and quartz. In the late Stage 3, Ag, As, and Sb sulfosalts were introduced and Fe-poor sphalerite and alabandite coexist with calcite and pyrite. Orpiment, marcasite and siderite along with Mn oxides, goethite and cerussite ascribed to a supergene stage. This deposit for a few decades was a source of a number of new minerals including benavidesite  $Pb_4(Mn,Fe)Sb_6S_{14}$ , uchucchacuaite  $AgMnPb_3Sb_5S_{12}$ , menchettiite  $AgPb_{2.40}Mn_{1.60}Sb_3As_2S_{12}$ , manganogadrolite  $AgMnAsS_3$ , keutschite  $Cu_2AgAsS_4$ , agmantinite  $Ag_2MnSnS_4$ , and spryite  $Ag_8(As^{3+}, As^{5+})S_6$ , and now hyršlite found in close association with orpiment, stibnite, quartz, tennantite/tetrahedrite, manganogadrolite and Pb–Ag–Mn–Sb–As–S sulfosalts, including menchettiite in a calcite matrix. Hyršlite forms very rare individual crystals up to ~300 μm, and euhedral to anhedral grains intergrown with manganogadrolite and Pb–Ag–Mn–Sb–As–S sulfosalts. The mineral is gray, opaque with metallic luster. It is brittle, without observable cleavage or parting. Indentation microhardness  $VHN_{25} = 215$  (202–221) kg/mm<sup>2</sup> corresponding to 4 of Mohs scale. Density was not measured because of paucity of available material;  $D_{calc} = 5.26$  g/cm<sup>3</sup> based on simplified chemical formula. In reflected light, hyršlite is grayish-white, with red internal reflections on thin edges or at grain boundaries. Pleochroism was not detected, bireflectance is moderate. Anisotropism is distinct in dark gray-to-creamy rotation tints. The reflectance values in air [ $R_{max}/R_{min}$  (nm)] (COM wavelengths are bolded) are: 39.0/33.6 (400), 38.8/32.3 (420), 38.9/32.6 (440), 39.1/32.6 (460), **39.0/32.6 (470)**, 39.0/32.4 (480), 39.1/32.6 (500), 38.9/32.4 (520), 38.6/32.2 (540), **38.5/32.1 (546)**, 38.3/31.8 (560), 38.1/31.8 (580), **37.9/31.5 (589)**, 37.8/31.4 (600), 37.4/31.2 (620), 37.0/30.9 (640), **36.7/30.7 (650)**, 36.3/30.6 (660), 35.7/30.0 (680), 35.5/29.7 (700). At short wavelengths, the reflectance values are lower compare to hepta- to hendekasartorites; decrease in the R values towards the long wavelengths is more moderate than for the “sartorite” species. The average of 11 WDS electron probe analyses on 3 grains [wt%, (range)] is: Pb 39.26 (38.72–39.71), Sb 17.47 (16.55–18.41), As 17.97 (17.28–18.46), S 24.60 (24.40–24.75); total 99.30. No other elements were detected. The empirical formula based on 56 apfu (24 Me + 32 S) is  $Pb_{7.92}Sb_{6.00}As_{10.02}S_{32.06}$  ( $\Sigma Me = 23.94$ ) or (based on 32 S apfu)  $Pb_{7.90}Sb_{5.98}As_{10.00}S_{32}$  ( $\Sigma Me = 23.89$ ) or (based on 24 Me apfu)  $Pb_{7.94}Sb_{6.01}As_{10.05}S_{32.15}$ . Compositionally hyršlite lies between guettardite and twinnite on the one hand, and hendekasartorite on the other hand. Powder X-ray data were not collected. The strongest lines of the calculated powder X-ray diffraction pattern are [ $d_{calc}$  Å ( $l_{calc}^\circ$ ;  $hkl$ )]: 3.880 (59; 021), 3.512 (100; 015), 3.493 (46; 211), 3.488 (47;  $\bar{2}13$ ), 2.974 (45; 213), 2.968 (47;  $\bar{2}15$ ), 2.776 (71; 221), 2.773 (70; 223). The parameters of the monoclinic unit cell of hyršlite refined from single-crystal data are:  $a = 8.475(3)$ ,  $b = 7.917(3)$ ,  $c = 20.039(8)$  Å,  $\beta = 102.070(6)^\circ$ ,  $V = 1314.8$  Å<sup>3</sup>; space group  $P2_1$ ,  $Z = 2$ . The crystal structure of hyršlite was solved by direct methods to  $R_1 = 0.0728$  for 2862  $F_o > 4\sigma(F_o)$  reflections. The structure contains 12 independent cation and 16 distinct S sites. There are four fully occupied Pb tricapped trigonal prismatic sites (combined into zig-zagging “walls” which separate As–Sb based slabs of the structure), two fully occupied As sites, one Sb site and five mixed (As,Sb) sites. In projection parallel to the **a** axis, the crystal structure is a typical member of the sartorite homologous series, a sartorite homologue  $N = 3;3$ , and homeotype of twinnite and guettardite. The surfaces of the tightly bonded double-layer in the (As,Sb)-rich slabs have different cation configurations—one resembles coordinations observed in guettardite but the opposite one, with (As,Sb) cation pairs and single polyhedra, appears unique among sartorite homologues. The unique variation of structural motif built by covalent bonds of As and Sb, bond configuration and polyhedron aggregation show that it is not just a composition point in a solid solution series, but independent mineral species. The mineral name honors Jaroslav Hyršl, Czech mineralogist and expert on Peruvian minerals, in particular on the Uchucchacua deposit. The holotype is deposited in the reference collection of the Naturhistorisches Museum Wien, Austria. **D.B.**

### MAGNESIOBELTRANDOITE-2N3S\*

F. Cámara, R. Cossio, D. Regis, V. Cerantola, M.E. Ciriotti, and R. Compagnoni (2018) Beltrandoite, a new root-name in the hōgbomite supergroup: the Mg end-member magnesioeltrandoite-2N3S. *European Journal of Mineralogy*, 30(3), 545–558.

Magnesioeltrandoite-2N3S (IMA 2016-073), ideally  $\text{Mg}_6\text{Al}_{20}\text{Fe}_2^+\text{O}_{38}(\text{OH})_2$ , trigonal, is a new member of the hōgbomite supergroup. It was found in a metamorphosed layered mafic complex along the stream “Marmore” of the middle Valtourneche, Aosta Valley, Italy (~N 45°49'36"; E 7°34'51") in the debris underneath the Etirol-Levaz slice (a lens-like continental fragment, sandwiched between the overlying blueschist- to greenschist-facies Combin zone and the underlying eclogite-facies Zermatt-Saas zone). The slice consists of pre-Alpine, most likely Variscan, amphibolite- to granulite-facies gneisses, micaschists and metabasics which were overprinted by Alpine eclogite-facies metamorphism with PT condition of formation thought to be ~560 °C and pressure up to ~24 kbar. The specimen containing magnesioeltrandoite-2N3S was derived from a lens-like body of a layered metagabbro where it occurs as massive chloritite bands, most likely after primary spinel pyroxenites. The mineral occurs in a fine-grained chlorite matrix locally containing centimeter to decimeter long darker boudins with relict green spinel, cut by corundum + chlorite ± dolomite veins. Locally, Cr-rich magnetite, Mn-ilmenite and pyrite are observed in the matrix and in alteration rims of relict phases (in particular magnesioeltrandoite-2N3S). Magnesioeltrandoite-2N3S forms subhedral to euhedral black (dark reddish-brown in thin section) grains (~50–400 μm), moderately elongated parallel to c axis. Grains are in direct contacts with clinocllore and dolomite or included in green spinel relics with core compositions ~Sp<sub>59</sub>Hc<sub>41</sub> up to Sp<sub>42</sub>Hc<sub>58</sub> in the rim of small grains or even Sp<sub>30</sub>Hc<sub>70</sub>. The Cr-rich spinel close to the corundum veins is more hercynite rich (Sp<sub>20</sub>Hc<sub>80</sub>) and contains also trace amounts of V. Large grains of hercynitic spinel are fractured and cracks are filled by dolomite and diaspore. Chlorites of the matrix show sharp zonation with enrichment of Fe and depletion of Si at the rims corresponding to Fe-bearing aluminous clinocllore “corundophilite”. Magnesioeltrandoite-2N3S shows limited zonation with slighter Ti-richer cores but never reaching hōgbomitic compositions. Most of the magnesioeltrandoite-2N3S grains show incipient alteration to clinocllore even richer in Fe and Al than the rims of crystals in the matrix. Magnesioeltrandoite-2N3S has dark brown streak and a vitreous luster. It is brittle, with uneven fracture and no cleavage observed. Mohs hardness is ~6–6½. Density was not measured due to small grain size and the presence of chlorite and magnesite inclusions;  $D_{\text{calc}} = 3.93 \text{ g/cm}^3$ . No fluorescence under UV radiation and no cathodoluminescence was observed. No reactions with HCl, HNO<sub>3</sub>, and H<sub>2</sub>SO<sub>4</sub> were observed. The mineral is weakly pleochroic with *E* (deep reddish brown) (along c axis) > *O* (reddish brown). It is optically uniaxial (–). The calculated mean refractive index is ~1.80. The Raman spectra collected with polarization perpendicular to the length of the crystal and along it shows significant difference in intensities and slight shifts in peak positions. The strongest bands are observed (cm<sup>-1</sup>) at 854, 717, 506, and 264. Minor bands present at 812, 657, 419, 371, and 109. A weak and polarized band centered at 3364 cm<sup>-1</sup> corresponds to an O–H bond parallel to c axis. The differences compare to Raman spectra of magnesiohōgbomite-2N4S (Shimura et al. 2012) for, and the “Ti-free hōgbomite” of Tsunogae and Santosh (2005) are discussed. The Synchrotron Mössbauer spectrum (with the beam focused to a spot size of ~15 × 15 μm) was collected from a single crystal previously checked using X-ray single-crystal diffraction to exclude the presence of different species inclusions. The refined Fe<sup>3+</sup>/Fe<sub>total</sub> ratio 46(2)% is in good agreement with observed values for Fe<sup>2+</sup> and Fe<sup>3+</sup> in these coordination environments. The average of WDS electron probe analysis (55 data points) is [wt% (range)]: MgO 10.43 (9.33–11.11), ZnO 0.34 (0.14–0.52), NiO 0.09 (0–0.16), MnO 0.23 (0.15–0.32), FeO 11.80 (10.83–14.18), Fe<sub>2</sub>O<sub>3</sub> 10.83 (9.66–12.13) [by charge balance and 28 cations pfu], Al<sub>2</sub>O<sub>3</sub> 61.10 (59.41–63.50), Cr<sub>2</sub>O<sub>3</sub> 1.98 (1.23–3.19), V<sub>2</sub>O<sub>3</sub> 0.15 (0.09–0.25), TiO<sub>2</sub> 2.91 (1.14–4.49), H<sub>2</sub>O

1.18 (1.16–1.19) [by stoichiometry considering 2 OH pfu], total 100.90. Sn, Si, P, Ni, Ca, Na, and K were below detection limits. The empirical formula based on 28 cations and 40 (38 O and 2 OH) anions pfu is  $[\text{Al}_{18.36}\text{Mg}_{3.96}\text{Fe}_{2.52}\text{Fe}_{2.08}\text{Ti}_{0.56}\text{Cr}_{0.40}\text{Zn}_{0.06}\text{V}_{0.03}\text{Mn}_{0.02}]_{228}\text{O}_{38}(\text{OH})_2$ . The strongest lines in the X-ray powder diffraction pattern are  $[d \text{ \AA} (l; hkl)]$ : 2.858 (42; 110), 2.735 (51; 107), 2.484 (46; 018), 2.427 (100; 115), 1.568 (29; 128), 1.514 (30; 0.2.12), 1.438 (42; 2.0.13), 1.429 (72; 220). The cell parameters refined from powder data are  $a = 5.7164(1)$ ,  $c = 22.9702(8)$  Å,  $V = 650.03$  Å<sup>3</sup>. Single-crystal X-ray studies on a crystal of 0.080 × 0.060 × 0.020 mm show the mineral is trigonal, space group  $P\bar{3}m1$ ,  $a = 5.7226(3)$ ,  $c = 23.0231(9)$  Å,  $V = 652.95$  Å<sup>3</sup>,  $Z = 1$ . The crystal structure of magnesioeltrandoite-2N3S was refined to  $R_1 = 0.0219$  for 1626  $I > 2\sigma(I)$  unique reflections. Magnesioeltrandoite-2N3S is isostructural with magnesiohōgbomite-2N3S. There are 10 symmetrically independent cation sites (four tetrahedral and six octahedral) and 10 anion sites. Two sites with octahedral coordination (*M3* and *M5*) and one site with tetrahedral coordination (*T4*) belong to the nolanite modules [composed by a T1-layer of tetrahedrally (*T4*) and octahedrally (*M5*) coordinated atoms and an O-layer built by octahedrally (*M3*) coordinated sites], while four sites with octahedral coordination (*M1*, *M6*, *M8*, and *M10*) and three sites with tetrahedral coordination (*T2*, *T7*, and *T9*) correspond to spinel modules [composed by T2-layers of tetrahedrally (*T2*, *T7*, and *T9*) and octahedrally (*M1* and *M8*) coordinated atoms and an O-layer built by octahedrally (*M1* and *M10*) coordinated sites]. The assigned composition of *M5* site is (Fe<sub>0.47</sub>Ti<sub>0.28</sub>Fe<sub>0.17</sub>Mg<sub>0.07</sub>) thus Fe<sup>3+</sup> is dominantly ordered in nolanite module (0.94 apfu), while some Fe<sup>3+</sup> is present in the sites with tetrahedral coordination (*T4*) of the nolanite module (0.16 apfu) and in the *T7* and *T9* sites of the T1-layer of the spinel modules (0.12 apfu each site), as well as in octahedral sites of the spinel modules (up to 0.74 apfu). Fe<sup>3+</sup> is dominant at only one of octahedral sites (*M5*) of the nolanite module, while Al is dominant at the *M3* site and in the nolanite module in a whole. The dominance of Fe<sup>3+</sup> at *M5* site where Ti and Sn are located in hōgbomite and nigerite, respectively, can be obtained through two charge-balanced substitutions: <sup>M5</sup>Ti<sup>4+</sup> + <sup>T4</sup>R<sup>2+</sup> (Fe, Mg, Zn) > <sup>M5</sup>Fe<sup>3+</sup> + <sup>T4</sup>R<sup>3+</sup> (Fe, Al, Cr) or <sup>M5</sup>Ti<sup>4+</sup> + <sup>T4</sup>R<sup>3+</sup> (Fe, Al, Cr) + <sup>O4</sup>(O)<sup>2-</sup> > <sup>M5</sup>Fe<sup>3+</sup> + <sup>T4</sup>R<sup>3+</sup> (Fe, Al, Cr) + <sup>O4</sup>(OH)<sup>-</sup>. The first one has been chosen for formula calculation. Magnesioeltrandoite-2N3S, is a new member of the hōgbomite supergroup  $[\text{N} \times \text{TM}_4\text{O}_7(\text{OH}) \times \text{S} \times \text{T}_2\text{M}_4\text{O}_8]$  (Mills et al. 2009) and the first “nolanitic” Fe<sup>3+</sup>-dominant member (thus can be considered as a parent species of a new “beltrandoite” mineral group). This magnesioeltrandoite-2N3S is very rich in Fe<sup>2+</sup> (Mg > Fe<sup>2+</sup> only for 0.10 apfu) being close to a potential new mineral “ferrobeltrandoite-2N3S”. The name is given according the rules of the hōgbomite supergroup nomenclature (Armbruster 2002) approved by CNMNC IMA. The proposed root-name beltrandoite honors Marco Beltrando (1978–2015), geologist and petrologist at the Department of Earth Sciences of the University of Torino, for his contributions to the evolution of the Alpine orogeny. The prefix is according the dominance of Mg in spinel modules and the suffix is according the polysomatic sequence of nolanite and spinel modules. The holotype material (a thin section and a 2 mm thick rock chip) is deposited in the Museo Regionale di Scienze Naturali di Torino, Italy. **D.B.**

**Comment:** Another Fe<sup>3+</sup>-dominant member of hōgbomite supergroup zincovelisite-6N6S was later approved by CNMNC IMA (see abstract below and comment to that).

### References cited

- Armbruster, T. (2002) Revised nomenclature of hōgbomite, nigerite, and taaffeite minerals. *European Journal of Mineralogy*, 14, 389–395.
- Mills, S.J., Hatert, F., Nickel, E.H., and Ferraris, G. (2009) The standardisation of mineral group hierarchies: application to recent nomenclature proposals. *European Journal of Mineralogy*, 21, 1073–1080.
- Shimura, T., Akai, J., Lazic, B., Armbruster, T., Shimizu, M., Kamei, A., Tsukada, K., Owada, M., and Yuhara, M. (2012) Magnesiohōgbomite-2N4S: a new polysome from the central Sor Rondane Mountains, East Antarctica. *American Mineralogist*, 97, 268–280.
- Tsunogae, T., and Santosh, M. (2005) Ti-free hōgbomite in spinel- and sapphirine-

bearing Mg-Al rock from the Palghat-Cauvery shear zone, southern India. *Mineralogical Magazine*, 69, 937–949.

### ZINCOVELESITE-6N6S\*

N.V. Chukanov, M.G. Krzhizhanovskaya, S. Jančev, I.V. Pekov, D.A. Varlamov, J. Göttlicher, V.S. Rusakov, Y.S. Polekhovskiy, A.D. Chervonnyi, and V.N. Ermolaeva (2018) Zincovelesite-6N6S,  $Zn_3(Fe^{3+}, Mn^{3+}, Al, Ti)_8O_{15}(OH)$ , a new hōgbomite-super group mineral from Jacupica mountains, Republic of Macedonia. *Mineralogy and Petrology*, 112(5), 733–742.

Zincovelesite-6N6S (IMA 2017-034),  $Zn_3(Fe^{3+}, Mn^{3+}, Al, Ti)_8O_{15}(OH)$ , trigonal, was discovered in the orogenic zone related to the “Mixed Series” metamorphic complex near the Nežilovo village (4.5 km NW) and about 25 km WSW of the city of Veles, Jacupica Mountains, Pelagonia mountain range, Republic of Macedonia (41°41'N, 21°25' E). Metamorphosed volcano-sedimentary formation composed mainly of albite augen gneisses and meta-rhyolites with lenses of dolomitic marbles metasomatically replaced by a very unusual and complex mineral assemblages. A specific feature of these metasomatic rocks is their formation under highly oxidizing conditions. As a result, the chalcophile elements (S, As, Sb, Zn, and Pb) are mainly concentrated in the form of oxides and oxy salts, while sulfides and sulfosalts are present only in trace amounts. In metasomatic rocks of the Nežilovo area, hōgbomite-super group minerals occur in predominantly oxide and predominantly silicate-baryte associations. In oxide rocks only zincovelesite-6N6S was found. In rocks containing baryte, Zn-rich amphiboles and micas as the major components, both  $Fe^{3+}$ - and Al-dominant hōgbomite-super group minerals occur (including zincovelesite-6N6S, zincohōgbomite-6N6S, and its  $Sb^{5+}$ - and  $Mn^{4+}$ -analogues). Relics of zircon and zincochromite belong to the earliest paragenesis. Thereafter franklinite and hetaerolite crystallized. During the next stage, franklinite and hetaerolite were partly replaced by gahnite to form predominantly franklinite–hetaerolite–gahnite aggregate. Zincovelesite-6N6S crystallized at a relatively late stage of metasomatic processes and probably has a hydrothermal origin. Ferricoironadite is one of the latest minerals in this association. Other associated minerals include As-rich fluorapatite, dolomite, Zn-bearing talc, almeidaite, hydroxycalcioroméite, zircon, quartz, and scheelite. In oxide zones zincovelesite-6N6S forms lenticular aggregates up to  $2 \times 2 \times 0.5$  mm consisting of thin near-coplanar platelets up to  $70 \times 70 \times 1$   $\mu m$  while in silicate-baryte zones it forms oriented pseudomorphs after gahnite and epitaxial (with parallel *c* axes) intergrowths with nežilovite up to  $0.5 \times 0.5 \times 0.1$  mm in size. Zincovelesite-6N6S is black, opaque and has a brownish-black streak and strong submetallic to metallic luster. It is brittle. The micro-indentation hardness  $VHN_{200} = 1118$  (946–1233) kg/mm<sup>2</sup> corresponding to  $\sim 6\frac{1}{2}$  of the Mohs scale. The density was not measured due to a very small crystal size;  $D_{calc} = 5.158$  g/cm<sup>3</sup>. In reflected light zincovelesite-6N6S is light gray with no internal reflections observed. It is anisotropic and birefractant. The reflectance values were measured in air between 400 and 700 nm with a 20 nm interval. The values for the COM wavelengths are [ $R_{min}$ ,  $R_{max}$  (%), (nm)]: 13.4, 17.1 (470), 12.8, 16.5 (546), 12.6, 16.2 (589), 12.2–15.6 (650). The infrared spectrum of zincovelesite-6N6S has bands at (cm<sup>-1</sup>): 3407 and 817 (O-H stretching and  $M \cdots O$ -H bending vibrations, respectively); strong bands in the range 360–650 ( $M \cdots O$ -stretching vibrations where  $M = Fe^{3+}, Mn^{3+}, Al, Ti$ ). The average of 15 WDS electron probe analyses [wt%, (range)] is: MgO 0.97 (0.34–1.36), CuO 0.50 (0.27–0.72), ZnO 30.80 (27.86–33.79), Al<sub>2</sub>O<sub>3</sub> 8.17 (7.23–8.69), Mn<sub>2</sub>O<sub>3</sub> 21.31 (19.72–24.05), Fe<sub>2</sub>O<sub>3</sub> 29.44 (26.97–33.44), TiO<sub>2</sub> 5.28 (3.07–7.97), Sb<sub>2</sub>O<sub>3</sub> 3.74 (1.24–6.52), H<sub>2</sub>O 1.1(2) (by gas chromatography of products of ignition at 1200 °C), total 101.31. Based on Mössbauer spectroscopy and Mn and Fe *K*-edge XANES spectroscopy, all Fe and at least most part of Mn are trivalent but substantial portion of Mn may be tetravalent. The empirical formula based on 16 O pfu is  $H_{1.05}(Zn_{3.26}Mg_{0.21}Cu_{0.05}Fe_{3.18}Mn_{2.32}Al_{1.38}Ti_{0.57}Sb_{0.20})_{\Sigma 11.17}O_{16}$ . The strongest lines of the powder X-ray diffraction pattern are [*d* Å (*hkl*)]: 2.952 (62;

110); 2.881 (61; 1.0.16); 2.515 (100; 204); 2.493 (88; 1.1.12); 2.451 (39; 1.0.20); 1.690 (19; 304,2.1.16); 1.572 (19; 2.0.28); 1.475 (29; 221). Single-crystal X-ray diffraction study could not be performed because aggregates of zincovelesite-6N6S are compact and consist of thin near-coplanar platelets up to 1  $\mu m$  thick. The powder diffraction study showed that the new mineral is trigonal, probable space group is  $P\bar{3}m1$ ,  $a = 5.902(2)$ ,  $c = 55.86(1)$  Å,  $V = 1684.8$  Å<sup>3</sup>, and  $Z = 6$ . Zincovelesite-6N6S is isostructural with hōgbomite-super group minerals. Zincovelesite-6N6S is the first  $Fe^{3+}$ -dominant member of the hōgbomite super group and, can be considered as a parent species of a new mineral group (see comment below) with  $Ti^{4+}$  as the major charge-compensating high-valent cation and  $Fe^{3+}$  as the major trivalent cation. The rootname *velesite* is given for the discovery locality near the city of Veles. Fragments of the holotype specimen are deposited in the Fersman Mineralogical Museum, Russian Academy of Sciences, Moscow, Russia, and in the National Institution Macedonian Museum of Natural History, Skopje, Macedonia. **Yu.U.**

**Discussion:** The authors claim that this is the first  $Fe^{3+}$ -dominant member of the hōgbomite super group. Actually, the first one was magnesiobeltrandoite-2N3S, IMA No. 2016-073 (see the abstract above), ideally  $Mg_6Al_{20}Fe_2^+O_{38}(OH)_2$ , approved by CNMNC IMA about a year before zincovelesite-6N6S (Cámara et al. 2016 not cited by the authors, and Cámara et al. 2018, the later probably published after the acceptance of their paper). In magnesiobeltrandoite-2N3S,  $Fe^{3+}$  is dominant over Ti in the nolanite module. According the classification of hōgbomite-super group approved by CNMNC IMA (Armbruster 2002) and the suggestions of Shiumura et al. (2012), “...*hōgbomite-group minerals are defined as  $Ti > Sn$ . The corresponding Ti-free samples should be classified into a newly defined group in close relation with hōgbomite and nigerite groups.*” Thus, the mineral deserved a new root-name, and it was chosen—beltrandoite. This classification also assigns a subgroup prefix to the root-name on the basis of the aluminium spinel module: ‘*zinc*’, ‘*ferro*’, or ‘*magnesio*’ depend on domination of gahnite, hercynite or spinel components respectively. “*A corresponding choice of prefixes is required if hōgbomite minerals with other spinel modules are discovered*” (Armbruster 2002). Unfortunately, no structure determination has been provided in the zincovelesite-6N6S description and it is not possible to discuss about the site partitioning between the two types of modules. It is reported that the Fe *K* XANES spectrum of zincovelesite-6N6S is very close to that of the spinel-type ferrite franklinite  $ZnFe_2O_4$ . Because, Al is  $> 1.5$  apfu and ( $Fe^{3+} + Mn^{3+} = 5.5$  apfu),  $Fe^{3+}$  and  $Mn^{3+}$  might be dominant cations in the octahedral sites of both spinel and nolanite modules. Yet, the classification by Armbruster (2002) did not foresee Al-poor spinel modules. The mineral clearly deserved a new name, but not a root-name following the classification in force at the time of the approval. It is rather confusing that IMA-CNMNC accepted the proposal of a new root-name based on a criterion used in another new mineral approved by the commission just few months before. It turns out evident that a new classification scheme was necessary for this group of minerals considering the new data presented by the team proposing zincovelesite-6N6S. At the present state of the art, to avoid any further confusion, any further member of this group should wait until an upgraded nomenclature of this super group is presented and approved by IMA-CNMNC. **F.C.**

### References cited

- Armbruster, T. (2002) Revised nomenclature of hōgbomite, nigerite, and taaffeite minerals. *European Journal of Mineralogy*, 14, 389–395.
- Cámara, F., Cossio, R., Regis, D., Ciriotti, M.E., and Compagnoni, R. (2016) Magnesiobeltrandoite-2N3S, IMA 2016-073. CNMNC Newsletter No. 34, December 2016, page 1318; *Mineralogical Magazine*, 80, 1315–1321.
- Cámara, F., Cossio, R., Regis, D., Cerantola, V., Ciriotti, M.E., and Compagnoni, R. (2018) Beltrandoite, a new root-name in the hōgbomite super group: the Mg end-member magnesiobeltrandoite-2N3S. *European Journal of Mineralogy*, 30, 545–558.
- Shimura, T., Akai, J., Lazic, B., Armbruster, T., Shimizu, M., Kamei, A., Tsukada, K., Owada, M., and Yuhara, M. (2012) Magnesiöhōgbomite-2N4S: a new polymorph from the central Sor Rondane Mountains, East Antarctica. *Mineralogical Magazine*, 97, 268–280.