New Mineral Names*,†

Dmitriy I. Belakovskiy[1], Yulia Uvarova[2], and Fernando Cámara[3]

[1]Fersman Mineralogical Museum, Russian Academy of Sciences, Leninskiy Prospekt 18 korp. 2, Moscow 119071, Russia
[2]CSIRO Mineral Resources, ARRC, 26 Dick Perry Avenue, Kensington, Western Australia 6151, Australia
[3]Dipartimento di Scienze della Terra "Ardito Desio", Università degli Studi di Milano, Via Mangiagalli, 34, 20133 Milano, Italy

In this issue

This New Mineral Names has entries for 13 new species, including falottaite, meieranite and high-pressure minerals found in meteorites, terrestrial impact rocks, and as inclusions in diamonds: hemleyite, hiroseite, ice-VII, kaitianite, maohokite, proxidecagonite, riesite, rubinite, uakitite, wangdaodeite, and zagamiite.

Falottaite*

S. Graeser and W Gabriel (2016) Falottait ($MnC_2O_4 \cdot 3H_2O$)—ein neues Oxalat-Mineral aus den Schweizer Alpen. Schweizer Strahler, 50(3), 20–27 (in German and French).

Falottaite (IMA 2013-044), $MnC_2O_4 \cdot 3H_2O$, orthorhombic, is a new mineral discovered in abandoned manganese mines of Falotta and Parsettens and Tinzen in the Oberhalbstein region, Canton Grisons, Switzerland. The mines were exploited in the past centuries up to the World War II. The manganese ores occur as lenses in radiolaritic rocks of the large Oberhalbstein ophiolithic zone. The origin of the synsedimentary ores related to a Jurassic ocean ridge volcanism. The whole complex was deformed by the Alpine metamorphism and influenced by lowest greenschist facies conditions. The primary ores consist mostly of braunite, rhodonite, and spessartite. The remobilization process produced several manganese arsenates: brandtite, sarkinite, manganberzeliite, tilasite, kemmlizite, bergslagite, grischunite, geigerite, and cabalzarite. Falottaite presumably resulted from reaction of humus and oxalic acids (from plants) with manganese minerals. Perfectly shaped colorless transparent ship-like crystals up to 1×0.5 mm were found in small fractures in the radiolarites, grown on small idiomorphic slightly rose quartz. The crystals are elongated along **c** and flattened on **b** with main forms {010}, {100}, and {101} modified by minor {210} and {10.1.10}. Twinning (law unknown) is presumably common. The streak is white, and the luster is vitreous. Falottaite does not fluoresce under UV radiation. Cleavage was not observed. Mohs hardness is estimated as 2½. Density was not measured; $D_{calc} = 1.924$ g/cm^3. In plane-polarized transmitted light falottaite is colorless and non-pleochroic. It is optically biaxial with $\alpha = 1.460$ and $\gamma = 1.560$ measured on the plain (010) (λ not specified). No other optical data provided. All crystals became milky white and opaque in a few months, being turned to lindbergite $MnC_2O_4 \cdot 2H_2O$. Only qualitative microprobe EDS analyses was performed due to instability the mineral during probe preparation and under the beam. The EDS spectra show only Mn, C, and O. The strongest lines in the powder XRD pattern are [(d Å, ($I\%$, hkl)]: 6.630 (100; 010), 4.635 (60; 201), 3.801 (90; 211), 3.153 (80; 212), 2.622 (70; 312), 1.726 (70; 233). The powder XRD data is identical to that of synthetic $MnC_2O_4 \cdot 3H_2O$ (ICPDS 32-648). The single-crystal study shows falottaite is orthorhombic, space group *Pcaa*. The unit-cell parameters refined from the Gandolfi data are $a = 10.527(5)$, $b = 6.626(2)$, $c = 9.783(6)$ Å, $V = 682.4$ Å^3. Structure refine-

ment was not performed. The mineral was named for its type locality. Type material (now in the form of the lindbergite pseudomorph after falottaite crystals) is deposited in the Natural History Museum Basel, Basel, Switzerland. **D.B.**

References cited

JCPDS International Center for Diffraction Data (1988) Swarthmore, Pennsylvania. Card # 32-648.

Hemleyite*

L. Bindi, M. Chen, and X. Xie (2017) Discovery of the Fe-analogue of akimotoite in the shocked Suizhou L6 chondrite. Scientific Reports, 7, 42674.

Hemleyite (IMA 2016-085), ideally $FeSiO_3$, trigonal, is a new mineral—Fe-analogue of akimotoite (ilmenite-structured $MgSiO_3$), and a predicted high-pressure polymorph of clinoferrosilite, ferrosilite, and pyroxferroite. Hemleyite was discovered in unmelted portion of the heavily shocked L6 Suizhou chondrite fallen on April 15, 1986, in Dayanpo, ~12.5 km southeast of Suizhou in Hubei, China. Shock-produced melt veins are less than 300 μm thick and contain high-pressure minerals including ringwoodite, majorite-pyrope garnet, akimotoite, *magnesiowüstite*, lingunite, tuite, xieite, and $(Mg,Fe)SiO_3$-glass (probably a vitrified mineral of perovskite structure). Hemleyite found as one subhedral crystal $\sim 7 \times 6 \times 5$ μm coexisting with forsterite, clinoenstatite and Fe-bearing pyroxene with a composition nearly identical to that of hemleyite. The physical and optical properties were not determined due to small size; $D_{calc} = 4.383$ g/cm^3. Hemleyite was initially identified by the Raman spectrum (similar to that of akimotoite), which displays bands at 795, 673, 611, 476, 403, and 342 cm^{-1} with the typical strong peak at 795 cm^{-1}, corresponding to the stretching vibrations of the SiO_6 octahedra. It has much sharper bands than those observed for ilmenite-type polymorphs in other chondrites indicating rather high crystallinity. The average of unspecified number of electron probe WDS analysis [wt% (range)] is: SiO_2 51.08 (50.68–51.85), Al_2O_3 1.26 (1.11–2.55), Cr_2O_3 0.61 (0.29–1.25), FeO 29.33 (26.88–30.52), MgO 12.71 (11.21–13.10), CaO 1.88 (0.95–2.03), MnO 1.76 (1.44–2.05), Na_2O 1.02 (0.88–1.39), total 99.65. The empirical formula based on 3 O pfu is $(Fe^{2+}_{0.48}Mg_{0.37}Ca_{0.04}Na_{0.04}Mn^{2+}_{0.03}Al_{0.03}Cr^{3+}_{0.01})_{\Sigma1.00}Si_{1.00}O_3$. The strongest lines in powder XRD pattern [d Å ($I\%$; hkl)] are: 3.520 (35; 012), 2.625 (100; 014), 2.376 (50; 110), 2.105 (50; 113), 1.762 (25; 024), 1.645 (50; 116), 1.415 (10; 124), 1.372 (20; 030). The unit-cell parameters refined from the powder data are $a = 4.7490(2)$, $c = 13.6934(9)$ Å, $V = 267.45$ Å^3. The single-crystal XRD data shows hemleyite is trigonal, space group $R\bar{3}$, $a = 4.7483(5)$, $c = 13.665(1)$ Å, $V = 266.82$ Å^3, $Z = 6$. The crystal structure was refined to

---

$R_1 = 0.0593$ for 187 observed $F_o > 4\sigma(F_o)$] reflections. It is represented by hexagonal close-packed O atoms with only two-thirds of the octahedral sites occupied. The octahedra share edges to form six-membered rings, thus forming (001) sheets linked into a framework by sharing faces and corners of octahedra. In hemleyite, the presence of (Fe,Mg) and Si specifically ordered into two octahedral sites (i.e., A and B) causes a decrease in symmetry from the corundum-type structure, space group $R\overline{3}c$ to $R\overline{3}$. Hemleyite was formed in a meteorite exposed to high pressures (<20 GPa) and temperatures (<2000 °C) during impact-induced shocks. That indicates the mineral could play a crucial role at the bottom of the Earth's mantle transition zone and within the uppermost lower mantle. The name in honors Russell J. Hemley (b.1954), former Director of the Geophysical Laboratory of the Carnegie Institution of Washington D.C., U.S.A., well-known for his research exploring the behavior of materials under extreme conditions of pressure and temperature. Holotype material is deposited in the collections of the Museo di Storia Naturale, Università degli Studi di Firenze, Italy. **D.B.**

Hiroseite*

L. Bindi, S.-H. Shim, T.G. Sharp, and X. Xie (2020) Evidence for the charge disproportionation of iron in extraterrestrial bridgmanite. Science Advances, 6(2), eaay7893.

Hiroseite (IMA 2019-019), ideally $FeSiO_3$, orthorhombic, is a newly discovered perovskite-supergroup mineral and the Fe analog of bridgmanite ($MgSiO_3$), which is considered to be the most abundant mineral in the Earth lower mantle. Hiroseite was found in a shock vein of a heavily shocked (S6) L6 chondrite meteorite Suizhou fallen in Dayanpo, 12.5 km SE of the Suizhou city, Hubei province, China. It occurs in a quenched shock melt as Fe-rich segregation consisting of hiroseite grains up to 8 μm in a matrix of Fe-bearing periclase, mantled by a rim of ringwoodite-ahrensite solid solution. The shock melt pocket is surrounded by forsterite $(Mg_{1.79}Fe_{0.19})Si_{1.01}O_4$. Other associated minerals are: pyroxene $(Mg_{0.38-0.75}Fe_{0.20-0.40}Na_{0.00-0.08}Al_{0.00-0.04}Ca_{0.01-0.02}Mn_{0.01-0.02})SiO_3$, taenite, troilite, and $MgSiO_3$ glass. The textures and compositions suggest hiroseite resulted from the transformation of a chemically zoned olivine. The fayalite-rich core transformed to hiroseite and Fe-rich periclase, while Mg-rich rim transformed to a ringwoodite-ahrensite. The spherical nanoparticles of metallic iron (Fe 96.5, Si 3.5 wt%) up to ~30 nm found in hiroseite are estimated to occupy ~2.6 to 4 % of its volume. Physical properties were not determined due to the small size of crystals. The Raman spectra obtained in the range 150–1300 cm^{-1} show peaks at (cm^{-1}): 486 (A_g mode derived from octahedral SiO_6 group vibrations), 363 strongest (E_g type of motions), 266 and 237 (octahedral deformations and rotational motions coupled to displacements of the dodecahedral cations). The spectra are similar to that of perovskite-structured pure $MgSiO_3$ with all the peaks displaced toward higher frequencies. The averaged electron probe analyses (ranges or deviations are not given) is Na_2O 0.80, CaO 0.95, MgO 12.64, MnO 0.01, FeO 26.91, Fe_2O_3 6.65 (Fe^{3+}/Fe^{2+} apportioned based on EELS analysis data, charge balance, and structure constrains), Al_2O_3 6.49, Cr_2O_3 0.01, SiO_2 45.34, total 99.80. The empirical formula based on 3 O pfu is $(Fe^{2+}_{0.44}Mg_{0.37}Fe^{3+}_{0.10}Al_{0.04}Na_{0.03}Ca_{0.02})_{\Sigma1.00}(Si_{0.89}Al_{0.11})_{\Sigma1.00}O_3$. The strongest lines in powder XRD pattern [d Å (I%; hkl)] are: 2.501 (16; 200), 2.468 (56; 121), 2.423 (18; 002), 1.751 (68; 040), 1.740 (100; 202), 1.434 (26; 240), 1.407 (33; 123), 1.231 (27; 410). A very weak peak at 2.79 Å attributed to very minor siderite. The least-squares refinement shows hiroseite is orthorhombic, space group $Pnma$, gave the following values: $a = 5.0016(5)$, $b = 7.0031(3)$, $c = 4.8460(3)$ Å, $V = 169.74$ Å^3, $Z = 4$; $D_{calc} = 5.16$. Single-crystal X-ray study on a fragment $7 \times 8 \times 5$ μm shows the sample is polycrystalline with broad single-crystal diffraction effects. Rietveld refinement fit ($R_{wp} = 6.83$%) to the orthorhombic perovskite structure with A-site occupancy [$Fe_{0.55}Mg_{0.45}$]. Hiroseite provides first direct evidence in nature of the Fe disproportionation

reaction $3Fe^{2+} = 2Fe^{3+} + Fe^0$, which has earlier been observed in high-pressure experiments. The possible role of this reaction in redox processes and the evolution of Earth is discussed. The mineral name honors Kei Hirose (b. 1968) for his fundamental contributions to the discovery of the post-perovskite phase in particular, and to the mineralogy of mantle perovskite in general. Type material is deposited in the Museo di Storia Naturale, Università di Firenze, Italy. **D.B.**

Ice-VII*

O. Tschauner, S. Huang, E. Greenberg, V.B. Prakapenka, C. Ma, G.R. Rossman, A.H. Shen, D. Zhang, M. Newville, A. Lanzirotti, and K. Tait (2018) Ice-VII inclusions in diamonds: Evidence for aqueous fluid in Earth's deep mantle. Science, 359(6380), 1136–1139.

Ice-VII (IMA 2017-029), H_2O, cubic, is the natural ice high-pressure polymorph above 2.4 GPa. It was discovered in inclusions in diamonds from Orapa (type locality) and Namaqualand (Botswana) and from Shandong (China). Diamonds consists of fibrous rims around inclusion-rich kernel. Ice-VII occurs in isolated inclusions (ranging from 3 μm × 10 μm to less than 2 μm × 3 μm) in proximity to small amounts of nickeliferous carbonaceous iron, ilmenite, and, in one case, to alkali halides. Many inclusions of silicates, carbonates, oxides, and halides are found within distances of several tens to 100 μm from the ice-VII inclusions. The composition of diamond hosted olivine (Fo 94–97) allow to suggest peridotitic origin of diamonds. Earlier a lower-pressure phase ice-VI has been reported as an inclusion in diamond on the basis of IR spectroscopy (Kagi et al. 2000). The indication of ice-VII is based on diffraction of hard X-rays (λ = 0.3344 Å) and a beam focused to 2 μm × 3 μm at the undulator beamline 13-IDD (GSECARS, Advanced Photon Source, Argonne National Laboratory) and correlate with IR absorption bands of O-H bending- and symmetric stretching in background subtracted spectra. The X-ray diffraction pattern of ice-VII is powder-like with no visible granularity. The strongest peaks are [d Å (I%; hkl)]: 2.237 (100; 011), 1.582 (11; 002), 1.291 (23; 112), 1.118 (7; 022), 1.000 (7; 013), 0.913 (2; 222), 0.845 (8; 123), 0.791 (1; 004). The patterns were unambiguously identified by Rietveld refinement ($R_p = 4.57$% with $\chi^2 = 1.71$ for 1398 observations) as those of ice-VII, cubic, space group $Pn\overline{3}m$, $a = 3.163$ Å, $V = 31.64$ Å^3. The presence of K and Cl was detected by micro-XRF mapping (amounts are not given). The content of Na, not detectable due to the host diamond absorbing its X-ray fluorescence, was constraint by Na/K ratio charge balanced with Cl$^-$. The Rietveld refinement of site occupancy shows K$^-$, Na$^-$, and Cl$^-$ ions reside in ice-VII on the same site as oxygen and no structural correlation occurs between dissolved ionic species. The geological implications of the presence of natural ice-VII are discussed. Ice-VII crystallizes from aqueous fluid trapped during diamond growth upon ascent of the host diamonds providing the evidence for the presence of aqueous fluid in the mantle transition zone and in its boundary with lower mantle. Inclusions of ice-VII remain at high pressure in rigid diamond host crystal allowing to determine minimum pressures of the surrounding diamond formation as ~6 GPa and 9 ± 1.6 GPa for diamonds from Orapa, ~12 ± 2 GPa for a diamond from Shandong, and 24–25 (±3) GPa for a specimen from Namaqualand. Entrapment conditions are estimated for the ice-VII inclusions that are currently at ~8 to 12 GPa as pressure-temperature regime of 400 to 550 km depth and 1400 to 1900 K. For inclusions at 24 to 25 GPa, the source region is estimated as 610 to 800 km depth. Type material (a triangular diamond fragment of 350 × 420 μm and 50–70 μm thick) is deposited in the Royal Ontario Museum, Toronto, Ontario, Canada. **D.B.**

References cited

Kagi, H., Lu, R., Davidson, P., Goncharov, A.F., Mao, H.K., and Hemley, R.J. (2000) Evidence for ice VI as an inclusion in cuboid diamonds from high P-T near infrared spectroscopy. Mineralogical Magazine, 64, 1089–1097.

Kaitianite*

C. Ma (2019) Discovery of kaitianite, $Ti_2^{3+}Ti^{4+}O_5$, in Allende: a new refractory mineral from the solar nebula. 82nd Annual Meeting of The Meteoritical Society (LPI Contrib. No. 2157), 6098.pdf.

Kaitianite (IMA 2017-078a), $Ti_2^{3+}Ti^{4+}O_5$, monoclinic, is a new mineral discovered in Allende CV3 carbonaceous chondrite meteorite fallen in Mexico on February 8th, 1969. It was identified in section USNM 3510-5 considered as a type specimen and deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., U.S.A. Fine-grained Ti_3O_5 was previously observed in a chondrite matrix clast in the Nilpena polymictic ureilite (Brearley 1993). Kaitianite occurs in two crystals, 0.3~0.6 × 3.6 μm and 0.2 × 1.1 μm, within one irregular grain in contact with tistarite and rutile, along with Ti^{3+}-bearing corundum, oxide $(Ti^{3+},Al,Zr,Si,Mg)_{1.95}O_3$ (related to panguite-kangite-type but highly-ordered structure), and Ti-xifengite. These grains are likely from the chondrule where mullite, khamrabaevite, and the type tistarite (Ti_2O_3) were identified. The average of unspecified number of electron probe WDS analyses (wt%) is Ti_2O_3 56.55, TiO_2 39.29, Al_2O_3 1.18, MgO 1.39, FeO 0.59, V_2O_3 0.08, total 99.07. The empirical formula based on 5 O pfu is $(Ti_{1.75}^{3+}Al_{0.05}Ti_{0.10}^{4+}Mg_{0.08}Fe_{0.02})(Ti_{1.00}^{4+})O_5$ $(Ti^{3+}/Ti^{4+}$ apportioned by stoichiometry). The strongest X-ray microdiffraction reflections are [d Å (I%; hkl)]: 4.689 (53; 200), 3.377 (75; $\overline{2}$02), 2.931 (73; $\overline{1}$12), 2.662 (100; 310), 2.466 (59; 112), 1.737 (66; $\overline{4}$22,$\overline{2}$23), 1.671 (67; $\overline{3}$14,023), 1.451 (52; 132,$\overline{3}$24,223). The EBSD data shows kaitianite is monoclinic, space group $C2/c$, a = 10.115, b = 5.074, c = 7.182 Å, β = 112°, V = 341.77 Å^3, Z = 4. The patterns can be indexed only by the V_3O_5-type structure and give a perfect fit by the synthetic γ-Ti_3O_5. Kaitianite is a first solar titanium oxide with structurally essential Ti^{3+} and Ti^{4+}, probably crystallized from a refractory melt or condensed from a gaseous reservoir under highly reduced conditions. The name is after two Chinese words "Kai Tian," meaning creating the heaven (sky), from the story of "Pan Gu Kai Tian" in the Chinese mythology. Pan Gu, the giant, created the world by separating the heaven and earth from an egg-shaped chaos. **D.B.**

References cited

Brearley, A.J. (1993) Occurrence and possible significance of rare Ti oxides (Magnéli phases) in carbonaceous chondrite matrices. Meteoritics & Planetary Science, 28(4), 590–595.

Maohokite*

M. Chen, J. Shu, X. Xie, and D. Tan (2019) Maohokite, a post-spinel polymorph of $MgFe_2O_4$ in shocked gneiss from the Xiuyan crater in China. Meteoritics & Planetary Science 54(3), 495–502.

Maohokite (IMA 2017-047), $MgFe_2O_4$, orthorhombic, a post-spinel polymorph of magnesioferrite was discovered in impact breccia from the Xiuyan crater in China. The impact breccias are composed of fragments of gneiss, amphibolite, marble in fine-grained matrix. Maohokite occurs in moderately shocked gneiss as crystallites 2–30 nm coexisting with reidite, TiO_2-II (srilankite), diaplectic quartz and feldspar glasses, and shocked ankerite decomposed into a multiphase mixture of magnesioferrite (up to 200 nm), maohokite, calcite (5300 nm), and diamond (2–5 nm). Regular physical and optical properties were not determined due to the size. D_{calc} = 5.33 g/cm^3. The Raman spectrum of shocked ankerite contains, along with bands related to magnesioferrite, the strong band at 602 cm^{-1} assigned to maohokite. The average of unspecified number of electron probe EDS analyses (in TEM mode) normalized to 100 wt% is (wt%, range): Fe_2O_3 75.12 (73.62–76.02), FeO 11.93 (9.92–16.25), MgO 11.95 (8.74–13.05), MnO 1.00 (0.67–1.34), total 100. The empirical formula based on 4 O pfu is $(Mg_{0.62}Fe_{0.35}^{2+}Mn_{0.03}^{2+})Fe_2^{3+}O_4$. The strongest reflections obtained by means of in situ synchrotron X-ray microdiffraction [d Å (I%; hkl)] are: 2.663 (100; 230), 1.932 (90; 321), 1.673 (20; 421), 1.533 (50; 501), 1.431 (12; 161), 1.155 (15; 252), 1.131

(12; 512), 1.087 (30; 820). Maohokite found to be orthorhombic, space group $Pnma$, a = 8.907(1), b = 9.937(8), c = 2.981(1) Å; V = 263.8(3) Å^3. It has $CaFe_2O_4$-type structure. Maohokite was formed from subsolidus decomposition of Fe-Mg carbonate via a self-oxidation-reduction reaction at impact pressure and temperature of 25–45 GPa and 800–900 °C. The name honors Hokwang Mao (b. 1941) of Geophysical Laboratory, Carnegie Institution of Washington, for his contribution to high pressure research. Type material is deposited in the Geological Museum, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences, Tianhe, China. **D.B.**

Meieranite*

H. Yang, X. Gu, R.T. Downs, S.H. Evans, J.J. Van Nieuwenhuizen, R.M. Lavinsky, and X. Xie (2019) Meieranite, $Na_2Sr_3MgSi_6O_{17}$, a new mineral from the Wessels mine, Kalahari Manganese Fields, South Africa. Canadian Mineralogist, 57(4), 457–466.

Meieranite (IMA 2015-009), ideally $Na_2Sr_3MgSi_6O_{17}$, orthorhombic, was discovered in the Wessels mine, Kalahari Manganese Fields, Northern Cape Province, South Africa (27°6′51.82″S, 22°51′18.31″E). The mineral occurs as isolated aggregates of grains up to 0.5 × 0.5 × 0.4 mm embedded in a matrix consisting mainly of pale green sugilite with a minor aegirine and pectolite. The mineral assemblage is probably a result of a hydrothermal event during metamorphism under conditions of 270–420 °C at 0.2–1.0 kbar. Meieranite is light blue to blue, transparent with white streak and vitreous luster. Cleavage is good on {010} with no parting and no twinning observed. The mineral is brittle with a Mohs hardness of 5.5; D_{meas} = 3.41(3), D_{calc} = 3.410 g/cm^3. In plane-polarized transmitted light meieranite is strongly pleochroic X = violet, Y = blue/violet, Z = blue. It is optically biaxial (–), with α = 1.610, β = 1.623, γ = 1.630 (white light), $2V_{meas}$ = 70(1)°, $2V_{calc}$ = 72°; X = **a**, Y = **b**, Z = **c**. Dispersion of optical axes is strong, $r > v$. The Raman spectrum has common features of nordite-group minerals with bands at the regions (cm^{-1}): 1200–900 (Si–O stretching within the SiO_4 groups); 800–750 (O–Si–O bending within the SiO_4 groups); 700–600 (Si–O_{br}–Si bending between SiO_4 tetrahedra: below 600 (rotational and translational modes of SiO_4 tetrahedra, M–O interactions and lattice modes). The average of nine point electron probe WDS analyses [wt% (range)] is: SiO_2 46.16 (45.52–46.74), CaO 0.21 (0.18–0.25), MgO 3.21 (2.74–4.29), MnO 2.53 (1.59–3.52), FeO 0.10 (0–0.26), Na_2O 7.75 (7.52–8.11), SrO 38.39 (38.07–38.97), BaO 0.52 (0.25–0.90), CoO 0.69 (0.41–0.81), PbO 0.56 (0.23–0.83), total 100.12. The empirical formula based on 17 O apfu is $Na_{1.96}(Sr_{2.91}Ba_{0.03}Ca_{0.03}Pb_{0.02})_{\Sigma2.99}(Mg_{0.62}Mn_{0.28}Co_{0.07}Fe_{0.01})_{\Sigma0.98}Si_{6.03}O_{17}$. The strongest reflections in the powder X-ray diffraction pattern are [d Å (I%; hkl)]: 3.550 (25; 123), 3.166 (42; 220), 2.990 (100; 222), 2.800 (84; 125), 2.623 (26; 040), 2.425 (17; 303), 2.126 (21; 242), 2.057 (27; 145), 1.778 (25; 343). The unit-cell parameters obtained from the powder XRD data are a = 7.9343(2), b = 10.4741(4), c = 18.2381(5) Å. Single-crystal XRD data collected from a crystal of 0.07 × 0.07 × 0.06 mm shows meieranite is orthorhombic, space group $P2_1nb$, a = 7.9380(2), b = 10.4923(3), c = 18.2560(6) Å, V = 1520.50 Å^3, Z = 4. The crystal structure was solved and refined to R_1 = 0.027 for 4738 independent $I>2σ(I)$ reflections. In the structure the layers of corner-sharing SiO_4 and $M^{2+}O_4$ tetrahedra (M^{2+} = Mg, Mn, Co, Fe) alternate along [010] with layers of NaO_6 and SrO_8 polyhedra. The tetrahedral layers consist of eight-, five-, and four-membered rings (with the ratio 1:2:1 respectively) and are composed of $[Si_6O_{17}]$ ribbons parallel to [101] and linked by MO_4 tetrahedra. The structure is topologically identical to that of the nordite-group minerals with the general chemical formula $Na_3SrR^{3+}M^{2+}Si_6O_{17}$, where R = (Ce,La). Chemically, meieranite related to nordite-group by substitution $2Sr^{2+}$ for $(Na^+ + R^{3+})$. The name honors Eugene Stuart Meieran (b. 1937), a member of the U.S. National Academy of Engineering, an avid mineral collector, who donated a number of important specimens to major museums, for his work in mineral preservation and education.

The cotype samples have been deposited at the University of Arizona Mineral Museum and the RRUFF Project, Tucson, Arizona, U.S.A. **D.B.**

PROXIDECAGONITE*

L. Bindi, J. Pham, and P.J. Steinhardt (2018) Previously unknown quasi-crystal periodic approximant found in space. Scientific Reports, 8, 16271.

Proxidecagonite (IMA 2018-038), $Al_{34}Ni_9Fe_2$, orthorhombic, is a new mineral discovered in a ~2.5 mm fragment of Khatyrka CV3 carbonaceous chondrite found at Listvenitovyi Stream, Koryak Upland, Chukotka, Russia. It has similar chemical composition to a recently discovered at the same meteorite quasi-crystalline mineral decagonite $Al_{71}Ni_{24}Fe_5$ (Bindi et al. 2015), but atomic arrangement is slightly distorted so that the symmetry conforms to the conventional laws of three-dimensional crystallography. That is reflected in the name, first part of which derived from the truncated Latin word *proximus* as periodic approximant to decagonite. Khatyrka meteorite formed 4.5 billion years ago and contains evidence of a heterogeneous distribution of pressures and temperatures during impact shock, in which some portions of the meteorite reached at least 5–10 GPa and 1200–1500 °C. The most recent strong shock supposedly took place in space a few hundred Ma. Proxidecagonite occurs as gray to black metallic anhedral grains up to ~20 μm associating with trevorite, diopside, forsterite, ahrensite, clinoenstatite, nepheline, coesite, stishovite, pentlandite, Cu-rich troilite, Al-rich taenite, icosahedrite, decagonite, khatyrkite, steinhardtite, and recently discovered in the same meteorite hollisterite (Al_3Fe), kryachkoite ($(Al,Cu)_6(Fe,Cu)$), and stolperite (AlCu) (Ma et al. 2017). In reflected light, proxidecagonite is weakly to moderately bireflectant, non-pleochroic with no internal reflections. It is anisotropic, without characteristic rotation tints. The reflectance values for **COM** wavelengths in air [R_{max}/R_{min} % (λ nm)] are: 31.2/28.8 (471.1), 32.0/29.4 (548.3), 32.8/30.6 (586.6), 33.7/31.5 (652.3). The average of four electron probe WDS analyses on the three homogeneous crystal fragments is [wt% (range)]: Al 58.75 (57.40–59.21), Ni 33.85 (32.92–34.15), Fe 7.09 (6.88–7.35), Mg 0.00 (0–0.02), Si 0.03 (0.01–0.04), P 0.00 (0–0.01), Co 0.01 (0–0.03), Cu 0.01 (0–0.02), Ca 0.00 (0–0.01), Zn 0.01 (0–0.02), S 0.00 (0–0.01), Cl 0.00 (0–0.01), total 99.76. The empirical formula based on 45 atoms pfu is $Al_{33.99}Ni_{9.00}Fe_{1.98}$ $Si_{0.02}Co_{0.01}$. The most intensive lines of the powder X-ray diffraction pattern [d Å (I%; hkl)] are: 3.96 (50; 203), 3.80 (40; 602), 3.403 (40; 421), 2.069 (50; 12.2.0), 2.045 (100; 10.2.3), 2.036 (30; 805), 2.033 (50; 040), 2.024 (70; 425). The unit-cell parameters refined from the powder data are $a = 28.861(2)$, $b = 8.1335(7)$, $c = 12.3442(9)$ Å, $V = 2897.7$ Å^3. The single-crystal XRD data shows proxidecagonite is orthorhombic, space group $Pnma$, $a = 29.013(3)$, $b = 8.156(1)$, $c = 12.401(2)$ Å, $V = 2934.4$ Å^3, $Z = 4$; $D_{calc} = 2.619$ g/cm^3. The crystal structure was refined to $R_1 = 2.46\%$ for 2360 observed $F_o > 4\sigma(F_o)$ reflections, and to $R_1 = 3.03\%$ for all 4537 independent reflections. The structure is similar to that of synthetic phase o'-$Al_{13}Co_4$ and represented by a close-packing of corner-sharing, empty (non-centered) polyhedra: Al_6 octahedra, Ni_2Al_3 and $NiAl_4$ trigonal bipyramids, Al_7 distorted pentagonal bipyramids, and Al_5 square pyramids. Polyhedra with pseudo-pentagonal symmetry tile the unit cell in a wave-like manner in the **ac**-plane with voids between them filled by the other polyhedra, which are also arranged in a wave-like fashion, so that Ni atoms intervene for maximal Ni–Al polar-covalent interactions within the structure. Type material is deposited in the Museo di Storia Naturale, Sezione di Mineralogia e Litologia, Università di Firenze, Italy. **D.B.**

References cited

Bindi, L., Yao, N., Lin, C., Hollister, L.S., Andronicos, C.L., Distler, V.V., Eddy, M.P., Kostin, A., Kryachko, V., MacPherson, G.J., Steinhardt, W.M., Yudovskaya, M., and Steinhardt, P.J. (2015) Decagonite, $Al_{71}Ni_{24}Fe_5$, a quasicrystal with decagonal symmetry from the Khatyrka CV3 carbonaceous chondrite. American Mineralogist, 100, 2340–2343.
Ma, C., Lin, C., Bindi, L., and Steinhardt, P.J. (2017) Hollisterite (Al_3Fe), kryachkoite

$(Al,Cu)_6(Fe,Cu)$, and stolperite (AlCu): Three new minerals from the Khatyrka CV3 carbonaceous chondrite. American Mineralogist, 102, 690–693.

RIESITE*

O. Tschauner, C. Ma, A. Lanzirotti, and M.G. Newville (2020) Riesite, a new high-pressure polymorph of TiO_2 from the Ries impact structure. Minerals, 10(1), 78.

Riesite (IMA 2015-110a), TiO_2, monoclinic, is a new mineral, high-pressure polymorph of TiO_2 discovered at the Ries impact structure, Germany, and named for the type locality. Riesite was found in thin section from a xenolith ZLN114, of garnet-sillimanite restite with a shock-melt veins that was trapped in suevite. The melt vein contains majorite-rich garnet (with stishovite inclusions), a jadeite-rich clinopyroxene, and accessory akaogiite, and reidite (the high-pressure polymorph of zircon). Riesite occurs as clasts (up to ~100 μm) composed of sub-micrometer grains. It was observed together with ilmenite, rutile, and akaogiite in several transformed or partially transformed rutile clasts. Physical and optical properties are not reported; $D_{calc} = 4.37$ g/cm^3. The average of 10-point electron probe WDS analyses [wt% (range)] is: TiO_2 99.25 (98.98–99.62), FeO 0.42 (0.33–0.53), CaO 0.03 (0.02–0.04), total 99.70. The strongest reflections of X-ray powder pattern [d Å (I%; hkl)] are: 3.490 (88; 110), 2.852 (100; $\bar{1}$11), 2.833 (70; 111), 2.359 (33; 120), 2.094 (22; 210), 1.682 (23; 122), 1.671 (26; $\bar{2}$02), 1.647 (27; $\bar{2}$21). Riesite is monoclinic, space group $P2/c$, $a = 4.519(3)$, $b = 5.503(8)$, $c = 4.888(2)$ Å, β = 90.59(8)°, $V = 121.5$ Å^3, $Z = 4$. The structure was refined by the Rietveld method to $R_p = 5.1\%$ and $\chi^2 = 11.2$ for 1534 observations. Riesite is closely related structurally to orthorhombic srilankite (TiO_2-II) [$Pnma$; $a = 4.5318(7)$, $b = 5.5019(7)$, $c = 4.9063(6)$ Å], from which it differs by having two distinct cation sites rather than one and through its monoclinic symmetry. The observation of riesite and akaogiite is consistent with peak pressure 20–25 GPa. Riesite forms only upon release from the shock state upon back transformation from akaogiite. Type material is deposited in the collections of the Institut für Geowissenschaften, Ruprecht-Karls Universität Heidelberg, Germany. **D.B.**

RUBINITE*

C. Ma, T. Yoshizaki, A.N. Krot, J.R. Beckett, T. Nakamura, K. Nagashima, J. Muto, and M.A. Ivanova (2017) Discovery of rubinite, $Ca_3Ti_2^{3+}Si_3O_{12}$, a new garnet mineral in refractory inclusions from carbonaceous chondrites. 80th Annual Meeting of the Meteoritical Society 2017 (LPI Contribution No. 1987), 6023.pdf.

C. Ma, T. Yoshizaki, T. Nakamura, and J. Muto (2017) Rubinite, IMA 2016-110. CNMNC Newsletter No. 36, April 2017, page 408; Mineralogical Magazine, 81, 403–409.

Rubinite (IMA 2016-110), $Ca_3Ti_2^{3+}Si_3O_{12}$, cubic, is a new mineral of garnet group, Ti^{3+}-analog of eringaite $Ca_3Sc_2Si_3O_{12}$, goldmanite $Ca_3V_2Si_3O_{12}$, uvarovite $Ca_3Cr_2Si_3O_{12}$, or andradite $Ca_3Fe_2Si_3O_{12}$. It was identified in five Ca-Al-rich inclusions (CAIs) in carbonaceous chondrite meteorites Vigarano, Allende, and Efremovka as irregular subhedral crystals, ~0.5–1, 1–8, and 1–20 μm respectively. In Vigarano it occurs in ultra-refractory fragment with Zr-panguite, spinel and daviste-diopside, all enclosed within forsterite aggregate. In Allende it found in fluffy type A (FTA) CAI with primary gehlenitic melilite, perovskite, spinel, hibonite, corundum, davisite, grossmanite, diopside, eringaite, and secondary anorthite, grossular, and Na-melilite. In Efremovka rubinite occurs within gehlenitic melilite with perovskite, spinel, and grossmanite in three compact type A (CTA) CAIs. The oxygen isotopes ratios were measured for rubinite, spinel, perovskite and other associated minerals in Efremovka CAIs. The macroscopic physical and optical properties were not determined due to small size; $D_{calc} = 3.63$ g/cm^3. The average of unspecified number electron probe analyses of rubinite in Allende is (wt%) CaO 32.68, Ti_2O_3 14.79, TiO_2 13.06 (Ti^{3+} and Ti^{4+} are partitioned by

stoichiometry), SiO_2 28.37 Al_2O_3 3.82, Sc_2O_3 1.80, Na_2O 1.01, ZrO_2, 0.80, MgO 0.79, V_2O_3 0.61, FeO 0.53, Y_2O_3 0.07, Cr_2O_3 0.05, total 98.38. The empirical formula based on 12 O pfu is $(Ca_{2.94}Na_{0.08})(Ti^{3+}_{1.04}Ti^{4+}_{0.59}Sc_{0.13}Mg_{0.10}$ $V_{0.04}Fe_{0.04}Zr_{0.03})(Si_{2.38}Al_{0.38}Ti^{4+}_{0.24})O_{12}$. The empirical formulae for rubinite from Efremovka and Vigarano are respectively: $(Ca_{2.97}Na_{0.06})(Ti^{3+}_{1.05}Ti^{4+}_{0.66}$ $Mg_{0.12}Sc_{0.09}Zr_{0.03}V_{0.03}Y_{0.01}Fe_{0.01})(Si_{2.36}Al_{0.48}Ti^{4+}_{0.16})O_{12}$ and $(Ca_{1.89}Y_{0.83}Mg_{0.28})$ $(Ti^{3+}_{0.59}Sc_{0.50}Zr_{0.72}Mg_{0.2}V_{0.02}Cr_{0.01})(Si_{1.64}Al_{1.18}Ti^{4+}_{0.07}Fe_{0.06})O_{12}$. The strongest reflection of the powder XRD pattern [d Å ($I\%$; hkl)] are: 3.047 (55; 004), 2.725 (100; 024), 2.488 (50; 224), 1.690 (34; 046), 1.629 (80; 246), 1.363 (18; 048), 1.330 (23; 248), 1.113 (20; 2.4.10). EBSD patterns can only be indexed using cubic space group $Ia\overline{3}d$ garnet structure with a = 12.1875 Å, V = 1810.27 Å^3, Z = 8. Rubinite is among the first solid materials in the solar nebula formed either as a condensate or through crystallization from an ^{16}O-rich Ca, Al, and Ti-rich melt under highly reduced conditions. The name honors Alan E. Rubin (b.1953), a cosmochemist at University of California, Los Angeles (UCLA), U.S.A., for his contributions to cosmochemistry and meteorite research. Type material is deposited in the Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California, U.S.A. (Vigarano), and in the Division of Earth and Planetary Materials Science, Tohoku University, Japan (Allende). **D.B.**

Uakitite*

V.V. Sharygin, G.S. Ripp, G.A. Yakovlev, Yu.V. Seryotkin, N.S. Karmanov, I.A. Izbrodin, V.I. Grokhovsky, and E.A. Khromova (2018) Uakitite VN, a new nitride in iron meteorites. 81st Annual Meeting of The Meteoritical Society 2018 (LPI Contribution No. 2067), 6252.pdf.

V.V. Sharygin, G.S. Ripp, G.A. Yakovlev, Yu.V. Seryotkin, N.S. Karmanov, I.A. Izbrodin, V.I. Grokhovsky, and E.A. Khromova (2020) Uakitite, VN, a new mononitride mineral from Uakit iron meteorite (IIAB). Minerals, 10(2), 150.

Uakitite (IMA 2018-003), ideally VN, cubic, was discovered in (and named for) Uakit iron meteorite (hexahedrite IIAB) found in 2016 on the stream Mukhtunnyi terrace, left feeder of the Uakit River, near the Uakit settlement, Baunt Evenk district, Republic of Buryatia, Russia. Uakitite occurs in small troilite–daubréelite (±schreibersite) inclusions up to 100 μm and in large troilite–daubréelite nodules up to 1 cm in kamacite—the main mineral of the meteorite (93–98 vol%). Other minor minerals in meteorite are nickelphosphide, taenite, cohenite, tetrataenite, kalininite, grokhovskyite, carlsbergite, heazlewoodite, pentlandite, sphalerite, copper, unidentified Mo-dominant phase (<0.5 μm), and magnetite. Carlsbergite (Cr analogue of uakitite CrN is a more abundant nitride in the Uakit meteorite, but it was not found in same inclusions with uakitite. Phase relations indicate uakitite as an early mineral in these association. It supposed to be formed due to high-temperature (>1000 °C) separation of Fe-Cr-rich sulfide liquid from Fe-metal melt. Uakitite forms euhedral (cubic) crystals (in daubréelite) or rounded grains (in schreibersite) up to 5 μm. The physical properties were not obtained due to grains' small size. D_{calc} = 6.128 g/cm^3. The synthetic VN is yellow, transparent with a strong luster and white streak. It is non-fluorescent, brittle with no cleavage or parting. Mohs hardness is 9–10. It is not soluble in water and weakly concentrated HCl, HNO_3, and H_2SO_4. In reflected light uakitite is light gray with a pinkish tint and no internal reflections. Refractive index for synthetic VN is n = 2.303 and reflectance R = 43.82% for λ = 587.6 nm. The average of 54 electron probe WDS analysis of uakitite [wt% (range)] is: V 71.33 (70.91–71.90), Cr 5.57 (5.02–6.18), Fe 1.56 (1.16–2.08), N 21.41 (21.22–21.54), Ti <0.005, total 99.88. The empirical formula based on 2 atoms pfu is $(V_{0.91}Cr_{0.07}Fe_{0.02})_{1.00}N_{1.00}$. The X-ray powder diffraction pattern was calculated using the structural data of the synthetic VN and the empirical formula of uakitite. The strongest reflections [d_{calc} Å ($I_{calc}\%$; hkl)] are: 2.386 (71; 111), 2.066 (100; 200), 1.461 (61;

220), 1.246 (29; 311), 1.193 (19; 222), 0.924 (21; 420), 0.844 (14; 422). Uakitite (δ-VN) is structurally related to the osbornite group (carlsbergite CrN and osbornite TiN). EBSD studies showed full structural identity between uakitite and its synthetic analog (NaCl-type structure). Fitting of the EBSD patterns for a synthetic VN model [cubic, $Fm\overline{3}m$, a = 4.1328(3) Å; V = 70.588 Å^3; Z = 4 resulted in the parameter MAD = 0.14–0.37° (best-good fit)]. The type specimens of are deposited in the collections of two institutes of Siberian Branch of Russian Academy of Sciences: the Central Siberian Geological Museum of the Institute of Geology and Mineralogy, Novosibirsk Siberian Branch of Russian Academy of Sciences, and Museum of Buryatia Scientific Center, Ulan-Ude, Russia. **D.B.**

Wangdaodeite*

X. Xie, X. Gu, H. Yang, M. Chen, and K. Li (2020) Wangdaodeite, the LiNbO$_3$-structured high-pressure polymorph of ilmenite, a new mineral from the Suizhou L6 chondrite. Meteoritics and Planetary Science, 55(1), 184–192.

Wangdaodeite (IMA 2016-007), ideally FeTiO$_3$, trigonal, is a new mineral, high-pressure polymorph of ilmenite from the Suizhou L6 chondrite meteorite that fell in the suburb of Suizhou City, Hubei Province, China. The occurrence of tiny grains of LiNbO$_3$-type FeTiO$_3$ was first reported (Dubrovinsky et al. 2009) in the Ries crater, Germany. In the Suizhou L6 chondrite wangdaodeite forms small irregular grains 2–20 μm (consisting of random-oriented domains 20–50 nm) inside or adjacent to the shock melt veins 0.02–0.20 mm thick in chondritic area of this meteorite consists of olivine, pyroxene, plagioclase, FeNi-metal and troilite, merrillite, chlorapatite, chromite, ilmenite. Melt veins contain maskelynite and shock-induced high-pressure minerals: ringwoodite, majorite, akimotoite, vitrified perovskite, lingunite, tuite, xieite, CaFe$_2$O$_4$-structured FeCr$_2$O$_4$, majorite–pyrope, *magnesiowüstite*, and hemleyite. No cleavage or parting were observed. Mohs hardness estimated by similar relief to associated ilmenite is 5–5.5. Macroscopic properties were not determined due to the small size of grains; D_{calc} = 4.72 g/cm^3. The reflectance values obtained for COM wavelengths [$R_1/R_2\%$ λ nm] are: 21.0/18.7 470, 19.9/17.9 546, 20.1/18.0 589, 20.4/18.3 650. Other optical properties are not reported. The Raman spectra of wangdaodeite show the bands at 174–179, 273–277, 560–567, and 738–743 cm^{-1}, being apparently different of those for ilmenite and similar to those of synthetic FeTiO$_3$, MnTiO$_3$, ZnTiO$_3$ with LiNbO$_3$ structure and to LiNbO$_3$ itself. Three additional peaks at 221–226, 406, and 686–690 cm^{-1} are interpreted as caused by the relics of precursor ilmenite. The average of 11 spot electron probe WDA analyses on 7 grains [wt% (range)] is: FeO 41.05 (39.59–41.50), MgO 2.79 (2.44–3.03), MnO 2.74 (2.13–4.38), Al$_2$O$_3$ 0.04 (0–0.10), V$_2$O$_3$ 0.19 (0–0.29), Cr$_2$O$_3$ 0.04 (0–0.09), TiO$_2$ 52.69 (52.13–53.92), total 99.54. The empirical formula based on 3O pfu is: $(Fe_{0.86}Mg_{0.10}Mn_{0.06})_{\Sigma1.02}Ti_{0.99}O_3$. The strongest reflections of the electron diffraction patterns of polycrystalline grains [d Å ($I\%$; hkl)] are: 3.75 (72; 10$\overline{2}$), 2.72 (100; 104), 2.56 (89; 2$\overline{1}$0), 2.23 (57; 2$\overline{1}$3), 1.86 (59; 20$\overline{4}$), 1.62 (41; 10$\overline{8}$), 1.51 (44; 3$\overline{1}$4), 1.48 (44; 300). Electron diffraction data is consistent with the lithium niobate structure and shows wangdaodeite is trigonal, space group $R3c$, a = 5.13(1), c = 13.78(1) Å, V = 314.06 Å^3, Z = 6. The corner-linked TiO$_6$ octahedra of adjacent octahedral layers in the structure of LiNbO$_3$-type FeTiO$_3$ are rotated relative to one another compare to ilmenite structure where TiO$_6$ octahedra share edges. Based on paragenesis and high-pressure and high-temperature experiments the P–T conditions for formation of wangdaodeite were estimated as 20–24 GPa and >1200 °C. The name honors Daode Wang (1932–2012), of the Guangzhou Institute of Geochemistry, Chinese Academy of Sciences (type material is now hosted in Geological Museum of that institute) for his contributions to systematic study of meteorites of China and Antarctic. **D.B.**

References cited

Dubrovinsky, L., El Goresy, A., Gillet, P., Wu, X., and Simionivici, A. (2009) A novel natural shock-induced high-pressure polymorph of $FeTiO_3$ ilmenite with the Li-niobate structure from the Ries crater, Germany. Meteoritics and Planetary Science, 44, A64.

ZAGAMIITE*

C. Ma, O. Tschauner, and J.R. Beckett (2019) A closer look at Martian meteorites: discovery of the new mineral zagamiite, $CaAl_2Si_{3.5}O_{11}$, a shock-metamorphic, high-pressure, calcium aluminosilicate. Ninth International Conference on Mars 2019 (LPI Contribution No. 2089), 6138.pdf.

Zagamiite (IMA 2015-022a), $CaAl_2Si_{3.5}O_{11}$, hexagonal, a new high-pressure calcium aluminosilicate was discovered in shock melt pockets in the basaltic shergottites Zagami and NWA 856. Later it was identified in other shergottites, like Tissint. The mineral was named for locality Zagami, Nigeria, where the Zagami meteorite fell. The meteorites in which zagamiite occurs consist mainly of zoned augite or pigeonite and the shock-generated plagioclase glass *maskelynite* with accessory ilmenite, titanomagnetite, baddeleyite, merrillite, apatite, and Fe sulfide. Other high pressure minerals liebermannite, lingunite, stishovite, and *tissinite*-II $(Ca,Mg,Na,\square_{0.14})(Al,Fe,Mg)Si_2O_6$, were found along with zagamiite in shock melt veins and pockets in Zagami (stishovite in NWA 856). Zagamiite suggested to be formed by crystallization from a melt derived from a plagioclase-rich mixture of plagioclase and clinopyroxene, rather than through solid state transformation of a precursor mineral. Zagamiite forms prismatic crystals, less than 50 nm × 100 nm to 400 nm × 1 μm. Data on physical properties were not obtained due to a small size. The averages of electron probe (mode is not specified) analysis of zagamiite from Zagami meteorite (6 points)/NWA 856 (8 points) are (wt%): SiO_2 56.95/56.22, Al_2O_3 28.27/27.26, CaO 9.96/10.71, Na_2O 2.67/2.49, FeO 1.01/1.64, K_2O 0.44/0.39, MgO 0.06/0.24, TiO_2 0.05/0.08, MnO 0.03/0.08, total 99.45/99.10. The empirical formulae based on 11 O pfu are $(Ca_{0.66}Na_{0.32}K_{0.03})_{\Sigma1.01}(Al_{1.94}Fe_{0.05}Mg_{0.01})_{\Sigma2.00}(Si_{3.51}Al_{0.11})_{\Sigma3.62}O_{11}$/ $(Ca_{0.71}Na_{0.30}K_{0.03})_{\Sigma1.04}(Al_{1.89}Fe_{0.09}Mg_{0.02})_{\Sigma2.00}(Si_{3.50}Al_{0.11})_{\Sigma3.61}O_{11}$. The main lines in the powder-like synchrotron diffraction pattern [d Å ($I\%$; hkl)] are: 2.701 (29; 110), 2.638 (49; 014), 2.488 (20; 112), 2.197 (15; 022), 2.050 (100; 023), 1.575 (67; 026), 1.547 (22; 031,124), 1.351 (44; 220). Zagamiite is hexagonal $P6_3/mmc$, $a = 5.403(2)$ Å, $c = 12.77(3)$ Å, $V = 322.84$ Å^3, $Z = 2$. The structure and cell parameters are very similar to those of synthetic phase CAS ($CaAl_4Si_2O_{11}$) which is distinctly different in chemistry mostly by differing site occupancies of the 12-coordinated $2c$ ($Ca_{4/5}Na_{1/5}$ in zagamiite vs. Ca_1 in CAS), octahedral $6g$ ($\sim Si_{3/4}\square_{1/4}$ vs. $Si_{2/3}Al_{1/3}$), and tetrahedral $4f$ ($\sim Si_{1/3}\square_{2/3}$ vs. $Al_{1/2}\square_{1/2}$) sites. CAS phase may be important in the Earth's mantle. Incompletely described natural CAS reported in Zagami and NWA 856 shergotites (Beck et al. 2004). Attempts to confirm the presence of CAS in the areas with zagamiite texturally equivalent to CAS-dominated regions described Beck et al. (2004) at the same meteorites were unsuccessful. Zagamiite type materials are deposited in the Smithsonian Institution, National Museum of Natural History, Washington, D.C., U.S.A. (Zagami), and in the E. Stolper's Martian Meteorite Collection of the Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, California, U.S.A. (NWA 856). **D.B.**

References cited

Beck, P., Gillet, P., Gautron, L., Daniel, I., and El Goresy, A. (2004) A new natural high-pressure (Na,Ca)-hexaluminosilicate $[(Ca_xNa_{1-x})Al_{3+x}Si_{3-x}O_{11}]$ in shocked Martian meteorites. Earth and Planetary Science Letters, 219 (1–2), 1–12.

UNITED STATES POSTAL SERVICE® — Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)

1. Publication Title: American Mineralogist (The)
2. Publication Number: 0070-760
3. Filing Date: 09/28/2020

4. Issue Frequency: 12 issues/yr; 6 print issues per year
5. Number of Issues Published Annually: Six (print) issues
6. Annual Subscription Price: $150.00 (U.S.)

7. Complete Mailing Address of Known Office of Publication (Not printer) (Street, city, county, state, and ZIP+4®):
Mineralogical Society of America
3635 Concorde Parkway, Suite 500, Chantilly, VA 20151-1110

Contact Person: Ann Benbow
Telephone (include area code): 703-652-9950

8. Complete Mailing Address of Headquarters or General Business Office of Publisher (Not printer):
Mineralogical Society of America
3635 Concorde Parkway, Ste 500, Chantilly, VA 20151-1110

9. Full Names and Complete Mailing Addresses of Publisher, Editor, and Managing Editor (Do not leave blank)

Publisher (Name and complete mailing address)
Mineralogical Society of America
3635 Concorde Pkwy, Suite 500, Chantilly, VA 20151-1110

Editor (Name and complete mailing address)
Don Baker; Hongwu Xu, Mineralogical Society of America
3635 Concorde Pkwy, Ste 500, Chantilly, VA 20151-1110

Managing Editor (Name and complete mailing address)
Rachel Russell, Mineralogical Society of America
3635 Concorde Pkwy, Ste 500, Chantilly, VA 20151-1110

10. Owner (Do not leave blank. If the publication is owned by a corporation, give the name and address of the corporation immediately followed by the names and addresses of all stockholders owning or holding 1 percent or more of the total amount of stock. If not owned by a corporation, give the names and addresses of the individual owners. If owned by a partnership or other unincorporated firm, give its name and address as well as those of each individual owner. If the publication is published by a nonprofit organization, give its name and address.)

Full Name	Complete Mailing Address
Mineralogical Society of America	3635 Concorde Parkway, Ste. 500 Chantilly, VA 20151-1110

11. Known Bondholders, Mortgagees, and Other Security Holders Owning or Holding 1 Percent or More of Total Amount of Bonds, Mortgages, or Other Securities. If none, check box → ☐ None

Full Name	Complete Mailing Address

12. Tax Status (For completion by nonprofit organizations authorized to mail at nonprofit rates) (Check one)
The purpose, function, and nonprofit status of this organization and the exempt status for federal income tax purposes:
☒ Has Not Changed During Preceding 12 Months
☐ Has Changed During Preceding 12 Months (Publisher must submit explanation of change with this statement)

PS Form 3526, July 2014 [Page 1 of 4 (see instructions page 4)] PSN: 7530-01-000-9931   PRIVACY NOTICE: See our privacy policy on www.usps.com.

---

13. Publication Title: American Mineralogist (The)
14. Issue Date for Circulation Data Below: 8/31/2020

15. Extent and Nature of Circulation

			Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Total Number of Copies (Net press run)			600	600
b. Paid Circulation (By Mail and Outside the Mail)	(1)	Mailed Outside-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	200	215
	(2)	Mailed In-County Paid Subscriptions Stated on PS Form 3541 (Include paid distribution above nominal rate, advertiser's proof copies, and exchange copies)	0	0
	(3)	Paid Distribution Outside the Mails Including Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and Other Paid Distribution Outside USPS®	210	252
	(4)	Paid Distribution by Other Classes of Mail Through the USPS (e.g., First-Class Mail®)	0	0
c. Total Paid Distribution (Sum of 15b (1), (2), (3), and (4)) ▶			410	467
d. Free or Nominal Rate Distribution (By Mail and Outside the Mail)	(1)	Free or Nominal Rate Outside-County Copies included on PS Form 3541	2	2
	(2)	Free or Nominal Rate In-County Copies Included on PS Form 3541	0	0
	(3)	Free or Nominal Rate Copies Mailed at Other Classes Through the USPS (e.g., First-Class Mail)	0	0
	(4)	Free or Nominal Rate Distribution Outside the Mail (Carriers or other means)	0	0
e. Total Free or Nominal Rate Distribution (Sum of 15d (1), (2), (3) and (4)) ▶			2	2
f. Total Distribution (Sum of 15c and 15e) ▶			412	469
g. Copies not Distributed (See Instructions to Publishers #4 (page #3)) ▶			188	131
h. Total (Sum of 15f and g) ▶			600	600
i. Percent Paid (15c divided by 15f times 100) ▶			99.6	99.6

* If you are claiming electronic copies, go to line 16 on page 3. If you are not claiming electronic copies, skip to line 17 on page 3.

PS Form 3526, July 2014 (Page 2 of 4)

UNITED STATES POSTAL SERVICE® — Statement of Ownership, Management, and Circulation (All Periodicals Publications Except Requester Publications)

16. Electronic Copy Circulation

		Average No. Copies Each Issue During Preceding 12 Months	No. Copies of Single Issue Published Nearest to Filing Date
a. Paid Electronic Copies ▶		2021	2296
b. Total Paid Print Copies (Line 15c) + Paid Electronic Copies (Line 16a) ▶		2411	2763
c. Total Print Distribution (Line 15f) + Paid Electronic Copies (Line 16a) ▶		2433	2765
d. Percent Paid (Both Print & Electronic Copies) (16b divided by 16c × 100) ▶		99.1	99.9

☒ I certify that 50% of all my distributed copies (electronic and print) are paid above a nominal price.

17. Publication of Statement of Ownership

☒ If the publication is a general publication, publication of this statement is required. Will be printed   ☐ Publication not required.
in the Nov/Dec 2020 issue of this publication.

18. Signature and Title of Editor, Publisher, Business Manager, or Owner

Ann E. Benbow MSA Executive Director

Date: 9/28/2020

I certify that all information furnished on this form is true and complete. I understand that anyone who furnishes false or misleading information on this form or who omits material or information requested on the form may be subject to criminal sanctions (including fines and imprisonment) and/or civil sanctions (including civil penalties).

PS Form 3526, July 2014 (Page 3 of 4)   PRIVACY NOTICE: See our privacy policy on www.usps.com.

American Mineralogist is now available online three ways

▼**1** *Via MSA* – The classic PDF presentation in a simple no-frills environment. To view: http://www.minsocam.org/msa/ammin/toc/. *Institutional Subscription information:* http://www.minsocam.org/msa/AmMin/subscription.html
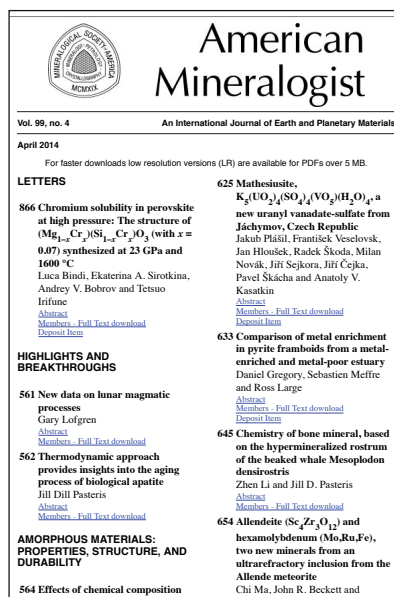
▶**2** *Via Geoscienceworld* – Since 2004, a comprehensive internet resource for research across the geosciences, built on a database of peer-reviewed journals and integrated with GeoRef. This gives global researchers a single point of access to 45 full-text scholarly journals and links to millions of relevant resources hosted elsewhere on the Web. http://ammin.geoscienceworld.org/. Many features including html and PDF views. *To subscribe:* http://www.geoscienceworld.org/site/subscriptions/
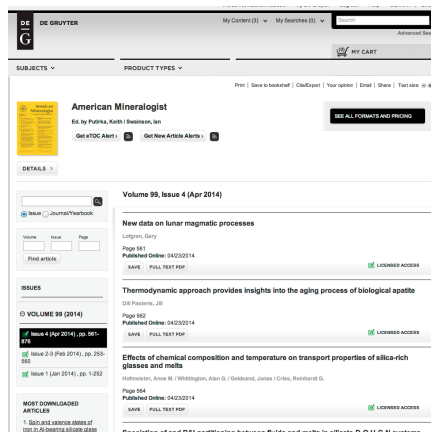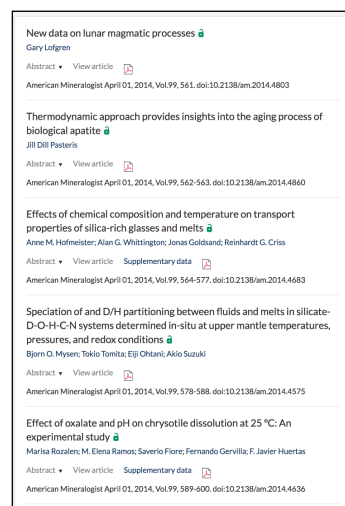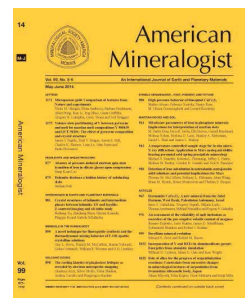
◀**3** *Via De Gruyter* – our newest offering, another way for libraries include in their collection our great articles and variety. The features you expect in today's web, such as eTOC alerts and new article alerts and cite/export. *To subscribe:* http://www.degruyter.com/view/j/ammin

Our Aims and Scope

American Mineralogist: Journal of Earth and Planetary Materials, is the flagship journal of the Mineralogical Society of America (MSA), continuously published since 1916. Our mission is to provide readers with reports on original scientific research, both fundamental and applied, with far reaching implications and far ranging appeal. Topics of interest cover all aspects of planetary evolution, and biological and atmospheric processes mediated by solid-state phenomena. These include, but are not limited to, mineralogy and crystallography, high- and low-temperature geochemistry, petrology, geofluids, bio-geochemistry, bio-mineralogy, synthetic materials of relevance to the Earth and planetary sciences, and breakthroughs in analytical methods of any of the aforementioned.

Have your librarian pick the one that suits your institution's needs and budget today!

American Mineralogist: Learn More

Editors: Don Baker and Hongwu Xu

We invite you to submit for publication the results of *original scientific research* in the general fields of mineralogy, crystallography, geochemistry, and petrology. Specific areas of coverage include, but are not restricted to, igneous and metamorphic petrology, experimental mineralogy and petrology, crystal chemistry and crystal-structure determinations, mineral spectroscopy, mineral physics, isotope mineralogy, planetary materials, clay minerals, mineral surfaces, environmental mineralogy, biomineralization, descriptive mineralogy and new mineral descriptions, mineral occurrences and deposits, petrography and petrogenesis, and novel applications of mineralogical apparatus and technique. Am Min also cultivates a number of special collections that are frequently updated.

Submit your paper: https://aminsubmissions.msubmit.net

Information on manuscript preparation:
http://www.minsocam.org/MSA/AmMin/Instructions.html

Am Min website
http://www.minsocam.org/msa/AmMin/AmMineral.html

Quick Facts

- Average submission-to-acceptance time averages ~4 months
- MSA member authors qualify for *free* online color
- Read research articles, reviews, special collections, and more
- Paper Highlights are noted each issue via the MSA talk list, Facebook, and Am Min web page
- Publish with us for high-quality, fast publication, with availability and visiblity worldwide
- Full array of the latest publishing options: e.g., Open access options (both Green and Gold), early publication, reprints, and e-links are all available
- Letters papers submission to acceptance time averages less than 2 months
- Impact Factor 2018: 2.63

Editorial and submission help available at peer_review@minsocam.org