**Falottaite**

S. Graeser and W Gabriel (2016) Falottait (MnC\textsubscript{2}O\textsubscript{4}·3H\textsubscript{2}O)—ein neues Oxalat-Mineral aus den Schweizer Alpen. Schweizer Strahler, 50(3), 20–27 (in German and French).

Falottaite (IMA 2013-044), MnC\textsubscript{2}O\textsubscript{4}·3H\textsubscript{2}O, 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 radiolaric rocks of the large Oberhalbstein ophiolitic 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 arseanates: brandtite, sarkinite, manganberzeliite, tilasite, kennismitze, bergslagite, grischunite, geigerite, and cabalzarite. Falottaite presumably resulted from reaction of humus and oxalic acids (from plants) with manganese minerals. Perfectly shaped colorless transparent rock-like crystals up to 1 × 0.5 mm were found in small fractures in the radiolarites, grown on small idiomorphic slightly rose quartz. The smallest subhedral crystal ~ 7 × 6 × 5 mm was deposited in the Natural History Museum Basel, Basel, Switzerland.

**Hemleyite**


Hemleyite (IMA 2016-085), ideally FeSiO\textsubscript{3}, trigonal, is a new mineral—Fe-analogue of akimotoite (ilmenite-structured MgSiO\textsubscript{3}), and a predicted high-pressure polymorph of clinoferosilite, 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, lingunitie, tuite, xiete, and (Mg,Fe)SiO\textsubscript{4}-glass (probably a vitrified mineral of perovskite structure). Hemleyite found as one subhedral crystal ~ 7 × 6 × 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\textsubscript{meas} = 4.383 g/cm\textsuperscript{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\textsuperscript{-1} with the typical strong peak at 795 cm\textsuperscript{-1}, corresponding to the stretching vibrations of the SiO\textsubscript{4} tetrahedra. 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\textsubscript{2} 51.08 (50.68–51.85), Al\textsubscript{2}O\textsubscript{3} 1.26 (1.11–2.55), Cr\textsubscript{2}O\textsubscript{3} 0.61 (0.29–1.25), CaO 29.33 (26.88–30.52), MgO 12.71 (11.21–13.10), FeO 1.88 (0.95–2.03), MnO 1.76 (1.44–2.05), Na\textsubscript{2}O 1.02 (0.88–1.39), total 99.65. The empirical formula based on 3 O pfu is (Fe\textsubscript{2+}\textsubscript{0.48Mg\textsubscript{0.37Ca\textsubscript{0.04}}\textsubscript{0.28}Mn\textsubscript{0.28}Ca\textsubscript{0.28}Mn\textsubscript{0.28}Mg\textsubscript{0.28}Al\textsubscript{0.28}Al\textsubscript{0.28}Al\textsubscript{0.28}Al\textsubscript{0.28}Al\textsubscript{0.28}Si\textsubscript{0.28}O\textsubscript{12}). The strongest lines in powder XRD pattern [d (Å, P(hkkl)] are: 3.520 (35; 012), 2.625 (100; 014), 2.376 (50; 212), 2.126 (50; 012), 2.02 (50; 212), 1.762 (70; 011). The single-crystal XRD data shows hemleyite is trigonal, space group R\textsubscript{3}, a = 6.7490(2), c = 13.6934(9) Å, V = 266.45 Å\textsuperscript{3}. The crystal structure was refined to
NEW MINERAL NAMES

ICE-VII*


Ice-VII (IMA 2017-029), H2O, 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 nickleiferous carbonate 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 periodic 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 (%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 (Rω = 4.57% with γ^2 = 1.71 for 1398 observations) as those of ice-VII, cubic, space group P63/m, a = 3.163 Å. 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 Cl1. 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.

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American Mineralogist, vol. 105, 2020
KAITIANITE*

C. Ma (2019) Discovery of kaitianite, Ti\textsubscript{3+}Ti\textsubscript{4+}O\textsubscript{8}, in Allende: a new refractory mineral from the solar nebula. 82\textsuperscript{nd} Annual Meeting of The Meteoritical Society (LPI Contrib. No. 2157), 6098.pdf.

Kaitianite (IMA 2017-078a), Ti\textsuperscript{3+}Ti\textsuperscript{4+}O\textsubscript{8}, monoclinal, is a new mineral discovered in Allende CV3 carbonaceous chondrite meteorite fallen in Mexico on February 8\textsuperscript{th}, 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\textsubscript{4+}O\textsubscript{8} 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\textsuperscript{3+}-bearing corundum, oxide (Ti\textsuperscript{3+}Al\textsubscript{2}Zr\textsubscript{2}Si\textsubscript{3}Mg\textsubscript{2}O\textsubscript{19} (related to panguite-kangite-type due to the size."

The empirical formula based on 4 O pfu is (Mg\textsubscript{0.62}Fe\textsubscript{2+}Si\textsubscript{0.05}Ti\textsubscript{4+}O\textsubscript{19}). The patterns can be indexed only by the V\textsubscript{3}O\textsubscript{5}-type apportioned by stoichiometry. The strongest X-ray microdiffraction reflections are \{d Å (P%; hkl)\}: 4.689 (53; 200), 3.377 (75; 202), 2.931 (73; 3\textbar{1}2), 2.662 (100; 3\textbar{1}0), 2.160 (59; 1\textbar{1}2), 1.737 (66; 2\textbar{2}2\textbar{3}), 1.671 (67; 3\textbar{1}4\textbar{0}3), 1.451 (52; 1\textbar{3}2\textbar{3}4\textbar{2}2\textbar{3}), 1.32 (12; 2\textbar{2}4\textbar{2}2\textbar{3}). The EBSD data shows kaitianite is monoclinic, space group C2/c, α = 10.115, β = 5.074, γ = 7.182 Å, β = 112°. V = 341.77 Å\textsuperscript{3}, Z = 4. The patterns can be indexed only by the V\textsubscript{3}O\textsubscript{5}-type structure and give a perfect fit by the synthetic γ-Ti\textsubscript{4+}O\textsubscript{8}. Kaitianite is a fossil solar titanium oxide with structurally essential Ti\textsuperscript{3+} and Ti\textsuperscript{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

MAOHOKITE*

M. Chen, J. Shu, X. Xie, and D. Tan (2019) Maohokite, a post-spinel polymorph of MgFe\textsubscript{2}O\textsubscript{4}, orthorhombic, was discovered in the Wessels mine, Kalahari Manganese Fields, South Africa. Canadian Mineralologist, 57(4), 457–466.

Maohokite (IMA 2015-009), ideally Na\textsubscript{0.19}Sr\textsubscript{0.81}Mg\textsubscript{0.12}Si\textsubscript{0.88}O\textsubscript{4}, orthorhombic, was discovered in the Wessels mine, Kalahari Manganese Fields, Northern Cape Province, South Africa (27°6′51.82″S, 22°5′11.31″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 aegerine 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. Maohokite is light blue to blue, transparent with white streak and vitreous luster. Cleavage is good on {1011} with no parting and no twinning observed. The mineral is brittle with a Mohs hardness of 5.5; D\textsubscript{max} = 3.411 (D\textsubscript{ae} = 3.410 g/cm\textsuperscript{3}). In plane-polarized transmitted light maohokite is strongly pleochroic X = violet, Y = blue, Z = blue. It is optically biaxial (+), with α = 1.610, β = 1.623, γ = 1.630 (white light), 2V\textsubscript{max} = 70°(12°), 2V \textsubscript{12°} = 72°; X = a, Y = b, Z = c. Dispersion of optical axes is strong, r > ω. The Raman spectrum has common features of nordite-group minerals with bands at the regions (cm\textsuperscript{-1}): 1200–900 (Si–O stretching within the SiO\textsubscript{4} groups); 800–750 (O–Si–O bending within the SiO\textsubscript{4} groups); 700–600 (Si–O\textsubscript{br}–Si bending). 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 maierite is orthorhombic, space group P2\textsubscript{1}2\textsubscript{1}2\textsubscript{1}, a = 7.9380(2), b = 10.4923(3), c = 18.2560(6) Å, V = 1320.50 Å\textsuperscript{3}, Z = 4. The crystal structure was solved and refined to R\textsubscript{1} = 0.027 for 4738 independent I=2ω(1) reflections. In the structure the layers of corner-sharing SiO\textsubscript{4} and M\textsuperscript{2+}O\textsubscript{4} tetrahedra (M\textsuperscript{2+} = Mg, Mn, Co, Fe) alternate along [010] with layers of Na\textsubscript{0.19}Sr\textsubscript{0.81}Mg\textsubscript{0.12}O\textsubscript{4}. The strongest reflections in the powder X-ray diffraction pattern are \{d Å (P%; hkl)\}: 3.550 (25; 123), 3.166 (42; 220), 2.990 (100; 222), 2.800 (84; 125), 2.623 (26; 940), 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 maierite is orthorhombic, space group P2\textsubscript{1}2\textsubscript{1}2\textsubscript{1}, a = 7.9380(2), b = 10.4923(3), c = 18.2560(6) Å, V = 1320.50 Å\textsuperscript{3}, Z = 4. The crystal structure was solved and refined to R\textsubscript{1} = 0.027 for 4738 independent I=2ω(1) reflections. In the structure the layers of corner-sharing SiO\textsubscript{4} and M\textsuperscript{2+}O\textsubscript{4} tetrahedra (M\textsuperscript{2+} = Mg, Mn, Co, Fe) alternate along [010] with layers of Na\textsubscript{0.19}Sr\textsubscript{0.81}Mg\textsubscript{0.12}O\textsubscript{4}. The strongest reflections in the powder X-ray diffraction pattern are \{d Å (P%; hkl)\}: 3.550 (25; 123), 3.166 (42; 220), 2.990 (100; 222), 2.800 (84; 125), 2.623 (26; 940), 2.425 (17; 303), 2.126 (21; 242), 2.057 (27; 145), 1.778 (25; 343).
The cotyle 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), Al3NiFe2, 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 Al3NiFe2 (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, clinodunita, nepheline, coesite, stishovite, pentlandite, Cu-rich troilite, Al-rich taenite, icosahe drite, coesite, stishovite, pentlandite, Cu-rich troilite, Al-rich taenite, icosahedrite, decagonite, coesite, stishovite, and stolperite (AlCu) (Ma et al. 2017). In reflected light, proxidecagonite is anisotropic, without characteristic rotation tints. The empirical formula based on 45 atoms pfu is Al33.99Ni9.00Fe1.98Mg0.00 (0–0.01), Zn 0.01 (0–0.02), S 0.00 (0–0.01), P 0.00 (0–0.01), Ca 33.85 (32.92–34.15), Fe 7.09 (6.88–7.35), Mg 0.00 (0–0.02), Si 0.03 (0–0.04), P 0.00 (0–0.01), Co 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 average of 10-point electron probe WDS analyses [wt% (range)] is: TiO2 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 (A (% P; hkℓ)]= 3.490 (88; 110), 2.852 (100; ℴ11), 2.833 (70; 111), 2.359 (33; 120), 2.094 (22; 210), 1.682 (23; 122), 1.671 (26; 202), 1.647 (27; 221). 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 Å3, Z = 4. The structure was refined by the Rietveld method to Rp = 5.1% and y2 = 11.2 for 1534 observations. Riesite is closely related structurally to orthorhombic stishovite (TiO2-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 rie site 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***


Rubinite (IMA 2016-110), Ca3Ti2Si3O12, cubic, is a new mineral of garnet group, Ti3+-analog of eringaite Ca3Sc2Si3O12, goldenmanite Ca3V2Si3O12, uvarovite Ca3Cr2Si3O12, or andradite Ca3Fe2Si3O12. 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 davisite-diopside, all enclosed within forsterite aggregate. In Allende it found in fluffy ultra-refractory fragment with Zr-panguite, spinel, and davisite-diopside, all enclosed within forsterite aggregate. In Allende it found in thin section from a xenolith ZLN1114, 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 reudite (the high-pressure polymorph of zircon). Rubinite occurs as clasts (up to ~100 μm) composed of submicrogram 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* = 4.37 g/cm³. The average of 10-point electron probe WDS analyses [wt% (range)] is: TiO2 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 (A (% P; hkℓ)]= 3.490 (88; 110), 2.852 (100; ℴ11), 2.833 (70; 111), 2.359 (33; 120), 2.094 (22; 210), 1.682 (23; 122), 1.671 (26; 202), 1.647 (27; 221). 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 Å³, Z = 4. The structure was refined by the Rietveld method to Rp = 5.1% and y2 = 11.2 for 1534 observations. Riesite is closely related structurally to orthorhombic stishovite (TiO2-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 rie site 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.**

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Ma, C., Lin, C., Bindi, L., and Steinhardt, P.J. (2017) Hollisterite (AlFe), kryachkoite (AlCu), (FeCu), and stolperite (AlCu): Three new minerals from the Khatyrka CV3 carbonaceous chondrite. American Mineralogist, 102, 690–693.

stoichiometry), SiO₂ 2.37A, Al₂O₃ 3.82, Sc₂O₃ 1.80, Na₂O 1.01, ZrO₂ 0.80, MgO 0.79, V₂O₅ 0.61, FeO 0.53, Y₂O₅ 0.07, Cr₂O₃ 0.05, total 98.38. The empirical formula based on 12 O pfu is (Ca₂.⁹⁴Naₐ.⁰₈)(Ti³⁺,⁰⁶V₀.⁵₉Sc₀.⁵₀Zr₀.⁷₂Mg₀.₁₆)O₁₂. The empirical formulae for rubinite from Efremovka and Vigarano are respectively: (Ca₂.⁹₀Na₀.₀₈)(Ti³⁺,⁰⁶Mg₀.₃₂Sc₀.₃₀V₀.₅₉)[Fe²⁺,⁰₆Fe³⁺₀.⁰₈]O₁₂ and (Ca₁.₈₉Y₀.₈₃Mg₀.₂₈)O₁₂. The strongest reflections of the powder XRD pattern [d Å (θ/2θ), 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; 024), 2.100. EBSD patterns can only be indexed using cubic space group Ia₃d garnet structure with a = 12.187 Å, V = 1810.27 Å³. The reflectance values obtained for COM wavelengths [R₁/RIₕ% ± nm] are: 20.1/0.87, 47.9, 19.0/17.9, 546, 20.0/18.5, 589, 24.0/18.3. The empirical formula based on 12 O pfu is: V₇₁.₃₃ (70.91–71.90), Cr₅.₅₇ (50.62–51.68), Fe₁.₅₆ (1.16–2.08), N₂₁.₄₁ (21.22–21.54), Ti <0.₀₁. The physical proper -

Wangdaodeite*  

Wangdaodeite (IMA 2016-007), ideally FeTiO₃, 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 LiNbO₃-type FeTiO₃ 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, vitriified perovskite, linguite, tuite, xite, CaFe₂O₄-structured FeCr₂O₄, majorite–pyrope, magnesiowüstite, and hemleyite. No cleavage or parting were observed. Mohs hardness estimated by similar reflectance to associated ilmenite is 5–5.5. Macroscope properties were not determined due to the small size of grains; Dₐ = 4.72 g/cm³. The reflectance values obtained for COM wavelengths [R₁/RIₕ% ± nm] are: 21.0/0.87, 47.9, 19.0/17.9, 546, 20.0/18.5, 589, 24.0/18.3. 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 FeTiO₃, MnTiO₃, ZnTiO₃ with LiNbO₃ structure and to LiNbO₃ 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 (39.39–41.50), MgO 2.79 (2.44–3.03), MnO 2.74 (2.13–4.38), Al₂O₃ 0.04 (0.00–0.10), V₂O₅ 0.19 (0.09–0.29), Cr₂O₃ 0.04 (0.00–0.09), TiO₂ 52.69 (52.13–53.92), total 99.54. The empirical formula based on 3O pfu is: (Fe₉₀Mg₁₀Mn₁₀)O₃[Fe₂O₃]. The strongest reflections of the electron diffraction patterns of polycrystalline grains [d Å (θ/2θ, hkl)] are: 3.75 (72; 102), 2.72 (100; 104), 2.56 (89; 210), 2.23 (57; 213), 1.86 (59; 204), 1.62 (41; 108), 1.51 (44; 374), 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 = 314.6 Å³, Z = 6. The corner-linked TiO₂ octahedral of adjacent octahedral layers in the structure of LiNbO₃-type FeTiO₃ are rotated relative to one another to accommodate ilmenite structure where TiO₂ 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.

* Wangdaodeite*
References cited

ZAGAMIITE

Zagamiite (IMA 2015-022a), CaAl$_2$Si$_3.5$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$_{0.71}$Na$_{0.30}$K$_{0.03}$Al$_{1.89}$Fe$_{0.09}$Mg$_{0.02}$Si$_{3.50}$Al$_{0.11}$O$_{11}$) 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 clino-pyroxene, rather than through solid state transformation of a precursor mineral. Zagamiite forms prismatic crystals, less than 50 nm x 100 nm to 400 nm x 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$_2$O$_3$ 28.27/27.26, CaO 9.96/10.71, Na$_2$O 2.67/2.49, FeO 1.01/1.64, K$_2$O 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$_{0.03}$Al$_{1.94}$Fe$_{0.05}$Mg$_{0.01}$Si$_{3.51}$Al$_{0.11}$O$_{11}$/ (Ca$_{0.71}$Na$_{0.30}$K$_{0.03}$Al$_{1.89}$Fe$_{0.09}$Mg$_{0.02}$Si$_{3.50}$Al$_{0.11}$O$_{11}$). The main lines in the powder-like synchrotron diffraction pattern \(d \ (\text{Å}, hkl)\) 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 \(P6_3/mmc\), \(a = 5.403(2) \ \text{Å}, \ c = 12.77(3) \ \text{Å}\). \(V = 322.84 \ \text{Å}^3\), \(Z = 2\). The structure and cell parameters are very similar to those of synthetic phase CAS (CaAl$_2$SiO$_5$) 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 (\(\sim Si_{3/4}O_{1/4}\) vs. \(Si_{2/3}Al_{1/3}\)), and tetrahedral 4f (\(\sim Si_{2/3}O_{1/3}\) vs. Al$_{1/2}$O$_{1/2}$) sites. CAS phase may be important in the Earth’s mantle. Incompletely described natural CAS reported in Zagami and NWA 856 shergottites (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
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