

OXIDES

CLASS D	OXIDES	
GROUP A	COORDINATION STRUCTURE	
TYPE A	SIMPLE	
SERIES A	FLUORITE STRUCTURE, CN = 8/4, cub/Fm3m. The fluorite structure is based on a simple cubic packing of the F atoms, with Ca occupying 1/2 of the cubic voids, forming a square pattern.	
DAAAA	THORIANITE	ThO ₂
DAAAB	CERIANITE-(Ce)	(Ce,Th)O ₂
DAAAC	URANINITE	UO ₂
DAAAD	VORLANITE	(CaU ⁶⁺)O ₄
SERIES B	BADDELEYITE SERIES, CN = 7, mon/P2₁/c. Structure consists of a framework of edge- and corner-sharing ZrO₇ polyhedra.	
DAABA	BADDELEYITE	ZrO ₂
DAABB	TUGARINOVITE	MoO ₂
DAABC	AKAOGIITE	TiO ₂
DAABD	RIESITE	TiO ₂
SERIES C	CORUNDUM SERIES, CN = 7, trig/R3c. Structure consists of a lattice of hexagonal closed-packed O atoms in which 2/3 of the octahedral sites are occupied by trivalent cations. The octahedra share edges to form 6-membered rings, and these are lined into gibbsite-like sheets // (0001). The sheets are linked into a framework by sharing faces and corners of octahedra.	
DAACA	CORUNDUM	Al ₂ O ₃
DAACB	HEMATITE	Fe ₂ O ₃
DAACC	ESKOLAITE	Cr ₂ O ₃
DAACD	TISTARITE	Ti ₂ O ₃
DAACE	KARELIANITE	V ₂ O ₃
DAACF	LUOGUFENGITE	Fe ₂ O ₃ orth/Pna2 ₁
DAACG	DELTALUMITE	Al ₂ O ₃
SERIES D	BIXBYITE SERIES, CN = 6/4, cub/la3. Structure consists of M octahedra sharing edges to form undulating chains along the principal crystal axes; the chains are linked into a checkerboard-like framework by sharing corners.	
DAADA	BIXBYITE	Mn ₂ O ₃
DAADB	AVICENNITE	Ti ₂ O ₃
DAADC	MAGHEMITE	Fe ₂ O ₃
DAADD	YTTRIAITE-(Y)	Y ₂ O ₃
DAADE	KANGITE	(Sc,Ti,Al,Zr,Mg,Ca) ₂ O ₃
DAADF	PANGUITE	(Ti,Al,Sc,Mg,Zr,Ca) _{1.8} O ₃
DAADG	MCALPINEITE	Cu ₃ TeO ₆ cub/la3

Roberts, A. C., Ercit, T. S., & Cureton, F. F. (1994). Mcalpineite, Cu₃TeO₆. H20, from the McAlpine mine, Tuolumne County, California, and from the Centennial Eureka mine, Juab County, Utah I. Mineralogical Magazine, 58, 417-424.

Carbone, C., Basso, R., Cabella, R., Martinelli, A., Grice, J.D. and Lucchetti, G. (2013) Mcalpineite from the Gambatesa mine, Italy, and redefinition of the species. *American Mineralogist*, 98, 1899-1905. Isostructural with bixbyite.

SERIES E	BISMITE, mon/P2₁/c. Structure consists of irregular BiO₆ polyhedra sharing corners and edges to form a framework. In sillenite, BiO₄ tetrahedra and flat BiO₃ pyramids share corners to form a framework. Some vacant O sites in the lattice create BiO₃ umbrella-shaped polyhedra.		
DAAEA	BISMITE	Bi ₂ O ₃	
DAAEB	SPHAEROBISMOITE	Bi ₂ O ₃	
DAAEC	SILLENITE	Bi ₁₂ SiO ₂₀	
SERIES F	HALITE Structure SERIES, CN = 6/6, cub/Fm3m. The structure is formed by the closest packing of Cl⁻ anions in cubic closest packing with Na⁺ cations occupying all the octahedral interstices.		
DAAFA	PARICLASE	MgO	
DAAFb	BUNSENITE	NiO	
DAAFC	MANGANOSITE	MnO	
DAAFD	LIME	CaO	
DAAFE	WÜSTITE	Fe _{1-x} O	
DAAFF	MONTEPONITE	CdO	
DAAFG	MURDOCHITE	Cu ₆ PbO _{8-x} (Cl,Br) _{2x} x = .5 (defect halite structure)	cub/Fm3m
DAAFH	EDDAVIDITE	Pb ₂ Cu ₁₂ O ₁₅ Br ₂	
SERIES G	WÜRTZITE Structure SERIES, CN = 4/4, hex/P6₃mc. Structure based on a hexagonal closest packing of the S atoms, with Zn atoms occupying one half of the tetrahedral voids, resulting in a triangular distribution pattern.		
DAAGA	ZINCITE	ZnO	
DAAGB	BROMELLITE	BeO	
SERIES H	TENORITE, mon/C2/c. The structure is a distortion derivative of cooperite. It is based on a simple cubic packing of the O atoms, with Cu atoms occupying 1/2 of the square voids. Structure consists of CuO₄ square planes sharing edges to form chains // [110] and [110]; the chains are linked by sharing corners.		
DAAHA	TENORITE	CuO	mon/C2/c
SERIES I	Open		
SERIES J	CUPRITE, cub/Pn3m. The structure consists of a framework of O²⁻Cu₄ tetrahedra in a ball and spoke configuration. The structure of paramelaconite is closely related to cuprite and tenorite and consists of interpenetrating rods of Cu-O (Cu⁺ forming two co-linear bonds with oxygen) and Cu²⁺-O (Cu²⁺ forming four bonds to oxygen atoms at the corners of a rectangle).		
DAAJA	CUPRITE	Cu ₂ O	
DAAJB	PARAMELACONITE	Cu ₂ ¹⁺ Cu ₂ ²⁺ O ₃	tetr/I4 ₁ /amd AM63-184
DAAJC	ICE-VII	H ₂ O	
SERIES K	ALLENDEITE, trig/R3. Allendeite has a fluorite-related superstructure. Zr and Sc are both seven-coordinated to oxygen.		
DAAKA	ALLENDEITE	Sc ₄ Zr ₃ O ₁₂	

TYPE B	COMPLEX		
SERIES A	SCHEELITE Structure SERIES, CN = 8, tetr/I4₁/a. The scheelite structure is a non-layered structure, and is formed by isolated WO₄ tetrahedra separated by Ca atoms, each of which is bonded to 8 oxygen atoms forming a dodecahedron. This structure is a distortion derivative of the zircon structure.		
DABAA	FERGUSONITE-(Ce)	(Ce,La,Y)NbO ₄	
DABAB	FERGUSONITE-(Nd)	(Nd,Ce)(Nb,Ti)O ₄	
DABAC	FERGUSONITE-(Y)	YNbO ₄	
DABAD	FORMANITE-(Y)	YTaO ₄	
SERIES B	FERGUSONITE-BETA SERIES, CN = 8, mon/I2. The structure is closely related to the alpha-PbO₂ and fluorite structures. Structures consist of TaO₆ octahedra and YO₈ polyhedra.		
DABBA	FERGUSONITE-BETA-(Ce)	(Ce,La,Nd)NbO ₄	
DABBB	FERGUSONITE-BETA-(Nd)	(Nd,Ce,La)NbO ₄	
DABBC	FERGUSONITE-BETA-(Y)	YNbO ₄	
DABBD	YTTROCOLUMBITE-(Y)	(Y,U,Fe)(Nb,Ta)O ₄	
DABBE	YTTROTANTALITE-(Y)	(Y,U,Fe)(Ta,Nb)O ₄	
DABBF	ISHIKAWAITE	(U,Fe,Y,Ca)(Nb,Ta)O ₄	orth/
DABBG	IWASHIROITE-(Y)	YTaO ₄	mon/P2/a
DABBH	TAKANAWAITE-(Y)	YtaO ₄	mon/I2/a
SERIES C	STIBIOCOLUMBITE Structure SERIES, CN = 6, orth/Pc2₁n. The structure is built up of slices of the ReO₃ structure parallel to (100) and has Sb atoms sandwiched in between to form two closely related structures both of which are very similar to thoreaulite. In the crystal structure of kyawthuite (R1 = 0.0269 for 593 reflections with Fo > 4σF), Sb⁵⁺O₆ octahedra share corners to form checkerboard-like sheets parallel to {001}. Bi³⁺ atoms, located above and below the open squares in the sheets, form bonds to the O atoms in the sheets, thereby linking adjacent sheets into a framework. Bi³⁺ is in lopsided 8 coordination, typical of a cation with stereoactive lone electron pairs. Kyawthuite is isostructural with synthetic β-Sb₂O₄ and clinocervantite (natural β-Sb₂O₄).		
DABCA	STIBIOCOLUMBITE	SbNbO ₄	
DABCB	STIBIOTANTALITE	SbTaO ₄	
DABCC	BISMUTOTANTALITE	Bi(Ta,Nb)O ₄	
DABCD	ALUMOTANTALITE	AlTaO ₄	
DABCE	CERVANTITE	SbSbO ₄	
DABCF	BISMUTOCOLUMBITE	Bi(Nb,Ta)O ₄	
DABCG	CLINOCERVANTITE	Sb ₂ O ₄ (Sb ³⁺ Sb ⁵⁺ O ₄) monoclinic polymorph of cervantite	
DABCH	KYAWTHUITE	Bi ³⁺ Sb ⁵⁺ O ₄	
SERIES D	PYROCHLORE SERIES, cub/Fd3m. (Niobium-dominant) The structure is based on a defect simple cubic packing of the OH and O atoms, with Na, Ca, and Nb occupying 1/2 of the cubic voids. The large cations Na and Ca have cubic coordination, while Nb has 6 coordination, due to the vacancies in the structure. Structure consists of corner-sharing (Nb,Ta,Ti)O₆ octahedra forming sheets of 3- and 6-membered rings // {110} with channels in the <110> directions that accommodates the (Na,Ca) atoms. PHYLLLOTUNGSTITE, orth/Cmcm. Structure of phyllotungstite can be described in terms of an ordered intergrowth to (001), of (111) blocks with pyrochlore-type structures and two-layer wide regions with a hexagonal tungsten bronze type structure. Cs atoms occupy 18 coordinate cavities in the HTB regions, and water molecules occupy F sites in the A₂B₂O₆F pyrochlore blocks. Hydroxynatropyrochlore, (Na,Ca,Ce)₂Nb₂O₆(OH), is a new Na-Nb-OH-dominant member of the pyrochlore supergroup from the Kovdor phoscorite-carbonatite pipe (Kola Peninsula, Russia). It is cubic, Fd-3m, a = 10.3211(3) Å, V = 1099.46 (8) Å³, Z = 8 (from powder diffraction data) or a = 10.3276(5) Å, V = 1101.5(2) Å³, Z = 8 (from single-crystal diffraction data). Hydroxynatropyrochlore is		

a characteristic accessory mineral of low-carbonate phoscorite of the contact zone of the phoscorite-carbonatite pipe with host foidolite as well as of carbonate-rich phoscorite and carbonatite of the pipe axial zone. It usually forms zonal cubic or cubooctahedral crystals (up to 0.5 mm in diameter) with irregularly shaped relics of amorphous U-Ta-rich hydroxykenopyrochlore inside. Characteristic associated minerals include rock-forming calcite, dolomite, forsterite, hydroxylapatite, magnetite, and phlogopite, accessory baddeleyite, baryte, barytocalcite, chalcopyrite, chamosite-clinochlore, galena, gladiusite, juonniite, ilmenite, magnesite, pyrite, pyrrhotite, quintinite, spinel, strontianite, valleriite, and zirconolite. Hydroxynatropyrochlore is pale-brown, with an adamantine to greasy lustre and a white streak. The cleavage is average on {111}, the fracture is conchoidal. Mohs hardness is about 5. In transmitted light, the mineral is light brown, isotropic, $n = 2.10(5)$ ($\Delta = 589$ nm). The calculated and measured densities are 4.77 and 4.60(5) g·cm⁻³, respectively. The mean chemical composition determined by electron microprobe is: F 0.05, Na₂O 7.97, CaO 10.38, TiO₂ 4.71, FeO 0.42, Nb₂O₅ 56.44, Ce₂O₃ 3.56, Ta₂O₅ 4.73, ThO₂ 5.73, UO₂ 3.66, total 97.65 wt. %. The empirical formula calculated on the basis of Nb+Ta+Ti = 2 apfu is (Na_{1.02}Ca_{0.73}Ce_{0.09}Th_{0.09}U_{0.05}Fe_{2+0.02})Σ_{2.00} (Nb_{1.68}Ti_{0.23}Ta_{0.09})Σ_{2.00}O_{6.03}(OH_{1.04}F_{0.01})Σ_{1.05}. The simplified formula is (Na, Ca, Ce)₂Nb₂O₆(OH). The mineral slowly dissolves in hot HCl. The strongest X-ray powder-diffraction lines [listed as (d in Å)(I)(hkl)] are as follows: 5.96(47)(111), 3.110(30)(311), 2.580(100)(222), 2.368(19)(400), 1.9875(6)(333), 1.8257(25)(440) and 1.5561(14)(622). The crystal structure of hydroxynatropyrochlore was refined to R₁ = 0.026 on the basis of 1819 unique observed reflections. The mineral belongs to the pyrochlore structure type A₂B₂O₆Y₁ with octahedral framework of corner-sharing BO₆ octahedra with A cations and OH groups in the interstices. The Raman spectrum of hydroxynatropyrochlore contains characteristic bands of the lattice, BO₆, B–O and O–H vibrations and no characteristic bands of the H₂O vibrations. Within the Kovdor phoscorite-carbonatite pipe, hydroxynatropyrochlore is the latest hydrothermal mineral of the pyrochlore supergroup, which forms external rims around grains of earlier U-rich hydroxykenopyrochlore and separated crystals in voids of dolomite carbonatite veins. The mineral is named in accordance with the pyrochlore supergroup nomenclature.

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DABDA	OXYCALCIOPYROCHLORE	Ca ₂ Nb ₂ O ₆
DABDB	HYDROPYROCHLORE	(H ₂ O, □) ₂ Nb ₂ (O, OH) ₆ (H ₂ O)
DABDC	HYDROXYCALCIOPYROCHLORE	(Ca, □) ₂ Nb ₂ (O, OH) ₆ (OH)
DABDD	OXYTTROPYROCHLORE-(Y)	(Y, □) ₂ Nb ₂ O ₆ O
DABDE	FLUORCALCIOPYROCHLORE	(Ca, □) ₂ Nb ₂ (O, OH) ₆ F
DABDF	OXYPLUMBOPYROCHLORE	Pb ₂ Nb ₂ O ₆ O
DABDG	KENOPLUMBOPYROCHLORE	(Pb, □) ₂ Nb ₂ O ₆ (□, O)
DABDH	FLUORNATROPYROCHLORE	(Na, REE, Ca) ₂ Nb ₂ (O, OH) ₆ F
DABDI	OXYNATROPYROCHLORE	(Na, Ca, U) ₂ Nb ₂ O ₆ (O, OH)

DABDJ	FLUORSTRONTIOPYROCHLORE	$(\text{Sr}, \square)_2\text{Nb}_2(\text{O}, \text{OH})_6\text{F}$
DABDK	FLUORKENOPYROCHLORE	$(\square, \text{Na}, \text{Ce}, \text{Ca})_2(\text{Nb}, \text{Ti})_2\text{O}_6\text{F}$
DABDL	ZERO-VALENT-DOMINANT PYROCHLORE	No definite chemistry
DABDM	TAZZOLIITE	$\text{Ba}_4\square_x\text{Na}_x\text{Ti}_2\text{Nb}_3\text{SiO}_{17}[\text{PO}_2(\text{OH})_2]_x(\text{OH})(1\square_{2x})(04_x40.5)$
DABDN	HYDROXYMANGANOPYROCHLORE	$(\text{Mn}, \text{Th}, \text{Na}, \text{Ca}, \text{REE})_2(\text{Nb}, \text{Ti})_2\text{O}_6(\text{OH})$
DABNO	FLUORNATROPYROCHLORE	$(\text{Na}, \text{Pb}, \text{Ca}, \text{REE}, \text{U})_2\text{Nb}_2\text{O}_6\text{F}$
DABNP	FLUORCALCIOPYROCHLORE	$(\text{Ca}, \text{Na})_2(\text{Nb}, \text{Ti})_2\text{O}_6\text{F}$
DABNQ	PHYLLOTUNGSTITE, orth/Cmcm	$\text{Cs}_{0.41}(\text{Na}, \text{K}, \text{Pb}, \text{Ca})[\text{W}_{10.87}\text{Fe}_{3.13}\text{O}_{35.75}(\text{OH})_{6.25}]\text{O}(\text{H}_2\text{O})_3$
DABNR	HYDROXYFERROROMEITE	$(\text{Fe}^{2+}_{1.5}\square_{0.5})\text{Sb}^{5+}_2\text{O}_6(\text{OH})$
DABNS	FLUORNATROCOULSELLITE	$\text{CaNa}_3\text{AlMg}_3\text{F}_{14}$ Rom/R $\bar{3}m$
DABNT	CESIOKENOPYROCHLORE	$\square\text{Nb}_2(\text{O}, \text{OH})_6\text{Cs}_{1-x}(x \sim 0.020)$
DABNU	HYDROKENOPYROCHLORE	$\square_2\text{Nb}_2\text{O}_4(\text{OH})_2(\text{H}_2\text{O})$
DABNV	HYDROXYKENOPYROCHLORE	$(\square, \text{Ce}, \text{Ba})_2(\text{Nb}, \text{Ti})_2\text{O}_6(\text{OH}, \text{F})$
DABNW	HYDROXYNATROPYROCHLORE	$(\text{Na}, \text{Ca}, \text{Ce})_2\text{Nb}_2\text{O}_6(\text{OH})$

SERIES E MICROLITE SERIES. (Tantalum-dominant)

DABEA	FLUORNATROMICROLITE	$(\text{Na}, \text{Ca}, \text{Bi})_2\text{Ta}_2\text{O}_6\text{F}$
DABEB	HYDROXYKENOMICROLITE	$(\square, \text{Na}, \text{Sb}^{3+})_2\text{Ta}_2\text{O}_6(\text{OH})$
DABEC	HYDROKENOMICROLITE-3R	$(\square, \text{H}_2\text{O})_2\text{Ta}_2(\text{O}, \text{OH})_6(\text{H}_2\text{O})$
DABED	FLUORCALCIOMICROLITE	$(\text{Ca}, \text{Na})_2\text{Ta}_2\text{O}_6\text{F}$
DABEE	OXYCALCIOMICROLITE	$\text{Ca}_2\text{Ta}_2\text{O}_6\text{O}$
DABEF	KENOPLUMBOMICROLITE	$(\text{Pb}, \square)_2\text{Ta}_2\text{O}_6(\square, \text{O}, \text{OH})$
DABEG	OXYSTANNOMICROLITE	$\text{Sn}_2\text{Ta}_2\text{O}_6\text{O}$
DABEH	OXYSTIBIOMICROLITE	$(\text{Sb}^{3+}, \text{Ca})_2\text{Ta}_2\text{O}_6\text{O}$
DABEI	HYDROMICROLITE	$(\text{H}_2\text{O}, \square)_2\text{Ta}_2(\text{O}, \text{OH})_6(\text{H}_2\text{O})$
DABEJ	ZERO-VALENT-DOMINANT MICROLITE	No definite chemistry
DABEK	open	
DABEL	OXYNATROMICROLITE	$(\text{Na}, \text{Ca}, \text{U})_2(\text{Ta}, \text{Nb})_2\text{O}_6(\text{O}, \text{F})$
DABEM	HYDROXYCALCIOMICROLITE	$\text{Ca}_{1.5}\text{Ta}_2\text{O}_6(\text{OH})$

SERIES F BETAFITE SERIES. (Titanium-dominant). Laachite is the Ti member of zirconolite structure type.

DABFA	OXYCALCIOBETAFITE	$\text{Ca}_2(\text{Ti}, \text{Nb})_2\text{O}_6\text{O}$
DABFB	OXYURANOBETAFITE	$(\text{U}, \text{Ca}, \square)_2(\text{Ti}, \text{Nb})_2\text{O}_6\text{O}$
DABFC	open	
DABFD	open	
DABFE	LAACHITE	$(\text{Ca}, \text{Mn})_2(\text{Zr}, \text{Mn})_2\text{Nb}_2\text{TiFeO}_{24}$ mon/C2/c
DABFF	ZIRKELITE	$(\text{Ca}, \text{Th}, \text{Ce})\text{Zr}(\text{Ti}, \text{Nb})_2\text{O}_7$ P3_12
DABFG	NOGGERATHITE-(Ce)	$(\text{Ce}, \text{Ca})_2\text{Zr}_2(\text{Nb}, \text{Ti})(\text{Ti}, \text{Nb})_2\text{Fe}^{2+}\text{O}_{14}$ orth/Cmca
DABFH	ZIRCONOLITE, 3O, 3T	$\text{CaZrTi}_2\text{O}_7$ mon/C2/c
DABFI	STEFANWEISSITE	$(\text{Ca}, \text{REE})_2\text{Zr}_2(\text{Nb}, \text{Ti})(\text{Ti}, \text{Nb})_2\text{Fe}^{2+}\text{O}_{14}$

SERIES G ELSMOREITE SERIES. (Tungsten-dominant)

DABGA	HYDROKENOELSMOREITE	$\square_2\text{W}_2\text{O}_6(\text{H}_2\text{O})$
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DABGB HYDROXYKENOELSMOREITE $(\square, \text{Pb})_2(\text{W}, \text{Fe}, \text{Al})_2(\text{O}, \text{OH})_6(\text{OH})$

SERIES H ROMEITE SERIES. (Antimony-dominant)

DABHA STIBIOROMEITE $\text{SbSb}_2\text{O}_6(\text{OH})$
 DABHB ARGENTOROMEITE $\text{Ag}_2\text{Sb}_2(\text{O}, \text{OH})_7$
 DABHC OXYCALCIOROMEITE $\text{Ca}_2\text{Sb}_2\text{O}_6\text{O}$
 DABHD OXYPLUMBOROMEITE $\text{Pb}_2\text{Sb}_2\text{O}_6\text{O}$
 DABHE BISMUTOROMEITE $\text{Bi}(\text{Sb}, \text{Fe})_2\text{O}_7$
 DABHF INGERSONITE $\text{Ca}_3\text{MnSb}_4\text{O}_{14}$, hex/P3₁21 (Structure in AM07-947)
 DABHG CUPROROMEITE $\text{Cu}_2\text{Sb}(\text{O}, \text{OH})_7$
 DABHH HYDROXYCALCIOROMEITE $(\text{Ca}, \text{Sb}^{3+})_2(\text{Sb}^{5+}, \text{Ti})_2\text{O}_6(\text{OH})$
 DABHI FLUORNATROROMEITE $(\text{Na}, \text{Ca})_2\text{Sb}_2(\text{O}, \text{OH})_6\text{F}$
 DABHJ FLUORCALCIOROMEITE $(\text{Ca}, \text{Sb}^{3+})_2(\text{Sb}^{5+}, \text{Ti})_2\text{O}_6\text{F}$

SERIES I CORUNDUM Derivative Structures, CN = 6/4, trig/R₃. The structure is an interstitial substitution derivative of corundum. The oxygen atoms form an hexagonal closest packing and Fe and Ti occupy 2/3 of the octahedral voids, with a honeycomb pattern, in alternate layers.

DABIA ILMENITE FeTiO_3
 DABIB PYROPHANITE MnTiO_3
 DABIC GEIKIELITE MgTiO_3
 DABID ECANDREWSITE $(\text{Zr}, \text{Fe}, \text{Mn})\text{TiO}_3$
 DABIE BRIZZIITE NaSbO_3
 DABIF PSEUDORUTILE $\text{Fe}_2\text{Ti}_3\text{O}_9$ P322
 DABIG MELANOSTIBITE $\text{Mn}(\text{Sb}, \text{Fe})\text{O}_3$
 DABIH New mineral name FeCrO_3
 DABIJ PAULOABIBITE NaNbO_3 trig/R₃
 DABIK WANGDAOEITE FeTiO_3 trig/R3c
 DABIL HEMLEYITE FeSiO_3
 DABIM LIUITE FeTiO_3 orth/Pnma

SERIES J MAGNETOPLUMBITE, trig/P6₃/mmc. The structure comprises alternating spinel-type slabs and perovskite-type layers.

DABJA MAGNETOPLUMBITE $\text{Pb}(\text{Fe}, \text{Mn})_{12}\text{O}_{19}$
 DABJB HAWTHORNEITE $\text{Ba}(\text{Ti}_3\text{Cr}_4\text{Fe}_2\text{Mg})\text{O}_{19}$
 DABJC HIBONITE $(\text{Ca}, \text{Ce})(\text{Al}, \text{Ti}, \text{Mg})_{12}\text{O}_{19}$
 DABJD YIMENGITE $\text{K}(\text{Cr}, \text{Ti}, \text{Fe}, \text{Mg})_{12}\text{O}_{19}$
 DABJE LINDQVISTITE $\text{Pb}_2(\text{Mg}, \text{Fe})\text{Fe}_{16}\text{O}_{27}$
 DABJF PLUMBOFERRITE PbFe_4O_7 , trig/P312
 DABJG NEZILOVITE $\text{PbZn}_2(\text{Mn}^{4+}, \text{Ti}^{4+})_2\text{Fe}_8\text{O}_{19}$
 DABJH HAGGERTYITE $\text{Ba}[\text{Fe}_6\text{Ti}_5\text{Mg}]\text{O}_{19}$
 DABJI BATIFERRITE $\text{Ba}[\text{Ti}_2\text{Fe}^{3+}_8\text{Fe}^{2+}_2]\text{O}_{19}$
 DABJJ OTJISUMEITE $\text{PbO}[\text{Ge}_4\text{O}_8]$
 DABJK HIBONITE-(Fe) $(\text{Fe}, \text{Mg})\text{Al}_{12}\text{O}_{19}$
 DABJL BARIOFERRITE $\text{BaFe}^{3+}_{12}\text{O}_{19}$

SERIES K **CRICHTONITE, trig-mon/R $\bar{3}$.** The structure is based on a close-packed anion framework with a nine-layer stacking sequence in which Sr, REE, and Pb atoms occupy one of the anionic sites in the cubic layers. The other metal atoms are ordered into both tetrahedral and octahedral interstices between the anion layers.

DABKA	CRICHTONITE	$(\text{Sr}, \text{La}, \text{Ce}, \text{Y})(\text{Ti}, \text{Fe}, \text{Mn})_{21}\text{O}_{38}$
DABKB	DAVIDITE-(Ce)	$(\text{Ce}, \text{La})(\text{Y}, \text{U}, \text{Fe})(\text{Ti}, \text{Fe})_{20}(\text{O}, \text{OH})_{38}$
DABKC	DAVIDITE-(La)	$(\text{La}, \text{Ce})(\text{Y}, \text{U}, \text{Fe})(\text{Ti}, \text{Fe})_{20}(\text{O}, \text{OH})_{38}$
DABKD	LANDAUIITE	$\text{NaMnZn}_2(\text{Ti}, \text{Fe})_6\text{Ti}_{12}\text{O}_{38}$
DABKE	LINDSLEYITE	$\text{BaMn}_3\text{Ti}_{14}^{4+}\text{Ti}_4^{3+}\text{O}_{38}$
DABKF	LOVERINGITE	$(\text{Ca}, \text{Ce})(\text{Ti}, \text{Fe}, \text{Cr}, \text{Mg})_{21}\text{O}_{38}$
DABKG	MATHIASITE	$(\text{K}, \text{Ca}, \text{Sr})(\text{Ti}, \text{Cr}, \text{Fe}, \text{Mg})_{21}\text{O}_{38}$
DABKH	SENAITE	$\text{Pb}(\text{Ti}, \text{Fe}, \text{Mn})_{21}\text{O}_{38}$
DABKI	MURATAITE-(Y)	$(\text{Na}, \text{Y})_6(\text{Zn}, \text{Fe})_5(\text{Ti}, \text{Nb})_{12}\text{O}_{29}(\text{O}, \text{F})_{10}\text{F}_4$, cub/F43m
DABKJ	DESSAUIITE-(Y)	$(\text{Sr}, \text{Pb})(\text{Y}, \text{U})(\text{Ti}, \text{Fe})_{20}\text{O}_{38}$ trig/R $\bar{3}$
DABKL	GRAMACCIOLIITE-(Y)	$(\text{Pb}, \text{Sr})(\text{Y}, \text{Mn})\text{Fe}_2(\text{Ti}, \text{Fe})_{18}\text{O}_{38}$
DABKM	CLEUSONITE	$\text{Pb}(\text{U}^{4+}, \text{U}^{6+})(\text{Ti}, \text{Fe}^{2+}\text{Fe}^{3+})_{20}(\text{O}, \text{OH})_{38}$
DABKN	PASEROITE	$\text{PbMn}^{2+}(\text{Fe}, \square)_2(\text{V}^{5+}, \text{Ti}, \square)_{18}\text{O}_{38}$
DABKO	MAPIQUIROITE	$(\text{Sr}, \text{Pb})(\text{Y}, \text{Y})\text{Fe}_2(\text{Ti}, \text{Fe}, \text{Cr})_{18}\text{O}_{38}$
DABKP	ALMEIDAITE	$\text{PbZn}_2(\text{Mn}, \text{Y})(\text{Ti}, \text{Fe})_{18}\text{O}_{36}(\text{OH}, \text{O})_2$
DABKQ	MIANNINGITE	$(\text{Pb}, \text{Ce}, \text{Na})(\text{U}^{4+}, \text{Mn}, \text{U}^{6+})\text{Fe}^{3+}_2(\text{Ti}, \text{Fe}^{3+})_{18}\text{O}_{38}$

SERIES L **SPINEL/NOLANITE-LIKE Structures, hex/P6 $\bar{3}$ mmc.** The model is based on a close packed anion framework with a 24 layer mixed stacking sequence along c. The interlayer articulation of the various polyhedra is controlled by the oxygen stacking sequence and is such that tetrahedra share only corners with octahedra, and octahedra share edges and corners.

DABLA	MAGNESIOHÖGBOMITE-2N2S	$(\text{Mg}, \text{Al}, \text{Fe}, \text{Ti})_{22}\text{O}_{30}(\text{OH})_2$
DABLB	MAGNESIOHÖGBOMITE-2N3S	$(\text{Mg}, \text{Al}, \text{Fe}, \text{Ti})_{9.6}\text{O}_{38}(\text{OH})_2$
DABLC	MAGNESIOHÖGBOMITE-6N6S	$(\text{Mg}, \text{Al}, \text{Fe}, \text{Ti})_{66}(\text{O}, \text{OH})_{96}$
DABLD	ZINCOHÖGBÖMITE-2N2S	$(\text{Zn}, \text{Al}, \text{Fe}, \text{Ti})_{22}(\text{O}, \text{OH})_{32}$
DABLE	ZINCOHÖGBOMITE-2N6S	$(\text{Zn}, \text{Fe}, \text{Ni}, \text{Mg}, \text{Co}, \text{Ti})\text{Al}_4\text{O}_8$
DABLF	FERRONIGERITE-2N1S	$\text{Al}_{10.9}\text{Sn}_2\text{Fe}_{1.7}\text{O}_{22}(\text{OH})_2$
DABLG	FERRONIGERITE-6N6S	$\text{Al}_{10.9}\text{Sn}_2\text{Fe}_{1.7}\text{O}_{22}(\text{OH})_2$
DABLH	MAGNESIONIGERITE-2N1S	$(\text{Mg}, \text{Al}, \text{Zn})_4(\text{Sn}, \text{Fe})_2\text{Al}_{10}\text{O}_{22}(\text{OH})_2$
DABLI	MAGNESIONIGERITE-6N6S	$(\text{Mg}, \text{Al}, \text{Fe}, \text{Ti})_{22}\text{O}_{30}(\text{OH})_2$
DABLJ	MAGNESIOTAAFFEITE-2N'2S	$\text{Mg}_3\text{BeAl}_8\text{O}_{16}$
DABLK	MAGNESIOTAAFFEITE-6N'3S	$(\text{Mg}, \text{Fe}, \text{Zn})_2\text{BeAl}_6\text{O}_{12}$
DABLL	FERROTAFFEITE-6N'3S	$\text{Be}(\text{Fe}, \text{Zn}, \text{Mg})_2\text{Al}_6\text{O}_{12}$
DABLM	FERROHÖGBOMITE-2N2S	$(\text{Fe}, \text{Mg}, \text{Al}, \text{Ti})_{22}\text{O}_{30}(\text{OH})_2$
DABLN	FERROTAFFEITE-2N'2S	$\text{Be}(\text{Fe}, \text{Mg}, \text{Zn})_3\text{Al}_8\text{O}_{16}$
DABLO	MAGNESIOHÖGBOMITE-2N4S	$(\text{Mg}, \text{Al}, \text{Fe}, \text{Ti})_{9.6}\text{O}_{38}(\text{OH})_2$
DABLP	MAGNESIOBELTRANDOITE-2N3S	$(\text{Mg}_6\text{Al}_2)(\text{Al}_{18}\text{Fe}^{3+}_2)\text{O}_{38}(\text{OH})_2$
DABLQ	ZINCOVELESITE-6N6S	$\text{Zn}_3(\text{Fe}^{3+}\text{Mn}^{3+}\text{Al}, \text{Ti})_8\text{O}_{15}(\text{OH})$
DABLR	ZINCONIGERITE-2N1S	$\text{ZnSn}_2\text{Al}_{12}\text{O}_{22}(\text{OH})_2$

SERIES M **NOLANITE, trig/P6₃mc.** Nolanite is isostructural with the M₂Mo₃O₈ group of synthetic compounds. It is based on a closest-packed anion framework with hc stacking and with cations ordered into six-fold and two-fold octahedral sites and into a two-fold tetrahedral site. Two types of cation (001) layers alternate in nolanite; the six-fold sites form a layer of edge-shared octahedra identical with the (111) octahedral layers in spinel and the two-fold sites form a layer of corner-shared octahedra and tetrahedra. The two-fold octahedrally coordinated M(2) shares corners with a six-membered ring of M(1) octahedra in one layer and shares edges with a triangular cluster of M(1) octahedra in the opposite layer. The structure of iseite is based on the kamiokite-type structure. The MoO₄ tetrahedra and MnO₆ octahedra are connected at the apical oxygen atoms to form a honeycomb-like lattice sheets in the a-b plane those sheets stack with the Mo octahedral sheet alternately along the c-axis.

DABMA	NOLANITE	(V,Fe,Fe,Ti) ₁₀ O ₁₄ (OH) ₂	
DABMB	RINMANITE	Zn ₂ Mg ₂ Fe ₄ Sb ₂ O ₁₄ (OH) ₂	
DABMC	KAMIOKITE	Fe ₂ Mo ₃ O ₈	hex/P6 ₃ mc
DABMD	ISEITE	Mn ₂ Mo ₃ O ₈	hex/P6 ₃ mc
DABME	MAJINDEITE	Mg ₂ Mo ₃ O ₈	hex/P6 ₃ mc

SERIES N **OLIVINE Structure type, orth/Pmab.** Structure based on zigzag chains of edge-sharing octahedra cross-linked by Si tetrahedra sharing three edges with the octahedra.

DABNA	CHRYSOBERYL	BeAl ₂ O ₄
DABNB	MAROKITE	CaMn ₂ O ₄
DABNC	MARIINSKITE	BeCr ₂ O ₄

SERIES O **SPINEL SERIES, cub/Fd3m.** The structure is based on a cubic closest packing of oxygen atoms with a half of the octahedral voids occupied by Al atoms forming a T lattice complex, and 1/8 of the tetrahedral voids occupied by Mg atoms forming a F lattice complex. Maohokite, a post-spinel polymorph of MgFe₂O₄, was found in shocked gneiss from the Xiuyan crater in China. Maohokite in shocked gneiss coexists with diamond, reidite, TiO₂-II, as well as diaplectic glasses of quartz and feldspar. Maohokite occurs as nano-sized crystallites. The empirical formula is (Mg_{0.62}Fe_{0.35}Mn_{0.03})₂+Fe₃+2O₄. In situ synchrotron X-ray microdiffraction established maohokite to be orthorhombic with the CaFe₂O₄-type structure. The cell parameters are a = 8.907 (1) Å, b = 9.937(8) Å, c = 2.981 (1) Å; V = 263.8 (3) Å³; space group Pnma. The calculated density of maohokite is 5.33 g cm³. Maohokite was formed from subsolidus decomposition of ankerite Ca(Fe₂₊,Mg)(CO₃)₂ via a self-oxidation-reduction reaction at impact pressure and temperature of 25–45 GPa and 800–900 °C. The formation of maohokite provides a unique example for decomposition of Fe-Mg carbonate under shock-induced high pressure and high temperature. The mineral and its name have been approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA 2017-047). The mineral was named maohokite after Hokwang Mao, a staff scientist at the Geophysical Laboratory,

DABOA	SPINEL	MgAl ₂ O ₄
DABOB	GALAXITE	MnAl ₂ O ₄
DABOC	HERCYNITE	FeAl ₂ O ₄
DABOD	GAHNITE	ZnAl ₂ O ₄
DABOE	MAGNETITE	FeFe ₂ O ₄
DABOF	MAGNESIOFERRITE	MgFe ₂ O ₄
DABOG	JACOBSITE	MnFe ₂ O ₄
DABOH	FRANKLINITE	ZnFe ₂ O ₄
DABOI	TREVORITE	NiFe ₂ O ₄
DABOJ	CUPROSPINEL	CuFe ₂ O ₄
DABOK	BRUNOGEIERITE	GeFe ₂ O ₄
DABOL	MAGNESIOCHROMITE	MgCr ₂ O ₄
DABOM	MANGANOCHEMITE	(Mn,Fe)Cr ₂ O ₄

DABON	CHROMITE	FeCr_2O_4	
DABOO	NICHROMITE	$(\text{Ni},\text{Co})(\text{Cr},\text{Fe})_2\text{O}_4$	
DABOP	COCHROMITE	$(\text{Co},\text{Ni})(\text{Cr},\text{Al})_2\text{O}_4$	
DABOQ	ZINCOCHROMITE	ZnCr_2O_4	
DABOR	COULSONITE	FeV_2O_4	
DABOS	VUORELAINENITE	$(\text{Mn},\text{Fe})(\text{V},\text{Cr})_2\text{O}_4$	
DABOT	ULVÖSPINEL	Fe_2TiO_4	
DABOU	QANDILITE	$(\text{Mg},\text{Fe})_2(\text{Ti},\text{Fe},\text{Al})\text{O}_4$	
DABOV	MAGNESIOCOULSONITE	MgV_2O_4	
DABOW	TEGENGRENITE	$(\text{Mg},\text{Mn}^{2+})_2(\text{Sb}_{0.5}\text{Mn}^{3+}_{0.5})\text{O}_4$	
DABPX	XIEITE	FeCr_2O_4	(orth/Bbmm)
DABPY	CHENMINGITE	FeCr_2O_4	orth/Pnma
DABPZ	MAOHOKITE	MgFe_2O_4	orth/Pnma`
DABP27	GUITE	$\text{Co}^{2+}\text{Co}^{3+}_2\text{O}_4$	cub/Fd3m
DABP28	DELLAGIUSSTAITE	$\text{V}^{2+}\text{Al}_2\text{O}_4$	cub/Fd3m
DABP29	THERMAEROGENITE	CuAl_2O_4	cub/Fd3m
DABP30	TSCHAUNERITE	$(\text{Fe}^{2+})(\text{Fe}^{2+}\text{Ti}^{4+})\text{O}_4$	orth/Cmcm

SERIES P **KORAGOITE, mon/P2₁. Structure consists of edge-sharing MnO₆, NbO₆ and TaO₆ octahedra forming zigzag columns // [010] ; the columns are linked by W trigonal prisms.**

DABPA	KORAGOITE	$(\text{Mn},\text{Mn},\text{Fe}, \square)_3(\text{Nb},\text{Mn})_2(\text{Nb},\text{Ta},\text{W}, \square)_3(\text{W},\text{Ti}, \square)_2\text{O}_{20}$	
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SERIES Q **HAUSMANNITE, tetr/I4₁/amd. The structure is a distortion derivative of spinel. It is based on a cubic closest packing of oxygens, with Mn²⁺ in octahedral voids, and Mn⁴⁺ in tetrahedral voids.**

DABQA	HAUSMANNITE	MnMn_2O_4	
DABQB	HETAEROLITE	ZnMn_2O_4	
DABQC	HYDROHETAEROLITE	$\text{Zn}_2\text{Mn}_4\text{O}_8 \cdot \text{H}_2\text{O}$	
DABQD	IWAKIITE	$\text{Mn}(\text{Fe},\text{Mn})_2\text{O}_4$	(P4 ₂ /nnm)

SERIES R **DEFECT FLUORITE Structure, tetr/I4₁/acd. The structure is based on a defect simple cubic packing of oxygen atoms with Mn atoms with two different co-ordinations, cubic and [6], and Si atoms with tetrahedral co-ordination. This structure can be considered as an interstitial substitution and defect derivative of fluorite.**

DABRA	BRAUNITE	$\text{MnMn}_6\text{SiO}_{12}$	
DABRB	ABSWURMBACHITE	$\text{CuMn}_6\text{SiO}_{12}$	
DABRC	NELTNERITE	$\text{CaMn}_6\text{SiO}_{12}$	
DABRD	GAREDALITE	$\text{ZrMn}^{2+}_2\text{Mn}^{3+}_4\text{SiO}_{12}$	

SERIES S **SPINEL-Like structures, orth/lbmm. The structure of manganostibite includes populated octahedra edge-sharing chains...Mn-Mn-Sb-Mn-Mn-Sb... which run parallel to the y-axis and these further share edges with Mn-O octahedral edge-sharing walls. The walls are three octahedral wide along the y-axis and run parallel to the z-axis. The tetrahedra share corners with the octahedral and occur as [T₃O₁₀] triple groups. Manganostibite belongs to an homologous series, M_{2n}O_{n-1}[T_nO_{3n+1}], where n = 3; the simplest member of this series is the spinel structure type.**

DABSA	MANGANOSTIBITE	$\text{Mn}_7\text{SbAsO}_{12}$	
DABSB	KATOPTRITE	$\text{Mn}_{13}\text{Sb}_2\text{Al}_4\text{Si}_2\text{O}_{28}$	mon/C2/m

DABSC	YEATMANITE	$(\text{Mn,Zn})_{13}\text{Sb}_2\text{Si}_4\text{Zn}_2\text{O}_{28}$	tric/P1
DABSD	FILIPSTADITE	$(\text{Mn,Mg})_2(\text{Sb}^{5+}_{0.5}\text{Fe}_{0.5})\text{O}_4$	

SERIES T **DEFECT SPINEL STRUCTURES.** The crystal structure of mayenite is described as an aluminate framework filled with disordered calcium and “extra” oxygen. The structure of harmunite consists of two symmetrically independent FeO_6 octahedra connected over common edges, forming double rutile-type $\infty^1[\text{Fe}_2\text{O}_6]$ chains. Four such double chains are further linked by common oxygen corners creating a tunnel-structure with large trigonal prismatic cavities occupied by Ca along [001]. The structure of shulamitite is intermediate between perovskite and brownmillerite. Wernerkrauseite is a Ca-deficient structural analogue of harmunite. Sharyginite structure consists of double layers of corner-sharing (Tik Fe) O_6 octahedra, which are separated by single layers of (FeO_4) tetrahedra.

Reference:

- Griffin, W.L., Gain, S.E.M., Bindi, L., Toledo, V., Cámara, F., Saunders, M., O’Reilly, S.Y. (2018): Carmeltazite, $\text{ZrAl}_2\text{Ti}_4\text{O}_{11}$, a New Mineral Trapped in Corundum from Volcanic Rocks of Mt Carmel, Northern Israel. *Minerals*, 8, 601; <https://doi.org/10.3390/min8120601>
The new mineral species carmelazite, ideally $\text{ZrAl}_2\text{Ti}_4\text{O}_{11}$, was discovered in pockets of trapped melt interstitial to, or included in, corundum xenocrysts from the Cretaceous Mt Carmel volcanics of northern Israel, associated with corundum, tistarite, anorthite, osbornite, an unnamed REE (Rare Earth Element) phase, in a Ca-Mg-Al-Si-O glass. In reflected light, carmelazite is weakly to moderately birefractant and weakly pleochroic from dark brown to dark green. Internal reflections are absent. Under crossed polars, the mineral is anisotropic, without characteristic rotation tints. Reflectance values for the four COM wavelengths (Rmin, Rmax (%) (λ in nm)) are: 21.8, 22.9 (471.1); 21.0, 21.6 (548.3), 19.9, 20.7 (586.6); and 18.5, 19.8 (652.3). Electron microprobe analysis (average of eight spot analyses) gave, on the basis of 11 oxygen atoms per formula unit and assuming all Ti and Sc as trivalent, the chemical formula $(\text{Ti}_{3+3.60}\text{Al}_{1.89}\text{Zr}_{1.04}\text{Mg}_{0.24}\text{Si}_{0.13}\text{Sc}_{0.06}\text{Ca}_{0.05}\text{Y}_{0.02}\text{Hf}_{0.01})\Sigma=7.04\text{O}_{11}$. The simplified formula is $\text{ZrAl}_2\text{Ti}_4\text{O}_{11}$, which requires ZrO₂ 24.03, Al₂O₃ 19.88, and Ti₂O₃ 56.09, totaling 100.00 wt %. The main diffraction lines, corresponding to multiple hkl indices, are (d in Å (relative visual intensity)): 5.04 (65), 4.09 (60), 2.961 (100), 2.885 (40), and 2.047 (60). The crystal structure study revealed carmelazite to be orthorhombic, space group Pnma, with unit-cell parameters a = 14.0951 (9), b = 5.8123 (4), c = 10.0848 (7) Å, V = 826.2 (1) Å³, and Z = 4. The crystal structure was refined to a final R₁ = 0.0216 for 1165 observed reflections with Fo > 4σ(Fo). Carmelazite exhibits a structural arrangement similar to that observed in a defective spinel structure. The name carmelazite derives from Mt Carmel (“CARMEL”) and from the dominant metals present in the mineral, i.e., Titanium, Aluminum and Zirconium (“TAZ”). The mineral and its name have been approved by the IMA Commission on New Minerals, Nomenclature and Classification (2018-103).

DABTA	BROWNMILLERITE	$\text{Ca}_2(\text{Al,Fe})\text{O}_5$	orth/lbm Perovskite deficient ty pe
DABTB	CHLORMAYENITE	$\text{Ca}_{12}\text{Al}_{14}\text{O}_{33}\text{Cl}_2$	cub/l43d
DABTC	SREBRODOLSKITE	$\text{Ca}_2\text{Fe}_2\text{O}_5$	orth/Pnma deficient perovskite type
DABTD	GROSSITE	CaAl_4O_7	mon/C2/c
DABTE	DMITRYIVANOVITE	CaAl_2O_4	mon/P2 ₁ /c
DABTF	BREARLEYITE	$\text{Ca}_{12}\text{Al}_{14}\text{O}_{32}\text{Cl}_2$	cub/l43d
DABTG	SHULAMITITE	$\text{Ca}_3\text{TiFe}^{3+}\text{AlO}_8$	orth/Pmma deficient perovskite type
DABTH	DIAOYUDAOITE (?)	$\text{NaAl}_{11}\text{O}_{17}$	hex/P6 ₃ /mmc
DABTI	HARMUNITE	CaFe_2O_4	orth/Pnma
DABTJ	CHLORKYUYGENITE	$\text{Ca}_{12}\text{Al}_{14}\text{O}_{32}[(\text{H}_2\text{O})_4\text{Cl}_2]$	cub/l43d
DABTK	FLUORMAYENITE	$\text{Ca}_{12}\text{Al}_{14}\text{O}_{32}\text{F}_2$	cub/l43d
DABTL	FLUORKYUYGENITE	$\text{Ca}_{12}\text{Al}_{14}\text{O}_{32}[(\text{H}_2\text{O})_4\text{F}_2]$	cub/l43d
DABTM	WERNERKRAUSEITE	$\text{Ca}(\text{Fe}^{3+},\text{Mn}^{3+})_2\text{Mn}^{4+}\text{O}_6$	orth/Pnma
DABTN	SHARYGINITE	$\text{Ca}_3\text{TiFe}_2\text{O}_8$	orth/P2 ₁ ma
DABTO	CARMELTAZITE	$\text{ZrAl}_2\text{Ti}_4\text{O}_{11}$	orth/Pnma
DABTP	KAHLENBERGITE	$\text{KAl}_{11}\text{O}_{17}$	hex/P6 ₃ /mmc

SERIES U **CALCIOTANTITE, hex/P6₃22.** Structure consists of sheets of edge-sharing TaO₇ pentagonal dipyramids // [001] which are linked into a framework by TaO₆ octahedra and caO₈ polyhedra.

DABUA	CALCIOTANTITE	CaTa ₄ O ₁₁	hex/P6 ₃ or P6 ₃ /m
DABUB	IRTYSHITE	Na ₂ (Ta,Nb) ₄ O ₁₁	
DABUC	NATROTANTITE	NaTa ₃ O ₈	

SERIES V **PETSCHCKITE, hex/P31m. Structures not known.** Mücke, A. & Strunz, H. (1978): Petscheckite and liandratite, two new pegmatite minerals from Madagascar. *American Mineralogist* **63**: 941-946
 - Tomašić, N., Raade, G. & Bermanec, V. (2004): REE-bearing petscheckite from Tiltvika, Nordland, Norway, and its heating products. *Neues Jahrbuch für Mineralogie Monatshefte* **2004 (4)** : 163-175

DABVA	PETSCHCKITE	UFe(Nb,Ta) ₂ O ₈
DABVB	LIANDRATITE	U(Nb,Ta) ₂ O ₈

SERIES W **SIMPSONITE, trig/P3. The structure is based on clusters of edge-sharing octahedra in close-packed layers along (001). The top layer contains the Ta octahedra while the lower layer contains the Al octahedra. The structure fits a HCP scheme.**

DABWA	SIMPSONITE	Al ₄ (Ta,Nb) ₃ (O,OH,F) ₁₄
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SERIES X **SWEDENBORGITE, hex/P6₃mc. The structure is based on a ch closest packing of oxygens and Na atoms. The Sb atoms occupy 1/8 of the octahedral voids, and the Be atoms 1/4 of the tetrahedral voids. The structure is built by two alternate kind of layers.**

DABXA	SWEDENBORGITE	NaBe ₄ SbO ₇
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SERIES Y **CALZIRTITE SERIES-CaF₂-CeO₂ Structure, CN = 7, tetr/I4₁/acd. Structure consists of a distorted fluorite-type structure consisting of a framework of edge- and corner-sharing ZrO₇₋₈ polyhedra and CaO₆ and TiO₆ octahedra.**

DABYA	CALZIRTITE	CaZr ₃ TiO ₉
DABYB	HIÄRNEITE	Ca ₂ (Zr,Ti) ₅ (Sb,Mn) ₂ O ₁₆
DABYC	TAZHERANITE	(Zr,Ca,Ti)O ₂

SERIES Z **LÅNGBANITE, trig/P31m. The structure of this complex mineral is based on “double hexagonal” close packing of cations in the sequence ABAC. Unlike the cations, the anion arrangement is not based on principles of close packing. The structure is conceived as consisting of four discrete layers which link by corner and edge sharing. At z=0, the ²⁻[Mn₉²⁺Sb₃⁵⁺O₂₄] ordered brucite-like sheet has a [M₃O₈] unit that mimics the octahedral sheet of spinel along [111]. At z = 1/4, the [Mn₉³⁺O₆(SiO₄)(SiO₄)₂O₁₈] unit relates to a sheet in schairerite and to the fundamental sheet in mitridatite. At z = 1/2, the [Mn₃²⁺O₆Mn₃³⁺O₂₃] sheet relates to pyrochlore and the large alunite-jarosite family. At z = 3/4, the [Mn₉³⁺O₃(SiO₄)₃O₁₈O₃] sheet is based on Mn₃OO₁₂ islands of three Mn-O atom distorted octahedra comprising three shared edges and one shared vertex, all nearly in a plane. Langbanite is considered to be an oxide-stuffed version of the La inter-metallic structure.**

DABZA	LÅNGBANITE	Mn ₄ Mn ₉ SbSi ₂ O ₂₄
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SERIES 27 **FEIITE, orth/Cmcm.**

DAB27A	FEIITE	Fe ²⁺ ₂ (Fe ²⁺ Ti ⁴⁺)O ₅
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GROUP B **FRAMEWORK STRUCTURES**

TYPE A **SIMPLE**

SERIES A **ANATASE, tetr/I4₁/amd. The structure is based on the cubic closest packing of oxygen atoms, where the Ti atoms are located in octahedral voids. On the layer parallel to (001) the Ti atoms show a square pattern, but in the plane parallel to the closest packed layers, the Ti atoms show a zig-zag pattern.**

DBAAA	ANATASE	TiO ₂
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SERIES B ICE, hex/P6₃/mmc. The structure is similar to that of tridymite but the relative size of the atoms forming the tetrahedra is inverted; instead of SiO₄ tetrahedra, it is based on O⁺H₄ tetrahedra. In the ice structure, each H₂O molecule is tetrahedrally coordinated to four neighboring H₂O molecules, analogous to Si in beta-tridymite.

DBABA ICE H₂O

SERIES C KROTITE, mon/P2₁/n. The structure is a stuffed derivative of tridymite.

DBACA KROTITE CaAl₂O₄ mon/P2₁/n

TYPE B COMPLEX

SERIES A PEROVSKITE SERIES, orth/Pnma. The structure is based on a cubic closest packing of oxygen and calcium atoms with Ti atoms occupying 1/4 of the octahedral voids with a square pattern. Structure consists of M octahedra share corners to create a 3-dimensional framework with cavities that accommodate the M cations.

On the basis of extensive studies of synthetic perovskite-structured compounds it is possible to derive a hierarchy of hettotype structures which are derivatives of the arisotypic cubic perovskite structure (ABX₃), exemplified by SrTiO₃ (tausonite) or KMgF₃ (parascandolaite) by: (1) tilting and distortion of the BX₆ octahedra; (2) ordering of A- and B-site cations; (3) formation of A-, B- or X site vacancies. This hierarchical scheme can be applied to some naturally-occurring oxides, fluorides, hydroxides, chlorides, arsenides, intermetallic compounds and silicates which adopt such derivative crystal structures. Application of this hierarchical scheme to naturally-occurring minerals results in the recognition of a perovskite supergroup which is divided into stoichiometric and non stoichiometric perovskite groups, with both groups further divided into single ABX₃ or double A₂BBX₆ perovskites. Subgroups, and potential subgroups, of stoichiometric perovskites include: (1) silicate single perovskites of the bridgmanite subgroup; (2) oxide single perovskites of the perovskite subgroup (tausonite, perovskite, loparite, lueshite, isolueshite, lakargiite, megawite); (3) oxide single perovskites of the macedonite subgroup which exhibit second order Jahn-Teller distortions (macedonite, barioperovskite); (4) fluoride single perovskites of the neighborite subgroup (neighborite, parascandolaite); (5) chloride single perovskites of the chlorocalcite subgroup (6) B-site cation ordered double fluoride perovskites of the cryolite subgroup (cryolite, elpasolite; simmonsite); (7) B-site cation ordered oxide double perovskites of the vapnikite subgroup (vapnikite, (?) latrappite). Non-stoichiometric perovskites include: (1) A-site vacant double hydroxides, or hydroxide perovskites, belonging to the söhngeite, schoenfliesite, and stottite subgroups; (2) Anion-deficient perovskites of the brownmillerite subgroup (srebrodolskite, shulamitite); (3) A-site vacant quadruple perovskites (skutterudite subgroup); (4) B-site vacant single perovskites of the oskarssonite subgroup [oskarssonite, waimirite-(Y)]; (5) B-site vacant inverse single perovskites of the cohenite and auricupride subgroups; (6) B-site vacant double perovskites of the diaboiteite subgroup; (7) anion-deficient partly-inverse B-site quadruple perovskites of the hematophanite subgroup.

DBBAA	PEROVSKITE	CaTiO ₃	
DBBAB	LATRAPPITE	(Ca,Na)(Nb,Ti)O ₃	
DBBAC	LOPARITE-(Ce)	(Ce,Na,Ca)(Ti,Nb)O ₃	
DBBAD	LUESHITE	NaNbO ₃	
DBBAE	TAUSONITE	SrTiO ₃	
DBBAF	MACEDONITE	PbTiO ₃	tetr/P4/mmm
DBBAG	NATRONIOBITE ?	NaNbO ₃	mon/
DBBAH	ISOLUESHITE	(Na,Ca,La)(Nb,Ti)O ₃	Pm3m
DBBAI	BARIOPEROVSKITE	BaTiO ₃	Orth/Amm2
DBBAJ	LAKARGIITE	CaZrO ₃	OrthPnma
DBBAK	MEGAWITE	CaSnO ₃	orth/Pbnm
DBBAL	NATALIAKULIKITE	Ca ₄ Ti ₂ (Fe ³⁺ Fe ²⁺)(Si,Fe ³⁺ ,Al)O ₁₁	orth/Pnma
DBBAM	VAPNIKITE	Ca ₃ UO ₆	mon/P2 ₁ /n
DBBAN	PARASCANDOLAITE	KMgF ₃	iso/Pm3
WAAA29	BRIDGMANITE	MgSiO ₃	orth/Pnma

DBBAO GOLDSCHMIDTITE KNbO₃ iso/Pm3m

SERIES B **AESCHYNITE SERIES, orth/Pbnm.** The structure consists of double chains of B octahedra linked in pairs by sharing edges, and extending indefinitely along b by sharing corners. The large A cations are accommodated in 8-coordinated sites in channels between the chains of octahedra, and the size of the site can be adjusted by rotating the octahedral chains about their common corners. Structure consists of dimmers of edge-sharing (Nb,Ta,Ti)O₆ octahedra sharing corners to form zigzag chains // [010]; REE polyhedra share edges to form chains // [010]; each REE polyhedron shares edges with six (Nb,Ta,Ti) octahedra to form a framework.

DBBBA AESCHYNITE-(Ce) (Ce,Ca,Fe,Th)(Ti,Nb)₂(O,OH)₆
 DBBBB AESCHYNITE-(Nd) (Nd,Ce,Ca)(Ti,Nb)₂(O,OH)₆
 DBBBC AESCHYNITE-(Y) (Y,Ca,Fe,Th)(Ti,Nb)₂(O,OH)₆
 DBBBD NIOBO-AESCHYNITE-(Ce) (Ce,Ca,Th)(Nb,Ti)₂(O,OH)₆
 DBBBE NIOBO-AESCHYNITE-(Nd) (Nd,Ce)(Nb,Ti)₂(O,OH)₆
 DBBBF TANTALAESCHYNITE-(Y) (Y,Ce,Ca)(Ta,Ti,Nb)₂O₆
 DBBBG RYNERSONITE Ca(Ta,Nb)₂O₆
 DBBBH VIGEZITE (Ca,Ce)(Nb,Ta,Ti)₂O₆
 DBBBI NIOBOAESCHYNITE-(Y) [(Y,Ln)Ca,Th,Fe](Nb,Ti,Ta)₂(O,OH)₆
 DBBBJ LORANSKITE-(Y) (Y,Ce,Ca)ZrTaO₆
 DBBBK KOBEITE-(Y) (Y,U)(Ti,Nb)₂(O,OH)₆

SERIES C **TANTITE, tric/P1. Structure not known.** Mineralogicheskii Zhurnal, Kiev (1983): 5(3): 90-93. American Mineralogist (1984): 69: 1193.

DBBCA TANTITE (Ta,Nb)₂O₅

SERIES D **WELINITE, hex/P3.** Structure consists of edge- and corner-sharing Mn²⁺ octahedra forming a framework with insular Si tetrahedra ; channels // {0001} contain partially occupied chains of face-sharing V⁵⁺ octahedra. The new mineral barwoodite (IMA2017-046), Mn₂+6(Nb₅₊,□)₂(SiO₄)₂(O,OH)₆, was found in miarolitic cavities at the Big Rock quarry (also known as the 3M quarry), Granite Mountain, Little Rock, Pulaski County, Arkansas, USA. It is interpreted as crystallizing from pegmatitic fluids. The mineral occurs as brownish-red hexagonal plates up to 3 mm in diameter. Crystals are transparent with vitreous luster and light orange streak. The tenacity is brittle, the Mohs hardness is approximately 3½, the fracture is curved, and there is one perfect cleavage on {001}. The calculated density for the empirical formula is 4.227 g/cm³. Barwoodite is optically uniaxial (–) with ω = 1.873(3) and ε = 1.855(5) (white light) and is nonpleochroic. Electron microprobe analyses (WDS mode) provided the empirical formula Mn₂+6(Nb₅₊+0.94Fe₃₊+0.18Mn³⁺+0.11□+0.77Σ2(SiO₄)₂[O₃.58(OH)₂.42]Σ6. The six strongest X-ray powder diffraction lines are [dobs Å(l)(hkl)]: 3.125(95)(11-1), 2.858(56)(021), 2.688(57)(210), 2.349(81)(300), 1.7930(100)(212), and 1.5505(75)(140,-3-21). Barwoodite is trigonal, P3, a 8.2139(10), c 4.8117(4) Å, V 281.14(7) Å³, and Z = 1. The structure determination for barwoodite (R1 = 0.0246 for 746 reflections with I_o > 2σI) shows it to be isostructural with welinite, franciscanite, and örebroite. Together, these four minerals comprise the welinite group.

DBBDA ÖREBROITE Mn₆(Sb,Fe)₂Si₂(O,OH)₁₄
 DBBDB FRANCISCANITE Mn₆(V,□)₂Si₂(O,OH)₁₄
 DBBDC WELINITE Mn₆(W,Mg)₂Si₂(O,OH)₁₄
 DBBDD BARWOODITE Mn²⁺₆Nb⁵⁺(SiO₄)₂O₃(OH)₃
 DBBDE SCORTICOITE Mn₆(Sb□)₂(SiO₄)₂O₃(OH)₃

SERIES E **EYSELITE, orth/P.** Structure not known due to small size of crystals. Roberts, A.C., Seward, T.M., Reusser, E., Carpenter, G.J.C., Grice, J.D., Clark, S.M., and Marcus. M.A. (2004): Eyselite, Fe₃+Ge₄+3O₇(OH), a new mineral species from Tsumeb, Namibia. Canadian Mineralogist, 42, 1771-1776.

DBBEA EYSELITE Fe³⁺Ge⁴⁺₃O₇(OH)

DBBEB	CESPLUMTANITE	$\text{Cs}_2\text{Pb}_3\text{Ta}_8\text{O}_{24}$	tetr. n/s known American Mineralogist (1989): 74: 501.
SERIES F	DERBYLITE, mon/P2₁/m. The structure is based on a closest-packed anion framework with a stacking sequence (hhc...). Small cations are ordered into 14 of the 30 octahedral sites per unit cell, forming $\alpha\text{-PbO}_2$ and V_3O_5 -type chains of edge-shared octahedra along [001]. In the cubic stacked anion layers, two anions per unit cell, are missing, forming cubo-octahedral cavities that are occupied by Ba, and by As^{3+}_2 pairs. The structure of batisivite is a combination of zigzag double chains of octahedra of $\alpha\text{-PbO}_2$ -type and columns of V_2O_5 -type. The channels formed by these structural units can be described as chains of cuboctahedral cavities running // to [011]. Ti, V, Cr, Fe, and Nb occupy the octahedral sites, whereas Ba and Si-O groups occupy the cuboctahedral sites.		
DBBFA	DERBYLITE	$\text{Fe}_4\text{Ti}_3\text{SbO}_{13}(\text{OH})$	
DBBFB	TOMICHITE	$(\text{V,Fe})_4\text{Ti}_3\text{AsO}_{13}(\text{OH})$	
DBBFC	HEMLOITE	$(\text{As,Sb})_2(\text{Ti,V,Fe,Al})_{12}\text{O}_{23}(\text{OH})$	
DBBFD	GRAESERITE	$(\text{Fe,Ti})_4\text{Ti}_3\text{AsO}_{13}(\text{OH})$	
DBBFE	BATISIVITE	$\text{V}_8\text{Ti}_6[\text{Ba}(\text{Si}_2\text{O}_7)]\text{O}_{22}$	
SERIES G	PEROVSKITE DERIVATIVE Structures. The structure is based on the stacking of four perovskite-like cells along [001].		
DBBGA	HEMATOPHANITE	$\text{Pb}_4\text{Fe}_3\text{O}_8\text{Cl}$	tetr/P4mm
SERIES H	MENEZESITE, cubic/Im$\bar{3}$. The main building unit of the structure is the $[\text{MgW}_{12}\text{O}_{42}]^{10-}$ heteropolyanion, formed by 12 face and corner sharing WO_6 -octahedra, enclosing a 12-fold coordinated cavity, which is occupied by Mg. The heteropolyanions occupy the corners and the body centered positions of the unit cell and are cross-linked in 3D by MgO_6 -octahedra to form a rigid 3D lattice in two ways. In the first, Mg (1) links the central polyanions to its eight neighbors in the corners of the unit cell, whereas, in the second, Mg (2) links the polyanions with their six neighbors across the unit-cell faces. These latter cations complete their octahedral coordinations with equatorial OH anions and water molecules in relation 1:2 to reach the electroneutrality of the compound. Am. Min. 93, 81.		
DBBHA	MENEZESITE	$\text{Ba}_2\text{MgZr}_4(\text{BaNb}_{12}\text{O}_{42}) \cdot 12\text{H}_2\text{O}$	
DBBHB	ASPEDAMITE	$\square_{12}(\text{Fe}^{3+}_2\text{Fe}^{2+})\text{Nb}_4(\text{ThNb}_9\text{Fe}^{3+}_2\text{Ti}^{4+}\text{O}_{42})((\text{H}_2\text{O})_9(\text{OH})_3)$	
SERIES I	BILLWISEITE, mon/C2/c. The structure consists of two distinct sheets of (Ta,Nb,W) octahedral and three distinct sheets of Sb^{3+} polyhedra // to (100). These sheets alternate in the a direction to form a continuous structure.		
DBBIA	BILLWISEITE	$\text{Sb}^{3+}_5\text{Nb}_3\text{WO}_{18}$	
SERIES J	RANKAMAITE, orth/Cmmm. In the rankamaite structure, the Ta atoms are coordinated by six and seven oxygen atoms in the form of distorted TaO_6 octahedra and TaO_7 pentagonal bipyramids, respectively. Every pentagonal bypramid shares edges with four octahedral, thus forming Ta_5O_{14} units. The K atom is in an 11-fold coordination, whereas one Na atom is in a 10-fold and the other is in a 12-fold coordination.		
DBBJA	RANKAMAITE	$(\text{Na}_{2.21}\text{K}_{1.26})_{3.37}(\text{Ta}_{9.12}\text{Nb}_{1.30}\text{Al}_{0.59})_{11}[\text{O}_{26.3}(\text{OH})_{4.7}]_{31}$	
DBBJB	SOSEDKOITE	$(\text{K,Na})_5\text{Al}_2(\text{Ta,Nb,Sb})_{22}\text{O}_{60}$	
SERIES K	TASHELGITE, mon/Pc. Rastsvetaeva, R.K., Aksenov, S.M., Verin, I.A. (2010): Crystal structure of complex natural aluminum magnesium calcium iron oxide. Crystallography Reports, 55, 563-568.		
	Rastsvetaeva, R.K., Aksenov, S.M., Chukanov, N.V. (2010): Structure of the tashelgite mineral $\text{Ca}_2\text{Mg}_2\text{Fe}_{22}+\text{Al}_{18}\text{O}_{32}(\text{OH})_2$ from Western Siberia: A new structure type. Doklady Chemistry, 434, 233-236.		

Ananyev, S.A. et al (2010), Tashelgite, IMA 2010-017. CNMNC Newsletter, August 2010, p.798, *Mineralogical Magazine* 74, 797-800.

Ananyev, S.A., Konovalenko, S.I., Rastsvetaeva, R.K., Aksenov, S.M., Chukanov, N.V., Sapozhnikov, A.N., Zagorsky, V.E. & Virus, A.A. (2011): Tashelgite, $\text{CaMgFe}_2\text{Al}_9\text{O}_{16}(\text{OH})$, a new mineral species from calc-skarnoid in Gorny Shoria. *Zapiski Rossiyskogo Mineralogicheskogo Obshchestva*, **140(1)**, 49-57 (in Russian). English translation: *Geology of Ore Deposits*, **53**, 751-757.

DBBKA	TASHELGITE	$\text{CaMgFe}^{3+}\text{Al}_9\text{O}_{16}(\text{OH})$
SERIES L	ROSIAITE, trig/P31m. Structure consists of gibbsite-like layers of edge-sharing SbO_6 octahedra // (0001), with 1/3 of the octahedral sites vacant, and are linked by PbO_6 octahedra situated above and below the vacant sites of the Sb layers.	
DBBLA	ROSIAITE	PbSb_2O_6
SERIES M	LUCASITE, mon/I2/a. The structure is related to the PbSb_2O_6-type structure, with ordering of Ce and Ti atoms in alternate {001} cations layers in a hexagonal closest-packed anion arrangement. The Ti-centered octahedra share edges to form gibbsite-like fused hexagonal rings. The Ce atoms are sandwiched between pairs of hexagonal rings and are displaced by 0.5 Å along [010] from the centers of octahedral sites to adopt eightfold co-ordination.	
DBBMA	LUCASITE-(Ce)	$(\text{Ce,L a})\text{Ti}_2(\text{O,OH})_6$
DBBMB	KASSITE	$\text{Ca}[\text{Ti}_2\text{O}_4(\text{OH})_2]$
SERIES N	CAFETITE, mon/P2₁/n. The TiO_6 octahedra form $[\text{Ti}_2\text{O}_5]$ sheets parallel to (001). The Ca atoms and water groups are located between the sheets to form a three-dimensional structure.	
DBBNA	CAFETITE	$\text{Ca}[\text{Ti}_2\text{O}_5](\text{H}_2\text{O})$
SERIES O	BACKITE, trig/P312. Tait, K.T., DiCecco, V., Cooper, M.A., Ball, N.A. and Hawthorne, F.C. (2014) Backite, IMA 2013-113. CNMNC Newsletter No. 19, February 2014, page 169; Mineralogical Magazine, 78, 165-170.	
	Tait, K.T., DiCecco, V., Ball, N.A., Hawthorne, F.C., Kampf, A.R. (2014): Backite, $\text{Pb}_2\text{Al}(\text{TeO}_6)\text{Cl}$, a new tellurate mineral from the Grand Central Mine, Tombstone Hills, Cochise County, Arizona: Description and crystal structure. <i>Canadian Mineralogist</i> , 52 , 935-942	
DBBOA	BACKITE	$\text{Pb}_2\text{AlTeO}_6\text{Cl}$ MOVE TO TELLURATES
SERIES P	TEWITE, orth/Pban. Tewite, with end-member formula $(\text{K}_{1.5}\square_{0.5})\Sigma_2(\text{Te}_{4+1.25}\text{W}_{0.25}\square_{0.5})\Sigma_2\text{W}_5\text{O}_{19}$ or $\text{K}_{1.5}(\text{Te}_{1.25}\text{W}_{0.25})\Sigma_{1.5}\text{W}_5\text{O}_{19}$, is a new mineral species (IMA2014-053), discovered in the vicinity of Nanyang village, Huaping County, located in the south of the Panzhihua–Xichang region, southwestern China. Tewite occurs in the Neoproterozoic Sinian light-weathered biotite–quartz monzonite, near the contact zone with gabbro. The associated minerals are alkali feldspar, biotite, clinoamphibole, ilmenite, zircon, zoisite, tourmaline, monazite-(Ce), allanite-(Ce), scheelite, tellurite and the new mineral wumuite ($\text{KA}_{10.33}\text{W}_2.67\text{O}_9$, IMA2017-067a), in addition to an unidentified, potentially new mineral corresponding to WO_3. Tewite forms platy crystals that range from $0.08 \times 0.1 \times 0.1$ to $0.1 \times 0.2 \times 0.5$ mm in size. The crystals are greenish yellow, with a light-yellow to white streak, translucent to transparent, and with adamantine luster. Mohs hardness is $3\frac{1}{2}$–4, and the tenacity is brittle. It has perfect {100}, {001}, and {010} cleavages, and the calculated density is 6.903 g/cm³. The mineral is biaxial positive with $2V = 70^\circ$. The Gladstone–Dale relationship predicts an average index of refraction of 2.04. The chemical composition determined by wavelength-dispersive electron-microprobe analysis is (wt%, average of n = 16): Na₂O 0.13, K₂O 5.08, WO₃ 83.34, TeO₂ 11.32, total 99.86. The empirical formula, based on 19 O, is $(\text{K}_{1.61}\text{Na}_{0.06}\square_{0.33})\Sigma_2.00(\text{Te}_{1.06}\text{W}_{0.35}\square_{0.59})\Sigma_2.00\text{W}_5\text{O}_{19}$. The eight strongest X-ray powder-diffraction lines [d in Å (I) (hkl)] are: 6.486 (50) (040), 3.8333 (100) (001), 3.6212 (30) (200), 3.1983 (65) (080), 2.4541 (50) (081), 1.8442 (30) (390), 1.6365 (25) (401), and 1.5743 (55) (480). Refinement of the crystal structure (R₁ = 0.075) gave the following data: orthorhombic, space group Pban, a = 7.2585(4), b = 25.8099(15), c = 3.8177(2)Å, Z = 2. Tewite has a new tungsten-bronze (TB)-type derivative structure. Distorted TeO₆ octahedra break TB slabs into ribbons which are displaced by $\frac{1}{2}$ a relative to their neighbors, while K partly occupies two mutually exclusive sites in hexagonal	

channels || c. Short-range order and displacement of K ions are likely responsible for an observed incommensurate modulation of the average structure indicated by weak satellite reflections, which were not considered in the structure refinement. The formation of the mineral may be related to the nearby quartz-vein-type Au mineralization; the mineral is formed by the metasomatic reaction of a high-temperature fluid rich in W and Te with the potassium feldspar in the monzonite. Tewite is a mineralogically unique K–Te–W oxide. The mineral is classified as a composite oxide, New Dana Classification class 07.04.03, of stoichiometry A₂B₂C₅O₁₉.

<http://www.cugb.edu.cn/uploadCms/outCampusHtml/2014/40100/20140917173131168166.shtml>

Li, G., Xue, Y. and Xiong, M.(2014) Tewite, IMA 2014-053. CNMNC Newsletter No. 22, October 2014, page 1245; *Mineralogical Magazine*, 78, 1241-1248.

DBBPA	TEWITE	$K_2(Te_{1.5}X_{0.5})_2W_5O_{19}$
SERIES Q	TULULITE, cub/F23. The tetrahedral framework of tululite is formed by T₇O₁₃ secondary building blocks, which consist of four corner-linked tetrahedra sharing a common oxygen atom and three tetrahedra sharing two O atoms with the neighbor SBU. Ca cations occupy three positions; two of them also contain a minor amount of Cd. The Ca sites surround an island (Fe, Al)O₆ octahedron and a (Si,P)O₄ tetrahedron in the centers of framework cages at the junction of eight SBUs. The (Fe,Al)O₆ octahedron is coordinated by 14 Ca positions into a 6-capped cube, whereas the (Si,P)O₄ tetrahedron is coordinated by six Ca positions into a regular octahedron. Khoury, H.N., Sokol, E.V., Kokh, S.N., Seryotkin, Y.V., Nigmatulina, E.N., Goryainov, S.V., Belogub, E.V. and Clark, I.D. (2015) Tululite, IMA 2014-065. CNMNC Newsletter No. 23, February 2015, page 53; <i>Mineralogical Magazine</i>, 79, 51-58.	
DBBQA	TULULITE	$Ca_{14}(Fe,Al)(Al,Zn,Fe,Si,P,Mn,Mg)_{15}O_{36}$
SERIES R	LANGHOFITE, tric/P1	
DBBRA	LANGHOFITE	$Pb_2(OH)[WO_4(OH)]$
GROUP C	RING STRUCTURES	
GROUP D	INSULAR STRUCTURES	
TYPE A	SIMPLE	
SERIES A	ARSENOLITE SERIES, cub/Fd3m. The structure consists of As₂O₆ molecules packed together in the unit cube in the same manner as are the carbon atoms in the diamond structure. Within the molecule, each As (Sb) atom has three oxygen neighbors at a distance that is 1.80 Å. Structure consists of four flat trigonal pyramids of MO₃ forming O-sharing M₄O₆ molecules that are linked by van der Waals bonding.	
DAAA	ARSENOLITE	As_2O_3
DAAAB	SENARMONTITE	Sb_2O_3
GROUP E	CHAIN STRUCTURES	
TYPE A	SIMPLE	
SERIES A	RUTILE SERIES, tetr/P4₂/mnm. Structure consists of edge-sharing M octahedra form straight chains // [001]; the chains are linked by sharing corners of the octahedra.	
DEAAA	RUTILE	TiO_2
DEAAB	PYROLUSITE	MnO_2
DEAAC	CASSITERITE	SnO_2
DEAAD	PLATTNERITE	PbO_2
DEAAE	ARGUTITE	GeO_2
DEAAF	STISHOVITE	SiO_2
DEAAG	TRIPUHYITE	$FeSbO_4$
DEAAH	open	

DEAAI	open		
DEAAJ	VARLAMOFFITE	$\text{Sn}_{1-x}\text{Fe}_x\text{O}_{2-x}(\text{OH})_x$	
SERIES B	Open		
SERIES C	RAMSDELLITE, orth/Pbnm. The structure is based on a hexagonal closest packing of oxygens, with one half of the octahedral voids occupied by Mn atoms, forming a double row pattern. The double rows on the adjacent layers are placed over the empty rows, that is in between the double rows of the adjacent layers. Structure consists of edge-sharing M octahedra forming double chains // [001], as in diasporite; the chains are linked by sharing corners of octahedra, creating channels // [001] that may contain small cations.		
DEACA	RAMSDELLITE	MnO_2	
DEACB	PARAMONTROSEITE	VO_2	
DEACC	NSUTITE	γMnO_2	hex/P6 ₃ /mmc
DEACD	AKHTEMSKITE	ϵMnO_2	
SERIES D	DOWNEYITE, tetr/P4₂/mbc. The structure consists of endless strings in which half of the oxygen atoms join the Se atoms and the other oxygens are bound only to one Se. The SeO_2 strings extending parallel to one another and to the c_0 axis can be imagined as flat SeO_3 pyramids that have selenium atoms at the apexes and oxygen atoms linking them to one another. These pyramids are nearly regular. Structure consists of corner-sharing SeO_3 pyramids forming isolated chains // [001]; the chains are linked by electrostatic interactions.		
DEADA	DOWNEYITE	SeO_2	
SERIES E	VALENTINITE, orth/Pccn. Structure consists of corner-sharing SbO_3 trigonal pyramids forming chains // [001].		
DEAEA	VALENTINITE	Sb_2O_3	
SERIES F	MONTROYDITE, orth/Pnma. Structure consists of infinite zigzag chains of Hg-O-Hg atoms running // [100]; the chains are packed into layers // (010).		
DEAFA	MONTROYDITE	HgO	
SERIES G	KYZYLKUMITE-SCHREYERITE SERIES, mon/P2₁/c. The structures can be derived from that of alpha PbO_2 by crystallographic shear // (110). Byrudite has the norbergite-type structure. The structure is based on a hexagonal closest packing of O, OH and F, with Mg atoms in octahedral voids forming a zigzag pattern, and Si atoms in tetrahedral voids. The serrated chain of edge-sharing octahedra consists of five unique octahedra. It can be imagined derived from olivine and brucite. The structure of Kyzylkumite has a modular structure based on hexagonal close packing of O atoms, which are made up of rutile and montroseite slices. In tivanite the rutile:montroseite ratio is 1:1, in kyzylkumite the ratio is 2:1. The common structure type of oxyvanite and berdesinskiite can be described by hexagonal closest O packing with 3/5 of the octahedral voids occupied. Site-occupancy refinements support previous studies on synthetic V_2TiO_5 and V_3O_5 indicating that a strongly distorted octahedrally coordinated site, forming pairs of face-sharing octahedral.		
DEAGA	KYZYLKUMITE	$\text{Ti}_2\text{V}^{3+}\text{O}_5(\text{OH})$	mon/P2 ₁ /c
DEAGB	SCHREYERITE	$\text{V}_2\text{Ti}_3\text{O}_9$	C2/c
DEAGC	OLKHONSKITE	$(\text{Cr},\text{V})_2\text{Ti}_3\text{O}_9$	C2/c,Cc,P2 ₁ /c,P2/c,Pc
DEAGD	BERDESINSKIITE	V_2TiO_5	C2/c or Cc
DEAGE	OXYVANITE	V_3O_5	C2/c
DEAGF	BYRUDITE	$(\text{Be},\square)(\text{V}^{3+},\text{Ti})_3\text{O}_6$	orth/Pnma
DEAGG	TIVANITE	$(\text{TiO}_2)(\text{VO}(\text{OH}))$	P2 ₁ /c

DEAGH	KLEBERITE	FeTi ₆ O ₁₁ (OH) ₅	mon/P2 ₁ /c
DEAGI	VERBIERITE	BeCr ³⁺ ₂ TiO ₆	
DEAGJ	MACHIITE	Al ₂ Ti ₃ O ₉	mon/C2/c
DEAGK	VESTAITE	(Ti ⁴⁺ Fe ²⁺)Ti ⁴⁺ ₃ O ₉	mon/C2/c
DEAGL	DAITIANITE	Ti ³⁺ ₂ Ti ⁴⁺ O ₅	mon/C2/c

SERIES H **CARMICHAELITE, mon/P2₁/c.** The structure consists of stacked chains of cation octahedra in an array of hexagonal closed-packed oxygen atoms, the hcp layers being parallel to (010).

DEAHA	CARMICHAELITE	(Ti,Cr,Fe,Mg,Al)O _{1.5} (OH) _{0.5}
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SERIES I **BIEHLITE, mon/2C/c.** Structure consists of edge-sharing MoO₆ octahedra forming zigzag chains // (001) that are flanked on two sides by Sb₂O₂ groups; the resulting ribbons are linked by weak Sb-O bonds.

DEAIA	BIEHLITE	(Sb,As) ² MoO ₆
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TYPE B **COMPLEX**

SERIES A **RUTILE DERIVATIVE Structure, tetr/P4₂/mm.** The structure of this series is based on a hexagonal closest packing with the Ta and Fe atoms occupying one half of the octahedral voids, with a row pattern. The structure is a substitution derivative of the rutile structure and is identical to the Sb^o₂Zn^o[O₆]^h inorganic structure type. The prominent feature of the structure is the presence of distorted, edge-sharing octahedra that form straight chains parallel to [001]. These chains have an intra-chain stacking sequence, ...A-B-B-A-B-B..., where A represents Fe²⁺ and B represents Ta in the ideal structural formula. Adjacent chains are linked by shared corners of the octahedra.

DEBAA	BYSTRÖMITE	MgSb ₂ O ₆
DEBAB	TAPIOLITE-(Fe)	(Fe,Mn)(Ta,Nb) ₂ O ₆
DEBAC	TAPIOLITE-(Mn)	(Mn,Fe)(Ta,Nb) ₂ O ₆
DEBAD	ORDONEZITE	ZnSb ₂ O ₆
DEBAE	TREDOUXITE	NiSb ₂ O ₆

SERIES B **ALPHA PbO₂ Substitution Derivative Structure, mon/P2/c.** The structure is based a hexagonal closest packing where the Fe and W atoms are located in one half of the octahedral voids, the Fe and the W atoms form a zigzag pattern like in brookite. The layers parallel to (100) containing the Fe atoms alternate with the layers containing the W atoms. The structure is a distortion derivative of ixiolite, and a substitution derivative of alpha PbO₂.

DEBBA	SANMARTINITE	ZnWO ₄
DEBBB	HEFTETJERNITE	ScTaO ₄
DEBBC	FERBERITE	FeWO ₄
DEBBD	HÜBERNITE	MnWO ₄
DEBBE	HUANZALAITE	MgWO ₄
DEBBF	ROSSOVSKYITE	(Fe ³⁺ ,Ta)(Nb,Ti)O ₄

SERIES C **ALPHA PbO₂ Derivative Structure, orth/Pcan, mon/C2/c.** The structure is composed of coordination polyhedra which link via edge-sharing to form alpha PbO-like zigzag chains along z. Chains are interconnected by corner-sharing linkages between levels of the closest-packed layering. The A and B polyhedra alternate along the zigzag chains of their level; adjacent levels necessarily consist only of chains of C polyhedra. The structure of lithiotantite is composed of a slightly distorted hexagonal close-packed array of O atoms stacked in the [-101] direction, with the metal atoms occupying half of the octahedral sites. There are four symmetrically non-equivalent cations sites, with three of them occupied mainly by (Ta⁵⁺ + Nb⁵⁺) and one by Li⁺. The four distinct octahedral share edges, forming two types of zigzag chains (A and B) extending along the b axis. The A chains are built exclusively

of (Ta,Nb)O₆ octahedra (M1 and M2), whereas the B chains consist of alternating (Ta, Nb)O₆ and LiO₆ octahedra (M3 and M4, respectively).

DEBCA	IXIOLITE	(Ta,Fe,Sn,Nb,Mn) ₄ O ₈	
DEBCB	ACHALAITE	(Fe,Mn)(Ti,Fe,Ta)(Nb,Ta) ₂ O ₈	
DEBCC	WODGINITE	(Ta,Nb,Sn,Mn,Fe) ₁₆ O ₃₂	
DEBCD	SAMARSKITE-(Y)	YFe ³⁺ Nb ₂ O ₈	(mon, C2/c)
DEBCE	LITHIOWODGINITE	(Li,Mn,Fe)(Ta,Nb,Sn) ₃ O ₃₂	
DEBCF	FERROWODGINITE	FeSnTa ₂ O ₈	
DEBCG	TITANOWODGINITE	MnTiTa ₂ O ₈	
DEBCH	SAMARSKITE-(Yb)	[(Yb + Y),U,Th,Ca,Fe](Nb,Ta,Ti)O ₄	
DEBCI	FERROTITANOWODGINITE	FeTi(Ta,Nb) ₂ O ₈	
DEBCJ	LITHIOTANTITE	Li(Ta,Nb) ₃ O ₈	
DEBCK	SRILANKITE	Ti(Ti,Zr)O ₄	
DEBCL	CALCIOSAMARSKITE	(Ca,Fe,Y)(Nb,Ta) ₂ O ₈	
DEBCM	TANTOLOWODGINITE	(Mn, □)TaTa ₂ O ₈	
DEBCN	EKEBERGITE	ThFeNb ₂ O ₈	

SERIES D **COLUMBITE, orth/Pcan.** The structure is based on a hexagonal closest packing, with the Fe and Nb atoms located in half of the octahedral voids, forming a zigzag pattern, similar to the arrangement in anatase and brookite. The layers containing the iron atoms alternate with pairs of layers containing the Nb atoms in rows of zigzag edge-sharing octahedra. This structure is a substitution derivative of wolframite, or still of $\alpha - \text{Pb}^{\text{o}}[\text{O}_2]^{\text{h}}$.

DEBDA	COLUMBITE-(Mn)	(Mn,Fe)(Nb,Ta) ₂ O ₆
DEBDB	TANTALITE-(Mn)	(Mn,Fe)(Ta,Nb) ₂ O ₆
DEBDC	COLUMBITE-(Fe)	(Fe,Mn)(Nb,Ta) ₂ O ₆
DEBDD	TANTALITE-(Fe)	FeTa ₂ O ₆
DEBDE	COLUMBITE-(Mn)	(Mg,Fe,Mn)(Nb,Ta) ₂ O ₆
DEBDF	TANTALITE-(Mg)	(Mg,Fe)(Ta,Nb) ₂ O ₆
DEBDG	QITIANLINGITE	(Fe,Mn) ₂ (Nb,Ta) ₂ WO ₁₀

SERIES E **THOREAULITE, mon/C2/c.** The structure consists of alternations of two types of layers perpendicular to x. One type of layer consists of corner-linked NbO₆ octahedra forming a flat, perforated, two-octahedron-thick sheet with closest-packed anions. The other type consists of distorted, edge-sharing Sn²⁺O₈ square antiprisms forming a flat, perforated sheet. The Sn²⁺ coordination polyhedron is severely distorted owing to the presence of a stereoactive lone-pair of electrons.

DEBEA	THOREAULITE	SnTa ₂ O ₆
DEBEB	FOORDITE	Sn(Nb,Ta) ₂ O ₆

SERIES F **PSEUDOBROOKITE SERIES, orth/ Pbcm.** Structure consists of edge- and corner-sharing MO₆ octahedra forming bands // [010]; the bands share edges with adjacent bands, creating channels // [010].

DEBFA	PSEUDOBROOKITE	Fe ₂ TiO ₅
DEBFB	ARMALCOLITE	MgTiTiO ₅

SERIES G **CRYPTOMELANE, mon or tetr, I4/m.** The structure consists of a framework of octahedrally coordinated metal ions. The octahedra are linked by edge-sharing to form double columns parallel to the tunnel axis. The double strings in turn share corners to form a three-dimensional framework

containing square tunnels. The structure of akaganeite is a modification of the hollandite structure. The octahedral cations are predominantly Fe^{3+} , whereas in virtually all other known hollandite-type compounds the octahedra primarily contain tetravalent cations, typically Mn or Ti, and Cl is the major cation tunnel species, as opposed to large univalent or divalent cations such as Ba or K that are typical in most hollandite-type phases.

DEBGA	ANKANGITE	$\text{Ba}(\text{Ti},\text{V},\text{Cr})_8\text{O}_{16}$	
DEBGB	CORONADITE	$\text{Pb}(\text{Mn},\text{Mn})_8\text{O}_{16}$	
DEBGC	CRYPTOMELANE	$\text{K}(\text{Mn},\text{Mn})_8\text{O}_{16}$	
DEBGD	HOLLANDITE	$\text{Ba}(\text{Mn},\text{Mn})_8\text{O}_{16}$	
DEBGE	MANJIROITE	$(\text{Na},\text{K})(\text{Mn},\text{Mn})_8\text{O}_{16}\cdot n\text{H}_2\text{O}$	
DEBGF	MANNARDITE	$\text{Ba}(\text{Ti}_6\text{V}_2)\text{O}_{16}$	
DEBGG	PRIDERITE	$(\text{K},\text{Ba})(\text{Ti},\text{Fe})_8\text{O}_{16}$	
DEBGH	REDLEDGEITE	$\text{BaTi}_6\text{Cr}_2\text{O}_{16}\cdot\text{H}_2\text{O}$	
DEBGI	ROMANECHITE	$(\text{Ba},\text{H}_2\text{O})(\text{Mn},\text{Mn})_5\text{O}_{10}$	mon/C2/c
DEBGJ	FERRIHOLLANDITE	$\text{Ba}(\text{Fe},\text{Mn})_8\text{O}_{16}$	
DEBGK	STRONTIOMELANE	$\text{SrMn}^{4+}_6\text{Mn}^{3+}_2\text{O}_{16}$	
DEBGL	HENRYMEYERITE	$\text{Ba}(\text{Ti}_7\text{Fe}^{2+})\text{O}_{16}$	
DEBGM	JEPPEITE	$(\text{K},\text{Ba})_2(\text{Ti},\text{Fe})_6\text{O}_{13}$	
DEBGN	AKAGANEITE	$\text{Fe}_{7.6}\text{Ni}_{0.4}\text{O}_{6.35}(\text{OH})_{9.65}\text{Cl}_{1.25}$	
DEBGO	TODOROKITE	$(\text{Mn},\text{Ca},\text{Mg})\text{Mn}_3\text{O}_7\cdot\text{H}_2\text{O}$	
DEBGP	FERRICORONADITE	$\text{Pb}(\text{Mn}^{4+}_6\text{Fe}^{3+}_2)\text{O}_{16}$	
DEPGQ	NIXONITE	$\text{Na}_2\text{Ti}_6\text{O}_{13}$	

SERIES H **MINIUM, tetr/P4₂/mbc.** The structure is based on the packing of $\text{Pb}^{\text{IV}}\text{O}_4$ chains, with Pb^{II} ions in the interstices, having 3n coordination. This arrangement is in agreement with the perfect cleavage along the (110) planes, and also with the strong valence of the Pb atoms in these chains. The versiliaite structure is related to schafarikite by every fourth Sb^{3+} ion in the ψ -tetrahedral chains is substituted by a Fe ion and a sulfide anion is added between two Fe cations in adjacent chains. The corner-sharing Fe tetrahedra connect the chains to build double-chain ribbons.

DEBHA	TRIPPKEITE	CuAs_2O_4	
DEBHB	SCHAFARZIKITE	FeSb_2O_4	
DEBHC	MINIUM	Pb_2PbO_4	
DEBHD	APUANITE	$\text{FeFe}_4\text{Sb}_4\text{O}_{12}\text{S}$	
DEBHE	VERSILIAITE	$\text{Fe}_4\text{Fe}_8\text{Sb}_{12}\text{O}_{32}\text{S}_2$	Pbam or Pba2
DEBHF	KUSACHIITE	CuBi_2O_4	

SERIES I **ALPHA PbO₂, orth/Pbcn.** Structure consist of edge-sharing PbO_6 octahedra forming zigzag chains // [001] that are corner-linked to analogous chains, two underlain and two overlain along [100], forming sheets // (100).

DEBIA	SCRUTINYITE	PbO_2	
DEBIB	SEIFERTITE	SiO_2	Pbcn/Pb2n

SERIES J **ANZAITE-(Ce), mon/C2/m.** The structure consists of alternating layers of type 1, populated by REE in an eightfold-coordinated and octahedrally coordinated Fe, and type 2, built of fivefold-and octahedrally coordinated Ti, stacked // to (001). This atomic arrangement is complicated by significant disorder affecting the Fe, fivefold-coordinated Ti and two of the four anion sites. Chakhmouradian, A.R., Cooper, M.A., Medici, L., Abdu, Y.A. and Shelukhina, Y.S. (2013) Anzaite -(Ce), IMA 2013-004. CNMNC Newsletter No. 16, August 2013, page 2701; *Mineralogical Magazine*, 77, 2695 - 2709.

DEBJA	ANZAITE-(Ce)	$Ce_4FeTi_6O_{18}(OH)_2$
SERIES K	RASPITE, mon/P2₁/a. Structure consists of WO₆ octahedra sharing edges to form zigzag chains // [010]; the chains are linked by Pb atoms.	
DEBKA	RASPITE	$PbWO_4$
SERIES L	COUSINITE, Structure not known. Q/D G.F. Davidson (1954): in Summary of progress Geol. Surv. G. Gr., p.70	
	J.F. Vaes (1958): "Cousiniet, een nieuw uraanmineral". Geologie en Mijnbouw 20, 449.	
	American Mineralogist: 44: 910.	
	M. Deliens (1975): "Une association de molybdates d'uranium de Shinkolobwe (région du Shaba, République du Zaïre)". Annales de la Société Géologique de Belgique 98, 155-160.	
	M. Deliens & P. Piret (1976): "Nouvelles données sur une umohoïte magnésienne de Shinkolobwe (région du Shaba, République du Zaïre)". Annales de la Société Géologique de Belgique 99, 205-209.	
DEBLA	COUSINITE	$MgU_2^{+4}Mo_2O_{13} \cdot 6H_2O$
SERIES M	ILSEMANNITE, amor. Q/D. Structure not known. Höfer (1871), Jb. Min.: 566.	
	Horton (1916), US Bureau of Mines Bulletin 111: 15.	
	Schaller (1917), WashingtonAc Sc., Journal: 7: 417.	
	Hess (1923), USGS Bulletin 750A.	
	Palache, Charles, Harry Berman & Clifford Frondel (1944), The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana Yale University 1837-1892, Volume I: Elements, Sulfides, Sulfosalts, Oxides. John Wiley and Sons, Inc., New York. 7th edition, revised and enlarged: 603-604.	
	Staples, Lloyd William (1951), Ilsemannite and jordisite: American Mineralogist: 36: 609-614.	
DEBMA	ILSEMANNITE	$Mo_3O_8 \cdot nH_2O$
SERIES N	KUDRYAVTSEVAITE, orth/Pnma. The structure consists of edge-sharing and corner-sharing chains composed of Mg, Fe and Ti atoms coordinated by six atoms of O and running along the b axis, with Na filling the tunnels formed by the chains. Anashkin, S., Bovkun, A., Bindi, L., Garanin, V. and Litvin, Y. (2013) Kudryavtsevaite, IMA 2012-078. CNMNC Newsletter No. 15, February 2013, page 10; Mineralogical Magazine, 77, 1-12.	
DEBNA	KUDRYAVTSEVAITE	$Na_3(Mg,Fe)(Fe,Ti)_2Ti_3O_{12}$
SERIES O	DUMORTIERITE, orth/Pnma. Structure consists three kinds of chains running parallel to <u>a</u>. The first is a partly disordered [Al,TaO₃] chain of face-sharing octahedra; the other two types are [Al₄O₁₂] chains, one of which joins to equivalent chains by reflection at the corners of octahedra to form [Al₄O₁₁] sheets. Dumortierite and magnesioidumortierite constitute a subgroup; holtite, nioboholtite, and titanoholtite constitute a subgroup and szklaryite is the first of a new subgroup.	
DEBOA	DUMORTIERITE	$Si_3B[Al_{6.75} \bullet 0.25O_{17.25}(OH)_{0.75}]$
DEBOB	MAGNESIODUMORTIERITE	$[Si(Si_{0.94}P_{0.01} \bullet 0.05)_2O_{15}(OH)_3]B[(Mg,Ti,Fe,\square)(Al,\square)(Al,Mg,\square)]_2$
DEBOC	HOLTITE	$(Al,Ta,\square)Al_6(BO_3)(Si,Sb^{3+}As^{3+})_3O_{12}(O,OH,\square)_3$
DEBOD	NIOBOHOLTITE	$(Nb_{0.6}\square_{0.4})Al_6BSi_3O_{18}$
DEBOE	TITANOHOLTITE	$(TiO_{0.75}\square_{0.25})Al_6BSi_3O_{18}$
DEBOF	SZKLARYITE	$\square Al_6BAS^{3+}_3O_{15}$

SERIES P	BECKETTITE-ADDIBISCHOFFITE SERIES, Sapphirine Supergroup		
DEBPA	BECKETTITE	$\text{Ca}_2\text{V}_6\text{Al}_6\text{O}_{20}$	
DEBPB	ADDIBISCHOFFITE	$\text{Ca}_2\text{Al}_6\text{Al}_6\text{O}_{20}$	
SERIES Q	BYRUDITE, mon/Pnma. The structure has the norbergite-type and is based on a hexagonal closest packing of O, OH and F, with Mg atoms in octahedral voids forming a zigzag pattern, and Si atoms in tetrahedral voids. The serrated chain of edge-sharing octahedra consists of five unique octahedra. It can be imagined derived from olivine and brucite.		
DEBQA	BYRUDITE	$\text{BeV}_2^{6+}\text{O}_6$	
GROUP F	LAYER STRUCTURES		
TYPE A	SIMPLE		
SERIES A	MOLYBDITE, orth/Pbnm. Structure consists of zigzag chains of edge-sharing MoO_6 octahedra // [001] which are linked by sharing corners of the octahedra.		
DFAAA	MOLYBDITE	MoO_3	
SERIES B	FREUDENBERGITE, mon/C2/m. Structure consists of edge-sharing $(\text{Ti,Fe})\text{O}_6$ octahedra forming double sheets // (001); the sheets are connected into a framework by sharing corners of octahedra in adjoining sheets; cavities in the framework are occupied by Na polyhedra.		
DFABA	FREUDENBERGITE	$\text{Na}_2(\text{Ti,Fe})_8\text{O}_{16}$	
SERIES C	BROOKITE, orth/Pbca. The structure is based on a closest packing with a <u>ch</u> sequence, where the Ti atoms are located in one half of the octahedral voids. On the closest packed layers, which are parallel to (100), the Ti atoms form a zigzag pattern. The Ti octahedra share three edges, resulting in zigzag chains with each octahedron sharing one edge with an octahedron of the adjoining chain. In tellurite, dimers of edge-sharing TeO_4 distorted square pyramids sharing corners to form corrugated sheets // (100) ; in paraqtellurite, similar distorted te square pyramids share corners to form a framework similar to that of cristobalite.		
DFACA	BROOKITE	TiO_2	
DFACB	TELLURITE	TeO_2	
DFACC	PARATELLURITE	TeO_2 tetr/ P4_12_12 or P4_32_12	
SERIES D	CLAUDETITE SERIES, mon/$\text{P2}_1/\text{n}$. Structure consists of flat trigonal pyramids of AsO_3 sharing O corners to form undulating sheets // (010), with chain-like units // [001].		
DFADA	CLAUDETITE	As_2O_3	
DFADB	STIBIOCLAUDETITE	AsSbO_3	
SERIES E	LITHARGE SERIES, tetr/$\text{P4}/\text{nm}$. Structure consists of PbO_4 square pyramids, with Pb at the apex, sharing edges to form undulating sheets // (001); the sheets are linked by van der Waals bonding.		
DFAEA	LITHARGE	PbO	
DFAEB	ROMARCHITE	SnO	
DFAEC	MASSICOT	PbO (Distorted Litharge Structure)	
DFAED	PALLADINITE	PdO tetr.	
SERIES F	SHAKHOVITE SERIES, mon/ Structure consists of isolated $\text{Sb}(\text{OH})_3\text{O}_3$ octahedra which are linked into layers // (010) by H-bonding; these layers are connected by Hg-Hg dimers.		
DFAFA	SHAKHOVITE	$(\text{Hg}^+)_4(\text{Sb}^{5+}\text{O}_3)(\text{OH})_3$	

TYPE B	COMPLEX		
SERIES A	EUXENITE SERIES, orth/Pbcn. Structure consists of zigzag chains of edge-sharing MO₆ octahedra // [001], as in scrutinyite, are linked to adjacent chains by sharing corners of octahedra, to form double layers // (100); the double layers are linked by a layer of Y polyhedra.		
DFBAA	EUXENITE-(Y)	(Y,Ca,Ce,U,Th)(Nb,Ta,Ti) ₂ O ₆	
DFBAB	TANTEUXENITE-(Y)	(Y,Ce,Ca)(Ta,Nb,Ti) ₂ (O,OH) ₆	
DFBAC	YTTROCRASITE-(Y)	(Y,Th,Ca,U)(Ti,Fe) ₂ (O,OH) ₆	
DFBAD	FERSMITE	(Ca,Ce,Na)(Nb,Te,Ti) ₂ (O,OH,F) ₆	
DFBAE	URANOPOLYCRASE	(U,Y)(Ti,Nb) ₂ O ₆	
DFBAF	POLYCRASE-(Y)	(Y,U)(Ti,Nb) ₂ O ₆	
SERIES B	BRANNERITE, mon/C2/m. In brannerite and thorutile, edge-sharing TiO₆ octahedra form zigzag chains // [010] ; the chains are joined into sheets // (001) by sharing edges of octahedra ; the sheets are linked by the large cations in 6 coordination.		
DFBBA	BRANNERITE	(U,Ca,Y,Ce)(Ti,Fe) ₂ O ₆	
DFBBB	THORUTITE	(Th,U,Ca)Ti ₂ (O,OH) ₆	
DFBBC	ORTHOBRANNERITE	UUTi ₄ O ₁₂ (OH) ₂ (orth/)	
SERIES C	KOECHLINITE, orth/Pna2₁. In koechlinite, sheets of corner-sharing (Mo,W)O₆ octahedra // [010] alternate with sheets of corner-sharing BiO₆ polyhedra; the sheets are linked by shared O atoms.		
DFBCA	KOECHLINITE	Bi ₂ MoO ₆	
DFBCB	RUSSELLITE	Bi ₂ WO ₆	
DFBCC	TUNGSTIBITE	Sb ₂ WO ₆	P22 ₁ 2 ₁
SERIES D	CREDNERITE, mon/C2/m. Structure consists of edge-sharing M³⁺O₆ octahedra forming sheets // (001); the sheets are linked by linear O-Cu-O groups // [001].		
DFBDA	CREDNERITE	CuMnO ₂	
SERIES E	DELAFOSSITE, trig/R3m. Structure consists of edge-sharing Fe³⁺O₆ octahedra forming sheets // (0001); the sheets are linked by linear O-Cu-O groups; the Cu atoms form a hexagonal array with short Cu-Cu distances.		
DFBEA	DELAFOSSITE	CuFeO ₂	
DFBEB	MCCONNELLITE	CuCrO ₂	
SERIES F	CHILUITE, hex/P6₃22, P6₃m or P6₃. Structure not known. May belong in the tellurate group.		
DFBFA	CHILUITE	Bi ₆ Te ₂ Mo ₂ O ₂₁	
DFFBF	SANTANAITE	Pb ₁₁ CrO ₁₆	
SERIES G	ZENZENITE, hex/P6₃/mcm. The structure is of the Pb₃Mn₇O₁₅ type and consists of layers perpendicular to the [001] direction of edge-sharing coordination octahedra around the Mn(Fe) positions. The Pb positions are located between the layers.		
DFBGA	ZENZENITE	Pb ₃ (Fe,Mn) ₄ Mn ₃ O ₁₅	
SERIES H	BAHIANITE, mon/C2/m. Structure consists of sheets // (001) of edge-sharing Al(O,OH)₆ octahedra alternating with linear trimers of edge-sharing Sb⁵⁺O₆ octahedra; the two entities are linked by sharing corners of octahedra.		

DFBHA	BAHIANITE	$\text{Al}_5\text{Sb}_3\text{O}_{14}$
SERIES I	CARLOSBARBOSAITE, orth/Cmcm. The structure contains a single U site with an appreciable deficiency in electron scattering, which is populated by U atoms and vacancies. The U site is surrounded by seven O atoms in a pentagonal bipyramidal arrangement. The Nb site is coordinated by four O atoms and two OH groups in an octahedral arrangement. The half-occupied tunnel Ca site is coordinated by four O atoms and four water groups. Octahedrally coordinated Nb polyhedra share edges and corners to form $\text{Nb}_2\text{O}_6(\text{OH})_2$ double chains, and edge-sharing pentagonal bipyramidal U polyhedra to form UO_5 chains. The $\text{Nb}_2\text{O}_6(\text{OH})_2$ and UO_5 chains share edges to form an open U-Nb- Φ framework with tunnels along [001] that contain $\text{Ca}(\text{H}_2\text{O})_4$ clusters. The structure is closely related to a family of synthetic U-Nb-O framework tunnel structures. The structure resembles that of holfertite.	
DFBIA	CARLOSBARBOSAITE	$(\text{Ca}_{0.5}\square_{0.5})(\text{UO}_2)_2(\text{NbSi})\text{O}_6(\text{OH})_2 \cdot 2\text{H}_2\text{O}$
SERIES J	ZIMBABWEITE, orth/Cmcb. The structure has a novel bronze-type, corrugated, corner-linked $\text{M}(1)_4\text{O}_{18}$ octahedral sheet made up of four- and eight-membered octahedral rings parallel to (100). Within the octahedral sheet, a large distorted seven-coordinated site, M(3), is occupied by Na. The octahedral sheets are cross-linked by trigonal-pyramidal arsenite groups and trigonal prisms around M(2), which is occupied by $(\text{PbNa}_{0.5}\text{K}_{0.5})$.	
DFBJA	ZIMBABWEITE	$\text{Na}(\text{Pb},\text{Na},\text{K})_2\text{As}_4(\text{Ta},\text{Nb},\text{Ti})_4\text{O}_{18}$
SERIES K	GREENWOODITE, trig/P$\bar{3}$m1. The structure is based on hexagonal closest packing of oxygen atoms with 4 distinct cation layers designated BV, BV1, V2, and V3 having a stacking sequence BV-V1-V2-V3-V2-V1-BV-V1-... the core layers contain 3 distinct V-dominated sites, one tetrahedral Si site and one Fe-dominated tetrahedral site containing a disordered mixture of equal amounts of trivalent and divalent cations. The BV layer is a disordered mixture of 2 endmember layer structures related by the coupled substitution $2\text{Ba} = 2\text{O} + 2\text{V} + 1\square + 2\text{H}$. In the Ba endmember the Ba is at a cubo-octahedral site formed by a hole in one of the hcp oxygen layers. In the VOH endmember the Ba is replaced by an O atom which forms the shared corner of a triplet of octahedral sites.	
DFBKA	GREENWOODITE	$\text{Ba}_{2-x}(\text{V}^{3+}\text{OH})_x\text{V}_9(\text{Fe}^{3+}\text{Fe}^{2+})_2\text{Si}_2\text{O}_{22}$
SERIES L	CHANGBAIITE, trig/R3m. Structure consists of dimmers of edge-sharing NbO_6 octahedra which are linked into sheets of 6-membered rings // (0001) with Pb in the rings; the sheets are linked by sharing corners of octahedra and by the Pb atoms.	
DFBLA	CHANGBAIITE	PbNb_2O_6
SERIES M	CHROMBISMITE, tetr/. Structure not known. Zhou Xinchun, Yan Jincai, Wang Guanxin, Wang Shizhong, Liu Liang, and Shu Guiming (1996): A new oxide of bismuth and chromium - Chrombismite. Acta Mineralogica Sinica 16(1), 335-339 (in Chinese with English abstract). - New Minerals 1995-1999, 48 (abstract). Zhou Xinchun, Yan Jincai, Wang Guanxin, Wang Shizhong, Liu Liang, and Shu Guiming (1997): Chrombismite, $\text{Bi}_{16}\text{CrO}_{27}$, a new mineral species from the Jialu gold mine, Shaanxi Province, China. Canadian Mineralogist 35, 35-38. Mineralogical Record 28, 484.	
DFBMA	CHROMBISMITE	$\text{Bi}_{16}\text{CrO}_{27}$
SERIES N	BAUMOITE, mon/P2$_1$/m.	
DFBNA	BAUMOITE	$\text{BaU}_3\text{Mo}_2\text{O}_{16}(\text{H}_2\text{O})_6$
SERIES O	OPHIRITE, tric/P$\bar{1}$. The structural unit in ophirite consist of a $[\text{Zn}_2\text{Mn}_2(\text{H}_2\text{O})_2]$ octahedral layer sandwiched between opposing heteropolytungstate tri-lacunary $(\text{FeW}_9\text{O}_{34})$ Keggin anions. Charge balance in the ophirite structure is maintained by the $\{[\text{Mg}_9\text{H}_2\text{O})_6]_4[\text{Ca}(\text{H}_2\text{O})_6]_2 \cdot 10\text{H}_2\text{O}\}^{12+}$ interstitial	

unit. The interstitial unit in the structure of ophirite is formed of two distinct $\text{Mg}(\text{H}_2\text{O})_6$ octahedra and a $\text{Ca}(\text{H}_2\text{O})_6\text{O}_1$ polyhedron, as well as five isolated water molecules the linkage between the structural unit and the interstitial unit results principally from H bonding between O atoms of the structural unit with H atoms of the interstitial unit. Ophirite is the first known mineral to contain a lacunary defect derivative of the Keggin anion, a heteropolyanion that is well known in synthetic phase. Kampf, A.R., Hughes, J.M., Marty, J., Nash, B.P. and Wright, S.E. (2013) Ophirite, IMA 2013-017. CNMNC Newsletter No. 16, 2013, page 2704, *Mineralogical Magazine*, **77**, 2695-2709.

Kampf, A.R., Hughes, J.M., Nash, B.P., Wright, S., Rossman, G.R., Marty, J. (2014): Ophirite, $\text{Ca}_2\text{Mg}_4[\text{Zn}_2\text{Mn}_3+2(\text{H}_2\text{O})_2(\text{Fe}_3+\text{W}_9\text{O}_{34})_2]\cdot 46\text{H}_2\text{O}$, a new mineral with a heteropolytungstate tri-lacunary Keggin anion. *American Mineralogist*, **99**, 1045-1051.

DFBOA OPHIRITE $(\text{Fe,Zn,Sb})_2(\text{Mn,Zn,Fe,Sb})_2(\text{H}_2\text{O})_2(\text{Zn,Fe,Fe,Mn})_2(\text{W,Mg})_{18}\text{O}_{68}$
 $\text{Mg}(\text{H}_2\text{O})_6(\text{Ca,Mn})(\text{H}_2\text{O})_6\cdot 10\text{H}_2\text{O}$

SERIES P **PAQUEITE, trig/P321.** Ma, C. (2013) Paqueite, IMA 2013- 053. CNMNC Newsletter No. 17, October 2013, page 3002; *Mineralogical Magazine*, **77**, 2997- 3005.

DFBPA PAQUEITE $\text{Ca}_3\text{TiSi}_2(\text{Al,Ti,Si})_3\text{O}_{14}$

SERIES Q **NOLLMOTZITE, mon/Cm. Structure consists upon $[\text{UV}(\text{UO}_2)_2\text{F}_3\text{O}_4]_2$ sheets of beta- U_3O_8 topology and contains an interlayer with $\text{MgF}_2(\text{H}_2\text{O})_4$.**

DFBQA NOLLMOTZITE $\text{Mg}[\text{U}^{5+}\text{V}(\text{U}^{6+}\text{O}_2)_2\text{O}_4\text{F}_3]\cdot 4\text{H}_2\text{O}$

Updated 05/20/19