

OLIGOSILICATES

CLASS U	OLIGOSILICATES		
GROUP A	MONOSILICATES (ISOLATED GROUPS OF SiO₄ TETRAHEDRA)		
TYPE A	SIMPLE CATION-LINKED STRUCTURES		
SERIES A	ZIRCON SERIES, tetr/I4₁/amd. Structure consists of zigzag chains of edge-sharing ZrO₈ triangular dodecahedra // [100] which are linked into a framework by sharing corner and edges with Si tetrahedral; chains of alternating corner-sharing ZrO₈ octahedra and Si tetrahedral // [001].		
UAAAA	ZIRCON	Zr[SiO ₄]	
UAAAB	THORITE	Th[SiO ₄]	
UAAAC	THOROGUMMITE (D)	Th[SiO₄]_{1-x}(OH)_{4x} A hydrated thorite. See CM 52, 769.	
UAAAD	COFFINITE	U[SiO ₄] _{1-x} (OH) _{4x}	
UAAAE	HAFNON	Hf[SiO ₄]	
UAAAF	STETINDITE-(Ce)	CeSiO ₄	
SERIES B	MONAZITE SERIES, mon/P2₁/n. The structure consists of [001] chains of intervening phosphate tetrahedra and REE polyhedra, with a REO₈ polyhedron in xenotime that accommodates the heavy lanthanides and a REO₉ polyhedron in monazite that preferentially incorporates the larger light rare earth elements (La-Gd).		
UAABA	HUTTONITE	ThSiO ₄	
UAABB	TOMBARTHITE-(Y) (D)	Y₄(Si,H₄)₄O₁₂(OH)_{4+2x} MIXTURE	
SERIES C	GARNET SERIES, cub/Ia3d. The structure consists of corner-sharing alternating YO₆ octahedra and Si tetrahedral forming chains // to the three cube edges of the unit cell, resulting in a framework with pseudo-cubic cavities that accommodate the X atoms. Each pseudo-cube shares edges with two tetrahedral, four octahedra and another four pseudo-cubes.		
UAACA	SPESSARTINE	Mn ₃ Al ₂ [SiO ₄] ₃	
UAACB	SCHORLOMITE	Ca ₃ (Ti,Fe) ₂ [(Si,Fe)O ₄] ₃	
UAACC	UVAROVITE	Ca ₃ Cr ₂ [SiO ₄] ₃	
UAACD	PYROPE	Mg ₃ Al ₂ [SiO ₄] ₃	
UAACE	ANDRADITE	Ca ₃ Fe ₂ [SiO ₄] ₃	
UAACF	MAJORITE	Mg ₃ (Fe,Al,Si) ₂ [SiO ₄] ₃	
UAACG	CALDERITE	(Mn,Ca) ₃ (Fe,Al) ₂ [SiO ₄] ₃	
UAACH	ALMANDINE	Fe ₃ Al ₂ [SiO ₄] ₃	
UAACI	GOLDMANITE	Ca ₃ (V,Al,Fe) ₂ [SiO ₄] ₃	
UAACJ	KNORRINGITE	Mg ₃ Cr ₂ [SiO ₄] ₃	
UAACK	GROSSULAR	Ca ₃ Al ₂ [SiO ₄] ₃	
UAACL	KIMZEYITE	Ca ₃ (Zr,Ti) ₂ [(Si,Al,Fe)O] ₄	
UAACM	KATOITE	Ca ₃ Al ₂ [SiO ₄] _{3-x} (OH) _{4x}	
UAACN	KERIMASITE	Ca ₃ Zr ₂ (Fe ³⁺ ₂ Si)O ₁₂	
UAACO	HENRITERMIERITE	Ca ₃ (Mn,Al) ₂ [(SiO ₄),(OH) ₄] ₃	
UAACP	MORIMOTOITE	Ca ₃ (Ti,Fe,Fe) ₂ [(Si,Fe) ₃ O] ₁₂	
UAACQ	YAFSOANITE	Ca ₃ Te ₂ [ZnO ₄] ₃	Pm3n
UAACR	WADALITE	Ca ₆ Al ₅ Si ₂ O ₁₆ Cl ₃	
UAACS	HOLTSTAMITE	Ca ₃ (Al,Mn) ₂ (SiO ₄) _{3-x} (H ₄ O ₄) _x	

UAACT	TOTURITE	$\text{Ca}_3\text{Sn}_2\text{Fe}_2\text{SiO}_{12}$
UAACU	MOMOIITE	$(\text{Mn}^{2+}, \text{Ca})_3(\text{V}^{3+}, \text{Al})_2(\text{SiO}_4)_3$
UAACV	MENZERITE-(Y)	$\{(\text{Y}, \text{REE})(\text{Ca}, \text{Fe}^{2+})_2\}[(\text{Mg}, \text{Fe}^{2+})(\text{Fe}^{3+}, \text{Al})](\text{SiO}_4)_3$
UAACW	ELBRUSITE-(Zr)	$\text{Ca}_3\text{U}^{6+}\text{ZrFe}^{3+}\text{Fe}^{2+}\text{O}_{12}$
UAACX	BITIKLEITE	$\text{Ca}_3\text{SbSnAl}_3\text{O}_{12}$
UAACY	ADRIANITE	$\text{Ca}_{12}(\text{Al}_4\text{Mg}_3\text{Si}_7)\text{O}_{32}\text{Cl}_6$
UAACZ	ERINGAITE	$\text{Ca}_3\text{Sc}_2\text{Si}_3\text{O}_{12}$
UAAC27	JEFFBENITE	$\text{Mg}_3\text{Al}_2\text{Si}_3\text{O}_{12}$
UAAC28	IRINARASSITE	$\text{Ca}_3\text{Sn}_2\text{Al}_2\text{SiO}_{12}$
UAAC29	ELTYUBYUITE	$\text{Ca}_{12}\text{Fe}^{3+}_{10}\text{Si}_4\text{O}_{32}\text{Cl}_6$
UAAC30	DZHULUITE	$\text{Ca}_3\text{SbSnFe}^{3+}_3\text{O}_{12}$
UAAC31	HUTCHEONITE	$\text{Ca}_3\text{Ti}_2(\text{SiAl}_2)\text{O}_{12}$
UAAC32	RUBINITE	$\text{Ca}_3\text{Ti}^{3+}_2\text{Si}_3\text{O}_{12}$
UAAC33	MONTENEVEITE	$\text{Ca}_3\text{Sb}^{5+}_2(\text{Fe}^{3+}_2\text{Fe}^{2+})\text{O}_{12}$
UAAC34	NIKMELENIKOVITE	$\text{Ca}_{12}\text{Fe}^{2+}\text{Fe}^{3+}_3\text{Al}_3(\text{SiO}_4)_6(\text{OH})_{20}$

SERIES D **SITINAKITE, tetr/P4₂/mcm.** Structure consists of four $\text{Ti}(\text{OH})_4\text{O}_2$ octahedra sharing edges to form clusters; these clusters share corners to form columns // [001]. Chains // [110] and [130] of edge-sharing $\text{NaO}_4(\text{H}_2\text{O})_2$ octahedra share edges with insular Si tetrahedra which are also connected to the columns; zeolitic channels // [001] contain K and water molecules.

UAADA	SITINAKITE	$\text{KNa}_2\text{Ti}_4[\text{O}_5/\text{OH}/(\text{SiO}_4)_2] \cdot 4\text{H}_2\text{O}$
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SERIES E **EULYTITE, cub/I43d.** The structure is based on BiO_3 pyramids, with Bi at the pyramidal apex, and Si tetrahedral sharing corners to form a framework.

UAAEA	EULYTINE	$\text{Bi}_4[\text{SiO}_4]_3$
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SERIES F **VAUQUELINITE Structure Series, mon/P2₁/c.** The structure of tornebohmite is based on linear chains // [010] of edge-sharing $\text{AlO}_4(\text{OH})^2$ octahedra which are linked by insular Si tetrahedra; the interchain regions contain slabs of linked REE polyhedra // (001). Vauquelinite and members of the brackebuschite group are isostructural. IMA2012-054 is a member of a polysomatic series having epidote and tornebohmite as endmembers.

UAAFA	TÖRNEBOHMITE-(Ce)	$(\text{Ce}, \text{La})_2[\text{SiO}_4]_2(\text{OH})$
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UAAFB	TÖRNEBOHMITE-(La)	$(\text{La}, \text{Ce})_2[\text{SiO}_4]_2(\text{OH})$
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SERIES G **RONDORFITE, cubic/Fd3.** The structure consists of four Si tetrahedra linked by the central Mg tetrahedron. The Ca is linked by oxygen in an octahedral coordination. The Cl atoms are situated in cavities of the structure.

UAAGA	RONDORFITE	$\text{Ca}_8\text{Mg}[\text{SiO}_4]_4\text{Cl}_2$
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SERIES H **IIMORIITE, tric/P1.** The structure consists of alternating (011) slabs of orthosilicate groups and carbonate groups, with no sharing of oxygen atoms between anionic complexes in adjacent slabs. Y(1) atoms separate adjacent tetrahedra along [100] within the orthosilicate slab, and Y(2) atoms separate adjacent carbonate groups along [100] within the carbonate slab. Adjacent orthosilicate and carbonate slabs are linked in (100) by bonding Y atoms from each slab to oxygen atoms of adjacent slabs, in the [011] ribbons of edge-sharing $\text{Y}(2)\text{O}_8$ polyhedra in the carbonate slab. CM-96/817.

UAAHA	IIMORIITE-(Y)	$\text{Y}_2[\text{CO}_3/\text{SiO}_4]$
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SERIES I	STRINGHAMITE, mon/P2₁/c. Structure consists of CuO ₄₊₂ octahedra sharing corners and edges with insular Si tetrahedra to form chains // [100] that are linked into open sheets // (010) by Cu square planes that share corners with both tetrahedra and octahedra; the sheets are linked by H-bonding from CaO ₅ (H ₂ O) polyhedra.		
UAAIA	STRINGHAMITE	CaCu[SiO ₄] ₂ H ₂ O	
SERIES J	LARNITE, mon/P2₁/n. Structure consists of Ca polyhedra sharing faces to form chains // [010] and [101] ; the chains are linked by Si tetrahedra that share one edge with a Ca polyhedron. Structure of flamite is a derivative of the hexagonal high-temperature variety of alpha- C ₂ S and is characterized by a cyclic triplet of individuals rotated 120° around c, interpreted as symplectite-like transformation twinning derived from alpha-C ₂ S		
UAAJA	LARNITE	Ca ₂ [SiO ₄]	
UAAJB	HATRURITE	Ca ₃ [SiO ₄]O	(may be related)
UAAJC	NAGELSCHMIDTITE	[Ca ₃ (PO ₄) ₂] [2(α-Ca ₂ SiO ₄)]	
	Sugiyama, K., Kato, Y. & Mikouchi, T. (2010): Structure of nagelschmidtite Ca ₇ Si ₂ P ₂ O ₁₆ . 20th General Meeting of the IMA (IMA2010), Budapest, Hungary, August 21-27, CD of Abstracts, p. 725.		
UAAJD	FLAMITE	Ca _{8-x} (Na,K) _x (SiO ₄) _{4-x} (PO ₄) _x	mon/Pnm2 ₁
SERIES K	APATITE Structure Series, hex/P6₃/m. Structure consists of a puckered simple hexagonal packing. Ca atoms occupy the trigonal prismatic voids and the P atoms, which have tetrahedral coordination, are located on the frontiers of these displaced parts of simple hexagonal packing, where the contact packing is closest.		
UAAKA	open		
UAAKB	FLUORELLESTADITE	Ca ₅ [SiO ₄ ,PO ₄ ,SO ₄] ₃ (F,OH,Cl)	
UAAKC	HYDROXYLELLESTADITE	Ca ₄ [Ca ₆ (OH) _{1.2} O _{0.5} Cl _{0.3}](SiO ₄) ₂ (SO ₄) ₂ [(Si,S)O ₄] ₂	P2 ₁
UAAKD	MATTHEDDLEITE	Pb ₂₀ [SiO ₄] ₇ (SO ₄) ₄ Cl ₄	
UAAKE	TRITOMITE-(Y)	(Y,Ca,La,Fe) ₅ ((Si,B,Al)O ₄) ₃ (O,OH,F)	
UAAKF	TRITOMITE-(Ce)	(Ce,La,Ca,Y,Th) ₅ ((Si,B,Al)O ₄) ₃ (O,OH,F)	
UAAKG	MELANOCERITE-(Ce)=TRITOMITE-(Ce) ?	(Ce,Ca)₅(Si,B)₃O₁₂(OH,F)_nH₂O	
UAAKH	BRITHOLITE-(Y)	(Y,Ca) ₅ (SiO ₄ ,PO ₄) ₃ (OH,F)	
UAAKI	BRITHOLITE-(Ce)	(Ce,Ca) ₅ (SiO ₄ ,PO ₄) ₃ (OH,F)	
UAAKJ	FLUORBRITHOLITE-(Ce)	(Ce,Ca) ₅ (SiO ₄ ,PO ₄) ₃ F	
UAAKK	FLUORCALCIOBRITHOLITE	(Ca,REE) ₅ [(Si,P)O ₄] ₃ F	
UAAKL	FLUORBRITHOLITE-(Y)	(Y,Ca) ₅ (SiO ₄ ,PO ₄) ₃ (F,OH)	
UAAKM	CHLORELLESTADITE	Ca ₅ (SiO ₄) _{1.5} (SO ₄) _{1.5} Cl	
SERIES L	BERYLLITE, orth, Structure not known. Doklady Akademiia Nauk, SSSR (USSR) (in Russian) (1954): 99: 451. American Mineralogist (1955): 40: 787. Andersen, S. (1967) On beryllite and bertrandite from the Ilimaussaq alkaline intrusion, South Greenland. Medd. Gronland, 181(4), 11-26.		
UAALA	BERYLLITE	Be ₃ [(OH) ₂ SiO ₄] ₂ H ₂ O	
SERIES M	SCHEELITE Structure Series, tetr/I4₁/a. The scheelite structure is a non-layered structure, and is formed by isolated WO ₄ 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.		
UAAMA	REIDITE	ZrSiO ₄	

SERIES N	SPHAEROBERTRANDITE, mon/P2₁/c. The structure consists of mixed framework formed by Be- and Si-tetrahedra which comprises 6- and 4-membered rings. All vertices of SiO ₄ tetrahedra are shared with 2 BeO ₄ tetrahedra. The OH anions are shared only between two Be tetrahedra. The structure contains Be(3)O ₃ chains screwed around 2 ₁ axis and reinforced by SiO ₄ tetrahedra. These (Be,Si,O) chains are linked by the dimers Be(2) ₂ O ₆ and by Be(1)O ₄ tetrahedra. Pekov, I.V., Chukanov, N. V., Larsen, A.O., Merlino, S., Pasero, M., Pushcharovsky, D.Y., Ivaldi, G., Zadov, A.E., Grishin, V. G., Åsheim, A., Taftø, J. & Chistyakova, N.I. (2003): Sphaerobertandite, Be ₃ SiO ₄ (OH) ₂ : new data, crystal structure and genesis. <i>European Journal of Mineralogy</i> . 15 : 157-166.
UAANA	SPHAEROBERTRANDITE Be ₃ (SiO ₄)(OH)
SERIES O	PALERMOITE STRUCTURE TYPE, mon/ P2₁/c. The structure is based on an M-O octahedral chain consisting of edge-linked dimer which is corner-linked. The carminite structure consists of Fe octahedra connected to each other by an edge at the mirror plane and by a corner at a two fold axis. The octahedra extend unbroken parallel to the z-direction in projection on (010) and are connected together in the x-direction by arsenate tetrahedra. Coordination about the lead atoms is eight fold. The structure is very similar to that of brackenbuschite. Structure of pilawite-(Y) consists of chains of edge- and corner-sharing AlO ₄ (OH) ₂ octahedra // [100] which are linked by P tetrahedra to form slabs // (010). The large cations are accommodated in distorted cubic cavities in the framework. Pieczka, A., Hawthorne, F.C., Cooper, M.A., Szełęg, E., Szuszkiewicz, A., Turniak, K., Nejbart, K. and Ilnicki, S.S. (2014) Pilawite, IMA 2013-125. CNMNC Newsletter No. 20, June 2014, page 551; <i>Mineralogical Magazine</i> , 78 , 549-558.
UAAOA	PILAWITE-(Y) Ca ₂ Y ₂ Al ₄ (SiO ₄) ₄ O ₂ (OH) ₂
TYPE B	COMPLEX CATION LINKED STRUCTURES
SERIES A	BYZANTIEVITE, hex/R3. The structure is an intercalation of three components, one fully ordered with 100% occupancy of cations sites, and two partially ordered with cation-site occupancies of 67% and 17% respectively. In the structure there are six peripheral sites, four 12-coordinated Ba-dominant sites, giving ideally 3 Ba pfu and two (10)-coordinated Na-dominant sites, giving ideally 1 Na pfu. There are two I blocks. The I block is a layer of Ba atoms and Na atoms. Along c there are two types of linkage of TS blocks (1) TS blocks link via AP cations which constitute the I block and (2) TS blocks link via common vertices of MH octahedra and AP and BP cations which constitute the I block. Pautov L.A., Agakhanov A.A., Sokolova E.V., Hawthorne F., Karpenko V.Yu. (2011) Byzantievite, Ba ₅ (Ca,REE,Y) ₂₂ (Ti,Nb) ₁₈ (SiO ₄) ₄ [(PO ₄),(SiO ₄)] ₄ (BO ₃) ₉ O ₂₂ [(OH),F] ₄₃ (H ₂ O) _{1.5} , a new mineral. <i>New Data on Minerals</i> 46:5-12
UABAA	BYZANTIEVITE Ba ₅ (Ca,REE,Y) ₂₂ (Ti,Nb) ₁₈ (SiO ₄) ₄ [(PO ₄),(SiO ₄)] ₄ (BO ₃) ₉ O ₂₂ [(OH),F] ₄₃ H ₂ O
SERIES B	KULIOKITE, tric/P1₁. Structure consists of edge- and face-sharing Y(O,OH,F) ₈ polyhedra form a framework that is linked by Al and Si tetrahedral.
UABBA	KULIOKITE-(Y) Y ₄ Al[F ₅ /(OH) ₂ /(SiO ₄) ₂]
SERIES C	JASMUNDITE, tetr/I4m2. Structure consists of pairs of face-sharing CaO ₅ S octahedra sharing edges with three other pairs to form 4-fold clusters. The clusters are linked by CaO ₆ octahedra, CaO ₈ polyhedra and Si tetrahedra.
UABCA	JASMUNDITE Ca ₁₁ [SiO ₄]O ₂ S
SERIES D	LARSENITE, orth/Pna2₁. Structure consists of corner-sharing Si and Zn tetrahedral forming 5-membered rings // (001) that share one of their corners to form chains // [100]; the chains are linked into a polar-symmetrical framework by 3-membered rings of Si and Zn tetrahedral, with all unbonded tetrahedral apices directed // [001]. Pb forms PbO ₃ and PbO ₄ pyramids with Pb at the pyramidal apex.
UABDA	LARSENITE PbZn[SiO ₄]
SERIES E	LIBERITE, mon/P1n1. Structure is related to that of distorted wurtzite-type; all cations are tetrahedrally coordinated, and every O atom is bonded to two Li, one Be and one Si atom.
UABEA	LIBERITE Li ₂ Be[SiO ₄]

SERIES F	HSIANGHUALITE, cub/I4₁32. structure consists of a framework of alternating Si and Be tetrahedral, analogous to the Al-Si framework in analcime, contains LiO ₃ F tetrahedral linked to the framework by shared O atoms; Ca is accommodated in cavities.	
UABFA	HSIANGHUALITE	Ca ₃ Li ₂ Be ₃ [SiO ₄] ₃ F ₂
SERIES G	Open	
SERIES H	ASBECASITE, hex/P3c1. Structure consists of TiO ₆ octahedra and CaO ₈ square prisms share corners and edges to form sheets // (0001); these sheets alternate with sheets composed of corner-sharing Be and Si tetrahedra with As ³⁺ O ₃ trigonal pyramids connected to the top and bottom of the sheet.	
UABHA	ASBECASITE	Ca ₃ (Ti,Sn)Be ₂ [(AsO ₃) ₆ (SiO ₄) ₂]
SERIES I	PARANATISITE SERIES, orth/Pmc2₁ The structure of paranatisite is described in terms of seven polyhedral layers, with emphasis on the role of three types of sheets. Two sheets consist of (TiO ₅) square pyramids, (SiO ₄) tetrahedral and (NaO ₆) octahedra: the third sheet consists of (NaO ₆) octahedra and (SiO ₄) tetrahedral. These sheets are based on the 4 ⁴ plane net in which the vertices are colored to represent occupancy by different cations and vacancies. A sheet can be characterized by the unit [^[6] M ₂ ^[4] T ₂ φ ₁₂], where M represent [6] – or [5] –coordinated cations, T represents [4]-coordinated cations.	
UABIA	PARANATISITE	Na ₄ [Ti O Ti O (SiO ₄) ₂]
UABIB	NATISITE	Na ₄ [Ti O Ti O (SiO ₄) ₂]
SERIES J	IVANYUKITE SERIES, cubic/P4₃m, trig/R3m. The structure of ivanyukite-Na-T is based upon a 3-dimensional framework of the pharmacosiderite type. It consists of FBB of four edge-sharing Ti-octahedra interlinked by SiO ₄ tetrahedra. The resulting framework has a 3-dimensional system of channels defined by 8-membered rings with a diameter of 3.5Å. The channels are occupied by Na and K cations and water molecules	
UABJA	IVANYUKITE-Na-T	Na ₂ [Ti ₄ O ₂ (OH) ₂ (SiO ₄) ₃] · 7H ₂ O
UABJB	IVANYUKITE-K	K ₂ [Ti ₄ (OH) ₂ O ₂ (SiO ₄) ₃] · 9H ₂ O
UABJC	IVANYUKITE-Cu	Cu[Ti ₄ (OH) ₂ O ₂ (SiO ₄) ₃] · 7H ₂ O
UABJD	IVANYUKITE-Na-C	Na ₂ [Ti ₄ O ₂ (OH) ₂ (SiO ₄) ₃] · 6H ₂ O
SERIES K	TRIMOUNSITE, mon/P2₁/c. The dominant element of the structure is a spiral-like chain composed of edge-sharing, strongly distorted TiO ₆ octahedra. Each octahedron shares four edges with four neighboring octahedra. The chain can also be thought of as composed of edge-sharing Ti ₂ O ₁₀ dimers in a obliquely staggered arrangement. The chains are aligned // to [001]. They are decorated, in a staggered arrangement, with isolated, slightly distorted silicate tetrahedra. These are connected to two TiO ₆ octahedra via a common O ligand the two non-equivalent (Y,REE) sites separate the chains from each other along both the a- and b-axis. The two sites are seven-fold coordinated, and occupied by Y atoms which are each substituted by REE to a very similar degree.	
UABKA	TRIMOUNSITE-(Y)	Y ₂ Ti ₂ [O ₅ SiO ₄]
UABKB	YFTISITE-(Y)	(Y,REE) ₄ Ti[O/(F,OH) ₆ /(SiO ₄) ₂]
SERIES L	VYUNTSPAKHKITE, mon/P2₁/c. Structure consist of chains of edge-sharing Y polyhedra // [100] sharing edges with Si ₂ O ₇ groups, forming layers // (010) ; the layers are linked by chains // [001] of edge-and face-sharing AlO ₅ polyhedra and Si tetrahedra.	
UABLA	VYUNTSPAKHKITE-(Y)	(Y,Yb) ₄ (Al _{2.5} ^{• 1.5})[(Al _{0.33} Si _{0.67}) _{1.5} ^{• 2.5}][SiO ₄] ₄ [O _{0.5} (OH) _{3.5}] ₂
SERIES M	TERNESITE, orth/Pnma. Structure consists of Ca polyhedra sharing edges to form zigzag columns // [100]; these are linked by sharing corners with insular S and Si tetrahedral. Hwang, S.-L., Shen, P., Chu, H.-T., Yui, T.-F., Varela, M.-E., Iizuka, Y. (2019): New minerals tsangpoite Ca ₅ (PO ₄) ₂ (SiO ₄) and matyhite Ca ₉ (Ca _{0.5} □ _{0.5})Fe(PO ₄) ₇ from angrite D'Orbigny. Mineralogical Magazine, 83, 293-313.	

Abstract:

Tsangpoite, ideally $\text{Ca}_5(\text{PO}_4)_2(\text{SiO}_4)$, the hexagonal polymorph of silicocarnotite, and matyhite, ideally $\text{Ca}_9(\text{Ca}_{0.5}\square_{0.5})\text{Fe}(\text{PO}_4)_7$, the Fe-analogue of Ca-merrillite, were identified from the D'Orbigny angrite meteorite by electron probe microanalysis, electron microscopy and micro-Raman spectroscopy. On the basis of electron diffraction, the symmetry of tsangpoite was shown to be hexagonal, $P63/m$ or $P63$, with $a = 9.489(4) \text{ \AA}$, $c = 6.991(6) \text{ \AA}$, $V = 545.1(6) \text{ \AA}^3$ and $Z = 2$ for 12 oxygen atoms per formula unit, and that of matyhite was shown to be trigonal, $R3c$, with $a = 10.456(7) \text{ \AA}$, $c = 37.408(34) \text{ \AA}$, $V = 3541.6(4.8) \text{ \AA}^3$ and $Z = 6$ for 28 oxygen atoms per formula unit. On the basis of their constant association with the grain-boundary assemblage: Fe sulfide + ulvöspinel + Al–Ti-bearing hedenbergite + fayalite–kirschsteinite intergrowth, the formation of tsangpoite and matyhite, along with kuratite (the Fe-analogue of rhönite), can be readily rationalised as crystallisation from residue magmas at the final stage of the D'Orbigny meteorite formation. Alternatively, the close petrographic relations between tsangpoite/matyhite and the resorbed Fe sulfide rimmed by fayalite + kirschsteinite symplectite, such as the nucleation of tsangpoite in association with magnetite \pm other phases within Fe sulfide and the common outward growth of needle-like tsangpoite or plate-like matyhite from the fayalite–kirschsteinite symplectitic rim of Fe sulfide into hedenbergite, infer that these new minerals and the grain-boundary assemblage might represent metasomatic products resulting from reactions between an intruding metasomatic agent and the porous olivine–plagioclase plate + fayalite-kirschsteinite overgrowth + augite + Fe sulfide aggregates. Still further thermochemical and kinetics evidence is required to clarify the exact formation mechanisms/conditions of the euhedral tsangpoite, matyhite and kuratite at the grain boundary of the D'Orbigny angrite.

UABMA	TERNESITE	$\text{Ca}_5(\text{SiO}_4)_2\text{SO}_4$
UABMB	SILICOCARNOTITE	$\text{Ca}_5(\text{SiO}_4)(\text{PO}_4)_2$
UABMC	TSANGPOITE	$\text{Ca}_5(\text{SiO}_4)(\text{PO}_4)_2$

SERIES N **ATELISITE, tetr/ $I4_2d$.** The structure shows structural homologies with those of zircon and xenotime, but is distinguished from by a characteristic alternation rotation of the SiO_4 -tetrahedra about $[001]$.

UABNA	ATELISITE-(Y)	$\text{Y}_4(\text{Si}_3\text{O}_8(\text{OH})_8)$
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SERIES O **WIKLUNDITE, trig/ $R3c$.** Structure consists of a stacking of five layers of polyhedra: three layers consist of trimmers of edge-sharing Mn^{2+} -dominant octahedra linked by SiO_4 tetrahedra, $(\text{Fe}^{3+}(\text{OH})_6)$ dominant octahedra and AsO_3 triangular pyramids; one layer of corner-sharing Si and Mn tetrahedra; and one layer of $\text{Mn}^{2+}\text{Cl}_6$ octahedra and $(\text{Pb}^{2+}(\text{OH})_3\text{Cl}_6)$ polyhedra.

UABOA	WIKLUNDITE	$\text{Pb}_2(\text{Mn}^{2+}, \text{Zn})_3(\text{Fe}^{3+}\text{Mn}^{2+})_2(\text{Mn}^{2+}, \text{Mg})_{19}(\text{As}^{3+}\text{O}_3)_2(\text{Si}, \text{As}^{5+}\text{O}_4)_6(\text{OH})_{18}\text{Cl}_6$
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TYPE C **OCTAHEDRAL CHAIN STRUCTURES LINKED TO INDEPENDENT SiO_4 TETRAHEDRA**

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

UACAA	FAYALITE	Fe_2SiO_4
UACAB	FORSTERITE	Mg_2SiO_4
UACAC	LIEBENBERGITE	$(\text{Ni}, \text{Mg})_2\text{SiO}_4$
UACAD	TEPHROITE	Mn_2SiO_4
UACAE	GLAUCOCHROITE	CaMnSiO_4
UACAF	KIRSCHSTEINITE	CaFeSiO_4
UACAG	MONTICELLITE	CaMgSiO_4
UACAH	LAIHUNITE	$\text{FeFe}_2[\text{SiO}_4]$ mon, ps. Orth/ $P2_1/a$
UACAI	WADSLEYITE	$\beta\text{-(Mg, Fe)}_2[\text{SiO}_4]$
UACAJ	CALCIO-OLIVINE	$\text{Ca}_2(\text{SiO}_4)$
UACAK	ASIMOWITE	Fe_2SiO_4

SERIES B 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.

UACBA	RINGWOODITE	γ -(Mg,Fe) ₂ [SiO ₄]
UACBB	BRUNOGEIERITE	Fe ²⁺ ₂ (Ge ⁴⁺ O ₄)
UACBC	AHRENSITE	γ -Fe ₂ SiO ₄

SERIES C TOPAZ SERIES, orth/Pbnm. The structure is based on crankshaft-like chains of edge-sharing AlO₄F₂ octahedra parallel to the c axis cross-linked by corner-sharing Si tetrahedra.

UACCA	TOPAZ	Al ₂ (F,OH) ₂ SiO ₄
UACCB	KRIESELITE	(Al,Ge) ₂ [(OH) ₂ /GeO ₄]
UACCC	TOPAZ-(OH)	Al ₂ (OH,F) ₂ SiO ₄

SERIES D TITANITE SERIES, mon/P2₁/a. The structure is a framework and consists of infinite chains of TiO₆ octahedra linked by their corners; between these chains and parallel to the c axis run columns of distorted calcium prisms. Si tetrahedra link the Ti chains in the (010) plane.

UACDA	TITANITE	CaTiOSiO ₄
UACDB	MALAYITE	CaSnOSiO ₄
UACDC	VANADOMALAYAITE	CaVOSiO ₄
UACDD	NATROTITANITE	[Na(Y,REE)]Ti(SiO ₄)O
UACDE	ZABINSKIITE	Ca[Al _{0.5} (Ta,Nb) _{0.5}](SiO ₄)O

SERIES E CEBOLLITE, orth?/. The structure is based on chains of Ca and Al octahedra linked to isolated monosilicate groups.

UACEA	CEBOLLITE	Ca ₅ Al ₂ (SiO ₄) ₃ (OH) ₄
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SERIES F KORNERUPINE SERIES, orth/Cmcm. Structure consists of chains // [010] of four edge-sharing Al octahedra and a nearly unoccupied (□,Mg,Fe) octahedron are combined via corners to form sheets // (100). Single chains // [010] of five Mg-Al-Mg-Al-Mg octahedra are linked by disilicate groups and (Si(B,Al))Si₃O₁₀ groups.

UACFA	KORNERUPINE	(•,Fe,Mg)(Mg,Al,Fe) ₅ Al ₄ ^{T1} Si ₂ ^{T2} (Si,Al) ₂ ^{T3} (Si,Al,B)(O,OH,F) ₂₂
UACFB	PRISMATINE	(•,Fe,Mg)(Mg,Al,Fe) ₅ Al ₄ ^{T1} Si ₂ ^{T2} (Si,Al) ₂ ^{T3} (B,Si,Al)(O,OH,F) ₂₂

SERIES G HUMITE SERIES, orth or mon/Pmcn/P2₁/b. 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.

UACGA	ALLEGHANYITE	Mn ₅ (SiO ₄) ₂ (OH) ₂
UACGB	CHONDRODITE	(Mg,Fe) ₅ (SiO ₄) ₂ (F,OH) ₂
UACGC	CLINOHUMITE	(Mg,Fe) ₉ (SiO ₄) ₄ (F,OH) ₂
UACGD	HUMITE	(Mg,Fe) ₇ (SiO ₄) ₃ (F,OH) ₂
UACGE	JERRYGIBBSITE	Mn ₉ (SiO ₄) ₄ (OH) ₂
UACGF	LEUCOPHOENICITE	Mn ₇ (SiO ₄) ₃ (OH) ₂
UACGG	MANGANHUMITE	(Mn,Mg) ₇ (SiO ₄) ₃ (OH) ₂
UACGH	NORBERGITE	Mg ₃ (SiO ₄)(F,OH) ₂
UACGI	RIBBEITE	(Mn,Mg) ₅ (SiO ₄) ₂ (OH) ₂

UACGJ	SONOLITE	$Mn_9(SiO_4)_4(OH)_2$
UACGK	REINHARDBRAUNSITE	$Ca_5[SiO_4]_2(OH,F)_2$
UACGL	HYDROXYLCLINOHUMITE	$Mg_9(SiO_4)_4(OH)_2$
UACGM	CHEGEMITE	$Ca_7(SiO_4)_3(OH)_2$
UACGN	KUMTYUBEITE	$Ca_5(SiO_4)_2F_2$
UACGO	HYDROXYLCHONDRODITE	$(Mg,Fe)_5(SiO_4)_2(OH,F)_2$
UACGP	EDGREWITE	$Ca_9(SiO_4)_4F_2$
UACGQ	FLUORCHEGEMITE	$Ca_7(SiO_4)_3F_2$
UACGR	HYDROXYLEDGREWITE	$Ca_9(SiO_4)_4(OH)_2$

SERIES H **SODDYITE, orth/Fddd. The structure is based on chains of pentagonal bipyramids centered on U atoms, joined on the edge. The chains are cross-linked through monosilicate groups.**

UACHA	SODDYITE	$[(UO_2)_2][SiO_4] \cdot 2H_2O$
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SERIES I **OLIVENITE Structure SERIES, orth/Pnmm. The structure is based on defect R^{21} packing layers of oxygen atoms with certain Cu atoms with coordination 5, and As atoms in tetrahedral voids. The R^{21} packing layers are formed by two rows forming a closest packing and one row with squares. In grandierite, chains // [001] of edge-sharing AlO_6 octahedra are connected along [100] by BO_3 triangles and AlO_5 trigonal dipyramids, and along [010] by $(Mg,Fe)O_5$ trigonal dipyramids and Si tetrahedra.**

UACIA	ANDALUSITE	$Al_2O[SiO_4]$
UACIB	KANONITE	$(Mn,Al)AlO[SiO_4]$
UACIC	GRANDIERITE	$(Mg,Fe)Al_3(BO_3)(SiO_4)O$
UACID	OMINELITE	$Fe^{2+}Al_3(BO_3)(SiO_4)O_2$

SERIES J **TUNDRITE SERIES, tric/P1. Structure consist of chains of edge-sharing TiO_6 octahedra // [001] which are linked into open sheets // (010) by insular Si tetrahedral; the cavities in the sheets are occupied by NaO_6 octahedra; the interlayer region between the sheets is occupied by REE and Na polyhedra and carbonate groups; the REE polyhedra share edges along [100] and the Na polyhedra share edges to form zigzag chains // [001].**

UACJA	TUNDRITE-(Ce)	$Na_3(Ce,La)_4(Ti,Nb)_2[SiO_4]_2(CO_3)_3O_4(OH) \cdot 2H_2O$
UACJB	TUNDRITE-(Nd)	$Na_3(Nd,La)_4(Ti,Nb)_2[SiO_4]_2(CO_3)_3O_4(OH) \cdot 2H_2O$
UACJC	KIHIMANITE-(Ce)	$Ce_2STiO_2(SiO_4)(HCO_3)_2(H_2O)$

SERIES K **EUCLASE, mon/P2₁/a. The structure is based on zigzag chains of edge-sharing AlO_5OH octahedra which are linked by Si tetrahedral to form sheets// (010); bonding is accomplished between the sheets by zigzag chains // [001] of corner-sharing BeO_3OH tetrahedra. Vayrynenite is isostructural.**

UACKA	EUCLASE	$Al_2[Be_2(OH)_2(SiO_4)_2]$
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SERIES L **ADELITE Structure Series, orth/P2₁2₁2₁. The structure is characterized by $AlO_4(OH)_2$ octahedra sharing edges to form chains linked by isolated SiO_4 (AsO_4) tetrahedra and CaO_7OH polyhedra.**

UACLA	MOZARTITE	$CaMn[SiO_4](OH)$
UACLB	VUAGNATITE	$CaAl[SiO_4](OH)$

SERIES M **LEPERSONNITE, orth/Pnmm or Pnn2. Structure not known MAY BE A MIXED CARBONATE. American Mineralogist (1983): 68: 1248**

UACMA	LEPERSONNITE-(Gd)	$Ca(Gd,Dy)_2(UO_2)_{24}(CO_3)_8[SiO_4]_4(OH)_{24} \cdot 48H_2O$
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SERIES N	CERVANDONITE, mon/Cm/R3m. Structure consists of the very unusual $As^{3+} > Si$ diadochy is accounted for by considering the presence in two different sites of sorosilicate anions, which are statistically replaced by AsO_3^{3-} anions and minor amounts of OH ; the positions of the oxygen atoms common to these anions are the same. The asymmetric unit also contains one eight-coordinated atomic site occupied by Ce and other REE lying on the three-fold axis. ; a bipyramical six-coordinated site occupied by Fe, Ti, or Al is also present. CM 08, 423
UACNA	CERVANDONITE-(Ce) $(Ce,Nd,La)(Fe,Ti,Al)_3[Si_2O_7]_{1+x-y}(AsO_3)_{1+x-y}(OH)_{3x-3y}$
SERIES O	CHESNOKOVITE, orth/lbca. Structure consists of isolated $[SiO_2(OH)_2]^{2-}$ tetrahedra and chains of edge-sharing $[Na(H_2O)_6]^+$ octahedra; interconnection of these groups is achieved only by H bonding, which accounts for the poor stability of the mineral.
UACOA	CHESNOKOVITE $Na_2[SiO_2(OH)_2] \cdot 8H_2O$
SERIES P	CHANTALITE, tetr/I4₁/a. Structure consists of zigzag chains of edge-sharing $AlO_2(OH)_4$ octahedra, two chains along [100] at z = 0 and 0.5, and two chains along [010] at z = 0.25 and 0.75, are linked into a framework by $CaO_4(OH)_4$ polyhedra and Si tetrahedral.
UACPA	CHANTALITE $CaAl_2[(OH)_4 SiO_4]$
SERIES Q	SARYARKITE, tetr/P4₂1₂ or P4₂2₁2. Structure not known. American Mineralogist (1964): 49: 1775.
UACQA	SARYARKITE-(Y) $Ca(Y,Th)Al_5[SiO_4]_2[PO_4,SO_4]_2(OH)_7 \cdot 6H_2O$
SERIES R	ELLENBERGERITE, hex/P6₃. Structure consists of dimmers of face-sharing MgO_5OH and AlO_6 octahedra sharing edges to form 2-periodic zigzag chains // [0001]; these are linked by shared OH to form 3-membered channels that contain insular SiO_3OH tetrahedral, and 6-membered channels that contain linear chains of face-sharing $(Mg_{1/3}(Ti,Zr)_{1/3} \square_{1/3})O_4(OH)_2$ octahedra and six interconnecting Si tetrahedral; the linear chains are surrounded by two H ions. Phosphoellenbergite is isostructural.
UACRA	ELLENBERGERITE $(Mg,Ti,Zr)Mg_3Al_3H[(OH)_3/(SiO_3OH)/(SiO_4)_3]$
SERIES S	YODERITE, mon/P2₁/m. Structure consists of chains // [010] of edge-sharing $(Al,Mg)O_5(OH)$ octahedra which are inter-connected by insular Si tetrahedra and two edge-sharing $(Al,Mg,Fe)(O,OH)_5$ trigonal dipyramids. May be related to mullite.
UACSA	YODERITE $Mg_2(Al,Fe)_6[SiO_4]_4O_2(OH)_2$
SERIES T	KYANITE SERIES, tric/P1. The structure is based on a cubic closest packing of OH and O atoms, with Al atoms in octahedral voids, and Fe and Si atoms in tetrahedral voids. H atoms are assumed to be located at octahedral voids. The structure of staurolite basically is composed of alternating layers of kyanite and $[AlFe_3O_3OH]$.
UACTA	KYANITE $Al_2O[SiO_4]$
UACTB	STAUROLITE $(Fe,Mg,Zn)_2Al_9[(Si,Al)O_4]_4O_6(OH)_2$ mon/C2/m
UACTC	MAGNESIOSTAUROLITE $(Mg,Fe,Zn)_2Al_9[(Si,Al)O_4]_4O_6(OH)_2$
UACTD	ZINCOSTAUROLITE $(Zn,Fe,Mg)_2Al_9[(Si,Al)O_4]_4O_6(OH)_2$
SERIES U	GERSTMANNITE, Structure consists of octahedra and edge-sharing dimmers of $Mn(O<OH)_6$ octahedra which are linked by sheets // (010) of corner-sharing Zn and Si tetrahedral // (010).
UACUA	GERSTMANNITE $(Mn,Mg)_2Zn(OH)_2[SiO_4]$
SERIES V	REE-Ca-Al-F silicate, orth/Pban. The structure consists of chains of edge-sharing AlO_6 -octahedra along [010] and by (001) layers of REE and Ca-atoms, each eightfold coordinated by F and O. Isolated Si-tetrahedra and additional eightfold coordinated REE-sites link the AlO_6 -chains and the layers. Disorder of Si across two sites related by symmetry occurs for one type of Si-tetrahedra.
UACVA	UNNAMED $(Y,Ln)_6CaAl_2O_2[SiO_4]_4(F,OH)_6$

SERIES W	<p>MIEITE, orth/Cmcm. Structure consists of infinite columns of corner-sharing TiO_6 octahedra decorated by SiO_4 tetrahedra. The columns are linked by two independent Y polyhedra with different coordination, YO_2F_5 and $\text{Y O}_5\text{F}_3$. A coupled substitution of $\text{Ti}^{4+} + \text{F} = \text{Al}^{3+} + \square$ was suggested for Mieiite-(Y). Mieiite-(Y) is isostructural with Yftisite-(Y), a discredited species. Miyawaki, R., Matsubara, S., Yokoyama, K., Shigeoka, M., Momma, K. and Yamamoto, S. (2014) Mieiite-(Y), IMA 2014- 020. CNMNC Newsletter No. 21, August 2014, page 799; <i>Mineralogical Magazine</i>, 78, 797-804.</p>		
UACWA	MIEITE-(Y)	$\text{Y}_4\text{Ti}(\text{SiO}_4)_2\text{O}[\text{F},(\text{OH})]_6$	
SERIES X	<p>CAYALSITE-(Y), orth/Pban; mon/P2/c. Two polytypes exist. The structure of the monoclinic polymorph is composed of two types of layers. The first layer (A) contains chains of edge sharing AlO_6 octahedra parallel to [010], decorated by bridging SiO_4 tetrahedra (Si1). The surface of this layer is formed by oxygen atoms coordinating Al and Si as well as by REE cations that occupy a general position of the P2/c space group. The second layer (B) contains F as the dominant anionic species at its outer surface. The center of the layer is mainly occupied by Y and by Ca. Voids in the layer are capped by additional Si atoms (Si2) that also belong to the layer surface. In the orthorhombic polytype, cayalsite-(Y)-10, the Si2 atoms occupy stacked positions with respect to both sides of the layer.</p>		
UACXA	CAYALSITE-(Y)	$\text{CaY}_6\text{Al}_2(\text{SiO}_4)_2\text{F}_6$	
TYPE D	<p>OCTAHEDRAL BRACELETS AND PINWHEELS WITH LINKED INDEPENDENT TETRAHEDRA</p>		
SERIES A	<p>MERWINITE SERIES. mon, P_2_1/a. The structure consists of corner-sharing MgO_6 octahedra and Si tetrahedral forming pseudo-hexagonal sheets // (010); each octahedron is linked to 6 Si tetrahedral in a pinwheel-like arrangements, as in glaserite; Ca are accommodated between adjoining sheets. Brianite is isostructural.</p>		
UADAA	Open		
UADAB	MERWINITE	$\text{Ca}_3\text{Mg}[\text{SiO}_4]_2$	mon/ P_2_1/a
UADAC	BREDIGITE	$\text{Ca}_7\text{Mg}[\text{SiO}_4]_4$	orth/ $\text{P}2\text{nn}$
LHBFA	APHTHITALITE	$(\text{K},\text{Na})_3\text{Na}[\text{SO}_4]_2$	
SERIES B	<p>CERITE SERIES, trig/R3c. The structure is related to a large family of “bracelet and pinwheel” structures derived from glaserite. Rods of two kinds run parallel to the c-axis. One rod is partly disordered and includes the (SiO_3OH) tetrahedron and (OH) groups, the latter bonded to the REE ions. The other rod which is fully occupied is based on the corner-, edge-, and face-linkages of $\text{Si}(1)\text{O}_4$ and $\text{Si}(2)\text{O}_4$ tetrahedra and $\text{REE}(1)\text{O}_8\text{OH}$, $\text{REE}(2)\text{O}_8\text{OH}$ and $\text{REE}(3)\text{O}_8\text{OH}$ polyhedra. Structure consists of two types of rods // [0001] ; one rod consists of edge- and face-sharing REE polyhedra to which insular SiO_4 tetrahedra are attached ; the other consists of SiO_3 tetrahedra, $(\text{Fe},\text{Mg})\text{O}_6$ octahedra and $\text{CaO}_6(\text{OH})_2$ polyhedra ; the rods are linked by sharing OH groups. Whitlock and strontiowhitlockite are isotype.</p>		
UADBA	CERITE-(Ce)	$(\text{Ce},\text{La},\text{Ca})_9(\text{Fe},\text{Mg})[(\text{OH})_3/\text{SiO}_3\text{OH}/(\text{SiO}_4)_6]$	
UADBB	CERITE-(La)	$(\text{La},\text{Ce},\text{Ca})_9(\text{Fe},\text{Mg})[\text{SiO}_4]_6[(\text{SiO}_3)(\text{OH})](\text{OH})_3$	
UADBC	TRANQUILLITYITE	$\text{Fe}^{2+}_8\text{Ti}_3(\text{Zr},\text{Y})_2[\text{O}_{12}/(\text{SiO}_4)_3]$	
UADBD	ALUMINOCERITE-(Ce)	$(\text{Ce},\text{La},\text{Ca})_9(\text{Al},\text{Fe})(\text{SiO}_4)_3[\text{SiO}_3(\text{OH})]_4(\text{OH})_3$	
UADBE	ULFANDERSSONITE-(Ce)	$[(\text{Ce}_8\text{Ca})\text{MgSi}_7\text{O}_{22}(\text{OH},\text{F})_4]^{8+}[\text{Ce}_7\text{MgSi}_4\text{O}_{21}(\text{OH},\text{F})_2\text{Cl}_3]^{8-}$	
SERIES C	<p>VICANITE SERIES, trig/R3m. The structure consists of three unique layers, layer A contains an $\text{Fe}(\text{SiO}_4)_6$ group and a threefold B_3O_9 borate ring. Each tetrahedron of the ring shares one O atom with one Si tetrahedron, forming an unusual $\text{Si}_3\text{B}_3\text{O}_{18}^{15-}$ polyanion. Layer B contains an AsO_4 tetrahedron and a BO_3 triangle. Layer C represents the disordered part of the structure containing two very close $\text{As}^{3+}\text{O}_3^{3-}$ and NaF_3^{2-} polyhedra, the occurrence of which is mutually exclusive and statistically disordered. A 3-dimensional network of $(\text{Ca},\text{REE},\text{Th})-(\text{O},\text{F})_n$ polyhedra provide connections among neighboring layers. Am Min 04-1540. These two minerals may also be classified as mixed-oxyanion borates considering that the $[\text{Si}_3\text{B}_2\text{O}_{18}]^{15-}$ polyanion consists of a three-membered ring of BO_4 tetrahedra linked to isolated SiO_4 tetrahedra.</p>		

UADCA	VICANITE-(Ce)	$(\text{Ca,Th})_9(\text{Ce,REE})_6(\text{Na}_{0.5}\text{As}_{0.5})\text{Fe}^{3+}\text{B}_3\text{B}[\text{F}_{10}/\text{O}_9/\text{AsO}_4/(\text{SiO}_4)_6]$
UADCB	OKANOANITE-(Y)	$\text{Na}_3[(\text{Y,REE})_{11}(\text{Ca,Fe})_{12}\text{B}_2[\text{F}_{14}/\text{O}_3/(\text{SiO}_4)_6]$
UADCC	HUNDHOLMENITE-(Y)	$(\text{Y,REE,Ca,Na})_{15}(\text{Al,Fe})\text{Ca}_x\text{As}^{3+}_{1-x}(\text{Si,As}^{5+})\text{Si}_6\text{B}_3(\text{O,F})_{48}$
UADCD	PROSHCHENKOITE-(Y)	$(\text{Y,REE,Ca,Na,Mn})_{15}\text{Fe}^{2+}\text{Ca}(\text{P,Si})(\text{Si}_6\text{B}_3(\text{O,F})_{48}$
UADCE	LAPTEVITE-(Ce)	$\text{Ca}_6(\text{Fe,Mn})\text{Y}_3\text{REE}_7(\text{SiO}_4)_3(\text{PO}_4)(\text{B}_3\text{Si}_3\text{O}_{18})(\text{BO}_3)\text{F}_{11}$

SERIES D **HARRISONITE, hex/R $\bar{3}$ m. The structure is based on three distinct (001) layers: $[\text{FeO}_6]^{10-}$ corundum-type layer, a layer of $[\text{SiO}_4]$ isolated tetrahedra, and a $[\text{Ca}(\text{PO}_4)_2]^{4-}$ slab of calcium polyhedra trigonal antiprisms with six apical $[\text{PO}_4]$ tetrahedra.**

UADDA HARRISONITE $\text{Ca}(\text{Fe,Mg})_6[\text{SiO}_4]_2[\text{PO}_4]_2$

TYPE E OCTAHEDRAL SHEET STRUCTURES

SERIES A **AFWILLITE SERIES, tri/P1. The structure is based on double chains // [010] of edge-sharing and corner-sharing Si and Ca polyhedra which are linked into sheets // (101) by sharing corners of polyhedra.**

UAEEA AFWILLITE $[\text{Ca}_{12}(\text{H}_2\text{O})_8][\text{SiO}_4]_4[\text{SiO}_2(\text{OH})_2]_4$

UAEEB BULTFONTEINITE $\text{Ca}_4[\text{F}(\text{EiO}_3\text{OH})]_2 \cdot 2\text{H}_2\text{O}$ tric/P $\bar{1}$

SERIES B Open

SERIES C **POLDERVAARTITE SERIES, orth/Pbca. The structure is based on three distinct cation polyhedra. The M1 site is coordinated by four O atoms and two OH groups in a cis-relationship to form a slightly distorted octahedron. The M2 site coordination resembles a very distorted trigonal dipyrmaid with two additional distinct O1 atoms capping the opposing trigonal faces. M2 is thus fivefold coordinated to two OH groups and three O²⁻ ions. The Si atom is fourfold-coordinated to three O atoms and one OH group at O1, forming an acid unit of $[\text{SiO}_3\text{OH}]^{3-}$. The structure can be described as a stacking of alternating poorly defined polyhedral layers parallel to (010).**

UAECA POLDERVAARTITE $\text{Ca}(\text{CaMn})[\text{SiO}_3\text{OH}](\text{OH})$

UAECB OLMITE $\text{CaMn}[\text{SiO}_3(\text{OH})](\text{OH})$

SERIES D **HODGKINSONITE, mon/P2 $\bar{1}$ /a. The structure is based on a corner-sharing of Zn and Si tetrahedral and MnO(OH)₅ octahedra forming a 3-dimensional framework.**

UAEDA HODGKINSONITE $\text{Zn}_2\text{Mn}[(\text{OH})_2\text{SiO}_4]$

SERIES E **KITTATINNYITE, hex/P6 $\bar{3}$ /mmc,P6 $\bar{3}$ mc, or P6 $\bar{2}$ c. Structures not known. Wallkilldellite may be isostructural. American Mineralogist (1983): 68: 1029-1032.**

UAEEA KITTATINNYITE $\text{Ca}_4\text{Mn}_2\text{Mn}_4[\text{SiO}_4]_4(\text{OH})_8 \cdot 18\text{H}_2\text{O}$

SERIES F **CHLORITOID SERIES, mon/tric/C2/c. Structure consists of brucite-like sheets of edge-sharing M(O,OH)₆ octahedra // (001) alternating with corundum-like sheets of Al(O,OH)₆ octahedra in which each octahedron shares four edges with other octahedra; the sheets are linked by Si tetrahedra.**

UAEFA CHLORITOID $(\text{Fe,Mn,Mg})_2\text{Al}_2[\text{Al}_2\text{Si}_2\text{O}_{10}](\text{OH})_4$

UAEFB OTTRELITE $(\text{Mn,Fe,Mg})_2\text{Al}_2[\text{Al}_2\text{Si}_2\text{O}_{10}](\text{OH})_4$

UAEFC CARBOIRITE $(\text{Fe,Mn})_2\text{Al}_2[\text{Al}_2\text{Ge}_2\text{O}_{10}](\text{OH})_4$

UAefd MAGNESIOCHLORITOID $(\text{Mg,Fe,Mn})_2\text{Al}_2[\text{Al}_2\text{Si}_2\text{O}_{10}](\text{OH})_4$

SERIES G **NABIMUSAITE, trig/R $\bar{3}$ m, trig/I422. The structure may be derived from that of hatrurite and is built up by an intercalation of three positively charged hatrurite-like modules of composition $[\text{Ca}_{12}(\text{SiO}_4)_4\text{O}_2\text{F}]^{3+}$, with inserted modules of $[\text{K}(\text{SO}_4)_2]^{3-}$. The hatrurite-like modules in nabimusaite are characterized by octahedrally coordinated anions sites and tetrahedrally coordinated cation sites. The structure is representative of the intercalated antiperovskite type. The structure of ariegilite is described as a stacking of the two modules $\{\text{F}_2\text{Ca}_{12}(\text{SiO}_4)_4\}^{4+}$ and $\{\text{Ba}(\text{PO}_4)_2\}^{4-}$ among (001). Dargaite, ideally**

BaCa₁₂(SiO₄)₄(SO₄)₂O₃, is an additional member of the arctite group belonging to minerals with a modular intercalated antiperovskite structure derived from hatrurite. The holotype specimen was found at a small outcrop of larnite pseudoconglomerates in the Judean Mts, West Bank, Palestinian Autonomy. Larnite, fluorellestadite–fluorapatite, brownmillerite, fluormayenite–fluorkyuygenite and ye'elimite are the main minerals of the holotype specimen; ternesite, shulamitite and periclase are noted rarely. Dargaite, nabimusaite and gazeevite occur in linear zones with higher porosity within larnite rocks. Pores are filled with ettringite and Ca-hydrosilicates, less commonly with gibbsite, brucite, baryte, katoite and calciolangbeinite. Dargaite is colourless, transparent with a white streak and has a vitreous lustre. It exhibits pronounced parting and imperfect cleavage along (001). Mohs' hardness is ~4.5–5.5. The empirical formula is (Ba_{0.72}K_{0.24}Na_{0.04})Σ1(Ca_{11.95}Mg_{0.04}Na_{0.01})Σ12[(SiO₄)_{0.91}[PO₄]_{0.05}[AlO₄]_{0.03}[Ti₄+O₄]_{0.01}]Σ4([SO₄]_{0.84}[PO₄]_{0.14}[CO₃]_{0.02})Σ2(O_{2.54}F_{0.46})Σ3. Dargaite is trigonal R-3m, the unit-cell parameters are: a = 7.1874(4) Å, c = 41.292(3) Å, V = 1847.32(19) Å³ and Z = 3. The crystal structure of dargaite was refined from X-ray single-crystal data to R1 = 3.79%. The calculated density is 3.235 g cm⁻³. The following main Raman bands are distinguished on the holotype dargaite (cm⁻¹): 122, 263, 323, 464, 523, 563, 641 and 644, 829 and 869, 947, 991 and 1116. The formation conditions of dargaite are linked to the local occurrence of pyrometamorphic by-products (gases, fluids and melts) transforming earlier mineral associations at ~900°C.

Galuskin, E.V., Gfeller, F., Armbruster, T., Galuskina, I.O., Vapnik, Y., Murashko, M., Włodyka, R. and Dzierżanowski, P. (2013) Nabimusaite, IMA 2012-057. CNMNC Newsletter No. 15, February 2013, page 5; Mineralogical Magazine, 77, 1-12. Galuskin, E.V., Gfeller, F., Galuskina, I.O., Armbruster, T., Vapnik, Y., Włodyka, R., Dzierżanowski, P. and Murashko, M. (2013) Zadovite, IMA 2013-031. CNMNC Newsletter No. 16, August 2013, page 2708; Mineralogical Magazine, 77, 26951-2709. Galuskin, E.V., Galuskina, I.O., Pakhomova, A., Armbruster, T., Vapnik, Y., Dzierżanowski, P. and Murashko, M. (2013) Aradite, IMA 2013-047. CNMNC Newsletter No. 17, October 2013, page 3001; Mineralogical Magazine, 77, 2997-13005. The structure comprises of two tetrahedral sites, which may host a broad compositional range of atoms such as Si, P, V and S.

UAEGA	NABIMUSAITE	KCa ₁₂ (SiO ₄) ₄ (SO ₄) ₂ O ₂ F
UAEBB	ZADOVITE	Na ₂ Ca ₆ [(SiO ₄)(PO ₄)](PO ₄) ₂ F
UAEGC	ARADITE	BaCa ₆ [(SiO ₄)(VO ₄)](VO ₄) ₂ F
UAEGD	GAZEEVITE	BaCa ₆ (SiO ₄) ₂ (SO ₄) ₂ O
UAEGE	DARGAITE	BaCa ₁₂ (SiO ₄) ₄ (SO ₄) ₂ O ₃
UAEGF	STRACHERITE	BaCa ₆ (SiO ₄)[(PO ₄)(CO ₃)] ₂ F
UAEGG	ARIEGILATITE	BaCa ₁₂ (SiO ₄) ₄ (PO ₄) ₂ F ₂ O

SERIES H **ATTAKOLITE, mon/C2/m.** The structure consists of sheets of Al octahedral chains cross-linked by independent tetrahedra of Si and P. The octahedral chains consist of edge-sharing dimers with apical connections at the tetrahedral links. The interstices in this layer are filled by Mn in seven-fold coordinated polyhedral sites (capped octahedron) and by Ca in tenfold-coordination polyhedral sites. Close structural similarities exist between attakolite and carminite, palermoite, tsumcorite, and the descloizite and adelite groups.

UAEHA	ATTAKOLITE	(Ca,Sr)Mn(Al,Fe) ₄ [(Si,P)O ₄]H(PO ₄) ₃ (OH) ₄
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SERIES I **MONGOLITE, tetr.** American Mineralogist (1986): 71: 1279.

UAEIA	MONGOLITE	Ca ₄ Nb ₆ [SiO ₄] ₅ O ₄ (OH) ₁₀ nH ₂ O
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SERIES J open

SERIES K **SPURRITE, mon/P2₁/a.** The spurrite structure is layered on (001). The layered topology has the 8-fold coordination polyhedra of Ca₁, Ca₂ and Ca₃ adjoining a carbonate group, whereas the 7-fold coordination polyhedra of Ca₄ and Ca₅ adjoins three silica tetrahedra and two carbonate groups. The structure of galuskinite has a modular character. One may define a polysomatic series with spurrite and larnite as endmembers and galuskinite as a 1:1 polysome built from regular alternating spurrite and larnite modules. Lazic, B., Armbruster, T., Savelyeva, V.B., Zadov, A.E., Pertsev, N.N. and Dzierżanowski, P. (2011): Galuskinite, Ca₇(SiO₄)₃(CO₃), a new skarn mineral from the Birkhin gabbro massif, Eastern Siberia, Russia. *Mineralogical Magazine*, **75**, 2631-2648.

UAEKA	SPURRITE	$\text{CaCa}_4[\text{CO}_3 (\text{SiO}_4)_2]$
UAEKB	GALUSKINITE	$\text{Ca}_7(\text{SiO}_4)_3(\text{CO}_3)$

SERIES L **PERHAMITE, trig/P3m1.** Structure consists of Si_3O_9 rings of corner-sharing tetrahedral, together with Si_2O_7 pairs of tetrahedral. These units corner-link to $(\text{Al},\text{Si})\text{O}_4$ tetrahedra above and below the plane at $z = \frac{1}{2}$ to form 4-member rings, which in turn corner-share to P tetrahedral in the crandallite blocks to give the 8-member rings. Structural details in AM06-1949. The structure comprises ordered blocks of crandalite-type structure, centered at $z = 0$, intergrown // to (001) with disordered aluminosilicate structure blocks centered at $z = \frac{1}{2}$ to form a microporous structure containing large channels along [100]. These channels are bounded by 8-membered rings of 6 tetrahedra (2 SiO_4 , 2 AlO_4 , and 2 PO_4) and two AlO_6 octahedra. Ca atoms and water molecules are distributed in the [100] channels. The phosphate mineral iangreyite is structurally related to the perhamite series.

UAELA	PERHAMITE	$\text{Ca}_3\text{Al}_7[\text{SiO}_4]_3(\text{PO}_4)_4(\text{OH})_3 \cdot 16.5\text{H}_2\text{O}$
UAELB	KRASNOITE	$\text{Ca}_3\text{Al}_{7.7}[\text{SiO}_4]_3(\text{PO}_4)_4\text{F}_2 \cdot 8\text{H}_2\text{O}$

TYPE F NETWORK LAYERED STRUCTURES

SERIES A **GADOLINITE Structure Series, mon/P2₁/c.** The structure is based on sheets of 4- and 8-membered rings of alternating Si tetrahedra and BO_4 tetrahedra with sheets bonded together by Fe atoms.

UAFAA	GADOLINITE-(Ce)	$(\text{Ce},\text{La},\text{Nd},\text{Y})_2\text{FeBe}_2\text{Si}_2\text{O}_{10}$
UAFAB	GADOLINITE-(Y)	$\text{Y}_2\text{FeBe}_2\text{Si}_2\text{O}_{10}$
UAFAC	HINGGANITE-(Ce)	$\text{Ce}_2\text{Be}_2\text{Si}_2\text{O}_8(\text{OH})_2$
UAFAD	HINGGANITE-(Y)	$(\text{Y},\text{Yb},\text{Er})_2\text{Be}_2\text{Si}_2\text{O}_8(\text{OH})_2$
UAFAE	HINGGANITE-(Yb)	$(\text{Yb},\text{Y})_2\text{Be}_2\text{Si}_2\text{O}_8(\text{OH})_2$
UAFAF	DATOLITE	$\text{Ca}_2\text{B}_2\text{Si}_2\text{O}_8(\text{OH})_2$
UAFAG	MINASGERAISITE-(Y)	$\text{CaY}_2\text{Be}_2\text{Si}_2\text{O}_{10}$
UAFAH	HOMILITE	$\text{Ca}_2(\text{Fe},\text{Mg})\text{B}_2\text{Si}_2\text{O}_{10}$
UAFAI	GADOLINITE-(Nd)	$\text{Nd}_2\text{FeBe}_2\text{Si}_2\text{O}_{10}$
UAFAJ	CALCYBEBOROSILITE-(Y)	$(\text{Y},\text{Ca})_2(\square, \text{Fe}^{2+})(\text{B},\text{Be})_2[\text{SiO}_4]_2(\text{OH},\text{O})_2$
UAFAK	OH AND FE ANALOGUE OF GADOLINITE-(Y)	

TYPE G URANYL SILICATE $[(\text{UO}_2)(\text{SiO}_4)]_n^{-2n}$ STRUCTURES

SERIES A **KASOLITE SERIES, mon/P2₁/c.** The structure consists of uranyl silicate chains composed of edge-sharing uranium pentagonal bipyramidal groups, forming sheets, and silicate tetrahedra linked by Ca atoms and water molecules.

UAGAA	KASOLITE	$\text{Pb}(\text{UO}_2)(\text{SiO}_4) \cdot \text{H}_2\text{O}$
UAGAB	URANOPHANE-BETA	$\text{Ca}(\text{UO}_2)(\text{SiO}_3\text{OH}) \cdot 5\text{H}_2\text{O}$
UAGAC	BOLTWOODITE	$\text{K}(\text{H}_3\text{O})(\text{UO}_2)(\text{SiO}_4)$
UAGAD	URANOPHANE	$\text{Ca}(\text{H}_3\text{O})_2 [(\text{UO}_2)_2(\text{SiO}_4)_2] \cdot 2\text{H}_2\text{O}$
UAGAE	NATROBOLTWOODITE	$(\text{Na},\text{K})(\text{H}_3\text{O})(\text{UO}_2)(\text{SiO}_4) \cdot \text{H}_2\text{O}$
UAGAF	SWAMBOITE-(Nd)	$\text{Nd}_{0.333}[(\text{UO}_2)(\text{SiO}_3\text{OH})](\text{H}_2\text{O})_{-2.5}$
UAGAG	URANOSILITE	$(\text{UO}_2)\text{Si}_7\text{O}_{15}$
UAGAH	URSILITE D	$\text{Mg}_4(\text{UO}_2)_2(\text{Si}_2\text{O}_5)_{5.5}(\text{OH})_5 \cdot 13\text{H}_2\text{O}$
UAGAI	CALCIOURSILITE	$\text{Ca}_4(\text{UO}_2)_4(\text{Si}_2\text{O}_5)_5(\text{OH})_6 \cdot 15\text{H}_2\text{O}$
UAGAJ	MAGNIOURSILITE	$\text{Mg}_4(\text{UO}_2)_4(\text{Si}_2\text{O}_5)_5(\text{OH})_6 \cdot 15\text{H}_2\text{O}$

GROUP B DISILICATES (ISOLATED GROUPS OF Si_2O_7 TETRAHEDRA) (INCLUDES MIXED ANION SILICATES OF GREATER Si/O RATIO)

TYPE A	SIMPLE CATION-LINKED STRUCTURES		
SERIES A	PERCLEVEITE, $\text{Ln}_2\text{Si}_2\text{O}_7$ Structure type- tetr/P4₁. The structure is shown to be isostructural with synthetic, low-temperature lanthanide disilicates. Holtstam, D., Norrestam, R. and Andersson, U. B. (2003): Percleveite-(Ce) - a new lanthanide disilicate mineral from Bastnäs, Skinnskatteberg, Sweden. <i>European Journal of Mineralogy</i>, 15, 725-731		
UBAAA	PERCLEVEITE-(Ce)	$\text{Ce}_2[\text{Si}_2\text{O}_7]$	Tetr/P4 ₁
SERIES B	RANKINITE, mon/P2₁/a. Structure consists of edge-sharing Ca polyhedra forming zigzag chains // [001] that are linked into sheets // (010) by disilicate groups and by sharing some edges with adjacent chains.		
UBABA	RANKINITE	$\text{Ca}_3[\text{Si}_2\text{O}_7]$	
SERIES C	RUSTUMITE, mon/C2/c. Structure consists of Si tetrahedra and disilicate groups connected into a framework by Ca atoms.		
UBACA	RUSTUMITE	$\text{Ca}_{10}[\text{Si}_2\text{O}_7]_2[\text{SiO}_4]\text{Cl}_2(\text{OH})_2$	
SERIES D	BARYSILITE, trig/R$\bar{3}$c. The structure consists of a $[\text{Pb}_2\text{Si}_2\text{O}_7]^{2-}$ framework characterized by distinct channels parallel to c. The framework consists of (001) sheets of symmetrically equivalent Si_2O_7 double tetrahedra which are linked three-dimensionally by Pb atoms. The remaining metal atoms lie inside the channels in Y-X-Y chains with distances of about 3.5 Å between the atoms in the chain and 12 Å between adjacent chains. The new structure contains one distorted MnO_6 polyhedron with six equivalent Mn-O bonds and one Si_2O_7 disilicate unit, and two non-equivalent Pb sites. The Pb(1) site has a highly irregular, one-sided coordination with six O ligands, indicating a stereoactive $6s^2$ lone-electron pair on the Pb ion, whereas the [6+3]-coordinated Pb(2) site is fairly regular. The Pb(2) site contains about 10% Ca, corresponding to the structural formula $\text{Pb}(1)_6(\text{Pb},\text{Ca})(2)_2\text{Mn}(\text{Si}_2\text{O}_7)$.		
UBADA	BARYSILITE	$\text{MnPb}_8(\text{Si}_2\text{O}_7)_3$	
SERIES E	CLINOHEDRITE, mon/Cc. Structure consists of edge-sharing $\text{CaO}_4(\text{H}_2\text{O})_2$ octahedra form zigzag chains // [100] that are connected into sheets // (010) by Si tetrahedra ; the sheets are linked by Zn tetrahedra.		
UBAEA	CLINOHEDRITE	$\text{Ca}_2\text{Zn}_2(\text{Si}_2\text{O}_7)(\text{OH})_2\cdot\text{H}_2\text{O}$	
SERIES F	NASONITE SERIES, hex/P6₃/m. The structure of nasonite can be derived in a simple way from that of the members of the apatite group. Disilicate groups characterize the structure of nasonite. The Pb atoms have irregular coordination polyhedra; Ca atoms are surrounded by six oxygens at the vertices of trigonal prisms forming columns along the three-fold axis. A partially covalent bonding system involving Pb, Cl, and O exists. A new structure has been determined for the mineral molybdophyllite. The structure is built up by a regular alternation of complex layers with a composition $\{\text{Mg}_9[\text{Si}_{10}\text{O}_{28}(\text{OH})_6][\text{OPb}_4]_2^{9+}$ and simple layers with a composition $[(\text{CO}_3)_3]\cdot\text{H}_2\text{O}$.		
UBAFA	NASONITE	$\text{Pb}_6\text{Ca}_4[\text{Cl}_2/(\text{Si}_2\text{O}_7)_3]$	
SERIES G	EDGARBAILEYITE, mon/C2/m. The structure is based on Hg occurring as two sets of symmetrically independent pairs. In addition, each Hg atom is coordinated by three O atoms at distances between 2.12 and 2.86 Å. These O atoms also provide tetrahedral coordination for the Si atoms; the SiO_4 tetrahedra share one O atom to form Si_2O_7 groups, which provide cross-links between the pairs of Hg atoms.		
UBAGA	EDGARBAILEYITE	$\text{Hg}_6[\text{Si}_2\text{O}_7]$	
SERIES H	Open		
SERIES I	JAFFEITE SERIES, hex/P$\bar{3}$. Structure of suolunite consists of columns of edge-sharing octahedra // [001] which are connected to create triangular and hexagonal channels; disilicate groups are accommodated in the triangular channels. In jaffeite, chains of edge-sharing $\text{Ca}(\text{O},\text{OH})_6$ octahedra // [0001] share corners to form a framework with 3- and 6-membered channels // [0001]; disilicate groups occupy the 3-membered channels.		

UBAIA	JAFFEITE	$\text{Ca}_6[\text{Si}_2\text{O}_7](\text{OH})_6$
UBAIB	SUOLUNITE	$\text{Ca}_2[\text{Si}_2\text{O}_5(\text{OH})_2]\cdot\text{H}_2\text{O}$

SERIES J **RUSINOVITE, orth/Cmcm.** The mineral has an OD structure of which only the average structure could be determined based on strong and sharp reflections recorded by single-crystal X-ray data. The average structure is characterized by columns of face-sharing disilicate units extending // to the a-axis. However, in the true structure, only each second disilicate group is occupied. Although rusinovite has a stoichiometry similar to the apatite-group mineral nasonite, the two structures are considerably different.

Evgeny V. Galuskin, Irina O. Galuskina, Biljana Lazic, Thomas Armbruster, Aleksandr E. Zadov, Tomasz Krzykawski, Kamila Banasik, Viktor M. Gazeev and Nikolai N. Pertsev (2011): Rusinovite, $\text{Ca}_{10}(\text{Si}_2\text{O}_7)_3\text{Cl}_2$: a new skarn mineral from the Upper Chegem caldera, Kabardino-Balkaria, Northern Caucasus, Russia. *Eur. J. Mineral.* 23, 837-844.

UBAJA	RUSINOVITE	$\text{Ca}_{10}(\text{Si}_2\text{O}_7)_3\text{Cl}_2$
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TYPE B COMPLEX CATION-LINKED STRUCTURES

SERIES A **AKLIMAITE, mon/B2/m.** Zadov, A.E., Pekov, I.V., Zubkova, N.V., Gazeev, V.M., Chukanov, N.V., Yapaskurt, V.O., Kartashov, P.M., Galuskin, E.V., Galuskina, I.O., Pertsev, N.N., Gurbanov, A.G., Pushcharovsky, D.Yu. (2012): Aklimaite, $\text{Ca}_4[\text{Si}_2\text{O}_5(\text{OH}_2)](\text{OH})_4\cdot 5\text{H}_2\text{O}$, a new natural hydrosilicate from Lakargi area (the North Caucasus, Russia). *Zapiski RMO*, 141(2), 21-31.
Zubkova, N.V., Pekov, I.V., Pushcharovsky, D.Yu., Zadov, A.E., Chukanov, N.V. (2012): The crystal structure of aklimaite, $\text{Ca}_4[\text{Si}_2\text{O}_5(\text{OH})_2](\text{OH})_4\cdot 5\text{H}_2\text{O}$. *Zeitschrift für Kristallographie*, 228, 452-455.

UBBAA	AKLIMAITE	$\text{Ca}_4[\text{Si}_2\text{O}_5(\text{OH})_2](\text{OH})_4\cdot 5\text{H}_2\text{O}$
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SERIES B **HARSTIGITE, orth/Pcmm.** Structure consists of Be and Si tetrahedral sharing corners to form sheets of 4-, 5-, and 8-membered rings // (100); the sheets are linked into a framework by Ca and Mn atoms.

UBBBA	HARSTIGITE	$\text{MnCa}_6\text{Be}_4[\text{SiO}_4]_2[\text{Si}_2\text{O}_7]_2(\text{OH})_2$
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SERIES C **KELDYSHITE SERIES, tric/P1.** Structure consists of ZrO_6 connected into a framework by disilicate groups; Na is accommodated in the cavities.

UBBCA	KELDYSHITE	$\text{Na}_2\text{Zr}[\text{Si}_2\text{O}_7]_n\text{H}_2\text{O}$
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UBBCB	PARAKELDYSHITE	$\text{Na}_2\text{Zr}[\text{Si}_2\text{O}_7]$
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UBBCC	KHIBINSKITE	$\text{K}_2\text{Zr}[\text{Si}_2\text{O}_7]$
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SERIES D **KRISTIENSENITE, tric/C1.** ZK 216, 442-448. Kristiansenite, ideally $\text{Ca}_2\text{ScSn}(\text{Si}_2\text{O}_7)(\text{Si}_2\text{O}_6\text{OH})$, a rare late-stage hydrothermal Sc-bearing sorosilicate mineral, was found in a gadolinite-fergusonite-type pegmatite of the MI-REE subclass related to the Karkonosze granite, exposed in a quarry at Szklarska Poręba, Lower Silesia, Poland. Kristiansenite occurs in an association with andradite, epidote, allanite-(Ce), titanite, fersmite, scheelite, Sc-bearing columbite-(Fe), a YNbO_4 mineral as fergusonite-(Y) or fergusonite-(Y)-beta, silesiaite and wolframite. Single-crystal study of the mineral (R1 of 4.96%), with composition $\text{Ca}_{2.00}(\text{Sn}_{0.97}\text{Sc}_{0.69}\text{Fe}_{3+0.17}\text{Mn}_{0.05}\text{Ti}_{0.04}\text{Zr}_{0.03}\text{Nb}_{0.02}\text{Al}_{0.02}\text{Ta}_{0.01})\Sigma 2(\text{Si}_2\text{O}_7)[(\text{Si}_{1.98}\text{Al}_{0.02})\Sigma 2\text{O}_6.03(\text{O H})_{0.97}]$, corroborates its triclinic structure with space group-symmetry C1, Z = 2, and unit-cell parameters $a = 10.0304(5)$, $b = 8.4056(4)$, $c = 13.3228(6)$ Å, $\alpha = 90.001(3)$, $\beta = 109.105(3)$, $\gamma = 89.997(3)^\circ$ and $V = 1061.40(9)$ Å³. In the structure of the mineral, the Ca and Si sites are dominantly occupied with Ca and Si, whereas the M1–M4 sites are disordered. The M3 and M4 sites are occupied dominantly by Sn and subordinately Sc, whereas the M1 and M2 sites are occupied dominantly by Sc and subordinately by remaining occupants, including Sn. Ferraris, G., Gula, A., Ivaldi, G., Nespolo, M. & Raade, G. (2001): Crystal structure of kristiansenite: a case of class IIB twinning by metric merohedry. *Zeitschrift für Kristallographie*. 216, 442-448.

- Raade, G., Ferraris, G., Gula, A., Ivaldi, G. & Bernhard, F. (2002): Kristiansenite, a new calcium-scandium-tin sorosilicate from granite pegmatite in Tørdal, Telemark, Norway. *Mineralogy and Petrology*. 75(1/2), 89-99.

- Menor Salván, C. & Prado Herrero, P. (2009): First find of Kristiansenite in Spain: Comparison with the type specimen by non-descriptive techniques. *Estudios Geológicos*, 19(2), 135-139.

UBBDA	KRISTIANSENITE	$\text{Ca}_2\text{ScSn}(\text{Si}_2\text{O}_7)(\text{Si}_2\text{O}_6\text{OH})$
UBDBB	SILESIAITE	$\text{Ca}_2\text{FeSn}(\text{Si}_2\text{O}_7)(\text{Si}_2\text{O}_6\text{OH})$

SERIES E **HEMIMORPHITE, orth/Imm2.** The structure consists of two double Si tetrahedral and four double ZnO_3OH tetrahedral forming a framework in which each lateral O atom is bonded to one Si and two Zn. Water molecules are accommodated in cavities in the structure.

UBBEA	HEMIMORPHITE	$\text{Zn}_4[\text{Si}_2\text{O}_7](\text{OH})_2 \cdot \text{H}_2\text{O}$
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SERIES F **BERTRANDITE, orth/Cmc2₁.** The structure consists of disilicate groups which are linked to undulating chains of tetrahedra, $[\text{O}_3\text{BeOHBeO}_3]_2 // [100]$, forming a framework. The structure can also be regarded as a hexagonal close packing of O and OH, in which 2/3 of the tetrahedral sites are occupied by ordered Be and Si.

UBBFA	BERTRANDITE	$\text{Be}_4[\text{Si}_2\text{O}_7](\text{OH})_2$
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SERIES G **KOLSKYITE, tric/P1.** Kolskyite is a new titanium silicate block mineral. The TS block consists of HOH sheets where H = heteropolyhedral and O=octahedral, and it is the main structural unit in the TS-block structures. There are four groups of TS-block structures where Ti = 1,2,3 and 4 apfu. The crystal structure of kolskyite belongs to Group IV where Ti = 4 apfu and is a combination of TS and I blocks.

UBBGA	KOLSKYITE	$\text{CaNa}_2\text{Ti}_4(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_7$
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SERIES H **ROWLANDITE, tric/P1 or P1.** The structure consists of Si_2O_7 groups together with $(\text{Mg,Fe})\text{O}_4\text{F}_2$ octahedrons, which connects with the 7-coordinated and 8-coordinated REEs polyhedral to form the 3-dimensional structure.

UBBHA	ROWLANDITE-(Y)	$\text{Y}_4\text{Fe}[\text{Si}_2\text{O}_7]_2\text{F}_2$
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UBBHB	MAGNESIOROWLANDITE-(y)	$\text{Y}_4(\text{Mg,Fe})[\text{Si}_2\text{O}_7]_2\text{F}_2$
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SERIES I **KHURAYYIMITE, mon/P2₁/c.**

UBBIA	KHURAYYIMITE	$\text{Ca}_7\text{Zn}_4(\text{Si}_2\text{O}_7)_2(\text{OH})_{10} \cdot 4\text{H}_2\text{O}$
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TYPE C OCTAHEDRAL CHAIN STRUCTURES LINKED TO Si_2O_7 GROUPS

SERIES A **LÄVENITE SERIES, mon/P2₁/a.** Series structures based on wall of octahedra, consisting of various cations, which are interconnected by corner sharing to create a framework strengthened by the disilicate units. A refinement of the baghdadite structure is characterized by the presence of walls of cation polyhedra, four columns large, linked together by both direct connection as well as by disilicate groups. Chirvinskyite, $(\text{Na,Ca})_{13}(\text{Fe,Mn,}\square)_2(\text{Ti,Nb})_2(\text{Zr,Ti})_3(\text{Si}_2\text{O}_7)_4(\text{OH,O,F})_{12}$, is a new wöhlerite-related zirconotitano-sorosilicate. It is triclinic, P1, $a = 7.0477(5)$, $b = 9.8725(5)$, $c = 12.2204(9)$ Å, $\alpha = 77.995(5)$, $\beta = 82.057(6)$, $\gamma = 89.988(5)^\circ$, $V = 823.35(9)$ Å³, $Z = 1$. The mineral was found in albitized alkaline pegmatites in a foyaitite of the Mt. Takhtarvumchorr (Khibiny alkaline massif, Kola Peninsula, Russia, N 67°40', E 33°33'). Chirvinskyite forms sheaf-like and radiated aggregates (up to 6 mm in diameter) of split fibrous crystals hosted by saccharoidal fluorapatite and albite. The mineral is pale cream in color, with a silky luster and a white streak. The cleavage is not recognized. Mohs hardness is 5. Chirvinskyite is biaxial (-), $\alpha 1.670(2)$, $\beta 1.690(2)$, $\gamma 1.705(2)$ (589 nm), $2V_{\text{calc}} = 80.9^\circ$. The calculated and measured densities are 3.41 and 3.07(2) g·cm⁻³, respectively. The empirical formula based on Si = 8 apfu is $(\text{Na}_9.81\text{Ca}_3.28\text{K}_0.01)\Sigma 13.10(\text{Fe}_0.72\text{Mn}_0.69\square_0.54\text{Mg}_0.05)\Sigma 2.00(\text{Ti}_1.81\text{Nb}_0.19)\Sigma 2.00(\text{Zr}_2.27\text{Ti}_0.63)\Sigma 2.90(\text{Si}_2\text{O}_7)_4\{(\text{OH})_5.94\text{O}_3.09\text{F}_2.97\}\Sigma 12.00$. Chirvinskyite belongs to a new structure type of minerals and inorganic compounds and is related to the wöhlerite-group minerals. Its modular "wallpaper" structure consists of disilicate groups Si_2O_7 and three types of "octahedral walls". The mineral is named in honor of Petr Nikolaevich Chirvinsky (1880–1955), Russian geologist and petrographer, head of the Petrography Department of the Perm' State University (1943–1953), for his contributions to mineralogy and petrology, including studies of the Khibiny alkaline massif.

UBCAA	CUSPIDINE	$\text{Ca}_4(\text{Si}_2\text{O}_7)(\text{F,OH})_2$
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UBCAB	LÄVENITE	$(\text{Na,Ca})_2(\text{Mn,Fe})(\text{Zr,Ti,Nb})\text{Si}_2\text{O}_7(\text{O,OH,F})_2$
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UBCAC	BAGHDADITE	$\text{Ca}_3(\text{Zr}, \text{Ti})\text{Si}_2\text{O}_7\text{O}_2$
UBCAD	BURPALITE	$\text{Na}_2\text{CaZrSi}_2\text{O}_7\text{F}_2$
UBCAE	WOEHLERITE	$\text{NaCa}_2(\text{Zr}, \text{Nb})\text{Si}_2\text{O}_7(\text{O}, \text{OH}, \text{F})_2$
UBCAF	NIOCALITE	$\text{Ca}_7\text{Nb}(\text{Si}_2\text{O}_7)_2\text{O}_3\text{F}$
UBCAG	JANHAUGITE	$(\text{Na}, \text{Ca})_3(\text{Mn}, \text{Fe})_3(\text{Ti}, \text{Zr}, \text{Nb})_2(\text{Si}_2\text{O}_7)_2\text{O}_2(\text{F}, \text{OH})$
UBCAH	NORMANDITE	$\text{NaCa}(\text{Mn}, \text{Fe})(\text{Ti}, \text{Nb}, \text{Zr})[\text{Si}_2\text{O}_7](\text{O}, \text{F})_2$
UBCAI	HIORTDAHLITE	$(\text{Na}, \text{Ca})_2\text{Ca}_4\text{Zr}(\text{Mn}, \text{Ti}, \text{Fe})(\text{Si}_2\text{O}_7)_2(\text{F}, \text{O})_4$
UBCAJ	MARIANOITE	$\text{Na}_2\text{Ca}_4(\text{Nb}, \text{Zr})_2(\text{Si}_2\text{O}_7)_2(\text{O}, \text{F})_2$
UBCAK	CHIRVINSKYITE	$(\text{Na}, \text{Ca})_{13}(\text{Fe}, \text{Mn}, \square)_2(\text{Ti}, \text{Nb})_2(\text{Zr}, \text{Ti})_3(\text{Si}_2\text{O}_7)_4(\text{OH}, \text{O}, \text{F})_{12}$

SERIES B **ROSENBUSCHITE SERIES, tric/P1.** Structure consists of sheets of edge-sharing Ca, Na, and Ti octahedra // (100) ; these are linked into slabe by double chains of edge-sharing MO_6 octahedra and disilicate groups, both of which are orientted // [001].

UBCBA	ROSENBUSHITE	$(\text{Ca}, \text{Na})_3(\text{Zr}, \text{Ti})(\text{Si}_2\text{O}_7)\text{OF}$
UBCBB	GÖTZENITE	$\text{NaCa}_5\text{Ti}(\text{Si}_2\text{O}_7)_2\text{OF}_3$
UBCBC	HAINITE-(Y)	$\text{Na}_2\text{Ca}_4(\text{Y}, \text{REE})\text{Ti}(\text{Si}_2\text{O}_7)_2\text{OF}_3$
UBCBD	KOCHITE	$\text{Na}_2(\text{Na}, \text{Ca})_4\text{Ca}_4(\text{Mn}, \text{Ca})_2\text{Zr}_2\text{Ti}_2(\text{Si}_2\text{O}_7)_4(\text{O}, \text{F})_4\text{F}_4$
UBCBE	SEIDOZERITE	$\text{Na}_2\{(\text{Na}, \text{Mn}, \text{Ti})_4[\text{Zr}, \text{Ti}]_2\text{O}_2\text{Si}_4\text{O}_{14}[\text{F}_2]\}$
UBCBF	GRENMARITE	$(\text{Na}, \text{Ca})_4(\text{Zr}, \text{Mn})_2(\text{Zr}, \text{Ti})(\text{Mn}, \text{Na})(\text{Si}_2\text{O}_7)_2(\text{O}, \text{F})_4$
UBCBG	FOGOITE-(Y)	$\text{Na}_3\text{Ca}_2\text{Y}_2\text{Ti}(\text{Si}_2\text{O}_7)_2\text{OF}_3$
UBCBH	open	
UBCBI	BATIEVAITE-(Y)	$\text{Y}_2\text{Ca}_2\text{Ti}[\text{Si}_2\text{O}_7]_2(\text{OH})_2(\text{H}_2\text{O})_4$

SERIES C **KENTROLITE SERIES, orth/Pbcn.** The structure is based on $^1_{\infty}[\text{M}^{3+}\text{O}_4]$ edge-sharing octahedral chains parallel to [001]. These octahedra are alternately cis and trans with respect to adjacent octahedra. The Si dimers are aligned nearly parallel to [100]. Structure can also be described as edge-sharing of $(\text{Mn}, \text{Fe})\text{O}_6$ octahedra forming zigzag chains // [001]; the chains are linked laterally by Pb and disilicate groups.

UBCCA	KENTROLITE	$\text{Pb}_2(\text{Mn}, \text{Fe})_2\text{O}_2[\text{Si}_2\text{O}_7]$
UBCCB	MELANOTEKITE	$\text{Pb}_2(\text{Fe}, \text{Mn})_2\text{O}_2[\text{Si}_2\text{O}_7]$

SERIES D **EPIDOTE SERIES, mon/P2₁/m.** The structure is based on continuous chains of Al octahedra bonded together by mono and disilicate groups. The Ca, Al, Fe and Si are interstitial in the structure. The structure of gatelite-(Ce) is described as a regular alternance of slabs of epidote-type structure (E) and slabs of tornebohmite-type structure (T) parallel to the (001) plane. Gateelite-(Ce) cab be regarded as a ET polisome within a polysomatic series having epidote and tornebohmite as end-members. The structure of schluterite-(Y) has $\text{Al}(\text{OH})_4\text{O}_2$ octahedra sharing (OH)-(OH) edges to form $[\text{M}\phi_4]$ chains that are decorated by disilicate groups that bridge O vertices of neighbouring octahedra in a staggered fashion on either side of the chain. These chains extend // to b, and are linked into a continuous framework via bonds to interstitial (Y,REE) atoms. The structure is related to the epidote group.

All minerals having a crystal structure and a chemical composition that can be described as a regular combination of modules of epidote-type structure (E) and modules of törnebohmite-type structure (T) fulfil the criteria of forming a mineral supergroup, named the gatelite supergroup. All members share the same general formula and topology, consisting of edge-sharing octahedral chains, cross-linked to each other by SiO_4 and Si_2O_7 groups, with the remaining large cavities occupied by Ca and REE \pm Na. By analogy with the epidote supergroup, three groups are defined to accommodate the existing accepted mineral species: (i) the gatelite group – includes members that can be derived from the mineral gatelite-(Ce) solely by homovalent substitutions, i.e., gatelite-(Ce), perbøeite-(Ce), and ferriperbøeite-(Ce); (ii) the västmanlandite group – includes members typified by the mineral västmanlandite-(Ce). This group is derived from gatelite-(Ce) by homovalent substitutions and one coupled heterovalent substitution of the type $\text{M1}[\text{M}3+] + \text{O4}[\text{O}2-] \rightarrow \text{M1}[\text{M}2+] + \text{O4}[\text{F}-]$. Västmanlandite-

(Ce) is the unique member of this potential group; and (iii) the alnaperbøeite group – includes members typified by the mineral alnaperbøeite-(Ce). This group is derived from gatelite-(Ce) by homovalent substitutions and one coupled heterovalent substitution of the type $A2+A3+A4[A3+3] + M3[M2+] \rightarrow A2+A3+A4[A3+2.5A+0.5] + M3[M3+]$. Alnaperbøeite-(Ce) is the unique known member of this potential group. We recommend that the nomenclature of the gatelite supergroup be based on the criterion of occupancy of key cation sites. In particular, A1 and M3 (and, in principle, M2) determine the root name. If the dominant cations at A1, M3 (and M2) exactly match those of an approved species, the same fixed root name – modified by an appropriate prefix – is given. If the dominant cation is different at any of these sites, a new root name is assigned. The members of the gatelite supergroup are rare minerals, although the number of occurrences is increasing. They have been found in REE-rich assemblages in a variety of geological settings, including granitic NYF pegmatites, carbonatite and associated fenites, alkali-syenites, and hydrothermal-metasomatic skarns. Most frequently, they coexist with to´rnebohmite-(Ce), allanite- or dollaseite-group minerals, bastnäs site-(Ce), cerite-(Ce), or fluorbritholite-(Ce). Analytical data available from the literature show extensive solid solution along the ferriperbøeite-(Ce)–va´stmanlandite-(Ce) and the perbøeite-(Ce)–alnaperbøeite-(Ce) joins, whereas there are few or no samples testifying to va´stmanlandite-(Ce)–gatelite-(Ce) or perbøeite-(Ce)–ferriperbøeite-(Ce) solid solutions. The present nomenclature recommendations were approved by the International Mineralogical Association Commission on New Minerals, Nomenclature and Classification.

UBCDA	ALLANITE-(Ce)	$CeCa(Fe,Fe,Al)_3(SiO_4)(Si_2O_7)O(OH)$
UBCDB	ALLANITE-(La)	$LaCa(Fe,Fe,Al)_3(SiO_4)(Si_2O_7)O(OH)$
UBCDC	ALLANITE-(Y)	$YCa(Fe,Fe,Al)_3(SiO_4)(Si_2O_7)O(OH)$
UBCDD	CLINOZOISITE	$Ca_2Al_3(SiO_4)(Si_2O_7)O(OH)$
UBCDE	DISSAKISITE-(Ce)	$Ca(Ce,La)MgAl_2(SiO_4)(Si_2O_7)O(OH)$
UBCDF	DOLLASEITE-(Ce)	$CaCeMg_2Al(SiO_4)(Si_2O_7)O(OH)$
UBCDG	EPIDOTE	$Ca_2Al_2(Fe,Al)(SiO_4)(Si_2O_7)O(OH)$
UBCDH	HANCOCKITE	$(Ca,Pb,Sr)_2(Al,Fe)_3(SiO_4)(Si_2O_7)O(OH)$
UBCDI	KHRISTOVITE-(Ce)	$(Ca,REE)REE(Mg,Fe)AlMn(SiO_4)(Si_2O_7)O(OH)$
UBCDJ	MUKHINITE	$Ca_2Al_2V(SiO_4)(Si_2O_7)O(OH)$
UBCDK	PIEMONTITE	$Ca_2(Al,Mn,Fe)_3(SiO_4)(Si_2O_7)O(OH)$
UBCDL	PIEMONTITE-(Sr)	$CaSr(Al,Mn,Fe)_3(SiO_4)(Si_2O_7)O(OH)$
UBCDM	ZOISITE	$Ca_2Al_3(SiO_4)(Si_2O_7)O(OH)$
UBCDN	MANGANIANDROSITE-(La)	$(Mn,Ca)(REE)(Al,Mn,Mn)_3[SiO_4][Si_2O_7]O(OH)$
UBCDO	FERRIALLANITE-(Ce)	$CaCe(Fe,Fe,Al)_3[SiO_4][Si_2O_7]O(OH)$
UBCDP	GATELITE-(Ce)	$(Ca,REE)_4[Al_2(Al,Mg)(Mg,Fe,Al)_4[SiO_4]_3[Si_2O_7](O,F)(OH,O)_2]$
UBCDQ	NIIGATAITE	$CaSrAl_3(SiO_4)(Si_2O_7)O(OH)$
UBCDR	TWEDDILLITE	$CaSr(Mn,Fe)_2(SiO_4)(Si_2O_7)O(OH)$
UBCDS	VASTMANLANDITE-(Ce)	$Ce_3CaMg_2Al_2Si_5O(OH)_2F$
UBCDT	EPIDOTE-(Sr)	$CaSrFe_3(SiO_4)(Si_2O_7)O(OH)$
UBCDU	DISSAKISITE-(La)	$Ca(La)MgAl_2(SiO_4)(Si_2O_7)O(OH)$
UBCDV	UEDAITE-(Ce)	$Mn^{2+}CeAl_2Fe^{2+}(Si_2O_7)(SiO_4)O(OH)$
UBCDW	MANGANIANDROSITE-(Ce)	$(Mn,Ca)(Ce,REE)Mn^{3+}Mn^{2+}[Si_2O_7][SiO_4]O(OH)$
UBCDX	VANADOANDROSITE-(Ce)	$(Mn,Ca)(Ce,REE)V^{3+}Mn^{2+}[Si_2O_7][SiO_4]O(OH)$
UBCDY	ASKAGENITE-(Nd)	$Mn^{2+}NdAl_2Fe^{3+}(Si_2O_7)(SiO_4)O_2$
UBCDZ	ALNAPERBOEITE-(Ce)	$(Ce_{2.5}CaNa_{0.5})(Al_4)Si_2O_7(SiO_4)_3O(OH)_2$
UBCD27	ALLANITE-(Nd)	$CaNdAl_2Fe^{2+}(SiO_4)(Si_2O_7)O(OH)$
UBCD28	FERRIALLANITE-(La)	$Ca(La,Ce,Th)(Fe,Al)(Al,Fe)(Fe^{2+}Mn,Ti,Mg)(SiO_4)(Si_2O_7)O(OH)$
UBCD29	PERBOEITE-(Ce)	$(CaCe_3)(Al_3Fe^{2+})(Si_2O_7)(SiO_4)_3O(OH)_2$
UBCD30	PIEMONTITE-(Pb)	$CaPbAlMn^{3+}[Si_2O_7][SiO_4]O(OH)$
UBCD31	SCHLUTERITE-(Y)	$(Y,REE)_2Al(Si_2O_7)(OH)_2F$

UBCD32	VANADOALLANITE-(La)	$\text{LaCa}(\text{V},\text{Al})_3(\text{SiO}_4)(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$
UBCD33	FERRIAKASAKAITE-(La)	$\text{CaLaFe}^{3+}\text{AlMn}^{2+}(\text{Si}_2\text{O}_7)(\text{SiO}_4)\text{O}(\text{OH})$
UBCD34	FERRIANDROSITE-(La)	$\text{MnLaFe}^{3+}\text{AlMn}^{2+}(\text{Si}_2\text{O}_7)(\text{SiO}_4)\text{O}(\text{OH})$
UBCD35	MANGANIAKASAKAITE-(La)	$\text{CaLaMn}^{3+}\text{AlMn}^{2+}(\text{Si}_2\text{O}_7)(\text{SiO}_4)\text{O}(\text{OH})$
UBCD36	FERRIPERBOEITE-(Ce)	$(\text{CaCe}_3)(\text{Fe},\text{Al}_2\text{Fe})(\text{Si}_2\text{O}_7)(\text{SiO}_4)_3\text{O}(\text{OH})_2$
UBCD37	FERRIAKASAKAITE-(Ce)	$\text{CaCeFeAlMn}_2(\text{Si}_2\text{O}_7)(\text{SiO}_4)\text{O}(\text{OH})$
UBCD38	FERRIPERBOEITE-(La)	$(\text{CaLa}_3)(\text{Fe}^{3+}\text{Al}_2\text{Fe}^{2+})[\text{Si}_2\text{O}_7][\text{SiO}_4]_3\text{O}(\text{OH})_2$
UBCD39	PERBOEITE-(La)	$(\text{CaLa}_3)(\text{Al}_3\text{Fe}^{2+})[\text{Si}_2\text{O}_7][\text{SiO}_4]_3\text{O}(\text{OH})_2$

SERIES E VESUVIANITE SERIES, tetr/P4/nnc. The structure consists of a framework of tetrahedra and octahedra with 18+1 Ca ions per formula unit. Edge-sharing octahedra form centro-symmetric trimers (Al,Mg)O₅OH-AIO₄(OH)₂-(Al,Mg)₅(OH). Channels along [001] contain 1Ca+1Fe+2(OH,O). The channels contain B.

UBCEA	VESUVIANITE	$\text{Ca}_{19}(\text{Al},\text{Mg})_{13}\text{B}_{0.5}(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{OH},\text{O},\text{F})_{10}$
UBCEB	WILUITE	$\text{Ca}_{19}(\text{Al},\text{Mg},\text{Fe},\text{Ti})_{13}(\text{B},\text{Al},\bullet)_5(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{OH},\text{O},\text{F})_{10}$
UBCEC	FLUORVESUVIANITE	$\text{Ca}_{19}(\text{Al},\text{Mg})_{13}(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{F},\text{OH})_{10}$
UBCED	MANGANVESUVIANITE	$\text{Ca}_{19}\text{Mn}(\text{Al},\text{Mn})_{10}(\text{Mg},\text{Mn})_2(\text{SiO}_4)(\text{Si}_2\text{O}_7)_4\text{O}(\text{OH})_9$
UBCEE	CYPRINE	$\text{Ca}_{19}\text{Cu}^{2+}(\text{Al}_{10}\text{Mg}_2)(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{OH})_{10}$
UBCEF	ALUMOVESUVIANITE	$\text{Ca}_{19}\text{Al}(\text{Al}_{10}\text{Mg}_2)(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{OH})_{10}$
UBCEG	MAGNESIOVESUVIANITE	$\text{Ca}_{19}\text{Mg}(\text{Al}_{10}\text{Mg}_2)(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{OH})_{10}$
UBCEH	HONGHEITE	$\text{Ca}_{19}\text{Fe}^{2+}\text{Al}_4(\text{Fe}^{3+},\text{Mg},\text{Al})_8(\square,\text{B})_4\text{BSi}_{18}\text{O}_{69}(\text{O},\text{HO})_9$
UBCEI	MILANRIEDERITE	$\text{Ca}_{19}\text{Fe}^{3+}\text{Al}_4(\text{Mg}_4\text{Al}_4)(\text{SiO}_4)_{10}(\text{Si}_2\text{O}_7)_4(\text{OH})_{11}$
UBCEJ	MANAEVITE-(Ce)	$\text{Ca}_{11}(\text{Ce},\text{H}_2\text{O},\text{Ca})_8\text{Mg}(\text{Al},\text{Fe})_4(\text{Mg},\text{Ti},\text{Fe}^{3+})_8[\text{Si}_2\text{O}_7]_4[\text{SiO}_4]_8(\text{H}_2\text{O})_2(\text{OH})_9$

SERIES F DELLAITE, tric/P1. The dellaite structure has structural similarities to both killalaite and trabzonite, all have modular-type structures. DAN SSSR 190, 831 (1970). American Mineralogist: 50: 2104.

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UBCFA	DELLAITE	$\text{Ca}_6(\text{Si}_2\text{O}_7)(\text{SiO}_4)(\text{OH})_{1.75}\text{Cl}_{0.25}$
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SERIES G ILVAITE SERIES, orth/Pbnm. The structure consists of 2-periodic double chains of edge-sharing Fe²⁺O₆ octahedra // [001] which are linked by Ca, isolated Fe³⁺ octahedra and disilicate groups.

UBCGA	ILVAITE	$\text{CaFe}_2\text{Fe}(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$
UBCOB	MANGANOILVAITE	$\text{CaFeFe}(\text{Mn},\text{Fe})(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$
UBCGC	AMAMOORITE	$\text{CaMn}^{2+}_2\text{Mn}^{3+}(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$

SERIES H JUANITE, orth/. Structure not known.

UBCHA	JUANITE Q/D	$(\text{Ca},\text{Na},\text{K})_{10}(\text{Mg},\text{Fe})_2(\text{Al},\text{Fe})_4(\text{SiO}_4)_5(\text{Si}_2\text{O}_7)_2(\text{OH},\text{F})_4$
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SERIES I	BARYLITE SERIES, orth/Pnma or Pn2₁a. The structure is based on corner-sharing Be tetrahedra forming chains // [001] that are bridged by disilicate groups, forming an open framework with cavities that accommodate Ba atoms. In andremeyerite, corner-sharing chains of flattened Fe tetrahedra // [010] are linked by disilicate groups to form a framework with Ba in the cavities. The scottyite structure is characterized by flattened CuO ₄ tetrahedra sharing corners with one another to form chains // to the c axis. These chains are interlinked by Si ₂ O ₇ tetrahedral dimers and Ba ²⁺ cations are bonded to seven O atoms in an irregular coordination. The structure of barylite is based upon tetrahedral framework consisting of BeO ₄ and SiO ₄ tetrahedra. BeO ₄ tetrahedra share corners to form chains // to the c axis. The chains are interlinked by the disilicate groups orientated // to the a axis. The Ba cations are in the framework channels and are coordinated by eleven O atoms. The obtained orthorhombic symmetry of clinobarylite is in contradiction with the monoclinic recently reported for this mineral.	
UBCIA	BARYLITE-2O	BaBe ₂ (Si ₂ O ₇)
UBCIB	ANDREMEYERITE	BaFe(Fe,Mn,Mg)[Si ₂ O ₇]
UBCIC	BARYLITE-1O	BaBe ₂ (Si ₂ O ₇) orth/Pmn2 ₁
UBCID	SCOTTYITE	BaCu ₂ (Si ₂ O ₇)
SERIES J	RADEKSKODAITE-(La), mon/P2₁/m.	
UBCJA	RADEKSKODAITE	(CaLa ₅)(Al ₄ Fe ²⁺)[Si ₂ O ₇][SiO ₄] ₅ O(OH ₃)
SERIES K	QUEITITE, mon/P2₁. Structure consists of 5-membered rings of Zr and Si tetrahedra sharing corners along [010] to form double layers // (001) ; S tetrahedra and irregularly coordinated Pb ₂ groups are accommodated between the double layers.	
UBCKA	QUEITITE	Pb ₄ Zn ₂ [SO ₄][SiO ₄ Si ₂ O ₇]
SERIES L	JUNITOITE, orth/Aea2. Structure consists of ZnO ₄ tetrahedral chains along b joined by Si ₂ O ₇ groups along a and c to form a three-dimensional network. Ca occurs in distorted CaO ₅ (H ₂ O) octahedra. The structure shows similarities to hemimorphite and other Ca-Zr silicates, but represents a unique tetrahedral framework.	
UBCLA	JUNITOITE	CaZn ₂ [Si ₂ O ₇]·H ₂ O
SERIES M	OPEN	
SERIES N	WERDINGITE, tric/P1. The structure is based on chains of Al octahedra parallel to c and cross-linked by disilicate groups. Al and Mg are in 5 coordination, Al and Fe in tetrahedral coordination and B in triangles. The mineral shows close structural relations to mullite, grandidierite, and sillimanite.	
UBCNA	WERDINGITE	(Mg,Fe) ₂ Al ₁₄ [O ₁₁ /(BO ₃) ₄ /(Si ₂ O ₇) ₂]
SERIES O	Open	
SERIES P	Open	
SERIES Q	THORTVEITITE SERIES, mon/C2/m. The structure consists of octahedral sheets that are one third filled with Ca (gittinsite), one third filled with Zr and one third vacant. The sheets are separated by disilicate groups, producing a void in the center of the unit cell. The Ca-O octahedra share three edges with the Zr-O octahedra and three edges with the octahedral voids to form the octahedral layer. Likewise, the octahedral voids share three edges with Zr-O octahedra. These voids show an irregular octahedral coordination. Ziesite and blossite may belong here.	
UBCQA	THORTVEITITE	Sc ₂ [Si ₂ O ₇]
UBCQB	KEIVIITE-(Yb)	(Yb,Y)[Si ₂ O ₇]
UBCQC	KEIVIITE-(Y)	(Y,Yb)[Si ₂ O ₇]
UBCQD	GITTINSITE	CaZr[Si ₂ O ₇] C2
UBCQE	YTRAILITE-(Y)	(Y,Th) ₂ [Si ₂ O ₇]

SERIES R	Open	
SERIES S	Open	
SERIES T	GANOMALITE, hex/P6. Structure consists of PbO ₃ triangular pyramids and PbO ₅ pentagonal pyramids sharing corners to form Pb ₉ O ₂₁ tunnels // [0001] ; Ca and Mn polyhedra share faces to form chains also // [0001] ; these units are linked into a framework by Si tetrahedra and disilicate groups. Ref. MM 49-85 579	
UBCTA	GANOMALITE	Pb ₉ Ca ₅ Mn[SiO ₄ □ Si ₂ O ₇] ₃
UBCTB	WAYNEBURNHAMITE	Pb ₉ Ca ₆ (Si ₂ O ₇) ₃ (SiO ₄) ₃
SERIES U	TILLEYITE SERIES, mon/P2₁/a. Structure consists of edge-sharing deformed CaO ₆ octahedra forming 2-periodic single chains and double chains // [001]. Corner-sharing of the octahedra in the double chains, and linking by disilicate groups creates ribbons // (100). The ribbons are linked by single chains and carbonate groups.	
UBCUA	TILLEYITE	Ca ₅ [(CO ₃) ₂ /Si ₂ O ₇]
UBCUB	KILLALAITE	Ca ₃ H[OH/Si ₂ O ₇]
TYPE D	OCTAHEDRAL BRACELETTS & PINWHEELS	
TYPE E	OCTAHEDRAL SHEET STRUCTURES	
SERIES A	CHEVKINITE SERIES, mon/P2₁/a. The gross structural features of the two minerals are essentially the same, consisting of sheets of octahedrally coordinated Ce atoms. These sheets have configurations much like the planes in rutile consisting of a double thickness of disilicate groups and MgO ₆ octahedra. The structure has a high number of O atoms that are not bonded to Si. Ti-O chains occur parallel to the b-axis: every two octahedra have an edge in common. Actually there are two series of octahedral chains parallel to the b-axis, which together form a layer. The Ce ions are in coordination 10 and lie between these layers of octahedra and the disilicate groups. CM04-1013.	
UBEAA	PERRIERITE-(Ce)	(Ce,La,Ca) ₄ (Fe,Mg) ₂ (Ti,Fe) ₃ (Si ₂ O ₇) ₂ O ₈
UBEAB	CHEVKINITE-(Ce)	(Ce,La,Ca) ₄ (Fe,Mg) ₂ (Ti,Fe) ₃ (Si ₂ O ₇) ₂ O ₈
UBEAC	STRONTIO-CHEVKINITE	(Sr,La,Ce,Ca) ₄ (Fe,Fe) ₂ (Ti,Zr) ₃ (Si ₂ O ₇) ₂ O ₈
UBEAD	RENGETE	Sr ₄ ZrTi ₄ (Si ₂ O ₇) ₂ O ₈
UBEAE	MATSUBARAITE	Sr ₄ TiTi ₄ (Si ₂ O ₇) ₂ O ₈
UBEAF	POLYAKOVITE-(Ce)	(Ce,REE,Ca) ₄ (Mg,Fe)(Cr,Fe) ₂ (Si ₂ O ₇) ₂ O ₈
UBEAG	KARNASURTITE-(Ce)	(Ce,La,Th)(Ti,Nb)(Al,Fe)[(Si,P) ₂ O ₇](OH) ₄ ·3H ₂ O
UBEAH	PERRIERITE-(La)	(La,Ce,Ca) ₄ (Fe,Mg) ₂ (Ti,Fe) ₃ (Si ₂ O ₇) ₂ O ₈
UBEAI	MAONIUPINGITE-(Ce)	(Ce,Ca) ₄ (Fe,Ti,Fe,□)(Ti,Fe,Fe,Nb) ₄ Si ₄ O ₂₂
UBEAJ	DINGDAOHENGITE-(Ce)	Ce ₄ Fe ²⁺ (Ti,Fe,Me,Fe) ₂ Ti ₂ Si ₄ O ₂₂
UBEAK	HEZUOLINITE	(Sr,REE) ₄ Zr(Ti,Fe) ₄ Si ₄ O ₂₂
UBEAL	CHRISTOFSCHAFFERITE-(Ce)	(Ce,La,Ca) ₄ Mn(Ti,Fe) ₃ (Fe,Ti)(Si ₂ O ₇) ₂ O ₈
UBEAM	DELHUYARITE-(Ce)	Ce ₄ Mg(Fe,W) ₃ (Si ₂ O ₇) ₂ O ₆ (OH) ₂
SERIES B	BIRAITE, mon,P2₁/c. Structure consists of polyhedral (001) sheets composed of pairs of edge-sharing [FeO ₆ octahedra, [Si ₂ O ₇] groups and carbonate triangles. Ce ³⁺ cations are in ten-fold coordination provide the linkage between neighboring polyhedral sheets.	
UBEBA	BIRAITE-(Ce)	Ce ₂ Fe ²⁺ (CO ₃)(Si ₂ O ₇)
SERIES C	STAVELOTITE, trig/P31. Structure consists of a very complex and densely packed array of atoms. It has four different polyhedral layers stacked // to the c axis: layer 1 consists of eight-coordinated distorted cube sites for Mn ²⁺ sharing edges with strongly distorted Mn ³⁺ polyhedra (tetragonal bipyramids), and also contains one planar square site for Cu ²⁺ . Layer 2 has more regular octahedra for Mn ³⁺ as well as for the Mn ⁴⁺ required for charge balance, and it contains SiO ₄ tetrahedra oriented in one	

direction. Layer 3 contains additional SiO₄ tetrahedra oriented in two different opposing directions in order to link with those of layers 2 and 4, thus forming disilicate groups, and it carries La in eightfold coordination. Layer 4 is of similar architecture to layer 2, but in an inverted position. Layers 1, 2 and 4 are geometrically similar to respective layers in the structure of langbanite.

UBECA STAVELOTITE-(La) $\text{La}_3\text{Mn}^{2+}_3\text{Cu}(\text{Mn}^{3+}, \text{Fe}^{3+}, \text{Mn}^{4+})_{26}[\text{Si}_2\text{O}_7]_6\text{O}_{30}$

SERIES D **FERSMANITE, mon/Aa.** Structure consists of chains of edge-sharing TiO₆ octahedra and Na(O,F)₈ polyhedra // [101] are connected into double sheets // (010); these sheets alternate with double sheets consisting of chains of edge-sharing CaO₆ deformed octahedra linked by corners to disilicate groups. In belkovite, three corner-sharing chains of (Nb,Ti)O₆ octahedra form trigonal columns // [0001] that are connected into a framework by disilicate groups; Ba is accommodated in channels // [0001].

UBEDA FERSMANITE $\text{Ca}_4(\text{Na}, \text{Ca})_4(\text{Ti}, \text{Nb})_4[\text{F}_3 | \text{O}_8 | (\text{Si}_2\text{O}_7)_2]$

UBEDB BELKOVITE $\text{Ba}_3(\text{Nb}, \text{Ti})_6[\text{O}_6/\text{Si}_2\text{O}_7]_2$

SERIES E **MOSANDRITE SERIES, mon/P2₁/c.** Structure consists of continuous sheets // (100) of edge-sharing (Ti,Na,Ca) octahedra with intercalated Na; these are linked on both sides by double chains of M polyhedra and disilicate groups, both of which are oriented // [001]. The structure of rinkite is a framework of TS (titanium silicate) blocks. The TS block consists of HOH sheets (H-heteropolyhedral, O-octahedral). The TS block of rinkite exhibits linkage and stereochemistry typical for Group I of /ti disilicate minerals: two H sheets connect to the O sheet such that two disilicate groups link to the trans edges of a Na polyhedron of the O sheet. Structure of dovyrenite is build by alternate stacking of Ca-polyhedral layers characteristic of the tobermorite structure and octahedral layers with attached disilicate groups known from the rosenbuschite group of minerals. In dovyrenite Ca occurs in sixfold-, sevenfold-, and eightfold-coordination. Am. Min. 08-456

UBEEA MOSANDRITE-(Ce) $\text{Ti}(\square, \text{Ca}, \text{Na})_3(\text{Ca}, \text{REE})_4(\text{Si}_2\text{O}_7)_2[\text{H}_2\text{O}, \text{OH}, \text{F}]_4 \cdot \text{H}_2\text{O}$

UBEEB NACARENIOBSITE-(Ce) $\text{Na}_3\text{Ca}_3(\text{Ce}, \text{La})(\text{Nb}, \text{Ti})(\text{Si}_2\text{O}_7)_2\text{OF}_3$

UBEEC RINKITE-(Ce) $(\text{Ca}, \text{Ce})_4\text{Na}(\text{Na}, \text{Ca})_2(\text{Si}_2\text{O}_7)_2\text{F}_2(\text{O}, \text{F})_2$ mon/P2₁ MinMag, 72, 887

UBEED ROUMAITE $(\text{Ca}, \text{Na}, \text{REE}, \square)_7(\text{Nb}, \text{Ti})[\text{Si}_2\text{O}_7]_2\text{OHF}_3$ mon/Cc

UBEEE DOVYRENITE $\text{Ca}_6\text{Zr}(\text{Si}_2\text{O}_7)_2(\text{OH})_4$

UBEEF RINKITE-(Y) $\text{Na}_2\text{Ca}_4\text{YTi}(\text{Si}_2\text{O}_7)_2\text{OF}_3$

SERIES F **MERO-PLESIOTYPE BAFERTISITE SERIES.** The general structure of this series consists of an ideally octahedral (O) sheet sandwiched between two heteropolyhedral (H) sheets; these sheets are formed by Ti-octahedra and disilicate groups [Si₂O₇]. On the whole, this series is considered of mero-plesiotype. In fact, the heterophyllosilicate HOH layer, to a first approximation, represents the common module in this series, whereas the interlayer content is variable (merotypism), and may modify its structure in different members (plesiotypism). See CM07-1247 for a complete description of the HCH and TS blocks.

The structure of betalomonosovite is a combination of a titanium silicate (TS) block and an intermediate (I) block. The TS block consists of HOH sheets and exhibits linkage and stereochemistry typical for Group IV of the TS-block minerals. The I block is a framework of Na polyhedra and P tetrahedra which ideally gives {Na₂□₄[PO₃(OH)][PO₂(OH)₂]} pfu. Betalomonosovite is a Na-poor OH-bearing analogue of lomonosovite. In the beta phase structure, there is less Na in the I block and in the TS block when compared to the lomonosovite structure. Zolotarev, A.A. Jr., Selivanova, E.A., Krivovichev, S.V., Savchenko, Y.E., Panikorovskii, T.L., Lyalina, L.M., Pautov, L.A., Yakovenchuk, V.N. (2018): Shkatulkalite, a Rare Mineral from the Lovozero Massif, Kola Peninsula: A Re-Investigation. Minerals, 8, 303; doi.org/10.3390/min8070303.

The crystal structure of shkatulkalite has been solved from the crystal from the Lovozero alkaline massif, Kola Peninsula, Russia. The mineral is monoclinic, P2/m, a = 5.4638(19), b = 7.161(3), c = 15.573(6) Å, β = 95.750(9)°, V = 606.3(4) Å³, R1 = 0.080 for 1551 unique observed reflections. The crystal structure is based upon the HOH blocks consisting of one octahedral (O) sheet sandwiched between two heteropolyhedral (H) sheets. The blocks are parallel to the (001) plane and are separated from each other by the interlayer space occupied by Na1 atoms and H₂O groups. The Na₂, Na₃, and Ti sites are located within the O sheet. The general formula of shkatulkalite can be written as Na₅(Nb_{1-x}Ti_x)₂(Ti_{1-y}Mn_{2+y})[Si₂O₇]₂O₂(OH)₂·nH₂O, where x + y = 0.5 and x ≈ y ≈ 0.25 for the sample studied. Shkatulkalite belongs to the seidozerite supergroup and is a member of the lamprophyllite group. The species most closely related to shkatulkalite are vuonnemite and epistolite.

The close structural relations and the reported observations of pseudomorphs of shkatulkalite after vuonnemite suggest that, at least in some environments, shkatulkalite may form as a transformation mineral species. Sokolova, E. & Hawthorne, F.C. (2019): From structure topology to chemical composition. XXVI. Crystal structure and chemical composition of a possible new mineral of the murmanite group (seidozerite supergroup), ideally $\text{Na}_2\text{CaTi}_4(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_4$, from the Lovozero alkaline massif, Kola Peninsula, Russia. *Mineralogical Magazine*, 83, 199-207.

Abstract:

The crystal structure of a murmanite-related mineral (MRM) of the murmanite group (seidozerite supergroup), ideally $\text{Na}_2\text{CaTi}_4(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_4$, from Mt. Pyalkimpor, the Lovozero alkaline massif, Kola Peninsula, Russia, was refined in space group P-1 with $a = 5.363(2)$, $b = 7.071(2)$, $c = 12.176(5)$ Å, $\alpha = 92.724(3)$, $\beta = 107.542(7)$, $\gamma = 90.13(2)^\circ$, $V = 439.7(4)$ Å³ and $R1 = 5.72\%$. On the basis of electron-microprobe analysis, the empirical formula calculated on 22 (O + F), with two constraints derived from structure refinement, $\text{OH} = 0.11$ per formula unit (pfu) and $\text{H}_2\text{O} = 3.89$ pfu, is $(\text{Na}_{2.12}\text{K}_{0.07}\text{Sr}_{0.01})\Sigma_{2.20}\text{Ca}_{0.85}(\text{Ti}_{3.01}\text{Nb}_{0.39}\text{Mn}_{0.20}\text{Fe}_{2+0.19}\text{Mg}_{0.17}\text{Zr}_{0.01}\text{Al}_{0.01})\Sigma_{3.98}(\text{Si}_{4.20}\text{O}_{14})[\text{O}_{3.9}\text{F}_{0.10}]\Sigma_{4}[(\text{H}_2\text{O})_{3.89}(\text{OH})_{0.11}]\Sigma_{4}[\text{P}_{0.03}]$, with $Z = 1$. It seems unlikely that {P0.03} belongs to MRM itself. The crystal structure of MRM is an array of TS blocks (Titanium-Silicate) connected via hydrogen bonds. The TS block consists of HOH sheets (H = heteropolyhedral, O = octahedral) parallel to (001). In the O sheet, the Ti-dominant MO1 site and Ca-dominant MO2 site give ideally $(\text{Ca})\text{Ti}_2$ pfu. In the H sheet, the Ti-dominant MH site and Na-dominant AP site give ideally Na_2Ti_2 pfu. The MH and AP polyhedra and Si_2O_7 groups constitute the H sheet. The ideal structural formula of MRM of the form $\text{AP}_2\text{MH}_2\text{MO}_4(\text{Si}_2\text{O}_7)_2(\text{XOM},\text{A})_4(\text{XOA})_2(\text{XPM},\text{A})_4$ is $\text{Na}_2\text{Ti}_2(\text{Ca})\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_4$. MRM is a Ca-rich and Na-poor analogue of murmanite, ideally $\text{Na}_2\text{Ti}_2\text{Na}_2\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{H}_2\text{O})_4$ and a Na-rich and (OH)-poor analogue of calciomurmanite, ideally $(\text{Ca})\text{Ti}_2(\text{Na})\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_2[\text{O}(\text{OH})](\text{H}_2\text{O})_4$. MRM and (murmanite and calciomurmanite) are related by the following substitutions: $\text{O}(\text{Ca}^{2+})\text{MRM} \leftrightarrow \text{O}(\text{Na}^{+2})\text{mur}$ and $\text{O}(\text{Ca}^{2+})\text{MRM} + \text{H}(\text{Na}^{+2})\text{MRM} + \text{O}(\text{O}^{2-})\text{MRM} \leftrightarrow \text{O}(\text{Na}^{+})\text{cal} + \text{H}(\text{Ca}^{2+})\text{cal} + \text{O}[(\text{OH})-\text{cal}]$. MRM is a possible new mineral of the murmanite group (seidozerite supergroup) where $\text{Ti} + \text{Mn} + \text{Mg} = 4$ apfu.

UBEF01	LAMPROPHYLLITE-2O	$(\text{Sr},\text{K},\text{Ba})_2\{(\text{Na}(\text{Na},\text{Fe})_2\text{Ti})[(\text{Zr},\text{Ti})_2\text{O}_2\text{Si}_4\text{O}_{14}]\text{O},\text{OH}\}_2$
UBEF02	BARYTOLAMPROPHYLLITE	$(\text{Ba},\text{Na})_2\{(\text{NaTi},\text{Fe},\text{Ba})_4[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}](\text{OH},\text{F})_2\}$
UBEF03	SHKATULKALITE	$(\text{Na},\square)_2\{(\text{Na},\text{Mn},\text{Ca},\square)_4[(\text{Ti},\text{Nb})_2(\text{O},\text{OH})_2\text{Si}_4\text{O}_{14}](\text{OH},\text{F})_2\cdot\text{H}_2\text{O}$
UBEF04	SELIVANOVAITE	$\text{NaTi}_3(\text{Ti},\text{Na},\text{Fe},\text{Mn})_4[(\text{Si}_2\text{O}_7)_2\text{O}_4(\text{OH},\text{H}_2\text{O})_4]\cdot n\text{H}_2\text{O}$
UBEF05	OPEN	
UBEF06	OPEN	
UBEF07	LILEYITE	$\text{Ba}_2(\text{Na},\text{Fe},\text{Ca})_3\text{MgTi}_2(\text{Si}_2\text{O}_7)_2\text{O}_2\text{F}_2$
UBEF08	CAMARAITE	$\text{Ba}_3\text{Na}(\text{Fe}^{2+},\text{Mn})_8\text{Ti}_4(\text{Si}_2\text{O}_7)_4\text{O}_4(\text{OH},\text{F})_7$
UBEF09	JINSHAJIANGITE	$(\text{Na},\text{Ca})(\text{Ba},\text{K})\{(\text{Fe},\text{Mn})_4[(\text{Ti},\text{Nb})_2\text{O}_3\text{Si}_4\text{O}_{14}](\text{F},\text{O})_2\}$
UBEF10	PERRAULTITE	$(\text{Na},\text{Ca})(\text{Ba},\text{K})\{(\text{Mn},\text{Fe})_4[(\text{Ti},\text{Nb})_2\text{O}_3\text{Si}_4\text{O}_{14}](\text{OH},\text{F})_2\}$
UBEF11	DELINDEITE	$\text{Ba}_2\text{Na}_2\text{Ti}_3(\text{Si}_2\text{O}_7)_2\text{O}_2(\text{OH})_2(\text{H}_2\text{O})_2$ CM42-1247
UBEF12	BAFERTISITE	$\text{Ba}_2\text{Fe}^{2+}_4\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_2(\text{OH})_2\text{F}_2$
UBEF13	HEJTMANITE	$\text{Ba}_2\{(\text{Mn},\text{Fe})_4[\text{Ti}_2(\text{O},\text{OH})_4\text{Si}_4\text{O}_{14}](\text{OH},\text{F})_2\}$
UBEF14	MURMANITE	$\text{Na}_2\{(\text{Ti},\text{Na},\square)_4[\text{Ti}_2\text{O}_2(\text{O},\text{OH})_2\text{Si}_4\text{O}_{14}](\text{O},\text{OH})_2\}$ CM42-797
UBEF15	EPISTOLITE	$\text{Na}_2\{(\text{Na}_3\text{Ti})[\text{Nb},\text{Ti})_2\text{O}_2(\text{O},\text{OH})_2\text{Si}_4\text{O}_{14}](\text{O},\text{F})_2\}$ CM42-797
UBEF16	BORNEMANITE	$\text{Na}_3\text{Ba}\{(\text{Na},\text{Ti},\text{Mn})_4[(\text{Ti},\text{Nb})_2\text{O}_2\text{Si}_4\text{O}_{14}](\text{F},\text{OH})_2\}\text{PO}_4$
UBEF17	VUONNEMITE	$\text{Na}_8\{(\text{Na},\text{Ti})_4[\text{Nb}_2\text{O}_2\text{Si}_4\text{O}_{14}](\text{O},\text{OH},\text{F})_2\}(\text{PO}_4)_2$
UBEF18	LOMONOSOVITE	$\text{Na}_8\{(\text{Na},\text{Ti})_4[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}](\text{O},\text{F})_2\}(\text{PO}_4)_2$
UBEF19	INNELITE-1A	$(\text{Ba},\text{K})_2\text{Ba}_2\{(\text{Na},\text{Ca})_3\text{Ti}[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}]\text{O}_2(\text{SO}_4)_2$
UBEF20	YOSHIMURAITE	$\text{Ba}_4\{(\text{Mn}_4[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}](\text{OH})_2\}(\text{PO}_4)_2$
UBEF21	BUSSENITE	$\text{Na}_2(\text{Ba},\text{Sr})_4\{(\text{Na},\text{Fe},\text{Mn})_4[\text{Ti}_2(\text{OH})_4\text{Si}_4\text{O}_{14}]\}(\text{CO}_3)_2(\text{OH})_2\text{F}_2$
UBEF22	QUADRUPHITE	$\text{Na}_{13}\text{Ca}\{(\text{NaMgTi}_2)[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}]\text{O}_2\}(\text{PO}_4)_4\text{F}_2$
UBEF23	SOBOLEVITE	$\text{Na}_{12}\text{CaMg}\{(\text{NaMgTi}_2)[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}]\text{O}_2\}(\text{PO}_4)_6\text{F}_2$
UBEF24	POLYPHITE	$\text{Na}_{14}(\text{Ca},\text{Mn},\text{Mg})_5\{(\text{Ti},\text{Mn},\text{Mg})_4[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}]\text{F}_2\}(\text{PO}_4)_6\text{F}_2$
UBEF25	NABALAMPROPHYLLITE	$\text{Ba}(\text{Na},\text{Ba})\{(\text{Na}_3\text{Ti}[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}](\text{OH},\text{F})_2\}$

UBEF26	SURKHOBITE	$(\text{Ba},\text{K})_2\text{CaNa}(\text{Mn},\text{Fe},\text{Fe})_8\text{Ti}_4(\text{Si}_2\text{O}_7)_4\text{O}_4(\text{F},\text{OH},\text{O})_6$
UBEF27	SCHULLERITE	$\text{Na}_2\text{Ba}_2\text{Mg}_2\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_2\text{F}_2$
UBEF28	BETALOMONOSOVITE	$\text{Na}_6\text{Ti}_4(\text{Si}_2\text{O}_7)_2[\text{PO}_3(\text{OH})][\text{PO}_2(\text{OH})_2](\text{OF})$
UBEF29	PHOSPHOINNELITE	$(\text{Ba},\text{K})_2\text{Ba}_2\{(\text{Na},\text{Ca})_3\text{Ti}[\text{Ti}_2\text{O}_2\text{Si}_4\text{O}_{14}]\text{O}_2(\text{PO}_4)_2$
UBEF30	BYKOVAITE	$\text{BaNa}\{(\text{Na},\text{Ti})_4[(\text{Ti},\text{Nb})_2(\text{OH},\text{O})_3\text{Si}_4\text{O}_{14}]\}(\text{OH},\text{F})_2 \cdot 3\text{H}_2\text{O}$
UBEF31	VIGRISHINITE	$\text{NaZnTi}_4\text{Ti}_x(\text{Si}_4\text{O}_{14})\text{O}_3(\text{OH})(\text{H}_2\text{O})_4$
UBEF32	NECHELYUSTOVITE	$(\text{Ba},\text{Na})_2\{(\text{Na},\text{Ti},\text{Mn})_4[(\text{Ti},\text{Nb})_2(\text{OH})_3\text{Si}_4\text{O}_{14}](\text{OH},\text{O},\text{F})_2\} \cdot 3\text{H}_2\text{O}$
UBEF33	EMMERICHITE	$\text{Ba}_2\text{Na}(\text{Na},\text{Fe}^{2+})_2(\text{Fe}^{3+},\text{Mg})\text{Ti}_2(\text{Si}_2\text{O}_7)_2\text{O}_2\text{F}_2$
UBEF34	ZVYAGINITE	$\text{NaZnNb}_2\text{Ti}[\text{Si}_2\text{O}_7]_2(\text{OH},\text{F})_3(\text{H}_2\text{O})_{4+x} (x < 1)$
UBEF35	SAAMITE	$\text{Ba}\square\text{Na}_3\text{Ti}_2\text{Nb}(\text{Si}_2\text{O}_7)_2\text{O}_2(\text{OH})\text{F}(\text{H}_2\text{O})_2$
UBEF36	KAZANSKYITE	$\text{BaNa}_3\text{Ti}_2\text{Nb}(\text{Si}_2\text{O}_7)_2\text{O}_2(\text{OH})_2(\text{H}_2\text{O})_4$
UBEF37	FLUORLAMPROPHYLLITE	$\text{Na}_3(\text{SrNa})\text{Ti}_3(\text{Si}_2\text{O}_7)_2\text{O}_2\text{F}_2$
UBEF38	BOBSHANNONITE	$\text{Na}_2\text{KBa}(\text{Mn},\text{Na})_8(\text{Nb},\text{Ti})_4(\text{Si}_2\text{O}_7)_4\text{O}_4(\text{OH})_4(\text{O},\text{F})_2$
UBEF39	BETALOMONOSOVITE	$\text{Na}_6(\text{Na},\text{Ti})_4(\text{Si}_2\text{O}_7)_2[\text{PO}_3(\text{OH})][\text{PO}_2(\text{OH})_2]\text{O}_2(\text{OF})$
UBEF40	CALCIOMURMANITE	$(\text{Na},\square)_2\text{Ca}(\text{Ti},\text{Mg},\text{Nb})_4[\text{Si}_2\text{O}_7]_2\text{O}_2(\text{OH},\text{O})_2(\text{H}_2\text{O})_4$
UBEF41	FLUORBARYTOLAMPROPHYLLITE	$(\text{Ba},\text{Sr})_2[(\text{Na},\text{Fe})_3(\text{Ti},\text{Mg})\text{F}_2(\text{Si}_2\text{O}_7)_2\text{O}_2]$

SERIES G

PUMPELLYITE SERIES, *mon/C2/m*. The structure is based on a three-dimensional framework generated by cross-linking ribbons composed of edge-sharing single chains of Al coordination octahedra and lateral bridging disilicate groups. The openings of the framework accommodate the Ca atoms and the water molecules. The minerals lawsonite, sursassite, ardennite, pumpellyite, orientite, macfallite, ruizite, bermanite all possess this basic structure but differ in the silicate polymerism. Structure consists of edge-sharing octahedra // [010] which are connected by Si and disilicate groups which share corners with the octahedra, and by Ca atoms which share edges with the octahedra. The crystal chemistry of poppiite, V-analogue of pumpellyite-group mineral, from the Komatsu mine, Saitama Prefecture, Japan and from the Gambatesa mine, Genova, Italy (type locality) were studied using electron microprobe (EMPA) and X-ray single-crystal diffraction methods. Both samples are characterized by very high V content, and the average V₂O₃ content is 31.1 wt% for the Komatsu poppiite and 25.4 wt% for the Gambatesa specimen. The Komatsu specimen in this study is the V-richest poppiite ever reported. Structure refinements converged to R₁ values of 5.01% for Komatsu and 3.74% for Gambatesa. The determined structural formula (Z = 4) of poppiite from the Komatsu and Gambatesa mines is

$\text{Ca}_2.00\text{X}(\text{V}_3+0.54\text{Fe}_3+0.01\text{Mg}_0.19\text{Mn}_2+0.22\text{Al}_0.04)\text{Y}(\text{V}_3+1.73\text{Fe}_3+0.03\text{Al}_0.24)\text{Si}_3.00\text{O}_{10.59}(\text{OH})_{3.41}$, and $\text{Ca}_2.00(\text{V}_3+0.49\text{Fe}_3+0.08\text{Mg}_0.19\text{Mn}_2+0.17\text{Al}_0.07)\text{Y}(\text{V}_3+1.35\text{Fe}_3+0.21\text{Al}_0.44)\text{Si}_3.00\text{O}_{10.64}(\text{OH})_{3.36}$, respectively. Both specimens are classified as poppiite-(V₃₊) because the X and Y octahedral sites are predominantly occupied by V₃₊. The Me₂₊:Me₃₊ ratio at X in this study is 0.41:0.59 for the Komatsu poppiite, and 0.36:0.64 for the Gambatesa one. The former has the larger unit-cell volume (1033.2 Å³) than the latter (1026.6 Å³). Both charge distribution analysis and located hydrogen sites indicate that O₅, O₇, O₁₀, and O₁₁ positions host hydroxyl groups. The distance and cell-dimensions positively correlate with mean ionic radius at Y. On the other hand, the a- and c-dimensions are shorter than the values expected by the regression lines estimated by approximately Me₂₊:Me₃₊ ≈ 0.5: 0.5 because of the high proportion of Me₃₊ at X. The studied poppiite crystals are characterized by small β angles [97.283(2)° for Komatsu, and 97.343(3)° for Gambatesa]. These values are considered to be related to distortional variations of the YO₆ octahedra caused by the different characteristics of octahedral V₃₊ ions compared to Fe₃₊ and Cr₃₊. The crystal structures of two Cr-rich pumpellyite-group minerals, shuiskite with 22.6 wt% Cr₂O₃ from the Biserskoe deposit and chromian pumpellyite-(Mg) with 16.4 wt% Cr₂O₃ from the Glavnoe Saranovskoe deposit (both belong to the Saranovskaya group of chromite deposits, Middle Urals, Russia) were studied through single-crystal X-ray diffraction. The structures (space group *C2/m*) of shuiskite with *a* = 19.2156(7), *b* = 5.9779(2), *c* = 8.8268(3) Å, β = 97.785(3)° and chromian pumpellyite-(Mg) with *a* = 19.1776(8), *b* = 5.9537(3), *c* = 8.8282(4) Å, β = 97.668(4)° were refined to *R*₁ = 3.01 and 3.12%, respectively; the structure of shuiskite was determined for the first time. The formulae (Z = 4) obtained from the structural refinements and taking into account electron-microprobe data are: ${}^w\text{Ca}_{2.00}\text{X}(\text{Mg}_{0.46}\text{Cr}_{0.36}\text{Al}_{0.18})\Sigma_{1.00}\text{Y}(\text{Cr}_{1.04}\text{Al}_{0.96})\Sigma_{2.00}\text{Z}\text{Si}_{3.00}\text{O}_{10.54}\text{OH}_{3.46}$ for shuiskite and ${}^w\text{Ca}_{2.00}\text{X}(\text{Mg}_{0.50}\text{Cr}_{0.30}\text{Al}_{0.20})\Sigma_{1.00}\text{Y}(\text{Al}_{1.30}\text{Cr}_{0.70})\Sigma_{2.00}\text{Z}\text{Si}_{3.00}\text{O}_{10.50}\text{OH}_{3.50}$ for chromian pumpellyite-(Mg). Molecular water is absent in both minerals. The presence of silanol groups Si-OH is confirmed by Infrared (IR) spectroscopy. The existence of shuiskite as an individual mineral in its initial sense, *i.e.*, with Mg and

Cr³⁺ dominant at the X and Y sites, respectively, is confirmed. The simplified formula of shuiskite has been refined: Ca₂(Mg,Cr)(Cr,Al)₂[SiO₄][Si₂O₆(OH,O)](OH,O)(OH)₂. The simplified formula of chromian pumpellyite-(Mg) is Ca₂(Mg,Cr)(Al,Cr)₂[SiO₄][Si₂O₆(OH,O)](OH,O)(OH)₂. In high-chromium pumpellyite-group minerals the preference of Cr for the Y site increases with increasing total Cr content: the distribution coefficient of Cr³⁺ between the X and Y sites, $K_D = (Cr/Al)_X / (Cr/Al)_Y$, is 2.79 in chromian pumpellyite-(Mg) and 1.85 in shuiskite.

UBEGA	JULGOLDITE-(Fe ²⁺)	Ca ₂ Fe(Fe,Al) ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEBB	OKHOTSKITE	Ca ₂ (Mn,Mg)(Mn,Al,Fe) ₂ Si ₃ O ₁₀ (OH) ₄
UBEGC	PUMPELLEYITE-(Fe ²⁺)	Ca ₂ FeAl ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGD	PUMPELLEYITE-(Fe ³⁺)	Ca ₂ (Fe,Mg,Fe)(AlFe) ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGE	PUMPELLEYITE-(Mg)	Ca ₂ MgAl ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGF	PUMPELLEYITE-(Mn)	Ca ₂ (Mn,Mg)(Al,Mn,Fe) ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGG	SHUISKITE	Ca ₂ (Mg,Al)(Cr,Al) ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGH	JULGOLDITE-(Fe ³⁺)	Ca ₂ Fe(Fe) ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGI	PUMPELLEYITE-(Al)	Ca ₂ Al ₃ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O
UBEGJ	POPPIITE	(Ca _{7.7} Na _{0.3}) ₈ (V _{1.3} Fe,Mg) ₄ (V _{6.9} Al) ₈ [(SiO ₄)(Si ₂ O ₇)] ₄ (OH) ₁₄
UBEGK	JULGOLDITE-(Mg)	Ca ₂ Mg(Fe,Al) ₂ (SiO ₄)(Si ₂ O ₇)(OH) ₂ ·H ₂ O

SERIES H **BARTELKEITE, mon/P2₁/m .(High-temperature lawsonite structure). Structure consists of single chains of edge-sharing FeO₆ and GeO₆ octahedra // to the c-axis, cross-linked by Ge₂O₇ tetrahedral dimers. The Pb atoms and the water groups occupy large cavities within the framework. The H bonding scheme is similar to that in lawsonite.**

UBEHA	BARTELKEITE	PbFeGe ⁶⁺ Ge ⁴⁺ ₂ O ₇ (OH) ₂ ·H ₂ O
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SERIES I **LAWSONITE SERIES, orth/Ccmm. The structure is based on a three-dimensional framework generated by cross-linking ribbons composed of edge-sharing single chains of Al coordination octahedra and lateral bridging disilicate groups. The openings of the framework accommodate the Ca atoms and the water molecules. The minerals lawsonite, sursassite, ardennite, pumpellyite, orientite, macfallite, ruizite, bermanite all possess a basic structure but differ in the silicate polymerism.**

UBEIA	LAWSONITE	Ca ₂ Al ₂ [Si ₂ O ₇](OH) ₂ ·H ₂ O
UBEIB	HENNOMARTINITE	SrMn ₂ [Si ₂ O ₇](OH) ₂ ·H ₂ O
UBEIC	NOELBENSONITE	BaMn ₂ [Si ₂ O ₇](OH) ₂ ·H ₂ O
UBEID	ITOIGAWAITE	SrAl ₂ [Si ₂ O ₇](OH) ₂ ·H ₂ O
UBEIE	CORTESOGNOITE	Ca[V ₂ O ₇](OH) ₂ ·H ₂ O

SERIES J **SURSASSITE SERIES, mon/P2₁/m. The structure is based on the ²⁻[M₂□₂(TO₄)₂] fundamental building block with connected (Ca,Mn²⁺)₇ polyhedra. In turn, these sheets are connected to symmetry-translated sheets by a variety of silicate polymers. The minerals lawsonite, sursassite, ardennite, pumpellyite, orientite, macfallite, ruizite, bermanite all possess a basic structure but differ in the silicate polymerism. Edge-sharing chains of Al octahedra // [010] are connected into a framework by Si tetrahedra and disilicate groups, with further linkage by Mn polyhedra; similar to the pumpellyite structure. The structure of sursassite is based on chains of edge-sharing aluminium octahedral arranged along the b axis, connected together by sharing corners with the Si(1)O₄ tetrahedron and the Si(2)Si(3)O₇ group. Two independent Mn cations occur between the Al chains and are linked to seven and six O atoms, respectively.**

UBEJA	SURSASSITE	Mn ₂ Al ₃ [SiO ₄][Si ₂ O ₇](OH) ₃
UBEJB	MACFALLITE	Ca ₂ Mn ₃ [SiO ₄][Si ₂ O ₇](OH) ₃

SERIES K **SAMFOWLERITE, mon/P2₁/c. The structure consists of layers of vertex-sharing TO₄ tetrahedra (T = Si,Be,Zn) alternating with layers of vertex- and edge-sharing CaO₈ bicapped trigonal prisms and MnO₆ octahedra, the layers being parallel to (102). The TO₄ groups and CaO₈-MnO₆ groups share vertices with**

one another across the layer boundaries to form the three-dimensional structure. Within the layers of tetrahedra, the TO_4 groups form a network of 4-, 5-, and 8-membered rings.

UBEKA SAMFOWLERITE $\text{Ca}_{14}\text{Mn}_3\text{Zn}_2(\text{Be},\text{Zn})_2\text{Be}_6[\text{SiO}_4]_6[\text{Si}_2\text{O}_7]_4(\text{OH},\text{F})_6$

SERIES L **DAVREUXITE, $\text{mon}/P2_1/m$. The structure consists of double and single chains of alternating vertex-sharing SiO_4 and AlO_4 tetrahedra aligned parallel to $[010]$. These chains share vertices with parallel chains of vertex-sharing AlO_6 and $\text{AlO}_5(\text{OH})$ octahedra. The $\text{Si}_2\text{O}_6(\text{OH})$ groups and Mn ions with distorted six-fold coordination occupy channels between the chains.**

UBELA DAVREUXITE $\text{Mn}_2\text{Al}_8[\text{Al}_2\text{Si}_2\text{O}_{10}][\text{AlSiO}_6]_2[\text{Si}_2\text{O}_6(\text{OH})]_2(\text{OH})_2$

SERIES M **ERICSSONITE SERIES,**

UBEMA ERICSSONITE $\text{BaMn}^{2+}\text{Fe}^{3+}(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$

UBEMB FERROERICSSONITE $\text{BaFe}^{2+}\text{Fe}^{3+}(\text{Si}_2\text{O}_7)\text{O}(\text{OH})$

SERIES R **MELILITE Structure Series $\text{tetr}/P4_2/m$. The structure consists of mirror-symmetrical disilicate groups and MO_4 tetrahedra sharing edges to form sheets of 5-membered rings // (001) that are linked by Ca ions.**

UBERA AKERMANITE $\text{Ca}_2\text{Mg}[\text{Si}_2\text{O}_7]$

UBERB GEHLENITE $\text{Ca}_2\text{Al}[(\text{AlSi})\text{O}_7]$

UBERC GUGIAITE $\text{Ca}_2\text{Be}[\text{Si}_2\text{O}_7]$

UBERD HARDYSTONITE $\text{Ca}_2\text{Zn}[\text{Si}_2\text{O}_7]$

UBERE MELILITE $(\text{Ca},\text{Na})_2(\text{Al},\text{Mg})[(\text{Si},\text{Al})_2\text{O}_7]$

UBERF JEFFREYITE $(\text{Ca},\text{Na})_2(\text{Be},\text{Al})[\text{Si}_2(\text{O},\text{OH})_7]$

UBERG OKAYAMALITE $\text{Ca}_2\text{B}_2\text{SiO}_7$

UBERH SODA-MELILITE $(\text{Na},\text{Ca})_2(\text{Al},\text{Mg},\text{Fe})(\text{Si}_2\text{O}_7)$ (NATRIUMMELILITE)

UBERI ALUMOAKERMANITE $(\text{Ca},\text{Na})_2(\text{Al},\text{Mg},\text{Fe})(\text{Si}_2\text{O}_7)$

UBERJ MELIPHANITE $\text{Ca}_4(\text{Na},\text{Ca})_4\text{Be}_4\text{AsSi}_7\text{O}_{24}(\text{F},\text{O})_4$

UBERK HYDROXYLGUGIAITE $(\text{Ca},\square)_2(\text{Si},\text{Be})(\text{Be},\text{Si})_2\text{O}_5(\text{OH})_2$

SERIES S **FRESNOITE, $\text{tetr}/P4bm$ Structure consists of disilicate groups and Ti-centered square pyramids linked to form flat sheets. Intercalated between these sheets are Ba^{2+} ions in highly distorted pentagonal antiprisms. The structure also can be described as consisting of 5-membered rings of corner-sharing Ti pyramids and disilicate groups forming sheets // (001) ; these are linked by Ba atoms. Structure closely related to the Melilite structure.**

UBESA FRESNOITE $\text{Ba}_2\text{TiO}[\text{Si}_2\text{O}_7]$

GROUP C **TRISILICATES (ISOLATED GROUPS OF Si_3O_{10} TETRAHEDRA)**

TYPE A **SIMPLE CATION-LINKED STRUCTURES**

SERIES A **ROSENHAHNITE, $\text{tric}/P1$. The structure consists of Ca polyhedra and insular $[\text{Si}_3\text{O}_8(\text{OH})_2]$ groups. The trisilicate group with point symmetry 1 consists of a central Si tetrahedron sharing corners with two adjacent $\text{SiO}_3(\text{OH})$ tetrahedra. One H atom bonds the trisilicate groups in linear chains, and the other links adjacent trisilicate groups across symmetry centers into a three-dimensional array.**

UCAAA ROSENHAHNITE $\text{Ca}_3[\text{Si}_3\text{O}_8(\text{OH})_2]$

SERIES B **TRABZONITE, $\text{orth}/\text{Ama}2$. The structure contains Si_3O_{10} trimers embedded in a framework of CaO_{6-8} polyhedra. Trabzonite and foshagite are polymorphs; foshagite has willastonite-like silicate chains and in contrast to trabzonite it does not contain silan groups Schweizerische mineralogische und petrographische Mitteilungen (1986): 66, 453.**

American Mineralogist (1988): 73: 1497.

Armbruster, T., Lazic, B., Gfeller, F., Galuskin, E.V., Galuskina, I.O., Savelyeva, V.B., Zadov, A.E., Pertsev, N.N., Dzierzanowski, P. (2011): Chlorine content and crystal chemistry of dellaite from the Birkhin gabbro massif, Eastern Siberia, Russia. Mineralogical Magazine, 75, 379-394.

T. Armbruster, B. Lazic, I.O. Galuskina, E.V. Galuskin, E. Gnos, K.M. Marzec, V.M. Gazeev (2012): Trabzonite, $\text{Ca}_4[\text{Si}_3\text{O}_9(\text{OH})]\text{OH}$: crystal structure, revised formula, new occurrence and relation to killalaite. Mineralogical Magazine 76, 455–472.

UCABA TRABZONITE $\text{Ca}_4[\text{Si}_3\text{O}_{10}]\text{H}_2\text{O}$

SERIES C **THALENITE SERIES, $\text{mon}/P2_1/n$. Structure consists of edge- and corner-sharing Y polyhedra connected into a framework by Si_3O_{10} groups.**

UCACA THALENITE-(Y) $\text{Y}_3[\text{Si}_3\text{O}_{10}](\text{F})$

TYPE B **COMPLEX CATION-LINKED STRUCTURES**

TYPE C **OCTAHEDRAL CHAIN STRUCTURES**

TYPE D **OCTAHEDRAL BRACELETTES & PINWHEELS**

SERIES A **LAURENTIANITE, $\text{hex}/P3$. The basic motif present in the crystal structure of laurentianite is a five-membered pinwheel of composition $[\text{Nb}_3\text{Si}_2\text{O}_{17}(\text{H}_2\text{O})_3]^{11-}$ consisting of three $\text{NbO}_5(\text{H}_2\text{O})$ octahedral linked to two SiO_4 tetrahedra. Individual Nb-Si pinwheels are linked into more complex, 18-membered hexagonal rings of composition $[\text{Nb}_6\text{Si}_{12}\text{O}_{54}(\text{H}_2\text{O})_6]^{30-}$, which in turn are linked to form a Nb-Si layer in the [001] plane. The Nb-Si layers are then joined along [001] through shared SiO_4 to produce a three-dimensional structure. Alternatively, the structure can also be considered as being layered along [001], with a silicate layer of (Si_2O_7) dimers and a layer of isolated $\text{NbO}_5(\text{H}_2\text{O})$ octahedral, the two layers alternating along [001]. The Na atoms are restricted to the silicate layer, occupying sites that almost directly overlie those of Nb.**

UCDAA LAURENTIANITE $[\text{NbO}(\text{H}_2\text{O})]_3(\text{Si}_2\text{O}_7)_2[\text{Na}(\text{H}_2\text{O})_2]_3$

TYPE E **OCTAHEDRAL SHEET STRUCTURES**

SERIES A **KINOITE, $\text{mon}/P2_1/m$. Structure consists edge-sharing $\text{CuO}_3(\text{H}_2\text{O})_2$ square pyramids forming undulating ladder-like chains // [001] that are linked by $\text{CaO}_5(\text{H}_2\text{O})$ octahedra and trimers of three-corner-sharing Si tetrahedra in mirror-symmetrical Si_3O_{10} groups.**

UCEAA KINOITE $\text{Cu}_2\text{Ca}_2 [\text{Si}_3\text{O}_{10}/(\text{H}_2\text{O})_2]$

SERIES B **AMINOFFITE, $\text{tetr}/P4_2/n$. The structure is based on (SiO_4) groups form linear $[\text{Si}_3\text{O}_{10}]$ trimers that are linked by (BeO_4) groups into a sheet of tetrahedra parallel to (001). The central (SiO_4) group of each trimer is four-connected, whereas all other SiO_4 and the (BeO_4) tetrahedral of the sheet are three-connected, that is, they each have one anion that does not bridge between tetrahedra. There are four-membered rings of alternating (BeO_4) and (SiO_4) tetrahedral, and these are linked through the four-connected Si tetrahedral to form six-membered rings of tetrahedral. The four-membered rings connect in rows such that their apices alternately point in the +c [001] direction and are lined together by interstitial Ca atoms and by H bonding between donor O(5) atoms and acceptor O(4) anions of adjacent sheets.**

UCEBA AMINOFFITE $\text{Ca}_3\text{Be}_2[(\text{OH})_2/\text{Si}_3\text{O}_{10}]$

SERIES C **ARDENNITE SERIES, $\text{orth}/Pn\text{mn}$. The structure is based on the $^2_{\infty}[\text{M}_2\text{O}_2(\text{TO}_4)_2]$ fundamental building block with connected $(\text{Ca},\text{Mn}^{2+})_{\text{O}7}$ polyhedra. In turn, these sheets are connected to symmetry-translated sheets by a variety of silicate polymers. The minerals lawsonite, sursassite, ardennite, pumpellyite, orientite, macfallite, ruizite, bermanite all possess a basic structure but differ in the silicate polymerism. Kannanite, a new Ca-dominant member of the ardennite series, was obtained from Kannan Mountain, Ozu, Ehime Prefecture, Japan. Kannanite occurs in fine quartz veins crossing the hematite-rich regions of an iron-manganese ore included in the metachert. These veins are pale orange in color, while the kannanite itself is brownish-orange to orange, with a thin section exhibiting weak pleochroism. The mineral was found in grain sizes ranging from several to 15 μm and has a Mohs**

hardness of 6 and a calculated density of 3.43 g cm⁻³. The mean refractive index obtained from the Gladstone–Dale relationship for this mineral is 1.788. The empirical formula for kannanite is (Ca_{3.60}Mn_{2+0.40})Σ₄(Al_{3.00}Mn_{3+1.31}Fe_{3+0.69}Mg_{0.71}Mn_{2+0.19}Ni_{0.06}Cu_{0.05})Σ₆[(V_{5+0.70}Si_{0.16}As_{0.14})Σ₁O_{3.84}(OH)_{0.16}](SiO₄)₂(Si₃O₁₀)(OH)₆, while the simplified formula is Ca₄[(Al,Mn₃₊,Fe₃₊)₅Mg](VO₄)(SiO₄)₂(Si₃O₁₀)(OH)₆. Kannanite has an orthorhombic structure with a space group Pnmm and unit cell parameters a = 8.8802(14) Å, b = 5.9919(13) Å, c = 18.882(3) Å and V = 1004.7(3) Å³. Kannanite is considered to be formed by the activities of metamorphic fluid accompanied with the Sanbagawa metamorphism. Kannanite, a new Ca–dominant member of the ardennite series, was obtained from Kannan Mountain, Ozu, Ehime Prefecture, Japan. Kannanite occurs in fine quartz veins crossing the hematite–rich regions of an iron–manganese ore included in the metachert. These veins are pale orange in color, while the kannanite itself is brownish–orange to orange, with a thin section exhibiting weak pleochroism. The mineral was found in grain sizes ranging from several to 15 μm and has a Mohs hardness of 6 and a calculated density of 3.43 g cm⁻³. The mean refractive index obtained from the Gladstone–Dale relationship for this mineral is 1.788. The empirical formula for kannanite is (Ca_{3.60}Mn_{2+0.40})Σ₄(Al_{3.00}Mn_{3+1.31}Fe_{3+0.69}Mg_{0.71}Mn_{2+0.19}Ni_{0.06}Cu_{0.05})Σ₆[(V_{5+0.70}Si_{0.16}As_{0.14})Σ₁O_{3.84}(OH)_{0.16}](SiO₄)₂(Si₃O₁₀)(OH)₆, while the simplified formula is Ca₄[(Al,Mn₃₊,Fe₃₊)₅Mg](VO₄)(SiO₄)₂(Si₃O₁₀)(OH)₆. Kannanite has an orthorhombic structure with a space group Pnmm and unit cell parameters a = 8.8802(14) Å, b = 5.9919(13) Å, c = 18.882(3) Å and V = 1004.7(3) Å³. Kannanite is considered to be formed by the activities of metamorphic fluid accompanied with the Sanbagawa metamorphism. The structure of alpeite is the same as that of other members of the ardennite group.

UCECA	ARDENNITE	(Mn,Ca,Mg) ₄ ((Al,Fe) ₅ Mg)((As,V)O ₄)[SiO ₄] ₂ [Si ₃ O ₁₀](OH) ₆
UCECB	ARDENNITE-V	[Al ₄ (Mg,Al,Fe,Mn) ₂][Si ₅ (V,Si)]O ₂₂ (OH) ₆
UCECC	CASSAGNAITE	(Ca,Mn ²⁺) ₄ (Fe ³⁺ ,Mn ²⁺ ,Al) ₂ [(O,OH) ₄ /(OH) ₄](SiO ₄) ₂ /Si ₃ O ₁₀]
UCECD	LAVOISIERITE	Mn ²⁺ ₈ [Al ₁₀ (Mn ³⁺ Mg)][Si ₁₁ P]O ₄₄ (OH) ₁₂
UCECE	KANNANITE	Ca ₄ Al ₄ (MgAl)(VO ₄)(SiO ₄) ₂ (Si ₃ O ₁₀)(OH) ₆
UCECF	ALPEITE	Ca ₄ Mn ³⁺ ₂ Al ₂ (Mn ³⁺ Mg)(SiO ₄) ₂ (Si ₃ O ₁₀)(V ⁵⁺ O ₄)(OH) ₆

SERIES D **ORIENTITE**, orth/P2mm. The structure is based on the ²_∞[M₂□₂(TO₄)₂] fundamental building block with connected (Ca,Mn²⁺)_{φ7} polyhedra. In turn, these sheets are connected to symmetry-translated sheets by a variety of silicate polymers. The minerals lawsonite, sursassite, ardennite, pumpellyite, orientite, macfallite, ruizite, bermanite all possess a basic structure but differ in the silicate polymerism.

UCEDA	ORIENTITE	Ca ₈ Mn ₁₀ ³⁺ [(OH) ₁₀ /(SiO ₄) ₃ /(Si ₃ O ₁₀) ₃].4H ₂ O
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SERIES E **PAVLOVSKYITE-KILCHOANITE SERIES**, orth/Pbcn. The structure of pavlovskyite represents a 1 :1 member of a polysomatic series with calcio-olivine γ-Ca₂SiO₄ and kilchoanite as end-member modules. The structure is characterized by strongly folded trisilicate units (Si₃O₁₀) interwoven with a framework of CaO₆ and CaO₈ polyhedra. Olivine-like slices with orthosilicate groups are interstratified with the characteristic trisilicate module of Ca₄(Si₃O₁₀) composition. The structure of kilchoanite consists of slabs of olivine-type groups // (001) alternate with slabs composed of Ca ions and short chains consisting of 3 corner-sharing Si tetrahedral. Dimorph of rankinite.

UCEEA	PAVLOVSKYITE	Ca ₈ (SiO ₄) ₂ (Si ₃ O ₁₀)
UCEEB	KILCHOANITE	Ca ₆ (SiO ₄)(Si ₃ O ₁₀) orth/l2cm

SERIES F **DAMAGISTRISITE**, orth/Amm2. Structure

UCEFA	DAMAGISTRISITE	BaCa ₂ Mn ³⁺ ₄ (Si ₃ O ₁₀)(Si ₂ O ₇)(OH) ₄ .3H ₂ O
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GROUP D **TETRASILICATES (ISOLATED GROUPS OF Si₄O₁₃ TETRAHEDRA)**

TYPE A

TYPE B

TYPE C

TYPE D

OCTAHEDRAL SHEET STRUCTURES

SERIES A	RUIZITE, mon/C2/m. The structure is based on the ${}^2_{\infty}[\text{M}_2\text{O}_2(\text{TO}_4)_2]$ fundamental building block with connected $(\text{Ca}, \text{Mn}^{2+})_{\text{O}7}$ polyhedra. In turn, these sheets are connected to symmetry-translated sheets by a variety of silicate polymers. The minerals lawsonite, sursassite, ardenite, pumpellyite, orientite, macfallite, ruizite, bermanite all possess a basic structure but differ in the silicate polymerism.
UDDAA	RUIZITE $\text{Ca}_2\text{Mn}_2(\text{OH})_2[\text{Si}_4\text{O}_{11}(\text{OH})_2]\cdot 2\text{H}_2\text{O}$
UDDAB	TANIAJACOITE $\text{SrCaMn}^{3+}_2[\text{Si}_4\text{O}_{11}(\text{OH})_4]\cdot 2\text{H}_2\text{O}$
UDDAC	STRONTIORUIZITE $\text{Sr}_2\text{Mn}^{3+}_2[\text{Si}_4\text{O}_{11}(\text{OH})_4]\cdot 2\text{H}_2\text{O}$
SERIES B	AKATOREITE, tric/P1. Structure consists of edge-sharing Mn and Al octahedra forming strips, three octahedra wide, // a; these strips are cross-linked into sheets // (101) by dimers of edge-sharing Mn tetrahedral. Three corner-sharing Si tetrahedral and one SiO_3OH tetrahedron form liner clusters. The sheets are linked by the sorosilicate clusters and by H bonds.
UDDBA	AKATOREITE $\text{Mn}_9\text{Al}_2[(\text{OH})_3/(\text{Si}_4\text{O}_{12})(\text{OH})]_2$
SERIES C	BUNNOITE, tric/P1. Structure is a layered structure with alternating tetrahedral and octahedral sheets // to the (111). In the tetrahedral sheets, there are six unique Si sites. These Si tetrahedral form sorosilicate $[\text{Si}_6\text{O}_{18}(\text{OH})]$ clusters. There are six unique Mn sites and one unique Al site in the octahedral sheets. The octahedra share edges to form continuous strips linked by $[\text{Mn}_2\text{O}_8]$ edge-sharing dimers. The structure is generally similar to that of akatoreite for which the sorosilicate cluster is shorter.
UDDCA	BUNNOITE $\text{Mn}_6\text{AlSi}_6\text{O}_{18}(\text{OH})_3$
SERIES D	HUBEITE, tric/P1. The structure consists of isolated $[\text{Si}_4\text{O}_{13}]$ chain fragments. An OH group is attached at one end of the unit, an anion at the other end acts as a hydrogen-bond acceptor. Two of these units link via H bonding to form interrupted 8-membered silicate rings that form layers in the (001) plane. One of the water groups bonds to two Ca atoms along the wall of the channel; the other water group lies within the channel and is held in place solely by H bonds. The Fe^{3+} and Mn^{2+} cations are octahedrally coordinated, and the Ca cation is 7-coordinated in an arrangement that corresponds to a capped octahedron these polyhedra share edges to form an octahedral sheet parallel to (001) at $z = 0$, with large holes that are overlain by the 8-membered tetrahedral rings, creating channels along the c-axis. CM42-825.
UDDDA	HUBEITE $\text{Ca}_2\text{Mn}^{2+}\text{Fe}^{3+}[\text{Si}_4\text{O}_{12}(\text{OH})](\text{H}_2\text{O})_2$
GROUP E	PENTASILICATES (ISOLATED GROUPS OF Si_5O_{16} TETRAHEDRA)
TYPE A	CATION-LINKED STRUCTURES
SERIES A	ZUNYITE, cub/F43m. Structure consists of clusters of four Si tetrahedral sharing corners with a central Si tetrahedron to form Si_5O_{16} pentamers; these are linked to $\text{AlO}_4(\text{O}, \text{OH}, \text{F}, \text{Cl})_{12}$ groups consisting of edge- and corner sharing $\text{Al}(\text{O}, \text{OH}, \text{F}, \text{Cl})_6$ octahedra and isolated Al tetrahedra.
UEAAA	ZUNYITE $\text{Al}_{12}[(\text{OH})_{14}/\text{F}_4/\text{Cl}/\text{AlO}_4/\text{Si}_5\text{O}_{16}]$
GROUP F	HEXASILICATES (ISOLATED GROUPS OF Si_6O_{19} TETRAHEDRA)
TYPE A	CHAIN-LINKED STRUCTURES
SERIES A	MEDAITE, mon/P2₁/n. The structure is based on the vanadatopentasilicate ion $[\text{VSi}_5\text{O}_{18}(\text{OH})]^{12-}$ comprising six tetrahedra linked together to form a chain fragment. This new representative of heteropolysilicate ions is an extended relative of the arsenatotrisilicate ion $[\text{AsSi}_3\text{O}_{12}(\text{OH})]^{8+}$ found in tiragalloite, and is the longest ion allied to sorosilicates describe so far. The tiragalloite structure is based on the presence of an arsenatotrisilicate ion $[\text{AsSi}_3\text{O}_{12}(\text{OH})]^{8+}$, comprising four tetrahedra linked together to form a chain fragment. This new ion is an extension of the trisilicate $[\text{Si}_3\text{O}_{10}]^{8-}$ ion with an additional As-centered tetrahedron linked to it. The new mineral species arsenmedaite, ideally $\text{Mn}_2+6\text{As}_5+\text{Si}_5\text{O}_{18}(\text{OH})$, has been discovered in quartz veinlets in the braunite ore deposit of the Molinello mine, Graveglia Valley, Ne, Genova, Liguria, Italy. It occurs as orange-reddish prismatic crystals, up to 200 μm in length, with a vitreous lustre, associated with braunite, quartz, calcite, As-rich medaite, calcian rhodocrosite, talc, and ganophyllite. Electron microprobe analysis of arsenmedaite gave (in wt%): $\text{V}_2\text{O}_5 = 1.84$, $\text{As}_2\text{O}_5 = 6.81$, $\text{SiO}_2 = 38.75$, $\text{CaO} = 0.70$, $\text{MnO} = 50.28$, $\text{H}_2\text{O}_{\text{calc}} = 1.42$, total 99.80. On the basis of $\Sigma\text{Me} = 12$ atoms per formula unit, the chemical formula of arsenmedaite is $(\text{Mn}_{5.89}\text{Ca}_{0.10})\Sigma 5.99[(\text{As}_{0.49}\text{V}_{0.17})\Sigma 0.66\text{Si}_{5.35}]\Sigma 6.01\text{O}_{17.69}(\text{OH})_{1.31}$. The main diffraction lines are [d in

Å (relative intensity) hkl]: 3.266 (100) 081, 3.159 (72) 052, 3.094 (82) 221, 2.963 (83) 091, 2.935 (79) 211, 2.788 (68) 072, and 2.612 (98) 082. The crystal-structure study gives a monoclinic unit cell, space group P21/n, with a = 6.7099(3), b = 29.001(1), c = 7.5668(3) Å, $\beta = 95.469(3)^\circ$, V = 1465.7(1) Å³, Z = 4. The crystal structure has been solved and refined to R1 = 0.062 on the basis of 3526 reflections with F0 > 4 σ (F0) and 287 parameters. Arsenmedaite is isotypic with medaite. In its crystal structure, six- to seven-fold coordinated Mn-centred polyhedra form wavy ribbons linked to TO4 tetrahedra centred by Si and (As,V). Its formation is likely related to the late-stage circulation of As- and Mn-rich hydrothermal fluids during the final stages of the Alpine tectono-metamorphic evolution of the manganese ore deposits of Eastern Liguria.

UFAAA	TIRAGALLOITE	Mn ₄ [AsSi ₃ O ₁₂ (OH)]
UFAAB	MEDAITE	(Mn,Ca) ₆ [(V,As)Si ₅ O ₁₈ (OH)]
UFAAC	ARSENMEDAITE	Mn ²⁺ ₆ As ⁵⁺ Si ₅ O ₁₈ (OH)

TYPE B MIXED ANION COMPOUNDS (TRIPLE AND SINGLE OR DOUBLE TETRAHEDRA + SEXTUPLE TETRAHEDRA)

SERIES A ILIMAUSITE SERIES, trig/R32. This complex structure consists of three layers, A, A', and O that are stacked according to the sequence AOA'O. The O layer consists of isolated NbO₆ octahedra that share their corners with Si tetrahedra belonging to the A and A' layers. Ba and K occupy the space between the octahedra and show 12 and 9 coordination. The A layer contains two equivalent silicate sheets formed by non-interconnected Si₆O₁₈ six-membered rings of corner-sharing Si tetrahedra. The two sheets sandwich isolated CeO₆ trigonal prisms plus Na cations that show 6 and 12 coordination. The bases of the Ce trigonal prisms connect the silicate six-membered rings, thus realizing a hexagonal net. The A' layer contains two equivalent silicate sheets composed of Si tetrahedra; the sheets sandwich Ce trigonal prisms only.

UFABA	ILIMAUSITE-(Ce)	(Ba,Na) ₁₀ K ₃ Na _{4.5} Ce ₅ (Nb,Ti) ₆ [Si ₁₂ O ₃₆][Si ₉ O ₁₈ (O,OH) ₂₄]O ₆
UFABB	DIVERSILITE-(Ce)	(Ba,K,Na,Ca) ₁₁₋₁₂ (Ce,REE,Fe,Th) ₄ (Ti,Nb) ₆ [Si ₆ O ₁₈] ₄ (OH,O) ₁₂ .nH ₂ O
UFABC	K-Ti analogue of ilimaussite-(Ce)	(Ba,Na) ₁₀ K ₃ Na _{4.5} Ce ₅ (Ti,Nb) ₆ [Si ₁₂ O ₃₆][Si ₉ O ₁₈ (O,OH) ₂₄]O ₆

GROUP G TRISILICATES WITH BRANCHED TETRAHEDRA (Si₃O₁₀(SiO₃))

TYPE A SINGLE LAYERS

TYPE B DOUBLE LAYERS

SERIES A FENCOOPERITE, hex/P3m1. The structure consists of two fundamental building blocks: the first is a trimer consisting of three tetragonal pyramids of FeO₅ polyhedra sharing a common vertex. The second building block consists of islands of double open-branched triple tetrahedra sharing vertices along [001]. The [Fe₃O₁₃] trimers cross-link the Si₈O₂₂ islands into a very open framework structure. The large cavities in this structure contain Ba polyhedra with 12-fold coordination, H₂O groups, CO₃ polyhedra and Cl⁻ ions.

UGBAA	FENCOOPERITE	Ba ₆ Fe ³⁺ ₃ [Si ₈ O ₂₃](CO ₃) ₂ Cl ₃ .H ₂ O
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GROUP H TRISILICATES WITH BRANCHED TETRAHEDRA (Si₃O₁₀(SiO₃)₂)

GROUP I BALOSILICATE STRUCTURES

TYPE A CONDENSED TETRAHEDRA OF THE TYPE (Si₅₆O₁₄₀)

SERIES A ASHCROFTINE, tetr/I4/mmm. Structure based on a giant [Si₄₈O₁₂₈] ball whose connections define a polyhedron, hence a balosilicate. Breaks in the ball admit an extensive circumjacent disordered region and together define the ¹∞[Si₅₆O₁₄₀] tubular inosilicate with channels and bulges, oriented parallel to [001]. All terminal oxygens point outside, away from the central channel. The ordered carbonate fraction defines, among other things, ordered [Na(CO₃)₄] clusters. The entire ordered region is called the curd. The large balls are encrusted with a border region, or limbus, with Y-O, Na-O, and K-O bonds. The disordered region of 12 atoms in the asymmetric unit, or the whey, consist of partly occupied Y(D) = (Si,B), Si; Na(d), K(D), and O²⁻, OH, H₂O sites.

UIAAA	ASHCROFTINE-(Y)	K ₁₀ Na ₁₀ (Y,Ca) ₂₄ (OH) ₄ (CO ₃) ₁₆ [Si ₅₆ O ₁₄₀]16H ₂ O AM87-1176
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