

CYCLOSILICATES

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| CLASS V | CYCLOSILICATES | | |
| GROUP A | MONOCYCLOSILICATES (UNBRANCHED SINGLE RINGS (P^rSi_pO_{3p})^{-2p}, where p = p^r, number of tetrahedra within one ring (ring periodicity)). | | |
| TYPE A | THREE MEMBERED SINGLE RING TETRAHEDRA STRUCTURES (Si₃O₉) WITHOUT INSULAR COMPLEX ANIONS. | | |
| SERIES A | BENITOITE SERIES, hex/P6c2. Structure consists of Si₃O₉ rings with 3-fold rotation symmetry and a mirror plane // to it; these rings are situated in planes 000 ¼ and 000 ¾ with 36° rotation of alternating rings along [0001]; 2 x 3 rings are linked into a 3-dimensional framework by O-sharing M octahedra and Ba polyhedra, both also on the 6 axis, but at c = 0 and ½. | | |
| VAAAA | BENITOITE | BaTi[Si ₃ O ₉] | |
| VAAAB | BAZIRITE | BaZr[Si ₃ O ₉] | |
| VAAAC | PABSTITE | Ba(Sn,Ti)[Si ₃ O ₉] | |
| VAAAD | BOBTRAILLITE | (Na,Ca) ₁₃ Sr ₁₁ (Zr,Y,Nb) ₁₄ [Si ₂ BO ₇ (OH) ₂] ₆ [Si ₃ O ₉] ₁₀ ·12H ₂ O | P3c1 |
| VAAAE | ROGERMITCHELLITE | Na ₁₂ (Sr,Na) ₂₄ Ba ₄ Zr ₂₆ [Si ₂ BO ₇ (OH) ₂] ₁₂ [Si ₃ O ₉] ₁₈ ·18H ₂ O | P3c1 |
| SERIES B | CATAPLEIITE SERIES, mon. The structure is close to benitoite. The cavities in the framework are occupied by NaO₆(H₂O)₂. The structure of calciumcatapleiite is characterized by a mixed framework of regular ZrO₆ octahedra and three-membered silicate rings, very similar to the framework of catapleiite. The water molecules also are similarly placed in the two minerals. Hilairite structure consists of spiral 6-periodic chains along [0001] with screw symmetry 3₁ or 3₂. Zr octahedra connect three chains by sharing O atoms; Na and zeolitic water are accommodated in the resulting channels. | | |
| VAABA | CATAPLEIITE | Na ₂ Zr[Si ₃ O ₉].2H ₂ O | B2/b |
| VAABB | CALCIUMCATAPLEIITE | CaZr[Si ₃ O ₉].2H ₂ O | Pbnn |
| VAABC | WADEITE | K ₂ Zr[Si ₃ O ₉] | P6 or P6 ₃ /m |
| VAABD | HILAIRITE | Na ₂ Zr[Si ₃ O ₉].3H ₂ O | R32 |
| VAABE | CALCIOHILAIRITE | CaZr[Si ₃ O ₉].3H ₂ O | R32 |
| VAABF | SAZYKINAITE-(Y) | Na ₅ YZr[Si ₃ O ₉] ₂ ·6H ₂ O | R32 |
| VAABG | PYATENKOITE-(Y) | Na ₅ (Y,Dy,Gd)[TiSi ₃ O ₉] ₂ ·6H ₂ O | R32 |
| VAABH | KOMKOVITE | BaZr[Si ₃ O ₉].2.4H ₂ O | R32 |
| VAABI | PSEUDOWOLLASTONITE | Ca ₃ [Si ₃ O ₉] | P1 or C2/c |
| SERIES C | WALSTROMITE SERIES, tric/P1. The structure consists of [Si₃O₉]⁶⁻ rings of Si tetrahedra in layers parallel to (101), with Ca ions about halfway between them. The Ba ions are roughly coplanar with the oxygen atoms. Refined structure consists of two different structural layers // to 101: a Si layer constituted by isolated 3-fold rings of SiO₄ tetrahedra and a Ca layer made by dimers of CaO₆ octahedra and chains of CaO₈ polyhedra interconnected via edge-sharing to form a Ca-polyhedral sheet. Additional edge-sharing chains of distorted 8-fold coordinated Pb polyhedra are also present. The isostructural comparison between margarosanite and walstromite are confirmed. | | |
| VAACA | WALSTROMITE | Ca ₂ Ba[Si ₃ O ₉] | |
| VAACB | MARGAROSANITE | Ca ₂ Pb[Si ₃ O ₉] | |
| SERIES D | MATHEWROGERSITE, hex/R3,R3,R32,R3m, or R32/m. Neues Jahrbuch für Mineralogie, Monatshefte (1986): 5: 203-208. | | |

American Mineralogist (1987): 72: 1025.

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| VAADA | MATHEWROGERSITE | $\text{Pb}_7(\text{Fe,Cu})[\text{Al}_3\text{Ge}[(\text{OH}),\text{H}_2]_6/(\text{Si}_3\text{O}_9)_4]$ |
| SERIES E | ROEBLINGITE, <i>mon/C2/m</i>. The structure consists of a $^{2-}[\text{Mn}(\text{Si}_3\text{O}_9)_2]^{10-}$ corner-linked sheet oriented parallel to <i>c</i>{001}, the plane of perfect cleavage. The large cations are tucked between the above sheets. All vertices of the MnO_6 octahedron link to the (Si_3O_9) radicals which are oligosilicate three-membered rings and are geometrically similar to the rings in paragenetically related margarosanite. Coordination polyhedra include $\text{Pb}\psi_7$; $\text{Ca}(1)\psi_8$ distorted square antiprisms; $\text{Ca}(2)\psi_7$ polyhedra similar to the Pb polyhedra; MnO_6 octahedra. | |
| VAAEA | ROEBLINGITE | $\text{Pb}_2\text{Ca}_6(\text{SO}_4)_2(\text{OH})_2(\text{H}_2\text{O})_4[\text{Mn}(\text{Si}_3\text{O}_9)_2]$ |
| TYPE B | FOUR TETRAHEDRA RING STRUCTURES $(\text{Si}_4\text{O}_{12})^{8-}$ | |
| SERIES A | TARAMELLITE SERIES, <i>orth/Pmmn</i>. The structure is based on the presence of B_2O_7 groups of two tetrahedra: they connect two four-fold rings of SiO_4 tetrahedra to form the anionic radical $[\text{B}_4\text{Si}_8\text{O}_{27}]^{16-}$. Boron is coordinated by two O(8) oxygens belonging to two different four-fold rings, by one of the “free” oxygens, O(3), of the old structure, and by a new oxygen O(10), which bridges the two tetrahedra of the B_2O_7 group. The anionic groups are superposed along <i>a</i>, with the planes of the four-fold rings roughly parallel to (100). Ba atoms lie between the four-fold rings, together with Cl, which is surrounded by three Ba atoms. The octahedral coordination of Me atoms is formed by four tetrahedron. Each Me octahedron shares two edges with two opposite adjacent octahedra; a chain of octahedra is thus formed along [100], and it connects four different anionic groups in the unit cell. | |
| VABAA | TARAMELLITE | $\text{Ba}_4(\text{Fe,Ti})_4[\text{B}_2\text{Si}_8\text{O}_{27}]\text{O}_2\text{Cl}_x$ |
| VABAB | TITANTARAMELLITE | $\text{Ba}_4(\text{Ti,Fe,Fe,Mg})_4[\text{B}_2\text{Si}_8\text{O}_{27}]\text{O}_2\text{Cl}_x$ |
| VABAC | NAGASHIMALITE | $\text{Ba}_4(\text{V,Ti})_4[\text{B}_2\text{Si}_8\text{O}_{27}]\text{O}_2\text{Cl}_x$ |
| SERIES B | BAOTITE, <i>tetr/I4₁/a</i>. Structure consists of Si_4O_{12} rings // (001) which are connected by rutile-like chains // [001] of Ti and (Ti,Nb) octahedra; Cl is accommodated between two rings, and Ca is in channels // [001]. | |
| VABBA | BAOTITE | $\text{Ba}_4\text{Ti}_4(\text{Ti,Nb,Fe})_4[\text{Si}_4\text{O}_{12}]\text{O}_{16}\text{Cl}$ |
| SERIES C | VERPLANCKITE, <i>hex/P6/mmm</i>. Structure consists of trimers of three corner-sharing MnO_5 square pyramids // (0001) which are connected into a framework by 4-membered rings of Si tetrahedra to form a framework with open channels // [0001], similar to those in muirite, that accommodate Ba and Cl. The 4-membered rings are // (1010). | |
| VABCA | VERPLANCKITE | $\text{Ba}_{12}(\text{Mn,Ti,Fe})_6[\text{Si}_4\text{O}_{12}]_3(\text{O,OH})_2(\text{OH,H}_2\text{O})_7\text{Cl}_9$ |
| SERIES D | KAINOSITE-PHOSINAITE SERIES, <i>orth/Pmnb</i>. The structure consists of a series of mixed layers of tetrahedra and octahedra that are stacked along <i>a</i>. Two different types of layers are present: a (SiP) layer with the composition $[\text{Na}(\text{SiO}_4)_2(\text{PO}_4)]$, and a (NaP) layer with the composition $[\text{Na}(\text{PO}_4)]$; there are two (SiP) layers on each side of a central (NaP) layer. The (SiP) layer has SiO_4 and PO_4 tetrahedra that are cross-linked by $\text{Na}(7)\text{O}_6$ octahedra. Within the layer, rings and mixed $\text{Na}(2)\text{O}_6\text{-PO}_4$ rings, which are both centered about a $\underline{2}$ axis and alternate along <i>a</i>. These rings form channels along <i>a</i>, the cores of which are occupied by REEO_8 and $\text{Na}(8)\text{O}_8$ polyhedra. The remaining NaO_6 octahedra and both CaO_7 and $(\text{Na,Ca})\text{O}_7$ polyhedra are positioned in the interstices between the rings. The (NaP) layer consists of PO_4 tetrahedra corner-linked to $\text{Na}(2)\text{O}_6$ octahedra, each PO_4 group sharing three of its corners with four $\text{Na}(2)\text{O}_6$ octahedra. Linking of the (SiP) and (NaP) layers along <i>a</i> is accomplished among corner-sharing tetrahedra and octahedra, reinforced by edge- and face-sharing Na, Ca and REE polyhedra. The structure of cerchiarite consists of single four-membered rings $[\text{Si}_4\text{O}_{12}]$, around the four-fold axes, corner-linked by [001] chains of edge-sharing Mn-octahedra. Other atoms share oxygens atoms with Mn-octahedra, to form two dimmers $[\text{Si}_2\text{O}_7]$ per cell. The structure of bobmeyerite consists of tetrahedra which share corners to form four-membered Si_4O_{12} rings centered on the <i>c</i> axis. The rings are linked by chains of edge-sharing AlO_6 octahedra running // to [001]. The framework thereby created contains large channels, running // to [001]. The Cl site is centered on the <i>c</i> axis alternating along [001] with the rings. Two non-equivalent Pb atoms are positions around the periphery of the channels both are eleven- | |

coordinated, bonding to the Cl atom on the c axis, to 8 O atoms in the framework and to two O sites in the channel.

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| VABDA | KAINOSITE-(Y) | $\text{Ca}_2\text{Y}_2[\text{Si}_4\text{O}_{12}]_2(\text{CO}_3)\text{H}_2\text{O}$ |
| VABDB | ASHBURTONITE | $\text{HPb}_4\text{Cu}_4[\text{Si}_4\text{O}_{12}][\text{HCO}_3]_4(\text{OH})_4\text{Cl}$ |
| VABDC | PHOSINAITE-(Ce) | $\text{Na}_{13}(\text{Na},\text{Ca})_2\text{Ca}_2\text{Ce}[\text{Si}_4\text{O}_{12}][\text{PO}_4]_4$ |
| VABDD | CLINOPHOSINAITE | $\text{Na}_{12}\text{Ca}_4[\text{Si}_4\text{O}_{12}][\text{PO}_4]_4$ |
| VABDE | BOBMEYERITE | $\text{Pb}_4\text{Al}_4(\text{Si}_4\text{O}_{12})(\text{S},\text{SiO}_4)((\text{OH})_7\text{Cl}(\text{H}_2\text{O})_3$ |
| VABDF | CERCHIARAITE-(Mn ³⁺) | $\text{Ba}_4\text{Mn}^{3+}_4\text{O}_3(\text{OH})_3[\text{Si}_4\text{O}_{12}][\text{Si}_2\text{O}_3(\text{OH})_4]\text{Cl}$ |
| VABDG | CERCHIARAITE-(Fe) | $\text{Ba}_4\text{Fe}^{3+}_6\text{O}_3(\text{OH})_3[\text{Si}_4\text{O}_{12}][\text{Si}_2\text{O}_3(\text{OH})_4]\text{Cl}$ |
| VABDH | open | |
| VABDI | CERCHIARAITE-(Al) | $\text{Ba}_4(\text{Al},\text{Fe}^{3+})_6\text{O}_3(\text{OH})_3[\text{Si}_4\text{O}_{12}][\text{Si}_2\text{O}_3(\text{OH})_4]\text{Cl}$ |

SERIES E **PAPAGOITE, mon/C2/m. Structure consists of edge-sharing Cu and Al octahedra alternating to form rutile-like chains // [010] that are linked into sheets //(001) by Ca octahedra; the sheets are connected along [001] by Si rings.**

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| VABEA | PAPAGOITE | $\text{Ca}_2\text{Cu}_2\text{Al}_2[\text{Si}_4\text{O}_{12}](\text{OH})_6$ |
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SERIES F **JOAQUINITE SERIES, orth/mon/ Ccmm, C2, P2₁2₁2₁. The structure of this group consists of a four-membered Si₄O₁₂ silicate ring, equivalents of which are linked by TiO₆ octahedra to form sheets parallel to (001). Sheets are stacked facing alternately up and down in the c direction; Ba atoms and water molecules occur midway between sheets on one level, and Na, Fe, and RE atoms on the alternate levels. The Fe and Na polyhedra, which also link sheets, are very irregular; Fe is 5-coordinated, and Na is 6-coordinated.**

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| VABFA | BARIO-ORTHOJOAQUINITE | $(\text{Ba},\text{Sr})_4\text{Fe}_2\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2\cdot\text{H}_2\text{O}$ |
| VABFB | BYELORUSSITE-(Ce) | $\text{NaMnBa}_2\text{Ce}_2\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{F},\text{OH})\text{H}_2\text{O}$ |
| VABFC | JOAQUINITE-(Ce)-2M | $\text{NaBa}_2\text{Ce}_2\text{Fe}(\text{Ti},\text{Nb})_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{F},\text{OH})\text{H}_2\text{O}$ |
| VABFD | JOAQUINITE-(Ce)-2O | $\text{NaBa}_2\text{Ce}_2\text{Fe}(\text{Ti},\text{Nb})_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{F},\text{OH})\text{H}_2\text{O}$ |
| VABFE | STRONTIOJOAQUINITE | $\text{Sr}_2\text{Ba}_2(\text{Na},\text{Fe})_2\text{Ti}_2[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_2\text{H}_2\text{O}$ |
| VABFF | STRONTIO-ORTHOJOAQUINITE | $\text{Sr}_2\text{Ba}_2(\text{Na},\text{Fe})_2\text{Ti}_2[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_2\text{H}_2\text{O}$ |
| VABFG | ORTHOJOAQUINITE-(La) | $\text{NaBa}_2(\text{La},\text{Ce})_2\text{Fe}(\text{Ti},\text{Nb})_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{OH},\text{O},\text{F})\text{H}_2\text{O}$ |

SERIES G **COLINOWENSITE, tetr/I4₁/acd. The structure consists of 4-membered single rings, arranged in sheets // to (001). The structure is further characterized by CuO₄ squares sharing corners with four neighboring silicate rings within a sheet. Ba cations are bonded to ten O atoms in irregular coordination.**

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| VABGA | COLINOWENSITE | $\text{Ba}_2\text{Cu}_2[\text{Si}_4\text{O}_{12}]$ |
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SERIES H **Open**

SERIES I **Open**

SERIES J **STRAKHOVITE, orth/Pnma. Structure consists of columns of Mn octahedra and Mn square pyramids // [010] which are connected by Si₄O₁₀(OH)₂ rings and Si₂O₇ groups. Zigzag chains // [001] of edge-sharing Ba polyhedra and corner-sharing (Na, Ba) polyhedra creating a framework with channels // [010] that contain water.**

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| VABJA | STRAKHOVITE | $\text{NaBa}_5(\text{Mn}^{2+}\text{Mn}^{3+})_4[\text{Si}_4\text{O}_{10}(\text{OH})_2](\text{Si}_2\text{O}_7)\text{O}_2(\text{F},\text{OH})\cdot\text{H}_2\text{O}$ |
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SERIES K **LABUNTSOVITE SERIES, mon/Cm. The structure is based on Si₄O₁₂ rings // (100) and chains of corner-sharing Nb octahedra // [100]; Na atoms and water molecules are accommodated in the cavities. The structure of komarovite contains layers k (010) of pyrochlore composition, one pyrochlore period thick, where Na and Ca take eight-coordinated cation positions, and Nb (+Ti) six-**

coordinated. The positions on surfaces of layers that are occupied by a monovalent anion in pyrochlore are in komarovite replaced by water molecules coordinated to Na atoms. The layers are interconnected by Si_4O_{12} rings with ring plane k (001). In the channels formed between layers and rings additional Na(+K) atoms are situated coordinated to O atoms from silicate rings and additional water molecules.

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| VABK01 | NENADKEVICHITE | $\text{Na}_{8-x}\text{Nb}_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4 \cdot 8\text{H}_2\text{O}$ |
| VABK02 | LABUNTSOVITE-Mn | $\text{Na}_4\text{K}_4\text{Mn}_2\text{Ti}_8(\text{Si}_4\text{O}_{12})_4(\text{O},\text{OH})_8 \cdot 10-12\text{H}_2\text{O}$ |
| VABK03 | VUORIYARVITE-K | $(\text{K},\text{Na})_{12-x}\text{Nb}_8[\text{Si}_4\text{O}_{12}]_4(\text{O})_8 \cdot 12-16\text{H}_2\text{O}$ |
| VABK04 | LEMMLEINITE-K | $\text{Na}_4\text{K}_4\text{Ti}_8(\text{Si}_4\text{O}_{12})_4(\text{O},\text{OH})_8 \cdot 8\text{H}_2\text{O}$ |
| VABK05 | KUZMENKOITE-Mn | $\text{K}_4\text{Mn}_2\text{Ti}_8[\text{Si}_4\text{O}_{12}]_4(\text{OH})_8 \cdot 10-12\text{H}_2\text{O}$ |
| VABK06 | KOROBITSYNITE | $\text{Na}_{8-x}\text{Ti}_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4 \cdot 8\text{H}_2\text{O}$ |
| VABK07 | PARALABUNTSOVITE-Mg | $\text{Na}_8\text{K}_8\text{Mg}_8 \text{Ti}_{16}(\text{Si}_4\text{O}_{12})_8(\text{O},\text{OH})_{16} \cdot 20-24\text{H}_2\text{O}$ |
| VABK08 | LABUNTSOVITE-Fe | $\text{Na}_4\text{K}_4[\text{Fe}_2\text{Ti}_8(\text{Si}_4\text{O}_{12})_4(\text{O},\text{OH})_8] \cdot 10-12\text{H}_2\text{O}$ |
| VABK09 | LEMMLEINITE-Ba | $\text{Na}_4\text{K}_4\text{Ba}_{2-x}\text{Ti}_8(\text{Si}_4\text{O}_{12})_4(\text{O},\text{OH})_8 \cdot 8\text{H}_2\text{O}$ |
| VABK10 | TSEPINITE-Na | $\text{Na}(\text{Na},\text{H}_3\text{O},\text{K},\text{Sr},\text{Ba})_{12-x}\text{Ti}_8[\text{Si}_4\text{O}_{12}]_4(\text{OH},\text{O})_8 \cdot 12-16\text{H}_2\text{O}$ |
| VABK11 | ORGANOVAITE-Mn | $\text{K}_8\text{Mn}_4\text{Nb}_{16}(\text{Si}_4\text{O}_{12})_8\text{O}_{16} \cdot 20-28\text{H}_2\text{O}$ |
| VABK12 | PARAKUZMENKOITE-Fe | $(\text{K},\text{Ba})_8\text{Fe}_4\text{Ti}_{16}[\text{Si}_4\text{O}_{12}]_8(\text{O},\text{OH})_{16} \cdot 20-28\text{H}_2\text{O}$ |
| VABK13 | ORGANOVAITE-Zn | $\text{K}_8\text{Zn}_4\text{Nb}_{16}(\text{Si}_4\text{O}_{12})_8\text{O}_{16} \cdot 20-28\text{H}_2\text{O}$ |
| VABK14 | LABUNTSOVITE-Mg | $\text{Na}_4\text{K}_4\text{Mg}_2\text{Ti}_8(\text{Si}_4\text{O}_{12})_4(\text{O},\text{OH})_8 \cdot 8-10\text{H}_2\text{O}$ |
| VABK15 | GJERDINGENITE-Fe | $\text{K}_4[(\text{H}_2\text{O})_4(\text{Fe},\text{Mn})_2][(\text{Nb},\text{Ti})_8(\text{Si}_4\text{O}_{12})_4(\text{OH},\text{O})_8] \cdot 8\text{H}_2\text{O}$ |
| VABK16 | GUTKOVAITE-Mn | $\text{Ca}_2\text{K}_4\text{Mn}_2\text{Ti}_8(\text{Si}_4\text{O}_{12})_4\text{O}_8 \cdot 10\text{H}_2\text{O}$ |
| VABK17 | KUZMENKOITE-Zn | $\text{K}_4\text{Zn}_2\text{Ti}_8[\text{Si}_4\text{O}_{12}]_4(\text{OH})_8 \cdot 10-12\text{H}_2\text{O}$ |
| VABK18 | KARUPMÖLLERITE-Ca | $(\text{Na},\text{Ca},\text{K})_4\text{Ca}_2\text{Nb}_8[\text{Si}_4\text{O}_{12}]_4(\text{O},\text{OH})_8 \cdot 14\text{H}_2\text{O}$ |
| VABK19 | ALSAKHAROVITE-Zn | $\text{NaSrKZn}(\text{Ti},\text{Nb})_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4 \cdot 7\text{H}_2\text{O}$ |
| VABK20 | TSEPINITE-K | $(\text{K},\text{Ba},\text{Na})_2(\text{Ti},\text{Nb})_2[\text{Si}_4\text{O}_{12}](\text{O},\text{OH})_2 \cdot 3\text{H}_2\text{O}$ |
| VABK21 | TSEPINITE-Ca | $(\text{Ca},\text{Na},\text{K})_2(\text{Ti},\text{Nb})_2[\text{Si}_4\text{O}_{12}](\text{O},\text{OH})_2 \cdot 3\text{H}_2\text{O}$ |
| VABK22 | PARATSEPINITE-Ba | $(\text{Ba},\text{Na},\text{K})_{2-x}(\text{Ti},\text{Nb})_2[\text{Si}_4\text{O}_{12}](\text{OH},\text{O})_2 \cdot 4\text{H}_2\text{O}$ |
| VABK23 | NESKEVAARAITE-Fe | $\text{NaK}_3\text{Fe}(\text{Ti},\text{Nb})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4 \cdot 6\text{H}_2\text{O}$ |
| VABK24 | KOMAROVITE | $(\text{Ca},\text{Mn})_2\text{Nb}_4[(\text{O},\text{F})_2\text{O}_6/\text{Si}_4\text{O}_{12}] \cdot 7\text{H}_2\text{O}$ |
| VABK25 | NA-KOMAROVITE | $(\text{Na},\text{Ca},\text{H})_2[(\text{OH},\text{F})_2\text{O}_4/\text{Si}_4\text{O}_{12}] \cdot \text{H}_2\text{O}$ |
| VABK26 | LEPKHENELMIITE-Zn | $\text{Ba}_2\text{Zn}(\text{Ti},\text{Nb})_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4 \cdot 7\text{H}_2\text{O}$ |
| VABK27 | GJERDINGENITE-Mn | $\text{K}_4[(\text{H}_2\text{O})_4(\text{Mn},\text{Fe})_2][(\text{Nb},\text{Ti})_8(\text{Si}_4\text{O}_{12})_4(\text{OH},\text{O})_8] \cdot 6\text{H}_2\text{O}$ |
| VABK28 | GJERDINGENITE-Ca | $\text{K}_2\text{Ca}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{O},\text{OH})_4 \cdot 6\text{H}_2\text{O}$ |
| VABK29 | GJERDINGENITE-Na | $(\text{K},\text{Na})_2\text{Na}(\text{Nb},\text{Ti})_4(\text{Si}_4\text{O}_{12})_2(\text{OH},\text{O})_4 \cdot 5\text{H}_2\text{O}$ |
| VABK30 | PARATSEPINITE-Na | $(\text{Na},\text{K},\text{Ba})_{2-x}(\text{Ti},\text{Nb})_2[\text{Si}_4\text{O}_{12}](\text{OH},\text{O})_2 \cdot 4\text{H}_2\text{O}$ |
| VABK31 | TSEPINITE-Sr | $(\text{Sr},\text{Ca},\text{K})_2(\text{Ti},\text{Nb})_2[\text{Si}_4\text{O}_{12}](\text{O},\text{OH})_2 \cdot 3\text{H}_2\text{O}$ |
| VABK32 | BUROVAITE-Ca | $(\text{K},\text{Na},\text{Sr},\text{Ba})_4\text{Ca}_2(\text{Ti},\text{Nb})_8[\text{Si}_4\text{O}_{12}]_4(\text{OH},\text{O})_8 \cdot 12\text{H}_2\text{O}$ |

TYPE C SIX TETRAHEDRA RING STRUCTURES (Si_6O_{18})

SERIES A ODINTSOVITE, orth/Fddd. Structure consists of Si_6O_{18} rings $\parallel(110)$ which are connected into bands $\parallel [110]$ and $\perp [110]$ by insular Be tetrahedra; the bands are linked into a heteropolyhedral framework by edge-sharing pairs of Ti octahedra; Ca and alkali ions are accommodated in cavities.

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| VACAA | ODINTSOVITE | $\text{K}_2(\text{Na},\text{Li})_4\text{Ca}_3\{\text{Ti}_2\text{O}_2[\text{Be}_4(\text{Si}_6\text{O}_{18})_2]\}$ |
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SERIES B **LOVOZERITE SERIES, trig/R $\bar{3}m$.** Structure consists of 6-membered rings with tetrahedra pointing alternately up and down. Na and Ca are both in 6- and 8-fold coordination.

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| VACBA | IMANDRITE | $\text{Na}_6\text{Ca}_{1.5}\text{Fe}(\text{Si}_6\text{O}_{18})$ |
| VACBB | KAZAKOVITE | $\text{Na}_6(\text{Mn},\text{H}_2)\text{Ti}(\text{Si}_6\text{O}_{18})$ |
| VACBC | KOASHVITE | $\text{Na}_6(\text{Ca},\text{Mn})(\text{Ti},\text{Fe})(\text{Si}_6\text{O}_{18}) \cdot \text{H}_2\text{O}$ |
| VACBD | LOVOZERITE | $\text{Na}_2\text{Ca}(\text{Zr},\text{Ti})(\text{Si}_6(\text{O},\text{OH})_{18})$ |
| VACBE | PETARASITE (Related) | $\text{Na}_5\text{Zr}_2(\text{Si}_6\text{O}_{18})(\text{Cl},\text{OH}) \cdot 2\text{H}_2\text{O}$ |
| VACBF | TISINALITE | $\text{Na}_3\text{H}_3(\text{Mn},\text{Ca},\text{Fe})(\text{Si}_6(\text{O},\text{OH})_{18}) \cdot 2\text{H}_2\text{O}$ |
| VACBG | ZIRSINALITE | $\text{Na}_6(\text{Ca},\text{Mn},\text{Fe})\text{Zr}(\text{Si}_6\text{O}_{18})$ |
| VACBH | LITVINSKITE | $\text{Na}_2(\square, \text{Na}, \text{Mn})\text{Zr}[\text{Si}_6\text{O}_{12}(\text{OH}, \text{O})_6]$ |
| VACBI | COMBEITE | $\text{Na}_4\text{Ca}_4[\text{Si}_6\text{O}_{18}]$ |
| VACBJ | KAPUSTINITE | $\text{Na}_5(\text{Na}, \text{Mn}^{2+})_{<1}\text{Zr}[\text{Si}_6\text{O}_{16}(\text{OH})_2]$ |
| VACBK | TOWNENDITE | $\text{Na}_8\text{Zr}(\text{Si}_6\text{O}_{18})$ |

SERIES C **BARATOVITE SERIES, mon,C2/c.** The structure consists of Si_6O_{18} rings connected by dense Ca-octahedral sheets and by Ti-octahedra, Li-tetrahedra, and 12-fold K-polyhedra. The structure of katayamalite contains a set of six-membered silicate rings interconnected by sheets of Ca atoms on one side and by an ordered mixture of Li, Ti and K atoms on the other side, forming layers which are stacked normal to (001). From the eight different metal sites, three are located on special positions, viz. on K and one Li atom on twofold rotation axes and one Ca atom on an inversion center.

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| VACCA | BARATOVITE | $\text{Li}_3\text{KCa}_7\text{Ti}_2[\text{Si}_6\text{O}_{18}]_2\text{F}_2$ |
| VACCB | KATAYAMALITE | $\text{Li}_3\text{KCa}_7\text{Ti}_2[\text{Si}_6\text{O}_{18}]_2(\text{OH})_2$ |
| VACCC | ALEKSANDROVITE | $\text{KCa}_7\text{Sn}_2\text{Li}_3[\text{Si}_{12}\text{O}_{36}]\text{F}_2$ |

SERIES D **BERYL SERIES, hex, P6/mcc.** The structure is formed by 6-membered rings of Si tetrahedra linked by BeO_4 tetrahedra, resulting in a framework. The Al atoms are located in the voids in octahedral coordination.

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| VACDA | BERYL | $\text{Be}_3\text{Al}_2[\text{Si}_6\text{O}_{18}]$ |
| VACDB | BAZZITE | $\text{Sc}_3\text{Al}_2[\text{Si}_6\text{O}_{18}]$ |
| VACDC | STOPPANIITE | $(\text{Fe},\text{Mg},\text{Al})_2(\text{Na},\square)[\text{Be}_3\text{Si}_6\text{O}_{18}] \cdot \text{H}_2\text{O}$ |
| VACDD | INDIALITE | $\text{Mg}_2[\text{Al}_4\text{Si}_5\text{O}_{18}]$ |
| VACDE | PEZZOTTAITE | $\text{Cs}(\text{Be}_2\text{Li})\text{Al}_2\text{Si}_6\text{O}_{18}$ |
| VACDF | FERROINDIALITE | $(\text{Fe},\text{Mg})_2[\text{Al}_4\text{Si}_5\text{O}_{18}]$ |
| VACDG | AVDEEVITE | $(\text{Na},\text{Cs})(\text{Be}_2\text{Li})\text{Al}_2(\text{Si}_6\text{O}_{18})$ |

SERIES E **DIOPTASE, hex/R $\bar{3}$.** The structure is based on distorted $\text{CuO}_4(\text{H}_2\text{O})_2$ octahedra sharing edges to form dimmers that are connected by corners to four other dimmers, and link the silicate rings into a 3-dimensional framework. Each outer O atom of the rings is linked to one Si and two Cu atoms. Water rings are accommodated in the open structure.

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| VACEA | DIOPTASE | $\text{Cu}_6[\text{Si}_6\text{O}_{18}] \cdot 6\text{H}_2\text{O}$ |
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SERIES F **SCAWTITE, mon/I2/m.** The structure of scawtite has four Ca sites with three types of coordination; Ca1 and Ca1B have 7-fold coordination, Ca2 has 6-fold coordination, and Ca3 has 8-fold coordination. The three Si tetrahedra form Si_6O_{18} rings, separated by triangular CO_3 groups. The structure is layer on (101), with the silicate rings and carbonate groups in one layer, and the CaO_n polyhedra in the other.

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| VACFA | SCAWTITE | $\text{Ca}_7[\text{Si}_6\text{O}_{18}][\text{CO}_3] \cdot 2\text{H}_2\text{O}$ |
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| SERIES G | TOURMALINE SERIES, hex/R3m. The structure is based on the packing of [Si₆O₁₈] and BO₃ groups in a ring structure, with Mg, Al, and Na atoms and OH in the interstices. | |
| VACGA | FLUOR-BUERGERITE | NaFe ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)O ₃ F |
| VACGB | CHROMDRAVITE | Na(Cr ₂ Mg)(Cr ₄ Mg ₂)(BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₄ |
| VACGC | DRAVITE | NaMg ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₄ |
| VACGD | ELBAITE | Na(Li,Al) ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₄ |
| VACGE | FERUVITE | Ca(Fe,Mg) ₃ (Al,Mg) ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₄ |
| VACGF | FOITITE | • (Fe ₂ (Al,Fe))Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₄ |
| VACGG | FLUOR-LIDDICOATITE | Ca(Li,Al) ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(O,OH,F) ₄ |
| VACGH | OLENITE | NaAl ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(O,OH) ₄ |
| VACGI | POVONDRAITE | NaFe ₃ Fe ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(O,OH) ₄ |
| VACGJ | SCHORL | NaFe ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₄ |
| VACGK | FLUOR-UVITE | (Ca,Na)(Mg,Fe) ₃ Al ₅ Mg(BO ₃) ₃ (Si ₆ O ₁₈)(OH,F) ₄ |
| VACGL | ROSSMANITE | (LiAl ₂)Al ₆ (Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₄ |
| VACGM | MAGNESIOFOITITE | (Mg ₂ ,Al)Al ₆ [Si ₆ O ₁₈](BO ₃) ₃ (OH) ₄ |
| VACGN | OXY-VANADIUM-DRAVITE | NaV ₃ (V ₄ Mg ₂)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACGO | HYDROXYUVITE | CaMg ₃ (Al ₅ Mg)[Si ₆ O ₁₈](BO ₃) ₃ (OH) ₃ (OH) |
| VACGP | LUINAITE-(OH) | (Na,□)(Fe,Mg) ₃ Al ₆ (BO ₃) ₃ Si ₆ O ₁₈ (OH) ₄ |
| VACGQ | CHROMO-ALUMINO-POVONDRAITE | NaCr ₃ (Al ₄ Mg ₂)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACGR | FLUOR-DRAVITE | NaMg ₃ Al ₆ O ₁₈ (BO ₃) ₃ (OH) ₃ F |
| VACGS | FLUOR-SCHORL | NaFe ₃ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₃ F |
| VACGT | VANADIO-OXY-DRAVITE | NaV ₃ (Al ₄ Mg ₂)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACGU | OXY-SCHORL | Na(Fe ²⁺ ₂ Al)Al ₆ Si ₆ O ₁₈ (BO ₃) ₃ (OH) ₃ O |
| VACGV | TSILAISITE | NaMn ²⁺ Al ₆ (Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ OH |
| VACGW | FLUOR-ELBAITE | Na(Li _{1.5} Al _{1.5})Al ₆ (Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ F |
| VACGX | OXY-CHROMIUM-DRAVITE | NaCr ₃ (Cr ₄ Mg ₂)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACGY | DARRELLHENRYITE | NaLiAl ₂ Al ₆ (BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₃ O |
| VACGZ | OXY-DRAVITE | Na(Al ₂ Mg)(Al ₅ Mg)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACG27 | VANADIO-OXY-CHROMIUM-DRAVITE | NaV ₃ (Cr ₄ Mg ₂)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACG28 | FLUOR-TSILAISITE | NaMn ₂₊₃ Al ₆ (Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ F |
| VACG29 | ADACHIITE | CaFe ²⁺ ₃ Al ₆ (Si ₅ AlO ₁₈)(BO ₃) ₃ (OH) ₃ (OH) |
| VACG30 | MARUYAMAITE | K(MgAl ₂)(Al ₅ Mg)(BO ₃) ₃ (Si ₆ O ₁₈)(OH) ₃ O |
| VACG31 | BOSIITE | NaFe ³⁺ ₃ (Al ₄ Mg ₂)(Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACG32 | LUCCHESIITE | CaFe ²⁺ ₃ Al ₆ (Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |
| VACG33 | OXY-FOITITE | □(Fe ²⁺ Al ₂)Al ₆ (Si ₆ O ₁₈)(BO ₃) ₃ (OH) ₃ O |

SERIES H **KOSTYLEVITE, mon/P2₁/a. Structure based on a framework of tetrahedral Si₆O₁₈ rings linked by Zr octahedra. The framework has wide channels along [001] in which half of the K atoms and all the water molecules are accommodated.**

VACHA KOSTYLEVITE K₄Zr₂[Si₆O₁₈]·2H₂O

SERIES I **ABENAKIITE, trig/R3. The structure consists of trigonal Si₆O₁₈ rings // (0001), with free corners alternating up and down, which are attached on both sides to one Na and three carbonate groups. This complex is part of a column // [0001] with three Na polyhedra and one REE polyhedron; chains of alternating Na polyhedra and P tetrahedra are located between the columns. SO₂ groups are in the cavities. Steenstrupine-(Ce) is closely related with identical rings.**

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| VACIA | ABENAKIITE-(Ce) | $\text{Na}_{26}\text{REE}_6[\text{Si}_6\text{O}_{18}][\text{PO}_4]_6(\text{CO}_3)_6(\text{SO}_2)\text{O}$ |
| VACIB | STEENSTRUPINE-(Ce) | $\text{Na}_{14}\text{Ce}_6\text{MnMnFe}_2(\text{Zr,Th})[\text{Si}_6\text{O}_{18}]_2(\text{PO}_4)_7(\text{OH})_2 \cdot 3\text{H}_2\text{O}$ $R\bar{3}m$ |
| VACIC | THOROSTEENSTRUPINE | $\text{Na}_{0.5}\text{Ca}_{1-3}(\text{Th,REE})_6(\text{Mn,Fe,Al,Ti})_{4-5-}$ $[\text{Si}_6(\text{O,OH})_{18}]_2[(\text{Si,P})\text{O}_4]_6(\text{OH,F,O})_x \cdot n\text{H}_2\text{O}$ |
| SERIES J | GERENITE-(Y), tric/P$\bar{1}$. The structure consists of the following elements: (1) Si_6O_{18} rings, oriented approximately parallel to (101), (2) chains of edge-sharing Y(1)O_6 and Y(2)O_6 octahedra oriented approximately parallel to [101], and (3) $\text{Ca}\phi_8$ polyhedra. The rings share corners with the chains of YO_6 octahedra to form a three-dimensional framework. | |
| VACJA | GERENITE-(Y) | $(\text{Ca,Na})_2(\text{Y,REE})_3[\text{Si}_6\text{O}_{18}] \cdot 2\text{H}_2\text{O}$ |
| SERIES K | CORDIERITE SERIES, orth/Cccm. The structure is based on a distortion substitution derivative of the beryl structure. | |
| VACKA | CORDIERITE | $\text{Mg}_2[\text{Al}_4\text{Si}_5\text{O}_{18}]$ |
| VACKB | SEKANINAITE | $(\text{Fe,Mg})_2[\text{Al}_4\text{Si}_5\text{O}_{18}]$ |
| TYPE D | EIGHT TETRAHEDRA RING STRUCTURES (Si_8O_{24}) | |
| SERIES A | MUIRITE, tetr, P4/mmm. Structure consists of 8-membered $[\text{Si}_8\text{O}_{24}]^{16-}$ rings // (001) which are linked by Ca and Ti trigonal prisms to form a framework with Ba, Cl and OH in the cavities. | |
| VADAA | MUIRITE | $\text{Ba}_{10}(\text{Ca,Mn,Ti})_4[\text{Si}_8\text{O}_{24}](\text{Cl,O,OH})_{12} \cdot 4\text{H}_2\text{O}$ |
| TYPE E | NINE TETRAHEDRA RING STRUCTURES (Si_9O_{27}) | |
| SERIES A | EUDIALYTE SERIES, hex/R$\bar{3}m$. Structure consists of two sheets of Si_3O_9 and Si_9O_{27} rings // (0001) which are sandwiched by 6-membered rings of edge-sharing Ca octahedra and by (Fe,Mn) polyhedra to form double sheets. In the unit cell, three such double sheets are interconnected by nine Zr octahedra to form a framework with elongated cavities // [0001] that contain (Na,Ca,REE), (F,Cl,O,OH, H_2O) and Si-Nb-W. | |
| VAEAA | EUDIALYTE | $\text{Na}_{15}\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Si}[\text{Si}_{25}\text{O}_{73}](\text{O,OH,H}_2\text{O})_3(\text{Cl,OH})_2$ |
| VAEAB | ALLUAIVITE | $\text{Na}_{19}(\text{Ca,Mn})_6(\text{Ti,Nb})_3[\text{Si}_{26}\text{O}_{74}]\text{Cl} \cdot 2\text{H}_2\text{O}$ |
| VAEAC | KENTBROOKSITE | $\text{Na}_{15}\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{O,OH,H}_2\text{O})_3(\text{F,Cl})_2$ |
| VAEAD | KHOMYAKOVITE | $\text{Na}_{12}\text{Sr}_3\text{Ca}_6\text{Fe}_3\text{WZr}_3[\text{Si}_{25}\text{O}_{73}](\text{O,OH,H}_2\text{O})_3(\text{Cl,OH})_2$ |
| VAEAE | MANGANOKHOMYAKOVITE | $\text{Na}_{12}\text{Sr}_3\text{Ca}_6\text{Mn}_3\text{WZr}_3[\text{Si}_{25}\text{O}_{73}](\text{O,OH,Cl})_3(\text{Cl,OH})_2$ |
| VAEAF | ONEILLITE | $\text{Na}_{15}\text{Ca}_3\text{Fe}_3\text{Mn}_3\text{NbZr}_3[\text{Si}_{25}\text{O}_{73}](\text{OH,Cl})_2(\text{O,OH,H}_2\text{O})_3$ |
| VAEAG | AQUALITE | $(\text{H}_3\text{O})_8(\text{Na,K,Sr})_5\text{Ca}_6\text{Zr}_3\text{Si}_{26}\text{O}_{66}(\text{OH})_9\text{Cl}$ |
| VAEAH | FERROKENTBROOKSITE | $\text{Na}_{15}\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{O,OH,H}_2\text{O})_3(\text{F,Cl})_2$ |
| VAEAI | FEKLICHEVITE | $\text{Na}_{11}\text{Ca}_9(\text{Fe,Fe})_2\text{Zr}_3\text{Nb}[\text{Si}_{23}\text{O}_{73}](\text{OH,H}_2\text{O,Cl,O})_5$ |
| VAEAJ | CARBOKENTBROOKSITE | $(\text{Na},\square)_{12}(\text{Na,REE})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{OH})_3(\text{CO}_3) \cdot \text{H}_2\text{O}$ |
| VAEAK | GEORGBARSANOVITE | $\text{Na}_{12}(\text{Mn,Sr,REE})_3\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{76})\text{Cl}_2 \cdot \text{H}_2\text{O}$ |
| VAEAL | IKRANITE | $(\text{Na,H}_3\text{O})_{15}(\text{Ca,Mn,REE})_6\text{Fe}_2\text{Zr}_3(\square,\text{Zr})(\square,\text{Si})(\text{Si}_{24}\text{O}_{66})(\text{O,OH})_6\text{Cl} \cdot n\text{H}_2\text{O}$ |
| VAEAM | LABYRINTHITE | $(\text{Na,K,Sr})_3\text{Ca}_{12}\text{Fe}_3\text{Zr}_6\text{Ti}(\text{Si}_{51}\text{O}_{144})(\text{O,OH,H}_2\text{O})_9\text{Cl}_2$ |
| VAEAN | RASLAKITE | $\text{Na}_{15}(\text{Ca}_3\text{Fe}_3)(\text{Na,Zr})_3(\text{Si,Nb})(\text{Si}_{25}\text{O}_{73})(\text{OH,H}_2\text{O})_3(\text{Cl,OH})_2$ |
| VAEAO | RASTSVETAEVITE | $\text{Na}_{27}\text{K}_8\text{Ca}_{12}\text{Fe}_3\text{Zr}_6(\text{Si}_{52}\text{O}_{144})(\text{O,OH,H}_2\text{O})_6\text{Cl}_2$ |
| VAEAP | TASEQITE | $\text{Na}_{12}\text{Sr}_3\text{Ca}_6\text{Fe}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{O,OH,H}_2\text{O})_3\text{Cl}_2$ |
| VAEAQ | ZIRSILITE-(Ce) | $(\text{Na},\square)_{12}(\text{REE,Na})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{OH})_3(\text{CO}_3) \cdot \text{H}_2\text{O}$ |
| VAEAR | ZAKHAROVITE-Mn ²⁺ | $\text{Na}_3\text{Mn}^{2+}_5\text{NaO}[\text{Si}_9\text{O}_{24}(\text{OH})_3 \cdot \text{Si}(\text{OH})_3] \cdot 6\text{H}_2\text{O}$ |
| VAEAS | JOHNSENITE-(Ce) | $\text{Na}_{12}(\text{Ce,REE,Sr})_3\text{Ca}_6\text{Mn}_6\text{Zr}_3\text{W}(\text{Si}_{23}\text{O}_{73})(\text{OH})_3(\text{CO}_3) \cdot \text{H}_2\text{O}$ |

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| VAEAT | MOGOVIDITE | $\text{Na}_9(\text{Ca}, \text{Na})_6\text{Ca}_6\text{Zr}_3\text{Si}_{25}\text{O}_{72}(\text{CO}_3)(\text{OH})_4$ |
| VAEAU | GOLYSHEVITE | $\text{Na}_{30}(\text{Ca}, \text{Na}, \text{Ce}, \text{Sr})_{12}(\text{Na}, \text{Mn}, \text{Fe}, \text{Ti})_6\text{Zr}_3\text{Ti}_3\text{Mn}(\text{Si}_{51}\text{O}_{144})(\text{OH}, \text{H}_2\text{O}, \text{Cl})_9$ |
| VAEAV | ZAKHAROVITE- Fe^{2+} | $\text{Na}_3(\text{Fe}^{2+}, \text{Mn}^{2+})_5\text{NaO}[\text{Si}_9\text{O}_{24}(\text{OH})_3 \cdot \text{Si}(\text{OH})_3]6\text{H}_2\text{O}$ |
| VAEAW | DUALITE | $\text{Na}_{30}(\text{Ca}, \text{Na}, \text{Ce}, \text{Sr})_{12}(\text{Na}, \text{Mn}, \text{Fe})_6\text{Zr}_3\text{Ti}_3\text{Mn}[(\text{OH}, \text{H}_2\text{O}, \text{Cl})_9/\text{Si}_{51}\text{O}_{144}]$ |
| VAEAX | ANDRIANOVITE | $\text{Na}_{12}(\text{K}, \text{Sr}, \text{Ce})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{Nb}(\text{Si}_{25}\text{O}_{73})(\text{O}, \text{H}_2\text{O}, \text{OH})_5$ |
| VAEAY | VORONKOVITE | $\text{Na}_{15}(\text{Na}, \text{Ca}, \text{Ce})_3(\text{Mn}, \text{Ca})_3\text{Fe}_3\text{Zr}_3(\text{Si}_{26}\text{O}_{72})(\text{OH}, \text{O})_4 \cdot \text{H}_2\text{O}$ |
| VAEAZ | MANGANOEUODIALYTE | $\text{Na}_{14}\text{Ca}_6\text{Mn}_3\text{Zr}_3[\text{Si}_{26}\text{O}_{72}(\text{OH})_2](\text{H}_2\text{O}, \text{Cl}, \text{O}, \text{OH})_6$ |
| VAEA27 | DAVINCIITE | $\text{Na}_{12}\text{K}_3\text{Ca}_6\text{Fe}^{2+}_3\text{Zr}_3(\text{Si}_{26}\text{O}_{73}\text{OH})\text{Cl}_2$ |
| VAEA28 | FENGCHENGITE | $\text{Na}_{12}\text{Ca}_3(\text{Ca}, \text{Sr})_6\text{Fe}_3\text{Zr}_3\text{Si}(\text{Si}_{25}\text{O}_{73})(\text{H}_2\text{O}, \text{OH})_3(\text{OH}, \text{Cl})_2$ |
| VAEA29 | ILYUKHINITE | $(\text{H}_3\text{O}, \text{Na})_{14}\text{Ca}_6\text{Mn}_2\text{Zr}_3(\text{Si}_{26}\text{O}_{72}(\text{OH})_2) \cdot 3\text{H}_2\text{O}$ |
| VAEA30 | SIUDAITE | $\text{Na}_8(\text{Mn}^{2+}_2\text{Na})\text{Ca}_6\text{Fe}^{3+}_3\text{Zr}_3\text{NbSi}_{25}\text{O}_{74}(\text{OH})_2\text{Cl} \cdot 5\text{H}_2\text{O}$ |

SERIES B **MEGACYCLITE, mon/P2₁/c.** Structure based on 18 Si(O,OH)₄ tetrahedra which are linked into [Si₁₈O₃₆(OH)₁₈]¹⁸⁻ rings // (001); corner-sharing Na polyhedra form chains // [010] lying in the (001) plane; the chains are linked by K octahedra and edge-sharing dimers of Na polyhedra.

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| VAEBA | MEGACYCLITE | $\text{Na}_8\text{K}[\text{Si}_9\text{O}_{18}(\text{OH})_9]_2 \cdot 19\text{H}_2\text{O}$ |
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SERIES C **CAPPELENITE, trig/P3.** The structure is based on a ²⁻[Si₃B₆O₂₄] tetrahedral corner-sharing sheet consisting of [B₆O₁₈] six-membered and [Si₃B₆O₂₇] nine-membered ring. The nine-membered rings are isomorphic to the insular [Si₃Si₆O₂₇] rings in eudialyte. [BaO₁₂] defines a hexagonal antiprism; [YO₇F], square antiprisms; [SiO₄] and BO₄, tetrahedra.

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| VAECA | CAPPELENITE-(Y) | $\text{Ba}(\text{Y}, \text{REE})_6[\text{Si}_3\text{B}_6\text{O}_{24}]\text{F}_2$ |
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TYPE F **TWELVE TETRAHEDRA RING STRUCTURES (Si₁₂O₃₆)**

SERIES A **TRASKITE, hex/P6m2.** Structure consists of 12-membered Si₁₂(O<OH)₃₆ rings // (0001) which are linked into a framework by edge- and corner-sharing Ba polyhedra, (Ca, Sr) trigonal prisms, (Ti, Fe) octahedra and Si₂O₆OH groups; water molecules are accommodated in large channels // [0001].

| | | |
|-------|----------|---|
| VAFAA | TRASKITE | $(\text{Ca}, \text{Sr})\text{Ba}_{24}(\text{Mg}, \text{Mn}, \text{Fe}, \text{Al})_{16}[\text{Si}_2\text{O}_7]_6[\text{Si}_{12}\text{O}_{36}](\text{O}, \text{OH})_{30}\text{Cl}_6 \cdot 14\text{H}_2\text{O}$ |
|-------|----------|---|

TYPE G **FOUR TETRAHEDRA RING STRUCTURES (BRANCHED)**

SERIES A **EAKERITE, mon/P2₁/a.** The structure is based on crankshaft-like chains, similar to those in feldspars, of composition AlSi₃O₉(OH), which are cross-linked to form a kinked sheet. Al is ordered, and the OH is bonded to it. Ca and Sn ions lie in sheets between the kinked aluminosilicate network. The Ca ions are coordinated by 4O, 2OH, and 2H₂O in square antiprism; these are edge-linked into chains which run across the aluminosilicate chains and which are cross-linked by Sn octahedra. The OH and H₂O are bonded to Ca and, by H bonds, to other O.

| | | |
|-------|----------|--|
| VAGAA | EAKERITE | $\text{Ca}_2\text{Al}_2\text{Sn}[\text{Si}_4\text{O}_{12}(\text{SiO}_3)_2](\text{OH})_2 \cdot 2\text{H}_2\text{O}$ |
|-------|----------|--|

TYPE H **SIX TETRAHEDRA RING STRUCTURES (BRANCHED)**

SERIES A **TIENSHANITE, hex/P6/m.** Structure based on a mica-like arrangement consisting of sheets of Si₆O₁₈ rings and 6-membered Si₃B₃O₁₈ rings enclosing sheets of MnO₅ square pyramids, TiO₆ octahedra and Ba polyhedra; the Mn pyramids share edges to form 6-membered rings. The mica-like layers are linked by K, Ca and Na atoms.

| | | |
|-------|-------------|--|
| VAHAA | TIENSHANITE | $\text{KNa}_3(\text{Na}, \text{K}, \square)_6(\text{Ca}, \text{Y}, \text{REE})_2\text{Ba}_6(\text{Mn}, \text{Fe}, \text{Zn}, \text{Ti})_6(\text{Ti}, \text{Nb})_6[\text{Si}_{36}\text{B}_{12}\text{O}_{114}][\text{O}_{5.5}(\text{OH}, \text{F})_{3.5}]\text{F}_2$ |
|-------|-------------|--|

TYPE I **EIGHT TETRAHEDRA RING STRUCTURES (LOOPED-BRANCHED)**

SERIES A **HYALOTEKITE SERIES, tric/I1.** The structure has three principal linked components: ⁰⁻[Si₄O₁₂] four-membered rings, ⁰⁻[B₂(Si_{3/2}Be_{1/2})O₁₂] four-membered rings and [Ca₂Pb₄O₂₆F] clusters. The tetrahedra link to form an incomplete framework of composition ³⁻[T₆O₁₄]

which remotely resembles that of the feldspars. The hyalotekite structure has a remote structural kinship with that of gillespite. The structure of itsiite is based upon a zeolite-like tetrahedral framework of corner-sharing tetrahedral consisting of four-membered silicate rings alternating with four-membered borate rings. The framework contains channels along each axis that host the Ba ions in ninefold coordination and Ca ions in sixfold coordination. The structure is very similar to those of hyalotekite and kapitsaite-(Y).

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| VAIAA | HYALOTEKITE | $(\text{Ba,Pb,K})_4(\text{Ca,Y})_2\text{Si}_8(\text{B,Be})_2(\text{Si,B})_2\text{O}_{28}\text{F}$ |
| VAIAB | KAPITSAITE-(Y) | $(\text{Ba,Pb,K})_4(\text{Y,Ca})_2\text{Si}_8(\text{B,Be})_2(\text{Si,B})_2\text{O}_{28}\text{F}$ |
| VAIAC | KHVOROVITE | $(\text{Pb,Ba,K})_4(\text{Ca})_2\text{Si}_8(\text{B,Be})_2(\text{Si,B})_2\text{O}_{28}\text{F}$ |
| VAIAC | ITSIITE | $\text{Ba}_2\text{Ca}[\text{BSi}_2\text{O}_7]_2$ |

GROUP B DICYCLOSILICATES

TYPE A THREE TETRAHEDRA RING STRUCTURES (${}^3\text{Si}_6\text{O}_{15}$)

SERIES A MOSKVINITE-(Y), orth/lbmm. The structure consists of two tetrahedrally coordinated T sites occupied by Si. The tetrahedra form three-membered double rings that link by sharing apical vertices to form a double ring of the form $[\text{Si}_6\text{O}_{15}]$. There are two [6]-coordinated sites, one occupied by (Y+REE) and the other occupied by Na. There is a [10]-coordinated site occupied by K. The $\{(\text{Y,REEO}_6)\}$ and (NaO_6) octahedra share common edges to form sheets parallel to (010); these sheets connect through $[\text{Si}_6\text{O}_{15}]$ double-rings to form a framework. Channels extend along {001} and contain K. Ref. CM 41-513.

| | | |
|-------|----------------|---|
| VBAAA | MOSKVINITE-(Y) | $\text{Na}_2\text{K}(\text{Y,REE})[\text{Si}_6\text{O}_{15}]$ |
|-------|----------------|---|

TYPE B FOUR TETRAHEDRA RING STRUCTURES (${}^4\text{Si}_8\text{O}_{20}$)

SERIES A STEACYITE SERIES, tetr/P4/mcc. The structure of this series consists of pseudo-cubic 4-membered double rings (cages) of Si tetrahedra are linked into a 3-dimensional framework by the cations.

| | | |
|--------|--------------|--|
| VBBA A | IRAQITE-(La) | $\text{K}(\text{La,Ce,Th})_2(\text{Ca,Na})_4[\text{Si}_8\text{O}_{20}]_2$ |
| VBBAB | STEACYITE | $\text{K}_{1-x}(\text{Na,Ca})_{2-y}\text{Th}_{1-z}[\text{Si}_8\text{O}_{20}]$ |
| VBBAC | TURKESTANITE | $\text{Th}(\text{Ca,Na})_2(\text{K}_{1-x}\square_x)[\text{Si}_8\text{O}_{20}] \cdot n\text{H}_2\text{O}$ |
| VBBAD | ARAPOVITE | $\text{U}^{4+}(\text{Ca,Na})_2(\text{K}_{1-x}\square_x)[\text{Si}_8\text{O}_{20}]$ |

TYPE C FIVE TETRAHEDRA RING STRUCTURES (${}^5\text{Si}_{10}\text{O}_{25}$)

TYPE D SIX TETRAHEDRA RING STRUCTURES (${}^6\text{Si}_{12}\text{O}_{30}$)

SERIES A OSUMILITE SERIES, hex/orth/P6/mcc/Pnna. The structure is based on the general formula $\text{CA}_2(\text{T}_2)_3(\text{T}_1)_{12}\text{O}_{30}$ where C is a 12-coordinated site located between two double rings of $(\text{Si,Al})\text{O}_4$ tetrahedra T1 is mainly occupied by K. There is a strong positive correlation between the size of the cations (Mg,Fe,Al) in octahedral coordination of the A site and the length of the a axis.

| | | |
|--------|----------------|---|
| VBDAA | ARMENITE | $\text{BaCa}_2\text{Al}_3[\text{Al}_3\text{Si}_3\text{O}_{30}] \cdot 2\text{H}_2\text{O}$ |
| VBDAB | BRANNOCKITE | $\text{KSn}_2\text{Li}_3[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAC | CHAYESITE | $\text{K}(\text{Mg,Fe})_4\text{Fe}[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAD | DARAPIOSITE | $\text{Na}_2\text{KLi}(\text{Zn,Mn})_2\text{Zr}[\text{Si}_{12}\text{O}_{30}]$ |
| VBD AE | EIFELITE | $\text{KNa}_3\text{Mg}_4[\text{Si}_{12}\text{O}_{30}]$ |
| VBD AF | EMELEUSITE | $\text{Na}_4\text{Li}_2\text{Fe}_2[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAG | MERRIHUEITE | $(\text{K,Na})_2(\text{Fe,Mg})_5[\text{Si}_{12}\text{O}_{30}]$ |
| VBD AH | MILARITE | $\text{KCa}_2\text{AlBe}_2[\text{Si}_{12}\text{O}_{30}] \cdot 0.5\text{H}_2\text{O}$ |
| VBD AI | OSUMILITE-(Fe) | $(\text{K,Na})(\text{Fe,Mg})_2(\text{Al,Fe})_3[(\text{Si,Al})_{12}\text{O}_{30}]$ |
| VBD AJ | OSUMILITE-(Mg) | $(\text{K,Na})(\text{Mg,Fe})_2(\text{Al,Fe})_3[(\text{Si,Al})_{12}\text{O}_{30}]$ |
| VBD AK | POUDRETTEITE | $\text{KNa}_2\text{B}_3[\text{Si}_{12}\text{O}_{30}]$ |
| VBD AL | ROEDDERITE | $(\text{Na,K})_2(\text{Mg,Fe})_5[\text{Si}_{12}\text{O}_{30}]$ |

| | | |
|--------|-------------------|---|
| VBDAM | SOGDIANITE | $(\text{K}, \text{Na})_2(\text{Li}, \text{Fe})_3(\text{Zr}, \text{Ti}, \text{Fe})[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAN | SUGILITE | $\text{KNa}_2(\text{Fe}, \text{Mn}, \text{Al})_2\text{Li}_3[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAO | YAGIITE | $(\text{Na}, \text{K})_{1.5}\text{Mg}_2(\text{Al}, \text{Mg})_3[(\text{Si}, \text{Al})_{12}\text{O}_{30}]$ |
| VBDAP | BEREZANSKITE | $\text{KLi}_3\text{Ti}_2\text{Si}_{12}\text{O}_{30}$ |
| VBDAQ | SHIBKOVITE | $\text{K}(\text{Ca}, \text{Mn}, \text{Na})_2(\text{K}_{2-x}\text{ }^\bullet\text{ }_x)_2\text{Zn}_3\text{Si}_{13}\text{O}_{30}$ |
| VBDAR | DUSMATOVITE | $\text{K}(\text{K}, \text{Na}, \square)(\text{Mn}, \text{Y}, \text{Zn})_2(\text{Zn}, \text{Li})_3[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAS | TRATTNERITE | $(\square, \text{K})(\text{Mg}, \text{Fe}^{2+})_3\text{Fe}^{3+}_2[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAT | ALMARUDITE | $\text{K}(\square, \text{Na})_2(\text{Mn}, \text{Fe}, \text{Mg})_2(\text{Be}, \text{Al})_3[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAU | OFTEDALITE | $(\text{ScCa})\text{KBe}_3\text{Si}_{12}\text{O}_{30}$ |
| VBDVA | FAIZIEVITE | $\text{K}_2\text{Na}(\text{Ca}_6\text{Na})\text{Ti}_4\text{Li}_6[\text{Si}_6\text{O}_{18}]_2[\text{Si}_1\text{O}_3]\text{F}_2$ |
| VBDAW | KLOCHITE | $\text{K}\square_2(\text{Fe}^{2+}\text{Fe}^{3+})\text{Zn}_3[\text{Si}_{12}\text{O}_{30}]$ |
| VBDAX | FRIEDRICHBECKEITE | $\text{K}(\square\text{Na})\text{Mg}_2(\text{Be}_2\text{Mg})\text{Si}_{12}\text{O}_{30}$ |
| VBDAY | AGAKHANOVITE-(Y) | $\text{YCaKBe}_3\text{Si}_{12}\text{O}_{30} \cdot \text{H}_2\text{O}$ |
| VBDAZ | ALUMINOSUGILITE | $\text{KNa}_2\text{Al}_2\text{Si}_3\text{Si}_{12}\text{O}_{30}$ |
| VBDA27 | LAURENTHOMASITE | $\text{Mg}_2\text{K}(\text{Be}_2\text{Al})\text{Si}_{12}\text{O}_{30}$ |

GROUP C **TRICYCLOSILICATES**
GROUP D **TETRACYCLOSILICATES**
GROUP E **PENTACYCLOSILICATES**
GROUP F **HEXACYCLOSILICATES**

Checked 05/10/19