MM8: The euclaylite group: A case study on mineral nomenclature

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Eudialyt-group minerals are Na-rich zeolites with varying amounts of Ca, Fe, Mn, Fe, Mg, AI, Mn, Fe, Co, Ni, Cu, Zn; X = Si, P, V, As, Mo. Compounds with accurate silicates, and molybdates) are known to belong to the adelite-descloizitestructure. Revisions of the group can presumably take place without laborious renaming.

Three different principles of naming minerals have been tested: (i) a hierarchical system with root names modified by use of modifiers and Levinson suffixes; (ii) a unique-name system with use of modifiers and Levinson suffixes; and (iii) a system based on the Linnean principle used in the biological world.

It is concluded that a hierarchical nomenclature system does not work for eudialyte-group minerals. Such a system would be either a multi-level system that would become either very complicated and cumbersome system with disproportionately many root names or a more flat system with fewer root names but monstrously long names with formula-like endings, e.g. eudialyte-NaNaNaNaCaMnNSiF for bytownite. Names with highly extended Levinson modifiers would be very difficult to remember, would have a high risk for misspelling and complete revisions of the system would frequently become necessary.

Conventional unique names with a maximum of one cation prefix are recommended for the eudialyte-group minerals, and this prefix should refer to the root name modified by use of modifiers and Levinson suffixes.

MM9: New investigations of the adelite-descloizite group

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More than a dozen minerals and some synthetic compounds (arsenates, vanadates, silicates, and molybdates) are known to belong to the adelite-descloizite structure type. They have the formula $M_{1+x}^{2-6}M_{2-x}^{2-6}(OH)_{m+n}K_{n}O_{15-n}$, where $M_{1}$ is Na, Cs, Pb, $M_{2}$ is Mg, Al, Mn, Fe, Co, Ni, Cu, Zn; $n$ = Si, P, V, As, Mn. Compounds with accurate structure refinements exhibit space-group symmetry $Pnma$ or $P2_12_12_1$. The parenteral structure is centro-symmetric. The deviation from the centro-symmetric parental structure is moderate. The type structure exhibits $M_{2}O_{6}$ octahedra (elongated trigonal prism) and $M_{1}$ cations in a three-dimensional network.

The concentration of hydrogrossular defects in the Si-deficient vesuvianite formed during (SiO$_4$)$^{4-}$→(H$_2$O)$^{4+}$ substitution in the isolated tetrahedra allows it to be considered as a analogue of hibschite in the hydrogrossular series. This vesuvianite is a member of the hypothetical series of vesuvianite - 'hydrovesuvianite' with the content of the 'hydrovesuvianite' molecule $Ca_{0.5}(Al,Mg,F)_2(O,OH,Fe,CH3)$, which is enriched in Mn. The Si-deficient vesuvianite probably has $P4_3$ or $P4_3/n$ symmetry.

MM11: High-Hydrated Si-Deficient Vesuvianite ('Hydrovesuvianite') From Yakutia, Russia

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The high-hydrated Si-deficient vesuvianite (Si = 15 a.p.f.u.) was discovered on the Wiluy deposit - the type-location of grossular and wiluite. The Si-deficient vesuvianite, occurring as sheet-like, yellowish (110)+{111) crystals up to 50 μm in size and as [001]+[111]+[110] light-green crystals up to 200 μm in size, is found in hibschite altered eudialyte - hibschite pseudomorphs after wiluite. In wiluite, the Si-deficient vesuvianite forms very thin zones in complex hydrogrossular-wiluite-vesuvianite pseudomorphs after wiluite and hibschite. Such zones are rarely observed in big crystals of wiluite.

The formula of high-hydrated Si-deficient vesuvianite is commonly given as $Ca_{0.5}(Al,Mg,F)_2(O,OH,Fe,CH3)$, which is enriched in Mn. The Si-deficient vesuvianite is characterized by increased unit-cell parameters ($a=15.65 Å$, $c=11.85 Å$) and a lower refractive index ($n=1.60$, $v=1.68$) compared with vesuvianite of similar composition from rodgites. Structural investigations of monocristals indicate that the Si-deficient vesuvianite probably has $P4_3$ or $P4_3/n$ symmetry.

MM12: The crystal chemistry of double-ring silicates: a new natural silicate with [SiO$_4$]$_2^-$ rings

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There have been two types of tetrahedral double-rings previously known for silicates. Four-membered double-rings, ideally [SiO$_4$]$_2^-$ occur in three minerals with the general formula $AB$$_3$[SiO$_4$]$_2^-$ [SiO$_4$]$_2^-$ H$_2$O, where $A$ = Th, K, REE; $B$ = Ca, Sr, Ni, Cr = K, Sr: steatocite, tektite-(Ls) and tartekeite. Six-membered double-rings, ideally [Si$_6$O$_{18}$]$_2^-$, occur in 18 minerals of the wiluite group with the general formula $AB(PO$_4$)$_2$$^{12+}$[Si$_6$O$_{18}$]$_2^-$[SiO$_4$]$_2^-$H$_2$O, where $A$ = T.
Si, Al, Ti = Li, Be, Mg, Mgs Al, Si; Mn; Zn; Fe = Al, Fe, Ti, Re, Zr, Fe, Ca, Na, Y, REE = Ba = Na, H2O. 2D =

The first occurrence of a three-membered double-ring [Si4O10]6− is described for a new natural silicate, Na2Y K(Y,REE) [Si2O5]6− from the province of the Dura-I-Ploj gli, the Alat mountain range, the Tian Shan mountains, Northern Tajikistan. The structure is orthorhombic, a = 10.623(2), b = 14.970(2), c = 8.553(1) Å. V = 1599.8(4) Å3. space group bahn, Z = 4, D (calc.) = 2.850 g·cm−3. The crystal structure was solved by direct methods and refined to an R1 index of 1.7% based on 936 observed \( F > 4 \sigma(F) \) unique reflections. In the crystal structure of Na2Y K(Y,REE) [Si2O5]6−, there are two tetrahedrally co-ordinated T sites occupied by Si with <Si-O> = 1.623 Å. The (Si2O5) tetrahedron forms a three-membered double-ring: [Si4O10]6−. There are two [Si]-

The topology of the Na2Y K(Y,REE) [Si2O5]6− framework is identical to that of synthetic Na2Y [Si2O5]6− (10.468(2), b = 15.247(1), c = 8.381(1) Å. V = 1338.3 Å3, space group hauus, Z = 4), but the arrangement of the channel cations is quite different.

MM13: Glauconite and celadonite: a nomenclature review

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Glaucite and celadonite are Fe2+–rich dioctahedral mica-type layer silicates. In the last 20 years, three nomenclature proposals were published about them by theIMA-CNMN (Rieder et al., 1998) and by the AIPEA (Bailey, 1980, 1986). In our work, we tested their viability on a range of chemical analyses carried out on Central European samples, as well as on analytical data of some references, generally considered essential. The samples included in the database represent various geological backgrounds and chemical compositions.

Based on the three possible cation positions in these minerals, a positive charge diagram \( x = 0-x = 8 \), was designed for the interpretation of both the species definitions and the chemical data. In the diagram, the following charge ranges were plotted (using a formula unit based on 11 oxygen atoms): 0–1 for the interlayer charge, 5–6 for the octahedral layer charge and 15–16 for the tetrahedral layer charge, respectively.

In the IMA terminology, celadonite is defined in terms of four true mica end-members while glaucite represents a series of interlayer-deficient micas. The decisive discrimination between celadonite and glaucite is the interlayer charge, with the dividing value of 0.85 per formula unit. In the IMA nomenclature of 1980, discriminative is the tetrahedral layer charge with a value of 15.8 (this corresponds to 0.2 Å per formula unit). The 1986 recommendation used however, the octahedral layer charge, and the discriminative value was this time 5.3 per formula unit.

Celadonite and glauconite have thus been distinguished by the charge values of all the three possible cation positions. The three classification schemes are partly overlapping, partly divergent. Relating the plotted analytical data to the three nomenclature systems, we try to evaluate their suitability for differentiating between celadonite and glauconite.

It should be noted however, that in practice chemistry-based nomenclatures have their own serious limitations because of the problems of preparation of chemically “pure” and “homogeneous” samples. The effect of typical analytical uncertainty on the classification is discussed. The indirect methods (XPD, IR) used in daily routine for discrimination between celadonite and glauconite are also evaluated.

This work was supported by OTKA grant #725873.
Below are the empirical formulae of eudialyte (I), alluaivite (4) and its some transitional varieties (2, 3), calculated for 29 atoms, that form a 'hard' carcass of a crystal structure of eudialyte (Si, Al, Zr, Ti, Nb, W):

\[
\begin{align*}
\text{I:} & \quad \text{Na}_6, \text{K}_6, \text{Cu}_2 \text{Al}_8 \text{Si}_{22} \text{O}_{76} \text{(OH)}_{16} \cdot 8 \text{H}_2\text{O} \\
\text{4:} & \quad \text{Na}_6, \text{K}_6, \text{Cu}_2 \text{Al}_8 \text{Si}_{22} \text{O}_{76} \text{(OH)}_{16} \cdot 8 \text{H}_2\text{O} \\
\text{2, 3:} & \quad \text{Na}_6, \text{K}_6, \text{Cu}_2 \text{Al}_8 \text{Si}_{22} \text{O}_{76} \text{(OH)}_{16} \cdot 8 \text{H}_2\text{O}
\end{align*}
\]

The crystalization of eudialyte took place under conditions of decreasing alkalinity/basicty of medium of mineral formation, which is shown by enrichment of composition by less basic components in comparison with more basic components (increasing of proportionsof ingredients - Ti/Zr, Na/K, Ca/Sr, Mn/Ca, Ce/La, increasing in origin, Crystals are emerald green, and was found at the Old Dutch Level mine dump, also known as the No. 2 Level microns in length.

FORTRAN, An enhanced offline version, programmed in MAUGUIN. It proved to be very useful to extend the new symbols to crystal SCHOENFLIES, and of up to 7 characters for the symbols after HERMANN-MAUGUIN placed in the World Wide Web.

A special feature of the new MinAbs edition is the extended symmetry information in form of ASCII shaped symbols. The use of subscript and superscript information in form of ASCII adapted symbols. The use of subscript and superscript was successfully applied in MinAbs.

A password is needed to access MinAbs. It will be granted, by request, to bona fide academics and students. The URL is: www.pausse.de/minabs/

### A12-4: Crystal structure of "redgellite", Cu2(OH)2(SO4)2·2H2O from the Red Gill Mine, Caldecott Fells, Cumbria, England

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"Redgellite" is the tentative name given to a phase as yet not submitted for formal mineral status. The crystal was obtained via Peter Braithwaite, Derbyshire, England and was found at the Old Dutch Level mine dump, also known as the No. 2 Level mine dump, at Red Gill Mine, Caldecott Fells, Cumbria, England. Oxidation processes presumably in the Tertiary produced the suite of supergene minerals for which the mine is famous. At other locations where redgellite occurs, it is clearly a dump oxidation product and is post-mining in origin. Crystals are emerald green, lath-shaped, and seldom greater than 60 microns in length.

Single crystal intensity data were collected using synchrotron radiation (\(\lambda = 0.6888\) \(\text{Å}\)) at ChemMatCARS, Sector 13, at the Advanced Photon Source, Argonne, IL using a tiny 60 x 30 x 4 mm crystal. Monoclinic unit-cell dimensions were \(a = 3.152(12)\), \(b = 10.49(3)\), \(c = 19.25(10)\) \(\text{Å}\), \(\beta = 90.09(2)\). The crystal structure was determined using direct methods and refined to a final \(R = 0.09\). Diffractions showed constant \(d\) streaking and speckling suggesting that even a sample of this size was polycrystalline. The crystal was also refined as a twin with - 80% - 20% split of twin components related by (1 0 0, 0 -1 0, 0 0 1).

Electron microprobe analyses were consistent with the derived structural composition.

The redgellite structure consists of CuO6 octahedra and SO4 tetrahedra. The CuO6 octahedra have four short distances of -2.0 \(\text{Å}\) and two longer distances ranging from -2.3-2.8 \(\text{Å}\). The octahedra share edges to form sheets that are zig-zag in cross section when viewed down the \(a\) axis and are stacked perpendicular to the \(c\) axis. Each leg of the zig-zag is four octahedra in length and repeats after every 7 octahedra. SO4 tetrahedra, that reside in the space between the Cu layers, form columns parallel to the \(a\) axis. The S site is only half occupied implying that only every other site in the column is filled. One O in SO4 is also bonded to Cu, and the remaining three that occupy the space between Cu layers are bonded only to S. A valence balance calculation suggests that 20 out of 30 oxygen atoms are actually OH and that two are H2O.

An oxygen atom is either bonded to Cu and S or exists as H2O when SO4 is absent. The geometry is correct for this oxygen to bridge two SO4 groups by forming hydrogen bonds. The remaining SO4 oxygen link adjacent Cu sheets via hydrogen bonds.
A2-7: Sewardite, CaFe\(^+2\)(AsO\(_4\))(OH)\(_2\), the Ca-analogue of carmnite, from Tsumeb, Namibia

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Sewardite, identified as CaFe\(^+2\)(AsO\(_4\))(OH)\(_2\), is the Ca-analogue of carmnite and is orthorhombic, Cccm (66), with unit-cell parameters derived from crystal structure analysis: \(a = 16.461(2)\), \(b = 7.434(1)\), \(c = 12.131(2)\) \(\text{Å}\), \(V = 1484.5(6)\) \(\text{Å}^3\), \(\alpha = 2.214(3): 1.1: 6.618\), \(Z = 8\). The strongest nine lines of the X-ray powder-diffraction pattern are: \(2\theta\) (\(d\) in X (\(00\))) = 4.874(90) (202), 4.735(70) (113), 3.889(60) (220), 3.167(100) (022), 3.018(50) (310), 2.988(50) (313), 2.919(70) (511), 2.833(90) (422), 2.814 and 1.775(333) (532), 066). The mineral occurs within a small 3 cm-sized vug on a single specimen collected from the Zn-Mn-bearing ore, Tsumeb, Namibia, as platy to slightly banded anhedral subhedral masses. These masses, which do not exceed 0.3 mm in maximum size, are intimately intergrown with a very dark green-black botryoidal taconasite supergroup mineral. Individual fragments tend to be between 50-100 \(\mu\)m in size with no obvious forms and are imperfect cleavages. Sewardite has physical properties which are very similar to those of carmnite: colour is dark red in mass to a much lighter red-orange on thin edges of small fragments; streak reddish brown; lustre vitreous; translucent (masses) to transparent (on thin edges); non-fluorescent; hardness (Mohs) 3½; brittle; splintery (in [001] direction) to uneven fracture; calculated density 4.15 g/cm\(^3\) (for empirical formula). In polished section, it is light bluish grey in plane-polarized reflected light in air, with ubiquitous very bright pink to red internal reflections; the phase is very weakly birefringent, non-anisotropic and with no pleochroism. The empirical formula is \(\text{Ca}_{21.6}\text{Fe}_{1.8}\text{As}_{10.4}\text{O}_{47}\text{H}_{2}\text{O}\), based on the basis of 10 atoms. The infrared-absorption spectra show bands for structural OH, substituting (H\(_2\)O) and amine. The mineral name honors Terry M. Seward, Professor of Geochemistry, ETH, Zurich, Switzerland, who first collected the mineral specimen in 1982. The crystal structure (\(R = 6\%\)) clearly shows that sewardite is the Ca-analogue of carmnite: talc-fully occupied by Ca\(^++\) and an octahedron principally occupied by Fe\(^+\). Mean bond lengths for the two minerals are virtually the same.

A2-8: Crystal structure of two hydrated minerals of the eudialyte group with doubled cell at -163°C

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Eudialyte is trigozolite-like zirconosilicate of very complicated and variable composition. Depending on the number of extraframework cations, there can be up to 21 Al acts (Na and some other elements: K, Sr, Ba, Ca, REE, Mn) for 3-22 atoms. In previously studied minerals this number is 12 to 13. Substantial deficiency of positive charges due to A-cation depletion is compensated by oxonium groups, which cannot be interpreted as neutral water molecules. The presence of these groups is also confirmed by the IR spectra of hydrated specimen. Using our previously studied minerals, we have compared 5 structures with different degrees of depletion. Two of them are potential new analogues of eudialyte minerals with ordered A-cation distribution and doubled c parameter. Both of them were recently found in alkaline pegmatites of the Khibina massif (Kola Peninsula, Russia) as crystals up to 1 cm in diameter with a perfect (001) cleavage. Highly decationated member (1): \(a = 14.234(1)\) \(\text{Å}\), \(c = 60.125(9)\) \(\text{Å}\), space group R3 \(\bar{c}\), \(R = 4.4\%\), H\(_2\)O \(\bar{R} = 0.85\). Moderately decationated member (2): \(a = 13.961(1)\) \(\text{Å}\), \(c = 60.3267(7)\) \(\text{Å}\), space group \(\text{R3} \bar{c}\), \(R = 3.5\%\), H\(_2\)O \(\bar{R} = 0.45\). The X-ray data were collected with a Bruker SMART CCD diffractometer at -163°C.

A comparison of these two minerals with other oxonium-containing samples, as well as with a highly alkaline specimen (H\(_2\)O\(_4\)Al\(_2\)) allowed us to draw conclusions about the hydration process in minerals of the group. The full hydration of A cations by loose and mobile oxonium groups is probably impossible because of structure destabilization. An increasing degree of hydration is accompanied by increasing contents of K, Sr, Ba and REE stabilizing the structure. The isomorphic replacement of A cations by oxonium groups can be either statistical in the unit cells or ordered. Both of them were recently found in alkaline pegmatites of the Khibina massif (Kola Peninsula, Russia) as crystals up to 1 cm in diameter with a perfect (001) cleavage. Highly decationated member (1): \(a = 14.234(1)\) \(\text{Å}\), \(c = 60.125(9)\) \(\text{Å}\), space group R3 \(\bar{c}\), \(R = 4.4\%\), H\(_2\)O \(\bar{R} = 0.85\). Moderately decationated member (2): \(a = 13.961(1)\) \(\text{Å}\), \(c = 60.3267(7)\) \(\text{Å}\), space group \(\text{R3} \bar{c}\), \(R = 3.5\%\), H\(_2\)O \(\bar{R} = 0.45\). The X-ray data were collected with a Bruker SMART CCD diffractometer at -163°C.

A2-9: Gjerdingenite-Fe, another new mineral of the labuntsovite group

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The CMMNM (IMA) has recently approved a new nomenclature of the labuntsovite group. The idea is to keep the number of new mineral names to a minimum by combining root names with suffix modifiers according to the content of cations in specific structural site. The labuntsovite minerals contain a variety of extra-framework sites in chains of a zoisite-like structure and...
not surprisingly, the Commission has had several proposals for new root names lately.

The group includes Ti/Nb alkali silicates with general formula Al2Bx(OH)y[Si4O10] (A = H2O, B = mainly alkali; the C and D sites can contain several types of cations but exclude each other, their distance being only ~ 2 Å if the D site is occupied by oxides, H2O molecules or other groups, which can complete the octahedral co-ordination of the D cations); M contains mainly Ti or Nb; there are two specific H2O sites, W1 and W2.

In the case of the new mineral gjeringdinite-Fe: the A site is empty; unexpectedly, the site W1 (renamed B') contains about equal amounts of H2O and K; the B site has N and Na plus an amount of H2O equal to the content of K in B' (the content of B' is within the co-ordination sphere of B); if there is a cation in B', the site must locally carry an oxygen atom or a vacancy; the content of Fe and Mn in site D is limited by the related content of water in site C. In this way, the following crystal-chemical formula was derived, which compiles well with the chemical analyses:

$$\text{K}_2\text{Na}_2\text{Al}_2\text{Ti}_2\text{O}_8\text{H}_2\text{O}_5$$

The new mineral pellouxite, (CuO.0,Ago,1)PbI0.4SbI1.6S27[ClO.4, (OH)0.5](OH)0.5, is the second oxy-chloro-sulfosalts after pillaite, and the fifth halogen-sulfosalts after dapsone, antidote, pellitane and pillaite. Like pillaite, pellouxite has been found at Buda of the Vena mine, a small Fe-Ba ore deposit in the Apuan Alps, northern Tuscany, Italy. Pellouxite is present in small fractures of a dolomite rock that hosts the massive Fe-Ba ore, together with many other Pb-Sb acicular sulfosalts, among which zinkenite, robinsonite, limnaitte, pillaite and scainite.

Pellouxite occurs as black acicular flattened crystals with metallic lustre, elongated on {100} and flattened on {100}, up to 1 mm long and less than 0.05 mm thick. The mineral is brittle, flexible, opaque and present a good (100) cleavage; the density (calc.) is 5.95 g/cm³. In reflected light, it is weakly birefringent (white to white-grey); with crossed polars, anisotropy is distinct, without polarisations (no twinning observed); red internal reflections are frequent. Reflectance values (randomly oriented section, mm, air/oil): 420, 38.3/23.6, 456, 37.2/23.4, 350, 36.9/21.5, 655, 35.2/23.6. Electron microprobe analysis (mean of 15 spot analyses - wt.% - empirical): Pb 47.17(20), Sn 8.31(23, Cu 0.89(5), Ag 0.59(5), S 19.08(6), Cl 0.30(3), O 0.39(15), Sum 99.60(3). Empirical formula (based on Pb + Sb = 22): Cu0.6Ag0.4PbI0.4SbI1.6S27[ClO.4, (OH)0.5](OH)0.5. The crystal structure of gramiccioliite-Y, biotite and Fe-Mn in site D is limited by the related content of water in site C. In this way, the following crystal-chemical formula was derived, which compiles well with the chemical analyses:

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hydrothermal conditions. The powder of starting material, Nd2(CO3)3·8H2O, was sealed with sodium aquaporous solution (0 - 0.5M NaHCO3 or NaOH) in a Teflon vessel or a platinum capsule. The reaction containers were kept at 100, 150, 200 or 250°C. The reaction process was traced varying the duration of reaction up to 7 days. The reaction products were filtered, washed with distilled water, and dried overnight at room temperature. They were characterized by XRD.

The starting material, Nd2(CO3)3·8H2O, decomposed within 30 minutes. A phase with the XRD pattern of Nd2(CO3)3·2.5H2O [ICDD 83-0923] was found as a decomposition product. Subsequently, kozolite-(Nd) and hydroxybastnasite-(Nd), the polymorph of kozolite-(Nd), were crystallized. The higher reaction temperature and the higher pressure tend to promote the formation of hydroxybastnasite-(Nd) instead of kozolite-(Nd). Since kozolite-(Nd) is the densest polymorph in comparison with hydroxybastnasite-(Nd), it is reasonable that kozolite-(Nd) crystallizes under lower pressure conditions. These observations suggest that kozolite-(Nd) is formed under conditions of lower temperature and lower pressure conditions. On the other hand, the yield of kozolite-(Nd) reduces and hydroxybastnasite-(Nd) was the dominant product in the reaction runs using sodium solutions with higher concentration and in the runs with elongated reaction duration. These trends indicate that kozolite-(Nd) may be a metastable phase in the present reaction system.

A12-13: [K6][Mn,Fe,Mg][4][Be,Al][4]Si2O8 g a new Mn-analogue of milarite from the Bellberg volcano, Eifel area, Germany

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The osumilite-type compounds, included under the title milarite group minerals, are classified as dihedral-ring silicates with the general formula \[ \text{A}^{2+}\text{B}^{2+}\text{Al}_{2}\text{Si}_{2}\text{O}_{8} \], where \( \text{A} = \text{Na, K, Ca, Cs, Ba; B} = \text{Na, K, Cs, H}_{2}\text{O} \). It is assumed that kozolite-(Nd) crystallizes under lower pressure conditions. These observations suggest that kozolite-(Nd) is formed under relatively lower-temperature and lower-pressure conditions. On the other hand, the yield of kozolite-(Nd) reduces and hydroxybastnasite-(Nd) was the dominant product in the reaction runs using sodium solutions with higher concentration and in the runs with elongated reaction duration. These trends indicate that kozolite-(Nd) may be a metastable phase in the present reaction system.

A12-15: Cavolite, CaV3O7, a new mineral from the Gambatesa mine, northern Apennines, Italy

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In Eastern Liguria, manganese ores occur near the bottom of lentic sequences (“Ossauri di Monte Ange” Formation) overlaying metamorphic ophiolites and consist of bainite-bearing layers within hamitite-rich sheets. Tectono-metamorphic re-equilibration under prehnite-pumpellyite facies conditions affected ophiolites and their sedimentary cover; a complex vein system, mainly localized at the fold hinges, developed, inducing reaction processes responsible for the formation of Mn-silicate and/or Mn-carbonate assemblages, at the expense of bainite + quartz assemblages. Fluids circulating along lentic fractures, at decreasing metamorphic conditions, lead to the concentration of elements such as Y, As, Ba and Sr and the precipitation of a great variety of uncommon minerals, included many new species.

Cavolite, CaV3O7, occurs at the Gambatesa mine (Eastern Liguria, Italy) filling microcracks in massive bands of caryophyllum + calcian rhodochrosite + quartz. The formation of these assemblages, replacing tektroite + rhodolite veinlets within the bainite layers, is referred to the increased activity of CO2-bearing and Ca-rich hydrothermal fluids in the veins, which also induced V mobilization.

Cavolite has been found as very rare radiated aggregates of strongly elongated prismatic to acicular crystals up to about 0.28 mm in length, intimately associated with an unidentified silicate phase. The crystals vary in colour from colourless to olive-green-brown; they are brittle, transparent and non-fluorescent, with vitreous luster and near white streaks; nocleavage, parting and twinning were observed.

Session 12 Abstracts

A12-14: Martinite, a new borosilicate mineral from Mont Saint-Hilaire, Quebec, Canada: description and crystal structure determination

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Martinite is a new mineral discovered as a rare, late-stage phase in sodalite syenite xenoliths at the Prudente quarry, Mont Saint-Hilaire, Quebec, Canada. It occurs as thin (<10 µm) lamellae to colourless pseudo-hexagonal plates up to 50 µm across in vugs, associated with villiaumite, endiolite group minerals, lovozerite group minerals, traskite and erdite. Results from single-crystal X-ray diffraction and EMP analyses indicate the ideal formula (Na, Ca)2Al4(Si16)O47·4H2O. Martinite is triclinic, P1, but is strongly pseudo-hexagonal \( a = 9.5437(7), b = 14.0288(10), c = 9.5349(6) \) Å, \( \alpha = 71.057(1), \beta = 119.788(1), \gamma = 105.846(1) \)°. Its crystal structure, which is strongly layered parallel to (010), is dominated by silicoborate (S) layers composed of SiO4 tetrahedra joined into distorted hexagonal rings which in turn are cross-linked in the (010) plane by (Si,Al)O4 and BO4 tetrahedra. Two such layers (S, S' related by a centre of symmetry) are joined along [010] for shared corners and edges with interlayer Na+ and SiO4 tetrahedra, forming a double six-membered ring of \( Si_{2}O_{5}(Si,Al)_{2}O_{4} \). This structure is considered a modular centrosymmetric structure with the stacking sequence, \( O \cdot S \cdot S' O \cdot O \cdot S' \).

Martinite is a member of the reyerite-type series, which includes reyerite, gyroelite, federite, truscottite and quaguite. These minerals constitute a group of layered alkalialkaline earth silicates containing a single or double tetrahedral sheet typical to develop as late-stage phases in highly alkaline environments. Considering its environment of formation (vugs in sodalite syenite xenoliths that are located proximal to a bietite-muscovite-quadric hornfels unit, martinite may be the product of the interaction of late-stage hydropyrolitic fluids and mesenemies, the latter possibly being a source of B and SiO4.
A new mineral, the Zn analogue of rancieite, has been discovered at the Dongnam mine, Korea. It occurs as compact subparallel fine-grained flaky or acicular aggregates in the massive manganese oxide ores which were formed by supergene oxidation of rhodochrosite-sulfide ores in the hydrothermal veins trending NS-N25E and cutting the Punghong limestone of Cambrian age. The flakes of the Zn analogue of rancieite are 0.2 mm for the largest one but usually <0.05 mm. The acicular crystals are elongated parallel to and flattened on (001). This mineral shows gradation to rancieite constituting its marginal part, thus both minerals are found in one and the same flake. The colour is bluish black, with dull lustre and brown streak in globular or massive aggregates. The cleavage is perfect in one direction. The hardness ranges from 2.5 to 4. Under reflected light it is anisotropic and birefringent. It shows reddish brown internal reflection. Chemical analyses using EJEL Superprobe 733 gave MnO 70.08, MnO 0.00, CeO 0.86, MgO 0.78, FeO 0.27, ZnO 12.67, K 0.13, Na 0.93, H2O 14.08 for a total of 100.00 wt%. Chemical analyses of different parts of both minerals suggest that rancieite and its Zn analogue constitute a continuous solid solution series. The empirical chemical formula for the Zn analogue of rancieite has been calculated following the general formula, RmMn+44O04H2O for the π1 phyllosilicate minerals, x varies from 0.81 to 1.28 in so far studied samples, thus averaging to 1.0. Therefore, the formula is close to the stoichiometric formula “second chapter” by Bayliss and Bridgely (1978). The Zn analogue of rancieite from the Dongnam mine has the formula (Zn,mn,Na,cs,Mn,cal,Mg,cal,Mn)(μ4−ν4Mn)O2−θGeO4−θSiO4−θH2O, thus the ideal formula is (Zn, Cs)Mn+44O04H2O, 3.85H2O. The mineral has a hexagonal unit cell with a = 2.840 Å, c = 7.486 Å and a/c = 1:2.63. The X-ray diffraction lines are 7.480 (vs 101), 3.740 (s) (102), 2.45 (m) (101), 2.34 (m) (101), 2.06 (w) (102), 1.76 (w) (105), 1.42 (m) (110). The DTA curve shows endothermic peaks at 65, 80, 100, 110 and 120°C. The IR absorption spectrum shows absorption bands at 445, 500 and 3400 cm−1.
completes, makes them important indicators of the type of association of alkaline rocks and the conditions of their formation.

A12-19: Kimzeyite from aposkarn rodolites, Wiluy River, Republic Sakha -Yakutia (Russia)

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Zirconian schorlomite and kimzeyite garnets described in the geological literature are usually associated with rocks of the ultrabasic-alkaline complexes (carbonatites) or with basic magmatic rocks. Minerals of the kimzeyite-schorlomite series occur in aposkarn metadolerites in the Wiluy deposit of schorlomite, grossular and wiluite on the Wiluy River, Republic Sakha-Yakutia. The metadolerites of the deposit comprise unisulfidic rodolites that are part of a metamorphosed layer of sodic-alkalic rocks. The first report on the formation of the deposit was connected with the formation of Siberian traps.

Garnets form metamictic rodolite-like, fine-grained rock consisting of talc and quartz. The spaces between the pseudomorphs are filled with serpentine and chlorite. Reticulated crystals related to an early skarn stage are represented by wiluite, garnet and high-Al diopside. Perovskite and apatite occur as accessory minerals.

Garnets of the schorlomite (Ca(T,O)3R3(Si5O18)3(R3SiO3)3) series and kimzeyite (Ca(Zr,Ti)3R3(Si5O18)3(R3SiO3)3) series are preserved as relics in the central parts of an idiomorphic crystal of rhombohedral habit exhibiting complex zoning. The central part of the crystal is composed of Zr-schorlomite-morinite. Zr and Ti contents are constant with variation ranging from 0.48 to 0.52 a.p.f.u. to 0.78 to 0.82 a.p.f.u., respectively. A reaction zone with increased Zr content varying from 0.78 to 0.82 a.p.f.u. (often Zr-Ti) follows. This zone is succeeded in turn by a homogeneous zone comprising Zr-bearite, Ti-andradite. The last zone overgrowing the metacristal is composed of grossular with a proportion of the andradite molecule.

Most of the fine-grained, Zr-containing garnets are characterised by a different type of zoning. The composition of three garnets changes from kimzeyite (with a Zr content ranging up to 0.83 a.p.f.u.) to Zr-schorlomite in the central zone surrounding Zr-andradite to Fe-grossular in the marginal zone. The high concentration of divalent elements in these garnets indicates a significant presence of morinite (Ca(Ti,R3)3R3(Si5O18)3) and Zr-morinite (Ca(Zr,Ti)3R3(Si5O18)3).

The discovery of schorlomite-kimzeyite series garnets in what are unusual aposkarn rodolites is unique. Firstly, the garnet described is a new genetic type of kimzeyite-Zr-schorlomite series garnet. Secondly, garnets are the main reservoir of octahedral Na (Kola Peninsula, Russia). The discovery of the new mineral species is significant because of its unique composition.

A12-20: Shirokshinite, K(Na,Mg)3SiO4F2: first mica with octahedral Na (Kola Peninsula, Russia)

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Shirokshinite is a late mineral found within an alkaline pegmatite of the Kirovskii Mine (Kavkavunchor Mt., Khibiny massif). The new species has been approved by the IMA. Minerals associated to shirokshinite are: microcline, k_tlukite, aegirine, galena, natrolite, krenonite, calcite, romhohedral calcite, natrolite, krenonite. Colourless, biaxial (-), α 1.526(1), β 1.553(2), γ 1.535(2); chemical composition: K<sub>2</sub>Ca<sub>2</sub>Nd<sub>4</sub>NaS<sub>12</sub>Si<sub>8</sub>O<sub>3</sub>(OH)·12H<sub>2</sub>O. From single-crystal X-ray diffraction and 140(2), c 10.196(2) Å, β 100.12(7)°, C2/c have been obtained.

The crystal structure of shirokshinite has been refined to R = 0.13 for 715 observed reflections. In spite of the high R value (due to poor crystallinity), the refined number of electrons (en) shows that the octahedral sites M cannot contain cations lighter than Na. The dimension of the site M1, larger than that of M2, and en show that these two sites are occupied by Na and Mg, respectively. Thus, the ratio Na/Mg found by chemical analysis is confirmed by the structure refinement.

IR spectroscopy played an important role in the characterization of the new mica. The IR spectrum of shirokshinite is unique but similar to that of taniolite: the presence of the heavier Na instead of Li<sup>+</sup> causes up to 40 cm<sup>-1</sup> shifts of some bands towards lower frequencies. It was reported an indirect evidence for octahedral Na in micas, but shirokshinite is the first reported mica with Na dominant in an octahedral site. Both octahedral and interlayer Na is instead quite common in the layer titanomagnetites; the structure of these minerals is based on mica-like layers where rows of Si-tetrahedra are replaced by rows of 6(c) co-ordinated Ti.

After the recent first description of a 20 mica polytype, the Khibiny massif becomes the type locality for two micas.

A12-21: Roedderite(?) from the Nagy Hill, Tarpa, NE Hungary: a problem with the classification based on electron microprobe analysis in the roedderite-merrilluite subgroup of the milarite group

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The Nagy Hill is an outcrop of a large early Sarmatian dacite body. Roedderite occurs at the contact of dacite and agglomerate, where it can be found on the joint surfaces and in the fissures of dacite as well as in agglomerate together with epidote. Roedderite forms greyish blue and blue, hexagonal, short prismatic crystals up to 1.5 mm, with forms {1010}, {1120}, {2130}, {1012} and {1122}.

In the literature the chemical formula of roedderite is written as (Na,K)(Mg,Fe)SiO<sub>3</sub>·H<sub>2</sub>O, while the formula of merrillite is (K,Na)(Fe,Mg)SiO<sub>3</sub>. The line is drawn at Fe(Fe + Mg) = 0.5 between roedderite and merrillite. The mineral is roedderite, if the above value is >0.5, but it is merrillite, if <0.5. However, this approach is incorrect because the general structural formula of the minerals of the milarite group is A<sub>2</sub>Li<sup>3+</sup>B<sub>3</sub>Si<sub>3</sub>O<sub>10</sub>·2H<sub>2</sub>O, so the formula of roedderite end-member should be written as K<sub>2</sub>Na<sub>3</sub>Fe<sub>2</sub>Mg<sub>2</sub>Si<sub>3</sub>O<sub>10</sub>. Similarly, the formula of merrillite end-member is Na<sub>2</sub>Fe<sub>3</sub>Si<sub>3</sub>O<sub>10</sub>. Thus there are two unnamed, theoretical end-members of the roedderite-merrillite subgroup, namely UN1 with composition Na<sub>2</sub>Fe<sub>3</sub>Si<sub>3</sub>O<sub>10</sub> and UN2 with composition NaMg<sub>2</sub>FeSi<sub>3</sub>O<sub>10</sub>.

Based on electron microprobe analysis the composition of Tarpa roedderite is the following: (K<sub>0.30</sub>Na<sub>0.70</sub>)(Fe<sub>0.45</sub>Mg<sub>0.55</sub>SiO<sub>3</sub>·H<sub>2</sub>O. Because both of Mg and Fe can occupy the A and Ti(2) sites, we can not give the structural formula of Tarpa mineral. If the total iron goes to the (2) sites, then the Tarpa mineral is roedderite, but if the total iron occupies the A sites, then our mineral represents the UN1 species. Merely based on electron microprobe analysis it is impossible to determine the distribution of Mg and Fe between A and Ti(2) sites.

A12-22: Duhamellite undiscovered

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Reinvestigation of duhamellite, originally described as Ca<sub>2</sub>Pb<sub>2</sub>(VO<sub>4</sub>)<sub>4</sub>(OH)<sub>6</sub>, 8H<sub>2</sub>O, has demonstrated that it is not a valid independent mineral species. Analyses of the type material and of additional samples by means of electron microscopy, X-ray powder and single-crystal diffractometry including structure refinements, and transmission electron microscopy have shown that duhamellite belongs to the adelitel-descliozite-group, MIM2(XO<sub>4</sub>)OH, and corresponds to a bismut- and calcium-bearing mellite, [PbCa(VO<sub>4</sub>)(OH)]. The chemical formula is (Pb,Bl,Ca,V<sub>2</sub>O<sub>4</sub>)(OH)<sub>4</sub>. Bl<sup>2+</sup> is an essential component; however, Pb<sup>2+</sup> dominates over Bl<sup>2+</sup> with a strong variation in the Pb/Bl ratio. All duhamellite samples contain small but distinct Ca<sup>2+</sup> contents; some also contain minor amounts of Au<sup>3+</sup> and Si<sup>4+</sup>.
The exchange mechanisms are: $[(\text{Ph},\text{Cu})^{2+} + \text{OH}^-] \rightarrow [\text{Bi}^{3+} + \text{O}^{2-}]$ and $[(\text{VO}_{1.5}\text{AsO}_{2})^{2+} + \text{OH}^+] \rightarrow [(\text{SiO}_4)^{2-} + \text{OH}^-]$, respectively, a coupled substitution $[(\text{Ph},\text{Cu})^{2+} + \text{VO}_{1.5}\text{AsO}_{2} + \text{OH}^+] \rightarrow [\text{Bi}^{3+} + (\text{SiO}_4)^{2-} + \text{OH}^-]$, which is possible to maintain the number of OH groups. Another exchange mechanism is $[(\text{VO}_{1.5}\text{AsO}_{2})^{2+} \rightarrow (\text{SiO}_4)^{2-}]$ or, in an extended form, $[(\text{Ph},\text{Cu})^{2+} + (\text{VO}_{1.5}\text{AsO}_{2})^{2+} + (\text{OH})^+] \rightarrow [\text{Bi}^{3+} + (\text{SiO}_4)^{2-} + (\text{OH})^-]$. The extended chemical formula is $\text{M}_{10}\text{Zn}_{2}\text{Ca}_{2}\text{Z}[(\text{O}_4\text{Si}_5\text{O}_4\text{OH})_2(\text{OH}_4)]$. Although the crystal structures of the Ca and Pb end-members are isostructural, their distinct space-group symmetries are $P2_12_12$ and $P2$, respectively. The structural change goes along with a change in the coordination number of the $M_1$ atom: in space group $P_{2}12_{1}2$ the mono-capped trigonal prism, whereas $M_{1}O_{1}$ in space group $P2_{1}2_{1}2_{1}$ is a square antiprism. The crystallographic role of the $M_1$ cations and the parallel substitution of $O_2^-$ groups by $\text{OH}^-$ atoms as well as their influence on the crystal structure is discussed: lone-pair electrons which are usually stereochemically active are expected for $M_{1} = \text{Bi}^{3+}$ atoms. X-ray film investigations show a splitting of the reflections along the $b^\prime$ direction; two reciprocal lattices exhibit a superposition; they correspond with each other in the $a^\#$ and $c^\#$ directions (at least they are not resolvable) but exhibit a deviation with respect to $d_{100}$ by $\pm 1\%$. All investigations of blastomani-calcian mottramite showed a superposition of two commensurate lattices.

A12-23: Systematics of the uranyl silicate minerals and their names

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Meguinissinite ([Mg, Cu]$\text{Cu}_2\text{CO}_3(\text{OH})_2$) is a member of the rosasite group carbonates found in few localities as secondary mineral phase in different rock-matrix such as gabbros, serpentinites, and massive dolomite. The reported chemical formula show a relatively wide range of Mg/Cu ratio (mostly Mg > Cu), but trace amount of Co, Ni, Zn, and Fe. Meguinissinite crystal structure is unknown and unambiguos data aboud crystal structure of rosasite group minerals, except for malachite, are scarce. Meguinissinite is considered (though with some reservations) as monoclinic with space group $P2_1/a$. We have found meguinissinite in a small chromitite xenolith sampled at Onverwacht, in the eastern part of the Bushveld Complex. The sample consists of anortobite patches of chromite grains spotted with drop-like inclusions of clinopyroxene, amphibole and Ni-rich phlogopite and partially rimmed and replaced by magnetite; gangue minerals are mainly serpentine, chlorites, Mg-Fe hydroxides silicates and Fe hydroxides, Cu-bearing phases, suggestive of the original presence of sulfides, are scattered in the matrix. Meguinissinite has been identified together with chrysocolla in a thin vein crossing the chromitite xenolith.

The veinin can be related to that observed near the top of the pipe where reactions with acid ground-water produce magnesite and chrysocolla. The X-ray powder pattern well agrees with those reported for the holotype from Red Mountain (California). However the reported weak peaks at $d = 11.98 \AA$ and of $d = 0.39 \AA$ have not been observed. No crystal suitable for single-crystal X-ray analysis has been found. The X-ray powder diffraction pattern indexed in the same space group $P2_1/a$ of malachite, gives cell parameters in good agreement with those from Red Mountain. Following the hypothesis that meguinissinite and malachite could be isostructural, calculated powder patterns for disordered and ordered distribution of Mg and Cu in the Cu-sites of the malachite structure indicate a possible preferred Mg-ordering in the Cu(2) malachite position for the meguinissinite structure. EPMMA and powder X-ray analysis together with X-ray elemental maps show only Mg and Cu in significative amounts; Fe has been detected in subordinate amounts. The presence of Si has been observed as a consequence of the intimate intergrowth together with chrysocolla. The relation Mg >Cu previously observed in the other reported occurrences, seems to be confirmed.

A12-25: Microlite-subgroup minerals from Concelção do Mato Dentro and São João do Rei, Minas Gerais, Brazil

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The type locality of ummanricrolite (originally "djalmaitie") is Posse farm (São José mine), 1 km from Brejãlãa town, Conceição do Mato Dentro county, Minas Gerais, Brazil. This is also the type locality for dukite. A second occurrence of "djalmaitie" was described in the Co(2) malachite position for the rosasite subgroup structure. EPMMA and powder X-ray analysis together with X-ray elemental maps show only Mg and Cu in significative amounts; Fe has been detected in subordinate amounts. The description of the distribution, properties, and cell constants of these minerals have been reported. Fleisher described ulvösite, calcium urasilite and magnesite urasilite, but these minerals are not listed in the Glossary of Mineral Species. I propose to CNMNN of IMA to approve of these names as well as pseudo-woolweite and pseudo-haiweite.