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Structural-Chemical Systematics of Minerals

Third Edition

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ISBN 978-3-319-72876-6 ISBN 978-3-319-72877-3 (eBook)
<https://doi.org/10.1007/978-3-319-72877-3>

Library of Congress Control Number: 2019934785

1st & 2nd editions: © Federal State Institution of Sciences Fersman Mineralogical Museum of the Russian Academy of Science 1997, 2007

3rd edition: © Springer Nature Switzerland AG 2020

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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

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Structural-Chemical systematic of minerals. A.A.Godovikov, S.N.Nenasheva.
– 3 nd updated edition. – M., 2016. – n p. Ill. 3. Bibliography: 69 ref.

The classification tables are complemented by the new mineral species, that were discovered at 2007-2016 years [4], [50]. The formulae of some mineral species were corrected and some mineral species were transferred to another taxons on account of the appearance of new data about the chemical composition or the crystal structures.

Structural-chemical systematic of minerals is representative of recent data on connection between chemical composition and crystal structures and properties of minerals, conditions of mineral formations, paragenesis. The chemical signs are the basis of structural-chemical systematic. The crystal structures of mineral consider on the middle and low-level taxons, but not on the high-level taxons, because the mineral structure is depend on chemical composition and physical-chemical parameters of mineralforming systems.

The classification tables are given, which include near by 5000 mineral species. This enables to use developed classification for scientific and practical purposes.

This book designed for the wide circle of mineralogists, petrographers, geochemists, students of geolodical institutions and colleges.

COVENTIONAL ABBREVIATIONS:

CN – coordinate number

HPC – hexagonal close-packed

CPC – cubic close-packed

CP – close-packed

FC – force characteristic (γ)

$$\gamma_{\text{orb}} = F/r_{\text{orb}}$$

$$\gamma_{\text{orb}}^{n+} = I_n/r^{n+}$$

$$\gamma_i = I_n/r_i$$

F – affinity of electron

 I_n – ionization potential of n –th electron r_{orb} – atom's orbital radius r_{orb}^{n+} – ion's orbital radius r_i – ionic radius

A.A. Godovikov introduced unnamed taxons. The names for these taxons was proposed by S.N.Nenasheva. These taxons marked by asterisk on the right from taxon. For example: quasytype*, quasisubtype*, overclass*.

The new taxons and new mineral species was introduced by S.N.Nenasheva, marked by asterisk on the left. For example: *3.2.5.3.6.3. Oxido-thiosulfates,*museumite, *telyushenkoite.

Formulas of mineral species are given in modern reference books: [4], [42], [46], [50].



Introduction

In spite of the existing opinions, especially of young scientists, that there is no sense to explore the systematic (in all forms) and that it is more important to get quite definite physical data, there are hundreds of works which are dedicated to the mineral systematic. Some well-known scientists worked on them, such as M. Lomonosov, J. Berzelius, V. Severgin, J.D. Dan, V. Vernadskiy, H. Strunz, A. Povarennykh, I. Kostov and other ones, and dedicate their investigations to systematic of minerals.

This can be explained by the following reasons:

- 1) There is a necessity to systematize different and numerous information on individual minerals. Without this it is not possible to get slim and scientific description. The comprehension of it usually comes with the age of scientist and with spreading of the scientific range of interests.
- 2) There are a lot of mineral properties which are used in their descriptions. We need to know them not only for mineral diagnostics, but also for clarification of their searching features, forming conditions of their paragenetic associations, capabilities of mineral utilization by humans.
- 3) By belonging of minerals to the complete different chemical compound types; by differences and complexity of their composition.
- 4) Among minerals there are substances which were formed in completely, even in interexcluded physical-chemical conditions.

Any of mineral systematics appears to be multidimensioned, because it should consider all the multitude of different mineral features. The systematic which is expressed in most usual table appearance could mirror, on essence, only one of all possible sections of multidimensioned area of mineral properties. The best of all modern systematic's appearances is systematic in computer databases on diskettes or on compact disks which are considered maximum number of different mineral properties. They allow to get different concrete sections of multidimensioned area of mineral properties, to clarify all correlations and queries.

Historically earlier were those of mineral systematics which were based on chemical features. Unfortunately all these variants are based on highly limited number of general chemical features, on very general ideas about connection between properties of elements and their position in Periodic system. These ideas could not mirror in necessary measure all varieties and regularities of chemical compounds and features of minerals, real complexities of connection between electronic structure of elements and structure, properties of substances they forming. Big troubles of chemical systematics are determined by unsatisfactory condition of nomenclature and classification of inorganic crystalline substances, including the majority of mineral species. All this brings to considerable drawbacks of these systematics, impossibility of their wide use. This is complicated by that usually authors of chemical systematics are not stopped on basing of their works, satisfying either on schemes of chemical features which were used in classification tables or on table of itself.

The next time group can be represented by crystallochemical, rather structural-geometrical, systematics which are widely spread. Appealing feature in all these systematics is that the concrete peculiarities of crystalline structures of minerals which can be obtained experimentally are in their basis. However, all similar systematics which can excellently demonstrate regularities of connections of mineral properties with geometrical peculiarities of their crystalline structures, be found practically weak in

solution questions on mineral genesis and paragenesis. This is clear, because the structure of minerals appears to be the secondary feature on comparison with their chemical features, as long as the structure itself is determined by chemical composition of mineral, physical-chemical parameters of system in which it forms and stays in.

In spite of widely spreading of such systematics, what is most likely the time tribute, they can not satisfy mineralogists, because of the shown reasons. This is most brightly expressed in whole series of works by I. Kostov, who has written in one of them: "In modern crystalline chemical classifications paragenetic connections between minerals are ignored, therefore we have formal, although slim in some cases distribution [39]. Unsatisfaction of mineralogists in this kind of systematics gives as a result the appearance of geochemical systematic of minerals by I. Kostov [40] in which by division of minerals in subclasses the element triads which characterize definite mineral associations set as a leading feature. Obviously, this cause the appearance of extremely unsuccessful and voluntary "chemical" systematic by E. Semenov [60] and very detailed, but without descriptive principles and often inconsequent systematic by A. Hoelzel [34] and A. Clark [12]. Speciesforming cations have the supreme position in class systematic in these works.

The luck of satisfying mineral systematic, obviously played its role in that the last time more and more reference books comes which have alphabetic mineral classification [16]; [2]; [57]; [17]; [51].

It is apparent that mineralogist will be satisfied, if systematic has on its basis chemical features which could enable to understand their connection with mineral structure and properties, mineralforming conditions and paragenesis. Features which are characterizing the structure of minerals should have not the highest taxon positions, but rather middle or even inferior taxon positions, because they are in straight dependence on chemical composition and physical-chemical parameters of mineralforming systems. It is important to aim for selecting in systematic such taxons which:

- a) could unite possibly greater number of mineral species, this should ease their general characteristic and save mineralogy from numerous repetitions which appear in such cases, when mineralogy, because of the luck of really well-developed systematic, is stated as descriptive science;
- b) could show gradual transformations from one taxons to other, their natural and numerous interconnections.

Maximally all these features could be represented in systematic which based on:

- a) detaily developed ideas about the connection between properties of elements and their electronic structure, their position in Periodic table;
- b) numerous chemical features which are often not considered in necessary measure and from which the chemical properties of minerals, mineralforming conditions and paragenesis are dependent;
- c) clarified regularities in connection between fundamental properties of elements and structure of chemical compound, their forming;
- d) regularities in structure and mineral properties variance on dependence on physical-chemical parameters of systems in which they have formed and stated.

Developing any systematic of natural objects including minerals, two approaches which are contrary on essence should be considered. One of them, the simple one, brings us for putting all considered objects in developed scheme, basing on "strong"

logical requests. In spite of bribing scientific vividness this way is impossible for natural objects and it could not bring to creation of their really natural systematic which considers all numerous natural connections a transformations among them. And exactly natural systematic is rather necessary and acquittal for them. This could explain that V. Vernadkiy [65], who complained on natural mineral systematic's absence, felt respect to it. The Mendeleev's success in creation of Periodic law and developing the table variant of Periodic system, could be explained simultaneously; when he instead of following the dependence of properties of elements on their atomic weights, proclaimed by himself, did three deviations, changing position in the following systems of element pairs: Co and Ni, Se and Br, Te and I which has been found its explanation later.

Such complexities which appeared on the simplest level of chemical objects - elements risen many times in conversion to their compounds, when atomic electronic structure, energy levels of electronic orbitals revealed not impurely, but rather through the chemical bond, crystalline structure of substance which extremely complicate the creation of natural systematic of minerals.

However, the situation is not completely lost and the exit could be found, if in systematic development consider not only the formal features, but also real mineral associations, their parageneses, differences in physical chemical parameters of mineralforming systems, giving favor in mineral order in systematic exactly to the last features. This way could be vindicated by two reasons. First, it is necessary to consider that natural mineral associations, sequential transformations in mineralforming processes are not accidental, but appear to be the results of selecting, sometimes long and complex, of individual elements by their properties in natural associations in whole. Thus, this feature could be considered as criteria of naturality of mineral systematic. More than, its utilization allows to unseal deep connections in properties of individual elements, motives of their definite behavior in mineralforming processes. Second, coordination of systematic not only with properties of minerals, their structure, but also with mineralforming conditions, their paragenesis, transformation conditions from one taxon to other one either on the same level or by its consequent deepening and detailing, has to be the most important demand of the mineralogy. Without it the scientific understanding and statement and finally the creation of natural mineral systematic is impossible. The numerous examples of what was said are mentioned below.

Let's concentrate on selecting principles of highest taxon systematic, their sequence, connections; however, remember, that definitions of lower taxons - mineral species, subspecies, seria (genus), varieties, groups, families which were given earlier [22], [25] are not considered by us. To the highest taxons we refer all taxons up to classes, quasiclasses and subclasses inclusive, although not all authors give them special names, tracing their sequence by numbers (first of all roman, and then arabic) and letters (first of all capital, and then small ones) or by consequent rising numeric indexes. We use for this purpose only arabic numbers and primary small letters of alphabet.

Before we go to consideration of taxons themselves it is necessary to stop on precise definition of the number of basic terms and positions.

We should begin with systematic of elementary substances¹, compounds in dependence on prevalence of one or another definite type of chemical bond in them -

¹ In majority chemistry courses, especially primary ones, elementary substances which include substances, consisting of atoms of one sort called simple substances. Mineralogists, who however, did not pay attention that this term is completely identical to term which defines simple binary compounds in contrast to complex or binary compounds, have borrowed this term from them.

geochemical systematic of elements and cations which is used in developed natural mineral systematic.

Division of elementary substances on metals, semi-metals and nonmetals

Special atomic properties of individual elements are most visible in elementary substances, because they contain no other atoms, except the atoms of given element. But even in this case there is no simple connection between the fundamental properties of elements, for example values of their force characteristics, order numbers, and physical or chemical properties of elementary substances as far as this dependence is complicated by chemical bond between atoms, by its type, by crystalline structure of given elementary substance which is stable in definite intervals of temperature and pressure, by other physical chemical parameters².

Elementary substances at all times are divided on: 1) metals, 2) semimetals or metalloids and 3) nonmetals. In Russia, however, the tendency of refusal from terms “semimetals” and “metalloids” which are exclude from chemical reference books and textbooks [1], has been strongly become apparent. In USA in latest reference books on chemistry they are sometimes even selected in tables by special color [4], [60]. Unfortunately, there are no strong term definitions given, that is why different authors have completely different boundaries between these groups of substances.

For example, in P.W. Atkins’s and J.A. Beran’s book [2] we can find the following definitions:

“A **metal** is a substance that conducts electricity, has a metallic luster, and malleable and ductile” (p.43).

“A **nonmetal** is a substance that does not conduct electricity and is neither malleable nor ductile” (p.43).

“A **metalloid** has the physical appearance and properties of a metal but behaves chemically like a nonmetal” (p.44).

Inspite of their lapidity and simplicity these definitions have insufficiency which brings to the different number of elementary substances, included in every group by different authors. First of all it is remarkable, that all used features are nonadequate. So, in definition of metal and nonmetal - it is electroconductivity, malleability, plasticity which are some of the physical properties. At the same time, there is no allusion about how these substances look (by the way it is not clear enough, what authors are consider by that - luster, color or something else), not rather about their chemical properties, but it is not clear which of them, although exactly some inconcrete physical magnitudes, including external look, and chemical properties are put in the term definition basis of “metalloid”. It is not amazing, that such situation brings to contradictions in relating some elementary substances to each of three stressed groups by different authors. Following that tables of comparing physical and chemical properties of metals and nonmetals from which, by incomprehensible reasons, the semimetals are completely excluded, are not improve the situation. Such situation is not confusing for majority of

² The narrow connection between elements properties - their electronic structure, their position in Periodic table and properties of elementary substances clarifying clearly on curve, called “atomic volumes curve” of elements which was used for explaining of Periodic law by D.I. Mendeleev [48], J.L. Meyer [49] for basing of elements division on atmo-, litho, chalco- and siderophylic by V.M. Goldschmidt [32] and many of the followers. However, usually scientists forget that this curve shows the dependence of specific element volumes of elementary substances, not the elements, on ordinal (atomic) numbers or atomic masses of elements. This could be explained by intersubstitution of terms “element” and “elementary (simple) substance”, what is completely impossible as noted earlier [21]

authors and is in accordance with dialectic logic, when metalloids or semimetals are defined as substances which have to be found on boundary between metals and nonmetals and which have properties both of metals and nonmetals [67].

As a result K.W. Whitten and K.D. Gailey [67] build boundary metals \leftrightarrow nonmetals strongly through diagonal $B \rightarrow Si \rightarrow As \rightarrow Te \rightarrow At$, and all mentioned elements are placed to the right from this boundary. They did not select semimetals concretely, although the indistinct definition for semimetals is included, and their selection is considered to be individual for every author. P.W. Atkins and J.A. Beran [3] as semimetals pick out Si, Ge, As, Sb, Te and Po, as far as Al, Ga, Sn and Bi are considered to be rather metals and B, C, P, Se, I and At are referred to nonmetals.

Considered definitions from native encyclopedic reference books are not more successful.

The most strong of them is definition of metals which is given in PED [54]. According to it, elementary substances which “have some typical properties: high electroconductivity and thermal conductivity, negative thermal electroconductivity coefficient³, ability to reflect electromagnetic waves (luster and untransparency), plasticity⁴ at usual conditions”, considered as metals (p. 409).

Metallic conductivity type usually explained by presence of free electrons in metals which appear as a result of valent and conductivity zone overlapping, because the width of the forbidden zone in metals (DE_0) is 0.

Definitions of “semimetal” term which are given by chemists are completely unsuccessful. Thus, in CED [11] we can find: “**Semimetals** (semimetallic elements, “fragile metals”) - elements, occupying places on boundary between metals and nonmetals (how this boundary comes - it is not mentioned, although by different authors it is completely different; meaning of “on boundary” is not clear enough - A.G.) in Periodic system of elements by Mendeleev (here is the evident mixing of terms “elementary substance” and “element” - A.G.). They characterize by covalent crystalline lattice (this is not right, because “lattices” of elementary As, Sb and Te which are practically referred to semimetals by all authors are quasimolecular - A.G.) along with metallic conductivity (As, Sb, Te have semiconductive type of conductivity - A.G.). To semimetals are referred Sb, Bi, Po, sometimes (when ? - A.G.) also Ge, As, Te, although they are conductors by conductivity type (not conductors, but semiconductors ! - A.G.), and by chemical properties (which of them ? - A.G.) - nonmetals, and Sn which has semiconductor modification” (p. 472). In addition to numerous rough mistakes in this definition it can be noted, that as basis of referring of element (as a matter of fact simple substance) to semimetals the existence of polymorphs with semiconductor properties (case of Sn which has lowtemperature modification - “gray tin” with diamond structure and semiconductor properties) have been chosen. This present to be absolutely impossible, because polymorphs, including those of them which have semiconductor properties are known for other elementary metallic substances and vice-versa, some nonmetals and semimetals have polymorphs with metallic conductivity (for example, polymorphs of Ge and Si which are stable at very high pressures).

More clear definition is given in PED [54], where we can find: “**semimetals**” - substances, occupying by electrical properties intermediate position between *metals* and

³ Metallic Al has unlike the other metals positive thermal electroconductivity coefficient.

⁴ Not all of the metals are plastic and have low hardness. The most bright examples of fragile metals which differ by perfect cleavage and high hardness, are Cr and Os. The cleavage can be also found in monocrystals of iron which has malleability properties in polycrystalline blanks, and other metals. As it was shown earlier [18], such properties of metals could be explained by peculiarities of their chemical bond, when the covalent component of chemical bond is appeared equally with its metallic component.

semiconductors; ... from one side semimetals remain to be conductors up to absolute temperature naught, but from another side - with minor (comparing to metals) concentration of current carriers i . With temperature rising the number of carriers increased, electroconductivity raised too" (p. 563). Thus, semimetals characterized although by high conductivity, but of semiconductor type.

In connection with it, it is expedient to give both more strong definition of boundaries between metals, semimetals and nonmetals, and list of elementary substances, referred to each of these groups.

Earlier [21] was shown, that the boundary between metals from one side and nonmetals and semimetals from the other one in expanded variant of Periodic system comes among s-elements through H and He, referred to nonmetals and Li - Be, referred to metals. Further this boundary comes through p-elements as broken line $B \rightarrow Si \rightarrow Ge \rightarrow Sb \rightarrow Bi$. To the left from this boundary are the elements, forming only metallic elementary substances which completely suited for definition from PED [54], mentioned earlier. To the right of this boundary there are elements, forming elementary substances which have the properties of nonmetals and semimetals.

Indicated boundary is determined by diagonal similarity in properties of element pairs B - Si and Ge - Sb; and belonging of pairs Si -Ge and Sb- Bi to shrink-analogies after d and f pressing respectively.

Comparing the values of forbidden zone width of elementary substances of p elements (DE_0, eV):

B	C(diamond)	N	O	F	Ne
1,5	5,2	-	-	-	-
Al	Si	P(bl.)	S	Cl	Ar
0	1,21	0,33	2,6	-	-
Ga	Ge	As	Se	Br	Kr
0	0,78	1,2	2,1	-	-
In	Sn	Sb	Te	I	Xe
0	0	0,12	0,32	1,35	-
Tl	Pb	Bi	Po	At	Rn
0	0	0	0	?	-

and the values of their specific resistancy (ρ , om cm; at 20^0C): (see the next page),

B	C(diamond)	N	O	F	Ne
$4 \cdot 10^6 - 10^7$	$> 10^{16}$	-	-	-	-
Al	Si	P(bl.)	S	Cl	Ar
$2,5 \cdot 10^{-6}$	$2,3 \cdot 10^5$	$3,1 \cdot 10^6$	$2,0 \cdot 10^{16}$	-	-
Ga	Ge	As	Se	Br	Kr
$1,4 \cdot 10^{-5}$	48-60	$3,5 \cdot 10^{-5}$	1,2.10	-	-
In	Sn	Sb	Te	I	Xe
$8,2 \cdot 10^{-6}$	$1,0 \cdot 10^{-5}$	$4,3 \cdot 10^{-5}$	$3 \cdot 5 \cdot 10^{-1}$	$1,3 \cdot 10^9$	-
Tl	Pb	Bi	Po	At	Rn
$1,8 \cdot 10^{-5}$	$1,9 \cdot 10^{-5}$	$1,0 \cdot 10^{-4}$	$42 \cdot 10^{-3}$?	-

we can see, that by the value of ΔE_0 not only elementary substances which could be found to the left of the boundary metal \leftrightarrow nonmetal - Al, Ga, In, Tl, Sn, Pb, but also Bi and Po which laying to the right of this boundary, should be referred to metals. By the value of specific resistivity the number of substances which could be referred to metals is even greater. Thus, besides mentioned ones, there are As, Sb and with small strain Te among them.

Another picture is drawn by comparing structures with physical properties, connected with them, of considered elementary substances. So, elementary Al, Ga, In, Tl, Sn and Pb which are found to the left from the boundary metal \leftrightarrow nonmetal, have specific for metals crystalline structures (except Ga) and malleability, plasticity. Quite another matter - elementary As, Sb, Bi and Te, found to the right from this boundary which characterized by quasimolecular crystalline structures, typical for nonmetals, and as an effect - perfect cleavage, high fragility, not usual for metals.

Such properties of elementary As, Sb, Bi and Te, satisfied both for metals and for nonmetals from the other side, give us opportunity to mark out these substances as semimetals.

Besides As, Sb, Bi and Te, rare radioactive Po and At should be referred to semimetals. Because of the rarity and small quantities in which these substances known, we can consider on properties on whole about their belonging to semimetals.

Thus, on definition of Po in SCE [59] we could find, that elementary Po slowly dissolves in HCl with formation of ion Po^{2+} which oxidize by radioactivity itself up to Po^{4+} . Hydrogen sulfide sediments sulfide PoS from solutions of Po salts. For Po the following substances are well known: oxides - PoO and PoO_2 , halogenides PoX_4 , sulfates $\text{Po}[\text{SO}_4]_2$ and $\text{PoO}[\text{SO}_4]$, halogensalts $\text{M}[\text{PoX}_6]$. By these and many other features Po - is typical metallic element. Considerably rarely Po reveals features of nonmetals, come forward with Po^{2-} in hydride H_2Po and in polonides.

In definition of At from CE [9] we could find: "For At it is typical to combine properties of both nonmetals (halogens) and metals (Po, Pb, and so on). Thus, analogically to iodine, At could be easily dissolved and extracted by organic solvents; by fugitiveness it gives way to I_2 , but it could also be distilled away. By acting on At solution of hydrogen, gaseous HAt forming in reaction moment. Simultaneously to I_2 , At in water solution is reduced by SO_2 and oxidized by Br_2 . However, like metals, At could be sedimented from hydrochloric acid solutions by hydrogen. In presence of oxidants in water acid solutions At exists in single charged cation which probably has the following structure: $[\text{At}(\text{H}_2\text{O})_x]^+$, where $x = 1$ or 2 " (p. 397).

Especially we should concentrate on elementary Si and Ge which are referred by some authors [3] to semimetals, although, according to mentioned earlier values of width of forbidden zone and their specific resistivity values, they should be referred to nonmetals. Their referring to semimetals most likely is a result of misunderstanding. This could be connected with that elementary Si and Ge in private life and trade received names "metallic" silicon and germanium respectively because of their strong not metallic, but rather semimetallic lustre which is a result of pretty high concentration of current bearers at normal temperature in these semiconductors with diamond type structure. In accordance with it, it is necessary to remember that simultaneous names are used for some other nonmetals, for example, "metallic selenium" and "metallic iodine" which are characterized in elementary state by semimetallic lustre too.

All that was said shows, that elementary substances should be divided on: metals, semimetals and nonmetals.

To the last ones the elementary B; C (different allotropes), Si, Ge, N, P (different allotropes), O_2 and so on allotropes of O, S_8 and other allotropes of S, Se_8 and other

allotropes of Se; F₂, Cl₂, Br₂, I₂, and also H₂ and noble gases - He, Ne, Ar, Kr, Xe and Rn referred. Among them diamond and other allotropes of C, native Se, Ge, S (different allotropes), Se are known as minerals.

Boundaries between considered groups of elementary substances, in that way, could be presented by following:

B	C	N	O	F	Ne
Al	Si	P	S	Cl	Ar
Ga	Ge	<u><i>As</i></u>	Se	Br	Kr
In	Sn	<u><i>Sb</i></u>	<u><i>Te</i></u>	I	Xe
Tl	Pb	<u><i>Bi</i></u>	<u><i>Po</i></u>	<u><i>At</i></u>	Rn

Here is the boundary between metals which are typed in normal style, and nonmetals which are typed in semibold style, and semimetals, selected by italic and underlined, is shown by semibold broken line; thin broken line - boundary between semimetals and nonmetals.

Basic types of chemical substances, selected by primary type of chemical bond

The majority of elementary substances are referred to metals. Considerably less of them are semimetals. Nonmetals are not so numerous too. There are incomprehensibly more compounds of different elements with each other. The chemical bond type in them, their crystalline structures and properties are dependent on differences in electronegativity between substance-forming elements (atoms, ions), their atomic (ordering) numbers. Changing of chemical bond type, properties of compounds in dependence on changing of fundamental properties of atoms, forming them, could be happened either consequently or sporadically. Earlier [18], [21], [27] it was mentioned, that chemical bond should be considered as metallic-covalent-ionic-residual one in whole; its character in compound is defined not only by extent of covalency (ionicity), in general case by proportional difference in force characteristics (electronegativities), but also by extent of metallicity, determined by ordering number of element or by average ordering number of electropositive elements in compound. The extent of its "residuality" could in some cases be one more measurement of chemical bond which although could not be easily expressed through the mentioned fundamental properties of elements and atoms. Despite that the nature of chemical bond in all its demonstrations is the same, usually four extreme types of chemical bond are selected: metallic, covalent, ionic and residual bond which are expressed in different compounds in different extent.

Metals which elements occupied left greatest part of extended variant of Periodic system, by interaction with each other are forming substances with typical metallic properties - first of all with high conductivity, strong metallic lustre, determined by metallic type of bond or simply by metallic bond. Such substances called metallides or intermetallides. Unfortunately these terms have lost the most part of their definition up today, so now it is necessary to concentrate on them.

Thus, in CED [11] we could find: "**Metallides** (intermetallides), chemical compounds of two or several metals. Compounds of transitive metals with more electropositive nonmetals (H, B, C, N and so on), characterized predominantly by

metallic type of chemical bond, are also frequently referred to metallides (but may be in vain! - A.G.)” (p. 325). We can see, that this “definition” of metallides which have been given by S.S. Kiparisov, not so much appears to be really definition, as noncritical exposition of different ways to it. When different authors are unrestricted in referring various compounds to metallides by their matter of taste, but not by the basis requests of their definition.

Definition of metallides, given in SCE [58] is not much better. “**Metallic compounds** (metallides, metalsimilar compounds, intermediate phases in alloys) - chemical compounds which have metallic properties (which of them? - A.G.) The majority of metallic compounds are formed by interacting of several metals (intermetallic compounds), but they could also include (in which appearance, in which quantities? - A.G.) C, N, B, Si, H and other nonmetals (which of them? - A.G.). In accordance with it metalsimilar carbides, nitrides, borides, silicides, hydrides and so on are referred to metallic (!!! - A.G.) compounds” (p. 139). But where should we refer numerous nonmetalsimilar carbides, nitrides, borides, silicides with covalent (muassonite) or even ionic chemical bond, compounds with polyradicals as $\text{Ca}[\text{C}_2]$ and what means “metalsimilar” - is not clear. In this way, this definition, belonging to B.K. Wolf, can not sustain any criticism too.

More recent definition from CE [10] is not also clarify this situation. Where we can find: “**Metallic compounds** (metallides) have metallic properties, in particular electrical conductivity which caused by metallic character of chemical bond. To metallic compounds refer compounds of metals with each other - *intermetallides* and more other compounds of metals (in general of transitive ones) with nonmetals. Metallic properties are usually strongly clarifying in rich-metal compounds - lowest carbides, nitrides, sulfides, oxides and so on” (p. 42).

The wide treatment of notion “metallides” (intermetallides) to which referred not only compounds of metals with each other, but also compounds with semimetals, H (hydrides), light nonmetals with from 1 up to 3 p-electrons - B, C, Si, N and P (borides, carbides, silicides, nitrides, phosphides), accepted by W. Pearson [53], P.I. Kripyakevich [41]. And what is more, P.I. Kripyakevich as intermetallides considers some selenides, sulfides, sulfosalts and even oxides, especially those of them which are subcompounds or substances with cluster [5] structure.

At the same time, in reference book on chemical nomenclature by A.I. Busev and I.P. Efimov [8] we could find much more narrow treatment of these terms: “**Metallides** (intermetallic compounds) - chemical compounds of metals with each other. The metallic chemical bond is the prevalent one in such compounds. Metallides are not submitting by regularities of composition permanency and simple divisible ratios.” (p. 109). The last statement is not, however, correct. Thus, among metals from one side there are compounds which are not submitting by simple divisible ratios, by usual valent states of elements - in composition of such compounds electropositive elements sharply predominate upon electronegative ones, and they called *subcompounds*. The electronic structure of such substances, their abilities of isomorphism are usually analyzed with consideration of so-called electronic concentration [33]. From the other side among metals there are a lot of compounds, in which elements have their usual valences and characterized by simple integer ratios. At the same time there are many compounds with variable in definite limits composition which are referred to metallides - bertollides, ordered alloys - Kurnakov’s phases.

Considering all mentioned contradictions in terminology, we will limit term metalloids only by compounds of metals with each other, - elements which could be found to the left from mentioned earlier boundary metal \leftrightarrow nonmetal in extended variant

of Periodic system. Term “intermetallides” like all its synonyms, should be recognized as indefinite, obsoleted and should be excluded from usage. Metallic conductivity, frequently metallic lustre and malleability are typical for metallides. These properties are defined by metallic type of chemical bond which is typical for these substances.

Simultaneously to metallides it is expedient to select also *semimetallides* to which we could refer compounds of metals with semimetals - arsenides, antimonides, bismuthides and tellurides (polonides and astatides which are not known in mineral forms, could be referred to them also). Here are the substances with high conductivity, frequently of semiconductive type, with metallic lustre, fragile, in some cases with cleavage, up to perfect one (tetradimite mineral family). These minerals are characterized by chemical bond with predominance of its metallic component.

After that, the association of compounds of electropositive (metallic) and semimetallic elements with the rest of nonmetallic elements in *nonmetallides* is coming real by itself. Overwhelming number of compounds from chalcogen up to halogen with pretty various properties, defined by consequent decreasing of metallicity extent and covalency extent of chemical bond and increasing of its ionicity extent in mentioned direction, are referred to nonmetallides.

Among nonmetallides IVa-nonmetallides are distinguished by their properties, what is defined by special - “passing” - place of IVa-elements in Periodic system. This clarifies in what to the left to IVa group practically only metallic elements could be found, but to the right from it - rather nonmetallic and semimetallic. There is only one exception - B which is referred to nonmetallic elements, placed in IIIa-group; the last two elements of IVa group - An and Pb are referred to metallic elements too. Exactly the same peculiar placement of IVa elements in Periodic system brings E. Zintl and H. Kaiser [69] to confinement, that this group could be considered as boundary between metallides and nonmetallides. Later this boundary was called Zintl boundary, although it was unclear, but rather diffusual, what was stressed by T.V. Massalskyi [47] and what is presented to be natural, because of that was said.

By special placement of IVa group in Periodic system such specific properties of IVa-nonmetals as their ability to form entire variety of organic compounds, including hydrocarbons, siliciumhydrogens (silanes, silones and so on), germaniumorganic compounds which are more rare, but rather close by structure and properties to them, could be explained. At the same time carbides, silicides and germanides could be considered as derivatives of respective hydrogen compounds. Depending on electropositive element, they could have completely different type of chemical bond, including metallic, covalent, residual or ionic one. By this the variety in properties of such compounds, including differences in crystalline structure, difficulty of determining their place in total sequence of taxon changing in systematic, is defined. Thus, it was already mentioned, that some authors include them in “intermetallides”. However, it is uncomfortable not only because of the specific properties of these substances, but also therefore, that such their position splits natural connections and transforms in united series: metallides → semimetallides → chalcogen compounds → oxygen compounds → halogen compounds which is presented to be natural changing of chemical bond type: metallic → metallic-covalent → ionic-covalent → covalent-ionic → ionic bond.

Considering what was said, the most correct way is to select from total series of different compounds those substances which are formed by IVa-nonmetallic elements, excluding compounds like carbonates which should be considered with the rest of oxygen compounds by particularities of their composition and properties. Compounds of IVa-nonmetals, including native minerals, carbides, silicides and organic compounds, should be considered as concluding ones in the systematic. Such compounds of Va-

nonmetals (N and P) as nitrides and phosphides which are close by their properties, structures, mineralforming conditions to carbides and silicides, and which have such common features with IVa-nonmetals, as for example that they belonging to the light (containing from 1 up to 3 p-electrons) typical p-elements (2 and 3 periods), are also referred here. It is important, that in this case organic compounds which are concluding the mineralogical systematic, are found their legal place.

Simple compounds, binary and more complex compounds, salts.

Such terms as simple compounds, binary and more complex compounds, salts, are very important in order to understand the basis of mineral systematic. Compounds of two elements which consist of simple cations and anions are usually referred to *simple* substances⁵. For example of simple compounds we could mention sphalerite ZnS, chalcocite Cu₂S, antimonite Sb₂S₃, hematite Fe₂O₃, halite NaCl and so on minerals. By their properties they could be referred to bases, amphoteric compounds, anhydrides. Some of them, for example, sphalerite ZnS, chalcocite Cu₂S, antimonite Sb₂S₃, halite NaCl are, at the same time, salts of nonoxygen acids, such as H₂S, HCl. Minerals which contain simple complex ions, for example, ammonium chloride NH₄Cl or simple complex anions, for example, pyrite Fe[S₂], arsenopyrite Fe[AsS], scutterudite Co₄[As₄]₃ could be referred to simple compounds too.

To *binary* or more complex compounds referred minerals which contain more than one cation. For example chalcopyrite CuFeS₂, stannite CuFeSnS₄, perovskite CaTiO₃, ferberite FeWO₄, gagarinite NaTRCaF₆, carnallite KMg(H₂O)₆ Cl₃.

Significantly more complex is term "salts". Thus, in book by A.I. Busev and I. P. Efimov [8] we could find: "Salts - the class (what is class is not defined at all and in this case this term hasn't any special taxonomic assignment - A.G.) of chemical compounds, crystalline substances which have ionic structure (not always! - A.G.). By dissociation in aqueous solutions salts give positive charging ions of metals and negative charging ions of acid residues (sometimes also ions of hydrogen or hydroxo-group)" (p. 419).

In CED [11] the following definition is given: "Salts - are the products of substitution of H atoms in acids instead of metal or of OH group in bases instead of acid residuum. By the complete substitution normal or average salts are forming, for example NaCl, K₂SO₄, (C₁₇H₃₅COO)₃Al. Incomplete substitution of H atoms brings to acid salts (for example ammonium hydrosulfate NH₄HSO₄) incomplete substitution of OH groups - to basis salts, for example aluminum dihydroxostearate (C₁₇H₃₅COO)Al(OH)₂ ... Salts usually have ionic crystalline structure⁶ and characterized by relatively high temperature values of melting and boiling points. Many salts are soluble in water⁷, with complete dissociation on ions" (p. 533).

The most essential drawback of all these definitions is that they are limited by oxygen and often water-soluble compounds. Only in acid definition which is given in

⁵ Electropositive components of compound called cations without any dependence on chemical bond type. That is why cations in compounds with different type of chemical bond are playing different role, approaching to idealized positive charged particle by increasing of chemical bond ionic extent. Thus, cations in the majority of sulfates, nitrates, chlorides (except minerals of Ag), halogen salts are close to ideal cations. By this time, in compounds with preferred metallic and covalent chemical bond, so-called cations takes their part only as electropositive components of compound. We could say the same thing about anions, as electronegative components of compound.

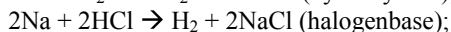
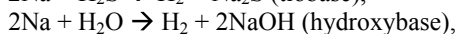
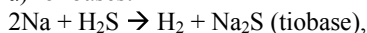
⁶ The chemical bond between cation and acid residuum in chalcophylic element salts, especially of weak acids, often is covalent.

⁷ Silicium acid salts - silicates, the most numerous among minerals, in majority hardly soluble in water; low solubility of compounds is one of the most important conditions of their long preservation in form of minerals in nature.

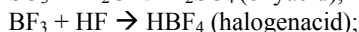
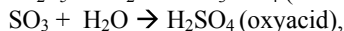
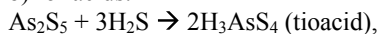
CED, it is mentioned, that the substitution of O atoms instead of S atoms brings to formation of tioacids. At the same time, salts of tioacids - tiosalts⁸ - are extremely numerous among minerals and have been considered since V.I. Vernadkiyi as products of reaction between tiobases (Na₂S, FeS, Cu₂S and etc.) and tioanhydrides (As₂S₃, Sb₂S₃, Bi₂S₃ and so on). The fact of existence of halogenanhydrides, halogen acids⁹, halogenbases and product of their reacting - halogensalts¹⁰ which are also numerous in nature [24] is practically ignored. Talking about bases, anhydrides, acids, salts, it is necessary, in this way, to distinguish chalco- oxy- and halogenbases, chalco- oxy- and halogenanhydrides, chalco-, oxy- and halogenacids, chalco-, oxy and halogensalts [26], [27].

Their forming could be presented by the following reactions:

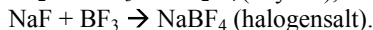
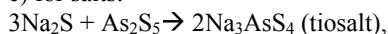
a) for bases:



b) for acids:



c) for salts:



Every of the enumerated groups of substances has special properties. Thus, typical bases are characterized by ionic cation-ligand bond, ionic homodesmic coordinate structure, and in limit, the most typical cases - good solubility in water and dissociation in solutions by the reactions like $\text{Na}_2\text{S} \rightarrow 2\text{Na}^+ + \text{S}^{2-}$, $\text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^-$, $\text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$. Bases are characterized by low valency (W) of cations, relatively high temperatures of melting point, low vapor resiliency. By increasing of covalent extent of bond cation-ligand, all mentioned properties become less definite.

Typical anhydrides, for example As₂S₅, As₂S₃, SO₃, P₂O₅, BF₃, SiF₄ are characterized by molecular (SO₃, P₂O₅, BF₃, SiF₄) or quasimolecular¹¹ (As₂S₅, As₂S₃)

⁸ Tiosalts are referred to chalcosalts, including tio- and seleniumsalts; here and further we use prefix "chalco" not as uniting term, covering compounds of all IVa-elements - O, S, Se, Te, Po, what is unsuccessfully recommended by "IUPAK chemical nomenclature rules" [52], but rather just as referring to compounds of S and Se one.

⁹ In CED [11] halogenacids are referred to so-called beyondacids (superacids, magical acids), defined as "complex nonwater (more correct - nonoxygen - A.G.) mineral acids, acidity of which is higher, then of 100% H₂SO₄" (p. 517); among their examples the products of reaction of halogenanhydrides (AsF₅, SbF₅, BF₃) with protoncontaining nonoxygen acids (HF and so on) are noted.

¹⁰ It should be noted, that chalcobases and halogenbases are at the same time the salts of nonoxygen acids such as sulfurhydrogen, hydrogen chloride and so on, differing by all usual for them properties, particularly by that they easily dissolve in water, dissociating on cations Na⁺ and anions S²⁻ (in case of Na₂S) and Cl⁻ (in case of NaCl).

¹¹ Term "quasimolecular structure", "quasimolecular crystal" are introduced for solid state substances, intermediate between lowmolecular or simply molecular (SO₃, P₂O₅, BF₃, SiF₄ - in their structures there are small discreet molecules which are connected with each other by residual bond) and polymeric highmolecular compounds. There are indefinite in one (chains and ribbons), two (layers) or even three dimensions (frameworks) in structure of quasimolecular compounds. Quasimoleculars are connected in structure by residuum, covalent-residual and so on bonds. From polymeric moleculars, quasimoleculars are

structure with covalent bond inside molecules (and quasimolecules) and residual bond between them. That is why the most typical of such substances are not dissolve in water or react with it intensively, they have low temperatures of melting points, high vapor resiliency. Highcovalent cations-anionformers (W usually 4, rare 3 like B) are extremely usual for them.

Chalco-, oxy- or halogensalts could be defined as products of reaction of chalco-, oxy- or halogenbases with chalco-, oxy- or halogenanhydrides which are in most typical cases have heterodesmical bond - ionic one between cations and acid residues and ionic-covalent one between anionformer and ligands. Such salts are good dissolving in water with formation of positive charged cations and negative charged complex anions, preserving in solutions the same form as in crystalline solids, although they are often hydrotated in one measure or another. Increasing of the covalent or metallicity extent of bond cation - acid residuum (anionic radical) brings to decreasing in salt solubility¹².

From the crystallochemical point if view the essential feature of salts is heterodesmicity of their structures for which both simple (Na^+ , Ca^{2+} and so on) and complex ($[\text{Mg}(\text{H}_2\text{O})_6]^{2+}$ and so on), including polymer ($[\text{Na}(\text{H}_2\text{O})_4]^{3+}$ and so on) cations and in obligatory order complex, mono- or heteronuclear, mono- or polymeric, for example, $[\text{SO}_4]^{2-}$, $[\text{SiO}_4]^{4-}$, $[\text{Si}_2\text{O}_6]^{4-}$, $[\text{AlSiO}_4]^-$, $[\text{B}_2\text{O}_5]^{4-}$ and so on anions are typical.

Belonging of given substance to simple, binary compound or to salt is determined by fundamental properties of substanceforming atoms - their FC and Z, their ratios, by affiliation of substance to chalcogen, oxygen or halogen compounds. General regularity is that transformation: simple compound \rightarrow binary compound \rightarrow salt, has come by increasing of difference in FC of substanceforming cations, i.e. by increasing of ionic extent of chemical bond; as far as decreasing of their total or average Z, i.e. decreasing of metallicity extent of chemical bond could be favorable for transformation either to one or to another direction.

All what was said could be illustrated by transformation simple compound \rightarrow binary substance \rightarrow salt in sequence of oxygen compounds AO_2 (simple cation A oxide) \rightarrow ABO_4 (complex cations A and B oxide) \rightarrow $\text{M}[\text{TO}_4]$ (oxysalt of M^{n+} cation and tetrahedral anionic radical $[\text{TO}_4]^{n-}$ with anionformer T) with dependence on difference in FC between cations (A and B; M and T) and total value of Z, in which cations A(B) and M(T) respect to s- and d-cations (Fig. 1). On considered figure simple oxides AO_2 with rutile structure and binary oxides ABO_4 with dirutile structure placed in the left part with minimal values of differences in FC and with oscillating in wide limits values ΣZ (area I). To the right and upward from this area there is area II - complex oxides with ferberite structure $^{(6)}\text{Fe}^{(6)}\text{WO}_4$, changing with increasing of differences in FC by area III - oxysalts with scheelite structure $^{(8)}\text{Ca}[\text{WO}_4]$. Further increasing of differences in FC brings to increasing of cation CN in oxysalts $\text{M}[\text{TO}_4]$ (changing of areas IV \rightarrow V \rightarrow VI) along with preserving their oxysalt nature.

differed by simple structure, saving of their forms in crystallic solid (in solid polymers macromolecules laid in packages or globulas). Crystallic solids which include quasimolecules, have not only near, but also far order, as far as in solid polymers far order is absent, that is why they have renthenoamorphic properties.

¹² To salts, as it was already said, referred also substances which could be considered as products of reaction between oxybases and nonoxygen acids like H_2S , HF and so on, for example, Na_2S , NaF and so on which in typical caseses have isodesmical structures, ionic bond, high solubility, dissociating on simple cations and anions and which are, at the same time, chalco- and halogenbases which should be considered, in order to avoid the confusion and because of the matives, mentioned earlier, as such, with distinguishing from other salts.

Analogical regularities were found for great number not only of other oxygen, but also of chalcogen and halogen compounds [26], [27].

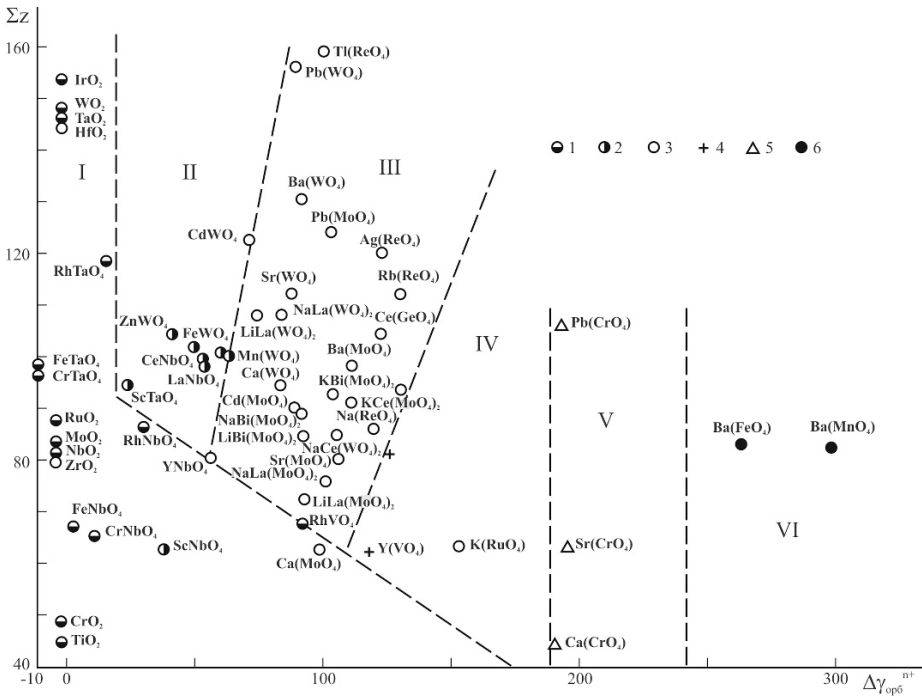


Fig.1 The dependence between the total value of atomic number (ΣZ) of atoms A(B), M(T), difference of their force characteristics ($\Delta\gamma_{\text{опб. n}^+}$) and the structure of compounds formed by them in sequence of oxygen compounds $2\text{AO}_2 \rightarrow \text{ABO}_4 \rightarrow \text{M}[\text{TO}_4]$.

(T) = *d*- cations; I – area of crystals with rutile (TiO_2 and so on.) or dirutile (FeNbO_4 and so on) structures, II – area of crystals with structure of ferberite FeWO_4 , III – of scheelite $\text{Ca}[\text{WO}_4]$ type, IV – of type of $\text{Y}[\text{VO}_4]$, V – of type of $\text{Pb}[\text{CrO}_4]$, VI – of type of $\text{Ba}[\text{FeO}_4]$; the type of structure: 1 – TiO_2 , 2 – FeWO_4 , 3 – $\text{Ca}[\text{WO}_4]$, 4 – $\text{Y}[\text{VO}_4]$, 5 – $\text{Pb}[\text{CrO}_4]$, 6 – $\text{Ba}[\text{FeO}_4]$.

All what was said tells not only about considerable differences in crystalline structures and properties of simple compounds, complex compounds, salts, but also about their natural change in mentioned order as long with changing of FC and Z, and creates the basis for classification of substances in limits of chalcogen, oxygen and halogen compounds.

Geochemical classification of elements and cations

The first highly successful geochemical systematic of elements which haven't lost its significance by now was element separating on geochemical (genetic) groups, offered 70 years ago by V.M. Goldschmidt [32]. This systematic he has based from one side on division of elements along with fusion of metals on metallic melt - sulfide melt,

harden as matte and silicate melt, harden as slag, taking this process as a model of Earth substance differentiation in development process. From the other side he has paid the attention that elements which are typical for mentioned metallurgy products, have taken not accidental, but rather defined position in curve of dependence of atomic volumes of elementary substances upon atomic (ordered) element number¹³ (Fig. 2).

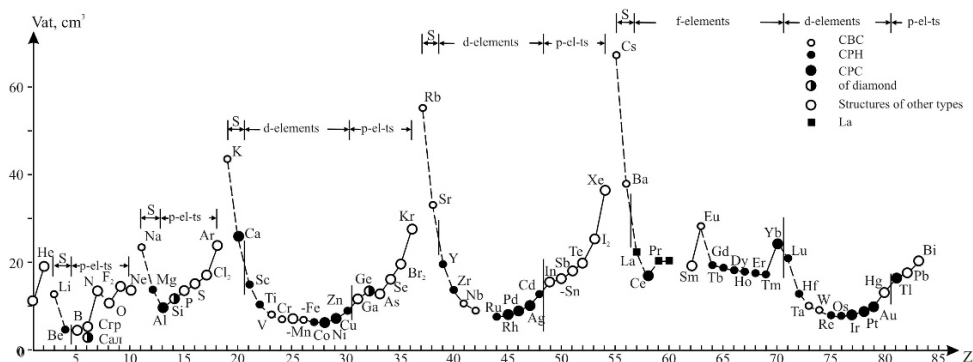


Fig. 2 The variation of atomic volume of elementary substances (V) by increasing of atomic number (Z) of corresponding elements. 1 – cubic body-centered, 2 – close-packing hexagonal, 3 – close-packing cubic, 4 – of diamond, 5 – ionic type structure, 6 – structures of La.

On this basis V.M. Goldschmidt has divided all elements on 4 groups:

1. *Siderophylic* elements, placed in minimal parts of curves of dependence of atomic volumes upon atomic number. To them he referred C, P, Fe, Co, Ni, Tc(Ma), Mo, Ru, Rh, Re, Os, Ir and Pt.
2. *Chalcophylic* elements, placed in ascending parts of curves of dependence of atomic volumes upon atomic number - S, Cu, Zn, Ga, Ge, As, Se, Pd (more correctly it should be referred to siderophylic elements), Ag, Cd, In, Sn, Sb, Te, Au, Hg, Tl, Pb, Bi и Po.
3. *Lithophylic* elements, placed in descending parts of curves of dependence of atomic volumes upon atomic number - Li, Be, B, Na, Al, Si, K, Ca, Sc, Ti, V, Cr, Mn, Rb, Sr, Y, Zr, Nb, Cs, Ba, Ln, Hf, Ta, W, Fr (it has not been placed yet on V.M.Goldschmidt's curve), Ra, Ac, Th, Pa, U; here he referred also O, F, Cl, Br, I, placed on ascending parts of considered curves, taking into account commonness of these elements in minerals of rocks and doing deviation from logical-formal in favor to natural element classification.

¹³ This curve, firstly used by D.I. Mendeleev [48] and L. Mayer [49], usually because of substitution of terms element and elementary (simple) substance, incorrectly called “curve of atomic volumes of elements”. Along with it, it is forgotten that in its basis have been put only one property of elements - their ordered numbers, as far as values of atomic volumes are referred to elementary substances, but not to elements and their utilization with clarifying of element properties is not correct enough, that was discussed in detail before [18], [19].

4. *Atmophylic* elements, placed in upward parts of curves of dependence of atomic volumes upon atomic number - He, N, Ne, Ar, Kr, Xe, Rn; here he referred H too.

Not disclaiming successfulness of offered by V.M. Goldschmidt terms which are correspond to objective existing regular connections of element structures and their behavior in natural processes, expressed, in particular, on mentioned figure, what was determined their vitality, it is necessary to stress, that such general conclusion of element properties inevitably brings us to disputable places of some of them, especially those ones which could be referred equally to different groups. We could note more contradictions which have roots in fact that curve of atomic volumes, used for systematic, was built with using only one element property - their order numbers. All other used values - atomic volumes - are referred not to elements - totality of atoms of one sort in free state, but rather to properties of elementary substances, depending upon their crystalline structure, physical-chemical parameters which are defined the stability of one or another concrete polymorphic modification.

Definite discrepancies of his systematic of elements to actual material V.M. Goldschmidt has felt himself soon. In accordance with it in 1928 year [33] he has already noted, that element comparing on atomic volumes is correct only if they are stated at the same valency condition and have the same CN. The same thing was noted by A.E. Fersman [14].

Definite limited nature of element classification offered by material V.M. Goldschmidt has been taken into account by V.V. Shcherbina [61], who stressed the importance of magnetic properties of elementary substances, type of cations, formed by given element for classification of elements. In connection with it he wrote: "... being of certain element in one or another group (considering geochemical groups of elements by Goldschmidt - A.G.) not disturbs it to clarify its peculiarities which could be typical for other groups. Thus, for iron it could be said, that it possess both lithophylic and chalcophylic and siderophylic properties, but, taking in mind, that world consists of metallic iron, that iron has a lot of properties of siderophylic elements, it could be referred to siderophylic elements. Tin, owing to paramagnetic properties, could be found mainly in form of cassiterite in association with lithophylic elements in nature, but by several of its properties (atomic structure, formation of complex sulfides and so on) it could be referred to chalcophylic elements. Presence of small quantities of tin in many sulfide minerals confirms this point of view.

Arsenic, when it plays cation part, i.e. in form of As_2S_3 and its compounds, undoubtedly is chalcophylic. Vice versa, anionic arsenic in sperrylite $PtAs_2$, smaltite $CoAs_2$ and so on characterize the siderophylic nature of these elements. Halloids, laid on ascending curve, referred to the typical lithophylic elements.

Palladium, owing to the sequence of its properties, is referred to chalcophylic elements by many authors, although, perhaps, more correctly to refer it to siderophylic group.

Molybdenum, inspite of its primary place in nature exclusively in form of sulfide - molybdenite¹⁴ - nevertheless could not be referred to chalcophylic elements, because molybdenum is paramagnetic (this is about elementary substance, but not about element - A.G.), not forming ion with 18 outer-shell electrons, not forming complex sulfides like $R_2S'MoS_2$ or $RS'MoS_2$; molybdenite frequently occurs without escort of other chalcophylic elements in nature. At least, litho-, chalco- and siderophylic properties,

¹⁴ V.V. Shcherbina failed to take in consideration the existence of different complex oxides of Mo and W, molybdates and tungstenates in nature. Along with it in some tungstenates, for example in scheelite, the quantity of isomorphous dashes of Mo achieves industrial significant values.

based on ionic structure, are periodical properties too. Lithophilic elements changed by siderophilic, and siderophilic - by chalcophilic, that is why element, placed between litho- and siderophilic elements, could be referred to chalcophilic elements hardly. As for its affinity with sulfur, it could be explained by nontypical placement of outer-shell electrons in molybdenum atom." (p. 32-33).

Unsatisfaction in V.M. Goldschmidt's systematic brings to development of personal geochemical systematics by several scientists. Particular interesting were those of them which were offered by A.E. Fersman [14] and A.N. Zavaritskyi [68].

In Fersman's systematic we should stress the selection of typical elements (i.e. elements with centrosymmetrical outer-shell and subouter-shell electrons). This were done by separating of these elements from the rest by double horizontal line. In upward part of table there are all typical elements from first three periods, and elements from K up to Ni including too. By this the special properties of majority of elements, referred to first seria of d-elements which referred, as it has been established later [62], to centrosymmetricals too, were pointed out.

Geochemical classification by A.N. Zavaritskyi differs by the greatest consequence and detailness. It is based, from one side, on element properties which are reflected in extended variant of Periodic system, from the other side - on enormous personal experience of outstanding petrographier and petrologer. He selected in limits of Periodic system 11 element areas:

1. Hydrogen area - H, stressing its special role in minerals.
2. Noble gas area - He, Ne, Ar, Kr, Xe, Rn.
3. Rock elements area - Li, Na, K, Rb, Cs, Be, Mg, Ca, Al, Si.
4. Area of elements of magnetic emanations - B, C, N, O, P, S, F, Cl.
5. Iron group elements area - Ti, V, Cr, Mn, Fe, Co, Ni. Touching this group A.N.Zavaritskyi noted, that "geological processes of iron ore forming are much closer to processes of rock forming, then to processes of forming of other element ores. Such ores are magmatic iron ores and ores of sediment genesis" (p. 16).
6. Rare element area - Sc, Y, Ln, Zr, Hf, Nb, Ta, as that A.N.Zavaritskyi noted definite convention in uniting of elements in this group.
7. Radioactive elements area - Fr, Ra, Ac, Th, Pa, U.
8. Platinum group elements area - Ru, Rh, Pd, Os, Ir, Pt.
9. Metallic (colour) elements area - Cu, Ag, Au, Zn, Cd, Hg, Ga, In, Tl, Ge, Sn, Pb.
10. Metalloid metalogenic elements (elements "sulfoacids") area - As, Sb, Bi, Se, Te, Po.
11. Heavy halloids area - I, Br, At.

Mo, W, Tc and Re remained without selected areas in A.N. Zavaritskyi's systematic.

Separately we need to note, that systematic by A.N. Zavaritskyi, as he noted himself, is by many features close to technical classification of elements by G.Berg, developed on the basis of exceptionally industrial (technical) features, what is consolidates the importance of both of them.

Our mineralogy-crystallochemical systematic of elements is prove to be close to considered earlier. This systematic developed with taking into account recent data on peculiarities of electronic structure of elements - studies about ceno- and noncentrosymmetrical electrons, elements, different extents of closeness (analogy) in properties of elements as a dependence on their electronegativeness, expressed by force characteristics - FC and order number of element Z [5], [26], [31], although it has some essential differences. It is comfortable to combine selected in this systematic 13 areas of elements into more important groups, using terminology of V.M. Goldschmidt,

changing, however, groups filling with considering of mentioned data. In this case we will have the following element systematic:

1. Hydrogen - H. Selecting H into separated group is corresponding to systematic by A.N. Zavaritskyi.
2. Lithophylic elements with low FC.
 - 2.1 Alkaline and alkaline-earth elements - Li, Na, K, Rb, Cs, Fr; Mg, Ca, Sr, Ba.
 - 2.2 Rare earth and radioactive elements - Sc, Y, Ln (La - Yb), Th, U.
 - 2.3 Amphoteric elements - Be, Al, (Ga)
 - 2.4 Centrosymmetrical d'-elements - Ti, V, Cr, Mn, Fe, Co, Ni - group of elements fully analogical to iron group of A.N. Zavaritskyi; Ti connected by diagonal similarity with Nb and Ta, referred to the next group 3.1. The isomorphism between them and commonness of Ti dashes in Nb and Ta minerals and vice versa could be explained by this.
3. Lithophylic elements with middle FC
 - 3.1 Noncentrosymmetrical d'-complexformers - Zr, Hf, Nb, Ta.
 - 3.2 Mo and W.
4. Noble-metallic (siderophylic) elements - Ru, Rh, Pd, Ag, Os, Ir, Pt, Au; among them Ag and Au often are found in chalcophylic minerals and associations.
5. Chalcophylic elements.
 - 5.1 Chalcophylic elements with low FC - Cu, Zn, Cd, Hg, (Ga), In, Tl, Pb.
 - 5.2 Chalcophylic elements with middle FC - Ge, Sn, As, Sb, Bi, Se, Te. Groups 5.1 and 5.2 are close to groups 9 - metallic (colour) elements and 10 - metalloid metalogenic elements (elements "sulfoacids") of A.N. Zavaritskyi respectively, with the exception of Ge and Sn which he referred to group 9.
6. Light anionformers - B, C, Si, N, P, O, S, F, Cl - group of elements fully analogical to group of elements of magmatic emanations by A.N. Zavaritskyi, included in form of anionformers (B, C, Si, N, P, S) or anions (O, F, Cl) into lithophylic minerals, and only S plays, along with it, anion role in chalcophylic minerals.
7. Heavy anionformers - Br and I.
8. Noble gases elements - He, Ne, Ar, Kr, Xe, Rn.

This mentioned systematic, however, needs in additional specifications, because, as it was said earlier [26], [27], the majority of elements are amphoteric and their acid-basic properties are defined by properties of other elements, included in compound, their ratios, physical-chemical parameters of systems in which this mineral was formed or placed. It was shown, that the considerations about amphoterity in use for crystalline substances, should be based on values of CN of cations. General regularity here is that increasing of cation's CN brings to strengthening of its basic properties, and decreasing of its CN, opposite, - to increasing of its acid properties. Thus, the cations of typical siderophylic elements could in crystallochemical relation be the analogies of typical lithophylic elements, and cations of typical chalcophylic elements could be the analogies of typical lithophylic elements. In this connection, we could point-out Mn^{2+} , Fe^{2+} , Co^{2+} , Ni^{2+} which along with CN = 6 are the crystallochemical analogies for Mg^{2+} ,

what is clarifying in wide isomorphism among them, formation not only isoformular, but also isostructural compound. Simultaneously, Pb^{2+} with CN 12 is crystallochemical analogue of Ba^{2+} , K^+ in minerals like hollandite, Ca^{2+} - in makedonite (PbTiO_3) which is close to perovskite structure (CaTiO_3); Tl^+ with CN = 12 is analogue of typical lithophylic alkaline K^+ in isostructural pair djerfisherite - thalfenisite. There are a lot of such examples, what is difficulties using of generalized systematic of elements (cations) like considered before.

Differences in acid-alkaline properties of cations with different CN is comfortable to express by set values of FC - their references to CN - FC/CN which along with the electronic type of cation (s-, f-, d-, p-), its order number allow to come to very important conclusions. Let's see it in detail in order, replying for transformation from s-, f- through d- to p-elements.

Elements of s- and f-type in majority give cations with so low values of FC/CN, that almost all of them could be referred to cations with alkaline or clear basic properties (Fig.3).

Particular place among s-cations occupies Li^+ , for which with CN = 4 FC/CN = 7,1, Mg^{2+} which has FC/CN with CN = 6 equal to 10,2, and with CN = 4 - 15,3; and Be^{2+} which FC/CN with CN = 6 equal to 21,8, and with CN = 4 - 32,8. All mentioned peculiarities of these cations clarify in their special behavior in compounds. Thus, Li^+ is not isomorphous to other s-cations of Ia-group with lower FC/CN. At the same time, its compounds by their properties and mineralforming conditions are clearly differ even from isostructural minerals. For example, we could cite holmquistite, lepidolite and spodumene which are in this connection "rara avis" in families of amphiboles, micas and pyroxenes respectively.

The role of $^{60}\text{Mg}^{2+}$ in minerals is also original. In many of them it shows isomorphism up to full one with cations like $^{56}\text{Fe}^{2+}$, $^{55}\text{Mn}^{2+}$, but not with other IIa-cations, in sequence of minerals (for example, in micas, chlorites) it is isomorphous in wide limits to $^{27}\text{Al}^{3+}$. But cations of $^{40}\text{Mg}^{2+}$ could be isomorphous even to cations like $^{27}\text{Al}^{3+}$ or they could play crystallochemical role, simultaneous to last ones which is appeared, for example, in oxyspinellides. By this way, in crystallochemical relation in Mg^{2+} the transformation to amphoteric cations is clarified.

The typical amphoteric s-cation is Be^{2+} , for which in minerals CN = 4 is usual (FC/CN = 32,8). The formation of minerals like beryllsilicates, characterized by that they contain heteronuclear beryllium-silicium radicals, beryllphosphates with mixed heteronuclear beryllium-phosphates radicals and so on minerals, is directly connected with this.

The U^{6+} for which more than 180 mineral species are known with U^{6+} in form of ion uranyl $(\text{UO}_2)^{2+}$, has special position among considering f-cations. Among them there are small number of respectively simple compounds, as far as the majority of them has properties of salts of weak acids, in which uranyl ion is included in complex anion radicals. This has been established in uranates and in numerous salts of uranyl-acids. Because by now there is no precise values of FC of U^{6+} , in order to determine the FC/CN ratio we have to take two extreme values of FC. Along with it, it is important, that even with respectively high values of CN ($8 = 2 + 6$ and $6 = 2 + 4$) they are noticeable higher than analogue values of almost all considered s- and f-cations, except $^{40}\text{Be}^{2+}$. Thus, all considered cations could be divided on two types 1) lithophylic s- and 2) lithophylic f-cations which are clearly isolated on mentioned Fig. 3.

As it was known, two d-elements - Sc and Y are close by their properties to lanthanides. Their closeness is so great, that they are usually situated in the same minerals in form of isomorphous mixtures and they could be hardly separated by chemical ways from

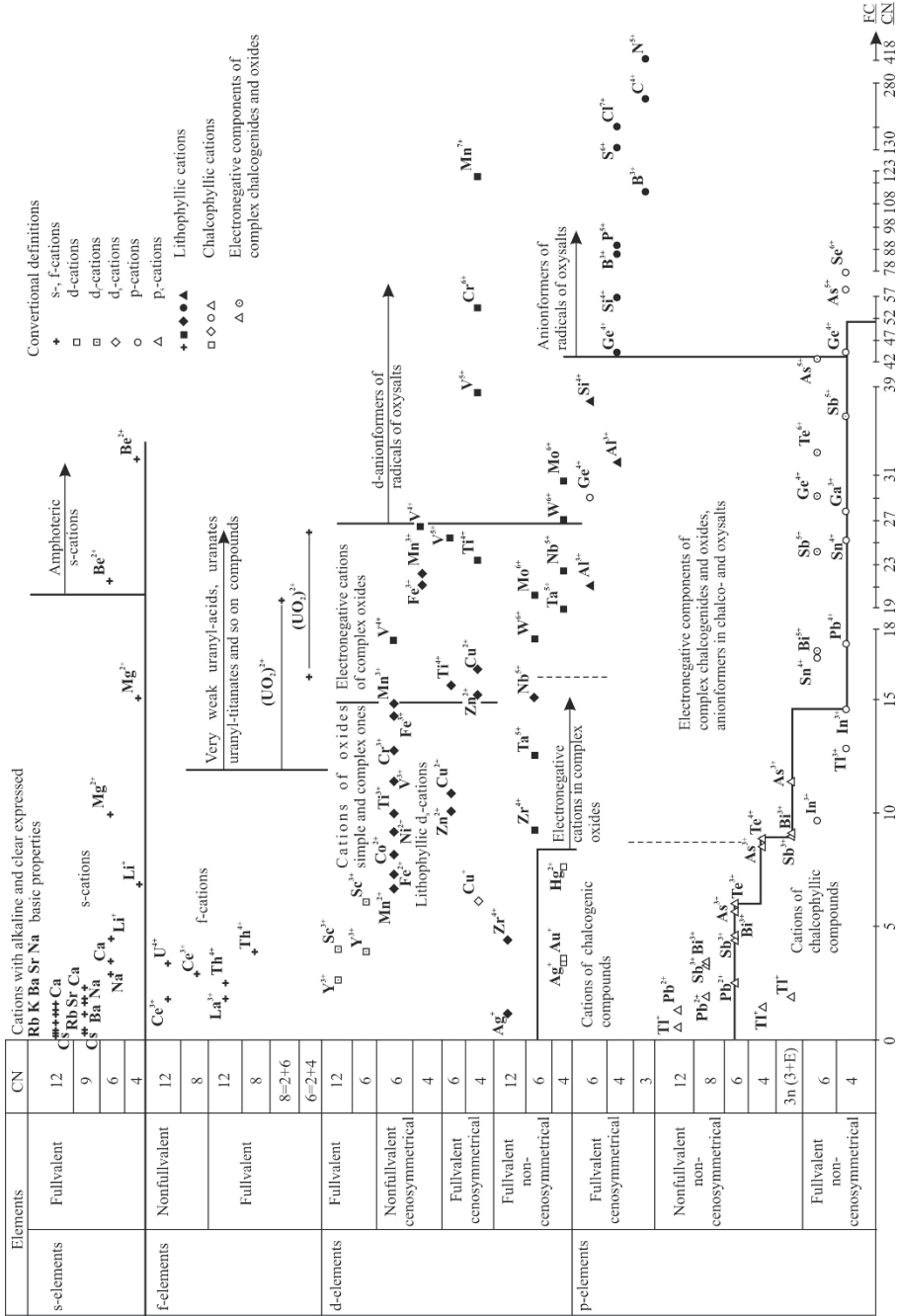


Fig. 3 The connection of reduced force characteristics (FC/CN) with acid-basic properties of cations.

each other. All this bring to association of all considered elements to rare-earth's group, for designation of which symbol TR was accepted. The comparison of values of FC/CN of Sc^{3+} and Y^{3+} with these values of lanthanides cations which was done in the same Fig.3, shows their pretty big closeness. Considering all that was said, these cations are designated as lithophylic d_s-cations. It shouldn't be forgotten, that maximal closeness with f-cations they have only with high CN, as long as with CN = 6, for example, Sc^{3+} could play crystallochemical role of ${}^{(6)}\text{Al}^{3+}$ which is presented in bazzite $(\text{Sc,Al})_2\text{Be}_3[\text{Si}_6\text{O}_{18}]$ which is crystallochemical analogue of beryl $\text{Al}_2\text{Be}_3[\text{Si}_6\text{O}_{18}]$.

Significantly more complex are the connections of values of FC/CN with acid-basic properties in other d-cations (Fig.3) (platinoides are excepted from consideration, because of their original properties and differences in behavior in minerals from majority of other elements). This is determined either by great variety of their valences and CN or by their belonging not only to lithophylic, but also to chalcophylic elements (cations).

Here first of all let's stop on nonfullvalent cations of centrosymmetrical d-elements which have been associated before by A.N. Zavaritskyi to group of iron, and by us - to group of centrosymmetrical d'-elements. In Fig. 3 it is clear, that by valency and value of FC/CN such cations as ${}^{(6)}\text{Mn}^{2+}$ (6,7), ${}^{(6)}\text{Fe}^{2+}$ (7,4), ${}^{(6)}\text{Co}^{2+}$ (8,3), ${}^{(6)}\text{Ni}^{2+}$ (9,3) are close to ${}^{(6)}\text{Mg}^{2+}$ (10,2). This is presented in isomorphism up to full one between these cations in many of minerals. Close values of FC/CN have also trivalent ${}^{(6)}\text{Ti}^{3+}$ (10,1), ${}^{(6)}\text{V}^{3+}$ (11,5), ${}^{(6)}\text{Cr}^{3+}$ (12,9), ${}^{(6)}\text{Fe}^{3+}$ (14,4), ${}^{(6)}\text{Mn}^{3+}$ (14,9), for which wide isomorphism both with each other and with ${}^{(6)}\text{Al}^{3+}$ (21,4) (oxyspinellides, pyroxenes, garnets and so on) is also noticed. It should be pointed-out, that in many of minerals there is a wide isomorphism between considered two- and trivalent cations (especially in micas, chlorites) too.

By value of FC/CN trivalent ${}^{(6)}\text{Ti}^{3+}$, ${}^{(6)}\text{V}^{3+}$, ${}^{(6)}\text{Cr}^{3+}$, ${}^{(6)}\text{Fe}^{3+}$, ${}^{(6)}\text{Mn}^{3+}$ are also close to ${}^{(4)}\text{Mg}^{2+}$ (15,3), what is explaining their close crystallochemical role in minerals like oxyspinellides. ${}^{(6)}\text{Ti}^{4+}$ (15,8), ${}^{(6)}\text{V}^{4+}$ (17,8), ${}^{(4)}\text{Fe}^{3+}$ (21,6), ${}^{(4)}\text{Mn}^{3+}$ (22,4), ${}^{(4)}\text{Ti}^{4+}$ (23,7), ${}^{(6)}\text{V}^{5+}$ (25,6), ${}^{(4)}\text{V}^{4+}$ (26,7) are playing different crystallochemical role. They are presented in complex oxides, for example, as electronegative amphoteric cations with very weak acid properties, weak anionformers in minerals like ferrisilicates getting closer in this relation to ${}^{(4)}\text{Be}^{2+}$ (32,8) и ${}^{(4)}\text{Al}^{3+}$ (32,2).

Here we should note, that by value of FC/CN among cations of Ti even ${}^{(4)}\text{Ti}^{4+}$ (23,7) is far from typical anionformers. That is why the respective substances which have not been known as minerals yet should be considered as complex oxides. Use of accepted in chemistry name titanates, considering salts of titanium acids, is very probational.

Considering mentioned closeness of these cations with such s-cations as ${}^{(6)}\text{Mg}^{2+}$, ${}^{(4)}\text{Mg}^{2+}$, ${}^{(4)}\text{Be}^{2+}$ and belonging of respective elements to lithophylls, all of them are designated by us as d_s-cations.

To d_s-cations also refered ${}^{(6)}\text{Zn}^{2+}$ (10,2) and ${}^{(6)}\text{Cu}^{2+}$ (11,0) which are close by FC/CN to ${}^{(6)}\text{Mg}^{2+}$ (10,2) and ${}^{(4)}\text{Mg}^{2+}$ (15,3), by what their close crystallochemical role, for example in oxyspinellides, pyroxenes and some other minerals is explained.

Special position on Fig.3 have cations of elements, selected by us as noncentrosymmetrical d'-complexformers - Zr, Hf, Nb and Ta. In spite of low values of FC/CN, these cations rarely play role of cations of simple compounds in minerals, for example, in simple oxides, zircon and so on. The role of electronegative cations in complex compounds like zirconates, tantaloniobates, where they, however, are not reaching the role of typical anionformers, are more characterizing for them. Their inclination for complexforming is clarifying in formation of mixed anionic radicals of

zircono- and tantalosilicates. By these features Ti^{4+} is very close to them. It is also forming minerals like titanosilicates, in which isomorphous substitutions between Ti and Nb, Ta are presented, what is reverberation of diagonal similarity Ti with Nb and Ta which was mentioned before.

By this way, Ti is presented as element with dual crystallochemical peculiarities - from one side it is one of the centrosymmetrical d²-elements, from another one - it comes forward as equitable member of noncentrosymmetrical d³-complexformers.

The role of electronegative cations in complex oxides, rushing for role of anionformers in oxysalts is more clearly presented in Mo^{6+} , W^{6+} , especially with CN = 4, responding to molybdates and tungstenates. At the same time it should be stressed, that anhydrides of respective acids are solid substances with high melting temperatures, they are hardly dissolve in water by what they are completely differ from anhydrides of typical oxyacids. They have considerable lower values of FC/CN (see Fig. 3). All this shows their natural connection with complex oxides and unnaturalness of their removing to principle different taxons, how it, for example, was done by A.S. Povarennykh [55], who considered minerals like tungstenates with CN of Mo^{6+} и W^{6+} equal to 6 among complex oxides, and minerals like scheelite with CN of Mo^{6+} и W^{6+} equal to 4 among complete different place in systematic - among oxysalts which are close to sulfates, with which they have not any genetic connections. They are associated with them only by formal features - similarity in CN and valences of anionformers. The same thing we could say about dragging off the vanadates with CN $V^{5+} = 4$ from other closely connected with them minerals of V^{5+} in which it has CN = 5 or 6 and consideration of them in common or closely with minerals of phosphates class only by formal features - isoformularity of respective acids, same valency of anionformers, similarity of their CN.

Thus, centrosymmetrical $(6)Ti^{4+}$, $(6)V^{4+}$, $(4)Fe^{3+}$, $(4)Mn^{3+}$, $(4)Ti^{4+}$, $(6)V^{5+}$, $(4)V^{4+}$ and noncentrosymmetrical $(6)Zr^{4+}$, $(6)Ta^{5+}$, $(6)Nb^{5+}$, $(6)W^{6+}$, $(4)Ta^{5+}$, $(6)Mo^{6+}$, $(4)Nb^{5+}$, $(4)W^{6+}$, $(4)Mo^{6+}$ are present the group of amphoteric cations with properties varying from weak basic ones with CN = 6 up to weak acid ones with CN = 4, ending on $(4)V^{5+}$ which shows the most acid properties. At the same time, fullvalent $(4)Cr^{6+}$ and $(4)Mn^{7+}$ have strong enough acid properties, what is expressed in their role as anionformers of strong chromic and manganic acids and their salts.

Considering what was said, it is expedient to divide all mentioned d-cations on three groups by their crystallochemical role in minerals:

- a) Lithophylic d-cations with low FC - $(4)Fe^{3+}$, $(4)Mn^{3+}$. It is convenient to unite them with s-cations, considering them as d_s-cations, because they are crystallochemically closely connected with other three- and bivalent d_s-cations, what is presented in paragenesis of respective minerals, placed in association or appropriately changing each other by changing of oxidizing potential Eh. At the same time it should not be forgotten about significant role of $(4)Fe^{3+}$ in chalcogen minerals.
- b) Lithophylic d-cations with middle FC - $(6)Ti^{4+}$, $(6)V^{4+}$, $(4)Ti^{4+}$, $(6)V^{5+}$, $(4)V^{4+}$, $(6)Zr^{4+}$, $(6)Ta^{5+}$, $(6)Nb^{5+}$, $(6)W^{6+}$, $(4)Ta^{5+}$, $(6)Mo^{6+}$, $(4)Nb^{5+}$, $(4)W^{6+}$, $(4)Mo^{6+}$, $(4)V^{5+}$. They form both simple and complex oxides which by their composition, sequence of properties and especially by their genesis are closely connected with oxysalts, ending this sequence. Dragging off the last ones by high constants of respective acids feature and consideration of these classes of minerals from this basis with oxysalts of p-anionformers (phosphates and sulfates), as it was usually done by logical-formal motives, is absolutely unnatural. Middle values of Eh, needed for formation of such minerals, their low solubility, character of paragenesis are in good agreement with it.

- c) Lithophylic d-cations with high FC - $(^4)\text{Cr}^{6+}$ и $(^4)\text{Mn}^{7+}$ which are d-anionformers of strong acids, consideration of which should end the oxygen compounds of lithophylic d-cations.

In addition to what was said let's cite the sequence of considered classes of oxyalts by increasing of pKa of respective acids:

- Class (4) - Vanadates (3,74; $\text{H}_3[\text{VO}_4]$)
- Class (4) - Molybdates (2,54; $\text{H}_2[\text{MoO}_4]$)
- Class (4) - Tungstenates (2,20; $\text{H}_2[\text{WO}_4]$)
- Class (4) - Chromates (0,80; $\text{H}_2[\text{CrO}_4]$)

As d_s-cation in some minerals could be $(^{12})\text{Ag}^+$ (1,2), playing, for example, in argentojarosite role of $(^{12})\text{K}^+$ (0,61), $(^4)\text{Zn}$ (15,3) и $(^4)\text{Cu}$ (16,5) which are usually typical chalcophylic cations and just sometimes play role of d_s-cations, for example, in oxyspinellides.

The rest of d-cations with CN = 4 and lower are typical chalcophylic.

The same features are in the basis of p-cations systematic (Fig. 3) which could be united by their role in minerals in 5 groups:

- a) p_s-cations of lithophylic elements - $(^6)\text{Al}^{3+}$ и $(^4)\text{Al}^{3+}$ which are close crystallochemically, as it have already been pointed-out, to $(^6)\text{Mg}^{2+}$ and especially to $(^4)\text{Mg}^{2+}$ and $(^4)\text{Be}^{2+}$. Here by value of FC/CN we could refer $(^6)\text{Ge}^{4+}$ and $(^6)\text{Si}^{4+}$. However, $(^6)\text{Si}^{4+}$ is stable only at very high pressures (stishovite with structure of rutile) and it appears extremely rarely in composition of minerals, formed in Earth crust. From them we could point only on one certainly established mineral - thaumasite with formulae $\text{Ca}_3\text{Si}(\text{OH})_6 [\text{CO}_3][\text{SO}_4]\cdot 12\text{H}_2\text{O}$. And if we take in consideration narrow genetical connection of minerals $(^6)\text{Ge}^{4+}$ and $(^6)\text{Si}^{4+}$ with minerals $(^4)\text{Ge}^{4+}$ и $(^4)\text{Si}^{4+}$, referred to very weak anhydrides of silicium and germanium acids and to their salts, it is expedient, because of the same purposes which were discussed previously, to consider the minerals of $(^6)\text{Ge}^{4+}$ и $(^6)\text{Si}^{4+}$ with minerals of $(^4)\text{Ge}^{4+}$ и $(^4)\text{Si}^{4+}$, separating them from those of $(^6)\text{Al}^{3+}$ и $(^4)\text{Al}^{3+}$. We should not forget about definite crystallochemical closeness of $(^4)\text{Al}^{3+}$ and $(^4)\text{Si}^{4+}$, presented in fact of existence of numerous alumosilicates with heteronuclear alumosilicium polymeric radicals.
- b) Lithophylic anionformers of oxyacids, to which fullvalent cations of p-elements, separated previously as light anionformers - $(^4)\text{Si}^{4+}$, $(^4)\text{B}^{3+}$, $(^4)\text{P}^{5+}$, $(^3)\text{B}^{3+}$, $(^4)\text{S}^{6+}$, $(^4)\text{Cl}^{7+}$, $(^4)\text{C}^{4+}$, $(^4)\text{N}^{5+}$ are referred. Here especially should be noted difference in CN which could have B, owing to its properties as anionformer are considerably changing - $(^4)\text{B}^{3+}$ by these features is placed between $(^4)\text{Si}^{4+}$ и $(^4)\text{P}^{5+}$, as far as $(^3)\text{B}^{3+}$ - between $(^4)\text{P}^{5+}$, and $(^4)\text{S}^{6+}$. Besides that, there are many minerals, consisting of polymeric radicals with $(^4)\text{B}^{3+}$ and $(^3)\text{B}^{3+}$ at the same time and which are considerably differ by their properties and forming conditions, paragenesis from other borates. To the same group we could refer the salts of $(^4)\text{S}^{4+}$ - sulfites, because inspite of low value of FC/CN of this anionformer (17.8), sulfuric acid is referred to strong acids (pKa=1.85). And its salts could be considered in connection with sulfates, from which they differ first of all by lower value of Eh, needed for their formation.
- c) p_s-cations of chalcophylic elements - $(^{12})\text{Tl}^+$, $(^{12})\text{Pb}^{2+}$, $(^8)\text{Pb}^{2+}$, $(^8)\text{Sb}^{3+}$ и $(^8)\text{Bi}^{3+}$. Among them $(^{12})\text{Tl}^+$ is, as it have already been said, crystallochemical analogue of $(^{12})\text{K}^+$ in pair djerfisherite - thalfenisite and so on minerals; $(^{12})\text{Pb}^{2+}$ - $(^{12})\text{Ca}^{2+}$ in

- macedonite; $^{(12)}\text{Ba}^{2+}$, $^{(12)}\text{K}^+$ - in minerals like hollandite; $^{(8)}\text{Pb}^{2+}$, $^{(8)}\text{Sb}^{3+}$ and $^{(8)}\text{Bi}^{3+}$ - $^{(8)}\text{Ca}^{2+}$, $^{(8)}\text{TR}^{3+}$ in minerals with structure of pyrochlore. The same cations are included in composition of some other lithophylic minerals.
- d) Chalcophylic p-cations with low FC, - $^{(4)}\text{Tl}^+$, $^{(3)}\text{Tl}^+$, $^{(6)}\text{Pb}^{2+}$, $^{(6)}\text{Sb}^{3+}$, $^{(6)}\text{Bi}^{3+}$, $^{(6)}\text{As}^{3+}$, $^{(6)}\text{Te}^{4+}$, $^{(4)}\text{As}^{3+}$, $^{(4)}\text{Te}^{4+}$, $^{(6)}\text{In}^{3+}$, $^{(4)}\text{Tl}^{3+}$, $^{(4)}\text{In}^{3+}$, $^{(6)}\text{Sn}^{4+}$, $^{(4)}\text{Pb}^{4+}$, $^{(4)}\text{Sn}^{4+}$, $^{(4)}\text{Ga}^{4+}$, coming forward as electropositive components in simple and complex chalcogen compounds, chalcosalts, in which CN of many cations is increasing, for example, for Pb^{2+} up to 7 and even 8, for Cu^+ up to 6 an so on; and also in oxygen minerals, referred to arsenites, ..., tellurites, tellurates.
- e) Chalcophylic p-cations with middle FC - $^{(3+E)}\text{Sb}^{3+}$, $^{(3+E)}\text{Bi}^{3+}$, $^{(3+E)}\text{As}^{3+}$, $^{(6)}\text{Bi}^{5+}$, $^{(6)}\text{Sb}^{5+}$, $^{(6)}\text{Te}^{6+}$, $^{(4)}\text{Sb}^{5+}$, $^{(6)}\text{As}^{3+}$, coming forward as electronegative components in complex sulfides and oxides, anionformers of chalcosalts \rightarrow oxysalts like arsenites, ..., tellurites and tellurates. Along with it by their properties and conditions of formation the last minerals are rather close to respective complex compounds, then to typical oxysalts like phosphates and sulfates, among which they usually are considered without any sense and basis. In this relation they are resembling considered earlier tantaloniobates, molybdates, tungstenates, vanadates.
- f) Chalcophylic anionformers of oxysalts radicals - $^{(4)}\text{Ge}^{4+}$, $^{(4)}\text{As}^{5+}$, $^{(4)}\text{Se}^{6+}$. Oxysalts, responding to such acids because of crystallochemical logical-formal similarity usually are referred in systematic just behind silicates, phosphates and sulfates respectively. Conditionally selenites are inserted here too which inspite of that anionformer $^{(4)}\text{Se}^{4+}$ has low value of FC/CN are the salts of strong enough acids, resembling in this relation sulfites with anionformer $^{(4)}\text{S}^{4+}$. However, taking in mind the conditions of formation of these minerals mainly because of oxidizing the chalcogen minerals, narrow their chemical and paragenetic connection with minerals, formed by elements of two previous groups, the most natural is to place this group at the end of our consideration of chalcophylic elements. Along with it, the following sequence of mineral classes depending on strength of their acids should be also contemplated:

Class (6) - Arsenites (9,23; H_3AsO_3)

Class (4) - Germanates (9,10; $\text{H}_2[\text{GeO}_4]$) - are considered just behind silicates

Class (6) - Tellurates (7,61; H_6TeO_6 or $\text{Te}(\text{OH})_6$)

Class (4) - Tellurites (2,57; H_2TeO_3)

Class - Selenites (2,75; H_2SeO_3)

Class (4) - Arsenates (2,25; $\text{H}_3[\text{AsO}_4]$)

Class (4) - Selenates (1,92; $\text{H}_2[\text{SeO}_4]$)

Resuming and taking into account some well-known facts, the systematic of the most important ions, including in minerals could be presented in the following form (the values of FC/CN are pointed-out in brackets):

- Hydrogen and hydrogencontaining ions, neutral molecules - H^+ , $(\text{H}_3\text{O})^+$, NH_4^+ , $(\text{OH})^-$; H_2O .
- Cations of lithophylic elements with low FC, including:
 - s-Cations - $^{(12)}\text{Cs}^+$ (0,35), $^{(12)}\text{Rb}^+$ (0,47), $^{(9)}\text{Cs}^+$ (0,47), $^{(12)}\text{K}^+$ (0,61), $^{(9)}\text{Rb}^+$ (0,63), $^{(12)}\text{Ba}^{2+}$ (0,96), $^{(12)}\text{Sr}^{2+}$ (1,3), $^{(9)}\text{Ba}^{2+}$ (1,3), $^{(12)}\text{Na}^+$ (1,5), $^{(12)}\text{Ca}^{2+}$ (1,8), $^{(9)}\text{Sr}^{2+}$ (1,8), $^{(9)}\text{Na}^+$ (2,0), $^{(9)}\text{Ca}^{2+}$ (2,5), $^{(6)}\text{Na}^+$ (3,1), $^{(6)}\text{Ca}^{2+}$ (3,7), $^{(6)}\text{Li}^+$ (3,7), $^{(4)}\text{Li}^+$ (7,1), $^{(6)}\text{Mg}^{2+}$ (10,2), $^{(4)}\text{Mg}^{2+}$ (15,3), $^{(6)}\text{Be}^{2+}$ (21,8), $^{(4)}\text{Be}^{2+}$ (32,8).

- b). f-Cations – $(^{12}\text{Ce}^{3+} (2,0), ^{12}\text{La}^{3+} (2,0), ^{12}\text{Th}^{4+} (2,7), ^{8}\text{Ce}^{3+} (3,1), ^{12}\text{U}^{4+} (3,65), ^{8}\text{Th}^{4+} (4,1))$; special properties has U^{6+} which is found in minerals mostly in form of ion of uranile $(\text{UO}_2)^{2+}$, forming weak uranyl acids, uranates and numerous uranyl-oxysalts.
- c). d_f-Cations - $(^{12}\text{Y}^{3+} (2,7), ^{6}\text{Y}^{3+} (4,0), ^{12}\text{Sc}^{3+} (4,2), ^{6}\text{Sc}^{3+} (6,3))$.
- d). d_s-Cations - $(^{12}\text{Ag}^+ (1,2), ^{6}\text{Mn}^{2+} (6,7), ^{6}\text{Fe}^{2+} (7,4), ^{6}\text{Co}^{2+} (8,3), ^{6}\text{Ni}^{2+} (9,3), ^{6}\text{Ti}^{3+} (10,10), ^{6}\text{Zn}^{2+} (10,2), ^{6}\text{Cu}^{2+} (11,0), ^{6}\text{V}^{3+} (11,5), ^{6}\text{Cr}^{3+} (12,9), ^{6}\text{Fe}^{3+} (14,4), ^{6}\text{Mn}^{3+} (14,9), ^{4}\text{Fe}^{3+} (21,6), ^{4}\text{Mn}^{3+} (22,4))$; partially the same role is played by $(^{4}\text{Zn}^{2+} (15,3)$ and $(^{4}\text{Cu}^{2+} (16,5))$ which are more characteristic for chalcophylic minerals; cations $(^{6}\text{Mn}^{2+} (6,7), ^{6}\text{Fe}^{2+} (7,4), ^{6}\text{Co}^{2+} (8,3), ^{6}\text{Ni}^{2+} (9,3), ^{6}\text{Cr}^{3+} (12,9), ^{6}\text{Fe}^{3+} (14,4), ^{6}\text{Mn}^{3+} (14,9), ^{4}\text{Fe}^{3+} (21,6), ^{4}\text{Mn}^{3+} (22,4))$, especially those which are selected with bold, are coming forward also as chalcophylic cations with low FC (Group. 4.d).
- e). p_s-Cations of lithophylic elements - $(^{6}\text{Al}^{3+} (21,4), ^{6}\text{Ge}^{4+} (29,2), ^{4}\text{Al}^{3+} (32,2), ^{6}\text{Si}^{4+} (37,6))$.
- f). p_s-Cations of chalcophylic elements - $(^{12}\text{Tl}^+ (0,48), ^{12}\text{Pb}^{2+} (1,3), ^{8}\text{Pb}^{2+} (1,9), ^{8}\text{Sb}^{3+} (3,3), ^{8}\text{Bi}^{3+} (3,4), ^{6}\text{Pb}^{2+} (2,5), ^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0))$; cations $(^{6}\text{Pb}^{2+} (2,5), ^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0))$ are presented as cations also in some chalcosalts.
3. Cations - complexformers of lithophylic elements with low - middle FC, including:
- a). Cations of noncensymmetrical d'-complexformers with low - middle FC - $(^{12}\text{Zr}^{4+} (4,5), ^{6}\text{Zr}^{4+} (9,4), ^{6}\text{Ta}^{5+} (12,7), ^{6}\text{Nb}^{5+} (15,2), ^{6}\text{W}^{6+} (17,8), ^{4}\text{Ta}^{5+} (19,1), ^{6}\text{Mo}^{6+} (20,6), ^{4}\text{Nb}^{5+} (22,7), ^{4}\text{W}^{6+} (26,8), ^{4}\text{Mo}^{6+} (30,9))$.
- b). Cations of censymmetrical d'-complexformers with middle FC - $(^{6}\text{Ti}^{4+} (15,8), ^{6}\text{V}^{4+} (17,8), ^{4}\text{Ti}^{4+} (23,7), ^{6}\text{V}^{5+} (25,6), ^{4}\text{V}^{4+} (26,7), ^{4}\text{V}^{5+} (38,4), ^{4}\text{Cr}^{6+} (54,4), ^{4}\text{Mn}^{7+} (121,3))$.
4. Chalcophylic cations with low FC, including:
- a). Cations of chalcophylic elements with low FC - $(^{4}\text{Ti}^+ (1,45), ^{3}\text{Ti}^+ (1,9), ^{6}\text{Pb}^{2+} (2,5), ^{4}\text{Ag}^+ (3,5), ^{4}\text{Au}^+ (3,6), ^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0), ^{4}\text{Cu}^+ (6,2), ^{4}\text{Hg}^{2+} (7,7), ^{4}\text{As}^{3+} (8,6), ^{4}\text{Te}^{4+} (8,9), ^{(3+E)}\text{Sb}^{3+} (8,9), ^{(3+E)}\text{Bi}^{3+} (9,1), ^{6}\text{In}^{3+} (9,7), ^{6}\text{Zn}^{2+} (10,2), ^{6}\text{Cu}^{2+} (11,0), ^{(3+E)}\text{As}^{3+} (11,4), ^{4}\text{Ti}^{3+} (12,8), ^{4}\text{In}^{3+} (14,6), ^{4}\text{Zn}^{2+} (15,3), ^{4}\text{Cu}^{2+} (16,5), ^{6}\text{Sn}^{4+} (16,9), ^{4}\text{Pb}^{4+} (17,5), ^{4}\text{Sn}^{4+} (25,3), ^{4}\text{Ga}^{3+} (37,8))$ and cations of the same elements with lower CN; cations $(^{6}\text{Pb}^{2+} (2,5), ^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0))$ are coming forward as cations in some oxides too (see group. 2.f), $(^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0), ^{4}\text{As}^{3+} (8,6), ^{4}\text{Te}^{4+} (8,9), ^{(3+E)}\text{Sb}^{3+} (8,9), ^{(3+E)}\text{Bi}^{3+} (9,1), ^{(3+E)}\text{As}^{3+} (11,4), ^{6}\text{Sn}^{4+} (16,9))$ - as complexformers in sequence of complex chalcogen and oxygen compounds (group 5).
- b). Some, firstly selected with bold, cations of censymmetrical d'-elements - $(^{6}\text{Mn}^{2+} (6,7), ^{6}\text{Fe}^{2+} (7,4), ^{6}\text{Co}^{2+} (8,3), ^{6}\text{Ni}^{2+} (9,3), ^{6}\text{Cr}^{3+} (12,9), ^{6}\text{Fe}^{3+} (14,4), ^{6}\text{Mn}^{3+} (14,9), ^{4}\text{Fe}^{3+} (21,6), ^{4}\text{Mn}^{3+} (22,4))$, widely known in minerals as d_s-cations (see group 2.f).
5. Chalcophylic cations-complexformers (in general cations of chalcophylic elements with middle FC) - $(^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0), ^{4}\text{As}^{3+} (8,6), ^{4}\text{Te}^{4+} (8,9), ^{(3+E)}\text{Sb}^{3+} (8,9), ^{(3+E)}\text{Bi}^{3+} (9,1), ^{(3+E)}\text{As}^{3+} (11,4), ^{6}\text{Sn}^{4+} (16,9), ^{6}\text{Bi}^{5+} (17,2), ^{6}\text{Sb}^{5+} (24,3), ^{6}\text{Ge}^{4+} (29,2), ^{6}\text{Te}^{6+} (33,1), ^{4}\text{Sb}^{5+} (36,4), ^{6}\text{As}^{5+} (42,4), ^{4}\text{Ge}^{4+} (43,6), ^{4}\text{As}^{5+} (63,7), ^{4}\text{Se}^{6+} (78,0))$; cations $(^{6}\text{Sb}^{3+} (4,4), ^{6}\text{Bi}^{3+} (4,6), ^{6}\text{As}^{3+} (5,7), ^{6}\text{Te}^{4+} (6,0), ^{4}\text{As}^{3+} (8,6), ^{4}\text{Te}^{4+} (8,9), ^{(3+E)}\text{Sb}^{3+} (8,9))$,

- $^{(3+E)}\text{Bi}^{3+}$ (9,1), $^{(3+E)}\text{As}^{3+}$ (11,4), $^{(6)}\text{Sn}^{4+}$ (16,9) are coming forward similar to cations of chalcophylic elements with low FC (group 4.a).
6. p-Anionformers (cations of light and heavy anionformers) - $^{(4)}\text{Si}^{4+}$ (56,4), $^{(4)}\text{B}^{3+}$ (86,2), $^{(4)}\text{P}^{5+}$ (90,3), $^{(3)}\text{B}^{3+}$ (114,9), $^{(4)}\text{S}^{6+}$ (130,2), $^{(4)}\text{Cl}^{7+}$ (181,8), $^{(3)}\text{C}^{4+}$ (238,8), $^{(3)}\text{N}^{5+}$ (418,3); $^{(4)}\text{S}^{4+}$ (17,8), $^{(3)}\text{I}^{5+}$ (23,7), $^{(3)}\text{Br}^{5+}$ (27,3).

The presented systematic of cations has been placed by us in the basis of subsequent mineral systematic, especially in limits of classes, selected by character of anions. At the same time it shows that the same cations could play cation role in minerals of different types, for example, in lithophylic and chalcophylic, come forward in some minerals as cations, presenting their basic properties, and in other ones - as anionformers, presenting their acid properties. The value of FC/CN predetermines the role of cations in compounds in total, but it could not be used as stricted formal criteria, because the properties of cations mostly depend also on delicacies in atomic structure, in particular on belonging to cenosymmetricals or noncenosymmetricals, on values of their Z. At the same time, in many cases it allows to consider not only the role of cation in compounds, but also about possibility of isomorphism between it and other cations, especially if they are close by other features.

Highest taxons of structural-chemical systematic of minerals, preceding classes

All what was said shows, that the principal type of chemical bond in compounds should be considered as major feature of the most important taxons of mineralogical systematic. By this feature all minerals could be united in five types:

1. Type: Minerals with principal metallic and metallic-covalent bond - native metals and semimetals, metallides and semimetallides.
2. Type: Minerals with principal metallic-covalent and ionic-covalent, rare van der Waals forces - chalcogen compounds and native VIa-nonmetals.
3. Type: Minerals with principal ionic-covalent and covalent-ionic - nonmetallides of light (typical, cenosymmetrical) VIa-element (O) - oxygen compounds.
4. Type: Minerals with principal covalent-ionic and ionic bond - halogen compounds.
5. Type: Carbon, its compounds (without carbonates) and related substances.

Touching the selected types, it should be noted, that type “elementary (simple) compounds” which is usually started the majority of well-known systematics is disappeared from their number. From our point of view this is not only justified, but also is necessary action because of the following purposes:

a). In type of elementary substances usually unite the substance with completely different types of chemical bond - metals, semimetals, nonmetals, semiconductors, molecular substances which have only one in common - every of these substances consists of atoms of one sort. At the same time the properties, formation conditions, paragenesis of elementary (native) substances with different type of chemical bond have nothing common with each other.

b). Because of what was said it is very difficult to build systematic of elementary substance so, that we could get natural transformation from them to minerals of the following taxon.

Considering what was pointed out and necessity of association of the most close to each other by properties, genesis and paragenesis minerals, in natural systematic of minerals, it is more expedient to specify native metals, metallides, semimetals, semimetallides from selected earlier type of “elementary (simple) substances” to independent type, what we have been done previously. Along with it native metals are removing in front of respective metallides, and semimetals - in front of respective semimetallides. Simultaneously, native nonmetals - S and Se, are considered in front of chalcogen compounds, at the expense of which they are often formed.

The considerable peculiarity of classification of minerals, as far as inorganic crystalline substances at all, is impossibility of utilizing the strict system approach in its development. This have been already clarified in special position of type V among all mentioned types, in specific place of native minerals in systematic, what was discussed above. The same thing should be taken into account with selection of further taxons in every type, when in the basis of their selection we should put different features, determined by complexity of their composition, peculiarities of chemical bond, crystalline structures, properties and conditions of formation of respective substances.

Thus type 1 divided on two subtypes: 1.1 - metals and metallides, 1.2 - semimetals and semimetallides, reflecting the considerable differences in chemical bond, structures, properties of both these and those ones. The last one, in its turn is divided on 2 quasisubtypes*: 1.2.1 - semimetals and semimetallides of Va-semimetals, 1.2.2 - semimetals and semimetallides of VIa-semimetals.

Type 2 firstly is dividing on two quasisubtypes*, uniting completely different by type of chemical bond substances: 2a. - elementary (native) VIa-nonmetals which are characterized by residuum chemical bond, and 2b. - chalcogen compounds which have principal metallic-covalent and ionic-covalent chemical bond. Further quasisubtype* 2b. is dividing on two subtypes: 2b.1. - chalcogen substances of sidero- and chalcophylic cations, and 2b.2 - chalcogen compounds of lithophylic cations, reflecting considerable differences in composition, stability in natural conditions, properties, conditions of formation and paragenesis of minerals from every subtype. In this case the requirement of consequent transformation from one taxons to other ones, is observed, because some minerals of the last subtype are close by composition, properties, conditions of formation to minerals, beginning the next type 3. Subtype 2b.1 in its turn is divided on two quasisubtypes*: 2b.1a. - sulfides and sulfosalts of sidero- and chalcophylic cations, 2b.1b. - selenides and selenosalts of sidero- and chalcophylic cations, reverberating differences in properties, conditions of formation and paragenesis of natural chalcogen compounds of S and Se, although many of them are connected by continuous isomorphous transformations. It should be taken in mind, that in minerals, referred to chalcogen compounds the consequent transformation from simple chalcogenides through complex ones to chalcosalts is often observed. Exactly by this it is expressed, that one authors consider all chalcosalts as complex chalcogenides, as far as other ones persistently isolate them in separate taxons as chalcosalts which are the natural end of sequences like simple chalcogenides → complex (binary and so on) chalcogenides → chalcosalts.

* The titles of taxons, selected by “*”, are suggested by S.N. Nenasheva for comparing convenience. A.A. Godovikov leave these taxons without any titles.

Type 3 is divided by belonging of minerals to iso- or anisodesmical compounds first of all on two subtypes: 3.1 - oxides and hydroxides (isodesmical), 3.2. - oxysalts (anisodesmical). In dependence on belonging of mineral cations of first of them to one or another type it is divided further on six consequently changing each other quasisubtypes*, what is responding for transformation from cations with low FC to cations with high FC, from lithophylic cations through chalcophylic ones to cations of nonmetallic elements with highest FC:

- 3.1a - oxides and hydroxides of lithophylic cations with low FC,
- 3.1b - oxides and hydroxides of lithophylic cations with middle FC,
- 3.1c - oxides and hydroxides of chalcophylic cations (except Va- and VIa-cations),
- 3.1d - oxides and hydroxides of Va-cations (As, Sb, Bi),
- 3.1e - oxides and hydroxides of VIa-cations (Te),
- 3.1f - oxides and hydroxides of nonmetallic (lithophylic) cations.

Subtype 3.2 is also divided further immediate on classes, what is considered below.

Type 4 initially is divided by the same features on two subtypes: 4.1 - halogenides (isodesmical) and 4.2 - halogensalts (anisodesmical). The last one by dependence on belonging of anionformers to d- or p-cations in its turn is divided on two quasisubtypes*: 4.2a. - halogensalts with d-anionformers and 4.2b. - halogensalts with p-anionformers. Here it is necessary to pay attention on, that the majority of authors, however, because of the tradition, taking roots in last century, by this time are considering halogensalts as complex halogenides. By this the fact of clear isolation of radical groups in their structures, for example, tetrahedral $[\text{BF}_4]^-$, $[\text{BeF}_4]^{2-}$, octahedral - $[\text{SiF}_6]^{2-}$, $[\text{AlF}_6]^{3-}$, polymeric - $[\text{BeF}_3]^-$, $[\text{B}_2\text{F}_7]^-$, $[\text{Al}_3\text{F}_{14}]^{2-}$ and other, many of which are stable in solutions, and high solubility of many of halogensalts, is completely ignored. Some halogenacids, for example, $\text{H}[\text{BF}_4]$, as it have been already noted, are so strong, that they have in chemistry name superacids or magical acids. All this monosemantically testifies about salt nature of halogensalts [24]. Misunderstanding of it carried on, for example H. Strunz [63] to consideration of halogensalts not only as complex halogenides, but also as isodesmical (!) compounds, to associating by this feature of all halogensalts with oxides. Rather exactly with this, the place, leading up to present time in mineralogical systematic to halogen compounds between chalcogen and oxygen compounds [51], [34], or between oxides and oxysalts [12], is connected. Although by chemical bond type, existence of halogensalts among halogen compounds, they should be considered behind oxygen compounds.

The sequence of types: chalcogen \rightarrow oxygen \rightarrow halogen compounds - responds, as it was stressed earlier, for regular changing in their representatives of principal chemical bond type in direction: metallic-covalent \rightarrow ionic-covalent \rightarrow covalent-ionic \rightarrow ionic bond.

The systematic of type 5 is building significantly more difficulty because of purposes, showed before. Initially it is divided on two quasisubtypes*, completely different by number of representatives, first of which - 5a. associating inorganic compounds, including native IVa-nonmetals, second one - 5b. - organic compounds. First of them is further divided on two subtypes: 5a.1. - elementary (native) IVa-nonmetals, 5a.2. - minerals with principal covalent and metallic-covalent chemical bond - carbides, and compounds which are close to them - silicides, nitrides and phosphides. Organic compounds in which the most important role is played by residuum bond, are further divided on to three subtypes: 5b.1. - salts of organic acids, 5b.2. - hydrocarbons and

related compounds, 5b.3. - natural mixtures of organic substances, including fossil resin.

Thus, we could obtain the following scheme of intersubordination of considered taxons:

1. Type: Minerals with principal metallic and metallic-covalent bond - native metals and semimetals, metallides and semimetallides.
 - 1.1. Subtype: Metals and metallides.
 - 1.2. Subtype: Semimetals and semimetallides (only of sidero- and chalcophylic cations)
 - 1.2.1 Quasisubtype*: Semimetals and semimetallides of Va-semimetals.
 - 1.2.2 Quasisubtype*: Semimetals and semimetallides of VIa-semimetals
2. Type: Minerals with principal metallic-covalent and ionic-covalent bond, rare van der Waals forces - chalcogen compounds and native VIa-nonmetals.
 - 2a. Quasitype*: Elementary (native) VIa-nonmetals (residium bond).
 - 2b. Quasitype*: Chalcogenic compounds - compounds of d-schrink-analogues - S and Se (metallic-covalent and ionic-covalent bond, rare van der Waals forces) - simple chalcogen compounds (isodesmical) → complex chalcogen compounds → chalcosalts (anisodesmical).
 - 2b.1. Subtype: Chalcogenic compounds of sidero- and chalcophylic cations.
 - 2b.1a. Quasisubtype*: Sulfides and sulfosalts of sidero- and chalcophylic cations.
 - 2b.1b. Quasisubtype*: Selenides and selenosalts of sidero- and chalcophylic cations.
 - 2b.2. Subtype: Chalcogen compounds of lithophylic cations.
3. Type: Minerals with principal ionic-covalent and covalent-ionic bond - nonmetallides of light (typical, centrosymmetrical) IVA-element (O) - oxygen compounds.
 - 3.1. Subtype: Oxides and hydroxides (isodesmical).
 - 3.1a. Quasisubtype*: Oxides and hydroxides of lithophylic cations with low FC - Force Characteristics.
 - 3.1b. Quasisubtype*: Oxides and hydroxides of lithophylic cations with middle FC.
 - 3.1c. Quasisubtype*: Oxides and hydroxides of chalcophylic cations (except Va- and VIa- cations) - simple and complex → arsenites, ..., tellurates.
 - 3.1d. Quasisubtype*: Oxides and hydroxides of Va-cations (As, Sb, Bi).
 - 3.1e. Quasisubtype*: Oxides and hydroxides of VIa-cations (Te).
 - 3.1f. Quasisubtype*: Oxides and hydroxides of nonmetallic (lithophylic) cations.
 - 3.2. Subtype: Oxysalts (anisodesmical).
4. Type: Minerals with principal covalent-ionic and ionic bond - halogen compounds.
 - 4.1. Subtype: Halogenides (isodesmical).
 - 4.2. Subtype: Halogensalts (anisodesmical)(with hexacyanoferrates and hexatiocyanates, rhodonides).
 - 4.2a. Quasisubtype*: Halogensalts with d-anionformers.
 - 4.2b. Quasisubtype*: Halogensalts with p-anionformers.
5. Type: Carbon, its compounds (without carbonates) and related substances.
 - 5a. Quasitype*: Inorganic compounds of carbon (without carbonates) and related substances.

- 5a.1. Subtype: Native minerals.
- 5a.2. Subtype: Minerals with principal covalent and metallic-covalent bond - carbides and related compounds - silicides, nitrides and phosphides.
- 5b. Quasitype*: Organic compounds.
 - 5b.1. Subtype: Salts of organic acids.
 - 5b.2. Subtype: Hydrocarbons and related compounds.
 - 5b.3. Subtype: Mixtures of organic compounds, including fossil resins.

After development of scheme of highest taxons of mineralogical systematic, we could begin to separate classes and to base their sequence, their subdivision on quasi and subclasses.

Classes and their sequence

As it have been already known, the classes of compounds in chemistry, since it have been suggested at the beginning of last century by J.J. Berzelius, are selected by anions. The same approach is preserved in mineralogy. However, there two questions which are considerable from the systematic's point of view:

- 1) which part of compound's formulae in which basis should be considered as anion;
- 2) which one should be the sequence of consideration of separate classes which place in it should occupy the compounds with several anions - arsenido-sulfides, sulfido-halogenides, silicato-carbonates, silicato-fluorides, arsenato-sulfates and so on.

For compounds with simple anions like S^{2-} , O^{2-} , F^- , Cl^- , even with polynuclear one like $[S_2]^{2-}$, $[As_4]^{4-}$, and so on, the question of selection of anion is pretty obvious and it could be ignored. It is not more clear also for compounds with complex anions like $[SiO_4]^{4-}$, $[SO_4]^{2-}$, $[CO_3]^{2-}$, including polymeric $[Si_6O_{18}]^{12-}$, $[Si_2O_5]^{2-}$ and so on, in which anionformers have the lowest of all possible values of coordination number, i.e. present their acid properties in maximal extent. However, situation for amorphous anionformers is getting even more difficult, when it is needed to make boundary between binary (complex) compounds and salts with complex anions, because anionformers could have different CN depending on acid-basic properties.

It was shown earlier, that as cations-anionformers (complexformers) could be considered:

1. Cations - complexformers of lithophylic elements with low-middle FC, including:
 - a). Cations of noncentrosymmetrical d'-complexformers with low-middle FC - $^{(12)}Zr^{4+}$, $^{(6)}Zr^{4+}$, $^{(6)}Ta^{5+}$, $^{(6)}Nb^{5+}$, $^{(6)}W^{6+}$, $^{(4)}Ta^{5+}$, $^{(6)}Mo^{6+}$, $^{(6)}Nb^{5+}$, $^{(4)}W^{6+}$, $^{(4)}Mo^{6+}$.
 - b). Cations of centrosymmetrical d-complexformers with middle FC - $^{(6)}Ti^{4+}$, $^{(6)}V^{4+}$, $^{(4)}Ti^{4+}$, $^{(6)}V^{5+}$, $^{(4)}V^{4+}$, $^{(4)}V^{5+}$, $^{(4)}Cr^{6+}$, $^{(4)}Mn^{7+}$.
2. Chalcophylic cations-complexformers (mainly cations of chalcophylic elements with middle FC) - $^{(6)}Sb^{3+}$, $^{(6)}Bi^{3+}$, $^{(6)}As^{3+}$, $^{(6)}Te^{4+}$, $^{(4)}As^{3+}$, $^{(4)}Te^{4+}$, $^{(3+E)}Sb^{3+}$, $^{(3+E)}Bi^{3+}$, $^{(3+E)}As^{3+}$, $^{(6)}Sn^{4+}$, $^{(6)}Bi^{5+}$, $^{(6)}Sb^{5+}$, $^{(6)}Ge^{4+}$, $^{(6)}Te^{6+}$, $^{(4)}Sb^{5+}$,

- (⁶)As⁵⁺, (⁴)Ge⁴⁺, (⁴)As⁵⁺, (⁴)Se⁶⁺, cations (⁶)Sb³⁺, (⁶)Bi³⁺, (⁶)As³⁺, (⁶)Te⁴⁺, (⁴)As³⁺, (⁴)Te⁴⁺, (^{3+E})Sb³⁺, (^{3+E})Bi³⁺, (^{3+E})As³⁺, (⁶)Sn⁴⁺, are coming forward similar to cations of chalcophylic elements with low FC (group 4.a).
3. p-Anionformers (cations of light and heavy anionformers) - (⁴)Si⁴⁺, (⁴)B³⁺, (⁴)P⁵⁺, (³)B³⁺, (⁴)S⁶⁺, (⁴)Cl⁷⁺, (³)C⁴⁺, (³)N⁵⁺, (⁴)S⁴⁺, (³)I⁵⁺, (³)Br⁵⁺.

Every of these three groups is responding to minerals of definite paragenesis, planning its specific sequence of mineral changing depending on changing of acid-basis conditions, oxidizing potential. Thus, cations - complexformers of lithophylic elements with low-middle FC are included in composition of oxygen compounds - complex oxides and oxysalts, placed predominantly in igneous rocks, in connected with them pegmatite and hydrothermal veins, in products of their metamorphism and weathering. The transformation from complex oxides to oxysalts is responding to increasing of acidity of cation-complexformer, decreasing of its CN from 6 through 5 up to 4. By this way we could design narrow genetically connected sequences of minerals like: (6)-vanadates → (5)-vanadates → (4)-vanadates, in which first their members are referred to typical complex oxides, and the last ones - are typical oxysalts, including of rather strong acids, to which we could refer (4)-vanadates and all the more (4)-arsenates. (4)-chromates and (4)-permanganates which are oxysalts of very strong acids, are ending these substances. Many of considered cations-complexformers are included in composition of genetically connected with each other minerals, referred to common paragenesis, for example, titanates and tantaloniobates of alkaline and rare-metallic granitic pegmatites, but (⁶)Zr⁴⁺, (⁶)Ti⁴⁺, (⁵)Ti⁴⁺, (⁶)Ta⁵⁺, (⁶)Nb⁵⁺ and so on cations are typical for mixed anionic radicals like zircono-, titano-, niobo-, tantalosilicaceous ones which are especially characteristic for parageneses of apatitic rocks and their derivatives.

The cations of the second group are typical for parageneses of two types. One of them is characterized by primary minerals in which as ligands coming S and Se. Mentioned cations-complexformers are included in composition of complex chalcogenides and chalcosalts of sulfide deposits of magmatogenic, volcanogenic and metamorphogenic genesis, different hydrothermal veins, genetically connected often with acid rocks. Another paragenesis which is typical for them, is forming in zone of oxidation of mentioned earlier primary paragenetic associations of minerals and for which both complex oxides and oxysalts up to salts of relatively strong oxyacids like arsenic acid, are characteristic.

The anionformers of third group are typical for mineral parageneses of magmatic and igneous rocks, their pegmatites (silicates, some phosphates, carbonates, borates), skarns (silicates, borates, carbonates), hydrothermal veins (especially carbonates and some sulfates), volcanic exhalations (sulfates, halogenides, halogensalts), crusts of weathering (silicates), marine sediments (halogenides, sulfates, carbonates, phosphates, borates), evaporites (borates, halogenides), zones of oxidation (carbonates, sulfates, nitrates and so on).

Thus, every of mentioned groups of cations-anionformers are included in composition of minerals of its own paragenesis, as if it is forming its own genetic branch.

Earlier [26], [27] it was shown, that:

a). The quantitative measure of acid-basic properties of elements (cations) is their force characteristic (FC) and the value of atomic number (Z): decreasing of FC with constant Z is responding to strengthening of basic properties of cations, and vice-versa increasing of (FC), - acidic ones. Typical cations have coordinate number (CN) by

one order or by two times less, then amphoteric cations, and amphoteric cations on their own turn - by one order lower, then typical anionformers.

b). The values of FC and Z of cations allow to clarify regular changing of structures of compounds in sequences, responding to transformation from simple compounds with coordinate structure to salts, and to predict with more probability the structures of unknown compounds either in total form, or in some of their details (for example, conditions of transformations from cubical “perovskites” to tetrahonal, orthorhombic and monoclinic), regularities of polymorphous transformations.

c). With constant in definite limits physical-chemical parameters, first of all temperature and pressure, straightening of acid properties of amphoteric cations is clarifying in increasing of their valency, and with permanent valency (with permanent in definite limits oxidizing potential) - in decreasing of theirs CN. On the contrary, increasing of their basic properties are responding to decreasing of valency, decreasing of theirs CN.

d). In compounds, containing only amphoteric cations, last ones play typical cation role; their basic properties are increasing by straightening of acid properties of ligands, including complex anions too.

e). For cations with basic properties low valences (lower or equal to 2), high CN (usually higher then 6) are typical. For cations with acid properties (anionformers) - high valency (equal or higher then 4) and low CN (usually lower then 6); amphoteric cations in this relations placed intermediate position.

f). The structures of simple compounds, containing cations with basic properties, are coordinate (PbS, MgO, NaCl, CaF₂ and so on); containing cations with acid properties - are molecular or quasimolecular (As₄S₄, As₂S₃, B₂O₃, CO₂, SO₃, B₂F₄ and so on). In agreement with it the first ones differ by their high melting temperatures, low vapor resiliency; and second ones - by low melting temperatures, high vapor resiliency.

g). Amphotherity from crystallochemical positions is clarifying initially in changing of coupling motive of cation polyhedres with amphoteric cations from typical cationic, when cation polyhedres are connecting by edges or even verges in compounds, not containing cations with very low FC (as it is, for example, in ilmenite) up to motives in which these polyhedres are connected with each other only by bridge ligands. Further decreasing of FC bring to change of CN by cation from CN > 6 to CN = 6, defined by difference in FC of elements - partners in compound, their average or summary atomic numbers, formation of complex anion. Visually this could be seen in sequences of compounds, containing, along with basic cations, cations with lower CN which are playing more distinct role of anionformers up to formation of complex anions, as it is, for example, in sequences: simple oxides → binary oxides → oxysalts like 2AO₂ (2TiO₂) → ABO₄ (FeWO₄) → M[TO₄] (Ca[WO₄]).

All this show us, that the boundary “complex compounds → salts” for compounds of different types is coming differently, defining first of all by fundamental properties of atoms, forming them, - their FC and Z.

At the same time, it is not correct to refer to compounds of definite type the substances only by their brutto-formulae which is not consider their structure. Thus by now, practically all authors refer oxygen compounds, containing Te⁶⁺, to salts of telluric acid or to tellurates, considering them as analogues of sulfates in narrow connection with last ones. By the first view this is absolutely natural, especially, if base on primitive-straightforward ideas about analogies of properties of elements in limits of separate subgroups of Periodic system, for example, expressing in association of O, S, Se, Te and Po in “chalcogenes”, as it is offered by “Nomenclature rules of IUPACK in chemistry” [52], and what is done by , for example G.B. Bokiý and N.A. Golubkova later [7]. They

are not considered differences between ceno- and noncenyosymmetrical elements [62], [20], [21], nonmetallic and semimetallic elements, elements shell- and shrink-analogues, their differences from nonshell- and nonshrink analogues [21], [31].

The similarity of brutto-formulae of sulfur, selenic and so-called telluric acids - H_2SO_4 , H_2SeO_4 and H_2TeO_4 respectively is pushing on this way. However, if first two compounds are fully respond to structural ideas about acids, because they contain separated tetrahedral complex radicals $[SO_4]^{2-}$ or $[SeO_4]^{2-}$ with CN S and Se, equal to 4, what gives us opportunity to write their structural formulae as $H_2 [SO_4]$ and $H_2 [SeO_4]$, this could not be said about "telluric acid". The investigation of this compound was not established in its structures the anionic groups $[TeO_4]^{2-}$ with CN of Te = 4. Instead of it, it was found that cations Te^{6+} have CN = 6, i.e. respond to CN of amphoteric or weak acid anionformers. The structure of this compound is to be consisting of chains of $TeO_4(OH)_2$ - octahedrons, in two opposite edges of which OH-ions are placed, connected with each other by common O atoms of equatorial edges of octahedrons [66]. It is easy to see, that by separating of repetition period of such structure we get structural formulae in form of $Te(OH)_2O_2$. Thus, this compound is hydroxido-oxide of Te^{6+} with very weak acid properties, clearly differing it from sulfur and selenic acids. That is why it should be considered not among acids and their salts in subtype 3.2. - oxysalts, but rather in subtype 3.1. - oxides and hydroxides at the end of it as compound with intermediate properties from oxides and hydroxides to acids and salts. The existence of so-called telluric acid with formulae $Te(OH)_6$ or H_6TeO_6 , for which the octahedral coordination of Te, different polymeric groups, established in it salts [66], close by this and other properties to complex oxides, is characteristic, is not changing this conclusion.

In advantage to what was said clear differences in properties of SO_3 , SeO_3 , H_2SO_4 , H_2SeO_4 from one side, and TeO_3 , $Te(OH)_6$ or H_6TeO_6 - from another are evident.

Thus, SO_3 in normal conditions - gas (b.p. $44,8^\circ C$), lower $16,8^\circ C$ - SO_3 - transparent icy mass; energetically reacts with water, forming sulfur acid $H_2 [SO_4]$ which has $pK_a = 1,94$;

SeO_3 - solid glassy or asbestic substance (m.p. $118,5^\circ C$; b.p. $185^\circ C$); energetically reacts with water, forming selenic acid $H_2 [SeO_4]$ with $pK_a = 1,92$;

TeO_3 - solid respectively inert substance, on which are not act neither cold water, nor diluted bases (m.p. - higher then $400^\circ C$); obtained by dehydration of H_6TeO_6 in oxygen atmosphere with presence of concentrated $H_2[SO_4]$; on the first stage of dehydration of H_6TeO_6 results $TeO_2(OH)_2$; the compound H_6TeO_6 has properties of weak acid with $pK_a = 7,61$.

All this considered to be natural, if take into account, that S and Se are connected by shrink-analogue, what is narrowing their properties, as far as Te differ from them, not being theirs shrink analogue. This responds also to systematic of cations which was given earlier, in accordance with which the typical in minerals for Te cation $^{60}Te^{6+}$ is referred to chalcophylic cations with middle FC, clearly differing in this aspect from $^{40}S^{6+}$ and $^{40}Se^{6+}$, for which CN = 6 has not been established in minerals. Shrink analogue of S and Se and not shrink-analogue with them of Te clarifying in elementary substance too, among which S and Se are nonmetals, as far as Te - semimetal¹⁵. By what

¹⁵ Misunderstanding of different stages of analogues between elements of one group [21], [31] often brings to absolutely absurd associations of elements in limits of subgroups. Unfortunately, this could be found even in reference books and manuals, standing several editions. As example to what was said we could note the subdivision of VIa-elements by N.S. Achmetov [1] on O, after that S and, at last "elements of subgroup of Se" - Se, Te and Po, as far as in fact they should be divided on: 1) nonmetallic cenyosymmetrical elements - O, 2) nonmetallic d-shrink analogues - S and Se, 3) semimetallic f-shrink

was said it is not amazing, that so-called salts of telluric acid and tellurates should be considered as complex oxides, containing ${}^{(6)}\text{Te}^{6+}$, what is confirmed by results of investigation of their crystalline structures. For example, we could mention mineral yafsoanite. The authors, who have discovered it [37], have opinion, that it is "referred to group (correct - to class - A.G.) of tellurates and it is complex salt of telluric acid" (p. 120) with formulae $(\text{Zn}_{1,38} \text{Ca}_{1,36} \text{Pb}_{0,26})_{\Sigma 3} \text{TeO}_6$. The investigation of its structure [36] shows, that the structural formulae of yafsoanite has form of ${}^{(8)}\text{Ca}_3 {}^{(6)}\text{Te}_2 [{}^{(4)}\text{ZnO}_4]_3$ and it should be considered as complex oxide - zincate with structure, analogical to those of garnet in which the role Si is played by Zn, and Te is coming as typical cation - Al. In this relation yafsoanite is analogical to isostructural synthetic complex oxides, called incorrectly garnets, and more correct - garnatites - with common formulae ${}^{(8)}\text{R}^{3+} {}^{(6)}\text{M}^{3+} {}^{(4)}\text{X}^{3+}\text{O}_4]_3$, where $\text{R}^{3+} = \text{Y, Ln}$; $\text{M}^{3+}, \text{X}^{3+} = \text{Fe, Al, Ga}$.

Analogical reasons force to consider the substances of Te^{4+} , often called tellurites, among complex oxides to which by the same purposes we refer also arsenites, antimonites and antimonates.

To complex oxides, considered at their end, we refer also compounds with d-oxoradicals, even with tetrahedral coordination of anionformer - vanadates, molybdates, tungstenates, because respective "acids" and "anhydrides" are not only solid substances with octahedral coordination of V^{5+} , Mo^{6+} , W^{6+} , but also have very weak acid properties, more weak, than those of silicium acid. Such position of considering substances is imagine to be even more well-grounded, because it reverberates the natural connections of them with complex oxides, in which CN of electronegative cations (including V^{5+} , Mo^{6+} , W^{6+}) is sequentially changing from 6 through 5 to 4. By this the considerable chemical differences in properties of d- and p-elements are clarifying, in particular as anionformers, forcing us to separate vanadates from class of phosphates and arsenates, and molybdates and tungstenates from class of sulfates and selenates in which they have been usually considered since last century by such common feature as group-analogue, and formal similarity of oxoradicals.

Among d-elements in this relation position only centrosymmetrical Cr and Mn in their highest oxidizing extent, oxygen compounds of which referred to strong anhydrides (acids), forming typical salts with heterodesmical bonds - chromates and permanganates. This allows to consider, for example, chromates exactly after sulfates.

The sequence of classes in most numerous by number of representatives subtype of oxysalts should be also considered in detail, because there is no common or somehow regular way, what is illustrated by respective parts of systematic by different authors:

E.S.Dana, [13]

VI. Salts of oxygen acids

VI. Oxygen salts (oxysalts)

1. Carbonates

2. Silicates

3. Niobates, tantalates

4. Phosphates, arsenates, vanadates, antimonates, antimonites, arsenites

analogues - Te and Po. The same could be said about all other groups, on which we could unstop, however special attention attracts accepted by him division of VIIIb-elements. N.S. Achmetov divide them strongly by verticals, selecting 3 groups : 1) Fe, Ru, Os; 2) Co, Rh, Ir; 3) Ni, Pd, Pt. Along with it, it has not been taken into account, that Fe, Co and Ni are centrosymmetricals. This bring to their high oxidizing, low normal electrode potentials, rareness in nature in native form. Other VIIIb elements - noncentrosymmetrical f-shrink-analogues and they are not accidentally usually considered in common as platinoides. High normal electrode potentials, usualness of their native form in nature - are the common features for them [28].

Phosphates and so on with sulfate-anions and so on
 Nitrates
 5. Borates
 Uranates
 6. Sulfates, chromates
 Tellurates; also tellurites, selenites
 7. Tungstenates, molybdates

A.G. Betekhtin, [6]

VI. Oxygen salts (oxysalts)

1 class. Iodates	6 class. Molybdates and tungstenates
2 class. Nitrates	7 class. Phosphates, arsenates and vanadates
3 class. Carbonates	8 class. Arsenites
4 class. Sulfates, selenates, tellurates	9 class. Borates
5 class. Chromates	10 class. Silicates

A.S. Povarennykh, [55]

Class III. Silicates, borosilicates, alumosilicates, beryllsilicates titanosilicates, zirconosilicates and uranosilicates	Class VII. Phosphates Class VIII. Tellurites and selenites Class IX. Tungstenates and molybdates Class X. Chromates and selenates
Class IV. Borates	Class XI. Sulfates
Class V. Vanadates	Class XII. Carbonates
Class VI. Arsenates	Class XIII. Iodates Class XIV. Nitrates

I. Kostov, [40]

Class V. Silicates	Class X. Chromates
Class VI. Borates	Class XI. Carbonates
Class VII. Phosphates, arsenates and vanadates	Class XII. Nitrates and iodates
Class VIII. Tungstenates and molybdates	A. Nitrates
Class IX. Sulfates	B. Iodates
A. Sulfates	
B. Selenates, selenites, tellurates and tellurites	

H. Strunz, [63]

V. Nitrates, carbonates, borates
 Va. Nitrates
 Vb. Carbonates
 Vc. Borates
 VI. Sulfates (chromates, molybdates, tungstenates)
 A.- D. Sulfates
 E. Chromates
 F. Molybdates and tungstenates
 VII. Phosphates, arsenates, vanadates
 VIII. Silicates

- A.A.Godovikov, [22]
- | | |
|--------------------------------|------------------------------|
| Subtype II.Oxysalts | Class 4.Borates |
| Class 1.Silicates | Quasiclass 1.(4)-Borates |
| Class 2.Phosphates (arsenates) | Quasiclass 2.(4)-(3)-Borates |
| Class 3.Sulfates | Quasiclass 3.(3)-Borates |
| | Class 5. Carbonates |
| | Class 6. Nitrates |
-
- A.R.Hoelzel,[34]
- | | |
|---|------------------------------------|
| 5.Carbonates, nitrates, borates | 7.Phosphates, arsenates, vanadates |
| 6.Sulfates. chromates, molybdates, tungstenates | 8.Silicates |
-
- A.M.Clark, [12]
- 9.Borates
 - 10.Borates with other anions
 - 11.Carbonates
 - 12.Carbonates with other anions
 - 13.Nitrates
 - 14.Silicates, not containing Al
 - 15.Silicates of Al
 - 16.Silicates, containing Al and other metals
 - 17.Silicates, containing also other anions
 - 18.Niobates and tantalates
 - 19.Phosphates
 - 20.Arsenates (also arsenates with phosphate-ion, but without other anions)
 - 21.Vanadates (and vanadates with arsenat- or phosphate-ions)
 - 22.Phosphates, arsenates or vanadates with other cations
 - 23.Arsenites
 - 24.Antimonates and antimonites
 - 25.Sulfates
 - 26.Sulfates with halogenid-ions
 - 27.Sulfites, chromates, molybdates and tungstenates
 - 28.Selenites, selenates, tellurites and tellurates
 - 29.Iodates
 - 30.Tioceanates

It is easy to see big discord, presented in position of separated classes by different authors. The situation is aggravating also by, that, usually, the explanations of accepted sequence are not given in publications.

In accepted by us sequence of substances change, responding to decreasing in them of extent of metallicity of chemical bond by increasing of its covalent extent, and after that ionicity, up to appearing of ionic compounds; oxysalts begin to appear at the end of class of oxides and hydroxides. In this case right after complex oxides and hydroxides, ending with minerals of silica family, it is natural to place the class of silicates - oxysalts of the most weak oxyacids, beginning of it with aluminosilicates, structures of many of which are derivatives of structures of different polymorphs of silica. The connection between properties and formation conditions of minerals of silica

family and silicates is so significant, that some mineralogists placed silica family into one class with silicates, excluding it from oxides [40], [43].

The silicates are close to complex oxides not only because they are salts of very weak silicium acids, but also by such properties as low solubility, high temperatures of melting point, and many of them also because they contain in their structure polymeric radicals, what makes them close to many of titanates, tantalio-niobates and so on minerals.

Oxides and silicates of lithophylic elements, usually, are forming in endogenous, often in hightemperature, processes; for oxides and silicates of chalcophylic elements it is more usual to form in oxidation zone conditions.

Further sequence of placement of classes it is more convenient to subdue to changing sequence of salts, responding to decreasing of straight of acids, forming these salts. Such sequence replies in total for increasing of ionicity extent of chemical bond between cations and acid radicals, decreasing of polymeric radicals role in salts, increasing of their solubility, changing of formation conditions from hypogenic to more and more lowtemperature ones, up to surface ones, regular changing of many physical properties of respective minerals.

This sequence, however, is disturbed in class of borates, including minerals, in which CN of B in oxyradicals could be 4; 3; 4 and 3. In dependence from it have been suggested [22] to divide borates onto 3 quasiclasses: 1) (4)-borates, 2) (3)-borates, 3) (4)-(3)-borates, considering them in systematic in mentioned sequence. First of them are structurally close to silicates; radical groups of (4)-borates could polycondensate with silicium-oxygen radicals, forming common heteronuclear polymeric radicals of borosilicates. (4)-Borates are characteristic for hypogenic conditions; high pressure and increased basicity are favorable for their formation. (3)-Borates are mainly hypogenic minerals too, as far as formation of (4)-(3)-borates is typical along with evaporation from marine and lacustrine water with formation of evaporates, in some crusts of weathering, rarely in lowtemperature hydrothermal veins.

In light of what was said we have accepted the following sequence of consideration of separate classes of oxysalts with lithophylic p-anionformers (in brackets the values of pKa and formulaes of acids, for which they are defined are given [44], for polybasic acids acid index is given of first stage of dissociation):

Class 1.Silicates	(9,9; H ₄ [SiO ₄])
Class 2.Borates	
Quasiclass a).(4)-Borates	
Quasiclass b).(3)-Borates	(9,15; H ₃ [BO ₃])
Quasiclass c).(4)-(3)-Borates	
Class 3.Carbonates	(3,25; H ₂ [CO ₃])
Class 4.Phosphates	(2,15; H ₃ [PO ₄])
Class 5.Sulfates	(1,94; H ₂ [SO ₄])
Class 6.Nitrates	(-1,64; H[NO ₃]; from [9] p. 98)
Class 6a.Iodates	(0,77; H [IO ₃])
Class 6b.Rodanates	(-1; H[CNS])

Referring of minerals to definite class of oxysalts is disputable, when in its composition there are several different anionic radicals, for example, [SiO₄]⁴⁻ and [PO₄]³⁻; [CO₃]²⁻ and [SO₄]²⁻; [CO₃]²⁻ and F⁻, i.e. when mineral is mixed salt [23]. Along with to mixed salts are not referred:

- a) Inclusion compounds which have structure with big cavities, in which addition ions are placed, sometimes with cations (oxides of Mn with tunnel structures like hollandite, minerals of cancrinite-vishneville series, zeolites);
- b) Minerals with hybrid structures in which separated layers are neutral or weakly charged packages, containing in their composition “heterogeneous” anion (tundrite, lomonosovite and so on minerals).

By now it has been suggested to refer such minerals to definite class by the most strong anion [22], [23]. However, modeling of developed systematic in exposition of A.E. Fersman Mineralogical museum RAS showed, that from the paragenetic point of view it is more convenient to do vice versa, referring minerals - mixed salt to this or that class by anion of the most weak acid [25].

Analogical approach is used by us for many other minerals with several anions which are not referred to oxysalts, such as arsenido-tellurides, arsenido-sulfides, sulfido-halogenides and so on.

In subtype of halogenides two classes are separated: 1. Fluorides and 2. Chlorides, bromides, iodides. Here fluorides are separated in independent class as derivatives of centrosymmetrical F, considerably differing by its properties and genesis, paragenesis from all other halogenides. The rest of halogenides is associated in one class somewhat conditionally. In it chlorides and bromides, as derivatives of d-shrink-analogues - Cl and Br - have much more similarities with each other, then with iodides. The last ones are referred to this class because they have few representatives among minerals. In systematic of inorganic crystalline substances they should be separated in independent class.

In subtype of halogensalts the separation of classes is executed on bases which were explained earlier [24], although they have different sequence. It, as in oxysalts case, respond to increasing of strength of respective halogenacids too.

The sequence of highest taxons in developed structural-chemical systematic of minerals

1. Type: Minerals with principal metallic and metallic-covalent bond - native metals and semimetals, metallides and semimetallides.

1.1. Subtype: Metals and metallides.

1.1.1. Class: Metals and metallides of sidero- and chalcophylic elements.

1.1.2. Class: Metals and metallides of lithophylic elements.

1.2. Subtype: Semimetals and semimetallides (of sidero and chalcophylic cations only).

1.2.1. Quasisubtype*: Semimetals and semimetallides of Va-semimetals.

1.2.1a. Class: Native Va-semimetals.

1.2.1b. Class: Va-Semimetallides - arsenides, antimonides, bismutides.

1.2.2. Quasisubtype*: Semimetals and semimetallides of VIa-semimetals.

1.2.2a. Class: Native VIa-semimetals.

1.2.2b. Class: VIa-semimetallides - tellurides.

2. Type: Minerals with principal metallic-covalent and ionic-covalent bond, rare van der Waals forces - native VIa-nonmetals, chalcogen compounds: - chalcogenides (isodesmical) → chalcosalts (anisodesmical).

2a. Quasitype*: Native VIa-nonmetals (van der Waals forces).

2b. Quasitype*: Chalcogenic compounds (metallic-covalent and ionic-covalent bond, rare van der Waals forces) - simple (isodesmical) → complex → chalcosalts (anisodesmical).

2b.1. Subtype: Chalcogenic compounds of sidero- and chalcophylic cations.

2b.1a. Quasisubtype*: Sulfides and sulfosalts of sidero- and chalcophylic cations.

2b.1a.1. Class: Sulfides of sidero- and chalcophylic cations.

2b.1a.2. Class: Sulfosalts of sidero and chalcophylic cations.

2b.1b. Quasisubtype*: Selenides and selenosalts of sidero- and chalcophylic cations.

2b.1b.1. Class: Selenides of sidero- and chalcophylic cations.

2b.1b.2. Class: Selenosalts of sidero- and chalcophylic cations.

2b.2. Subtype: Chalcophylic compounds of lithophylic cations.

2b.2.1. Class: Sulfides (and selenides) of lithophylic cations.

2b.2.2. Class: Sulfosalts of lithophylic cations.

3 Type: Minerals with principal ionic-covalent and covalent-ionic bond - nonmetallides of light (typical, centrosymmetrical) VIa-element (O) - oxygen compounds: Oxides and hydroxides (isodesmical → anisodesmical) → oxosalts (anisodesmical).

3.1. Subtype: Oxides and hydroxides (isodesmical).

3.1a. Quasisubtype*: Oxides and hydroxides of lithophylic cations with low FC - Force Characteristics.

3.1a.1. Class: Oxides and hydroxides of s-, d_s- and p_s-cations.

3.1a.2. Class: Oxides and hydroxides of f-cations with low FC - of 4-valent f-cations.

3.1a.3. Class: Oxides and hydroxides of f-cations with middle FC - of 6-valent f-cations (U⁶⁺) → uranyl (UO₂)²⁺ compounds- uranyl acids, uranates and their derivatives (uranium micas and related minerals).

3.1b. Quasisubtype*: Oxides and hydroxides of lithophylic cations with middle FC.

3.1b.1. Overclass*: Oxides of Zr .

3.1b.1a. Class: Simple oxides of Zr.

3.1b.1b. Class: Complex oxides of Zr → titanates of zirconium → zirconotitanates.

3.1b.2. Overclass*: Oxides of Sn⁴⁺ and Ti⁴⁺.

3.1b.2a. Class: Simple oxides and hydroxides of Sn⁴⁺ and Ti⁴⁺.

3.1b.2b. Class: Complex oxides of Ti⁴⁺ (Sn⁴⁺) → titanates (stannates), ((6)-titanates, (6)-stannates only).

3.1b.3. Overclass*: Oxides and hydroxides of Nb⁵⁺ and Ta⁵⁺.

3.1b.3a. Class: Simple oxides and hydroxides of Nb⁵⁺ and Ta⁵⁺.

3.1b.3b. Class: Complex oxides of Nb⁵⁺ and Ta⁵⁺ ((6)-tantalonibates → (4)-tantalonibates).

3.1b.4. Overclass*: Oxides and hydroxides of Mo and W .

3.1b.4a. Class: Simple oxides and hydroxides of Mo and W .

3.1b.4b. Class: Complex oxides and hydroxides of Mo and W ((6)-molybdates and tungstenates → (4)-molybdates and tungstenates).

3.1b.5. Overclass*: Oxides and hydroxides of Mn⁴⁺.

3.1b.5a. Class: Simple oxides and hydroxides of Mn⁴⁺.

3.1b.5b. Class: Complex oxides and hydroxides of Mn⁴⁺.

- 3.1b.6. Overclass*: Oxides and hydroxides of V^{4+} .
- 3.1b.6a. Class: Simple oxides and hydroxides of V^{4+} .
- 3.1b.6b. Class: Complex oxides and hydroxides of V^{4+} (vanadites).
- 3.1b.7. Overclass*: Oxides and hydroxides of V^{5+} .
- 3.1b.7a. Class: Simple oxides and hydroxides of V^{5+} .
- 3.1b.7b. Class: Complex oxides and hydroxides of V^{5+} ((6)-vanadates → (5)-vanadates → (4)-vanadates).
 - 3.1b.7b.1. Quasiclass: (6)-Vanadates.
 - 3.1b.7b.2. Quasiclass: (5)-Vanadates.
 - 3.1b.7b.3. Quasiclass: (4)-Vanadates.
- 3.1c. Quasisubtype*: Oxides and hydroxides of chalcophylic cations (except Va- and VIa-cations).
 - 3.1c.1. Overclass*: Oxides and hydroxides of Ib-cations.
 - 3.1c.2. Overclass*: Oxides and hydroxides of IIb-cations.
 - 3.1c.3. Overclass*: Oxides and hydroxides of IIIa-cations.
 - 3.1c.4. Overclass*: Oxides and hydroxides of IVa-cations.
 - 3.1d. Quasisubtype*: Oxides and hydroxides of Va-cations.
 - 3.1d.1. Overclass*: Oxides and hydroxides of As^{3+} , Sb^{3+} , Bi^{3+} .
 - 3.1d.1a. Class: Simple oxides and hydroxides of As^{3+} , Sb^{3+} , Bi^{3+} .
 - 3.1d.1b. Class: Complex oxides and hydroxides of As^{3+} , Sb^{3+} , Bi^{3+} → (6)-Arsenites, antimonites, bismutites.
 - 3.1d.2. Overclass : Oxides and hydroxides of As^{5+} , Sb^{5+} , Bi^{5+} (all are complex) → arsenates, antimonates and bismutates (only (6)-arsenates, (6)-antimonates and (6)-bismutates).
 - 3.1e. Quasisubtype*: Oxides and hydroxides of VIa-cations (Te).
 - 3.1e.1. Overclass*: Oxides and hydroxides of Te^{4+} .
 - 3.1e.1a. Class: Simple oxides and hydroxides of Te^{4+} .
 - 3.1e.1b. Class: Complex oxides and hydroxides of Te^{4+} → tellurites.
 - 3.1e.2. Overclass: Oxides and hydroxides of Te^{6+} (all are complex) → tellurates (all (6)-tellurates).
 - 3.1f. Quasisubtype*: Oxides and hydroxides of nonmetals (lithophylic) elements.
 - 3.1f.1. Class: Oxides and hydroxides of Si and Ge (silicic and germanium anhydrides, silicic and germanium acids).
 - 3.1f.2. Class: Oxides and hydroxides of B (boric anhydride and boric acids).
 - 3.1f.3. Class: Oxides and hydroxides of Se (selenic anhydride).
- 3.2. Subtype: Oxosalts (anisodesmical).
 - 3.2.1. Class: Silicates.
 - 3.2.1a. Class: Germanates (zone of oxidization of Tsumeb and Franse).
 - 3.2.2. Class: Borates.
 - 3.2.2.1. Quasiclass: (4)-Borates.
 - 3.2.2.2. Quasiclass: (3)-Borates.
 - 3.2.2.3. Quasiclass: (4)-(3)-Borates.
 - 3.2.3. Class: Carbonates.
 - 3.2.4. Class: Phosphates.
 - 3.2.4.1. Quasiclass: Orthophosphates
 - 3.2.4.2. Quasiclass: Pyrophosphates
 - 3.2.4.3. Quasiclass: Triphosphates
 - 3.2.4a. Class: Arsenates.
 - 3.2.4a.1. Quasiclass: (6)-Arsenates.

3.2.4a.2. Quasiclass: (4)-Arsenates (orthoarsenates).

*3.2.4b. Class: Arsenites

3.2.5. Class: Sulfates.

3.2.6. Class: Sulfites.

3.2.6a. Class: Selenites.

3.2.7. Class: Chromates.

3.2.8. Class: Nitrates.

3.2.8a. Class: Iodates.

*3.2.8b. Class: Iodites

3.2.8c. Class: Rhodanates (thiocyanates).

4. Type: Minerals with principal covalent-ionic and ionic bond - halogen compounds.

4.1. Subtype: Halogenides (isodesmical).

4.1.1. Class: Fluorides.

4.1.2. Class: Chlorides, bromides.

4.1.2a. Class: Iodides.

4.2. Subtype: halogensalts (anisodesmical) (with hexacyanoferrates and hexathiocyanates, rhodonides).

4.2a. Quasisubtype*: Halogensalts with d-anionformers.

4.2a.1. Class: Chloroferrites and chlorocuprites (of s-cations and NH_4^+ only).

4.2a.2. Class: Hexachlorferrates and hexachlormanganates (of s-cations only).

4.2b. Quasisubtype*: Halogensalts with p-anionformers.

4.2b.1. Class: Fluoraluminates (of s-cations only).

4.2b.2. Class: Fluorborates (of s-cations only).

4.2b.3. Class: Fluorsilicates (of s-cations and NH_4^+ only).

4.2b.4. Class: Chloraluminates (of s-cations only).

5. Type: Carbon, its compounds (without carbonates) and related substances.

5a. Quasitype*: Inorganic compounds (without carbonates) and related substances.

5a.1. Subtype: Native minerals.

5a.2. Subtype: Minerals with principal covalent or metallic-covalent bond - carbides and related compounds - silicides, nitrides and phosphides.

5a.2.1. Class: Carbides.

5a.2.1a. Class: Silicides.

5a.2.2. Class: Nitrides.

5a.2.2a. Class: Phosphides.

5b. Quasitype*: Organic carbon compounds (mineral with principal van der Waals forces bond).

5b.1. Subtype: Salts of organic acids.

5b.1.1. Class: Salts of benzopolycarbonic acids ($\text{C}_6\text{H}_{6-n}(\text{COOH})_n$; $n = 6$).

5b.1.2. Class: Salts of citric acids (citrates).

5b.1.3. Class: Salts of acetic acids (acetates).

5b.1.4. Class: Salts of oxalic acids (oxalates).

*5b.1.5. Class: Salts of formic acids (formates).

5b.2. Subtype: Hydrocarbons and related compounds.

5b.2.1. Class: Hydrocarbons cyclic (by decreasing of $x = \text{H} : \text{C}$).

5b.2.2. Class: Hydrocarbons oxygenbearing (by increasing of $\text{O} : \text{C}$).

5b.2.3. Class: Nitrogenbearing organic compounds.

5b.3. Subtype: Mixtures of organic substances, including amber and related substances..

So, the principles of taxon separation in developed structural-chemical systematic of minerals are presented in table #1.

Table #1. General enumeration of the taxons of structural-chemical classification of minerals

Taxon	Feature	Examples
1	2	3
Type	It is principle type of chemical bond (but not a single type of chemical bond)	The five types are uniting all minerals species: 1.Type: Minerals with principal metallic and metallic-covalent bond - native metals and semimetals, metallides and semimetallides. 2.Type: Minerals with principal metallic-covalent and ionic-covalent bond, rare van der Waals forces - chalcogen compounds and native VIa nonmetals. 3.Type: Minerals with principal ionic-covalent and covalent-ionic bond - nonmetallides of light (typical, noncensymmetrical) VIa element (O) - oxygen compounds. 4.Type: Minerals with principle covalent-ionic and ionic bond - halogen compounds. 5.Type: Carbon, its compounds (without carbonates) and related substances.
Quasi-type*	Type of chemical bond (this taxon is divided when more higher taxon unites the minerals with three or more types of chemical bond)	There are two quasitypes at the second type of minerals with principal metallic-covalent and ionic-covalent bond, rare van der Waals forces - chalcogen compound and native VIa nonmetals: 2a. Native VIa nonmetals (van der Waals forces); 2b. Chalcogenic compounds (metallic-covalent and ionic-covalent bond rare van der Waals forces) - simple (isodesmical) -> complex -> chalcosalts (anisodesmical)
Subtype	1.Type of chemical bond, (only single type of chemical bond) 2. Type of cation (siderophylic, chalcophylic or lithophylic) 3. Belonging of	There are two subtypes at the 1. taxon of minerals with principal metallic and metallic-covalent bond - native metals and semimetals, metallides and semimetallides: 1.1 Metals and metallides; 1.2 Semimetals and semimetallides. There are two subtypes at the 2b. quasitype of the second type: 2b.1. Chalcogenic compounds of sidero- and chalcophylic cations (metallic-covalent bond); 2b.2. Chalcogenic compounds of lithophylic cations (ionic-covalent bond). There are two subtypes at the 3 type of minerals with

	mineral isodesmical and anisodesmical compounds	to and principal ionic-covalent and covalent-ionic bond - nonmetallides of light (typical, noncentrosymmetrical) VIA-element (O) - oxygen compounds: 3.1. Oxides and hydroxides (isodesmical); 3.2. Oxysalts (anisodesmical) There are two subtypes at the 4 type of minerals with principle covalent-ionic and ionic bond - halogen compounds: 4.1. Halogenides (isodesmical); 4.2. Halogenosalts (anisodesmical) (with hexacyanoferrates and hexatiocyanates, rhodonides).
Quasi-subtype*	1. Anion 2. Type of cation and FC of cation	There are two quasitypes at the 2b.1. subtype chalcogen compounds of sidero- and chalcophylic cations (metallic-covalent bond): 2b.1a. Sulfides and sulfosalts of sidero- and chalcophylic cations; 2b.1b. Selenides and selenosalts of sidero- and chalcophylic cations. There are six consequently changing quasitypes at the 3.1 Subtype oxides and hydroxides (isodesmical), that are corresponding for transferal from the cations with low FC to the cations with high FC, from lithophylic cations to chalcophylic and to nonmetallic cations of the elements with mostly high FC: 3.1a - Oxides and hydroxides of lithophylic cations with low FC; 3.1b - Oxides and hydroxides of lithophylic cations with middle FC; 3.1c - Oxides and hydroxides of chalcophylic cations (without Va- and VIA- cations); 3.1d - Oxides and hydroxides Va- cations (As, Sb, Bi); 3.1e - Oxides and hydroxides VIA- cation (Te); 3.1f - Oxides and hydroxides of nonmetals (lithophylic) elements;
Over-class*	Cation	There are seven overclasses at the 3.1b. taxon - oxides and hydroxides of lithophylic cations with middle FC: 3.1b.1. Oxides Zr; 3.1b.2. Oxides Ti (Ti^{4+}); 3.1b.3. Oxides and hydroxides Nb^{5+} и Ta^{5+} ; 3.1b.4. Oxides and hydroxides Mo и W; 3.1b.5. Oxides and hydroxides Mn^{4+} ; 3.1b.6. Oxides and hydroxides V^{4+} ; 3.1b.7. Oxides and hydroxides V^{5+} .

Class	<p>Type of anion (simple, complex) or compound (simple, complex)</p> <p>2. Anionforming, when minerals are anisodesmical compounds</p>	<p>There are two classes at the 2b.1a. quasytype- sulfides and sulfosalts of sidero- and chalcophylic cations:</p> <p>2b.1a.1. Class: Sulfides of sidero- and chalcophylic cations; 2b.1a.2. Class: Sulfosalts of sidero- and chalcophylic cations;</p> <p>There are two classes at the 3b.1b.1. overclass - oxides Zr: 3.1b.1a. Class: Simple oxides of Zr; 3.1b.1b. Class: Complex oxides of Zr -> titanates of Zr -> zirconotitanates.</p> <p>There are eleven classes at the 3.2. subtype - Oxosalts (anisodesmical): 3.2.1. Class: Silicates; 3.2.2. Class: Borates; 3.2.3. Class: Carbonates; 3.2.4. Class: Phosphates; 3.2.4a. Class: Arsenates; 3.2.5. Class: Sulfates; 3.2.6. Class: Sulfites; 3.2.6a. Class: Selenites; 3.2.7. Class: Nitrates; 3.2.7a. Class: Iodates; 3.2.7b. Class: Rhodonates (tiocyanates).</p>
Quasi class	<p>Coordination number of the anionforming</p>	<p>There are three quasiclasses at the 3.1b.7b. class - complex oxides and hydroxides of V^{5+} ((6)-vanadates -> (5)-vanadates -> (4)-vanadates): 3.1b.7b.1. Quasiclass: (6)-vanadates; 3.1b.7b.2 Quasiclass: (5)-vanadates; 3.1b.7b.3 Quasiclass: (4)-vanadates;</p> <p>There are tree quasiclasses at the borates class: 1) (4)-borates; 2) (3)-borates; 3) (4)-(3)-borates: 3.2.2.1. Quasiclass: (4)-Borates; 3.2.2.2. Quasiclass: (3)-Borates; 3.2.2.3. Quasiclass: (4)-(3)-Borates;</p>
Subclass	<p>The size of FC</p>	<p>There are three subclasses at the class of silicates: 1) silicates with low FC; 2) silicates with middle FC; 3) silicates of chalcophylic elements.</p>
Family	<p>The minerals of one family have similar of equal compound, single</p>	<p>The family of zeolites unite the subfamilies: thomsonite, scolecite-natrolite, garronite, wairakite, gmelinite, stilbite, stellerite, mordenite. The micas family unite dioctahedral and trioctahedral micas</p>

	genesis or paragenesis	and all polytypes.
Subfamily	Similar or equal compound and same type of structure	There are five subfamilies at the chalcopyrite family: talnakhite, actually chalcopyrite, germanite, briartite, morozeviczite. There are three subfamilies at the stannite family: stannoidite, actually stannite, rodostannite.
Series (genus)	Uninterrupted solid solutions between two or greater number of the extreme members	The forsterite genus and garnet genus among of the middle tetrasilicates
Group	The same type of the compound or structure	The dolomite group include dolomite, ankerite, kutnohorite, benstonite, eitelite. All its minerals have one type structure, but they have not the uninterrupted solid solutions between ones.
Mineral species	There is an individual chemical compound, extreme member of the solid solutions, middle member of the uninterrupted solid solutions.	a) There are three mineral species at the genus monticellite: monticellite, glaucochroite, kirnschsteinite. b) There are five mineral species at the forsterite genus: forsterite, fayalite, tephroite, liebenbergite, laihunite.



Structural-Chemical Systematic of Minerals

1. TYPE: MINERALS WITH PRINCIPAL METALLIC END METALLIC-COVALENT BOND – NATIVE METALS AND SEMIMETALS, METALLIDES AND SEMIMETALLIDES

1.1. SUBTIPE: METALS AND METALLIDES

1.1.1. *Class*: Metals and metallides of sidero- and chalcophylic elements

1.1.1.1. Minerals of heavy noncensymmetrical *d*-elements (with 5 – 10 *d*-electrons)

1.1.1.1.1. Minerals of **VIIIb**-elements (platinoides Pn)

1.1.1.1.1.1. Native metals

Platinum group

Platinum	Pt
Iridium	Ir
Palladium	Pd
Rhodium	(Rh,Pt)

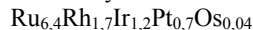
Osmium group

Osmium	Os
Ruthenium	Ru
*Rutheniridosmin	(Ir,Os,Ru)

1.1.1.1.1.2. Metallides

*Iridrhodruthenium

1.1.1.1.1.2.1. Only Pn



1.1.1.1.1.2.2. Ferreeds

Isoferroplatinum group

Isoferroplatinum	Pt ₃ Fe
Unnamed 023	Pt ₂ (Ir,Os)Fe
*Chengdeite	(Ir,Pt,Os,Ru) ₃ (Fe,Ni)
*Unnamed	Pt ₂ Fe

Tetraferroplatinum group

Unnamed 021	RhFe
Tetraferroplatinum	Pt _{1+x} Fe (0 ≤ x ≤ 1)
Unnamed 022	Pt(Fe,Ni,Cu)
Ferronickelplatinum	Pt ₂ FeNi
Tulameenite	Pt ₄ Fe ₂ CuNi or Pt ₂ FeCu
Unnamed 305	Pt ₃ Cu ₂ Fe
Group Pn₂(Fn,Cu)₃	
Unnamed 308	(Os,Ir,Ru,Pt) ₂ Fe ₃
Unnamed 306	(Ru,Os,Ir,Pt) ₂ (Fe,Ni,Cr) ₃
Unnamed 454	Pt ₂ (Fe,Bi) ₃

Group Pn(Fn,Cu)₃	
Unnamed 304	Pt(Ni,Cu,Fe) ₃
Unnamed 307	(Pt,Ir,Os)(Fe,Ni,Cr,Cu) ₃
Unnamed 302	PtCu ₂ Fe
Unnamed 498	1.1.1.1.1.2.3. Pn and Ag PdAg
Unnamed 455 2,(6)	1.1.1.1.1.2.4. Pn, Ag and Tl (Pd,Ag) ₈ Tl ₃
Unnamed 456 1,75	Pd ₆ AgTl ₄
Unnamed 453 2,5	1.1.1.1.1.2.5. Pn and Tl (Pd,Sn,Cu,Fe) ₅ (Tl,S) ₂
Unnamed 443	1.1.1.1.1.2.6. Pn and Au PdAu ₃
Potarite	1.1.1.1.1.2.7. Mercureeds (amalgams) PdHg
Unnamed 514	1.1.1.1.1.2.8. Cuprides 1.1.1.1.1.2.8.1. Proper cuprides Pt ₃ Cu
Unnamed 515	(Pd,Pt,Au) ₂ Cu
*Skaergaardite	PdCu
Hongshiite	PtCu
*Unnamed	PtCu _{1-x} Sb _x
Unnamed 433	Pt ₂ Cu ₃
Unnamed 303	PtCu ₃
*Nielsenite	PdCu ₃
*Bortnikovite	*1.1.1.1.1.2.8.2. Cuprido-zincides Pd ₄ Cu ₃ Zn
Cabriite family	1.1.1.1.1.2.8.3. Cuprido-stanides
Unnamed 019	Pd ₆ Cu ₂ (Sn,Sb)
Cabriite	Pd ₂ CuSn
Unnamed 389	Rh ₂ CuSn
Stannopalladinite	(Pd,Cu) ₃ Sn ₂
Unnamed 411	1.1.1.1.1.2.9. Stanides 1.1.1.1.1.2.9.1. Proper stanides (Pd,Pt) ₇ (Sn,Pb) ₂
Zvyagintsevite family	
Zvyagintsevite series	
Rustenburgite	Pt ₃ Sn
Atokite	Pd ₃ Sn
Zvyagintsevite	Pd ₃ (Pb,Sn)
Unnamed	Pd ₃ Pb
Maslenytskovite series	
Maslenytskovite-(Pt)	Pt _{3-x} Pd _x Sn _{1-y} □ _y (0,6 ≤ x ≤ 1,5); (0 ≤ y ≤ 0,1)
Maslenytskovite-(Pd)	Pd _{3-x} Pt _x Sn _{1-y} □ _y (0,6 ≤ x ≤ 1,5); (0 ≤ y ≤ 0,1)
Taimyrite	(Pd,Cu,Pt) ₃ Sn
*Tatyanaita	(Pt,Pd,Cu) ₉ Cu ₃ Sn ₄

Paolovite family	
Palarstanide	$\text{Pd}_5(\text{Sn,As})_2$
Unnamed 020	$(\text{Pt,Pd})_5(\text{Sn,Sb})_2$
Paolovite	Pd_2Sn
Niggliite group	
Niggliite	PtSn
Unnamed 436	$(\text{Ni,Pt})\text{Sn}$
Unnamed 233	1.1.1.1.1.2.9.2. Stanides-arsenides $\text{Pd}_6\text{Sn}_2\text{As}$
	1.1.1.1.1.2.10. Plumbides
	1.1.1.1.1.2.10.1. Proper plumbides
Plumbopalladinite	Pd_3Pb_2
*Norilskite	$(\text{Pd,Ag})_{2-x}\text{Pb}$ (0.08 \leq x \leq 0.11)
	1.1.1.1.1.2.10.2. Plumbido-sulfides
*Shandite	$\text{Pb}_2\text{Ni}_3\text{S}_2$
Rhodplumsite	$\text{Rh}_3\text{Pb}_2\text{S}_2$
*Laflammeite	$\text{Pd}_3\text{Pb}_2\text{S}_2$
1.1.1.1.2. Minerals of Ib -elements	
1.1.1.1.2.1. Minerals of Ag	
1.1.1.1.2.1.1. Native metals	
Silver family	
Silver-3C	Ag
Silver -2H	
Silver -4H	
1.1.1.1.2.1.2. Metallides	1.1.1.1.2.1.2.1. Ag, Au and Cu
Unnamed 005	AuAgCu
	1.1.1.1.2.1.2.2. Mercureeds (amalgams)
*Amalgam	(Ag,Hg)
	1.1.1.1.2.1.2.2.1. Simple
Moschellandsbergite family	
*Eugenite	$\text{Ag}_{11}\text{Hg}_2$
Luanheite	Ag_3Hg
Moschellandsbergite	Ag_2Hg_3
Paraschachnerite	$\text{Ag}_{1,2}\text{Hg}_{0,8}$
Schachnerite	$\text{Ag}_{1,1}\text{Hg}_{0,9}$
1.1.1.1.2.1.2.2.2. Complex	1.1.1.1.2.1.2.2.2.1. Ag, Au and Hg
Unnamed 016	$\text{Au}_5\text{Ag}_{10}\text{Hg}$
Unnamed 015	$\text{Au}_{1,6}\text{Ag}_{7,4}\text{Hg}$
1.1.1.1.2.2. Minerals of Au	
1.1.1.1.2.2.1. Native metals	
Gold series	
Gold	Au
Electrum	(Au,Ag)
1.1.1.1.2.2.2. Metallides	1.1.1.1.2.2.2.1. Mercureeds (amalgams)
Unnamed 3	(Au,Ag) ₃ Hg
Weishanite	(Au,Ag) _{1,2} Hg _{0,8}

*Amalgam	(Au,Ag) ₂ Hg
*Amalgam	α-AuAgHg
*Amalgam	(Au,Ag)Hg
	1.1.1.1.2.2.2.2. Cuprides
Auricupride family	
Unnamed 464	Au ₃ Cu
Auricupride	AuCu ₃
Tetra-auricupride	AuCu
	*1.1.1.1.2.2.2.3. Stannides
*Yuanjiangite	AuSn
*Unnamed	AuSn ₂
*Nisnite	Ni ₃ Sn
	1.1.1.1.2.2.2.4. Plumbides
*Novodneprite	AuPb ₃
Anyuite	AuPb ₂
*Hunchunite	Au ₂ Pb
1.1.1.1.3. Minerals of IIb -elements	
1.1.1.1.3.1. Native metals	
Mercury	Hg
1.1.1.1.3.2. Metallides	1.1.1.1.3.2.1. Cuprides
Kolymite	Cu ₇ Hg ₆
*Belendorffite	Cu ₇ Hg ₆ trig.,pseudo-cub.
	1.1.1.1.3.2.2. Plumbides
Leadamalgam (altmarkite)	Hg _{0,3} Pb _{0,7}
1.1.1.2. <u>Minerals of centrosymmetrical <i>d</i>-elements</u>	
*1.1.1.2.1. Minerals of VIIIb -elements	
*1.1.1.2.1.1. Native metals	
1.1.1.2.2. Minerals of VIIIb -elements (Fn)	
1.1.1.2.2.1. Native metals	
Iron family	
Iron	α-Fe
*Hexaferrum	(Fe _{0,65} Ir _{0,14} Os _{0,08} Ru _{0,08} Rh _{0,03} Ni _{0,01} Cu _{0,01}) _{Σ1,00}
Nickel series	
Nickel	Ni
Taenite	γ-(Ni,Fe)
Kamacite	α-(Fe,Ni)
1.1.1.2.2.2. Metallides	1.1.1.2.2.2.1. Only Fn
Awaruite	up FeNi ₂ to FeNi ₃
Tetrataenite group	
Tetrataenite	FeNi
Wairauite	FeCo
Unnamed 014	Fe ₂ Co
	1.1.1.2.2.2.2. Chromides
Ferchromide series	
Ferchromide	Cr _{1,5} Fe _{0,2}
Chromferide	Cr _{0,2} Fe _{1,5}
	1.1.1.2.2.2.3. Stanides
Unnamed 288	Ni ₃ Sn ₂

	1.1.1.2.2.2.4. Plumbides
	1.1.1.2.2.2.4.1. Plumbido-sulfides
Shandite	$\text{Ni}_3\text{Pb}_2\text{S}_2$
	*1.1.1.2.2.2.5. Tantalido-niobides
*Jedwabite	$\text{Fe}_7(\text{Ta},\text{Nb})_3$
1.1.1.2.3. Minerals of Ib -elements (Cu)	
1.1.1.2.3.1. Native metals	
Copper	Cu
1.1.1.2.3.2. Metallides	
1.1.1.2.3.2.1. Zincides	
Brass family	
Unnamed 009	$\text{Cu}_{4,45}\text{Zn}$
Unnamed 008	Cu_3Zn
*Unnamed	$(\text{Cu}, \text{Au}, \text{Ag})_4\text{Zn}$
*Unnamed	$\text{Cu}_{1,81}\text{Zn}_{1,2}\text{Fe}_{0,07}$
Brass	$\beta\text{-CuZn}$
Zhanghengite	CuZn
Danbaite	CuZn_2
1.1.1.2.3.2.2. Stanides	
Bronze family	
Unnamed 013	$(\text{Cu}, \text{Ni}, \text{Sn})$
Unnamed 012	Cu_3Sn
Bronze-n	Cu_6Sn_5
Unnamed 007	$\text{Cu}(\text{Sn}, \text{Sb})$
*Unnamed solid solution	$\text{Cu}_3\text{AuHg}_{0,4}\text{Sn}_{0,7}\text{-Cu}_3\text{Au}_{1,8}\text{HgSn}$
1.1.1.2.3.2.3. Aluminides	
Cupalite	$(\text{Cu}, \text{Zn})\text{Al}$
Khatyrkite	$(\text{Cu}, \text{Zn})\text{Al}_2$
1.1.1.2.4. Minerals of IIb -elements(Zn and Cd)	
1.1.1.2.4.1. Native metals	
Zinc group	
Zinc	Zn
Cadmium	Cd
1.1.1.2.4.2. Metallides	
1.1.1.2.4.2.1. Aluminides	
Unnamed 011	Zn_2Al
Unnamed 010	ZnAl_2
*1.1.1.2.5. Minerals of VIb -elements	
*1.1.1.2.5.1. Native metals	
*Titanium	Ti
1.1.1.3. <u>Minerals of noncensymmetrical p-elements</u>	
1.1.1.3.1. Minerals of IIIa -elements	
1.1.1.3.1.1. Native metals	
Indium	In
1.1.1.3.2. Minerals of IVa -elements	
1.1.1.3.2.1. Native metals	
Tin	Sn

Lead

Pb

1.1.2. **Class:** Metals and metallides of lithophylic elements1.1.2.1. Minerals of light *d*-elements_ (with 1 – 4 *d*-electrons)1.1.2.1.1. Minerals of noncenosymmetrical *d*-elements1.1.2.1.1.1. Minerals of *Vb*-elements

1.1.2.1.1.1.1. Native metals

*1.1.2.1.1.2. Minerals of *VIb*-elements

*1.1.2.1.1.2.1. Native metals

*Hexamolybdenum (Mo,Ru,Fe)

*Tungsten W

1.1.2.1.2. Minerals of cenosymmetrical *d*-elements1.1.2.1.2.1. Minerals of *VIb*-elements

1.1.2.1.2.1.1. Native metals

Chromium

Cr

1.1.2.2. Minerals of light *p*-elements1.1.2.2.1. Minerals of light cenosymmetrical *p*-elements1.1.2.2.1.1. Minerals of *IIIa*-elements

1.1.2.2.1.1.1. Native metals

Aluminium

Al

*1.1.2.2.1.1.2. Metallides

*Unnamed

Al_{0,98}(Si,Cu,Ag)_{0,02}

*Unnamed

Al_{0,72}(Si,Cu,Ag,Mn,Fe)_{0,28}

*Unnamed

Al_{0,7}(Si,Mn,Fe)_{0,3}

*Icosahedrite

Al₆₃Cu₂₄Fe₁₃

1.2. Subtype: Semimetals and semimetallides (ohly of sidero- and chalcophylic cations)

1.2.1. Quasisubtype*: Semimetals and semimetallides of *Va*-elements1.2.1a. **Class:** Native *Va*-semimetalls**Arsenic family****Arsenic group**

Arsenic

As

*Pararsenolamprite

As

Stibarsen (allemontite)

SbAs

Antimony

Sb

Bismuth

Bi

Arsenolamprite

As

Paradocrasite

Sb₂(Sb,As)₂1.2.1b. **Class:** *Va*-Semimetals- arsenides, antimonides, bismuthides1.2.1b.1. Minerals of heavy *d*-elements (with 5 – 10 *d*-electrons)1.2.1b.1.1. Minerals of heavy noncenosymmetrical *d*-elements (with 5 – 10 *d*-electrons)1.2.1b.1.1.1. Minerals of *VIIIb*-cations (Pnⁿ⁺)

1.2.1b.1.1.1.1. Arsenides

Unnamed 231 2,5	(Pd,Ni) ₅ As ₂
Palladoarsenide family 2	
Palladoarsenide	Pd ₂ As
*Rhodarsenide	(Rh,Pd) ₂ As
*Palladodymite	(Pd,Rh) ₂ As
Palladobismutharsenide	Pd ₁₀ (BiAs ₄) _{Σ5}
Unnamed	Pd ₈ (BiAs ₃) _{Σ4}
*Unnamed	Pd ₃ (Sb,As)
*Polkanovite 1,7	Rh ₁₂ As ₇
1.2.1b.1.1.1.1.2.1.2. Complex	1.2.1b.1.1.1.1.2.1.2.1. Only Pn
Unnamed 403 2	OsRuAs
	1.2.1b.1.1.1.1.2.1.2.2. Pn and Fn
Unnamed 232 2,(6)	Pd ₂ Ni ₆ As ₃
*Unnamed 2,5	Pd ₅ (As,Te,Sn) ₂
*Unnamed 2,5	(Pd,Pt) ₅ (Sn,As,Sb) ₂
Unnamed 223 2,(3)	Pd ₃ Ni ₄ As ₃
Majakite group	
Majakite	PdNiAs
Zaccariniite = Unnamed 387	RhNiAs
Unnamed 381 1,7(3)	Pd _{1,6} NiAs _{1,5}
*Menshikovite	Pd ₃ Ni ₂ As ₃
	1.2.1b.1.1.1.1.2.1.2.3. Pn and Cu
Unnamed 434 8,(3)	(Pt,Pd) ₁₇ Cu ₈ As ₃
Unnamed 221 3,5	(Pd,Cu) ₇ (As,Sb) ₂
	1.2.1b.1.1.1.1.2.1.2.4. Pn and Hg
Atheneite 2	Pd ₂ (As _{0,75} Hg _{0,25})
	1.2.1b.1.1.1.1.2.1.2.5. Pn and Pb
Borishanskiite 2	Pd _{1+x} (As,Pb) ₂ (x=0-0.2)
	1.2.1b.1.1.1.1.2.1.2.6. Pn and Sn
Group Pd₆SnAs 7	
Unnamed 310	Pd ₆ SnAs
Unnamed 311	Pd ₆ SnSb
1.2.1b.1.1.1.2.2.2. Subantimonido-arsenides (simple)	
Mertieite family	
Mertieite-I 2,2	Pd _{5+x} (Sb,As) _{2-x} (x=0.1-0.2)
Isomertieite 2,2	Pd ₁₁ Sb ₂ As ₂
Mertieite-II 2,(6)	Pd ₈ (Sb,As) ₃
1.2.1b.1.1.1.2.3. Subarsenido-sulfides	
1.2.1b.1.1.1.1.2.3.1. Simple	
Unnamed 229 2,(6)	Pd ₈ As ₂ S
1.2.1b.1.1.1.2.3.2. Complex	
Daomanite 0,(6)	CuPtAsS ₂
1.2.1b.1.1.1.3. Monoanionic	
1.2.1b.1.1.1.3.1. Pn ²⁺ and Pn ³⁺ (complex)	
1.2.1b.1.1.1.3.1.1. Proper arsenides	
Unnamed 225 1,(3)	Pd ₄ As ₃ → Pd ²⁺ ₃ Pd ³⁺ As ₃

1.2.1b.1.1.1.1.3.1.2. Arsenido- sulfides

Unnamed 401 1 $\text{Os}^{2+}\text{Rh}^{3+}\text{AsS}$

1.2.1b.1.1.1.1.3.2. Pn^{3+}

1.2.1b.1.1.1.1.3.2.1. Proper arsenides (simple)

Ruthenarsenite group 1

Cherepanovite RhAs
 Ruthenarsenite (Ru,Ni)As
 Unnamed 309 Pd(As,Te)

1.2.1b.1.1.1.1.3.2.2. Arsenido- sulfides (simple)

Unnamed 177 0,(8) $\text{Pd}^{3+}_8\text{As}_6\text{S}_3$

*1.2.16.1.1.1.1.3.2.3. Arsenido -tellurides

*Törmroosite $\text{Pd}_{11}\text{As}_2\text{Te}_2$

1.2.1b.1.1.1.2. Antimonides

1.2.1b.1.1.1.2.1. Polyantimonides

1.2.1b.1.1.1.2.1.1. Pn^{2+}

1.2.1b.1.1.1.2.1.1.1. Proper Polyantimonides (simple)

Geversite group (?)

Geversite Pt[Sb₂]
 Unnamed 161 0,5 Pd[Sb₂] (?)

1.2.1b.1.1.1.2.1.1.2. Polybismuthido-anthimonido-tellurides (simple)

1.2.1b.1.1.1.2.1.2. Pn^{3+}

1.2.1b.1.1.1.2.1.2.1. Polyantimonido -sulfides (simple)

Tolovkite group (?)

Tolovkite Ir[SbS]
 *Changchengite Ir[BiS]
 Unnamed 158 0,5 Rh[SbS]

1.2.1b.1.1.1.2.2. Subantimonides (simple)

Unnamed 472 4 Pd₄Sb
 Unnamed 429 3 (Pd,Cu)₃Sb
 *Naldrettite Pd₂Sb
 Stibiopalladinite 2,5 Pd₅Sb₂
 Unnamed 234 2 (Pd,Pt,Ni)₂(Sb,Sn)
Genkinite series (?)
 Genkinite 1,(3) (Pt,Pd,Rh,Ni)₄Sb₃
 Unnamed 493 1,(3) (Pd,Pt)₄Sb₃
 *Ungavaite Pd₄Sb₃

1.2.1b.1.1.1.2.3. Monoanionic

1.2.1b.1.1.1.2.3.1. Pn^{2+}

1.2.1b.1.1.1.2.3.1.1. Proper antimonides (simple)

Unnamed 445 1,5 $(\text{Pt,Pd})_3\text{Sb}_2 \rightarrow (\text{Pt,Pd})^{2+}_3\text{Sb}_2$

1.2.1b.1.1.1.2.3.2. Minerals Pn^{3+}

1.2.1b.1.1.1.2.3.2.1. Proper antimonides

1.2.1b.1.1.1.2.3.2.1.1. Simple

Sudburyite group

Unnamed 142 1 RhSb
 Sudburyite 1 PdSb

Unnamed 471 1	Pd(Sb,Te,Bi)
Stumpflite 1	PtSb
1.2.1b.1.1.1.2.3.2.1.2. Simple→Complex	
Unnamed 179 0,(6)	Pd ₂ (Sb,Te) ₃
1.2.1b.1.1.1.3. Bismuthides	
1.2.1b.1.1.1.3.1. Polybismuthides	
1.2.1b.1.1.1.3.1.1. Pn ²⁺	
1.2.1b.1.1.1.3.1.1.1. Polybismuthides with Bi : Pn = 2 - dibismuthides (simple)	
Froodite group	
Insizwaite 0,5	Pt[(Bi,Sb) ₂]
Froodite	Pd[Bi ₂]
1.2.1b.1.1.1.3.1.2. Pn ^{>3+} (?)	
1.2.1b.1.1.1.3.1.2.1. Polybismuthides → subbismuthides (?) with Bi : Pn = 0,(3) (simple)	
Unnamed 230 0,(3)	PdBi ₃
1.2.1b.1.1.1.3.2. Subbismuthides (complex)	
Unnamed 018 6	Pd ₃ Pb ₃ Bi
Unnamed 228 4	(Pd,Rh,Pt) ₃ Pb(Bi,Te)
1.2.1b.1.1.1.3.3. Monoanionic	
1.2.1b.1.1.1.3.3.1. Pn ³⁺	
1.2.1b.1.1.1.3.3.1.1. Proper bismuthides (simple)	
Series (Pt,Pd)(Bi,Sb)	
Unnamed 446 1	(Pt,Pd)(Bi,Sb)
Unnamed 143 1	(Pt,Pd)(Bi,Sb)
Polarite	Pd(Bi,Pb)
1.2.1b.1.1.1.3.3.1.2. Pn ²⁺ and Pn ⁴⁺	
1.2.1b.1.1.1.3.3.1.2.1. Proper bismuthides (complex)	
Urvantsevite	Pd(Bi,Pb) ₂
1.2.1b.1.1.2. Minerals of Ib-cations	
1.2.1b.1.2.1. Minerals of Ag	
1.2.1b.1.2.1.1. Arsenides	
1.2.1b.1.2.1.1.1. Polyarsenido (?) -sulfides (simple)	
Dervillite 0,(6)	Ag ₂ AsS ₂
1.2.1b.1.2.1.1.2. Monoanionic (complex)	
Kutinaite	(Ag ₆ Cu ₁₄) _{Σ20} As ₇ → (Ag ₆ Cu ₁₃) ⁺ _{Σ19} Cu ²⁺ As ₇
1.2.1b.1.2.1.2. Antimonides	
1.2.1b.1.2.1.2.1. Polyantimonides (?) (simple)	
Allargentum	Ag _{1-x} Sb (0,09 < x < 0,16)
1.2.1b.1.2.1.2.2. Monoanionic (simple)	
Dyscrasite	Ag ₃ Sb
1.2.1b.1.2.2. Minerals of Au	
1.2.1b.1.2.2.1. Antimonides	
1.2.1b.1.2.2.1.1. Polyantimonides (?) (simple – Au ²⁺)	
Aurostibite 0,5	Au[Sb ₂]

1.2.1b.1.1.2.2.1.2. Monoanionic

1.2.1b.1.1.2.2.1.2.1. Au⁺

1.2.1b.1.1.2.2.1.2.1.1. Antimonido-sulfides (complex)

Criddleite $\text{TlAu}_3\text{Ag}_2\text{Sb}^{3+}_{10}$

1.2.1b.1.1.2.2.2. Bismutides

1.2.1b.1.1.2.2.2.1. Subbismutides (simple)

Maldonite Au_2Bi 1.2.1b.1.1.3. Minerals of **IIb**-cations (Hg)

1.2.1b.1.1.3.1. Antimonides

1.2.1b.1.1.3.1.1. Monoanionic

1.2.1b.1.2.3.1.1.1. Antimonido-sulfides (complex)

Tvalchrelidzeite $\text{Hg}_3\text{SbAsS}_3$ 1.2.1b.1.2. Minerals of centrosymmetrical d-cations1.2.1b.1.2.1. Minerals of **VIIIb**-cations (Fnⁿ⁺)

1.2.1b.1.2.1.1. Arsenides

1.2.1b.1.2.1.1.1. Polyanionic

1.2.1b.1.2.1.1.1.1. Fn²⁺ (seldom Fn⁴⁺ ?)

1.2.1b.1.2.1.1.1.1.1. Proper arsenides with As : Fn = 2 – diarsenides (simple)

Löllingite familyKrutovite $\text{Ni}[\text{As}_2]$ Pararammelsbergite $\text{Ni}[\text{As}_2]$ **Löllingite** group (compare with marcasite (group); ullmannite (series))Rammelsbergite $\text{Ni}[\text{As}_2]$ Safflorite $\text{Co}[\text{As}_2]$ Löllingite $\text{Fe}[\text{As}_2]$ Clinosafflorite $\text{Co}[\text{As}_2]$ 1.2.1b.1.2.1.1.1.2. Minerals of Fn³⁺

1.2.1b.1.2.1.1.1.2.1. Proper arsenides with As : Fn = 3 – Triarsenides (simple)

Skutterudite seriesNickelskutterudite (chloanthite) $(\text{Ni},\text{Co},\text{Fe})\text{As}_3$ Skutterudite CoAs_3 *Ferroskutterudite $(\text{Fe},\text{Co})\text{As}_3$

1.2.1b.1.2.1.1.1.2.2. Arsenido-sulfides with (As+S) : Fn = 2 – diarsenido-sulfides (simple)

Gersdorffite series (?) (compare with pyrite (group))Gersdorffite $\text{Ni}[\text{AsS}]$ Unnamed 450 $(\text{Ni},\text{Fe},\text{Co})[\text{AsS}]$ **Arsenopyrite** family (compare with marcasite (group); ullmannite (series))Cobaltite $\text{Co}[\text{AsS}]$ Glaucodote $(\text{Co},\text{Fe})[\text{AsS}]$ Alloclasite $(\text{Co},\text{Fe})[\text{AsS}]$ Arsenopyrite $\text{Fe}[\text{AsS}]$ Seinäjokite $(\text{Fe},\text{Ni})[(\text{Sb},\text{As})_2]$ *Unnamed $(\text{Fe},\text{Ni})\text{SbAs}$ *Oenite CoSbAs

1.2.1b.1.2.1.1.1.2.3. Arsenido-selenides with (As+Se) : Fn = 2 – diarsenido-selenides

Unnamed 479 $\text{Co}[\text{AsSe}](?)$

*Jolliffeite NiAsSe

1.2.1b.1.2.1.1.2. Subarsenides

1.2.1b.1.2.1.1.2.1. Proper arsenides (simple)

Maucherite family

Dienierite = nickelskutterudite $(\text{Ni}, \text{Co}, \text{Fe})\text{As}_3$

Orcelite 2,5 $\text{Ni}_{5-x}\text{As}_2$

Unnamed 385 2,(3) $(\text{Ni}, \text{Fe})_7(\text{As}, \text{Sb})_3$

Maucherite 1,375 $\text{Ni}_{11}\text{As}_8$

1.2.1b.1.2.1.1.2.2. Subarsenido-antimonido-sulfides (simple)

Vozhminite $(\text{Ni}, \text{Co})_4(\text{As}, \text{Sb})\text{S}_2$

1.2.1b.1.2.1.1.3. Monoanionic

1.2.1b.1.2.1.1.3.1. Fn^{2+}

1.2.1b.1.2.1.1.3.1.1. Proper arsenides (simple)

Oregonite FeNi_2As_2

1.2.1b.1.2.1.1.3.2. Fn^{3+}

1.2.1b.1.2.1.1.3.2.1. Proper arsenides (simple)

Nickeline family**Nickeline series**

Nickeline NiAs

Langisite CoAs

Breithauptite NiSb

Modderite group

Modderite orth. CoAs

Westerveldite orth. $(\text{Fe}, \text{Ni})\text{As}$

1.2.1b.1.2.1.1.3.3. Fn^{3+} and Fn^{4+}

1.2.1b.1.2.1.1.3.3.1. Arsenido-sulfides (complex)

Unnamed 157 $(\text{Co}, \text{Ni})_2\text{AsS}_2 \rightarrow \text{Fn}^{3+}\text{Fn}^{4+}\text{AsS}_2$

1.2.1b.1.2.1.1.3.4. Fn^{4+}

1.2.1b.1.2.1.1.3.4.1. Proper arsenides (simple)

Unnamed 162 $(\text{Ni}, \text{Pd})_3\text{As}_4$

1.2.1b.1.2.1.2. Antimonides

1.2.1b.1.2.1.2.1. Polyanionic

1.2.1b.1.2.1.2.1.1. Fn^{2+}

1.2.1b.1.2.1.2.1.1.1. Proper polyantimonides with Sb : Fn = 2 - diantimonides (simple)

Nisbite group (?) (compare with pyrite (series))

Nisbite $\text{Ni}[\text{Sb}_2]$

Unnamed 159 $\text{Co}[\text{Sb}_2]$

*1.2.1b.1.2.1.2.1.1.2. Proper polyantimonides with Sb : Fn = 3 – триантимониды

*Kieftite CoSb_3

1.2.1b.1.2.1.2.1.2. Fn^{3+}

1.2.1b.1.2.1.2.1.2.1. Polyantimonido-sulfides with (Sb+S) : Fn = 2 - diantimonides-sulfides (simple)

Ullmannite family (compare with marcasite (droup.); arsenopyrite (series))

Ullmannite	Ni[SbS]
Willyamite	(Co,Ni)[SbS]
Costibite	Co[SbS]
Paracostibite	Co[SbS]
Gudmundite	Fe[SbS]

1.2.1b.1.2.1.2.2. Subantimonides (simple)

Unnamed 384 3	Ni ₃ Sb
Unnamed 383 2	(Ni,Cu) ₂ Sb

1.2.1b.1.2.1.2.3. Monoanionic

1.2.1b.1.2.1.2.3.1. Fn²⁺1.2.1b.1.2.1.2.3.1.1. Bismuthido-sulfides (complex – Ni²⁺ and Pb²⁺)

Parkerite (an. 3)	Ni ₃ (Bi,Pb) ₂ S ₂
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1.2.1b.1.2.1.2.3.2. Fn²⁺ and Fn³⁺1.2.1b.1.2.1.2.3.2.1. Antimonido-sulfides → bismuthido-tellurido-sulfides → Bismuthido-sulfides (complex – Ni²⁺ and Ni³⁺)**Hauchecornite** family (Ni²⁺₅Ni³⁺₄X₂S₈, X = As³⁻, Sb³⁻, Bi³⁻, Te²⁻)

Arsenohauchecornite	Ni ²⁺ ₁₀ Ni ³⁺ ₈ Bi ₃ AsS ₁₆
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Hauchecornite group

Tučekite	Ni ²⁺ ₅ Ni ³⁺ ₄ Sb ₂ S ₈
Hauchecornite	Ni ²⁺ ₅ Ni ³⁺ ₄ Bi(Sb,Bi) ₈ S ₈
Bismutohauchecornite	Ni ²⁺ ₅ Ni ³⁺ ₄ Bi ₂ S ₈
Tellurohauchecornite	Ni ²⁺ ₆ Ni ³⁺ ₃ BiTeS ₈

1.2.1b.1.2.1.2.3.3. Fn³⁺ and Fn⁴⁺1.2.1b.1.2.1.2.3.3.1. Bismuthido-sulfides (complex- Ni³⁺ and Ni⁴⁺)

Parkerite (an. 1 and 2)	Ni ³⁺ ₂ Ni ⁴⁺ Bi ₂ S ₂
-------------------------	---

1.2.1b.1.2.2. Minerals of **Ib**-cations

1.2.1b.1.2.2.1. Arsenides

1.2.1b.1.2.2.1.1. Polyanionic (only Cu²⁺)

1.2.1b.1.2.2.1.1.1. Poper arsenides (simple)

Paxite	Cu[As ₂]
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1.2.1b.1.2.2.1.1.2. Arsenido-sulfides (simple)

Lautite	Cu[AsS] [∞]
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1.2.1b.1.2.2.1.2. Subarsenides (simple)

Algodonite	Cu ₁₇ As ₃
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1.2.1b.1.2.2.1.3. Monoanionic

1.2.1b.1.2.2.1.3.1. Cu⁺

1.2.1b.1.2.2.1.3.1.1. Poper arsenides (simple)

Domeykite family

Domeykite	α-Cu ₃ As
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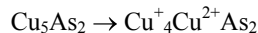
Metadomeykite β -Cu₃As

1.2.1b.1.2.2.1.3.2. Cu⁺ and Cu²⁺

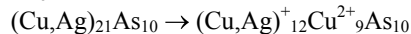
1.2.1b.1.2.2.1.3.2.1. Proper arsenides (complex)

Koutekite family

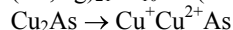
Koutekite



Novakite



Unnamed 220



1.2.1b.1.2.2.2. Antimonides

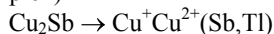
1.2.1b.1.2.2.2.1. Subantimonides (simple)

1.2.1b.1.2.2.2.2. Monoanionic

1.2.1b.1.2.2.2.2.1. Cu⁺ and Cu²⁺

1.2.1b.1.2.2.2.2.1.1. Proper antimonides (complex)

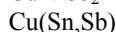
Cuprostibite



*Zlatogorite



*Sorosite



1.2.1b.1.2.2.2.2.1.2. Antiminido-sulfides (complex)

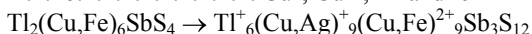
1.2.1b.1.2.2.2.2.1.2.1.1. Cu⁺, Cu²⁺ and Tl⁺

Rohaite



1.2.1b.1.2.2.2.2.1.2.1.2. Cu⁺, Cu²⁺, Tl⁺ and Fe²⁺

Chalcothallite 3



1.2.1b.2. Minerals of noncensymmetrical p-cations

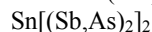
1.2.1b.2.1. Minerals of **IVa**-cations

1.2.1b.2.1.1. Minerals of Sn²⁺ (?)

1.2.1b.2.1.1.1. Antimonides

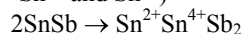
1.2.1b.2.1.1.1.1. Polyanionic(?) antimonido-arsenides (simple)

Unnamed 181 0,25



1.2.1b.2.1.1.1.1. Моноанионные (сложные - Sn²⁺ and Sn⁴⁺)

Stistaite



1.2.2. Quasisubtype*: Semimetals and semimetallidess of **Va**-semimetals

1.2.2a. **Class:** Native **VIa**-semimetals

Tellurium

Te

1.2.2b. **Class:** **VIa**-semimetals -tellurides

1.2.2b.1. Minerals of heavy *d*-cations (with 5 – 10 *d*-electrons)

1.2.2b.1.1. Minerals of noncensymmetrical *d*-cations

1.2.2b.1.1.1. Minerals of **VIIIb**-cations (Pnⁿ⁺)

1.2.2b.1.1.1.1. Polytellurides (?)

1.2.2b.1.1.1.1.1. Proper polytellurides (simple)

*Unnamed (Pd теллурид)



Unnamed 180 0,(3)



*Merenskyite Pd_{1-x}Pt_xBi_yTe_{2-y} (0 ≤ x ≤ 0,5); (0 ≤ y ≤ 0,(6)) или PdTe₂

*Gaotaiite 0,375



Unnamed 119 2	$\text{Pd}_2(\text{Te,As})$
*Unnamed	$\text{Pd}_{11}\text{Te}_2\text{As}_2$
1.2.2b.1.1.1.2.3. Subtellurido-sulfides (complex)	
Unnamed 116 2,5	$(\text{Pd,Cu,Sn})_5(\text{Te,S})_2$
Vasilite 2,3	$(\text{Pd,Cu})_{16}(\text{S,Te})_7$
1.2.2b.1.1.1.3. Monoanionic	
1.2.2b.1.1.1.3.1. Pn^{2+} and Pn^{3+} (complex)	
1.2.2b.1.1.1.3.1.1. Proper tellurides	
Unnamed 439 0,75	$(\text{Pt,Pd,Ni})_3\text{Te}_4 \rightarrow (\text{Pt,Pd,Ni})^{2+}(\text{Pt,Pd,Ni})^{3+}_2\text{Te}_4$
1.2.2b.1.1.1.3.1.2. Tellurido-antimonides	
1.2.2b.1.1.1.3.1.3. Tellurido-bismuthides (antimonides).	
Unnamed 226 0,875	$\text{Pd}_7(\text{Bi,Te})_8 \rightarrow \text{Pd}^{2+}_5\text{Pd}^{3+}_2(\text{Bi,Te})_8$
Unnamed 173 0,8(3)	$\text{Pd}_5(\text{Bi,Sb})_2\text{Te}_4 \rightarrow \text{Pd}^{2+}\text{Pd}^{3+}_4(\text{Bi,Sb})_2\text{Te}_4$
1.2.2b.1.1.1.3.2. Pn^{3+} (simple)	
Kotulskite series	
Kotulskite	$\text{Pd}(\text{Te,Bi})_{2-x} (x \sim 0.4)$
Sobolevskite	PdBi
Unnamed 444 0,(8)	$\text{Pd}^{3+}_8\text{Bi}_6\text{Te}_3$
1.2.2b.1.1.1.3.3. Pn^{3+} and Pn^{4+} (complex)	
1.2.2b.1.1.1.3.3.1. Proper tellurides	
Unnamed 171 0,625	$(\text{Ni,Pd})_5(\text{Te,Bi})_8 \rightarrow (\text{Ni,Pd})^{3+}_4(\text{Ni,Pd})^{4+}(\text{Te,Bi})_8$
1.2.2b.1.1.1.3.3.2. Tellurido-antimonides	
Borovskite 0,6	$\text{Pd}_3\text{SbTe}_4 \rightarrow \text{Pd}^{3+}\text{Pd}^{4+}_2\text{SbTe}_4$
1.2.2b.1.1.1.3.4. Pn^{4+} (simple)	
Moncheite	PtTe_2
Merenskyite	PdTe_2
(Kotulskite) see. Sobolevskite series	
*Mayingite	IrBiTe
*Telluromayingite	$\text{Ir}(\text{Te,Bi})_2$
1.2.2b.1.1.2. Tellurides of <i>Ib</i> -cations	
1.2.2b.1.1.2.1. Tellurides of Ag^+	
1.2.2b.1.1.2.1.1. Polyanionic (?)	
1.2.2b.1.1.2.1.1.1. Simple	
Unnamed 155 0,25	$(\text{Au,Ag})(\text{Te,Pb})_4$
1.2.2b.1.1.2.1.1.2. Complex (Ag^+ , Cu^+ nad Cu^{2+})	
Cameronite 0,8	$\text{AgCu}_7\text{Te}_{10} \rightarrow \text{Ag}^+\text{Cu}^+_5\text{Cu}^{2+}_2[\text{Te}_2]_5$
1.2.2b.1.1.2.1.2. Subtellurides	
1.2.2b.1.1.2.1.2.1. Simple	
Unnamed 109 3,5	Ag_7Te_2
Empressite family	
Stützite 1,(6)	$\text{Ag}_{5-x}\text{Te}_3$
Unnamed 382 1,5	Ag_3Te_2
Empressite 1	AgTe
1.2.2b.1.1.2.1.2.2. Complex (Ag и Bi)	
Unnamed 185 2	Ag_3BiTe_2
Unnamed 398 1,57	$\text{Ag}_8\text{Bi}_3\text{Te}_7$
Unnamed 237 0,75	AgBi_2Te_4

1.2.2b.1.1.2.1.3. Monoanionic

1.2.2b.1.1.2.1.3.1. Proper tellurides

1.2.2b.1.1.2.1.3.1.1. Simple

Hessite 2



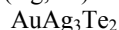
1.2.2b.1.1.2.1.3.1.2. Complex

1.2.2b.1.1.2.1.3.1.2.1. Ag^+ and Au^+ **Petzite** family 2

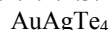
Muthmannite



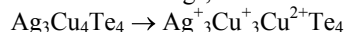
Petzite

1.2.2b.1.1.2.1.3.1.2.2. Ag^+ and Au^{3+}

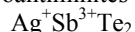
Sylvanite

1.2.2b.1.1.2.1.3.1.2.3. Ag^+ , Cu^+ and Cu^{2+}

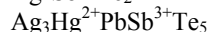
Henryite

1.2.2b.1.1.2.1.3.1.2.4. Ag^+ and $\text{Sb}^{3+} \rightarrow$ telluroantiminites

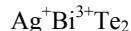
Unnamed 186 1



*Mazzettiite

1.2.2b.1.1.2.1.3.1.2.5. Ag^+ and $\text{Bi}^{3+} \rightarrow$ tellubismuthites Ag

Volynskite



1.2.2b.1.1.2.1.3.2. Tellurido-sulfides

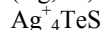
1.2.2b.1.1.2.1.3.2.1. Simple

Cervelleite family (?) 2

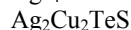
Unnamed 110



Cervelleite



*Unnamed



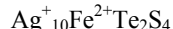
1.2.2b.1.1.2.1.3.2.2. Complex

1.2.2b.1.1.2.1.3.2.2.1. Ag^+ and Cu^+

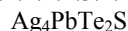
Unnamed 111 2

1.2.2b.1.1.2.1.3.2.2.2. Ag^+ and Fe^{2+}

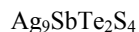
Unnamed 317 1,8

1.2.2b.1.1.2.1.3.2.2.3. Ag^+ and Pb^{2+}

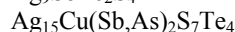
Unnamed 397 1,28

1.2.2b.1.1.2.1.3.2.2.4. Ag^+ and 3-valence Vacations \rightarrow tellurosulfoantimonites of Ag^+ **Benleonardite** family (?)

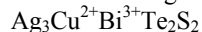
Unnamed 316



Benleonardite

1.2.2b.1.1.2.1.3.2.2.5. Ag^+ , Cu^{2+} and 3-valence Vacations \rightarrow tellurosulfobismuthites of Ag^+ and Cu^{2+}

Unnamed 154 0,8



*1.2.2b.1.1.2.1.3.3. Tellurido-selenides

*Kurilite



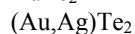
1.2.2b.1.1.2.2. Tellurides of Au

1.2.2b.1.1.2.2.1. Polytellurides (?) (simple \rightarrow complex)**Calaverite** family 0,5 (x = 2)

Calaverite



Krennerite



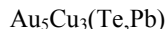
Kostovite AuCuTe_4

1.2.2b.1.1.2.2.2. Subtellurides (complex)

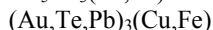
Bezsmertnovite 11 $\text{Au}_8\text{Cu}_2\text{PbTe}$ or, more precisely $\text{Au}_{8-x}\text{Ag}_x\text{Cu}_{2-y}\text{Fe}_y\text{Pb}_{1-z}\text{Te}_{1+z}$
($0 \leq x \leq 0,7$); ($0,16 \leq y \leq 0,36$); ($0 \leq z \leq 0,28$)

Bogdanovite group (?) 8

Unnamed 131

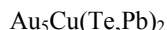


Bogdanovite

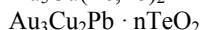


Bilibinskite group (?) 3

Unnamed 130



Bilibinskite

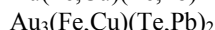


Group. (?) 2

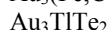
Unnamed 128



Unnamed 129



*Honeaite

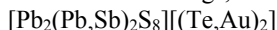


1.2.2b.1.1.2.2.3. Monoanionic

1.2.2b.1.1.2.2.3.1. Tellurides of Au^+

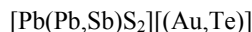
1.2.2b.1.1.2.2.3.1.1. Tellurido-sulfides (complex of Au^+ , Pb^{2+} , Sb^3 , Te^{4+}) \rightarrow telluro-sulfoantimonites of Au^+ and Pb^{2+} to tellurosulfoantimonites of Ag^+ , Pb^{2+} and Te^{4+}

*Museumite

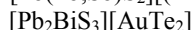


Nagyagite series

Nagyágite



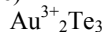
*Buckhornite



1.2.2b.1.1.2.2.3.2. Tellurides of Au^{3+} (?)

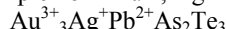
1.2.2b.1.1.2.2.3.2.1. Proper tellurides (simple)

Montbrayite 1,5



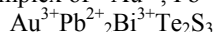
1.2.2b.1.1.2.2.3.2.2. Tellurido-arsenides (complex of - Au^{3+} , Ag^+ и Pb^{2+})

Unnamed 313 1



1.2.2b.1.1.2.2.3.2.3. Tellurido-arsenides (complex of - Au^{3+} , Pb^{2+} и Bi^{3+})

Unnamed 474 0,5



1.2.2b.1.1.3. Tellurides of **IIb**-cations (only Hg^{2+})

1.2.2b.1.1.3.1. Monoanionic (simple)

Coloradoite



1.2.2b.1.2. Minerals of centrosymmetrical *d*-cations

1.2.2b.1.2.1. Minerals of **VIIIb**-cations (Fn^{n+})

1.2.2b.1.2.1.1. Polyanionic

1.2.2b.1.2.1.1.1. Fn^{2+}

1.2.2b.1.2.1.1.1.1. Proper polytellurides with $\text{Te} : \text{Fn} = 2$ ditellurides (simple)

Frohbergite series

Mattagamite



Frohbergite



1.2.2b.1.2.1.1.1.2. Polytellurido-selenides with $(\text{Te} + \text{Se}) : \text{Fn} = 2$ ditellurido-selenides (simple)

Kitkaite



1.2.2b.1.2.1.2. Monoanionic

*Imgreite	NiTe
1.2.2b.1.2.1.2.1. Fn^{3+} and Fn^{4+}	
1.2.2b.1.2.1.2.1.1. Tellurido-antiminides (complex)	
Vavřinite 0,(6)	$\text{Ni}_2\text{SbTe}_2 \rightarrow \text{Ni}^{3+}\text{Ni}^{4+}\text{SbTe}_2$
1.2.2b.1.2.1.2.2. Fn^{4+}	
1.2.2b.1.2.1.2.2.1. Proper tellurides (simple)	
Melonite	NiTe_2
1.2.2b.1.2.2. Tellurides of <i>Ib</i> -cations	
1.2.2b.1.2.2.1. Monoanionic	
1.2.2b.1.2.2.1.1. Cu^+ и Cu^{2+} (complex)	
Ricardite family	
Rickardite	$\text{Cu}_{3-x}\text{Te}_2$
Weissite	Cu_{2-x}Te
1.2.2b.1.2.2.1.2. Cu^{2+} (simple)	
Vulcanite	CuTe
1.2.2b.2. <u>Minerals of <i>p</i>-cations</u>	
1.2.2b.2.1. Tellurides of <i>IVa</i> -cations (Pb^{n+})	
1.2.2b.2.1.1. Subtellurido-sulfides (complex)	
*Saddlebackite	$\text{Pb}_2\text{Bi}_2\text{Te}_2\text{S}_3$
Unnamed 208 1,(3)	$\text{PbBi}_3\text{TeS}_2$
1.2.2b.2.1.2. Monoanionic	
1.2.2b.2.1.2.1. Pb^{2+}	
1.2.2b.2.1.2.1.1. Proper tellurides	
1.2.2b.2.1.2.1.1.1. Simple	
Altaite	PbTe
1.2.2b.2.1.2.1.1.2. Complex (Pb^{2+} and Bi^{3+})	
Rucklidgeite group ($x=1(3)$)	
Rucklidgeite	$(\text{Pb},\text{Ag},\text{Bi})\text{Bi}_2\text{Te}_4$
Aleksite	$\text{PbBi}_2(\text{Te}_2\text{S}_2)_{\Sigma 4}$
Kochkarite 1,4	PbBi_4Te_7
1.2.2b.2.1.2.1.2. Tellurido-sulfides (simple)	
Unnamed 236 1	Pb_2TeS
1.2.2b.2.1.2.1.3. Tellurido-chlorides (complex of - Pb^{2+} and Te^{4+})	
Radhakrishnaite	$\text{PbTe}_3(\text{Cl},\text{S})_2$
1.2.2b.2.1.2.2. Pb^{2+} and Pb^{4+}	
1.2.2b.2.1.2.2.1. Proper tellurides (complex)	
Unnamed 238	$\text{Pb}_2\text{Te}_3 \rightarrow \text{Pb}^{2+}\text{Pb}^{4+}\text{Te}_3$
1.2.2b.2.1.2.3. Pb^{4+}	
1.2.2b.2.1.2.3.1. Proper tellurides (simple)	
Unnamed 239 0,5	PbTe_2
1.2.2b.2.1.2.3.2. Tellurido-chlorides (simple)	
Kolarite	PbTeCl_2
1.2.2b.2.2. Tellurides of <i>Va</i> -cations	
1.2.2b.2.2.1. Subtellurides	
1.2.2b.2.2.1.1. Proper tellurides (simple)	
Hedleyite 2,(3)	Bi_7Te_3

Unnamed 396	2,25	Bi_9Te_4
Unnamed 125	1,5	Bi_3Te_2
Pilsenite	1,(3)	Bi_4Te_3
Tsumoite	1	BiTe
Unnamed 412	0,75	Bi_3Te_4
1.2.2b.2.2.1.2. Subtellurido-sulfides (simple)		
Unnamed 121	3	$\text{Bi}_{15}\text{TeS}_4$
Unnamed 122	2,25	$\text{Bi}_9\text{Te}_2\text{S}_2$
Series (?)		
"Mineral K"	1,5	$\text{Bi}_9(\text{Te}_2\text{S})_2$
"Mineral L"	1,5	Bi_3TeS
Unnamed 418	1,5	Bi_6TeS_3
"Mineral P"	1,5	$\text{Bi}_{15}(\text{TeS}_4)_2$
Joseite series	1,(3)	
Joseite-B		$\text{Bi}_4\text{Te}_2\text{S}$
Joseite-A		Bi_4TeS_2
* Baksanite series		
*Baksanite		$\text{Bi}_6(\text{Te}_2\text{S}_3)$
Ingodite series	1	
Sulphotsumoite		$\text{Bi}_3\text{Te}_2\text{S}$
Ingodite		Bi_2TeS
Unnamed 147		Bi_2TeS
"Mineral M"		$(\text{Bi},\text{Pb})_2\text{TeS}$
Unnamed 153		Bi_4TeSe_3
Unnamed 148		$\text{Bi}(\text{S},\text{Te})$
Series (?)	0,75	
Unnamed 126		$\text{Bi}_3(\text{Te},\text{Se})_3\text{S}$
Unnamed 123		$\text{Bi}_3\text{Te}_2\text{S}_2$
1.2.2b.2.2.2. Monoanionic		
1.2.2b.2.2.2.1. Sb^{3+} and Bi^{3+}		
1.2.2b.2.2.2.1.1. Proper tellurides (simple)		
Tellurobismuthite group 0,(6)		
Telluroantimony		$\text{Sb}_2\text{Te}_2\text{Te}$
Tellurobismuthite		$\text{Bi}_2\text{Te}_2\text{Te}$
*Unnamed		Bi_2Te
*1.2.2b.2.2.2.1.2. Complex		
*Unnamed		$\text{Sb}(\text{Ni},\text{Fe},\text{Pd})_2\text{Te}_2$
*Unnamed		$(\text{Sb},\text{Bi})\text{Pd}(\text{Ni},\text{Fe})\text{Te}_2$
1.2.2b.2.2.2.1.2.1. Tellurido-sulfides (simple)		
Tetradymite family 0,(6)		
Tetradymite		$\text{Bi}_2\text{Te}_2\text{S}$
Kawazulite		$\text{Bi}_2\text{Te}_2\text{Se}$
*Vihorlatite		$\text{Bi}_{24}\text{Te}_4\text{Se}_{17}$
*Unnamed		$\text{Bi}_4\text{Te}_2\text{Se}$
*Unnamed		$\text{Bi}_6(\text{Te},\text{Se})_3$
1.2.2b.2.2.2.2. Bi^{3+} and Bi^{5+} (?) (polytellurides) (?) (simple)		
Unnamed 152	0,6	$\text{Bi}^{3+}\text{Bi}^{5+}_3\text{Te}_5$ (?)
Unnamed 151	0,4	$\text{Bi}^{5+}_2\text{Te}_5$ (?)

2. TYPE: MINERALS WITH PRINCIPAL METALLIC-COVALENT AND IONIC- COVALENT BOND , RARE VAN DER WAALS FORSES (NATIVE VIA-NONMETALS) – CHALCOGENIC COMPOUNDS: CHALCOGENIDES (ISODESMICAL) →CHALCOSALTS (ANISODESMICAL)

2a. Quasitype*: Native VIa-nonmetals (van der Waals forses)

Sulfur family

α -Sulfur	S
β -Sulfur	S
Rosickyite	S
*Sulfurite amorphous	S ₈
Selenium	Se

2b. Quasitype*: Chalcogenic compounds (metallic-covalent and ionic-covalent bond , rare van der Waals forses)-simple (isodesmical) → complex → chalcosalts (anisodesmical).

2b.1. Subtype: Chalcogenic compounds of sidero- and chalcophylic cations

2b.1a. Quasisubtype*: Sulfides and sulfosalts of sidero- and chalcophylic cations

2b.1a.1. **Class:** Sulfides of sidero- and chalcophylic cations

2b.1a.1.1. Minerals of heavy *d*-cations (with 5 – 10 *d*-electrons) and their crystallochemical analogues.

2b.1a.1.1.1. Minerals of centrosymmetrical *d*-cations

2b.1a.1.1.1.1. Minerals of **VIIb – VIIIb**-cations (Mn, Fe, Co, Ni) and their crystallochemical analogues (Cr³⁺, V³⁺, V⁴⁺, Ti³⁺) – cations of wide iron family – Fnⁿ⁺

2b.1a.1.1.1.1.1. Polyanionic

2b.1a.1.1.1.1.1.1. Minerals of M²⁺

2b.1a.1.1.1.1.1.1.1. Simple→ complex

Pyrite group

Vaesite	Ni[S ₂]
Cattierite	Co[S ₂]
Pyrite	Fe[S ₂]
Villamaninite	Cu(Ni,Co,Fe)[S ₂] ₂
Fukuchilite	(Cu,Fe)[S ₂]
Hauerite	Mn[S ₂]

Marcasite group (compare with arsenopyrite (series.))

Marcasite	Fe[S ₂]
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2b.1a.1.1.1.1.2. Subsulfides

2b.1a.1.1.1.2.1. Simple

Heazlewoodite 1,5	Ni ₃ S ₂
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2b.1a.1.1.1.2.2. Complex

2b.1a.1.1.1.2.2.1. Only Fn'

Pentlandite family

Pentlandite group 1,125

Pentlandite	(Co,Ni,Fe) _{<1} Fe ₄ Ni ₄ S ₈
Cobaltpentlandite	Co ₉ S ₈
Mackinawite	(Fe,Ni) ₉ S ₈
Godlevskite	(Ni,Fe) ₉ S ₈
Smythite	(Fe,Ni) ₉ S ₁₁

	2b.1a.1.1.1.1.2.2.2. Fn', Pt, Cu and Pb
Kharaelakhite	(Cu,Pt,Pb,Fe,Ni) ₉ S ₈
*Sugakiite	Cu(Fe,Ni) ₈ S ₈
*Tarkianite	(Cu,Fe)(Re,Mo) ₄ S ₈
	2b.1a.1.1.1.1.2.2.3. Fn', Cu, Cd and Pb
Shadlunite series	
Manganese-shadlunite	(Mn,Pb,Cd)Cu ₄ Fe ₄ S ₈
Shadlunite	(Pb,Cd)Cu ₄ Fe ₄ S ₈
	2b.1a.1.1.1.1.2.2.4. Fn' and Ag
Argentopentlandite	Ag(Fe,Ni) ₈ S ₈
	2b.1a.1.1.1.1.2.2.5. Fn' and Hg
Donharrisite	Ni ₈ Hg ₃ S ₉
	*2b.1a.1.1.1.1.2.2.6. Fn' и Nb
*Edgarite	FeNb ₃ S ₆
2b.1a.1.1.1.1.3. Monoanionic	
2b.1a.1.1.1.1.3.1. M ²⁺ (simple)	
Troilite family 1	
Troilite group	
Millerite	NiS
Jaipurite	γ-CoS
Troilite	FeS
Unnamed 139	(Fe,Ni,Ir)S
Unnamed 386	(Ni,Fe,Ir,Cu,Rh,Pt)S
Alabandite	MnS
Unnamed 138	β-MnS
*Rambergite	γ-MnS
Unnamed 141	CrS
	2b.1a.1.1.1.1.3.2. Fe ²⁺ and Fe ³⁺ (complex)
	2b.1a.1.1.1.1.3.2.1. Only Fn
	2b.1a.1.1.1.1.3.2.1.1. Fe ²⁺ >> Fe ³⁺
Pyrrhotite family	
Hexapyrrhotite series (?)	Fn _{1-x} S (x = от 0 до 0,17)
Pyrrhotite-1C	Fe _{1-x} S
Unnamed 331	(Fe,Ni) _{1-x} S
Unnamed 140	(Fe,Ag) _x S
Polysomatic series of clino(mono)pyrrhotites	nFeSFe ₂ S ₃ or Fe ²⁺ _n Fe ³⁺ ₂ S _{3+n}
Pyrrhotite-6C (n = 9)	Fe ₁₁ S ₁₂ → Fe ²⁺ ₉ Fe ³⁺ ₂ S ₁₂
Pyrrhotite-11C (n = 8)	Fe ₁₀ S ₁₁ → Fe ²⁺ ₈ Fe ³⁺ ₂ S ₁₁
Pyrrhotite-5C (n = 7)	Fe ₉ S ₁₀ → Fe ²⁺ ₇ Fe ³⁺ ₂ S ₁₀
Pyrrhotite-4C (n = 5)	Fe ₇ S ₈ → Fe ²⁺ ₅ Fe ³⁺ ₂ S ₈
	2b.1a.1.1.1.1.3.2.1.2. M ²⁺ : M ³⁺ = 1,5
Smythite	Fe ₅ S ₆ → Fe ²⁺ ₃ Fe ³⁺ ₂ S ₆
*Murchisite	Cr ₅ S ₆
	2b.1a.1.1.1.1.3.2.1.3. M ²⁺ : M ³⁺ = 0,5;
Sulfospinelides family Fn; M ²⁺ = Fn ²⁺ , Cu ²⁺ , Zn ²⁺ ; M ³⁺ = Fn ³⁺ ; In ³⁺ (compare with sulfospinelides of Pn (series.); selenospinelides (series.); oxospinelides (series.))	
Linnæite series - only of Fn ²⁺ и Fn ³⁺	

Polydymite	$\text{Ni}^{2+}\text{Ni}^{3+}_2\text{S}_4$
Siegenite	$\text{Co}^{2+}(\text{Ni},\text{Co})^{3+}_2\text{S}_4$
Nickel Linnaeite = polydymite	$\text{Ni}^{2+}\text{Ni}^{3+}_2\text{S}_4$
Linnaeite	$\text{Co}_3\text{S}_4 \rightarrow \text{Co}^{2+}\text{Co}^{3+}_2\text{S}_4$
Violarite	$\text{Fe}^{2+}\text{Ni}^{3+}_2\text{S}_4$
Greigite	$\text{Fe}_3\text{S}_4 \rightarrow \text{Fe}^{2+}\text{Fe}^{3+}_2\text{S}_4$
Carrollite series - $\text{M}^{2+} = \text{Cu}^{2+}$; $\text{M}^{3+} = \text{Fn}^{3+}$	
Fletcherite	$\text{Cu}(\text{Ni},\text{Co})_2\text{S}_4$
Carrollite	$\text{Cu}(\text{Co},\text{Ni})_2\text{S}_4$
Daubreelite group - $\text{M}^{2+} = \text{Fe}^{2+}$; $\text{M}^{3+} = \text{Cr}^{3+}$	
Daubreelite	$\text{Fe}^{2+}\text{Cr}^{3+}_2\text{S}_4$
Brezinaite group - $\text{M}^{2+} = \text{Fe}^{2+}$, Cr^{2+} ; $\text{M}^{3+} = \text{Cr}^{3+}$, Ti^{3+}	
Brezinaite	$\text{Cr}_3\text{S}_4 \rightarrow \text{Cr}^{2+}\text{Cr}^{3+}_2\text{S}_4$
Heideite	$(\text{Fe},\text{Cr})^{2+}_{1+x}(\text{Ti}^{3+},\text{Fe}^{2+})_2\text{S}_4$
Kalininite group - $\text{M}^{2+} = \text{Cu}^{2+}$, Zn^{2+} ; $\text{M}^{3+} = \text{Cr}^{3+}$, Sb^{3+}	
Florensovite	$\text{Cu}(\text{Cr}_{1,5}\text{Sb}_{0,5})_2\text{S}_4$
Kalininite	ZnCr_2S_4
*Kuprokalininite	CuCr_2S_4
Indite	$\text{FeIn}_2\text{S}_4 \rightarrow \text{Fe}^{2+}_{1-3x}\text{Fe}^{3+}_{2x}\text{In}_2\text{S}_4$ ($0 \leq x \leq 0,33$)
*Cadmoindite	CdIn_2S_4
*Jichengite	$\text{Cu}^+_2\text{Ir}^{3+}_6(\text{Ni},\text{Fe})^{2+}_{10}\text{S}_{20}$
	2b.1a.1.1.1.1.3.2.1.4. $2\text{M}^{3+} \rightarrow \text{M}^+\text{M}^{2+}\text{M}^{3+}$
Cubanite family - $\text{M}^+ = \text{Cu}^+$, Ag^+ ; $\text{M}^{2+} = \text{Fe}^{2+}$; $\text{M}^{3+} = \text{Fe}^{3+}$	
Isocubanite	$\text{CuFe}_2\text{S}_3 \rightarrow \text{Cu}^+\text{Fe}^{2+}\text{Fe}^{3+}\text{S}_3$
Cubanite	$\text{CuFe}_2\text{S}_3 \rightarrow \text{Cu}^+\text{Fe}^{2+}\text{Fe}^{3+}\text{S}_3$
Argentopyrite	$\text{AgFe}_2\text{S}_3 \rightarrow \text{AgFe}^{2+}\text{Fe}^{3+}\text{S}_3$
Sternbergite	$\text{AgFe}_2\text{S}_3 \rightarrow \text{AgFe}^{2+}\text{Fe}^{3+}\text{S}_3$
*Unnamed	$(\text{Cu},\text{Ag},\text{Fe})_6\text{S}_4 \rightarrow \text{Cu}_3\text{Ag}_2\text{FeS}_4$
2b.1a.1.1.1.2. Minerals of <i>Ib</i> -cations	
2b.1a.1.1.1.2.1. Polyanionic (simple)	
Unnamed	$\text{Cu}[\text{S}_2]$
2b.1a.1.1.1.2.2. Mono-polyanionic (complex)	
Covellite	$3\text{CuS} \rightarrow \text{Cu}^+_2\text{S}\text{Cu}^{2+}[\text{S}_2]$
2b.1a.1.1.1.2.3. Monoanionic	
2b.1a.1.1.1.2.3.1. $\text{M}^+ \rightarrow \text{M}^+$ and M^{2+} (simple \rightarrow complex)	
2b.1a.1.1.1.2.3.1.1. Only Cu	
Polysomatic (?) series of chalcocite $m\text{Cu}_2\text{S}_n\text{CuS}$ или $\text{Cu}^+_{2m}\text{Cu}^{2+}_n\text{S}_{m+n}$	
Chalcocite	($m=1$; $n=0$) Cu_2S
Tetrachalcocite	($m=24$; $n=1$) $\text{Cu}_{49}\text{S}_{25} \rightarrow \text{Cu}^+_{48}\text{Cu}^{2+}\text{S}_{25}$
Djurleite	($m=15$; $n=1$) $\text{Cu}_{31}\text{S}_{16} \rightarrow \text{Cu}^+_{30}\text{Cu}^{2+}\text{S}_{16}$
Digenite	($m=4$; $n=1$) $\text{Cu}_9\text{S}_5 \rightarrow \text{Cu}^+_8\text{Cu}^{2+}\text{S}_5$
Roxbyite	($m=4$; $n=1$) $\text{Cu}_9\text{S}_5 \rightarrow \text{Cu}^+_8\text{Cu}^{2+}\text{S}_5$
Anilite	($m=3$; $n=1$) $\text{Cu}_7\text{S}_4 \rightarrow \text{Cu}^+_6\text{Cu}^{2+}\text{S}_4$
Geerite	($m=3$; $n=2$) $\text{Cu}_8\text{S}_5 \rightarrow \text{Cu}^+_6\text{Cu}^{2+}_2\text{S}_5$
Spionkopite	($m=11$; $n=17$) $\text{Cu}_{39}\text{S}_{28} \rightarrow \text{Cu}^+_{22}\text{Cu}^{2+}_{17}\text{S}_{28}$
Yarrowite	($m=1$; $n=7$) $\text{Cu}_9\text{S}_8 \rightarrow \text{Cu}^+_2\text{Cu}^{2+}_7\text{S}_8$
2b.1a.1.1.1.2.3.1.2. Cu^+ and Hg^{2+}	

Gortdrumite	$\text{Cu}^+_6\text{Hg}^{2+}_2\text{S}_5$
	2b.1a.1.1.1.2.3.1.3. Cu^+ and Pb^{2+}
Betekhtinite	$(\text{Cu},\text{Fe})_{21}\text{Pb}_2\text{S}_{15}$
2b.1a.1.1.1.2.3.2. M^+ and $2\text{M}^{2+} \rightarrow \text{M}^+\text{M}^{3+}$ (complex)	
	2b.1a.1.1.1.2.3.2.1. $\text{M}^+ : \text{M}^{2+} \cong 2; \text{Cu} : \text{Fe} \cong 5$
Bornite series	
Bornite (orange)	$\text{Cu}_{5-x}\text{FeS}_{4+x}$
Bornite (brown- usual)	$\text{Cu}^+_5\text{Fe}^{3+}\text{S}_4$
Bornite (pink)	$\text{Cu}_{5+x}\text{FeS}_{4-x}$
	2b.1a.1.1.1.2.3.2.2. $\text{Cu} : \text{Fe} = 3$
*Wilhelmramsayite	$\text{Cu}_3\text{FeS}_3 \cdot 2\text{H}_2\text{O}$
Idaite	$\text{Cu}_3\text{FeS}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2\text{Fe}^{3+}\text{S}_4$
*Unnamed	$\text{Cu}_4\text{FeS}_4 \rightarrow \text{Cu}^+_2\text{Cu}^{2+}_2\text{Fe}^{2+}\text{S}_4$
*Unnamed	$(\text{Cu}_{0,96}\text{K}_{0,04})(\text{Fe}_{0,6}\text{Cu}_{0,4})(\text{S}_{1,98}\text{O}_{0,02})$
	2b.1a.1.1.1.2.3.2.3. $2\text{M}^{2+} \rightarrow \text{M}^+\text{M}^{3+}$
	when $\text{M}^+ \cong \text{M}^{3+}$
Chalcopyrite family ($x = \text{number of additional cations or vacancies to 1 CuFeS}_2$)	
*Horomanite	$\text{Fe}_6\text{Ni}_3\text{S}_8$
*Samaniite	$\text{Cu}_2\text{Fe}_5\text{Ni}_2\text{S}_8$
Talnakhite subfamily ($x > 0; \text{Cu} \cong \text{Fn}$)	
Mooihoekite ($x = 1/2$)	$\text{Cu}_9\text{Fe}_9\text{S}_{16} \rightarrow \text{Cu}^+_9\text{Fe}^{2+}_4\text{Fe}^{3+}_5\text{S}_{16}$ ($2\Box 3\text{Fn}^{3+} \rightarrow \text{Cu}^+ 4\text{Fn}^{2+}$)
Putoranite ($x = 1/4$)	$\text{Cu}_9\text{Fe}_9\text{S}_{16} \rightarrow \text{Cu}^+_9\text{Fe}^{2+}_4\text{Fe}^{3+}_5\text{S}_{16}$ ($2\Box 3\text{Fe}^{3+} \rightarrow \text{Cu}^+ 4\text{Fe}^{2+}$)
Haycockite ($x = 1/4$)	$\text{Cu}_8\text{Fe}_{10}\text{S}_{16} \rightarrow \text{Cu}^+_8\text{Fe}^{2+}_6\text{Fe}^{3+}_4\text{S}_{16}$ ($2\Box 4\text{Fn}^{3+} \rightarrow 6\text{Fn}^{2+}$)
Talnakhite ($x = 1/8$)	$\text{Cu}_9(\text{Fe},\text{Ni})_8\text{S}_{16} \rightarrow \text{Cu}^+_9\text{Fe}^{2+}\text{Fe}^{3+}_7\text{S}_{16}$ ($\Box \text{Fn}^{3+} \rightarrow \text{Cu}^+\text{Fn}^{2+}$)
Proper chalcopyrite subfamily ($x = 0; \text{Cu}^+ = \text{Fe}^{3+}(\text{Ga}^{3+}, \text{In}^{3+})$)	
Isochalcopyrite	CuFe_2S_3
Chalcopyrite group	
Chalcopyrite	CuFeS_2
Gallite	CuGaS_2
Roquesite	CuInS_2
Germanite subfamily ($2\text{Fe}^{3+} \rightarrow \text{M}^{2+}\text{M}^{4+}; \text{M}^{4+} = \text{Ge}^{4+}$)	
Proper germanite subfamily ($x > 0; \text{M}^+ = \text{Cu}^+; \text{M}^{2+} = \text{Cu}^{2+}, \text{Zn}^{2+}$)	
Germanite series ($x = 1/8$)	
Germanite	$\text{Cu}^+_8\text{Cu}^{2+}_5\text{Fe}_2\text{Ge}_2\text{S}_{16}$
*Maikainite	$\text{Cu}_{20}(\text{Fe},\text{Cu})_6\text{Mo}_2\text{Ge}_6\text{S}_{32} \rightarrow \text{Cu}^+_{20}(\text{Fe},\text{Cu})^{2+}_6\text{Mo}^{4+}_2\text{Ge}^{4+}_6\text{S}_{32}$
*Ovamboite	$\text{Cu}_{20}(\text{Fe},\text{Cu},\text{Zn})_6\text{W}_2\text{Ge}_6\text{S}_{32} \rightarrow \text{Cu}^+_{20}(\text{Fe},\text{Cu},\text{Zn})^{2+}_6\text{W}^{4+}_2\text{Ge}^{4+}_6\text{S}_{32}$
*Calvertite	$\text{Cu}_{10}\text{GeS}_8 \quad \text{Cu}^+_8\text{Cu}^{2+}_2\text{Ge}^{4+}\text{S}_8$
Renierite	$\text{Cu}^+_{10}(\text{Zn},\text{Cu})^{2+}_2\text{Fe}^{3+}_4\text{Ge}^{4+}_2\text{S}_{16}$
Briartite subfamily ($x = 0; \text{M}^+ = \text{Cu}^+; \text{M}^{2+} = \text{Fe}^{2+}, \text{Zn}^{2+}$)	
Briartite	$\text{Cu}^+_8(\text{Fe},\text{Zn})^{2+}_4\text{Ge}_4\text{S}_{16}$
*Barquillite	$\text{Cu}^+_2(\text{Cd},\text{Fe})^{2+}_2\text{GeS}_4$
Morozeviczite subfamily ($x < 0; \text{M}^+ = \text{Cu}^+; \text{M}^{2+} = \text{Pb}^{2+}, \text{Cu}^{2+}, \text{Ge}^{2+}; \text{M}^{3+} = \text{Fe}^{3+}, \text{As}^{3+}$)	
Morozeviczite	$\text{Pb}_3\text{Ge}_{1-x}\text{S}_4$

Polkovicite ($x = 0,625$)	$(\text{Fe,Pb})_3(\text{Ge,Fe})_{1-x}\text{S}_4$
Stannite family ($2\text{Fe}^{3+} \rightarrow \text{M}^{2+}\text{M}^{4+}$; $\text{M}^{4+} = \text{Sn}^{4+}$; Mo^{4+} , W^{4+})	
Stannoidite subfamily ($x > 0$; $\text{M}^+ = \text{Cu}^+$; $\text{M}^{2+} = \text{Fe}^{2+}$, Cu^{2+} ; $\text{M}^{3+} = \text{Fe}^{3+}$, V^{3+})	
Mawsonite group ($x = 1/4$)	
Mawsonite	$\text{Cu}_6^+\text{Fe}^{3+}_2\text{Sn}^{4+}_8\text{S}_8$ $(\square 2\text{Fe}^{3+} \rightarrow 2\text{Cu}^+\text{Sn}^{4+})$
Chatkalite	$\text{Cu}_6^+\text{Fe}^{2+}_2\text{Sn}^{4+}_8\text{S}_8$ $(\square 4\text{Fe}^{3+} \rightarrow 2\text{Cu}^+\text{Fe}^{2+}_2\text{Sn}^{4+})$
Stannoidite series ($x = 1/6$)	
Stannoidite	$\text{Cu}_8^+(\text{Fe,Zn})^{2+}_2\text{Fe}^{3+}_2\text{Sn}^{4+}_2\text{S}_{12}$ $\square 4\text{Fe}^{3+} \rightarrow 2\text{Cu}^+\text{Fe}^{2+}_2\text{Sn}^{4+}$
Cuprostannoidite	$\text{Cu}_8^+\text{Cu}^{2+}_2\text{Fe}^{3+}_2\text{Sn}^{4+}_2\text{S}_{12}$ $(\square 4\text{Fe}^{3+} \rightarrow 2\text{Cu}^+\text{Cu}^{2+}_2\text{Sn}^{4+})$
Nekrasovite series ($x = 1/8$)	
Nekrasovite	$\text{Cu}_{26}\text{V}_2\text{Sn}_6\text{S}_{32} \rightarrow \text{Cu}_{18}\text{Cu}^{2+}_8\text{V}^{3+}_2\text{Sn}^{4+}_6\text{S}_{32}$ $(2\square 16\text{Fe}^{3+} \rightarrow 2\text{Cu}^+\text{Cu}^{2+}_2\text{V}^{3+}_6\text{Sn}^{4+})$
Proper stannite subfamily ($x = 0$; $\text{M}^+ = \text{Cu}^+$, Ag^+ ; $\text{M}^{2+} = \text{Fe}^{2+}$, Zn^{2+} , Cu^{2+} , Cd^{2+} , Hg^{2+} ; $\text{M}^{3+} = \text{Fe}^{3+}$, In^{3+} ; $\text{M}^{4+} = \text{Sn}^{4+}$, Mo^{4+} , W^{4+})	
Sakuraiite	$(\text{Cu,Zn,Fe,In,Sn})\text{S}$
Stannite series	
Stannite	$\text{Cu}_2\text{FeSnS}_4$
Kuramite	$\text{Cu}_2\text{CuSnS}_4$
Cernyite	$\text{Cu}_2\text{CdSnS}_4$
Velikite	$\text{Cu}_2\text{HgSnS}_4$
Hocartite	$\text{Ag}_2\text{FeSnS}_4$
Pirquitasite	$\text{Ag}_2\text{ZnSnS}_4$
K�esterite series	
Ferrok�esterite	$\text{Cu}_2(\text{Fe,Zn})\text{SnS}_4$
K�esterite	$\text{Cu}_2(\text{Zn,Fe})\text{SnS}_4$
Petrukite	$\text{Cu}_2(\text{Fe,Zn})\text{SnS}_4$
Hemusite group ($\text{M}^{2+} = \text{Cu}^{2+}$; $\text{M}^{4+} = \text{Sn}^{4+}$, Mo^{4+} , W^{4+})	
*Catamarcaite	Cu_6GeWS_8
Hemusite	$\text{Cu}_6\text{MoSnS}_8 \rightarrow \text{Cu}_4\text{Cu}^{2+}_2\text{Mo}^{4+}_2\text{Sn}^{4+}_8\text{S}_8$ $(4\text{Fe}^{3+} \rightarrow \square 2\text{Mo}^{4+}\text{Sn}^{4+})$
Kiddcreekite	$\text{Cu}_6\text{WSnS}_8 \rightarrow \text{Cu}_4\text{Cu}^{2+}_2\text{W}^{4+}_2\text{Sn}^{4+}_8\text{S}_8$ $(4\text{Fe}^{3+} \rightarrow \square 2\text{W}^{4+}\text{Sn}^{4+})$
Vinciennite ($\text{M}^{2+} = \text{Cu}^{2+}$; $\text{M}^{3+} = \text{Fe}^{3+}$, As^{3+} ; $\text{M}^{4+} = \text{Sn}^{4+}$)	$\text{Cu}_{10}\text{Fe}_4\text{SnAsS}_{16} \rightarrow \text{Cu}_7\text{Cu}^{2+}_3\text{Fe}^{3+}_4\text{Sn}^{4+}_4\text{AsS}_{16}$ $(4\text{Cu}^+\text{Fe}^{3+} \rightarrow 3\square\text{Sn}^{4+}\text{As}^{3+})$
Mohite ($\text{M}^{2+} = 0$; $\text{M}^{4+} = \text{Sn}^{4+}$)	$\text{Cu}_4^+\text{Sn}^{4+}_2\text{S}_6$ $(3\text{Fe}^{3+} \rightarrow \text{Cu}^+\text{Sn}^{4+})$
Rhodostannite subfamily ($x < 0$, $\text{M}^+ = \text{Cu}^+$; $\text{M}^{2+} = \text{Fe}^{2+}$; $\text{M}^{4+} = \text{Sn}^{4+}$)	
Rhodostannite ($x = 1/2$)	$\text{Cu}_2^+\text{Fe}^{2+}_2\text{Sn}^{4+}_3\text{S}_8$ $(2\text{Cu}^+\text{Fe}^{3+} \rightarrow 2\square\text{Fe}^{2+}_2\text{Sn}^{4+})$
*Toyohaite	$\text{Ag}_2^+\text{Fe}^{2+}_2\text{Sn}^{4+}_3\text{S}_8$
2b.1a.1.1.1.2.3.2.4. $\text{M}^{2+} = \text{Cu}^{2+}$, Fe^{2+} ; $\text{Cu} : \text{Fe} = 5$	
Nukundamite	$\text{Cu}_{3,4}\text{Fe}_{0,6}\text{S}_4$

2b.1a.1.1.1.3. Minerals of **IIb**-cations - Zn^{2+} (and Cd^{2+})

2b.1a.1.1.1.3.1. Monoanionic (simple)

Sphalerite family

Sphalerite-3C ZnS

Sphalerite-2H (wurtzite)

*Wurtzite-2H, -15R, -18R, 21R, 4H, 8H polytypes

Sphalerite-3R (matraite)

*Buseckite (Fe,Zn,Mn)S

*Rudashevskite (Fe,Zn)S

Hawleyite-3C CdS

Hawleyite -2H (greenockite)

*26.1a.1.1.1.3.2. Complex

*Unnamed $Zn_2(Fe,Cu)S_3$ 2b.1a.1.1.2. Minerals of heavy noncensymmetrycal *d*-cations2b.1a.1.1.2.1. Minerals of **VIIIb**-cations (platinoides- Pn^{n+})

2b.1a.1.1.2.1.1. Polyanionic (simple)

Laurite groupErlichmanite Os[S₂]Laurite Ru[S₂]

2b.1a.1.1.2.1.2. Subcompound

2b.1a.1.1.2.1.2.1. Simple

*Miassite $Rh_{17}S_{15}$ *Kingstonite (Rd,Ir,Pt)₃S₄

2b.1a.1.1.2.1.2.2. Complex

Rhodplumsite $Rh_3Pb_2S_2$

2b.1a.1.1.2.1.3. Monoanionic

2b.1a.1.1.2.1.3.1. Pn^{2+}

2b.1a.1.1.2.1.3.1.1. Simple

Cooperite family

Cooperite PtS

Vysotskite (Pd,Ni,Pt)S

*Unnamed (Pt,Pd)₃S₂

2b.1a.1.1.2.1.3.1.2. Complex

Braggite (Pt,Pd,Ni)S

*Unnamed PtSnS

2b.1a.1.1.2.1.3.2. M^{2+} and M^{3+} (complex)Sulfospinelides family Pn^{n+} (compare with sulfospinelides Fn^{n+} (series))2b.1a.1.1.2.1.3.2.1. Cu^{2+} , Fe^{2+} and Pn^{3+} *Lisiguangite $CuPtBiS_3$ *Malyshevite $PdBiCuS_3$ **Malanite** groupMalanite $(Cu,Fe)^{2+}Pt^{3+}(Ir,Co,Pd)^{3+}S_4$ Cuproiridsite $Cu^{2+}Ir^{3+}_2S_4$ Cuprorhodsite $(Cu,Fe)^{2+}Rh^{3+}_2S_4$ *Ferrorhodsite $(Fe,Cu)(Rh,Ir,Pt)_2S_4$ 2b.1a.1.1.2.1.3.2.2. Cu^{2+} , Pb^{2+} and Pn^{3+} **Inaglyite** subfamilyXingzhongite $PbCuFe^{3+}_{0,67} \bullet_{0,33}(Ir,Rh,Pt)_2S_4$

Inaglyite group	
Inaglyite	$\text{Pb}^{2+}\text{Cu}^{2+}_3(\text{Ir,Pt})^{3+}_8\text{S}_{16}$
Konderite	$\text{Pb}^{2+}\text{Cu}^{2+}_3(\text{Rh,Pt,Ir})^{3+}_8\text{S}_{16}$
*Konderite-Fe	$(\text{Fe,Pb})^{2+}\text{Cu}^{2+}_3(\text{Rh,Ir,Pd,Pt})^{3+}_8\text{S}_{16}$
2b.1a.1.1.2.1.3.3. Pn^{3+} (simple)	
Bowieite group	
Kashinite	$(\text{Ir,Rh})_2\text{S}_3$
Bowieite	$(\text{Rh,IrPt})_2\text{S}_3$
2b.1a.1.1.2.1.3.4. Pn^{4+} и Pn^{6+} (complex)	
Beta-iridisite	$4\text{Ir}_{0,75}\text{S}_2 \rightarrow \text{Ir}^{4+}\text{Ir}^{6+}_2\text{S}_8 (?)$
2b.1a.1.1.2.2. Minerals of Ib -cations and Tl^+ ($\text{CN} \leq 4$)	
2b.1a.1.1.2.2.1. Minerals of Tl^+ ($\text{CN} \leq 4$)	
2b.1a.1.1.2.2.1.1. Monoanionic	
2b.1a.1.1.2.2.1.1.1. Simple	
Carlinite	Tl_2S
2b.1a.1.1.2.2.1.1.2. Complex	
Raguinite	$\text{TlFe}^{3+}\text{S}_2$
*Unnamed	$\text{Tl}_2(\text{Cu,Fe})_6\text{S}_5$
2b.1a.1.1.2.2.2. Minerals of Ag^+ and Au^+	
2b.1a.1.1.2.2.2.1. Monoanionic	
2b.1a.1.1.2.2.2.1.1. Proper sulfides	2b.1a.1.1.2.2.2.1.1.1. Simple
*Unnamed	AuS
Acanthite family	
Acanthite	Ag_2S
Argentite	Ag_2S
2b.1a.1.1.2.2.2.1.1.2. Complex	2b.1a.1.1.2.2.2.1.1.2.1. Ag^+ and Fe^{3+} , In^{3+}
*Lenaite	AgFeS_2
*Laforêtite	AgInS_2
	2b.1a.1.1.2.2.2.1.1.2.2. Ag^+ and Cu^+
Stromeyerite family	
Jalpaite	Ag_3CuS_2
Mckinstryite	$\text{Ag}_5\text{Cu}_3\text{S}_4$
Stromeyerite	AgCuS
	2b.1a.1.1.2.2.2.1.1.2.2. Ag^+ and Au^+
Uytenbogaardtite family	
Uytenbogaardtite	AuAg_3S_2
Petrovskaitite	$\text{AuAg}(\text{S,Se})$
	2b.1a.1.1.2.2.2.1.1.2.3. $\text{Ag}^+(\text{Cu}^+)$ and Hg^{2+}
Balkanite family	
Danielsite	$(\text{Cu,Ag})_{14}\text{Hg}^{2+}\text{S}_8$
Balkanite group	
Balkanite	$\text{Ag}_5\text{Cu}_9\text{Hg}^{2+}\text{S}_8$
Imiterite	Ag_2HgS_2
	2b.1a.1.1.2.2.2.1.1.2.4. $\text{Ag}^+(\text{Cu}^+)$ and Pb^{2+}
Furutobeite	$\text{AgCu}_5\text{PbS}_4$
	2b.1a.1.1.2.2.2.1.1.2.5. Ag and $\text{Sn}^{4+}(\text{Ge}^{4+})$
Canfieldite group	
Canfieldite	Ag_8SnS_6

Argyrodite	Ag_8GeS_6
*Putzite	$(\text{Cu}_{4,7}\text{Ag}_{3,3})_8\text{GeS}_6$
*Calvertite	$\text{Cu}_{10}\text{GeS}_8 \rightarrow \text{Cu}_8^+\text{Cu}^{2+}_2\text{Ge}^{4+}\text{S}_8$
*Alburnite	$\text{Ag}_8\text{GeTe}_2\text{S}_4$

2b.1a.1.1.2.2.2. Sulfido-halogenides (complex)

*Iltisite	$\text{AgHgS}(\text{Cl},\text{Br})$
Perroudite	$\text{Ag}^+_4\text{Hg}^{2+}_5\text{S}_5(\text{I},\text{Br})_2\text{Cl}_2$
*Capgaronnite	$\text{AgHgS}(\text{Cl},\text{Br},\text{I})$

2b.1a.1.1.2.3. Minerals of **IIb**-cations – Hg^{2+}

2b.1a.1.1.2.3.1. Monoanionic

2b.1a.1.1.2.3.1.1. Proper sulfides (simple)

Cinnabar family

Cinnabar	HgS
Metacinnabar	HgS
Hypocinnabar	HgS
Polhemusite	$(\text{Zn},\text{Hg})\text{S}$

2b.1a.1.1.2.3.1.2. Sulfido-halogenides (simple)

Corderoite family

*Kenshuite	$\text{Hg}_3\text{S}_2\text{Cl}_2$
Corderoite	$\text{Hg}_3\text{S}_2\text{Cl}_2$
Lavrentievite	$\text{Hg}_3\text{S}_2(\text{Cl},\text{Br})_2$
*Radtkeite	$\text{Hg}_3\text{S}_2\text{ClI}$
Arzakite	$\text{Hg}_3^{2+}\text{S}_2(\text{Br},\text{Cl})_2$
Grechishchevite	$\text{Hg}_3\text{S}_2(\text{Br},\text{Cl},\text{I})_2$

2b.1a.1.2. Minerals of noncentrosymmetrical *p*-cations2b.1a.1.2.1. Minerals of **IVa**-cations (all monoanionic)

2b.1a.1.2.1.1. Minerals of Sn

2b.1a.1.2.1.1.1. Minerals of Sn^{2+}

2b.1a.1.2.1.1.1.1. Simple

Herzenbergite	SnS
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2b.1a.1.2.1.1.1.2. Complex

*Unnamed	SnGeS_3
Teallite	PbSnS_2
*Suredaite	PbSnS_3
2b.1a.1.2.1.1.2. Minerals of Sn^{2+} and Sn^{4+} (complex)	
Ottemannite	$\text{Sn}^{2+}\text{Sn}^{4+}\text{S}_3$

2b.1a.1.2.1.1.3. Minerals of Sn^{4+} (simple)

Berndtite-2 <i>T</i>	SnS_2
Berndtite-4 <i>H</i>	

2b.1a.1.2.1.2. Minerals of Pb

2b.1a.1.2.1.2.1. Minerals of Pb^{2+} (simple)

Galena-clausthalite series

Galena	PbS
Clausthalite	PbSe see selenides

2b.1a.1.2.2. Minerals of *Va*-cations

2b.1a.1.2.2.1. Subsulfides (simple and complex)

Realgar family

Duranusite	As ₄ S
Pääkkönenite	Sb ₂ AsS ₂
Dimorphite	As ₄ S ₃
Realgar	4AsS → As ₄ S ₄
Pararealgar	AsS
Alacranite	As ₈ S ₉
Uzonite	As ₄ S ₅

2b.1a.1.2.2.2. Monoanionic (only As³⁺, Sb³⁺, Bi³⁺)

2b.1a.1.2.2.2.1. Proper sulfides (simple and complex)

Orpiment family**Orpiment** group

Orpiment	[As ₂ S ₃] ^{∞2}
*Anorpiment	[As ₂ S ₃]
Getchellite	[SbAsS ₃] ^{∞2}

Stibnite group

Stibnite	Sb ₂ S ₃
Bismuthinite	Bi ₂ S ₃
Metastibnite	Sb ₂ S ₃
Wakabayashillite	(As,Sb) ₆ As ₄ S ₁₄

2b.1a.1.2.2.2.2. Sulfido-oxides (simple)

Kermesite	Sb ₂ S ₂ O
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*2b.1a.1.2.2.2.3. Sulfido-halogenidesy

*Demecheleite-(Br)	BiSBr
*Demecheleite-(Cl)	BiSCl

2b.1a.2. **Class:** Sulfosalts of sidero- and chalcophylic cations2b.1a.2.1. Sulfosalts of heavy *d*-cations2b.1a.2.1.1. Minerals of centrosymmetrical *d*-cations2b.1a.2.1.1.1. Minerals of **VIIIb**- and **VIIIb**-cations - the family of Fn'

2b.1a.2.1.1.1.1. Sulfoantimonites and sulfobismuthites

2b.1a.2.1.1.1.1.1. Fn'²⁺

2b.1a.2.1.1.1.1.1.1. Simple

Berthierite group

Berthierite	FeSb ₂ S ₄
*Clerite	MnSb ₂ S ₄
Garavellite	FeBiSbS ₄
*Grațianite	MnBi ₂ S ₄

2b.1a.2.1.1.1.1.1.2. Complex

2b.1a.2.1.1.1.1.1.2.1. Fn'²⁺ and Cu⁺**Lapieite** group

Lapieite	Cu ⁺ Ni ²⁺ SbS ₃
Mückeite	Cu ⁺ Ni ²⁺ BiS ₃

2b.1a.2.1.1.1.1.1.2.2. Fn'²⁺ and Ag⁺

Samsonite	$\text{Ag}_4\text{Mn}^{2+}\text{Sb}_2\text{S}_6$
2b.1a.2.1.1.1.2. Fn^{3+} (complex - Fn^{3+} , Cu^+ , and Pb^{2+})	
Miharaite	$\text{Cu}^+\text{Pb}^{2+}\text{Fe}^{3+}\text{BiS}_6$
2b.1a.2.1.1.2. Minerals of IIb-cations	
2b.1a.2.1.1.2.1. Sulfoarsenites	
2b.1a.2.1.1.2.1.1. Cu^+ (simple)	
Sinnerite	$\text{Cu}_6\text{As}_4\text{S}_9$
*Watanabeite	$\text{Cu}_4(\text{As},\text{Sb})_2\text{S}_5$
2b.1a.2.1.1.2.1.2. Cu^+ and Cu^{2+} (all complex)	
Enargite family ($\text{M}^+ = \text{Cu}^+$; $\text{M}^{2+} = \text{Cu}^{2+}$; M^+ : $\text{M}^{2+} < 1$; $\text{Y}^{3+} = \text{As}^{3+}$, V^{3+})	
Colusite subfamily ($\text{M}^+ : \text{M}^{2+} \cong 0,86$)	
Colusite	$\text{Cu}_{13}\text{VAs}_3\text{S}_{16} \rightarrow \text{Cu}^+\text{Cu}^{2+}_7\text{VAs}_3\text{S}_{16}$
*Stibicolusite	$\text{Cu}_{26}\text{V}_2(\text{Sb},\text{Sn},\text{As})_6\text{S}_{32}$
*Germanocolusite	$\text{Cu}_{26}\text{V}_2(\text{Ge},\text{As})_6\text{S}_{32}$
Proper enargite subfamily ($\text{M}^+ : \text{M}^{2+} = 0,5$)	
Enargite	$\text{Cu}_3\text{AsS}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2\text{AsS}_4$
*Unnamed	Cu_3AsS_4
Luzonite series	
Luzonite	$\text{Cu}_3\text{AsS}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2\text{AsS}_4$
Famatinitite	$\text{Cu}_3\text{SbS}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2\text{SbS}_4$
Sulvanite series (?)	
Arsenosulvanite	$\text{Cu}_3(\text{As},\text{V})\text{S}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2(\text{As},\text{V})\text{S}_4$
Sulvanite	$\text{Cu}_3\text{VS}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2\text{VS}_4$
2b.1a.2.1.1.2.2. Sulfoarsenito-sulfoantimonites	
2b.1a.2.1.1.2.2.1. M^+ and M^{2+} (complex)	
Fahlores family ($\text{M}^+ = \text{Cu}^+$, Ag^+ ; $\text{M}^{2+} = \text{Cu}^{2+}$, Fe^{2+} , Zn^{2+} , Cd^{2+} , Hg^{2+})	
Proper fahlores subfamily ($\text{M}^+ : \text{M}^{2+} = 5$)	
Fahlores series - tennantite - tetrahedrite (compare with giraudite (group))	
Ferrotennantite	$\text{Cu}^+_{10}\text{Fe}^{2+}_2\text{As}_4\text{S}_{13}$
Coppite	$\text{Cu}_{10}\text{Fe}_2\text{Sb}_4\text{S}_{13}$
Freibergite	$\text{Ag}_6\text{Cu}_4\text{Fe}_2\text{Sb}_4\text{S}_{13}$
Tennantite (cuprotennantite)	$\text{Cu}_{10}\text{Cu}_2\text{As}_4\text{S}_{13}$
Tetrahedrite (cuprotetrahedrite)	$\text{Cu}_{10}\text{Cu}_2\text{Sb}_4\text{S}_{13}$
Miedziankite	$\text{Cu}_{10}\text{Zn}_2\text{As}_4\text{S}_{13}$
Argentotennantite	$(\text{Ag},\text{Cu})_{10}(\text{Zn},\text{Fe})_2(\text{As},\text{Sb})_4\text{S}_{13}$
Sandbergerite	$\text{Cu}_{10}\text{Zn}_2\text{Sb}_4\text{S}_{13}$
Zincsandbergerite	$\text{Ag}_6\text{Cu}_4\text{Zn}_2\text{Sb}_4\text{S}_{13}$
Cadmian tetrahedrite	$\text{Cu}_{10}\text{Cd}_2\text{Sb}_4\text{S}_{13}$
Mercurian tennantite	$\text{Cu}_{10}\text{Hg}_2\text{As}_4\text{S}_{13}$
Schwazite (mercurian tetrahedrite)	$\text{Cu}_{10}\text{Hg}_2\text{Sb}_4\text{S}_{13}$
Goldfieldite series	
Goldfieldite	$\text{Cu}_{10}\text{Te}_4\text{S}_{13}$
Nowackiite subfamily ($\text{M}^+ : \text{M}^{2+} = 2$)	
Nowackiite	$\text{Cu}_6\text{Zn}_3\text{As}_4\text{S}_{12}$
Aktashite	$\text{Cu}_6\text{Hg}_3\text{As}_4\text{S}_{12}$
Gruzdevite	$\text{Cu}_6\text{Hg}_3\text{Sb}_4\text{S}_{12}$

2b.1a.2.1.1.2.3. Sulfoantimonites	
2b.1a.2.1.1.2.3.1. Cu^+ (simple)	
Skinnerite	Cu_3SbS_3
*Unnamed	$(\text{Cu,Zn})_3(\text{Sb,As})\text{S}_3$
Chalcostibite	CuSbS_2
2b.1a.2.1.1.2.4. Sulfobismuthites	
2b.1a.2.1.1.2.4.1. Cu^+	
2b.1a.2.1.1.2.4.1.1. Simple	
Wittichenite family	
Wittichenite	Cu_3BiS_3
Emplectite	CuBiS_2
Cuprobismutite	$\text{Cu}_8\text{AgBi}_{13}\text{S}_{24}$
Hodrušhite	$\text{Cu}_4\text{Bi}_6\text{S}_{11}$
2b.1a.2.1.1.2.4.1.2. Complex (Cu^+ , Ag^+ , Pb^{2+})	
Larosite	$(\text{Cu,Ag})_{21}\text{PbBiS}_{13}$
*Kupčikite	$\text{Cu}_{3,4}\text{Fe}_{0,6}\text{Bi}_5\text{S}_{10}$
*Pizgrischite	$\text{Cu}_{17}\text{PbBi}_{17}\text{S}_{35}$
2b.1a.2.1.2. <u>Sulfosalts of noncensymmetrical <i>d</i>-cations and <i>p_d</i>-cations</u>	
2b.1a.2.1.2.1. Minerals of Ib -cations and Tl^+	
2b.1a.2.1.2.1.1. Tl^+	
2b.1a.2.1.2.1.1.1. Sulfoarsenites	
2b.1a.2.1.2.1.1.1.1. Proper sulfoarsenites	
2b.1a.2.1.2.1.1.1.1.1. Simple	
Ellisite	Tl_3AsS_3
Lorandite	TlAsS_2
*Fangite	Tl_3AsS_4
*Bernardite	$\text{Tl}(\text{As,Sb})_5\text{S}_8$
*Gillulyite	$\text{Tl}_2\text{As}_{7,5}\text{Sb}_{0,3}\text{S}_{13}$
2b.1a.2.1.2.1.1.1.1.2. Complex	
2b.1a.2.1.2.1.1.1.1.2.1. Tl^+ (Cu,Ag) ⁺ and Hg^{2+}	
Routhierite	$\text{Tl}(\text{Cu,Ag})(\text{Hg,Zn})_2(\text{As,Sb})_2\text{S}_6$
*Arsiccioite	$\text{TlAgHg}_2(\text{As,Sb})_2\text{S}_6$
*Sb-routhierite	$\text{TlCuHg}_2(\text{Sb,As})_2\text{S}_6$
*Stalderite	$\text{TlCu}(\text{Zn,Fe,Hg})_2\text{As}_2\text{S}_6$
*Gabrielite	$\text{Tl}_2\text{AgCu}_2\text{As}_3\text{S}_7$
*Erniggliite	$\text{Tl}_2\text{SnAs}_2\text{S}_6$
*Sicherite	$\text{TlAg}_2(\text{As}_2\text{Sb})_{\Sigma 3}\text{S}_6$
*Raberite	$\text{Tl}_5\text{Ag}_4\text{As}_6\text{SbS}_{15}$
2b.1a.2.1.2.1.1.1.1.2.2. Tl^+ and Hg^{2+}	
Christite	TlHgAsS_3
Simonite	$\text{TlHgAs}_3\text{S}_6$
2b.1a.2.1.2.1.1.1.1.2.3. Tl^+ , (Cu^+ , Ag^+) and Pb^{2+}	
Wallisite group	
Wallisite	$\text{TlCuPbAs}_2\text{S}_5$
Hatchite	$\text{TlAgPbAs}_2\text{S}_5$
*Dalnegroite	$\text{Tl}_{5-x}\text{Pb}_x(\text{As,Sb})_{21-x}\text{S}_{34}$
*Unnamed	$(\text{Tl,Ag})_2\text{Pb}_6(\text{As,Sb})_{16}\text{S}_{31}$
2b.1a.2.1.2.1.1.1.1.2.4. Tl^+ and Pb^{2+}	

Hutchinsonit	$\text{TlPbAs}_5\text{S}_9$
*Edenharterite	$\text{TlPbAs}_3\text{S}_6$
*Jentschite	$\text{TlPbAs}_2\text{SbS}_6$
*Boscardinit	$\text{TlPb}_4(\text{Sb}_7\text{As}_2)_{\Sigma 9}\text{S}_{18}$
2b.1a.2.1.2.1.1.2. Sulfoarsenito-sulfoarsenates (complex)	
Imhofite	$\text{Tl}_{5,8}\text{As}_{15,4}\text{S}_{26}$
2b.1a.2.1.2.1.1.2. Sulfoantimonites	
2b.1a.2.1.2.1.1.2.1. Simple	
Weissbergite	TlSbS_2
*Jankovicite	$\text{Tl}_5\text{Sb}^{3+}_9(\text{As},\text{Sb})^{3+}_4\text{S}_{22}$
Pierrotite family	
Pierrotite	$\text{Tl}_2(\text{Sb}_6\text{As}_4)_{\Sigma 10}\text{S}_{16}$
Parapierrotite	$\text{Tl}_2(\text{Sb}_9\text{As})_{\Sigma 10}\text{S}_{16}$
*Protochabournéite	$\text{Tl}_{5-x}\text{Pb}_{2x}(\text{Sb},\text{As})_{21-x}\text{S}_{34}$ ($x \sim 1.2-1.5$)
Chabourneite	$\text{Tl}_{10}(\text{Sb}_{22,5}\text{As}_{19,5})_{42}\text{S}_{68}$
2b.1a.2.1.2.1.1.2.2. Complex	2b.1a.2.1.2.1.1.2.2.1. Tl^+ and Hg^+
Vaughanite	$\text{Tl}^+\text{Hg}^+\text{Sb}^{3+}_4\text{S}_7$
	2b.1a.2.1.2.1.1.2.2.2. Tl^+ and Hg^{2+}
Vrbaite	$\text{Tl}_4\text{Hg}_3(\text{Sb}_2\text{As}_8)_{\Sigma 10}\text{S}_{20}$
2b.1a.2.1.2.1.2. Minerals of Ag	
2b.1a.2.1.2.1.2.1. Sulfoarsenites	
2b.1a.2.1.2.1.2.1.1. Simple	
Pearceite series	
Pearceite	$(\text{Ag},\text{Cu})_{16}\text{As}_2\text{S}_{11}$
*Pearceite Tac	$(\text{Ag},\text{Cu})_{16}\text{As}_2\text{S}_{11}$
*Cupropearceite	$(\text{Ag}_9\text{Cu}_7)_{16}\text{As}_2\text{S}_{11}$
*Antimonpearceite	$(\text{Ag},\text{Cu})_{16}(\text{Sb},\text{As})_2\text{S}_{11}$
Polybasite	$(\text{Ag},\text{Cu})_{16}\text{Sb}_2\text{S}_{11}$
*Arsenopolybasite	$(\text{Ag},\text{Cu})_{16}(\text{As},\text{Sb})_2\text{S}_{11}$
*Selenopolybasite	$\text{Ag}_{15}\text{CuSb}_2\text{S}_9\text{Se}_2$
Proustite family	
Proustite series	
Proustite	Ag_3AsS_3
Pyrrargyrite	Ag_3SbS_3
Xanthoconite group	
Xanthoconite	Ag_3AsS_3
Pyrostilpnite	Ag_3SbS_3
Smithite family	
Smithite	AgAsS_2
Trechmannite	AgAsS_2
	2b.1a.2.1.2.1.2.1.2. Complex (Ag^+ and Hg^{2+})
Laffittite	AgHgAsS_3
*Fettelite	$[\text{Ag}_6\text{As}_2\text{S}_7][\text{Ag}_{10}\text{HgAs}_2\text{S}_8]$
*Debattistiite	$\text{Ag}_9\text{Hg}_{0,5}\text{As}_6\text{S}_{12}\text{Te}_2$
*2b.1a.2.1.2.1.2.1.3. Complex (Ag^+ , Cd^{2+} , Pb)	
*Quadratite	$\text{Ag}(\text{Cd},\text{Pb})(\text{As},\text{Sb})\text{S}_3$
*Manganoquadratite	AgMnAsS_3

2b.1a.2.1.2.1.2.2. Sulfoarsenites (simple)

Billingsleyite $\text{Ag}_7(\text{As,Sb})\text{S}_6$

*26.1a.2.1.2.1.2.2.1. Sulfoarsenito-halogenides

*Mutnovskite $\text{Pb}_2\text{AsS}_3(\text{I,Cl,Br})$

2b.1a.2.1.2.1.2.3. Sulfoantimonites

2b.1a.2.1.2.1.2.3.1. Simple

Stephanite family (compare with selenostephanite)Stephanite Ag_5SbS_4 **Miargyrite** subfamilyMiargyrite AgSbS_2 *Cubargyrite AgSbS_2 *Baumstarkite AgSbS_2 Aramayoite $\text{Ag}(\text{Sb,Bi})\text{S}_2$ *Ferdowsite $\text{Ag}_8(\text{Sb}_5\text{As}_3)_{\Sigma 8}\text{S}_{16}$ 2b.1a.2.1.2.1.2.3.2. Complex (Ag^+ and Pb^{2+})Brongniardite = diaphorite $\text{Ag}_3\text{Pb}_2\text{Sb}_3\text{S}_8$ Roshchinite $\text{Ag}_{19}\text{Pb}_{10}\text{Sb}_{51}\text{S}_{96}$ Diaphorite $\text{Ag}_3\text{Pb}_2\text{Sb}_3\text{S}_8$ *Tubulite $\text{Ag}_2\text{Pb}_{22}\text{Sb}_{20}\text{S}_{53}$ *Unnamed $\text{Ag}_3\text{Pb}_6(\text{Sb,Bi})_{11}\text{S}_{24}$

2b.1a.2.1.2.1.2.4. Sulfoantimonites

2b.1a.2.1.2.1.2.4.1. Simple \rightarrow complexMatildite AgBiS_2 *Schapbachite AgBiS_2 *Unnamed cub. AgBiS_2 Benjaminite $\text{Ag}_3\text{Bi}_7\text{S}_{12}$ **Pavonite** seriesPavonite AgBi_3S_5 Cupropavonite $\text{AgCu}_2\text{PbBi}_5\text{S}_{10}$ *Cupromakopavonite $\text{N} = 4,5$ $\text{Ag}_3\text{Cu}_8\text{Pb}_4\text{Bi}_{19}\text{S}_{38}$ *Cupromakovickyite $\text{N} = 4$ $\text{Ag}_2\text{Cu}_8\text{Pb}_4\text{Bi}_{18}\text{S}_{36}$ *Makovickyite $\text{Ag}_{1,5}\text{Bi}_{5,5}\text{S}_9$ *Dantopaite $\text{Ag}_5\text{Bi}_{13}\text{S}_{22}$ *Cu-Pb-benjaminite $\text{N} = 7.86$ *Cu-Pb-mummeite $\text{N} = 8$ *Unnamed $\text{Ag}_5\text{CuPbBi}_4(\text{S,Se})_{10}$ *Borodaevite $[\text{Ag}_5(\text{Fe,Pb})\text{Bi}_7]_{\Sigma 13}(\text{Sb,Bi})_2\text{S}_{17}$

2b.1a.2.1.2.1.2.4.2. Complex

2b.1a.2.1.2.1.2.4.2.1. Ag^+ and Cu^+ Arcubisite $\text{Ag}_6\text{CuBiS}_4$ 2b.1a.2.1.2.1.2.4.2.2. $\text{Ag}^+(\text{Cu}^+)$ and Pb^{2+} Padéraite $\text{Cu}_7(\text{Cu,Ag})_{0.33}\text{Pb}_{1.33}\text{Bi}_{11.33}\text{S}_{22}$ Mummeite $\text{Cu}_{0.58}\text{Ag}_{3.11}\text{Pb}_{1.10}\text{Bi}_{6.65}\text{S}_{13}$ **Berryite** seriesBerryite-(Cu) $(\text{Cu,Ag})_5\text{Pb}_3\text{Bi}_7\text{S}_{16}$ Berryite-(Ag) $(\text{Ag,Cu})_5\text{Pb}_3\text{Bi}_7\text{S}_{16}$

p-Ourayite	$\text{Ag}_{3,6}\text{Pb}_{2,8}\text{Bi}_{5,6}\text{S}_{13}$
Treasurite	$\text{Ag}_7\text{Pb}_6\text{Bi}_{15}\text{S}_{32}$
Gustavite	$\text{AgPbBi}_3\text{S}_6$
Ourayite	$\text{Ag}_3\text{Pb}_4\text{Bi}_5\text{S}_{13}$
*Terrywallaceite	$\text{AgPb}(\text{Sb},\text{Bi})_3\text{S}_6$
*26.1a.2.1.2.1.2.5. Sulfoarsenantimonites	
*Unnamed	$\text{Ag}_2\text{SbAsS}_4$
2b.1a.2.1.2.2. Minerals of IIb -cations (Hg^{2+})	
2b.1a.2.1.2.2.1. Sulfoarsenites (complex)	
Galkhaite	$(\text{Hg}_5\text{Cu})\text{CsAs}_4\text{S}_{12}$
2b.1a.2.1.2.2.2. Sulfoantimonites (mono-polyanionic) (simple)	
Livingstonite	$\text{HgSb}_4\text{S}_8 \rightarrow \text{Hg}^{2+}\text{Sb}^{3+}_4\text{S}_6[\text{S}_2]$
*26.1a.2.1.2.2.3. Sulfobismuthites (complex)	
*Grumiplucite	HgBi_2S_4
2b.1a.2.2. <u>Sulfosalts of noncensymmetrical p-cations</u>	
2b.1a.2.2.1. Minerals of IVa -cations (only Pb^{2+})	
2b.1a.2.2.1.1. Sulfoarsenites	
2b.1a.2.2.1.1.1. Simple	
Jordanite series	
Jordanite	$\text{Pb}_{14}(\text{As},\text{Sb})_6\text{S}_{23}$
Geocronite	$\text{Pb}_{14}(\text{Sb},\text{As})_6\text{S}_{23}$
*Marumoite	$\text{Pb}_8\text{As}_{10}\text{S}_{23}$
Gratonite	$\text{Pb}_9\text{As}_4\text{S}_{15}$
*Tsugaruite	$\text{Pb}_4\text{As}_2\text{S}_7$
Kirkiite	$\text{Pb}_{10}(\text{As}_3\text{Bi}_3)_{\Sigma 6}\text{S}_{19}$
Dufrénoysite	$\text{Pb}_2\text{As}_2\text{S}_5$
Baumhauerite	$\text{Pb}_3\text{As}_4\text{S}_9$ or $\text{Pb}_{12}\text{As}_{16}\text{S}_{36}$
*Argentobaumhauerite = baumhauerite 2a	$\text{Ag}_{1,5}\text{Pb}_{22}\text{As}_{33,5}\text{S}_{72}$
Liveingite	$\text{Pb}_{18,5}\text{As}_{25}\text{S}_{56}$
Sartorite	PbAs_2S_4
2b.1a.2.2.1.1.2. Complex	
2b.1a.2.2.1.1.2.1. Pb^{2+} and Cu^+	
Seligmannite ($y = \text{MS} : \text{M}_2\text{S} = 2$)	CuPbAsS_3
Marrite	2b.1a.2.2.1.1.2.2. Pb^{2+} and $\text{Ag}^+(\text{Cu}^+)$ AgPbAsS_3
Lengenbachite ($y = \leq 6$)	$(\text{Ag},\text{Cu})_2\text{Pb}_6\text{As}_4\text{S}_{13}$ *26.1a.2.2.1.1.3. $\text{Pb}^{2+}, \text{Cd}$ $\text{Pb}_{20}\text{Cd}_2(\text{As},\text{Bi})_{22}\text{S}_{50}\text{Cl}_{10}$
*Tazievite	$\text{Pb}_{20}\text{Cd}_2(\text{As},\text{Bi})_{22}\text{S}_{50}\text{Cl}_{10}$
*26.1a.2.2.1.1.3. $\text{Pb}^{2+}, \text{Hg}$	
*Daliranite	$\text{PbHgAs}_2\text{S}_6$
2b.1a.2.2.1.2. Sulfoantimonites	
2b.1a.2.2.1.2.1. Proper sulfoantimonites	
2b.1a.2.2.1.2.1.1. Simple	
Falkmanite	$\text{Pb}_{5,4}\text{Sb}_{3,6}\text{S}_{11} \sim \text{Pb}_3\text{Sb}_2\text{S}_6$

Boulangerite	$Pb_5Sb_4S_{11}$
*Moëloite	$Pb_6Sb_6S_{17}$ or $Pb_6Sb_6S_{14}(S_3)$
Semseyite	$Pb_9Sb_8S_{21}$
Madocite	$Pb_{19}(Sb,As)_{16}S_{43}$
Veenite	$Pb_2(Sb,As)_2S_5$
Sorbyite	$Pb_9Cu(Sb,As)_{11}S_{26}$
Heteromorphite	$Pb_7Sb_8S_{19}$
Launayite	$Pb_{10}Cu(Sb,As)_{13}S_{30}$
Robinsonite	$Pb_4Sb_6S_{13}$
Plagionite	$Pb_5Sb_8S_{17}$
Twinnite series (?)	
Guettardite	$Pb(Sb,As)_2S_4$
Twinnite	$Pb(SbAs)_{\Sigma 2}S_4$
Rathite	$Pb_{12-x}Ag_2Tl_{x/2}As_{18+x/2}S_{40}$
Zinkenite	$Pb_9Sb_{22}S_{42}$
Fülöppite	$Pb_3Sb_8S_{15}$
Playfairite	$Pb_{16}(Sb,As)_{19}S_{44}Cl$
2b.1a.2.2.1.2.1.2. Complex	2b.1a.2.2.1.2.1.2.1. Pb^{2+} and Fn^{2+}
Jamesonite family	
Jamesonite series (?)	
Jamesonite	$Pb_4FeSb_6S_{14}$
Benavidesite	$Pb_4(Mn,Fe)Sb_6S_{14}$
*Marrucciite	$Hg_3Pb_{16}Sb_{18}S_{46}$
Bournonite (y = 2)	2b.1a.2.2.1.2.1.2.2. Pb^{2+} and Cu^+
Tintinaite series (y = 11)	$CuPbSbS_3$
Tintinaite-(Sb)	$Pb_{10}Cu_2Sb_{16}S_{35}$
Tintinaite-(Bi)	$Pb_{10}Cu_2(Bi,Sb)_{16}S_{35}$
Meneghinite series (y=26-20)	
Meneghinite	$CuPb_{13}Sb_7S_{24}$
Jaskolskiite	$Cu_xPb_{2+x}(Sb,Bi)_{2-x}S_5$ (x = 0,2)
*Rouxelite	$Cu_2HgPb_{22}Sb_{28}S_{64}(O,S)_2$
*Izoklakeite	$(Cu,Fe)_2Pb_{27}(Sb,Bi)_{19}S_{57}$
*Unnamed	$Cu_5Fe_6Pb_6Bi_2S_{21}$ (?)
Rayite	2b.1a.2.2.1.2.1.2.3. Pb^{2+} and Tl^+ , Ag^+
TlAg ₃ Pb ₁₆ Sb ₁₆ S ₄₂	
2b.1a.2.2.1.2.1.2.4. Pb^{2+} and $Ag^+(Cu^+)$	
Andorite family (y=2)	
Andorite group	
Freieslebenite	$AgPbSbS_3$
Andorite	$AgPbSb_3S_6$
Senandorite	$AgPbSb_3S_6$
Ramdohrite (y = 4)	$Ag_3Pb_6Sb_{11}S_{24}$
Fizelyite (y = 5,6)	$Ag_5Pb_{14}Sb_{21}S_{48}$
Owyheeite family (y = 8)	
Owyheeite	$Ag_{3+x}Pb_{10-2x}Sb_{11+x}S_{28}$ (-0,13 ≤ x ≤ 0,2)
Zoubekite	$AgPb_4Sb_4S_{10}$
*Parasterryite	$Ag_4Pb_{20}(Sb_{14.5}As_{9.5})_{24}S_{58}$
Sterryite	$(Ag,Cu)_2Pb_{10}(Sb,As)_{12}S_{29}$

	2b.1a.2.2.1.2.1.2.5. Pb^{2+} , Fn^{2+} and Ag^+
Uchucchacuaite	$AgPb_3Mn^{2+}Sb_5S_{12}$
*Menchettite	$AgPb_{2.40}Mn^{2+}_{1.60}Sb_3As_2S_{12}$
*Unnamed	$AgPb_9(Sb,As)_{13}S_{29}$
	2b.1a.2.2.1.2.1.2.6. Pb^{2+} , Fn^{2+} , Sn^{2+} and Sn^{4+}
Franckeite series	
Franckeite	$Pb_5Fe^{2+}Sn^{2+}Sn^{4+}_2Sb_2S_{14}$
Cylindrite	$Pb_3Fe^{2+}Sn^{2+}Sn^{4+}_3Sb_2S_{14}$
2b.1a.2.2.1.2.2. Sulfoantimonito-halogenides (simple)	
Dadsonite	$Pb_{23}Sb_{25}S_{60}Cl$
Ardaite	$Pb_{19}Sb_{13}S_{35}Cl_7$
*26.1a.2.2.1.2.3. Sulfoantimonito-chlorido-oxides (simple)	
*Pillaite	$Pb_9Sb_{10}S_{23}ClO_{0.5}$
*Pellouxite	$(Cu,Ag)_2Pb_{21}Sb_{23}S_{55}ClO$
*26.1a.2.2.1.2.4. Sulfoantimonito-oxides (simple)	
*Scainiite	$Pb_{14}Sb_{30}S_{54}O_5$
*Chovanite	$Pb_{15-2x}Sb_{14+2x}S_{36}O_x$
2b.1a.2.2.1.3. Sulfobismuthites	
2b.1a.2.2.1.3.1. Proper sulfobismuthites	
2b.1a.2.2.1.3.1.1. Simple	
Aschamalmite	$Pb_6Bi_2S_9$
Lillianite family	
Lillianite	$Pb_{3-2x}Ag_xBi_{2+x}S_6$
Xilingolite	$Pb_3Bi_2S_6$
Cosalite	$Pb_2Bi_2S_5$
Cannizzarite	$Pb_8Bi_{10}S_{23}$
Galenobismutite	$PbBi_2S_4$
*Kudriavite	$(Cd,Pb)Bi_2S_4$
Sakharovaite	$(Pb,Fe)_5(Bi,Sb)_6S_{14}$ (?)
*Mozgovaite	$PbBi_4(S,Se)_7$
Ustarasite	$Pb(Bi,Sb)_6S_{10}$
*Crerarite	$(Pb,Pt)Bi_3(S,Se)_{4-x}$ ($x \sim 0.7$)
2b.1a.2.2.1.3.1.2. Complex	
2b.1a.2.2.1.3.1.2.1. Pb^{2+} and Cu^+	
*Pizgrischite	$Cu_{17}PbBi_{17}S_{35}$
Aikinite homologous series – $Cu_{1-x}Pb_{1-x}Bi_{1+x}S_3$	
Aikinite	($0 < x < 0,11$) $CuPbBiS_3$
Friedrichite	($0,13 < x < 0,20$) $Cu_5Pb_5Bi_7S_{18}$
*Felbertalite	($x = 0,26$) $Cu_2Pb_6Bi_8S_{19}$
Hammarite	($0,32 < x < 0,38$) $Cu_2Pb_2Bi_4S_9$
*Emilite	($x = 0,32$) $Cu_{10,7}Pb_{10,7}Bi_{21,3}S_{48}$
Lindströmite	($x = 0,4$) $Cu_3Pb_3Bi_7S_{15}$
Krupkaite	($0,41 < x < 0,48$) $CuPbBi_3S_6$
*Paarite	($x = 0,58$) $Cu_{1,7}Pb_{1,7}Bi_{6,3}S_{12}$
*Zalzburgite	($x = 0,6$) $Cu_{1,6}Pb_{1,6}Bi_{6,4}S_{12}$
Gladite	($0,62 < x < 0,77$) $CuPbBi_5S_9$
*Unnamed	($x = 0,75$) $CuPbBi_7S_{12}$
*Pekoite	($x = 0,83$) $CuPbBi_{11}(S,Se)_{18}$

*Unnamed	(x = 0,92)	CuPbBi ₂₃ S ₃₆
Nuffildite		Cu _{1,4} Pb _{2,4} Bi _{2,4} Sb _{0,2} S ₇
*Angelaite		Cu ₂ AgPbBiS ₄
Neyite	(Cu,Ag) ₂ Pb ₇ Bi ₆ S ₁₇ or	Ag ₂ Cu ₆ Pb ₂₅ Bi ₂₆ S ₆₈
*Cupronyite		Cu ₇ Pb ₂₇ Bi ₂₅ S ₆₈
Kobellite		Pb ₁₁ (Cu,Fe) ₂ (Bi,Sb) ₁₅ S ₃₅
Eclarite		(Cu,Fe)Pb ₉ Bi ₁₂ S ₂₈
Giessenit		(Cu,Fe) ₂ Pb _{26,4} (Bi,Sb) _{19,6} S ₅₇
Heyrovskyite		2b.1a.2.2.1.3.1.2.2. Pb ²⁺ and Ag ⁺ , Au ⁺ Pb ₆ Bi ₂ S ₉
Vikingite family		
Vikingite		Ag ₅ Pb ₈ Bi ₁₃ S ₃₀
Eskimoite		Ag ₇ Pb ₁₀ Bi ₁₅ S ₃₆
Ourayite		Ag ₃ Pb ₄ Bi ₅ S ₁₃
*Jonassonite Au(Bi,Pb) ₅ S ₄		Au(Bi,Pb) ₅ S ₄
Levyclaудite		2b.1a.2.2.1.3.1.2.3. Pb ²⁺ , Cu ⁺ and Sn ⁴⁺ Cu ₃ Pb ₈ Sn ⁴⁺ ₇ (Bi,Sb) ₃ S ₂₈
*Coiraitite		(Pb,Sn) _{12,5} Sn ⁴⁺ ₅ Fe ²⁺ ₃ As ₃ S ₂₈
*26.1a.2.2.1.3.1.2.4. Pb ²⁺ , In ³⁺ , Sn ⁴⁺		
*Znamenskyite		Pb ₄ In ₂ Bi ₄ S ₁₃
*Abramovite		Pb ₂ InSnBiS ₇
26.1a.2.2.1.3.2. Sulfobismuthito-halogenides		
*26.1a.2.2.1.3.2.1. Simple		
*26.1a.2.2.1.3.2.2. Complex		
*Vurroite		*26.1a.2.2.1.3.2.2.1. Pb, Sn ⁴⁺ Pb ₂₀ Sn ₂ (Bi,As) ₂₂ S ₅₄ Cl ₆
*26.1a.2.2.1.4. Sulfoselenobismuthites		
*26.1a.2.2.1.4.1. Simple		
*Babkinite		Pb ₂ Bi ₂ (S,Se) ₃
*26.1a.2.2.1.5. Sulfoselenotelluroantimonites		
*Tsnigrinite		Ag ₉ SbTe ₃ (S,Se) ₃
2b.1b. Quasisubtype*: Selenides and selenosalts of sidero- and chalcophilic cations		
2b.1b.1. Class: Selenides sidero- and chalcophilic cations		
2b.1b.1.1. Minerals of heavy <i>d</i> -elements and their crystallochemical analogues.		
2b.1b.1.1.1. <u>Minerals of centrosymmetrical <i>d</i>-cations</u>		
2b.1b.1.1.1.1. Minerals of VIIIb -cations - families of Fn ⁿ⁺		
2b.1b.1.1.1.1.1. Polyanionic		
2b.1b.1.1.1.1.1.1. Fn ²⁺ (simple)		
Trogtalite family		
Trogtalite group		
Penroseite		(Ni,Co,Cu)[Se ₂]
Trogtalite		Co[Se ₂]
Kullerudite group		
Kullerudite		Ni[Se ₂]
Ferroselite		Fe[Se ₂]

*Dzharkenite	Fe[Se ₂]
2b.1b.1.1.1.1.2. Monoanionic	
2b.1b.1.1.1.1.2.1. Fn ²⁺ (simple)	
Sederoholmite family	
Sederoholmite group	
Sederoholmite	β-NiSe
Frebaldite	CoSe
Mäkinenite	γ-NiSe
2b.1b.1.1.1.1.2.2. Minerals of M ²⁺ and M ³⁺ (complex)	
Selenospinelides family (M ²⁺ : M ³⁺ = 0,5; compare with sulfospinelides of Fn (family); sulfospinelides of Pn (family))	
Bornhardtite family	(M ²⁺ and M ³⁺ only Fn)
Wilkmanite	Ni ₃ Se ₄ → Ni ²⁺ Ni ³⁺ ₂ Se ₄
Bornhardtite group	
Trüstedtite	Ni ₃ Se ₄
Bornhardtite	Co ₃ Se ₄ → Co ²⁺ Co ³⁺ ₂ Se ₄
Tyrellite series (M ²⁺ = Cu ²⁺ , M ³⁺ = Fn ³⁺)	
Tyrellite-(Ni) (an.1)	Cu(Ni,Co) ₂ Se ₄
Tyrellite-(Co) (an.2)	Cu(Co,Ni) ₂ Se ₄
2b.1b.1.1.1.2. Minerals of <i>Ib</i> -elements – Cu (and Tl ⁺ with CN ≤ 4)	
2b.1b.1.1.1.2.1. Polyanionic (simple)	
Krutaite family	
Krutaite	Cu[Se] ₂
Bambollaite	Cu[(Se,Te) ₂]
2b.1b.1.1.1.2.2. Mono polyanionic (complex)	
Klockmannite (compare with covellite)	3CuSe → Cu ₂ Se·Cu[Se ₂]
2b.1b.1.1.1.2.3. Monoanionic	
2b.1b.1.1.1.2.3.1. Cu ⁺	
2b.1b.1.1.1.2.3.1.1. Simple	
Berzelianite family	
Berzelianite	Cu ₂ Se
Bellidoite	Cu ₂ Se
2b.1b.1.1.1.2.3.1.2. Complex	2b.1b.1.1.1.2.3.1.2.1. Cu ⁺ and Tl ⁺
Crookesite	TlCu ₇ Se ₄
2b.1b.1.1.1.2.3.2. Cu ⁺ and Cu ²⁺ (complex)	
2b.1b.1.1.1.2.3.2.1. Cu ⁺ , Tl ⁺ and Cu ²⁺ and Cu ²⁺ (Fe ³⁺);	
Sabatierite family M ⁺ : M ²⁺ = up 6 (sabatierite) to 2 (when 2M ²⁺ ← M ⁺ M ³⁺) (bukovite)	
Sabatierite	Tl ⁺ Cu ⁺ ₅ Cu ²⁺ Se ₄
Bukovite	Tl ⁺ ₂ Cu ⁺ _{3+x} Fe ³⁺ Se _{4-x}
2b.1b.1.1.1.2.3.2.2. Cu ⁺ : Cu ²⁺ = 2	
Umangite	Cu ₃ Se ₂ → Cu ⁺ ₂ Cu ²⁺ Se ₂
2b.1b.1.1.1.2.3.2.3. Cu ⁺ : Cu ²⁺ = 0,(6)	
Athabascaite	Cu ₅ Se ₄ → Cu ⁺ ₂ Cu ²⁺ ₃ Se ₄

	2b.1b.1.1.1.2.3.2.4. $M^+ : M^{2+} = 0,2$ (Cu,Fe,Ag) ₉ Se ₈
Geffroyite	
2b.1b.1.1.1.2.3.3. M^{2+}	
2b.1b.1.1.1.2.3.3.1. Complex	
2b.1b.1.1.1.2.3.3.1.1. $2M^{2+} \rightarrow Cu^+M^{3+}(Fe^{3+})$	
Eskebornite (comp. chalcopyrite (subfam.))	$Cu^+Fe^{3+}Se_2$
2b.1b.1.1.1.2.3.3.1.2. $3M^{2+} \rightarrow 2M^+(Cu^+)M^{4+}(Sn^{4+})$	
Selenocernyite (comp.stannite (series))	$Cu^+_2Cd^{2+}Sn^{4+}Se_4$
2b.1b.1.1.1.3. Minerals of IIb -cations - Zn^{2+} (and Cd^{2+})	
2b.1b.1.1.1.3.1. Monoanionic (simple)	
Stilleite family (compare with sphalerite (family))	
Stilleite	ZnSe
Cadmoselite	CdSe
2b.1b.1.1.2. <u>Minerals of heavy noncensymmetrical d-cations</u>	
2b.1b.1.1.2.1. Minerals of VIIIb -cations (Pn^{n+})	
2b.1b.1.1.2.1.1. Subselenides	
2b.1b.1.1.2.1.1.1. Simple	
*Sudovikovite	PtSe ₂
*Verbeekite	PdSe ₂
Palladseite	Pd ₁₇ Se ₁₅
*Luberoite	Pt ₃ Se ₄
2b.1b.1.1.2.1.1.2. Complex	
*Jagueite	Pd ₃ Cu ₂ Se ₄
*Unnamed	Pd ₃ Cu ₂ Se ₄
Oosterboschite	(Pd,Cu) ₇ Se ₅
*Miessiite	Pd ₁₁ Te ₂ Se ₂
*Chrisstanleyite	Pd ₃ Ag ₂ Se ₄
*Padmaite	PdBiSe
*Jacutingaite	Pt ₂ HgSe ₃
*Tischendorfite	Pd ₈ Hg ₃ Se ₉
*Unnamed	(Pb,Cu,Hg) _{1,16} Se
2b.1b.1.1.2.2. Minerals of Ib -cations	
2b.1b.1.1.2.2.1. Monoanionic	
2b.1b.1.1.2.2.1.1. Ag^+	
2b.1b.1.1.2.2.1.1.1. Proper selenides	
2b.1b.1.1.2.2.1.1.1.1. Simple	
Naumannite	Ag ₂ Se
2b.1b.1.1.2.2.1.1.1.2. Complex	2b.1b.1.1.2.2.1.1.1.2.1. Cu^+ and Ag^+
Eucairite	AgCuSe
*Selenojalpaite	Ag ₃ CuSe ₂
*Unnamed	(Ag,Cu) ₁₄ S ₆ Se ₃
Fischesserite	2b.1b.1.1.2.2.1.1.1.2.2. Ag and Au ⁺ AuAg ₃ Se ₂
2b.1b.1.1.2.2.1.1.1.2. Selenido-sulfides	

- 2b.1b.1.1.2.2.1.1.1.2.1. Simple
 Aguilarite Ag_4SeS
- 2b.1b.1.1.1.2.2.1.1.2.2. Complex
 Penzhinite $\text{Au}^+\text{Ag}^+(\text{Ag}_{2,65}\text{Cu}_{0,35})^{2+}_{\Sigma 3}(\text{S}_{3,31}\text{Se}_{0,69})_{\Sigma 4}$
- 2b.1b.1.1.2.3. Minerals of **IIb**-cations (Hg^{2+})
 2b.1b.1.1.2.3.1. Monoanionic (simple)
 Tiemannite HgSe
- *26.16.1.1.2.3.2. Complex
 *Brodtkorbite Cu_2HgSe_2
- 2b.1b.1.2. Minerals of noncensymmetrical *p*-cations
 2b.1b.1.2.1. Minerals of **IVa**-cations
 2b.1b.1.2.1.1. Minerals of Pb
 2b.1b.1.2.1.1.1. Monoanionic (simple)
 2b.1b.1.2.1.1.1.1. Pb^{2+}
 Clausthalite (comp.galena – clausthalite (series)) PbSe
- 2b.1b.1.2.2. Minerals of **Va**-cations
 2b.1b.1.2.2.1. Subselenido-sulfides (simple)
 *Antimonelite Sb_2Se_3
- Laitakarite** family
Laitakarite series
 Ikunolite $\text{Bi}_4(\text{S},\text{Se})_3$
 Laitakarite $\text{Bi}_4(\text{Se},\text{S})_3 \rightarrow \text{Bi}_4\text{Se}_2\text{S}$
 Nevskite $(\text{Bi},\text{Pb})(\text{Se},\text{S})$
 Laphamite As_2Se_3
- 2b.1b.1.2.2.2. Monoanionic
 2b.1b.1.2.2.2.1. Selenido-sulfides (at that number selenido-tellurides) (simple)
Guanajuatite family
Paraguanajuatite group
 Paraguanajuatite Bi_2Se_3
 Skippenite $\text{Bi}_2(\text{Se}_2\text{Te})_{\Sigma 3}$
 Guanajuatite Bi_2Se_3
 *Telluronevskite Bi_3TeSe_2
 *Vihorlatite $\text{Bi}_{24}\text{Se}_{17}\text{Te}_4$
- 2b.1b.2. **Class**: Selenosalts of sidero- and chalcophylic cations
 2b.1b.2.1. Selenosalts of heavy *d*- cations
 2b.1b.2.1.1. Minerals of censymmetrical *d*-cations
 2b.1b.2.1.1.1. Minerals of **Ib**-cations
 2b.1b.2.1.1.1.1. Cu^+
 2b.1b.2.1.1.1.1.1. Selenoarsenites (simple)
 Mgrite Cu_3AsSe_3
- 2b.1b.2.1.1.1.2. Cu^+ and $\text{Cu}^{2+}(\text{Fe}^{2+}, \text{Zn}^{2+}, \text{Hg}^{2+}, \text{Pb}^{2+})$ (complex)
 2b.1b.2.1.1.1.2.1. Selenoarsenites
 Chameanite $\text{Cu}_3(\text{Cu},\text{Fe})^{2+}\text{As}(\text{Se},\text{S})_4$
 *Unnamed $(\text{Cu},\text{Co},\text{Ni})_7\text{As}_3\text{Se}_6$
- 2b.1b.2.1.1.1.2.2. Selenoarsenito-selenoantimonites

- Giraudite** series (compare with fahlores (series))
 Giraudite (Se-sandbergerite) $\text{Cu}_6[\text{Cu}_4(\text{Fe,Zn})_2]\text{As}_4\text{Se}_{13}$
 Hakite (Se-schwazite) $\text{Cu}_{10}\text{Hg}_2\text{Sb}_4(\text{Se,S})_{13}$
- 2b.1b.2.1.1.1.2.3. Selenoantimonites
 Permingeatite (comp. enargite (family)) $\text{Cu}_3\text{SbSe}_4 \rightarrow \text{Cu}^+\text{Cu}^{2+}_2\text{SbSe}_4$
- 2b.1b.2.1.1.1.2.4. Selenobismuthites and seleno-sulfobismutites
 *2b.1b.2.1.1.1.2.4.1. Cu^+
 *Eldragonite $\text{Cu}^+_6\text{BiSe}^{2-}_4(\text{Se}_2)^{2-}$
 2b.1b.2.1.1.1.2.4.2. Cu^+ , Hg^{2+} and Pb^{2+}
 Petrovicite $\text{Cu}_3\text{HgPbBiSe}_5$
 2b.1b.2.1.1.1.2.4.3. Cu^+ and Pb^{2+}
 *Schlemaite $(\text{Cu},\square)_6(\text{Pb,Bi})\text{Se}_4$
 Součekite (compare with aikinite (series)) $\text{CuPbBi}(\text{SeS}_2)_{\Sigma 3}$
 *Součekite-like mineral $\text{Cu}_{2,1-2,6}\text{Ag}_{0,7}\text{Pb}_{0,3}\text{Bi}_{0,2}\text{Se}_3$ (?)
 Proudite $\text{Pb}_8\text{Bi}_{10}\text{S}_{23}$
 Watkinsonite $\text{PbCu}_2\text{Bi}_4\text{Se}_8$
 Nordströmite $\text{CuPb}_3\text{Bi}_7(\text{S,Se})_{14}$ S : Se = 2,4
 Junoite $\text{Cu}_2\text{Pb}_3\text{Bi}_8(\text{S,Se})_{16}$ S : Se = 1,7 - 4,8
 Pekoite $\text{CuPbBi}_{11}(\text{S,Se})_{18}$ S : Se = 5,2
- 2b.1b.2.1.2. Selenosalts of noncensymmetrical d-cations
 *2b.1b.2.1.2.1. Minerals of **VIIIb**-cations
 *Kalungaite PdAsSe
 *Milotaite PdSbSe
- 2b.1b.2.1.2.2. Minerals of **Ib**-elements
 2b.1b.2.1.2.2.1. Minerals of Ag
 2b.1b.2.1.2.2.1.1. Selenoantimonites (simple)
 Selenostephanite (comp. stephanite (group.)) $\text{Ag}_5\text{Sb}(\text{Se,S})_4$
 *Selenopolybasite $\text{Ag}_{15}\text{CuSb}_2\text{S}_9\text{Se}_2$
- 2b.1b.2.1.2.2.1.2. Selenobismutites (simple)
 Bohdanowiczite AgBiSe₂
 *Litochlebite $\text{Ag}_2\text{PbBi}_4\text{Se}_8$
- 2b.1b.2.2. Selenosalts of noncensymmetrical p-cations
 2b.1b.2.2.1. Minerals of **IVa**-cations (Pb^{2+})
 2b.1b.2.2.1.1. Seleno-sulfobismutites (at that number telluro-selenosulfobismutit) (simple)
Weibullite family
 Weibullite $\text{Ag}_{0,3}\text{Pb}_{5,3}\text{Bi}_{8,3}(\text{S,Se})_{18}$
 Wittite $\text{Pb}_8\text{Bi}_{10}(\text{S,Se})_{23}\text{Se}$
 Poubaitte (Te,Se-galenobismutite) $\text{PbBi}_2(\text{Se,Te,S})_4$
- 2b.2. Subtype: Chalcogenic compounds of lithophylic cations
 2b.2.1. **Class**: Sulfides (and selenides) of lithophylic cations
 2b.2.1.1. Minerals of light d-elements (with 1 – 4 d-electrons)
 2b.2.1.1.1. Minerals of censymmetrical d-elements

*26.2.1.1.1.1. Minerals of *IVb*-elements

*Wassonite TiS

2b.2.1.1.1.1. Minerals of *Vb*-elements2b.2.1.1.1.1.1. Minerals of M^{5+} 2b.2.1.1.1.1.1.1. SimplePatronite $V[S_2]_2$ *Colimaite K_3VS_4 2b.2.1.1.2. Minerals of noncensymmetrical *d*-elements2b.2.1.1.2.1. Minerals of *VIb*-elements

2b.2.1.1.2.1.1. Monoanionic

2b.2.1.1.2.1.1.1. Minerals of M^{4+} 2b.2.1.1.2.1.1.1.1. Simple**Molybdenite** family**Molybdenite** groupMolybdenite -2*H* MoS_2 Molybdenite -3*R*Tungstenite-2*H* WS_2 *Tungstenite-3*R* WS_2 Drysdallite $MoSe_2$ Jordisite MoS_2 *Rheniite ReS_2 *26.2.1.1.2.2. Minerals of *VIb*-элементов and *VIIb*-elements*Tarkianite $(Re,Mo)_4(Cu,Fe)S_8$ *Buseckite $(Fe,Zn,Mn)S$ 2b.2.1.2. Sulfides of *s*-elements2b.2.1.2.1. Sulfides of *Ia*-cations and Tl^+ (with CN=8-12) (all monoanionic)2b.2.1.2.1.1. Sulfides of $Tl^+(K)$ 2b.2.1.2.1.1.1. Proper sulfides 2b.2.1.2.1.1.1.1. Complex
2b.2.1.2.1.1.1.1.1. $M^+(K^+,Tl^+,Cu^+)$ and
 $M^{3+}(Fe^{3+})$ **Murunskite** groupThalcusite $Tl_2Cu_3Fe^{3+}S_4$ Murunskite $K_2Cu_3Fe^{3+}S_4$ 2b.2.1.2.1.1.1.1.2. $M^+(K^+,Tl^+)$, $M^{2+}(Fe^{2+})$ and $M^{3+}(Fe^{3+})$ **Rasvumite** groupPicotpaulite $TlFe^{2+}Fe^{3+}S_3$ Rasvumite $KFe^{2+}Fe^{3+}S_3$ 2b.2.1.2.1.1.1.1.3. $M^+(K^+)$, $M^{2+}(Fe^{2+})$ and $M^{3+}(Fe^{3+})$ *Owensite $(Ba,Pb)_6(Cu^{1+},Fe,Ni)_{25}S_{27}$ Bartonite $K_6(Fe,Cu)_{20}S_{26}S$ *Chlorbartonite $K_6(Fe,Cu)_{24}S_{26}(Cl,S)$

2b.2.1.2.1.1.2. Sulfido-chlorides 2b.2.1.2.1.1.2.1. Complex

Djerfisherite groupThalfenisite $Tl_6(Fe,Ni,Cu)_{25}S_{26}Cl$ Djerfisherite $K_6(Fe,Cu,Ni)_{25}S_{26}Cl$

2b.2.1.2.1.2. Sulfides of Na

2b.2.1.2.1.2.1. Complex	2b.2.1.2.1.2.1.1. Anhydrous
Chvilevaite	2b.2.1.2.1.2.1.1.1. $M^+(Na^+)$ and $M^{2+}(Fe^{2+}, Cu^{2+}, Zn^{2+})$ $Na_2Cu_2(Fe,Cu,Zn)^{2+}_2S_4$
Caswellsilverite	2b.2.1.2.1.2.1.1.2. $M^+(Na^+)$ and $M^{3+}(Cr^{3+})$ $NaCr^{3+}S_2$
Erdite	2b.2.1.2.1.2.1.2. Hydrous
Coyoteite	2b.2.1.2.1.2.1.2.1. $M^+(Na^+)$ and $M^{3+}(Fe^{3+})$ $Na^+Fe^{3+}S_2 \cdot 2H_2O$ $Na^+Fe^{3+}_3S_5 \cdot 2H_2O$
Orickite	2b.2.1.2.1.2.1.2.2. $M^+(Na^+, K^+, Cu^+)$, $M^{2+}(Fe^{2+})$ and $M^{3+}(Fe^{3+})$ $CuFeS_2 \cdot nH_2O$
Schöllhornite	2b.2.1.2.1.2.1.2.3. $M^+(Na^+)$, $M^{3+}(Cr^{3+})$ and $M^{6+}(Cr^{6+})$ $Na_{0,3}CrS_2 \cdot H_2O$
*Pautovite	$CsFe_2S_3$
2b.2.1.2.2. Sulfides of IIa -cations and their crystallochemical analogues (all monoanionic)	
2b.2.1.2.2.1. Proper sulfides	2b.2.1.2.2.1.1. Simple
Niningerite family	
Oldhamite	CaS
Niningerite series	
Niningerite -(Mg)	(Mg,Fe,Mn)S
Niningerite -(Fe)	(Fe,Mg,Mn)S
*Keilite	(Fe,Mg)S
*26.2.1.2.2.1.2. Complex	
*26.2.1.2.2.1.2.1. Hydrates	
*Cronusite	$Ca_{0,2}(H_2O)_2CrS_2$
2b.2.1.2.2.2. Sulfido-oxides	2b.2.1.2.2.2.1. Complex
Sarabauite	$CaSb^{3+}_{10}S_6O_{10}$
*Apuanite	$Fe^{2+}Fe^{3+}_4Sb^{3+}_4O_{12}S$
*26.2.1.2.2.3. Sulfido-oxido-carbonates	*26.2.1.2.2.3.1. Hydrates
*Ignicolorite	$FeS_2 \cdot 0.7CaCO_3 \cdot 2.8 H_2O$
2b.2.1.2.2.3. Sulfido-hydroxides	2b.2.1.2.2.3.1. Complex
Valleriite family	
Valleriite	$(Mg,Al)_3(Fe,Cu)_4(OH)_6S_4 \rightarrow$ $4(Fe,Cu)S \cdot 3(Mg,Al)(OH)_2$
*Ferrovalleriite	$2(Fe,Cu)S \cdot 1.53[(Fe,Al,Mg)(OH)_2]$
Haapalaite	$(Mg,Fe^{2+})_3(Fe,Ni)^{2+}_4(OH)_6S_4 \rightarrow$ $4(Fe,Ni)S \cdot 3(Mg,Fe^{2+})(OH)_2$
Tochilinite	$(Mg,Fe)_5Fe_6(OH)_{10}S_6 \rightarrow$ $6FeS \cdot 5(Mg,Fe^{2+})(OH)_2$
*Ferrotchilinite	$FeS \cdot 0.85[Fe(OH)_2]$
Yushkinite	$(Mg,Al)(OH)_2 \cdot VS_2$
*Vyalsovite	$FeS \cdot Ca(OH)_2 \cdot Al(OH)_3$
*Ekplexite	$(Mg_{1-x}Al_x)(Nb,Mo,W)(OH)_{2+x}S_2$
*Kaskasite	$Mg_{1-x}Al_x(OH)_{2+x}(Mo,Nb)S_2$

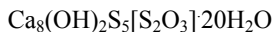
*Manganokaskasite $Mn_{1-x}Al_x(OH)_{2+x}(Mo,Nb)S_2$

2b.2.1.2.2.4. Sulfido-tiosulfates

2b.2.1.2.2.4.1. Hydrate

2b.2.1.2.2.4.1.1. Basic

Bazhenovite



2b.2.2. **Class:** Sulfosalts of lithophylic cations

2b.2.2.1. Minerals of Ia-elements and Tl^+ (with CN = 8-12)

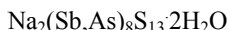
2b.2.2.1.1. Sulfoantimonites

2b.2.2.1.1.1. Proper sulfoantimonites

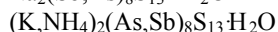
2b.2.2.1.1.1.1. Simple

2b.2.2.1.1.1.1.1. Crystalline hydrate (middle)

Gerstleyite



*Ambrinoite



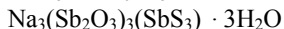
2b.2.2.1.1.2. Sulfoantimonito-antimonites

2b.2.2.1.1.2.1. Hydrate (basic)

Cetineite



*Ottensite



3. TYPE: MINERALS WITH PRINCIPAL IONIC-COVALENT AND COVALENT- IONIC BOND – NONMETALLIDES OF LIGHT (TYPICAL NONCENOSYMMETRICAL) VIA-ELEMENT (O) – OXIGEN COMPOUNDS: OXIDES AND HYDROXIDES (ISODESMICAL → ANISODESMICAL) → OXOCALTS (ANISODESMICAL)

3.1. SUBTYPE: OXIDES AND HYDROXIDES (ISODESMICAL)

3.1a. *QUASISUBTYPE: OXIDES AND HYDROXIDES OF LITHOPHYLLIC CATIONS WITH LOW FC*

3.1a.1. **Class:** Oxides and hydroxides of *s*-, *d*_s- and *p*_s-cations

3.1a.1.1. Oxides and hydroxides of *s*-, *d*_s- and *p*_s-cations without Li^+ , Be^{2+}

3.1a.1.1.1. Monoanionic

3.1a.1.1.1.1. Proper oxides

3.1a.1.1.1.1.1. M^{2+}

3.1a.1.1.1.1.1.1. Simple

Periclase group

Periclase



Hongquiiite дискредитирован



Manganosite



Wüstite



Bunsenite



Lime



3.1a.1.1.1.1.1.2. M^+ , M^{2+} and M^{3+}

3.1a.1.1.1.1.1.2.1. Complex



Diayudaoite



Oxospinelides family - AB_2O_4 ; $A(M^{2+}) : B(M^{3+}) = 2$

Spinel subfamily $A = Mg^{2+}, Fe^{2+}, Mn^{2+}, Ni^{2+}, Co^{2+}$; $B = Al^{3+}, V^{3+}, Cr^{3+}, Mn^{3+}, Fe^{3+}, Co^{3+}, Ni^{3+}, Mg^{2+}$

Magnetite series $({}^6A)({}^6B)({}^4B')O_4$; $A = Mg^{2+}, Fe^{2+}, Ni^{2+}, Mn^{2+}$; $B = Fe^{3+}, Mn^{3+}$; $B' = Fe^{3+}$

*Cuprospinel	(Cu,Mg)Fe ₂ O ₄
Magnesioferrite	MgFe ₂ O ₄
Trevorite	NiFe ₂ O ₄
Magnetite	Fe ₃ O ₄ → ⁽⁶⁾ Fe ²⁺ ⁽⁶⁾ Fe ⁽⁴⁾ FeO ₄
Jacobsite	Mn ²⁺ Fe ₂ ³⁺ O ₄
Chromite series	⁽⁴⁾ A ⁽⁶⁾ B ₂ O ₄ ; A = Mg ²⁺ , Fe ²⁺ , Mn ²⁺ , Co ²⁺ , Ni ²⁺ ; B = Mg, Cr ³⁺ , Al ³⁺ , V ³⁺
Magnesiochromite	MgCr ₂ ³⁺ O ₄
Cochromite	CoCr ₂ O ₄
Chromite	FeCr ₂ O ₄
Manganochromite	Mn ²⁺ Cr ₂ O ₄
*Xieite orth.	FeCr ₂ O ₄
Spinel series	⁽⁴⁾ A ⁽⁶⁾ B ₂ O ₄ ; A = Mg ²⁺ , Mn ²⁺ , Fe ²⁺ ; B = Al ³⁺ , Fe ³⁺
Spinel	MgAl ₂ O ₄
*Krotite	CaAl ₂ O ₄
Hercynite	Fe ²⁺ Al ₂ O ₄
Galaxite	Mn ²⁺ Al ₂ O ₄
*Brunogeierite	GeFe ₂ O ₄ → (Ge ²⁺ , Fe ²⁺)Fe ³⁺ ₂ O ₄
Coulsonite series	⁽⁴⁾ A ⁽⁶⁾ B ₂ O ₄ ; A = Mn ²⁺ , Fe ²⁺ ; B = V ³⁺ , Cr ³⁺
Vuorelainenite	Mn ²⁺ V ₂ ³⁺ O ₄
*Magnesiocoulsonite	MgV ₂ ³⁺ O ₄
Coulsonite	FeV ₂ O ₄
*Unnamed	Mn ₃ La ₂ O ₅
Hausmannite group	⁽⁴⁾ A ⁽⁶⁾ B ₂ O ₄ ; A = Fe ²⁺ , Mg ²⁺ , Mn ²⁺ ; B = Cr ³⁺ , Fe ³⁺ , Mn ³⁺
Iwakiite	Mn ²⁺ Fe ₂ ³⁺ O ₄
Hausmannite	MnMn ₂ O ₄
Marokite	CN M ²⁺ = 8 ⁽⁸⁾ Ca ⁽⁶⁾ Mn ₂ O ₄
3.1a.1.1.1.1.2. M ²⁺ , M ³⁺	M ²⁺ : M ³⁺ = ≥ 1
Muskoxite	Mg ₇ Fe ₄ ³⁺ (OH) ₂₆ · H ₂ O
Brownmillerite family	
Brownmillerite	Ca ₂ (Al,Fe) ₂ O ₅ ≅ ≅ ^(5,9) Ca ₂ ⁽⁶⁾ (Fe,Al)O ⁽⁴⁾ (Al,Fe)O ₄
Srebrodolskite	Ca ₂ Fe ₂ O ₅ → ^(5,9) Ca ₂ ⁽⁶⁾ FeO ⁽⁴⁾ FeO ₄
*Tululite	Ca ₁₄ (Fe ³⁺ , Al)(Al, Zn, Fe ³⁺ , Si, P, Mn, Mg) ₁₅ O ₃₆
	M ²⁺ : M ³⁺ = < 1
*Aciculite	CaFe ₂ O ₄
*Harmunite	CaFe ₂ O ₄
Mayenite	⁽⁸⁾ Ca ₁₂ ^(5,4) Al ₁₄ O ₃₃
*Dmitryivanovite	CaAl ₂ O ₄
*Grossite	CaAl ₄ O ₇
*Barioferrite	BaFe ³⁺ ₁₂ O ₁₉
3.1a.1.1.1.1.3. M ³⁺	
3.1a.1.1.1.1.3.1. Simple	
Corundum family	
*Deltalumite	Al ₂ O
Corundum group	
Corundum	Al ₂ O ₃
*Tistarite	Ti ₂ O ₃

Hematite	Fe_2O_3
Unnamed	$(\text{Ru,Fe})_2\text{O}_3$
Eskolaite	Cr_2O_3
Karelianite	V_2O_3
Maghemite series	
Maghemite	$\gamma\text{-Fe}_2\text{O}_3 \rightarrow \text{Fe}_{2,67}\text{O}_4 \rightarrow ({}^6\text{Fe}^{3+}_{0,67}\square_{0,33}{}^6\text{Fe}^{3+} {}^4\text{Fe}^{3+}\text{O}_4)$
Titanomaghemite	$\text{Fe}(\text{Fe,Ti})_2\text{O}_4$
Luogufengite	$\varepsilon\text{-Fe}_2\text{O}_3$
*Ittriaite-(Y)	Y_2O_3
Bixbyite	$\text{Mn}_2^{3+}\text{O}_3$
	3.1a.1.1.1.3.1. Hydrates
Akdalaite	$(\text{Al}_2\text{O}_3)_5 \cdot \text{H}_2\text{O}$
*3.1a.1.1.1.1.4. M^{2+} , M^{3+} , M^{4+} , M^{5+}	
*Wernerkrauseite	$\text{CaFe}^{3+}_2\text{Mn}^{4+}\text{O}_6$
*Bitikleite (SnAl)	$\text{Ca}_3\text{SnSb}[\text{AlO}_4]_3$
*Dzhuluite – new name of bitikleite-(SnFe)	$\text{Ca}_3\text{SbSn}[\text{FeO}_4]_3$
*Usturite - new name of bitikleite-(ZrFe).	$\text{Ca}_3\text{SbZr}[\text{FeO}_4]_3$
3.1a.1.1.1.2. Hydroxido-oxides	
3.1a.1.1.1.2.1. Proper hydroxido-oxides M^{3+}	3.1a.1.1.1.2.1.1. Simple
Diaspore family	
Diaspore group	
Diaspore	$\alpha\text{-Al}(\text{OH})\text{O}$
Montroseite	$\alpha\text{-(V,Fe)}(\text{OH})\text{O}$
Bracewellite	$\alpha\text{-Cr}(\text{OH})\text{O}$
Groutite	$\alpha\text{-Mn}(\text{OH})\text{O}$
Goethite	$\alpha\text{-Fe}(\text{OH})\text{O}$
Grimaldiite	$(\text{Cr,Al})(\text{OH})\text{O}$
Guyanaite	$(\text{Cr,Fe,Al})(\text{OH})\text{O}$
Feroxyhyte	$\delta\text{-Fe}(\text{OH})\text{O}$
Akaganeite group	
Akaganeite	$\beta\text{-Fe}(\text{OH,Cl})\text{O}$
Feitknechtite	$\text{Mn}(\text{OH})\text{O}$
Böhmite group	
Böhmite	$\gamma\text{-Al}(\text{OH})\text{O}$
Lepidocrocite	$\gamma\text{-Fe}(\text{OH})\text{O}$
*Tsumgallite	$\text{Ga}(\text{OH})\text{O}$
3.1a.1.1.1.3. Hydroxides	
3.1a.1.1.1.3.1. M^{2+}	3.1a.1.1.1.3.1.1. Simple
Brucite family	
Brucite	$\text{Mg}(\text{OH})_2$
Amakinite	$(\text{Fe,Mg})(\text{OH})_2$
Pyrochroite group	
Pyrochroite	$\text{Mn}(\text{OH})_2$
Theophrastite	$\text{Ni}(\text{OH})_2$
Portlandite	$\text{Ca}(\text{OH})_2$

3.1a.1.1.1.3.2. M^{3+} **Gibbsite** family

Gibbsite	$Al(OH)_3$
Bayerite	$Al(OH)_3$
Nordstrandite	$Al(OH)_3$
Doyleite	$Al(OH)_3$
Söhngeite	$Ga(OH)_3$
*Bernalite	$Fe(OH)_3$

3.1a.1.1.1.3.3. M^{2+} , M^{3+}

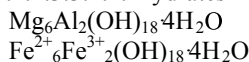
*Taschelgite

3.1a.1.1.1.3.3.1. Complex
 $CaMgFe^{2+}Al_9O_{16}(OH)$

Meixnerite

3.1a.1.1.1.3.3.1.1. Hydrates

*Fougerite



3.1a.1.1.2. Polyanionic

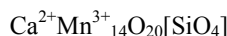
3.1a.1.1.2.1. Proper oxides

3.1a.1.1.2.2. Oxido-silicates

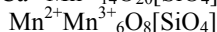
3.1a.1.1.2.2.1. Complex

Braunite family

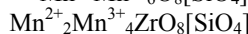
Braunite II



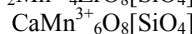
Braunite



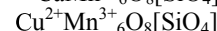
*Gadetalite



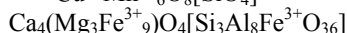
Neltnerite



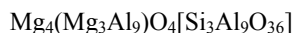
*Abswurbachite



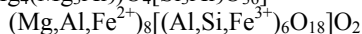
Dorrite

**Sapphirine** family

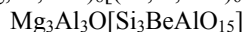
Sapphirine



Sapphirine-1TC, -2M, -4M polytypes



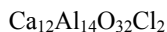
Surinamite



*3.1a.1.1.1.2.1. Hydrates

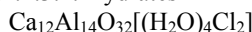
3.1a.1.1.2.3. Oxido-halogenides

*Brearleyite

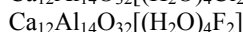


3.1a.1.1.2.3.1. Hydrates

*Kyuygenite = Chlorkyuygenite



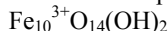
*Fluorkyuygenite



3.1a.1.1.2.4. Hydroxido-oxides

Ferrihydrite

3.1a.1.1.2.4.1. Simple

**Manganite** family

Manganite

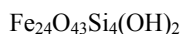


Heterogenite-3R

*Heterogenite-2H*

3.1a.1.1.2.5. Hydroxido-oxido-silicates

*Macaulayite

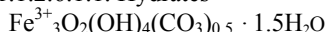


*3.1a.1.1.2.6. Hydroxido-oxido-carboates

*3.1a.1.1.2.6.1. Simple

*3.1a.1.1.2.6.1.1. Hydrates

*Mössbauerite



*3.1a.1.1.2.6.2. Complex

*3.1a.1.1.2.6.2.1. Hydrates

- *Trébeurdenite $\text{Fe}^{2+}_2\text{Fe}^{3+}_4\text{O}_2(\text{OH})_{10}(\text{CO}_3) \cdot 3\text{H}_2\text{O}$
- *3.1a.1.1.2.7. Hydroxido-carbonates
 *Karchevskiyte $\text{Mg}_{18}\text{Al}_9(\text{OH})_{54}\text{Sr}_2[\text{CO}_3]_9(\text{H}_2\text{O})_6(\text{H}_3\text{O})_5$
- *3.1a.1.1.2.8. Hydroxido-oxido-sulfates
 *3.1a.1.1. 2.8.1. Simple *3.1a.1.1. 2.8.1.1. Hydrates
 *Schwertmannite $\text{Fe}_{16}\text{O}_{16}(\text{OH})_{9,6}(\text{SO}_4)_{3,2} \cdot 10\text{H}_2\text{O}$ or \rightarrow
 $\text{Fe}_{16}\text{O}_{16}(\text{OH})_y(\text{SO}_4)_z n\text{H}_2\text{O}$, где $2 \leq z \leq 3,5$; $16-y = 2z$
- 3.1a.1.1.2.9. Hydroxido-oxido-halogenides 3.1a.1.1.2.9.1. Simple
 Zarchikhite $\text{Al}(\text{OH})_2\text{F}$
 *3.1a.1.1. 2.9.1.1. Hydrates
 *Lesukite $\text{Al}_2(\text{OH})_5\text{Cl}2\text{H}_2\text{O}$
- 3.1a.1.1.2.9.2. M^{2+} , M^{3+}
 3.1a.1.1.2.9.2.1. Complex *3.1a.1.1. 2.9.2.1. Hydrates
 Iowaite $\text{Mg}_6\text{Fe}_2^{3+}(\text{OH})_{16}\text{Cl}_2 \cdot 4\text{H}_2\text{O}$
 *Droninoite $\text{Ni}_3\text{Fe}^{3+}(\text{OH})_8\text{Cl}2\text{H}_2\text{O}$
- 3.1a.1.2. Oxides and hydroxides Be^{2+} (all monoanionic)
 3.1a.1.2.1. Proper oxides
 3.1a.1.2.1.1. Simple
 Bromellite BeO
 3.1a.1.2.1.2. Complex
 *Rhodizite $\text{KBe}_4\text{Al}_4(\text{B}_{11}\text{Be})\text{O}_{28}$
 *Londonite $\text{CsBe}_5\text{Al}_4\text{B}_{11}\text{O}_{28}$
 *Byrudite $(\text{Be}, \square)(\text{V}^{3+}, \text{Ti}^{4+})_3\text{O}_6$
- Taaffeite family**
 Taaffeite $\text{Mg}_3\text{Al}_8\text{BeO}_{16}$
 *Magnesiotaaffeite-2N'2S гексаг. $\text{Mg}_3\text{Al}_8\text{BeO}_{16}$
 *Magnesiotaaffeite-6N'3S тригон. $\text{Mg}_2\text{BeAl}_6\text{O}_{12}$
 *Ferrotaaffeit-2N'2S $(\text{Fe}^{2+}, \text{Mg}, \text{Zn})_3\text{Al}_8\text{BeO}_{16}$
 *Ferrotaaffeit-6N'3S $\text{BeFe}_2^{2+}\text{Al}_6\text{O}_{12}$
 Pehrmanite synonym of *Ferrotaaffeit-6N'3S
 Chrysoberyl Al_2BeO_4
 *Maryinskite $\text{Be}(\text{Cr}, \text{Al})_2\text{O}_4$
- 3.1a.1.2.2. Hydroxides
 3.1a.1.2.2.1. Simple
Behoite family
 Behoite $\beta\text{-Be}(\text{OH})_2$
 Clinobehoite $\text{Be}(\text{OH})_2$
- 3.1a.1.3. Oxides and hydroxides of Zn^{2+} , Pb^{2+} , As^{3+} , Sb^{3+} and Sb^{5+} lithophylic paragenetic association of Franclin and Sterling Hill, New Jersey, USA, Langban and Jacobsberg, Sweden.
 3.1a.1.3.1. Minerals of Zn^{2+}
 3.1a.1.3.1.1. Simple
 3.1a.1.3.1.1.1. Neutral

Zincite	(Zn,Mn)O
3.1a.1.3.1.2. Complex	
3.1a.1.3.1.2.1. Neutral	
Franklinite group $({}^4)A({}^6)B_2O_4$; A = Zn ²⁺ , Mn ²⁺ , Fe ²⁺ ; B = Al ³⁺ , Fe ³⁺ , Mn ³⁺	(compare with oxospinelides (family))
Gahnite	ZnAl ₂ O ₄
Franklinite	(Zn,Mn,Fe)(Fe,Mn) ₂ O ₄
Hetaerolite family (?) $({}^4)A({}^6)B_2O_4 \rightarrow H_{3x}AB_{2-x}O_4$; A = Zn ²⁺ ; B ³⁺ = Mn ³⁺	
Hetaerolite	$({}^4)ZnMn_2O_4$
Hydrohetaerolite	HZnMn ³⁺ _{5/3} O ₄
*Cianciulliite	Mn(Mg,Mn)Zn ₂ (OH) ₁₀ ·2·4H ₂ O
3.1a.1.3.2. Minerals of Pb ²⁺	
3.1a.1.3.2.1. Complex	
3.1a.1.3.2.1.1. Neutral	
Plumboferrite	Pb ₂ (Fe ³⁺ ,Mn ²⁺ ,Mg) ₁₁ O ₁₉
Magnetoplumbite	PbFe ₁₂ ³⁺ O ₁₉
(compare with hibonite (group))	
*Ferricoronadite	Pb[Mn ⁴⁺ ₆ (Fe ³⁺ ,Mn ³⁺) ₂]O ₁₆
*Nežilovite	PbZn ₂ (Mn ⁴⁺ ,Ti ⁴⁺) ₂ Fe ³⁺ ₈ O ₁₉
	3.1a.1.3.2.1.2. Oxido-hydroxides
Quenselite	PbMn ³⁺ (OH)O ₂
Hematophanite	Pb ₄ Fe ³⁺ ₃ (OH,Cl)O ₈
3.1a.1.3.3. Minerals of As ³⁺ and Sb ³⁺	
3.1a.1.3.3. Complex	3.1a.1.3.3.1. Neutral
Stenhuggarite	CaFe ³⁺ Sb ³⁺ As ³⁺ ₂ O ₇
Filipstadite	(Mn,Mg) ₄ Fe ³⁺ Sb ⁵⁺ O ₈
(compare with oxospinelides (family.); ₄	
3.1a.1.3.4. Minerals of Sb ⁵⁺	
3.1a.1.3.4.1. Proper oxides	
3.1a.1.3.4.1.1. Complex	3.1a.1.3.4.1.1.1. Neutral
Monimolite	(Pb,Ca) ₃ Sb ⁵⁺ ₂ O ₈ (?)
Melanostibite	Mn ²⁺ ₂ Fe ³⁺ Sb ⁵⁺ O ₆
Ingersonite	Ca ₃ MnSb ⁵⁺ ₄ O ₁₄
Swedenborgite	NaBe ₄ Sb ⁵⁺ O ₇ → ⁽¹²⁾ Na[⁽⁴⁾ Be ₄ O(⁽⁶⁾ Sb ⁵⁺ O ₆)] ^{∞3}
*Rinmanite	Zn ²⁺ ₂ Sb ⁵⁺ ₂ Mg ₂ Fe ³⁺ ₄ O ₁₄ (OH) ₂
3.1a.1.3.4.2. Oxido-silicates	
3.1a.1.3.4.2.1. Complex	3.1a.1.3.4.2.1.1. Neutral
Katoptrite series	
Katoptrite	$({}^6)(Mn^{2+}_5Sb^{5+}_2)_{\Sigma 7}({}^4)(Mn^{2+}_8Al_4Si_2)_{\Sigma 14}O_{28} ^{\infty 2}$
Yeatmanite	$({}^6)(Mn^{2+}_5Sb^{5+}_2)_{\Sigma 7}({}^4)(Mn^{2+}_2Zn_8Si_4)_{\Sigma 14}O_{28} ^{\infty 2}$
*Örebroite	Mn ₆ ²⁺ (Fe ³⁺ ,Sb ⁵⁺) ₂ (SiO ₄) ₂ (O,OH) ₆
3.1a.2. Class: Oxides and hydroxides of <i>f</i> -cations low FC of 4-valence <i>f</i> -cations	
3.1a.2.1.1. Proper oxides	
3.1a.2.1.1.1. Monoanionic	
3.1a.2.1.1.1.1. Neutral	

Uraninite group

Uraninite	UO ₂
Thorianite	ThO ₂
Cerianite-(Ce)	(Ce,Th)O ₂

3.1a.2.1.1.2. Polyanionic oxides (peroxides)

3.1a.2.1.1.2.1. Hydrates

Studtite family

Studtite	UO ₄ ·2H ₂ O → U[O ₂] ₂ ·2H ₂ O
Metastudtite	UO ₄ ·2H ₂ O → U[O ₂] ₂ ·2H ₂ O

3.1a.3. **Class:** Oxides and hydroxides of *f*-cations with middle FC – 6-valence *f*-cations (U⁶⁺) → compounds uranyl (UO₂)²⁺ – k. uranyl acids, uranates and their derivatives (uranium micas and related minerals)

3.1a.3.1. Uranyl acids and uranates

3.1a.3.1.1. Uranyl acids (hydrates of uranyl hydroxides)

*Paulscherrite	UO ₂ (OH) ₂
Paraschoepite	UO ₃ ·2H ₂ O

Schoepite family

Schoepite	[(UO ₂) ₈ O ₂ (OH) ₁₂] ^{∞2} ·(H ₂ O) ₁₂
Metaschoepite	[(UO ₂) ₈ O ₂ (OH) ₁₂] ^{∞2} ·(H ₂ O) ₁₀

3.1a.3.1.2. Uranates

3.1a.3.1.2.1. Basic

*Vorlanite	CaU ⁶⁺ O ₄
Metacalcicouranoite	[(UO ₂) ₂ O ₂ (OH) ₂] ^{∞2} (Ca,Na ₂ ,Ba)

3.1a.3.1.2.2. Hydrates

3.1a.3.1.2.2.1. Oxides-hydroxides

Ianthinite	[(UO ₂) ₄ O ₆ (OH) ₄] ^{∞2} U ⁴⁺ ₂ ·9H ₂ O
Vandendriesscheite family (y = 7)	y = UO ₂ : Me ²⁺

Vandendriesscheite	[(UO ₂) ₁₀ O ₆ (OH) ₁₁] ^{∞2} Pb _{1.5} ·11H ₂ O
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Metavandendriesscheite	[(UO ₂) ₇ O ₂ (OH) ₁₂] ^{∞2} Pb·nH ₂ O
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Becquerelite family (y = 6) Ba(UO₂)₆O₄(OH)₆ · 8H₂O

Vandenbrandeite	[(UO ₂) ₂ (OH) ₈] ^{∞2} Cu ₂
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Becquerelite	[(UO ₂) ₆ O ₄ (OH) ₆] ^{∞2} Ca(H ₂ O) ₄ ·4H ₂ O
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Billietite	[(UO ₂) ₆ O ₄ (OH) ₆] ^{∞2} Ba(H ₂ O) ₇ ·7H ₂ O
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Compreignacite	[(UO ₂) ₆ O ₄ (OH) ₆] ^{∞2} K ₂ ·7H ₂ O
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Fourmarierite family (y = 4) PbO (UO₂)₄(OH)_{4+2x} · 4H₂O

Fourmarierite	[(UO ₂) ₄ O _{3-2x} (OH) _{4+2x}] ^{∞2} Pb _{1-x} ·4H ₂ O or
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	[(UO ₂) ₄ O ₃ (OH) ₄] ^{∞2} Pb·4H ₂ O
--	--

	[(UO ₂) ₃₆ O ₃₆ (OH) ₂₄] ^{∞2} (Fe ³⁺ ,Mg) _x Pb ²⁺ _{8.6} ·41H ₂ O
--	--

Richetite

Agrinierite family	
Agrinierite (y = 3)	[(UO ₂) ₃ O ₃ (OH) ₂](K ₂ ,Ca,Sr)·H ₂ O

Protasit (y = 3)	[(UO ₂) ₃ O ₃ (OH) ₂] ^{∞2} Ba(H ₂ O) ₃
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Rameauite (y=1.5)	[(UO ₂) ₃ O ₃ (OH) ₂] ^{∞2} K ₂ Ca·6H ₂ O
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Curite family

Curite (y = 2.(6))	[(UO ₂) ₄ O _{4+x} (OH) _{3-x}] ^{∞2} Pb _{3+x} (H ₂ O) ₂
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Sayrite (y = 2.5)	[(UO ₂) ₅ O ₆ (OH) ₂] ^{∞2} Pb ₂ ·4H ₂ O
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*Spriggite (y = 2)	[(UO ₂) ₆ O ₈ (OH) ₂] ^{∞2} Pb ₃ ·3H ₂ O
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Masuyite (y=1.75)	[(UO ₂) ₃ O ₃ (OH) ₂] ^{∞2} Pb(H ₂ O) ₃
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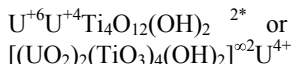
Clarkeite family ($y = 2$)

Wölsendorfite	$[(\text{UO}_2)_{14}\text{O}_{19}(\text{OH})_4]^{2+} \text{Pb}_7 \cdot 12\text{H}_2\text{O}$
Calciouranoite	$[(\text{UO}_2)_2\text{O}_2(\text{OH})_2]^{2+} (\text{Ca}, \text{Ba}, \text{Pb}, \text{K}, \text{Na}) \cdot 4\text{H}_2\text{O}$ ^{1*}
Bauranoite	$[(\text{UO}_2)_2\text{O}_2(\text{OH})_2]^{2+} \text{Ba} \cdot 4\text{H}_2\text{O}$
Clarkeite	$[(\text{UO}_2)_2\text{O}_2(\text{OH})_2]^{2+} (\text{Na}, \text{K}, \text{Ca}, \text{Pb}) \cdot n\text{H}_2\text{O}$
Uranosphærite ($y = 0.6$)	$[(\text{UO}_2)\text{O}_2(\text{OH})]^{2+} \text{Bi}$

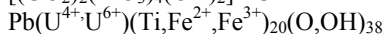
3.1a.3.2. Uranilo-titanates

3.1a.3.2.1. Basic

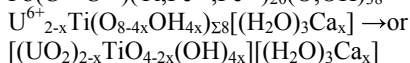
Orthobrannerite



*Cleusonite

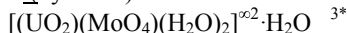


*Holfertite

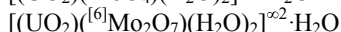


3.1a.3.3a. Uranilo-molybdenic acids (hydrates)

*Umohoite



Iriginite

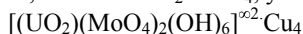


3.1a.3.3b. Uranilo-molybdates

3.1a.3.3b.1. Basic → acid

Deloryite group ($x = 0.5$; $y = 0.25$, where $x = \text{UO}_2 : \text{MoO}_4$, $y = \text{UO}_2 : \text{Me}^{2+}$)

Deloryite



3.1a.3.3b.1.1. Hydrates

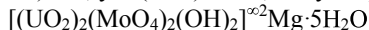
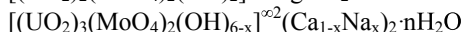
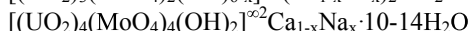
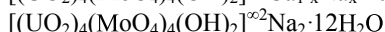
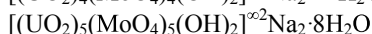
3.1a.3.3b.1.1.1. Basic → acid

Moluranite group ($x = 0.43$; $y = 1,5$)

Moluranite



Urmolite family ($x = (\text{UO}_2) : (\text{MoO}_4) = 1$; $y = (\text{UO}_2) : \text{M}^{2+}$; $2 \leq y \leq 5$)

Cousinite ($y = 2$)Calcurmolite ($y = 3$)* Unnamed 1 ($y = 4$)Unnamed 2 ($y = 4$)Naturmolite ^{4**} ($y = 5$)

Uranotungstite group ($x = 2$; $y = 2$)

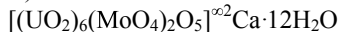
Uranotungstite



3.1a.3.3b.1.1.2. Neutral

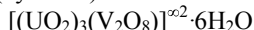
Tengchongite group ($x = 3$; $y = 6$)

Tengchongite

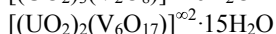


3.1a.3.4a. Uranylo-vanadic acids (hydrates)

Ferganite



Uvanite



3.1a.3.4b. Uranyl-polyvanadates

3.1a.3.4b.1. Hydrates

3.1a.3.4b.1.1. Neutral

^{1*} The structure formula is given by analogy with bauranoite.

^{2*} Metamict; the crystal structure formula is assigned from morphology and crystallochemical consideration.

^{3*} Initial formula has been changed by putting out the $(\text{MoO}_4)^{2-}$ radical.

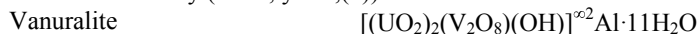
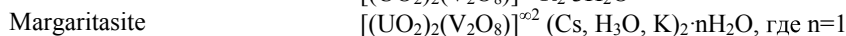
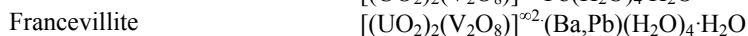
^{4*} The name does not approved by the CNMNM IMA and is used after G. A. Sidorenko.

Rauvite group (x = 0.2; y = 2)

3.1a.3.4c. Uranylo-(5)-vanadates

3.1a.3.4c.1. Hydrates

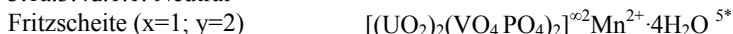
3.1a.3.4c.1.1. Basic

Vanuralite family (x = 1; y = 1,(3))**Tyuyamunite** family**Carnotite** family (x = 1; y = 2)**Curienite** family (x = 1; y = 2)

3.1a.3.4d. Uranylo-(4)-vanadates

3.1a.3.4d.1. Hydrates

3.1a.3.4d.1.1. Neutral



3.1a.3.5a. Uranylo-telluric acids_(anhydrous)



3.1a.3.5b. Uranylo-tellurites

3.1a.3.5b.1. Neutral



3.1a.3.6a. Uranylo-silica acids_(hydrates)

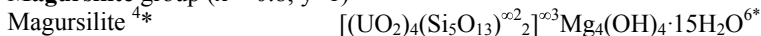


3.1a.3.6b. Uranylo-silicates

3.1a.3.6b.1. Uranylo-mono-disilicates (κ = 1.2)

3.1a.3.6b.1.1. Hydrates

3.1a.3.6b.1.1.1. Basic

Magursilite group (x = 0.8; y=1)

^{5*} The structure formula is assigned from morphology and crystallochemical consideration of synthetic phase. There is no chemical analyses for original mineral.

^{6*} The structure formula is assigned by A. A. Godovikov from physical properties, initial chemical analysis and crystallochemical consideration.

Ursilite (Calciumursilite) ^{7*}	$[(\text{UO}_2)_4(\text{Si}_5\text{O}_{13})_2]^{x2} \text{Ca}_4(\text{OH})_4 \cdot 15\text{H}_2\text{O}$ ^{6*}
Calcioursilite	$[(\text{UO}_2)_4(\text{Si}_2\text{O}_5)_5]\text{Ca}_4(\text{OH})_6 \cdot 15\text{H}_2\text{O}$
3.1a.3.6b.1.1.2. Neutral	
Weeksite family (x = 0.8; y = 2)	
Haiweeite group	
Metahaiweeite	$[(\text{UO}_2)_2(\text{Si}_5\text{O}_{13})_2]^{x2} \text{Ca} \cdot n\text{H}_2\text{O}$ ^{8*}
Haiweeite	$[(\text{UO}_2)_2\text{Si}_5\text{O}_{12}(\text{OH})_2]\text{Ca} \cdot 6\text{H}_2\text{O}$
Weeksite	$[(\text{UO}_2)_2(\text{Si}_5\text{O}_{13})_2]^{x2} (\text{K}, \text{Na})_2(\text{H}_2\text{O})_4$
*Coutinhoite	$[(\text{UO}_2)_2(\text{Si}_5\text{O}_{13})]\text{Th}_x\text{Ba}_{1-2x} \cdot 3\text{H}_2\text{O}$
*3.1a.3.6b.2. Uranylo-disilicates	
*3.1a.3.6b.2.1. Hydrates	
*Carlosbarbosaite	$[(\text{UO}_2)_2(\text{Nb}^{5+}\text{Si})\text{O}_6(\text{OH})_2]\text{Ca}_{0.5}\square_{0.5} \cdot 2\text{H}_2\text{O}$
3.1a.3.6b.2. Uranylo-tetrasilicates	
3.1a.3.6b.2.1. Hydrates	
3.1a.3.6b.2.1.1. Neutral	
Kasolite group (x = 1; y = 1)	
Oursinite	$(\text{UO}_2)_2(\text{SiO}_3\text{OH})_2]^{x2} (\text{Co}, \text{Mg}) \cdot 6\text{H}_2\text{O}$
Kasolite	$[(\text{UO}_2)(\text{SiO}_4)]^{x2} \text{Pb}(\text{H}_2\text{O})$
3.1a.3.6b.2.1.2. Acid	
Swamböite group (x = 1; y = 2)	
Swamböite	$[(\text{UO}_2)_6(\text{SiO}_3\text{OH})_6]^{x2} \text{U}^{6+} \cdot 30\text{H}_2\text{O}$
Sklodowskite family (x = 1; y = 2)	
Sklodowskite	$[(\text{UO}_2)_2(\text{SiO}_4\text{H})_2]^{x2} \text{Mg}(\text{H}_2\text{O})_4 \cdot 2\text{H}_2\text{O}$
Cuprosklodowskite	$[(\text{UO}_2)_2(\text{SiO}_3\text{OH})_2]^{x2} \text{Cu}(\text{H}_2\text{O})_4 \cdot 2\text{H}_2\text{O}$
Uranophane	$[(\text{UO}_2)_2(\text{SiO}_3\text{OH})_2]^{x2} \text{Ca}(\text{H}_2\text{O})_4 \cdot \text{H}_2\text{O}$
Beta-uranophane	$[(\text{UO}_2)_2(\text{SiO}_3\text{OH})_2]^{x2} \text{Ca}(\text{H}_2\text{O})_4 \cdot \text{H}_2\text{O}$
*Uranophane mon.	$[(\text{UO}_2)_2(\text{SiO}_3\text{OH})_2]^{x2} \text{Ca}(\text{H}_2\text{O})_4 \cdot \text{H}_2\text{O}$
Sodium boltwoodite	$[(\text{UO}_2)(\text{SiO}_3\text{OH})]^{x2} (\text{Na}, \text{K})(\text{H}_2\text{O})$
Boltwoodite	$[(\text{UO}_2)(\text{SiO}_3\text{OH})]^{x2} \text{K}(\text{H}_2\text{O})$
3.1a.3.7a. Uranylo-phosphoric acids (hydrates)	
Vanmeersscheite family (x = 1.5; y = 1.5)	
Vanmeersscheite	$[(\text{UO}_2)_3(\text{PO}_4)_2]\text{U}(\text{OH})_6 \cdot 4\text{H}_2\text{O}$
Metavanmeersscheite	$[(\text{UO}_2)_3(\text{PO}_4)_2]\text{U}(\text{OH})_6 \cdot 2\text{H}_2\text{O}$
3.1a.3.7b. Uranylo-phosphates	
3.1a.3.7b.1. Uranylo-phosphates f-cations	
3.1a.3.7b.1.1. Basic	
Althupite (x = 1.75; y = 2)	$[(\text{UO}_2)_7\text{O}_2(\text{OH})_5(\text{PO}_4)_4]\text{AlTh} \cdot 15\text{H}_2\text{O}$
3.1a.3.7b.1.2. Hydrates	
3.1a.3.7b.1.2.1. Basic (x = 1.5; y = 2)	
Francoisite-(Nd)	$[(\text{UO}_2)_3\text{O}(\text{OH})(\text{PO}_4)_2]^{x2} \text{Nd} \cdot 6\text{H}_2\text{O}$
*Francoisite-(Ce)	$[(\text{UO}_2)_3\text{O}(\text{OH})(\text{PO}_4)_2]^{x2} \text{Ce} \cdot 6\text{H}_2\text{O}$

^{7*} The name does not approved by the CNMNM IMA and is used after A. A. Chernikov.

^{8*} The structure formula is assigned from morphology which is close to morphology of weeksite, initial chemical analysis and crystallochemical consideration.

3.1a.3.7b.2. Uranylo-phosphates *s*-, *d*_s- и *p*_s-cations3.1a.3.7b.2.1. Actually uranylo-phosphates ($x = \text{UO}_2 : \text{PO}_4$, $y = \text{UO}_2 : \text{Me}^{2+}$)

3.1a.3.7b.2.1.1. Hydrates

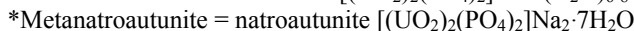
3.1a.3.7b.2.1.1.1. Basic

Kamitugaite ($x = 2.5$; $y = 2$) $[(\text{UO}_2)_5(\text{P,AsO}_4)_2(\text{OH})_9]^{+2}\text{PbAl}\cdot 9\cdot 5\text{H}_2\text{O}$ Renardite ($x = 2$; $y = 2$) $[(\text{UO}_2)_2(\text{PO}_4)(\text{OH})_2]^{+2}\text{Pb}\cdot 7\text{H}_2\text{O}$ **Mundite** familyMundite ($x = 1.5$; $y = 2$) $[(\text{UO}_2)_3\text{O}(\text{OH})(\text{PO}_4)_2]^{+2}\text{Al}\cdot 6\cdot 5\text{H}_2\text{O}$ Upalite ($x = 1.5$; $y = 2$) $[(\text{UO}_2)_3\text{O}(\text{OH})(\text{PO}_4)_2]^{+2}\text{Al}(\text{H}_2\text{O})_5\cdot 2\text{H}_2\text{O}$ **Dumontite** family**Dumontite** group ($x = 1.5$; $y = 1.5$)Phurcalite $[(\text{UO}_2)_3\text{O}_2(\text{PO}_4)_2]^{+2}\text{Ca}_2(\text{H}_2\text{O})_7$ Dumontite $[(\text{UO}_2)_3\text{O}_2(\text{PO}_4)_2]^{+2}\text{Pb}_2(\text{H}_2\text{O})_5$ Bergenite $[(\text{UO}_2)_3\text{O}_2(\text{PO}_4)_2]^{+2}(\text{Ba}_{1.33}\text{Ca}_{0.67})_2\cdot 16\text{H}_2\text{O}$ (Ba: Ca=2)**Dewindite** group ($x = 1.5$; $y = 1$)Dewindite $[\text{H}(\text{UO}_2)_3(\text{PO}_4)_2\text{O}_2]^{+2}\text{Pb}_3(\text{H}_2\text{O})_9\cdot 3\text{H}_2\text{O}$ **Phosphuranylite** familyPhosphuranylite ($x = 1.75$; $y = 2$.(3)) $\{[(\text{UO}_2)_3(\text{PO}_4)_2\text{O}_2]^{+2}(\text{UO}_2)\}^{+3}(\text{H}_3\text{O})_3\text{KCa}(\text{H}_2\text{O})_8$ Yingjiangite ($x = 1.75$; $y = 3.5$) $[(\text{UO}_2)_7(\text{PO}_4)_4(\text{OH})_6]\text{K}_2\text{Ca}\cdot 6\text{H}_2\text{O}$ Threadgoldite ($x=1$; $y = 1$.(3)) $[\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Al}(\text{OH})(\text{H}_2\text{O})_4\cdot 4\text{H}_2\text{O}$ Phuralumite ($x = 1.5$; $y = 1$) $[(\text{UO}_2)_3\text{O}(\text{OH})(\text{PO}_4)_2]^{+2}\text{Al}_2(\text{OH})_3\cdot 11\text{H}_2\text{O}$ Triangulite ($x = 1$; $y = 0$.(8)) $[(\text{UO}_2)_4(\text{PO}_4)_4(\text{OH})_5]^{+2}\text{Al}_3\cdot 5\text{H}_2\text{O}$ Vochtenite ($x = 1$; $y = 1.6$) $[(\text{UO}_2)_4(\text{PO}_4)_4(\text{OH})]^{+2}(\text{Fe,Mg})\text{Fe}^{3+}\cdot (12-13)\text{H}_2\text{O}$ *Lakebogaitite ($x = 0.5$; $y = 0.4$) $[(\text{UO}_2)_2(\text{PO}_4)_4(\text{OH})_2]\text{CaNaFe}^{3+}_2\text{H}\cdot 8\text{H}_2\text{O}$ Moreauite ($x = 0$.(3); $y = 0$.(2)) $[(\text{UO}_2)(\text{PO}_4)_2]^{+2}\text{Al}_3(\text{PO}_4)(\text{OH})_2\cdot 13\text{H}_2\text{O}$ Ranunculite ($x = 1$; $y = 0.5$) $[(\text{UO}_2)(\text{PO}_4)]^{+2}\text{HAl}(\text{OH})_3\cdot 4\text{H}_2\text{O}$ Furongite ($x = 1$; $y = 0$.(3)) $[(\text{UO}_2)_7(\text{PO}_4)_{13}]^{+2}\text{Al}_{13}(\text{OH})_{14}\cdot 58\text{H}_2\text{O}$

3.1a.3.7b.2.1.1.2. Neutral

Torbernite family ($y = 2$)**Torbernite** group α -Torbernite (tetrag.) $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Cu}(\text{H}_2\text{O})_4\cdot 8\text{H}_2\text{O}$ β -Torbernite (tricl.) $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Cu}(\text{H}_2\text{O})_4\cdot 8\text{H}_2\text{O}$ *Metasaleeite $[(\text{UO}_2)_2(\text{PO}_4)_2]\text{Mg}\cdot 8\text{H}_2\text{O}$ Saleeite $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Mg}(\text{H}_2\text{O})_4\cdot 6\text{H}_2\text{O}$ Autunite $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Ca}\cdot 11\text{H}_2\text{O}$ *Uranospatite $[(\text{UO}_2)(\text{PO}_4)_2]\text{Al}_{1-x}\square_x(\text{H}_2\text{O})_{20+3x}\text{F}_{1-x}$, $0 < x < 0,33$ **Metatorbernite** groupMetatorbernite $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Cu}(\text{H}_2\text{O})_8$ **Przhevalskite** groupPrzhevalskite $[(\text{UO}_2)(\text{PO}_4)]^{+2}\text{Pb}\cdot 4\text{H}_2\text{O}$ **Sabugalite** family ($y = 2$)Sabugalite $[(\text{UO}_2)_4(\text{PO}_4)_4]^{+2}\text{HAl}(\text{H}_2\text{O})_4\cdot 8\text{H}_2\text{O}$ Bassetite $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Fe}^{2+}(\text{H}_2\text{O})_4(\text{H}_2\text{O})_4$ Lehnerite $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Mn}^{2+}(\text{H}_2\text{O})_4(\text{H}_2\text{O})_4$ Meta-uranocircite I $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Ba}(\text{H}_2\text{O})_8$ Meta-uranocircite II $[(\text{UO}_2)_2(\text{PO}_4)_2]^{+2}\text{Ba}(\text{H}_2\text{O})_6$

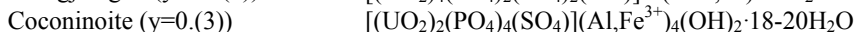
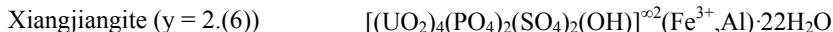
(synthetic phase)

Uranocircite group**Meta-autunite** group**Parsonsite** family ($y = 0.5$)

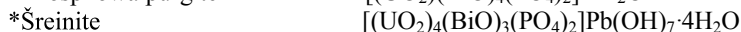
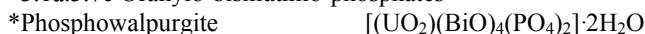
3.1a.3.7b.2.2. Uranylo-phosphato-sulfates

3.1a.3.7b.2.2.1. Hydrates

3.1a.3.7b.2.2.1.1. Basic



*3.1a.3.7c Uranylo-bismuthilo-phosphates



3.1a.3.8a. Uranylo-arsenic acids



3.1a.3.8b. Uranylo-arsenates

3.1a.3.8b.1. Neutral

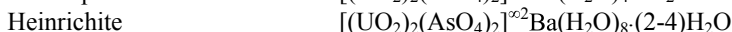
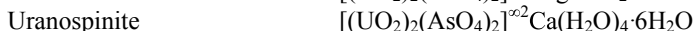
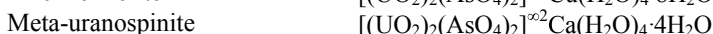
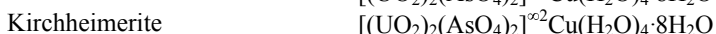
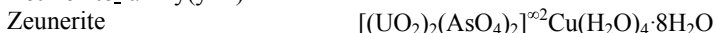


3.1a.3.8b.2. Hydrates

3.1a.3.8b.2.1. Basic



3.1a.3.8b.2.2. Neutral

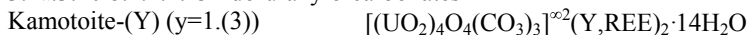
**Uranospinite** family ($y = 2;$)**Novacekite** group**Zeunerite** family ($y=2$)^{9*} The structure formula is assigned on the analogy of dumontite.

Metalodevite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Zn}(\text{H}_2\text{O})_4 \cdot 6\text{H}_2\text{O}$
Metaheinrichite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Ba}(\text{H}_2\text{O})_8$
Metazeunerite family (y=2)	
Metazeunerite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Cu}(\text{H}_2\text{O})_4 \cdot 4\text{H}_2\text{O}$ or $[(\text{UO}_2)(\text{AsO}_4)]^{+2}_2\text{Cu}(\text{H}_2\text{O})_8$
Novacekite-I	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Mg}(\text{H}_2\text{O})_4 \cdot 8\text{H}_2\text{O}$
Metanováčekite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Mg}(\text{H}_2\text{O})_4 \cdot 2 \cdot 4\text{H}_2\text{O}$
Kahlerite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Fe}^{2+}(\text{H}_2\text{O})_4 \cdot 8\text{H}_2\text{O}$
*Metarauchite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]\text{Ni} \cdot 8\text{H}_2\text{O}$
*Rauchite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]\text{Ni} \cdot 10\text{H}_2\text{O}$
Arsenuranospathite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]\text{AlF} \cdot 20\text{H}_2\text{O}$
Abernathyite family (y=2)	
Metakirchheimerite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Co}(\text{H}_2\text{O})_4 \cdot 4\text{H}_2\text{O}$
Metakahlerite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}\text{Fe}^{2+}(\text{H}_2\text{O})_4 \cdot 4\text{H}_2\text{O}$
Sodium uranospinite	$[(\text{UO}_2)_2(\text{AsO}_4)_2]^{+2}(\text{Na}_2, \text{Ca})(\text{H}_2\text{O})_4 \cdot 6\text{H}_2\text{O}$
Abernathyite	$[(\text{UO}_2)(\text{AsO}_4)]^{+2}\text{K}(\text{H}_2\text{O})_3$
*Nielsbohrite	$[(\text{UO}_2)_3(\text{AsO}_4)]\text{K}(\text{OH})_4 \cdot \text{H}_2\text{O}$
H-metauranospinite	$[(\text{UO}_2)(\text{AsO}_4)]^{+2}(\text{H}_3\text{O})(\text{H}_2\text{O})_3$
*3.1a.3.8b. Uranylo-arsenato-arsenites	
*3.1a.3.8b.1. Hydrates	
*Seelite	$[(\text{UO}_2)(\text{AsO}_3)_x(\text{AsO}_4)_{1-x}]^{+2}_2\text{Mg} \cdot 7\text{H}_2\text{O}$ (x = ~ 0,7)
*3.1a.3.8r. Uranylo-arsenous acids	
*Chadwikite	$(\text{UO}_2)\text{H}(\text{AsO}_3)$
*3.1a.3.8r.1. Hydrates	
*Mineral D	$(\text{UO}_2)\text{H}(\text{AsO}_3) \cdot \text{H}_2\text{O}$
*Štěpíte	$(\text{UO}_2)\text{H}_2(\text{AsO}_3)_2 \cdot 4\text{H}_2\text{O}$
*3.1a.3.8d. Uranylo-arsenites	
*3.1a.3.8d.1. Hydrates	
*Dymkovite	$[(\text{UO}_2)_2(\text{As}^{3+}\text{O}_3)_2]\text{Ni} \cdot 7\text{H}_2\text{O}$
3.1a.3.9a. Uranylo-bismuthilo-arsenic acids (hydrates)	
Walpurgite	$[(\text{UO}_2)(\text{BiO})_4(\text{AsO}_4)_2]^{+2} \cdot 2\text{H}_2\text{O}$
3.1a.3.9b. Uranylo-bismuthilo-arsenates	
3.1a.3.9b.1. Hydrates	
3.1a.3.9b.1.1. Basic	
Asselbornite (y=4)	$[(\text{UO}_2)_4(\text{BiO})_3(\text{AsO}_4)_2]\text{Pb}(\text{OH})_7 \cdot 4\text{H}_2\text{O}$
3.1a.3.10a. Uranylo-carbonic acids	
Rutherfordine family	
Rutherfordine	$[(\text{UO}_2)(\text{CO}_3)]^{+2}$
*Blatonite	$[(\text{UO}_2)(\text{CO}_3)]^{+2} \cdot \text{H}_2\text{O}$
Joliotite	$[(\text{UO}_2)(\text{CO}_3)]^{+2} \cdot 1,5 \cdot 2\text{H}_2\text{O}$
*Oswaldpeetersite	$(\text{UO}_2)_2(\text{CO}_3)(\text{OH})_2 \cdot 4\text{H}_2\text{O}$
3.1a.3.10 b. Uranylo-carbonates	

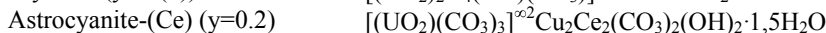
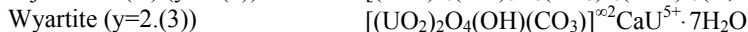
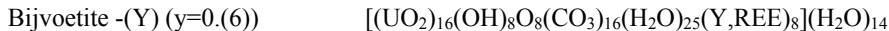
3.1a.3.10 b.1. Uranylo-carbonates f-cations

3.1a.3.10 b.1.1. Hydrates

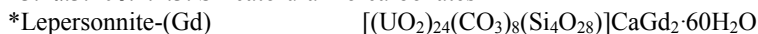
3.1a.3.10 b.1.1.1. Oxido-uranylo-carbonates



3.1a.3.10 b.1.1.2. Basic



*3.1a.3.106.1.1.3. Silicato-uranilo-carbonates

3.1a.3.10 b.2. Uranylo-carbonates s-, d_s- и p_s-cations

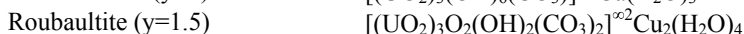
3.1a.3.10 b.2.1. Actually uranilo-carbonates

3.1a.3.10 b.2.1.1. Neutral

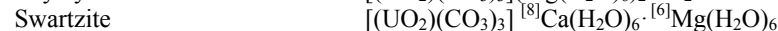
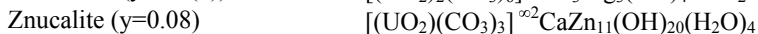
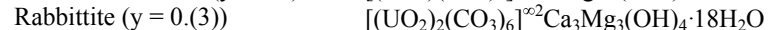
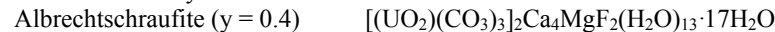


3.1a.3.10 b.2.1.2. Hydrates

3.1a.3.10 b.2.1.2.1. Basic

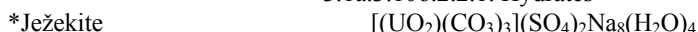


3.1a.3.10 b.2.1.2.2. Neutral

Zellerite family (y = 1)**Liebigite** family (y = 0.5)**Rabbittite** family

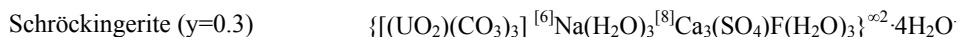
*3.1a.3.106.2.2. Uranylo-carbonato-sulfates

*3.1a.3.106.2.2.1. Hydrates



3.1a.3.10 b.2.3. Uranylo-carbonato + sulfato-fluorides

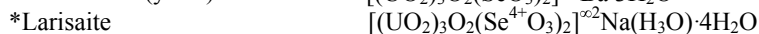
3.1a.3.10 b.2.3.1. Neutral



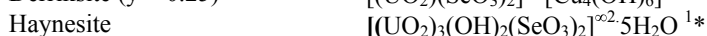
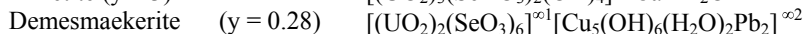
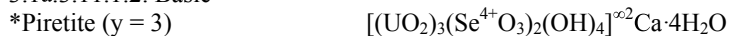
3.1a.3.11. Uranylo-selenites

3.1a.3.11.1. Hydrates

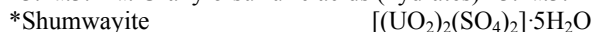
3.1a.3.11.1.1. Basic



3.1a.3.11.1.2. Basic



*3.1a.3.12a. Uranylo-sulfuric acids (hydrates) *3.1a.3.12a.1. Neutral



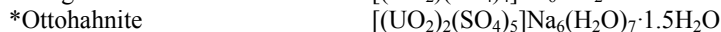
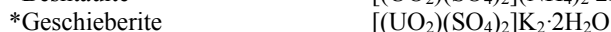
*3.1a.3.12a.2. Basic



*3.1a.3.12b. Uranylo-sulfates

*3.1a.3.12b.1. Uranylo-sulfates *s*-, *d_s*-, *u p_s*-cations

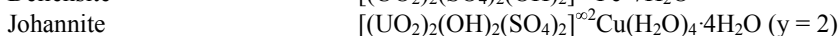
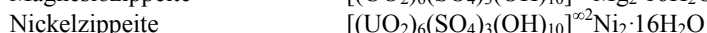
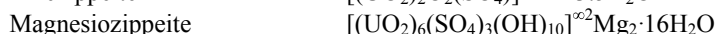
*3.1a.3.12b.1.1. Neutral *3.1a.3.12b.1.1.1. Hydrates



*3.1a.3.12b.1.1.1.1. Basic



*3.1a.3.12b.1.1.1.1.1. Hydrates

Metauranopilite**Nickel-zippeite group** ($y = 3$)*3.1a.3.12b.2. Oxido-uranylo-sulfates *s*-, *d_s*-, *u p_s*-cations

*3.1a.3.12b.2.1. Hydrates

Zippeite group

Sodium zippeite (y = 1,5)	$[(\text{UO}_2)_8\text{O}_5(\text{SO}_4)_4]\text{Na}_5(\text{OH})_3 \cdot 12\text{H}_2\text{O}$
Zippeite (y = 1,5)	$[(\text{UO}_2)_4\text{O}_3(\text{SO}_4)_2]\text{K}_3(\text{OH}) \cdot 3\text{H}_2\text{O}$
Cobaltzippeite	$[(\text{UO}_2)_2\text{O}_2(\text{SO}_4)]\text{Co} \cdot 3.5\text{H}_2\text{O}$
*Plavnoite	$[(\text{UO}_2)_2\text{O}_2(\text{SO}_4)]\text{K}_{0.8}\text{Mn}_{0.6} \cdot 3.5\text{H}_2\text{O}$
*Pseudojohannite (y = 1,2)	$[(\text{UO}_2)_4\text{O}_4(\text{SO}_4)_2(\text{OH})_2]\text{Cu}_3 \cdot 12\text{H}_2\text{O}$
Uranopilite	$[(\text{UO}_2)_6(\text{SO}_4)\text{O}_2(\text{OH})_6(\text{H}_2\text{O})_6]^{20} \cdot (\text{H}_2\text{O})_8$
*Marécottite	$[(\text{UO}_2)_8\text{O}_6(\text{SO}_4)_4]\text{Mg}_3(\text{OH})_2 \cdot 28\text{H}_2\text{O}$

*3.1a.3.126.3. Uranylo-sulfato-sulfites

*3.1a.3.126.3.1. Basic	*3.1a.3.126.3.1.1. Hydrates
*Meisserite	$[(\text{UO}_2)(\text{SO}_4)_3(\text{SO}_3\text{OH})]\text{Na}_5(\text{H}_2\text{O})$
*Belakovskiite	$[(\text{UO}_2)(\text{SO}_4)_4(\text{SO}_3\text{OH})]\text{Na}_7(\text{H}_2\text{O})_3$

*3.1a.3.126.4. Uranylo-sulfato-chlorides *3.1a.3.126.4. 1. Hydrates

*Bluelizardite	$[(\text{UO}_2)(\text{SO}_4)_4]\text{Na}_7\text{Cl}(\text{H}_2\text{O})_2$
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*3.1a.3.126.3. Uranylo-sulfates *f*-cations

*3.1a.3.12.1.3. Basic	*3.1a.3.12.1.3.1. Hydrates
*Sejkoraite-(Y)	$[(\text{UO}_2)_8\text{O}_6(\text{SO}_4)_4(\text{OH})_2]\text{Y}_2 \cdot 26\text{H}_2\text{O}$

3.1b. QUASISUBTIPE AND HYDROXIDES LITHOPHYLIC CATION WITH MIDDLE FC

3.1b.1. **Overclass***: Oxides of Zr3.1b.1a. **Class**: Simple oxides of Zr

3.1b.1a.1. Neutral

Baddeleyite family

Baddeleyite	ZrO_2
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3.1b.1b. **Class**: Complex oxides of Zr^{4+} → titanates of Zr^{4+} → zirconotitanates

3.1b.1b.1. Neutral

*Lakargiite	$\text{Ca}(\text{Zr}, \text{Ti}, \text{Sn})\text{O}_3$ или CaZrO_3
Srilankite	ZrTi_2O_6
*Zirconolite-2M	$\text{CaZrTi}_2\text{O}_7$
*Zirconolite-3O	$\text{CaZrTi}_2\text{O}_7$
*Zirconolite-3T	$\text{CaZrTi}_2\text{O}_7$
Tazheranite	$\text{Ca}_2\text{Zr}_5\text{Ti}_2\text{O}_{16}$
Calzirtite	$\text{Ca}_2\text{Zr}_5\text{Ti}_2\text{O}_{16} \rightarrow ({}^8\text{Ca}({}^8)(\text{CaZr})_{\Sigma 2}({}^7)\text{Zr}_4({}^6)\text{Ti}_2\text{O}_{16}$
*Calzirtite orth.	$\text{Ca}_2\text{Zr}_5\text{Ti}_2\text{O}_{16}$
*Härneite	$(\text{Ca}, \text{Mn}^{2+}, \text{Na})_2(\text{Zr}, \text{Mn}^{3+})_5(\text{Sb}^{5+}, \text{Ti}, \text{Fe}^{3+})_2\text{O}_{16}$
Zirkelite	$(\text{Ti}, \text{Ca}, \text{Zr})\text{O}_{2-x}$
*Laachite	$(\text{Ca}, \text{Mn})_2\text{Zr}_2\text{Nb}_2\text{TiFeO}_{14}$
*Elbrusite-(Zr)	$\text{Ca}_3(\text{Zr}_{1.5}\text{U}_{0.5}^{6+})\text{Fe}_3^{3+}\text{O}_{12}$
*Polymignite	$(\text{Ca}, \text{Fe}, \text{Y}, \text{Th})(\text{Nb}, \text{Ti}, \text{Ta}, \text{Zr})\text{O}_4$
*Unnamed	$(\text{Gd}, \text{Ce}, \text{Ca}, \text{La}, \text{U})_4\text{ZrTi}_2\text{O}_{12}$
*3.1b.1b.1.1. Hydrates	
*Menesezite	$\text{Ba}_2\text{MgZr}_4(\text{BaNb}_{12}\text{O}_{42}) \cdot 12\text{H}_2\text{O}$
*Allendeite	$\text{Sc}_4\text{Zr}_3\text{O}_{12}$

3.1b.2. **Overclass***: Oxides of Sn^{4+} and Ti^{4+} 3.1b.2a. **Class**: Simple oxides and hydroxides of Sn^{4+} and Ti^{4+} 3.1b.2a.1. Oxides of Sn^{4+} 3.1b.2a.1.1. Neutral

Cassiterite	SnO ₂
3.1b.2a.2. Hydroxides of Sn ⁴⁺	
3.1b.2a.2.1. Simple	3.1b.2a.2.1.1. Oxido-hydroxides
Varlamoffite	(Sn,Fe) ²⁺ (O,OH) ₂
3.1b.2a.2.2. Complex (hydrostannates)	
Schoenfliesite	3.1b.2a.2.2.1. Neutral
Stottite group	Mg[Sn ⁴⁺ (OH) ₆]
Jeanbandyite	(Fe ³⁺ ,Mn ²⁺)[Sn ⁴⁺ (OH, O) ₆]
Tetrawickmanite	Mn ²⁺ [Sn ⁴⁺ (OH) ₆]
Stottite	Fe ²⁺ [Ge ⁴⁺ (OH) ₆]
Wickmanite group	
Vismirnovite	Zn[Sn ⁴⁺ (OH) ₆]
Mushistonite	(Cu,Zn,Fe)[Sn ⁴⁺ (OH) ₆]
Natanite	Fe ²⁺ [Sn ⁴⁺ (OH) ₆]
Wickmanite	(Mn,Ca)[Sn ⁴⁺ (OH) ₆]
Burtite	Ca[Sn ⁴⁺ (OH) ₆]
3.1b.2a.3. Simple oxides of Ti ⁴⁺	3.1b.2a.3.1. Neutral
Rutile family	
Rutile	TiO ₂
Brookite	TiO ₂
Anatase	TiO ₂
*Monoclinic	TiO ₂
*Orthorhombic. TiO ₂ with structure α-PbO ₂	TiO ₂
*Akaogiite	TiO ₂
Ilmenorutile series	
Ilmenorutile	Fe _x (Nb,Ta) _{2x} 4Ti _{1-x} O ₂
Strüverite	(Ti,Ta,Fe ³⁺)O ₂
*Carmichaelite	*3.1b.2a.3.1.2. Basic (Ti,Cr,Fe)(O,OH) ₂ (Ti,Cr,Fe)(O,OH) ₂
3.1b.2b. Class : Complex oxides of Ti ⁴⁺ (Sn ⁴⁺) → titanates (stannates) (only (6)-titanates, (6)-stannates)	
3.1b.2b.1. Titanates of s-, d _s - and p _s -cations	
3.1b.2b.1.1. M ³⁺ (Fe ³⁺ , Cr ³⁺ , V ³⁺ , Al ³⁺)	3.1b.2b.1.1.1. Neutral
Pseudorutile family	
Pseudorutile	Fe ³⁺ ₂ Ti ₃ O ₉
Schreyerite	V ³⁺ ₂ Ti ₃ O ₉
Kyzylkumite	V ³⁺ ₂ Ti ₃ O ₉
*Olkhonskite	(Cr,V) ₂ Ti ₃ O ₉
*Unnamed	(Cr,V) ₂ Ti ₄ O ₁₁
*Unnamed	(Cr,V) ₂ Ti ₂ O ₇
Pseudobrookite family	
Pseudobrookite	Fe ³⁺ ₂ TiO ₅
*Panguite	(Ti,Sc,Al,Mg,Zr,Ca) _{1.8} O ₃ or (Ti,Sc,Al,Mg,Zr,Ca) ₃ O ₅
*Kangite	(Sc,Ti,Al,Zr,Mg,Ca,□) ₂ O ₃

Berdesinskiite	$V^{3+}_2TiO_5$
*Oxyvanite	$V^{3+}_2V^{4+}O_5$
Priderite family (compare with cryptomelane (group))	
Priderite	$K(Ti_7^{4+}Fe^{3+})O_{16}$
*Batiferite	$(Ti_2Fe^{3+}_8Fe^{2+}_2)O_{19}Ba$
*Haggertyite	$[(Ti^{4+}_5Fe^{2+}_4Fe^{3+}_2Mg)O_{19}]Ba$
*Henrymeyerite	$(Ti_7Fe)O_{16}Ba$
*Ankangite (discredited)	$(Ti, V^{3+}, Cr^{3+})_8O_{16}Ba$
Mannardite group	
Mannardite	$ V^{3+}_2Ti_6O_{16} ^{∞3}Ba$
Redledgeite	$ Cr^{3+}_2Ti_6O_{16} ^{∞3}Ba$ or $Ba_x[(Cr, Fe, V)^{3+}_{2x}Ti_{8-2x}]O_{16}$
	3.1b.2b.1.1.2. Basic
Tivanite	$V^{3+}Ti(OH)O_3$
3.1b.2b.1.2. M^{3+} and M^{2+}	
3.1b.2b.1.2.1. Neutral	
Senaite series (compare with crichtonite (series))	
Landauite	$(Na, Pb)(Mn^{2+}, Y)(Zn, Fe)_2(Ti, Fe^{3+}, Nb)_{18}(O, OH, F)O_{38} \rightarrow$ or $^{(12)}Na\{(Ti^{4+}_{15}Fe^{3+}_3Mn^{2+})_{\Sigma 19}(O, OH, F)O_{30}\}^{∞3}ZnO_{4 2}\}^{∞3}$
Senaite	$Pb(Mn, Y, U)(Fe, Zn)_2(Ti, Fe, Cr, V)_{18}O_{38} \rightarrow$ or $Pb\{(Ti, Fe, Mn)_{19}O_{30}\}^{(4)}(Fe, Mn)O_{4 2}\}^{∞3}$
Lindsleyite	$(Ba, Sr)(Zr, Ca)(Fe, Mg)_2(Ti, Cr, Fe)_{18}O_{38}$
Mathiasite	$(K, Ba)(Zr, Ca)(Fe, Mg)_2(Ti, Cr)_{18}O_{38} \rightarrow$ or $(K, Ba)\{(Ti, Cr)_{18}O_{30}\}^{(4)}(Fe, Mg)O_{4 2}\}^{∞3}$
Hibonite group (compare with magnetoplumbite (group))	
Hibonite	$(Ca, TR)(Al, Mg, Ti)_{12}O_{19}$
*Hibonite-(Fe)	$(Fe, Mg)Al_{12}O_{19}$
Hawthorneite	$Ba(MgCr^{3+}_4Fe^{2+}_2Fe^{3+}_2Ti^{4+}_3)_{\Sigma 12}O_{19}$
Yimengite	$K(Cr, Ti, Fe, Mg)_{12}O_{19}$
*Shulamitite	$Ca_3TiFe^{3+}AlO_8$
Uhligite	$Ca_3(Ti, Al, Zr)_9O_{20} (?)$
Jeppeite	$(K, Ba)_2(Ti, Fe^{3+})_6O_{13}$
Kennedyite	$MgFe^{3+}_2Ti_3O_{10}$
*3.16.26.1.2.2. Oxido-hydroxides	
*Almeidaite	$PbZn_2(Mn, Y)(Ti, Fe^{3+})_{18}O_{36}(OH, O)_2$
Polysomatic series of magnesiohögbomite	
*Magnesiohögbomite-2N2S	$Mg_6(Al_{14}Ti_2)O_{30}(OH)_2$
*Magnesiohögbomite-2N3S	$Mg_8(Al_{18}Ti_2)O_{38}(OH)_2$
*Magnesiohögbomite-6N6S	$Mg_{18}(Al_{42}Ti_6)O_{90}(OH)_6$
Högbomit series	
<i>Högbomit-10T</i> = *magnesiohögbomite-2N2S	
<i>Högbomit-15R</i> = *magnesiohögbomite-6N6S	
<i>Högbomit-18R</i> = *magnesiohögbomite-6N6S	
* <i>Högbomit-24R</i> = *magnesiohögbomite-6N6S	
*Zincohögbomit-2N2S	$Zn_6(Al_{14}Ti_2)_{\Sigma 16}O_{30}(OH)_2$
*Zincohögbomit-2N6S	$Zn_{14}(Al_{30}Ti_2)_{\Sigma 32}O_{62}(OH)_2$

* Ferrohöbommit-2N2S	$(\text{Fe}^{2+}_3\text{ZnMgAl})_{\Sigma 6}(\text{Al}_{14}\text{Fe}^{3+}\text{Ti}^{4+})_{\Sigma 16}\text{O}_{30}(\text{OH})_2$
	3.1b.2b.1.2.2. Basic
Nigerite family	
*Magnesionigerite-2N1S = пенчжичжуанит	$\text{Mg}_4(\text{Al}_{10}\text{Sn}_2)_{\Sigma 12}\text{O}_{22}(\text{OH})_2$
*Magnesionigerite-6N6S	$\text{Mg}_{18}(\text{Al}_{42}\text{Sn}_6)_{\Sigma 48}\text{O}_{90}(\text{OH})_6$
Ferronigerite-2N1S	$(\text{Fe,Mg})_4(\text{Al}_{10}\text{Sn}_2)_{\Sigma 12}\text{O}_{22}(\text{OH})_2$
*Ferronigerite-6N6S	$\text{Fe}_8(\text{Al}_{42}\text{Sn}_6)_{\Sigma 48}\text{O}_{90}(\text{OH})_6$
*Pengzhizhongite = Magnesionigerite-2N1S	$\text{Mg}_4(\text{Al}_{10}\text{Sn}_2)_{\Sigma 12}\text{O}_{22}(\text{OH})_2$
	3.1b.2b.1.2.3. Hydrates
Cafetite	$\text{Ca}(\text{Fe}^{3+}, \text{Al})_2\text{Ti}_4\text{O}_{12} \cdot 4\text{H}_2\text{O}$ $\text{Ca}[\text{Ti}_2\text{O}_5](\text{H}_2\text{O})$

3.1b.2b.1.3. M^{2+} ($2 \text{M}^{2+} \rightarrow \text{M}^+\text{M}^{3+}$)

3.1b.2b.1.3.1. Neutral

Armalcolite	$(\text{Mg,Fe}^{2+})\text{Ti}^{4+}_2\text{O}_5$
Ilmenite series	
Geikielite	MgTiO_3
Ecandrewsite	$(\text{Zn,Fe,Mn})\text{TiO}_3$
Ilmenite	$\text{Fe}^{2+}\text{TiO}_3$
Pyrophanite	MnTiO_3
Perovskite family (compare with latrappite)	
Perovskite	CaTiO_3
*Barioperovskite	BaTiO_3
*Megoite	CaSnO_3
Loparite-(Ce)	$(\text{Na,Ce,Sr})(\text{Ce,Th})(\text{Ti,Nb})_2\text{O}_6$
Tausonite	SrTiO_3
*K-Sr-loparite	$(\text{Sr,L,K,Ce,Ca,Th,Na})(\text{Ti,Cr,Nb})\text{O}_3$
Macedonite	PbTiO_3

Ulvöspinel series (compare with oxispinelides (series); sulfospinelides (series); selenospinelides (series))

Qandilite	$\text{MgTi}^{4+}[\text{MgO}_4] \rightarrow \text{Mg}_2\text{TiO}_4$
Ulvöspinel (ulvite)	$\text{Fe}^{2+}\text{Ti}^{4+}[\text{Fe}^{2+}\text{O}_4] \rightarrow \text{Fe}^{2+}_2\text{TiO}_4$
	3.1b.2b.1.3.2. Basic
Kassite	$\text{CaTi}_2(\text{OH})_2\text{O}_4$

3.1b.2b.1.4. Titanates of M^{3+} and M^+

	3.1b.2b.1.4.1. Basic \rightarrow acids
Freudenbergite	$\text{Na}[\text{Fe}^{3+}\text{Ti}_3\text{O}_8]^{3-} \rightarrow$ $(^{12})\text{Na}_{1-y}[\text{Fe}^{3+}_{1-x}\text{Ti}_{3-x}\text{Si}_x\text{O}_8\text{H}_{3x+y}]^{3-}$

3.1b.2b.2. Titanates of *s*-, *d*_s- and *p*_s-cations with unknown structure and questionable

Kleberite	$\text{FeTi}_6\text{O}_{11}(\text{OH})_5$
Manganbelyankinite	$(\text{Mn,Ca})(\text{Ti,Nb})_5\text{O}_{12} \cdot 9\text{H}_2\text{O}$
Belyankinite	$\text{Ca}(\text{Ti,Zr,Nb})_6\text{O}_{13} \cdot 14\text{H}_2\text{O} (?)$

3.1.3.2.2.2. Titanates of *f*-cationsa

	3.1.3.2.2.2.1. Neutral \rightarrow Basic
Crichtonite series (compare with senaites (series))	

*Davidite-(Ce)	$\text{Ce}(\text{Y,U})\text{Fe}_2(\text{Ti,Fe,Cr,V})_{18}(\text{O,OH,F})_{38}$
Davidite-(La)	$\text{La}(\text{Y,U})\text{Fe}_2(\text{Ti,Fe,Cr,V})_{18}(\text{O,OH,F})_{38}$
*Unnamed	$(\text{Ca,Ce})\text{Sc}(\text{Ti,Fe,Al})_{20}(\text{O,OH})_{38}$
Loveringite	$(\text{Ca,Ce,La})(\text{Zr,Fe})(\text{Mg,Fe})_2(\text{Ti,Fe,Cr,Al})_{18}\text{O}_{38}$
*Dessauite-(Y)	$\text{SrYFe}^{3+}_2(\text{Ti}_{11}\text{Fe}_7)_{\Sigma 18}\text{O}_{38}$
Crichtonite	$(\text{Sr,La,Ce,Y}) (\text{Ti,Fe}^{3+},\text{Mn})_{21}\text{O}_{38} ^{\infty 3}$
*Gramaccioliite – (Y)	$(\text{Pb,Sr})(\text{Y,Mn})(\text{Ti,Fe}^{3+})_{18}\text{Fe}^{3+}_2\text{O}_{38}$
Brannerite family	
Brannerite group	
Lucasite-(Ce)	$(\text{Ce,La})\text{Ti}_2(\text{O,OH})_6$
Brannerite	$(\text{U,Ca,Ce})(\text{Ti,Fe}^{3+})_2\text{O}_6$
Thorutite	$(\text{Th,U,Ca})\text{Ti}_2(\text{O,OH})_6$
Yttrocrasite-(Y)	$(\text{Y,Th,Ca,U})(\text{Ti,Fe}^{3+})_2(\text{O,OH})_6$
3.1b.3. Overclass *: Oxides and hydroxides of Nb^{5+} and Ta^{5+}	
3.1b.3a. Class : Simple oxides and hydroxides of Nb^{5+} and Ta^{5+}	
3.1b.3a.1. Neutral	
Tantite	$(\text{Ta,Nb})_2\text{O}_5$
Ixiolite family	
Ixiolite group	
Ixiolite	$(\text{Ta,Fe,Sn,Nb,Mn})_4\text{O}_8$
*Unnamed	$(\text{Sc,Fe}^{3+})(\text{Nb,Ta})\text{O}_4$
Wodginite group	
*Titanowodginite	$\text{Mn}^{2+}\text{TiTa}_2\text{O}_8$
*Ferroowodginite	$\text{Fe}^{2+}\text{SnTa}_2\text{O}_8$
* Fe^{2+} -Ti-wodginite	$(\text{Fe,Mn})_4(\text{Ti,Sn,Ta})_4(\text{Ta,Nb,W})_8\text{O}_{32}$
*Tantalowodginite	$(\text{Mn}_2,\square)_4\text{Ta}_4\text{Ta}_8\text{O}_{32}$
*Wodginite	$\text{MnSnTa}_2\text{O}_8$
3.1b.3a.2. Hydroxides	
Kimrobinsonite	$\text{Ta}(\text{OH})_3(\text{O,CO}_3)$
3.1b.3b. Class : Complex oxides of Nb^{5+} and Ta^{5+} ((6)-tantalonioabates → (4)-tantalonioabates)	
3.1b.3b.1. Tantaloniobates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s -cations	
3.1b.3b.1.1. Tantaloniobates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s -cations (without Li and Be)	
3.1b.3b.1.1.1. Proper tantaloniobates	
3.1b.3b.1.1.1.1. $\text{M}^{4+} = \text{Sn}^{4+}(\text{Ti}^{4+})$	
3.1b.3b.1.1.1.1.1. Neutral	
3.1b.3b.1.1.1.2. $\text{M}^{3+} = \text{Al}^{3+}$	
3.1b.3b.1.1.1.2.1. Neutral	
Alumotantite	AlTaO_4
*Heftetjernite	ScTaO_4
3.1b.3b.1.1.1.2.2. Basic	
Simpsonite	$\text{Al}_4(\text{Ta,Nb})_3\text{O}_{13}(\text{OH,F})$
3.1b.3b.1.1.1.3. $\text{M}^{2+} (\text{Sn}^{2+}, \text{Mg}, \text{Fe}^{2+}, \text{Mn}^{2+}, \text{Ca}^{2+})$	
3.1b.3b.1.1.1.3.1. Neutral → acids → basic	
Thoreaulite series	
Foordite	$\text{Sn} \text{Nb}_2\text{O}_6 ^{\infty 2}$
Thoreaulite	$\text{Sn} \text{Ta}_2\text{O}_6 ^{\infty 2}$
Tapiolite series	

Tapiolite-Fe	FeTa_2O_6
Tapiolite-Mn	MnTa_2O_6
Columbite series	
Columbite-(Mg) = Magnocolumbite	$(\text{Mg,Fe,Mn})(\text{Nb,Ta})_2\text{O}_6$
Columbite-(Fe) = Ferrocolumbite	FeNb_2O_6
Columbite-(Mn) = Manganocolumbite	$(\text{Mn,Fe})(\text{Nb,Ta})_2\text{O}_6$
Ferrotantalite = tantalite-(Fe)	FeTa_2O_6
Manganotantalite = tantalite-(Mn)	MnTa_2O_6
*Magnesiotantalite = tantalite-(Mg)	MgTa_2O_6
Calciotantite	$\text{CaTa}_4\text{O}_{11}$
Rynersonite family	
Rynersonite	$\text{Ca}(\text{Ta,Nb})_2\text{O}_6$
Changbaiite	PbNb_2O_6
Microlite family (compare with pyrochlore (series))	
Microlite series	
Bariopyrochlore	$\text{Ba}_2\text{Nb}_2\text{O}_7$
*Hydropyrochlore	$(\text{H}_2\text{O}\square)_2\text{Nb}_2(\text{O,OH})_6\cdot\text{H}_2\text{O}$
*Hydroxycalcio-pyrochlore	$(\text{Ca,Na,U,\square})_2(\text{Nb,Ti})_2\text{O}_6(\text{OH})$
*Aspedamite	$\square_{12}(\text{Fe}^{3+},\text{Fe}^{2+})_3\text{Nb}_4[\text{Th}(\text{Nb,Fe}^{3+})_{12}\text{O}_{42}](\text{H}_2\text{O,OH})_{12}$
*Oxystibiomicrolite	$(\text{Sb,Ca})_2\text{Ta}_2\text{O}_6\text{O}$
*Fluorcalcio-microlite	$(\text{Ca,Na,\square})_2\text{Ta}_2\text{O}_6\text{F}$
Bariomicrolite = *hydrokenomicrolite	$(\square,\text{H}_2\text{O})_2\text{Ta}_2(\text{O,OH})_6(\text{H}_2\text{O})$
Parabariomicrolite	$\text{BaTa}_4\text{O}_{10}(\text{OH})_2\cdot 2\text{H}_2\text{O}$
*Hydrokenomicrolite	$(\square,\text{H}_2\text{O})_2\text{Ta}_2(\text{O,OH})_6(\text{H}_2\text{O})$
Bismutomicrolite series	
*Hydroxykenomicrolite	$(\square,\text{Na,Sb}^{3+})_2\text{Ta}_2\text{O}_6(\text{OH})$
*Fluorsodicmicrolite	$(\text{Na,Ca})\text{Ta}_2\text{O}_6\text{F}$
Stibiobetafite = oxycalcio-pyrochlore	$\text{Ca}_2\text{Nb}_2\text{O}_6\text{O}$
Stannomicrolite = oxystannomicrolite	$\text{Sn}_2\text{Ta}_2\text{O}_6\text{O}$
Cesplumtantite	$(\text{Cs,Na})_2(\text{Pb, Sb}^{3+},\text{Sn}^{2+})_3\text{Ta}_8\text{O}_{24}$
3.1b.3b.1.1.1.3.2. Hydrates	
Gerasimovskite	$(\text{Mn,Ca})(\text{Nb,Ti})_{5-6}\text{O}_{12-16}\cdot 8-9\text{H}_2\text{O} (?)$
Franconite	$(\text{Na,Ca})_2(\text{Nb,Ti})_4\text{O}_{11}\cdot 9\text{H}_2\text{O}$
*Hochelagaite	$(\text{Ca,Na,Sr})\text{Nb}_4\text{O}_{11}\cdot 8\text{H}_2\text{O}$
*Ternovite	$(\text{Mg,Ca})\text{Nb}_4\text{O}_{11}\cdot 10\text{H}_2\text{O}$
*Peterandresenite	$\text{Mn}_4\text{Nb}_6\text{O}_{19}\cdot 14\text{H}_2\text{O}$
3.1b.3b.1.1.1.4. M^{3+} and M^+	
Sosedkoite	3.1b.3b.1.1.1.4.1. Neutral $(\text{K,Na})_5\text{Al}_2(\text{Ta,Nb,Sb})_{22}\text{O}_{60}$
3.1b.3b.1.1.1.5. M^+	
Rankamaite	3.1b.3b.1.1.1.5.1. Neutral \rightarrow basic $(\text{Na,K,Pb})(\text{Ta,Nb,Al})_4(\text{O,OH})_{10}$
Natrotantite	$\text{Na}_2\text{Ta}_4\text{O}_{11}$
Irtyschite	$\text{Na}_2(\text{Ta,Nb})_4\text{O}_{11}$
Latrappite	$(\text{Ca,Na})(\text{Nb,Ti,Fe})\text{O}_3$ (compare perovskite (series); loparite (group)) macedonite (group));
Lueshire family	

Lueshite	NaNbO_3
*Isolueshite	$(\text{Na}, \text{La}, \text{Ca})_2(\text{Nb}, \text{Ti})\text{O}_3$
3.1b.3b.1.1.2. Tantaloniobato-tungstenates of $\text{Mg}, \text{Fe}^{2+}, \text{Mn}^{2+}$	
	3.1b.3b.1.1.2.1. Neutral
Qitianlingite	$(\text{Fe}, \text{Mn})_2^{2+}(\text{Nb}, \text{Ta})_2\text{W}^{6+}\text{O}_{10}$
*Koragoite	$\text{Mn}_2^{2+}\text{Mn}^{3+}\text{Nb}_2(\text{Nb}, \text{Ta})_3\text{W}_2\text{O}_{20}$
3.1b.3b.1.2. Tantaloniobates of Li	
	3.1b.3b.1.2.1. Neutral
Lithiotantite family	
Lithiotantite	$\text{Li}(\text{Ta}, \text{Nb})_3\text{O}_8$
Lithiowodginite	$\text{Li}(\text{Ta}, \text{Nb})_3\text{O}_8$
3.1b.3b.2. Tantaloniobates of <i>f</i> -elements	
3.1b.3b.2.1. Tantaloniobates of U	
3.1b.3b.2.1.1. Neutral	
Liandratite	$\text{U}^{6+}(\text{Nb}, \text{Ta})_2\text{O}_8$
Petscheckite	$\text{U}^{4+}\text{Fe}^{2+}(\text{Nb}, \text{Ta})_2\text{O}_8$
3.1b.3b.2.2. Tantaloniobates of TR	
3.1b.3b.2.2.1. Neutral → basic	
Euxenite series	
Euxenite-(Y)	$(\text{Y}, \text{Ca}, \text{Ce}, \text{U}, \text{Th})_2(\text{Nb}, \text{Ta}, \text{Ti})_2\text{O}_6 ^{\infty 3}$
Vigezzite	$(\text{Ca}, \text{Ce})_2(\text{Nb}, \text{Ta}, \text{Ti})_2\text{O}_6 ^{\infty 3}$
*Titanvigezzite	$(\text{Ca}, \text{Ce})_2(\text{Ti}, \text{Nb}, \text{Si}, \text{Ta})_2\text{O}_6 ^{\infty 3}$
Fersmite	$(\text{Ca}, \text{Ce}, \text{Na})_2(\text{Nb}, \text{Ti}, \text{Fe}, \text{Al})_2(\text{O}, \text{OH}, \text{F})_6 ^{\infty 3}$
Tanteuxenite-(Y)	$(\text{Y}, \text{Ca}, \text{Ce})_2(\text{Ta}, \text{Nb}, \text{Ti})_2(\text{O}, \text{OH})_6 ^{\infty 3}$
Aeschnite series	
Niobo-aeschnite-(Ce)	$(\text{Ce}, \text{Ca}, \text{Th})_2(\text{Nb}, \text{Ti})_2(\text{O}, \text{OH})_6 ^{\infty 3}$
*Niobo-aeschnite-(Nd)	$(\text{Nd}, \text{Ce})_2(\text{Nb}, \text{Ti})_2(\text{O}, \text{OH})_6 ^{\infty 3}$
*Niobo-aeschnite-(Y)	$(\text{Y}, \text{Ca}, \text{Ce}, \text{Nd}, \text{Th})_2(\text{Nb}, \text{Ta}, \text{Ti}, \text{Fe})_2(\text{O}, \text{OH})_6$
*Yttrioniobo-aeschnite-(Ce)	$(\text{Ce}, \text{Y}, \text{Ca}, \text{Th})_2(\text{Nb}, \text{Ti}, \text{Ta})_2\text{O}_6$
Tantal-aeschnite-(Y)	$(\text{Y}, \text{Ce}, \text{Ca})_2(\text{Ta}, \text{Ti}, \text{Nb})_2\text{O}_6 ^{\infty 3}$
Aeschnite-(Nd)	$(\text{Nd}, \text{Ce}, \text{Ca}, \text{Th})_2(\text{Ti}, \text{Nb})_2(\text{O}, \text{OH})_6 ^{\infty 3}$
Aeschnite-(Ce)	$(\text{Ce}, \text{Ca}, \text{Fe}, \text{Th})_2(\text{Ti}, \text{Nb})_2(\text{O}, \text{OH})_6 ^{\infty 3}$
Aeschnite-(Y)	$(\text{Y}, \text{Ca}, \text{Fe}, \text{Th})_2(\text{Ti}, \text{Nb})_2(\text{O}, \text{OH})_6 ^{\infty 3}$
Polycrase series	
Polycrase-(Y)	$(\text{Y}, \text{Ca}, \text{Ce}, \text{U}, \text{Th})_2(\text{Ti}, \text{Nb}, \text{Ta})_2\text{O}_6 ^{\infty 3}$
*Uranopolycrase	$(\text{U}, \text{Y})_2(\text{Ti}, \text{Nb})_2\text{O}_6$
Kobeite-(Y)	$(\text{Y}, \text{U})_2(\text{Ti}, \text{Nb})_2(\text{O}, \text{OH})_6$
Loranskite-(Y)	$(\text{Y}, \text{Ce}, \text{Ca})\text{ZrTaO}_6$
Samarskite series	
*Calciosamarskite	$(\text{Ca}, \text{Fe}, \text{Y})_2(\text{Nb}, \text{Ta}, \text{Ti})\text{O}_4$
Samarskite-(Y)	$(\text{Y}, \text{Ce}, \text{U}, \text{Fe}^{3+})_3(\text{Nb}, \text{Ta}, \text{Ti})_5\text{O}_{16}$
*Samarskite-(Yb)	$(\text{Yb}, \text{Y}, \text{REE}, \text{U}, \text{Th}, \text{Ca}, \text{Fe}^{2+})_2(\text{Nb}, \text{Ta}, \text{Ti})\text{O}_4$
Pyrochlore series	
Ytropyrochlore-(Y) discredited	(compare with microlite (series))
Yttrobetafite-(Y) discredited	
Betafite	$\text{Ca}_2(\text{Ti}, \text{Nb})\text{O}_6(\text{OH})$

Uranpyrochlore discredited	
Ceripyrochlore-(Ce)	$\text{Ce}_2\text{Nb}_2\text{O}_6(\text{OH})$
Plumbopyrochlore	$\text{Pb}_2\text{Nb}_2\text{O}_7$
Pyrochlore	$\text{NaCaNb}_2\text{O}_6\text{F}$
*Fluornatropyrochlore	$(\text{Na},\text{Pb},\text{Ca},\text{REE},\text{U})_2\text{Nb}_2\text{O}_6\text{F}$
*Hydroxymanganopyrochlore	$(\text{Mn},\text{Th},\text{Na},\text{Ca},\text{REE})_2(\text{Nb},\text{Ti})_2\text{O}_6(\text{OH})$
Uranmicrolite	$(\text{U}_{0.5}\text{Ca}_{0.5})\text{Ta}_2\text{O}_6(\text{OH})$
Calciobetafite	$\text{Ca}_2(\text{NbTi})\text{O}_6(\text{OH})$
*Bismutopyrochlore discredited	
Murataite-(Y)	$((\text{Y},\text{Na})_6\text{Zn}(\text{Zn},\text{Fe}^{3+})_4(\text{Ti},\text{Nb},\text{Na})_{12}\text{O}_{29}(\text{O},\text{F},\text{OH})_{10}\text{F}_4$
Beta-fergusonite series	
Beta-fergusonite-(Ce)	$(\text{Ce},\text{La},\text{Nd})[\text{NbO}_4]$
Beta-fergusonite-(Nd)	$(\text{Nd},\text{Ce})[\text{NbO}_4]$
Beta-fergusonite-(Y)	$\text{Y}[\text{NbO}_4]$
Ishikawaite	$(\text{U},\text{Fe},\text{Y})\text{NbO}_4$
Fergusonite series	
*Iwashiroite-(Y)	YT aO_4
*Fergusonite-(Ce)	$\text{CeNbO}_4 \cdot 0.3\text{H}_2\text{O}$
Fergusonite-(Y)	$(\text{Y},\text{Er},\text{Ce},\text{Fe})[(\text{Nb},\text{Ta},\text{Ti})\text{O}_4]$
Formanite-(Y)	$\text{Y}[(\text{Ta},\text{Nb})\text{O}_4]$
Yttrotantalite-(Y)	$(\text{Y},\text{U},\text{Fe}^{2+})[(\text{Ta},\text{Nb})\text{O}_4]$
3.1b.3b.2.3. Tantaloniobates of Sb^{3+} and Bi^{3+} 3.1b.3b.2.3.1. Neutral	
Stibiotantalite family	
Stibiotantalite group	
Stibiotantalite	$\text{Sb}(\text{Ta},\text{Nb})\text{O}_4 ^{\infty 2}$
Stibiocolumbite	$\text{Sb} \text{NbO}_4 ^{\infty 2}$
Bismutocolumbite	$\text{Bi} \text{NbO}_4 ^{\infty 2}$
*Yttrocolumbite-(Y)	YNbO_4
Bismutotantalite	$\text{Bi}(\text{Ta},\text{Nb})\text{O}_4 ^{\infty 2}$
Zimbabweite	${}^{(8)}\text{Na}\{{}^{(6)}(\text{PbNa}_{0.5}\text{K}_{0.5})_{\Sigma 2}\text{As}^{3+}_4\{{}^{(6)}(\text{Ta}_3\text{Nb}_{0.5}\text{Ti}_{0.5})_{\Sigma 4}\text{O}_{18}\}^{\infty 2}\}_2^{\infty 2}$
*Unnamed	$\text{Mn}^{2+}_3\text{U}^{4+}\text{As}^{3+}_2\text{Sb}^{3+}_2\text{Ta}^{5+}_2\text{Ti}^{4+}_2\text{O}_{20}$

*3.16.3b.2.3.4. Tantaloniobato-tungstenates Sb^{3+} и Bi^{3+}

*Billwiseite $\text{Sb}^{3+}_5(\text{Nb},\text{Ta})_3\text{WO}_{18}$

3.1b.4. **Overclass***: Oxides and hydroxides of Mo and W

3.1b.4a. **Class**: Simple oxides and hydroxides of Mo and W

3.1b.4a.1. Neutral

Tugarinivite MoO_2

Molybdite MoO_3

*Cupromolybdite $\text{Cu}^{2+}_3\text{Mo}^{6+}_2\text{O}_9$

3.1b.4a.2. Oxido-hydroxides

Tungstite $\text{WO}_3 \cdot \text{H}_2\text{O} \rightarrow \text{H}_2\text{WO}_4 \rightarrow \text{W}(\text{OH})_2\text{O}_2$

Alumotungstite series

Alumotungstite $\square_2\text{W}_2\text{O}_6(\text{H}_2\text{O})$

Ferritungstite = hydroknoelsmoreite $\square_2\text{W}_2\text{O}_6(\text{H}_2\text{O})$

3.1b.4a.3. Hydrates (molybdenum and tungsten acids)

Hydrotungstite family

Sidwellite	$\text{MoO}_3 \cdot 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{MoO}_4 \cdot \text{H}_2\text{O} \rightarrow \text{Mo}(\text{OH})_2\text{O}_2 \cdot \text{H}_2\text{O}$
Hydrotungstite	$\text{WO}_3 \cdot 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{WO}_4 \cdot \text{H}_2\text{O} \rightarrow \text{W}(\text{OH})_2\text{O}_2 \cdot \text{H}_2\text{O}$
Meymacite	$\text{WO}_3 \cdot 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{WO}_4 \cdot \text{H}_2\text{O} \rightarrow \text{W}(\text{OH})_2\text{O}_2 \cdot \text{H}_2\text{O}$
*Elsmoreite	$\text{WO}_3 \cdot 5\text{H}_2\text{O}$

3.1b.4b. **Class:** Complex oxides and hydroxides of Mo and W ((6)-molybdates and tungstenates \rightarrow (4)-molybdates and tungstenates)

3.1b.4b.1. Molybdates and tungstenates of *s*-, *d*_s- and *p*_s-cations

3.1b.4b.1.1. Proper molybdates and tungstenates

3.1b.4b.1.1.1. $\text{M}^{3+}(\text{Al}^{3+}, \text{Fe}^{3+})$ 3.1b.4b.1.1.1.1. Oxido-hydroxides \rightarrow
 \rightarrow hydroxides \rightarrow hydrates

Anthoinite family

Anthoinite	$\text{AlWO}_3(\text{OH})_3$
Mpororoite	$\text{AlWO}_3(\text{OH})_3 \cdot \text{H}_2\text{O}$
*Bamfordite	$\text{Fe}^{3+}\text{Mo}_2(\text{OH})_3\text{O}_6 \cdot \text{H}_2\text{O}$
*Ferrimolybdate	$\text{Fe}^{3+}_2[\text{MoO}_4]_3 \cdot 8\text{H}_2\text{O} (?)$
*Ophirite	$\text{Ca}_2\text{Mn}_4[\text{Zn}_2\text{Mn}^{3+}_2(\text{H}_2\text{O})_2(\text{Fe}^{3+}\text{W}_9\text{O}_{34})_2] \cdot 46\text{H}_2\text{O}$

3.1b.4b.1.1.2. M^{3+} and M^{2+} 3.1b.4b.1.1.2.1. Oxido-hydroxides
Jixianite $\text{Pb}(\text{W}, \text{Fe}^{3+})_2(\text{O}, \text{OH})_7$

3.1b.4b.1.1.3. M^{3+} , M^{2+} and M^+ 3.1b.4b.1.1.3.1. Hydrates
Phyllotungstite $\text{H}\text{Ca}\text{Fe}^{3+}_3[\text{WO}_4]_6 \cdot 10\text{H}_2\text{O}$
*Pittongite $(\text{Na}, \text{H}_2\text{O})_{0.7}(\text{W}, \text{Fe}^{3+})(\text{O}, \text{OH})_3$

3.1b.4b.1.1.4. M^{2+} 3.1b.4b.1.1.4.1. Neutral

Wolframite series

*Huanzalaite	MgWO_4
Ferberite	FeWO_4
Huebnerite	MnWO_4
Sanmartinite	$(\text{Zn}, \text{Fe}, \text{Ca}, \text{Mn})\text{WO}_4$

Scheelite series

Powellite	$\text{Ca}[\text{MoO}_4]$
Scheelite	$\text{Ca}[\text{WO}_4]$

* 3.16.46.1.1.5 M^{2+} и Mo^{4+}

*Kamiokite $\text{Fe}^{2+}_2\text{Mo}^{4+}_3\text{O}_8 \rightarrow \text{Fe}^{2+}_2\text{Mo}^{4+}[\text{MoO}_4]_2$

3.1b.4b.1.2. Molybdato (tungstenato)-vanadates

3.1b.4b.1.2.1. Hydrates
Rankachite $\text{Ca}_{0.5}(\text{V}^{4+}, \text{V}^{5+})(\text{W}^{6+}, \text{Fe}^{3+})_2\text{O}_8(\text{OH}) \cdot 2\text{H}_2\text{O}$

3.1b.4b.1.3. Molybdato (tungstenato)-phosphates

3.1b.4b.1.3.1. Hydrates
Melkovite $[\text{Ca}_2(\text{H}_2\text{O})_{15}\text{Ca}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{P}_2\text{Fe}_3^{3+}\text{O}_{36}(\text{OH})]$

3.1b.4b.1.4. Phospho- molybdato- phosphates

3.1b.4b.1.4.1. Hydrates

Mendozavilite family

Paramendozavilite $\text{NaAl}_4\text{Fe}^{3+}_7(\text{OH})_{16}[\text{PMo}_{12}\text{O}_{40}][\text{PO}_4]_5 \cdot 56\text{H}_2\text{O}$

Mendozavilite-NaFe	$[\text{Na}_2(\text{H}_2\text{O})_{15}\text{Fe}^{3+}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{P}_2\text{Fe}_3^{3+}\text{O}_{35}(\text{OH})_2]$
*Mendozavilite-NaCu	$[\text{Na}_2(\text{H}_2\text{O})_{15}\text{Cu}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{P}_2\text{Fe}_3^{3+}\text{O}_{34}(\text{OH})_3]$
*Mendozavilite-KCa	$[\text{K}_2(\text{H}_2\text{O})_{15}\text{Ca}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{P}_2\text{Fe}_3^{3+}\text{O}_{34}(\text{OH})_3]$

*3.1b.4b.1.5. Molybdato (tungstenato)-arsenates

*3.1b.4b.1.5.1. Hydrates

* Betpakdalite group	
*Betpakdalite-CaCa	$[\text{Ca}_2(\text{H}_2\text{O})_{17}\text{Ca}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2^{5+}\text{Fe}_3^{3+}\text{O}_{36}(\text{OH})]$
*Betpakdalite-CaMg	$[\text{Ca}_2(\text{H}_2\text{O})_{17}\text{Mg}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2^{5+}\text{Fe}_3^{3+}\text{O}_{36}(\text{OH})]$
*Betpakdalite-NaCa	$[\text{Na}_2(\text{H}_2\text{O})_{17}\text{Ca}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2^{5+}\text{Fe}_3^{3+}\text{O}_{34}(\text{OH})_3]$
*Betpakdalite-NaNa	$[\text{Na}_2(\text{H}_2\text{O})_{16}\text{Na}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2^{5+}\text{Fe}_3^{3+}\text{O}_{33}(\text{OH})_4]$
*Obradovičite-KCu	$[\text{K}_2(\text{H}_2\text{O})_{17}\text{Cu}^{2+}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2\text{Fe}_3^{3+}\text{O}_{34}(\text{OH})_3]$
*Obradovičite-NaCu	$[\text{Na}_2(\text{H}_2\text{O})_{17}\text{Cu}^{2+}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2\text{Fe}_3^{3+}\text{O}_{34}(\text{OH})_3]$
*Obradovičite-NaNa	$[\text{Na}_2(\text{H}_2\text{O})_{16}\text{Na}(\text{H}_2\text{O})_6][\text{Mo}_8^{6+}\text{As}_2\text{Fe}_3^{3+}\text{O}_{33}(\text{OH})_4]$

3.1b.4b.2. Molybdates and tungstenates of *f*-elements

*3.1b.4b.2.1. Proper molybdates and tungstenates

	3.1b.4b.2.1.1. Neutral
Sedovite	$\text{U}^{4+}[\text{MoO}_4]_2$
	3.1b.3.4b.2.2. Basic
Mourite	$\text{U}^{4+}\text{Mo}_5(\text{OH})_{10}\text{O}_{12}$
Yttrotungstite -(Y) series	
Cerotungstite-(Ce)	$(\text{Ce},\text{Nd})\text{W}_2(\text{OH})_3\text{O}_6$
*Yttrotungstite-(Ce)	$(\text{Ce},\text{REE})\text{W}_2(\text{OH})_3\text{O}_6$
Yttrotungstite-(Y)	$(\text{Y},\text{REE})\text{W}_2(\text{OH})_3\text{O}_6$

*3.1b.4b.2.2. Molybdato- and tungstenato - arsenates

*3.1b.4b.2.2.1. Neutral

*Paraniite-(Y)	$\text{Ca}_2(\text{Y},\text{REE})(\text{AsO}_4)(\text{WO}_4)_2$
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3.1b.4b.3. Molybdates and tungstenates of *d*-cations3.1b.4b.3.1. Molybdates of Mo^{4+}

3.1b.4b.3.1.1. Hydrates

Ilseemannite	$(\text{Mo}^{6+}_2\text{Mo}^{4+})\text{O}_8\cdot\text{H}_2\text{O} \rightarrow \text{MoMo}_2\text{O}_8\cdot\text{H}_2\text{O} \rightarrow \text{Mo}^{4+}[\text{MoO}_4]_2\cdot\text{H}_2\text{O} (?)$
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3.1b.4b.3.2. Molybdates and tungstenates of *Ib*-cations - Cu^{2+}

3.1b.4b.3.2.1. Proper molybdates and tungstenates 3.1b.4b.3.2.1.1. Basic

Lindgrenite family

Lindgrenite	$\text{Cu}^{2+}_3(\text{OH})_2[\text{MoO}_4]_2$
*Markascherite	$\text{Cu}^{2+}_3(\text{OH})_4[\text{MoO}_4]$
*Szenicsite	$\text{Cu}^{2+}_3(\text{OH})_4[\text{MoO}_4]$
Cuprotungstite	$\text{Cu}^{2+}_3(\text{OH})_2[\text{WO}_4]_2$

*3.1b.4b.3.2.2. Oxido-molybdato (tungstenato)-sulfates

*Vergasovaite	$\text{Cu}^{2+}_3\text{O}[\text{MoO}_4][\text{SO}_4]$
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3.1b.4b.4. Molybdates and tungstenates of *p*-metals3.1b.4b.4.1. Molybdates and tungstenates of *IVa*-cations – Pb^{2+}

3.1b.4b.4.1.1. Proper molybdates and tungstenates

3.1b.4b.4.1.1.1. Neutral

Wulfenite family**Wulfenite group**

Wulfenite	Pb[MoO ₄]
Stolzite	Pb[WO ₄]
Raspite	Pb[WO ₄]
*Raspite, beneficiate Te	Pb[(W _{0.56} Te _{0.44})O ₄]

3.1b.4b.4.1.1.2. Oxido-molybdate-halogenides

Pinalite	Pb ₃ O[WO ₄]Cl ₂
*Parkinsonite	Pb ₇ MoO ₉ Cl ₂

3.1b.4b.5. Molybdates and tungstenates of semimetals

3.1b.4b.5.1. Molybdates and tungstenates of Bi³⁺

3.1b.4b.5.1.1. Proper molybdates and tungstenates

3.1b.4b.5.1.1.1. Oxido-molybdates (tungstenates)

*Biehlite	(Sb,As) ³⁺ ₂ Mo ⁶⁺ O ₆
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Koehlinite group

Koehlinite	Bi ₂ MoO ₆ → [Bi ₂ O ₂] ^{∞2} [MoO ₄] ^{∞2}
Russellite	Bi ₂ WO ₆ → [Bi ₂ O ₂] ^{∞2} [WO ₄] ^{∞2}

*3.1b.4b.5.1.1.1.1 Oxido-hydroxido-molybdates (hydrates)

*Gelsaite	BiMo ⁶⁺ _{2-5x} Mo ⁵⁺ _{6x} O ₇ (OH)·H ₂ O (0 ≤ x ≤ 0.4) or Bi ³⁺ Mo ⁶⁺ _{2+x} O ₇ (OH)·H ₂ O
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*3.1b.4b.5.1.1.2. Oxido –molybdate-arsenates

*Schlegelite	Bi ₇ O ₄ [MoO ₄] ₂ [AsO ₄] ₃
*Vajdakite	[(Mo ⁶⁺ O ₂) ₂ (H ₂ O) ₂ As ³⁺ ₂ O ₅]·H ₂ O

*3.1b.4b.5.1.1.1.1. Hydrates

3.1b.4b.5.1.2. Molybdate-tellurates of Bi³⁺

3.1b.4b.5.1.2.1. Neutral

Chiluite	Bi ₆ Mo ₂ Te ₂ O ₂₁
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3.1b.5. Overclass*: Oxides and hydroxides of Mn⁴⁺

3.1b.5a. **Class:** Simple oxides and hydroxides of Mn⁴⁺ → complex oxides and hydroxides of Mn⁴⁺

3.1b.5a.1. Neutral oxido-hydroxides

Pyrolusite family (compare with rutile (family); cassiterite (group))

Pyrolusite	β -MnO ₂
Ramsdellite	γ -MnO ₂
*Akhtenskite	ε -MnO ₂
Nsutite	Mn ²⁺ _x Mn ⁴⁺ _{1-x} (OH) _{2x} O _{2-2x}

3.1b.5b. **Class:** Complex oxides and hydroxides of Mn⁴⁺

*3.1b.5b.1. Neutral

*Strontiomelane	SrMn ⁴⁺ ₆ Mn ³⁺ ₂ O ₁₆
*Zenzénite	Pb ₃ (Fe ³⁺ ,Mn ³⁺) ₄ Mn ⁴⁺ ₃ O ₁₅

3.1b.5b.1. Oxido-hydroxides → hydrates

Cryptomelane family (compare with priderite (family))**Coronadite group**

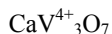
Manjiroite	$\text{Na}(\text{Mn}_7^{4+}\text{Mn}^{3+})\text{O}_{16}$
Coronadite	$\text{Pb}(\text{Mn}_6^{4+}\text{Mn}^{3+}_2)\text{O}_{16}$
Cryptomelane group	
Hollandite	$\text{Ba}(\text{Mn}_6^{4+}\text{Mn}^{3+}_2)\text{O}_{16}$
Cryptomelane	$\text{K}(\text{Mn}_7^{4+}\text{Mn}^{3+})_8\text{O}_{16}$
Romanèshite	$(\text{Ba}, \cdot\text{H}_2\text{O})_2(\text{Mn}^{4+}, \text{Mn}^{3+})_5\text{O}_{10}$
Todorokite family	
*Jianshuiite	$\text{MgMnO}_7 \cdot 3\text{H}_2\text{O}$
Todorokite	$(\text{Na}, \text{Ca}, \text{K}, \text{Ba}, \text{Sr})_{1-x}(\text{Mn}, \text{Mg}, \text{Al})_6\text{O}_{12} \cdot 3-4\text{H}_2\text{O}$
Woodruffite	$\text{Zn}_2\text{Mn}_5^{4+}\text{O}_{12} \cdot 4\text{H}_2\text{O}$
Rancieite series	
Takanelite	$(\text{Mn}^{2+}, \text{Ca})_{2x}\text{Mn}^{4+}_{1-x}\text{O}_2 \cdot 0.7\text{H}_2\text{O}$
Rancieite	$(\text{Ca}, \text{Mn}^{2+})_{0.2}(\text{Mn}^{4+}, \text{Mn}^{3+})\text{O}_2 \cdot 0.6\text{H}_2\text{O}$
Chalcophanite series	
Chalcophanite	$(\text{Zn}, \text{Fe}^{2+}, \text{Mn}^{2+}) \text{Mn}^{4+}_3\text{O}_7 ^{∞2} \cdot 3\text{H}_2\text{O}$
*Ni-chalcophanite	$(\text{Ni}, \text{Cu}, \text{Co}^{3+}) \text{Mn}^{4+}_3\text{O}_7 ^{∞2} \cdot 5\text{H}_2\text{O}$
*Ernieckelite	$\text{Ni} \text{Mn}^{4+}_3\text{O}_7 ^{∞2} \cdot 3\text{H}_2\text{O}$
Aurorite	$(\text{Mn}, \text{Ag}, \text{Ca}) \text{Mn}^{4+}_3\text{O}_7 ^{∞2} \cdot 3\text{H}_2\text{O}$
*Jianshuiite	$(\text{Mg}, \text{Mn})^{2+} \text{Mn}^{4+}_3\text{O}_7 ^{∞2} \cdot 7\text{H}_2\text{O}$
Cesarolite	$\text{Pb}(\text{OH}) \text{Mn}^{4+}_3\text{O}_6(\text{OH}) ^{∞2}$
Lithiophorite family	
Lithiophorite group	
Lithiophorite	$ (\text{Al}, \text{Li})(\text{OH})_2 ^{∞2} \text{MnO}_2 ^{∞2}$
Mn^{2+} -lithiophorite	$ (\text{Al}, \text{Mn}^{2+}, \text{Li})(\text{OH})_2 ^{∞2} \text{MnO}_2 ^{∞2}$
Janggunitite	$ (\text{Mn}^{2+}, \text{Fe}^{3+})_{1+x}(\text{OH})_4 ^{∞2} \text{Mn}^{4+}_{5-x}(\text{OH})_2\text{O}_8 ^{∞2}$
Birnessite series	$\text{R}_{2x}(\text{OH} \cdot \text{H}_2\text{O})_{6x} (\text{Mn}^{4+}, \text{Mn}^{3+}, \text{Mg}, \text{Ca})_{1-x}(\text{OH})_2\text{O} ^{∞2}$, R = Na, K; 1/2Ca, 1/2Mg; 1/3Mn ³⁺
Mn-Birnessite	
Mg-Birnessite	
Ca-Birnessite (or simple birnessite)	
Na-Birnessite	
*Clinobirnessite	
Asbolane series	$\text{M}_{1-y}(\text{OH})_{2-2y+x}\text{Mn}^{4+}_2(\text{OH})_{2x}\text{O}_{4-2x}$; M = Al, Fe ³⁺ , Ni ²⁺ , Co ²⁺ , Fe ²⁺ , Ca
Al-Asbolane	
Ni-Asbolane	
Co-Asbolane	
Vernadite	$\text{MnO}_2 \cdot n\text{H}_2\text{O}$
3.1b.6. Overclass *: Oxides and hydroxides of V ⁴⁺	
3.1b.6a. Class : Simple oxides and hydroxides of V ⁴⁺	
	3.1b.6a.1. Neutral
Paramontroseite	VO_2
	3.1b.6a.2. Oxido-hydroxides (hydrates ?)
Doloresite	$6\text{VO}_2 \cdot 4\text{H}_2\text{O} \rightarrow \text{V}^{4+}_6(\text{OH})_4\text{O}_4$
Duttonite family	
Duttonite	$\text{VO}_2 \cdot \text{H}_2\text{O} \rightarrow \text{V}^{4+}(\text{OH})_2\text{O}$
Lenoblite	$\text{VO}_2 \cdot \text{H}_2\text{O} \rightarrow \text{V}^{4+}(\text{OH})_2\text{O}$

3.1b.6b. **Class:** Complex oxides and hydroxides of V^{4+} → vanadites

3.1b.6b.1. Oxides of *s*-cations and V^{4+}

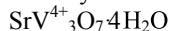
*3.1b.6b.1.1. Neutral

*Cavoite

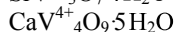


3.1b.6b.1.2. Hydrates

*Bassoite



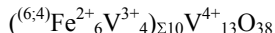
Simplotite



3.1b.6b.2. Oxides of *d*-cations and V^{4+}

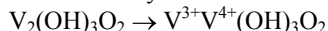
3.1b.6b.2.1. Neutral

Nolanite



3.1b.6b.2.2. Oxido-hydroxides

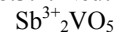
Häggite



3.1b.6b.3. Oxides of *p*-cations and V^{4+}

3.1b.6b.3.1. Neutral

Stibivanite



3.1b.7. **Overclass***: Oxides and hydroxides of V^{5+}

3.1b.7a. **Class:** Simple oxides and hydroxides of V^{5+}

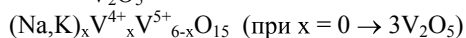
3.1b.7a.1. Neutral

Shcherbinaite family

Shcherbinaite



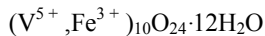
Bannermanite



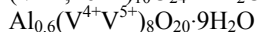
3.1b.7a.2. Hydrates

Homologous series of **navajoite** -

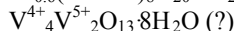
Navajoite



Bariandite



Vanoxite



3.1b.7b. **Class:** Complex oxides and hydroxides of V^{5+} → (6)-vanadates → (5)-vanadates → (4)-vanadates

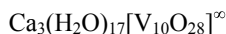
3.1b.7b.1. Quasiclass: (6)-Vanadates

3.1b.7b.1.1. (6)- Vanadates of *s*-, *d*_s- and *p*_s-cations

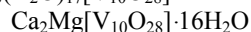
3.1b.7b.1.1.1. Hydrates

Pascoite family

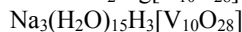
Pascoite



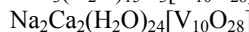
*Magnesiopascoite



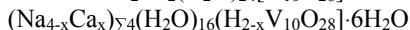
*Rakovanite



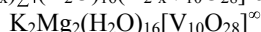
*Kokinosite



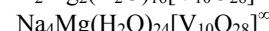
*Gunterite



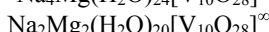
Hummerite



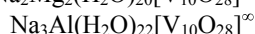
Huemulite



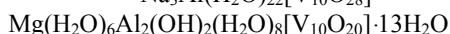
*Lasalite



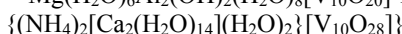
*Hughesite



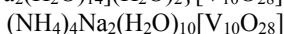
*Postite



*Wernerbaurite

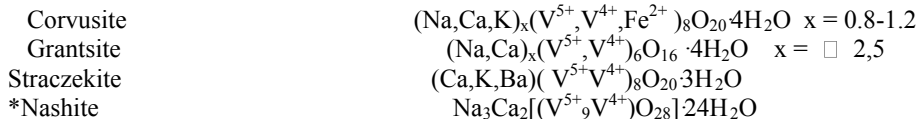


*Schindlerite



3.1b.7b.1.2. (6)-Vanadates of *d*-cations3.1b.7b.1.2.1. (6)-Vanadates of V^{4+}

3.1b.7b.2.1.1. Hydrates

Corvusite series3.1b.7b.1.2.2. (6)-Vanadates of *p*-cations

3.1b.7b.1.2.2.1. Neutral

Dreyerite family (compare with pucherite)

3.1b.7b.2. Quasiclass: (5)-Vanadates

3.1b.7b.2.1. (5)-Vanadates of *s*-, *d*_s- and *p*_s-cations

3.1b.7b.2.1.1. Proper (5)-vanadates

3.1b.7b.2.1.1.1. (5)-Vanadates with $[(^{5}V_6O_{16})]^\infty$ - radicals

3.1b.7b.2.1.1.1.1. Hydrates (neutral)

Hewettite family**Hewettite** group3.1b.7b.2.1.1.2. (5)-Vanadates with $[(^{5}V_2O_6)]^\infty$ - radicals

3.1b.7b.2.1.1.2.1. Basic → hydrates (basic)

Delrioite family

3.1b.7b.2.1.1.2.2. Hydrates (neutral)

Rossite family

3.1b.7b.2.1.2. (5)-Vanadates-(4)-vanadates

3.1b.7b.2.1.2.1. Hydrates (basic)

3.1b.7b.2.2. (5)-Vanadates of *d*-cations3.1b.7b.2.2.1. (5)-Vanadates of V^{4+}

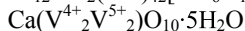
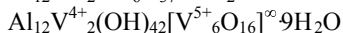
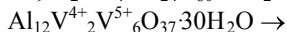
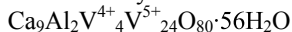
3.1b.7b.2.2.1.1. Proper (5)-vanadates

Sherwoodite

Satpaevite

Melanovanadite

3.1b.7b.2.2.1.1.1. Hydrates

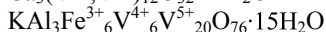
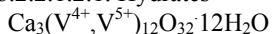


3.1b.7b.2.2.1.2. (5)-Vanadates-(4)-vanadates

Hendersonite

Bokite

3.1b.7b.2.2.1.2.1. Hydrates



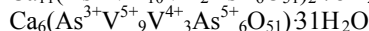
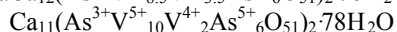
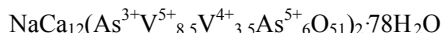
*3.16.76.2.2.1.3. (5)-Vanadato-(4)-vanadao-arsenito-arsenstes

*3.16.76.2.2.1.3.1. Hydrates

*Vanarsite

*Morrisonite

*Gatewayite



3.1b.7b.3. Quasiclass: (4)-Vanadates

3.1b.7b.3.1. (4)-Vanadates of s -, d_s - and p_s - cations

3.1b.7b.3.1.1. Divanadates

*Metamunirite

*Ronneburgite

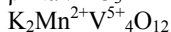
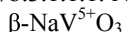
Munirite

*Dickthomssenite

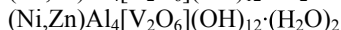
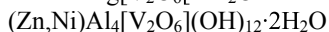
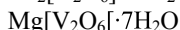
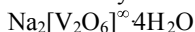
Alvanite

*Ankinovichite

*3.1b.7b.3.1.1.1. Neutral



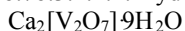
3.1b.7b.3.1.1.2. Hydrates



3.1b.7b.3.1.2. Trivanadates

Pintadoite

3.1b.7b.3.1.2.1. Hydrates



3.1b.7b.3.1.3. Tetravanadates

3.1b.7b.3.1.3.1. $\text{M}^{3+} = \text{Al}^{3+}, \text{Fe}^{3+}$ ($2\text{M}^{3+} \rightarrow \text{M}^{2+}\text{M}^{4+}$)

3.1b.7b.3.1.3.1.1. Proper tetravanadates

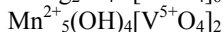
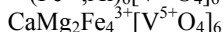
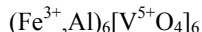
*3.1b.7b.3.1.3.1.1.1. Neutral

*Ziminaite

*Koksharovite

*Reppiaite

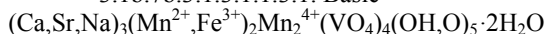
*Argandite



3.1b.7b.3.1.3.1.1.3. Hydrates

Santafeite

3.1b.7b.3.1.3.1.1.3.1. Basic



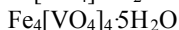
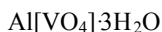
3.1b.7b.3.1.3.1.1.3.2. Neutral

Schubnelite family

Steigerite

Fervanite

Schubnelite



Rusakovite $(\text{Fe}^{3+}, \text{Al})_5(\text{OH})_9[(\text{VO}_4), (\text{PO}_4)]_2 \cdot 3\text{H}_2\text{O}$
 *Kolovratite $(\text{Ni}, \text{Zn})_x\text{VO}_4 \cdot n\text{H}_2\text{O}$

3.1b.7b.3.1.3.1.2. Vanadato-phosphates

3.1b.7b.3.1.3.1.2.1. Hydrates

Schoderite family

Schoderite $\text{Al}_2[\text{VO}_4][\text{PO}_4] \cdot 8\text{H}_2\text{O}$

Metaschoderite $\text{Al}_2[\text{VO}_4][\text{PO}_4] \cdot 6\text{H}_2\text{O}$

*3.16.76.3.1.3.1.3. Vanadato-arsenates

*Gottlobite $\text{CaMg}(\text{OH})[(\text{VO}_4), (\text{AsO}_4)]$

*Nabiasite $\text{BaMn}_9(\text{OH})_2[(\text{V}, \text{As})\text{O}_4]_6$

*Fianelite $\text{Mn}^{2+}_2\text{V}^{5+}(\text{V}^{5+}, \text{As}^{5+})\text{O}_7 \cdot 2\text{H}_2\text{O}$

3.1b.7b.3.1.3.2. M^{3+} and M^{2+}

Lyonsite

*Grigorievite

3.1b.7b.3.1.3.2.1. Neutral

$\text{Cu}^{2+}_3\text{Fe}^{3+}_4[\text{VO}_4]_6$

$\text{Cu}^{2+}_3\text{Fe}^{3+}_2\text{Al}_2[\text{VO}_4]_6$

3.1b.7b.3.1.3.2.2. Basic

$\text{PbFe}^{3+}_2(\text{OH})_2[\text{VO}_4]_2$

$\text{PbMn}^{3+}_2(\text{OH})_2[\text{VO}_4]_2$

$\text{Ba}_2\text{Mn}^{3+}(\text{OH})[\text{VO}_4]_2$

Mounanaite

*Krettnichite

*Tokyoite

3.1b.7b.3.1.3.3. M^{3+} , M^{2+} and M^+

3.1b.7b.3.1.3.3.1. Neutral

Howardevansite

$\text{Na}_2\text{Cu}^{2+}_2\text{Fe}^{3+}_4[\text{VO}_4]_6$

3.1b.7b.3.1.3.4. M^{2+}

3.1b.7b.3.1.3.4.1. Oxido-tetrvanadates and tetrvanadato-chlorides

Heyite

$\text{Pb}_5\text{Fe}^{2+}_2\text{O}_4[\text{VO}_4]_2$

3.1b.7b.3.1.3.4.2. Basic

Descloizite family**Calciovolborthite group**

Calciovolborthite

$\text{CaCu}(\text{OH})[\text{VO}_4]$

Calcium mottramite

$\text{Pb}_2\text{CaCu}_3(\text{OH})_3[\text{VO}_4]_3$

Descloizite group

Descloizite

$\text{Pb}(\text{Zn}, \text{Cu})(\text{OH})[\text{VO}_4]$

Mottramite

$\text{PbCu}(\text{OH})[\text{VO}_4]$

Čechite

$\text{Pb}(\text{Fe}^{2+}, \text{Mn})(\text{OH})[\text{VO}_4]$

Pyrobelonite

$\text{PbMn}(\text{OH})[\text{VO}_4]$

Vesignieite

$\text{BaCu}_3(\text{OH})_2[\text{VO}_4]_2$

Leningradite

$\text{PbCu}_3\text{Cl}_2[\text{VO}_4]_2$

Brackebuschite series

Gamagarite

$\text{Ba}_2(\text{Fe}, \text{Mn})^{3+}(\text{OH})[\text{VO}_4]_2$

Brackebuschite

$\text{Pb}_2(\text{Mn}, \text{Fe})^{3+}(\text{OH})[\text{VO}_4]_2$

*Calderonite

$\text{Pb}_2\text{Fe}^{3+}(\text{OH})[\text{VO}_4]_2$

*Fe-brackebuschite

$(\text{Pb}_{1,8}\text{Zn}_{0,2})(\text{Fe}^{3+}_{0,75}\text{Mn}^{3+}_{0,15}\text{Al}_{0,1})(\text{OH})[\text{VO}_4]_2$

3.1b.7b.3.1.3.5. Vanadates of M^{2+} and M^+

3.1b.7b.3.1.3.5.1. Polyvanadates

3.1b.7b.3.1.3.5.1.1. Hydrates

Huemulite	$\text{Na}_4\text{Mg}(\text{H}_2\text{O})_{24}[\text{V}_{10}\text{O}_{28}]^\infty$
3.1b.7b.3.1.3.5.2. Tetravanadates	
	3.1b.7b.3.1.3.5.2.1. Neutral
Palenzonaite	$\text{NaCa}_2\text{Mn}^{2+}_2[\text{VO}_4]_3$
*Schäferite	$\text{NaCa}_2\text{Mg}^{2+}_2[\text{VO}_4]_3$
3.1b.7b.3.1.3.5.3. Vanadates with unknown structure	
	3.1b.7b.3.1.3.5.3.1. Hydrates
Kazakhstanite	$\text{Fe}^{3+}_5(\text{OH})_9\text{V}^{4+}_3\text{V}^{5+}_{12}\text{O}_{39}\cdot 9\text{H}_2\text{O}$
3.1b.7b.3.2. (4)-Vanadates of <i>f</i> -cations	
3.1b.7b.3.2.1. Tetravanadates	3.1b.7b.3.2.1.1. Neutral
Wakefieldite series	
Wakefieldite-(Ce)	$\text{Ce}[\text{VO}_4]$
Wakefieldite-(Y)	$\text{Y}[\text{VO}_4]$
*Wakefieldite-(La)	$\text{La}[\text{VO}_4]$
*Wakefieldite-(Nd)	$\text{Nd}[\text{VO}_4]$
3.1b.7b.3.3. (4)-Vanadates of <i>d</i> -cations	
3.1b.7b.3.3.1. Vanadates of <i>Ib</i> -cations	
3.1b.7b.3.3.1.1. Cu^{2+}	
3.1b.7b.3.3.1.1.1. Trivanadates	3.1b.7b.3.3.1.1.1.1. Neutral
Ziesite family	
Ziesite	$\beta\text{-Cu}_2[\text{V}_2\text{O}_7]$
Blossite	$\alpha\text{-Cu}_2[\text{V}_2\text{O}_7]$
	3.1b.7b.3.3.1.1.1.2. Hydrates (basic)
Volborthite	$\text{Cu}_3(\text{OH})_2(\text{H}_2\text{O})_2[\text{V}_2\text{O}_7]$
*Karpenkoite	$(\text{Co,Zn})_3(\text{OH})_2(\text{H}_2\text{O})_2[\text{V}_2\text{O}_7]$
3.1b.7b.3.3.1.1.1.3. Оксидо-триванадато-хлориды	
3.1b.7b.3.3.1.1.1.3.1. Кристаллогидраты (основные)	
*Engelhauptite	$\text{KCu}_3(\text{OH})_2[\text{V}_2\text{O}_7]\text{Cl}$
*3.1b.7b.3.3.1.1.2. Триванадато-тетраванадаты	
*3.1b.7b.3.3.1.1.2.1. Оксидо-триванадато-тетраванадаты	
*Kainotroprite	$\text{Cu}_4\text{Fe}^{3+}\text{O}_2[\text{V}_2\text{O}_7][\text{VO}_4]$
3.1b.7b.3.3.1.1.3. Tetravanadates	3.1b.7b.3.3.1.1.3.1. Neutral
Mcbirneyite	$\text{Cu}_3[\text{VO}_4]_2$
*Pseudolyonsite	$\text{Cu}_3[\text{VO}_4]_2$
*Borisenkoite	$\text{Cu}_3[(\text{V,As})\text{O}_4]_2$
	3.1b.7b.3.3.1.1.3.2. Oxido-tetravanadates
Stoiberite family	
Stoiberite	$\text{Cu}_5\text{O}_2[\text{VO}_4]_2$
*Starovaite	$\text{KCu}_5\text{O}[\text{VO}_4]_3$
Fingerite	$\text{Cu}_{11}\text{O}_2[\text{VO}_4]_6$
*3.1b.7b.3.3.1.1.3.3. Oxido-tetravanadato-chlorides	
*Averievite	$\text{Cu}_5\text{O}_2[\text{VO}_4]_2\cdot\text{CuCl}_2\cdot\text{MCl}$, M=Cs,K,Rb

*Yaroshevskite	$\text{Cu}_9\text{O}_2[\text{VO}_4]_4\text{Cl}_2$
	3.1b.7b.3.3.1.1.3.4. Hydroxides
Turanite	$\text{Cu}_5(\text{OH})_4[\text{VO}_4]_2$
*3.16.76.3.3.1.2. M^+ и M^{2+}	
*3.16.76.3.3.1.2.1. Ag^+ , Hg^{2+}	
*Tillmannsite	$(\text{Ag}_3\text{Hg})(\text{V,As})\text{O}_4$
3.1b.7b.3.3.1.3. Cu^{2+} , Pb^{2+} and Bi^{3+}	
3.1b.7b.3.3.1.3.1. Tetravanadates	3.1b.7b.3.3.1.3.1.1. Hydrates (basic)
Duhamelite	$\text{Pb}_2\text{Cu}_4\text{Bi}(\text{OH})_3[\text{VO}_4]_4 \cdot 8\text{H}_2\text{O}$
*3.16.76.3.3.2. Vanadates of IIb-cations	
*3.16.76.3.3.2.1. Zn^{2+}	
*3.16.76.3.3.2.1.1. Trivanadates	
*3.16.76.3.3.2.1.1.1. Hydrates	
*Martyite	$\text{Zn}_3(\text{OH})_2[\text{V}_2\text{O}_7] \cdot 2\text{H}_2\text{O}$
3.1b.7b.3.4. (4)-Vanadates of <i>p</i> -cations	
3.1b.7b.3.4.1. Vanadates of <i>IVa</i> -cations	
3.1b.7b.3.4.1.1. Pb^{2+}	
3.1b.7b.3.4.1.1.1. Trivanadates	3.1b.7b.3.4.1.1.1.1. Neutral
Chervetite	$\text{Pb}_2[\text{V}_2\text{O}_7]$
3.1b.7b.3.4.1.1.2. Tetravanadates	3.1b.7b.3.4.1.1.2.1. Tetravanadato-chlorides
	3.1b.7b.3.4.1.1.2.1.1. Oxido-chlorido-vanadates
Kombatite	$\text{Pb}_{14}\text{O}_9[\text{VO}_4]_2\text{Cl}_4$
	3.1b.7b.3.4.1.1.2.1.2. Neutral
Vanadinite	$\text{Pb}_5[\text{VO}_4]_3\text{Cl}$ (compare with apatite (family); pyromorphite (group))
3.1b.7b.3.4.1.1.2.2. Tetravanadato-chromates	3.1b.7b.3.4.1.1.2.2.1. Hydrates
Cassedanneite	$\text{Pb}_5(\text{VO}_4)_2(\text{CrO}_4)_2 \cdot \text{H}_2\text{O}$
3.1b.7b.3.4.1.2. Pb^{2+} and Bi^{3+}	
3.1b.7b.3.4.1.2.1. Hydrovanadato-tetravanadates	3.1b.7b.3.4.1.2.1.1. Hydrates
Pottsite	$\text{PbBi}[\text{VO}_3\text{OH}][\text{VO}_4] \cdot 2\text{H}_2\text{O}$
3.1b.7b.3.4.2. Vanadates of <i>Va</i> -cations	
3.1b.7b.3.4.2.1. Tetravanadates (orthovanadates)	3.1b.7b.3.4.2.1.1. Neutral
Pucherite	$\text{Bi}^{(4)}[\text{VO}_4]^\infty$ (compare with dreyerite (family))
	3.1b.7b.3.4.2.1.2. Oxido-hydroxides
Schumacherite	$\text{Bi}^{3+}_3(\text{OH})\text{O}[\text{VO}_4]_2$
*Hechtsbergite	$\text{Bi}_2\text{O}(\text{OH})[\text{VO}_4]$

3.1c. **Quasisubtype***: Oxides and hydroxides of chalcophylic cations (without Va- and VIa- cations)

3.1c.1. **Overclass***: oxides and hydroxides of **Ib**-cations

3.1c.1.1. Cu^+

3.1c.1.1.1. Simple

Cuprite Cu_2O

3.1c.1.2. Cu^+ and Fe^{3+} (Cu^{2+})

3.1c.1.2.1. Complex

Delafossite family

Delafossite group

Delafossite $\text{Cu}^+\text{Fe}^{3+}\text{O}_2$

Mconnellite $\text{Cu}^+\text{Cr}^{3+}\text{O}_2$

Crednerite CuMnO_2

Paramelaconite $\text{Cu}^+_2\text{Cu}^{2+}_2\text{O}_3$

3.1c.1.3. Cu^{2+}

3.1c.1.3.1. Proper oxides

3.1c.1.3.1.1. Simple

Tenorite CuO

3.1c.1.3.2. Oxido-halogenides 3.1c.1.3.2.1. Simple

Melanothallite Cu_2OCl_2

3.1c.1.3.2.2. Complex

Murdochite $\text{Pb}^{4+}_2\text{Cu}^{2+}_{12}\text{O}_{15}(\text{Cl},\text{Br})_2$

3.1c.1.3.3. Hydroxides and hydroxido-halogenides

3.1c.1.3.3.1. Simple

Spertiniite $\text{Cu}(\text{OH})_2$

3.1c.1.3.3.2. Hydrates

Calumetite family

Calumetite $\text{Cu}(\text{OH},\text{Cl})_2 \cdot 2\text{H}_2\text{O}$

Anthonyite $\text{Cu}(\text{OH},\text{Cl})_2 \cdot 3\text{H}_2\text{O}$

3.1c.2. **Overclass***: Oxides and hydroxides of **IIb**-cations

3.1c.2.1. Oxides and hydroxides of Hg

3.1c.2.1.1. Hg^+

3.1c.2.1.1.1. Oxido-halogenides

3.1c.2.1.1.1.1. Simple

Poyarkovite family

Poyarkovite Hg_3OCl

Kadyrelite $\text{Hg}_6^{1+}\text{Br}_3\text{O}_{1.5}$

3.1c.2.1.1.2. Hydroxido-oxido-halogenides

3.1c.2.1.1.2.1. Simple

Eglestonite $\text{Hg}^+_6(\text{OH})\text{OCl}_3$

3.1c.2.1.2. Hg^+ and Hg^{2+}

3.1c.2.1.2.1. Oxido-halogenides

3.1c.2.1.2.1.1. Complex

Terlinguaite	$\text{Hg}_2\text{OCl} \rightarrow \text{Hg}^+\text{Hg}^{2+}\text{OCl}$
*Aurivilliusite	$\text{Hg}^+\text{Hg}^{2+}\text{OI}$
*Tedhadleyite	$\text{Hg}^{+}_{10}\text{Hg}^{2+}_4\text{O}_4\text{I}_2(\text{Cl},\text{Br})_2$
*3.1c.2.1.2.2. Oxido-sulfides	
*Deanesmithite	$\text{Hg}^{+}_2\text{Hg}^{2+}_3\text{Cr}^{6+}\text{O}_5\text{S}_2$
3.1c.2.1.3. Hg^{2+}	
3.1c.2.1.3.1. Proper oxides	
3.1c.2.1.3.1.1. Simple	
Montroydite	HgO
3.1c.2.1.3.2. Oxido-halogenides	
3.1c.2.1.3.2.1. Simple	
Comancheite family	
Pinchite	$\text{Hg}_5\text{O}_4\text{Cl}_2$
*Terkinguacreekite	$\text{Hg}^{2+}_3\text{O}_2\text{Cl}_2$
Comancheite	$\text{Hg}_{13}\text{O}_9(\text{Cl},\text{Br})_8$
*3.1c.2.1.3.3. Oxido-halogenido-carbonates	
*Vasilyevite	$\text{Hg}^{2+}_{10}\text{O}_6\text{I}_3(\text{Br},\text{Cl})_3(\text{CO}_3)$
3.1c.2.2. Oxides and hydroxides of Zn^{2+} and Cd^{2+}	
3.1c.2.2.1. Simple oxides and hydroxides	
3.1c.2.2.1.1. Proper oxides	
3.1c.2.2.1.1.1. Simple	
Zincite	ZnO (compare with bromellite (group))
Monteponite	CdO (compare with periclase (series))
3.1c.2.2.1.2. Hydroxides	
3.1c.2.2.1.2.1. Simple	
Sweetite family	
Sweetite	$\text{Zn}(\text{OH})_2$
Ashoverite	$\text{Zn}(\text{OH})_2$
Wülfingite	$\text{Zn}(\text{OH})_2$
3.1c.3. Overclass *: Oxides and hydroxides of IIIa -cations	
3.1c.3.1. Proper oxides	
3.1c.3.1.1. Simple	
Avicennite	Tl_2O_3
3.1c.3.2. Hydroxides	
3.1c.3.2.1. Simple	
Dzhalindite	$\text{In}(\text{OH})_3$
3.1c.4. Overclass *: Oxides and hydroxides of IVa -cations	
3.1c.4.1. Oxides and hydroxides of Pb	
3.1c.4.1.1. Oxides and hydroxides of Pb^{2+}	
3.1c.4.1.1.1. Proper oxides	
3.1c.4.1.1.1.1. Simple	

Litharge family

Litharge	PbO
Massicot	β -PbO
*Unnamed	α -PbO

3.1c.4.1.1.2. Oxido-halogenides

3.1c.4.1.1.2.1. Simple

Mendipite	Pb ₃ O ₂ Cl ₂
*Damaraita	Pb ₃ O ₂ (OH)Cl

3.1c.4.1.1.3. Oxido-silicato-chlorides

3.1c.4.1.1.3.1. Simple

Asisite	Pb ₇ SiO ₈ Cl ₂ → Pb ₇ O ₄ [SiO ₄]Cl ₂
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3.1B.4.1.1.4. Oxido-borato-carbonato- chlorides

3.1B.4.1.1.4.1. Simple

*Mereheadite	Pb ₄₇ O ₂₄ (OH) ₁₃ Cl ₂₅ (BO ₃) ₂ (CO ₃)
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3.1c.4.1.2. Oxides and hydroxides of Pb²⁺ and Pb⁴⁺

3.1c.4.1.2.1. Proper oxides

3.1c.4.1.2.1.1. Complex

Minium	Pb ₃ O ₄ → Pb ²⁺ ₂ Pb ⁴⁺ O ₄
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3.1c.4.1.3. Oxides and hydroxides of Pb⁴⁺

3.1c.4.1.3.1. Proper oxides

3.1c.4.1.3.1.1. Simple

Plattnerite family

Plattnerite	PbO ₂
Scrutinyite	α -PbO ₂

*3.1B.4.1.3.1.1. Complex

*Lindqvistite	Pb ²⁺ ₂ Mn ²⁺ Fe ³⁺ ₁₆ O ₂₇
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3.1c.4.2 Oxides and hydroxides of Ge и Sn

3.1c.4.2.1. Oxides and hydroxides of Sn²⁺

3.1c.4.2.1.1. Proper oxides

3.1c.4.2.1.1.1. Simple

Romarchite	SnO
------------	-----

3.1c.4.2.1.2. Oxido-hydroxides and oxido-hydroxido-halogenides

3.1c.4.2.1.2.1. Simple

Hydroromarchite family

Hydroromarchite	Sn ₃ (OH) ₂ O ₂
Abhurite	Sn ₃ (OH) ₂ OCl ₂
*Unnamed	Sn ₄ O(OH,F) ₆

*3.1c.4.2.1.2.2. Complex

*Eyselite	Fe ³⁺ Ge ⁴⁺ ₃ O ₇ (OH)
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*3.1B.4.2.1.2.2. Oxides and hydroxides of Ge⁴⁺

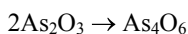
*Krieselite

3.1d. Quasisubtype*: Oxides and hydroxides of **Va**-катионов3.1d.1. **Overclass***: Oxides and hydroxides of $As^{3+}, Sb^{3+}, Bi^{3+}$ 3.1d.1a. Class: Simple oxides and hydroxides of $As^{3+}, Sb^{3+}, Bi^{3+}$

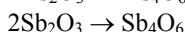
3.1d.1a.1. Proper oxides

Arsenolite family**Arsenolite** group

Arsenolite



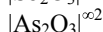
Senarmontite



Valentinite



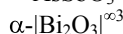
Claudetite



*Stibioclaudetite



Bismite



*Sphaerobismoite



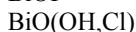
3.1d.1a.2. Oxido (hydroxido)-halogenides

Bismoclite group

Zavaritskite



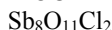
Daubreeite



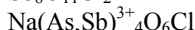
Bismoclite



Onoratoite

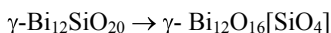


*Torrecillasite



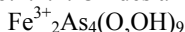
3.1d.1a.3. Oxido-silicates

Sillenite

3.1d.1b. **Class**: Complex oxides and hydroxides of $As^{3+}, Sb^{3+}, Bi^{3+} \rightarrow$ (6)-arsenites, antiminites, bismuthites3.1d.1b.1. Arsenites of *s*-, *d_s*- and *p_s*- cations3.1d.1b.1.1. Arsenites of M^{3+}

3.1d.1b.1.1.1. Oxides and hydroxides

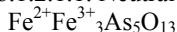
Karibibite

3.1d.1b.1.2. M^{3+} and M^{2+}

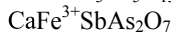
3.1d.1b.1.2.1. Proper arsenites

3.1d.1b.1.2.1.1. Neutral

Schneiderhöhnite



Stenhugarite



*3.1d.1b.1.2.1.2. Basic

*Graeserite

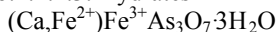


*Fetiasite

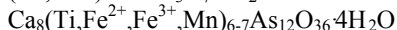


3.1d.1b.1.2.1.3. Hydrates

Lazarenkoite



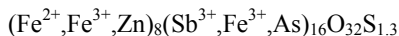
Cafarsite



3.1d.1b.1.2.2. Arsenito-sulfides

3.1d.1b.1.2.2.1. Neutral

Versiliaite



3.1d.1b.1.3. Arsenites of M^{2+}

3.1d.1b.1.3.1. Proper arsenites

Schafarzikite 3.1d.1b.1.3.1.1. Neutral
 $FeSb_2O_4$

3.1d.1b.1.3.1.2. Basic

Manganarsite family

Manganarsite $Mn_3(OH)_4As_2O_4$

Magnussonite $Mn_5(OH,Cl)As_3O_9$

3.1d.1b.1.3.1.3. Acid

Trigonite $Pb_3Mn(AsO_3)_2(AsO_2OH)$

3.1d.1b.1.3.1.4. Hydrates

Rouseite $Pb_2Mn(AsO_3)_2 \cdot 2H_2O$

3.1d.1b.1.3.2. Arsenito-halogenides 3.1d.1b.1.3.2.1. Neutral

Nanlingite $NaCa_5LiMg_{12}(AsO_3)_2[Fe^{2+}(AsO_3)_6]F_{14}$

*Lucabindiite $(K,NH_4)(As_4O_6)(Cl,Br)$

3.1d.1b.2. Arsenites of *d*-cations3.1d.1b.2.1. Arsenites of Ti^{4+} , V^{4+} 3.1d.1b.2.1.1. Basic**Tomichite** family**Tomichite** group

Tomichite $(V,Fe)^{3+}_4Ti_3(OH)AsO_{13}$

Derbylite $Fe^{3+}_4Ti_3(OH)SbO_{13}$

Hemloite $(Ti,V^{3+},Fe^{2+},Fe^{3+})_{12}(OH)(As,Sb)^{3+}_2O_{23}$

*3.1r.16.2.1.2. Hydrates

*Dukeite $Bi^{3+}_{24}Cr^{6+}_8O_{57}(OH)_6(H_2O)_3$

3.1d.1b.2.2. Arsenites of *Ib*-cations3.1d.1b.2.2.1. Arsenites of Au (only Au^+)

3.1d.1b.2.2.1.1. Antimonito- antimonates

3.1d.1b.2.2.1.1.1. Neutral

*3.1d.16.2.2.1.2. Antimonites

*Unnamed $Au_2Sb^{3+}O_2(OH)$

3.1d.1b.2.2.2. Arsenites of Cu (only Cu^{2+})

3.1d.1b.2.2.2.1. Neutral

Trippkeite $CuAs_2O_4$

*3.1d.16.2.2.3. Bismuthites Cu (only Cu^{2+}) и M^{3+}

*Kusachiite $CuBi_2O_4$

*3.1r.16.2.2.3.1. Bismuthito-oxido-sulfato-halogenides

*Atlasovite $Cu^{2+}_6Fe^{3+}Bi^{3+}O_4[SO_4]_5KCl$

3.1d.1b.2.3. Arsenites of *IIb*-cations

3.1d.1b.2.3.1. Arsenites of Hg

3.1d.1b.2.3.1.1. Oxido-halogenides

Kelyanite $Hg_{12}SbO_6BrCl_2$

3.1d.1b.2.3.2. Arsenites of Zn

3.1d.1b.2.3.2.1. Neutral

Leiteite familyLeiteite $ZnAs_2O_4$ Reinerite $Zn_3As_2O_6$ 3.1d.1b.3. Arsenites of *p*-cations3.1d.1b.3.1. Arsenites of **IVa**-cations (Pb^{2+})

3.1d.1b.3.1.1. Proper arsenites

3.1d.1b.3.1.1.1. Neutral

Paulmooreite $Pb_2As_2O_5$

3.1d.1b.3.1.2. Arsenito-halogenites 3.1d.1b.3.1.2.1. Neutral →basic

Nadorite groupNadorite $PbSbO_2Cl$ Perite $PbBiO_2Cl$ Finnemanite $Pb_5As_3O_9Cl$ Gebhardtite $Pb_8As_4O_{11}Cl_6$ Freedite $Pb_8Cu^+(As^{3+}O_3)_2O_3Cl_5$ **Ecdemite** family**Ecdemite** groupEcdemite $Pb_6As_2O_7Cl_4$ Thorikosite $Pb_3(OH)(Sb_{0.6}As_{0.4})O_3Cl_2$ Heliophyllite $Pb_6As_2O_7Cl_4$ 3.1d.2. **Overclass:** Oxides and hydroxides of As^{5+} , Sb^{5+} , Bi^{5+} (all complex) → arsenates, antimonates and bismuthates (only (6)-arsenates, (6)-antimonates and (6)-bismuthates)

3.1d.2.1. Quasiclass: (6)-arsenates, (6)-antimonates and (6)-bismuthates

3.1d.2.1.1. (6)-Arsenates, (6)-antimonates and (6)-bismuthates of - *s*-, *d*_s- and *p*_s- cations3.1d.2.1.1.1. ((6) - Arsenates, (6) - antimonates and (6) - bismuthates of *s*-, *d*_s- and*p*_s- cations (without Li and Be)3.1d.2.1.1.1.1. (6)-Arsenates, (6)-antimonates and (6)-bismuthates of M^{3+}

3.1d.2.1.1.1.1.1. Proper (6)-Arsenates, (6)-antimonates and (6)-bismuthates

3.1d.2.1.1.1.1.1.1. Basic

Bahianite $Al_5(OH)_2Sb_3O_{14} \rightarrow \{Al_5(OH)_2|Sb_3O_{14}\}^{\infty 3}$ 3.1d.2.1.1.1.2. (6)-Antimonates of M^{3+} and M^{2+}

3.1d.2.1.1.1.2.1. Neutral

Melanostibite $Mn^{2+}_2Fe^{3+}SbO_6$ *Paganoite $NiBi^{3+}As^{5+}O_5$ Cualstibite $Cu_2AlSb^{5+}(OH)_{12}$ *Zincalstibite $(Zn,Cu)_2Al(OH)_6[Sb(OH)_6]$ или $Zn_2AlSb(OH)_{12}$ *Omsite $(Ni,Cu)_2Fe^{3+}(OH)_6[Sb(OH)_6]$

3.1d.2.1.1.1.2.2. (6)-Antimonates-sulfato-hlorides

3.1d.2.1.1.1.2.3.1. Basic

Mammothite $Pb_6Cu_4Al(OH)_{16}SbO_2[SO_4]_2Cl_4$ 3.1d.2.1.1.1.3. (6)- antimonates M^{2+}

3.1d.2.1.1.1.3.1. Neutral

Byströmite group (compare with tapiolite (group)) $MgSb_2^{5+}O_6$

Byströmite	$\text{MgSb}^{5+}_2\text{O}_6$
Triphuyite	$\text{Fe}^{2+}\text{Sb}^{5+}_2\text{O}_6$ or FeSbO
	*3.1r.2.1.1.1.3.2. Basic
*Bottinoite	$\text{Ni}[\text{Sb}^{5+}(\text{OH})_6]_2 \cdot 6\text{H}_2\text{O}$
	3.1d.2.1.1.1.3.3. Oxido-antimonates
Ingersonite	$\text{Ca}_3\text{MnSb}^{5+}_4\text{O}_{14}$
	3.1d.2.1.1.1.3.3.1. Hydrates
Brandholzite	$\text{Mg}(\text{H}_2\text{O})_6[\text{Sb}(\text{OH})_6]_2$
3.1d.2.1.1.1.4. (6)-Antimonates M^{2+} and M^+	
	3.1d.2.1.1.1.4.1. Basic
Roméite series (compare with pyrochlore (series); partzite (series))	
*Fluorcalcioroméite	$[\text{Sb}^{5+}_2\text{O}_6]^{3-}(\text{Ca},\text{Na})_2\text{F}$
*Oxycalcioroméite	$\text{Ca}_2\text{Sb}_2\text{O}_7$
*Oxyplumboroméite	$\text{Pb}_2\text{Sb}_2\text{O}_7$
Na-romeite	$[\text{Sb}_2\text{O}_6]^{3-}(\text{Na},\text{Ca},\text{Mn})_2(\text{OH},\text{F})$
Lewisite	$[(\text{Sb},\text{Ti})_2(\text{O},\text{OH})_6]^{3-}(\text{Ca},\text{Fe},\text{Na})_2(\text{O},\text{OH})$
3.1d.2.1.1.1.5. (6)-Antimonates of M^+	3.1d.2.1.1.1.5.1. Acid
Mopungite	$\text{Na}[\text{Sb}(\text{OH})_6]$
	*3.1d.2.1.1.1.5.2. Neutral
*Brizziite	$\text{NaSb}^{5+}\text{O}_3$
3.1d.2.1.1.2. (6) - Antimonates of Be → beryllo-antimonates	
	3.1e.2.1.1.2.1. Neutral
Swedenborgite	$\text{NaBe}_4\text{SbO}_7 \rightarrow$ $(^{12})\text{Na}[(^{4})\text{Be}_4\text{O}({}^{(6)}\text{SbO}_6)]^{3-}$
3.1d.2.1.2. (6)-Arsenates, (6)-antimonates of <i>d</i> -cations	
3.1d.2.1.2.1. (6)-Arsenates, (6)-antimonates of <i>Ib</i> -elements	
3.1d.2.1.2.1.1. (6)-Arsenates, (6)-antimonates of Cu^{2+}	
	3.1e.2.1.2.1.1.1. Basic
Namibite	$\text{Cu}(\text{BiO})_2[\text{VO}_4](\text{OH})$
3.1d.2.1.2.1.2. (6) Antimonates of Cu^+	
	3.1e.2.1.2.1.2.1. Acid-basic
Partzite group (compare with pyrochlore (series); romeite (series))	
Partzite	$\text{Cu}_2\text{Sb}_2\text{O}_5(\text{OH})_2 (?) \rightarrow$ $[\text{Sb}_2\text{O}_5]^{3-}.\text{Cu}_2(\text{OH})_2 (?)$
Stetefeldtite	$\text{Ag}_2\text{Sb}_2(\text{O},\text{OH})_7 \rightarrow$ $[\text{Sb}_2(\text{O},\text{OH})_6]^{3-}.\text{Ag}_2(\text{O},\text{OH})$
*Auriacusite	$\text{Fe}^{3+}\text{Cu}^{2+}[(\text{As},\text{Sb})\text{O}_4]\text{O}$
3.1d.2.1.2.2. (6)-Arsenates and (6)-antimonates of <i>IIb</i> -elements	
3.1d.2.1.2.2.1. (6)-Arsenates and (6)-antimonates of Hg	
	3.1d.2.1.2.2.1.1. Basic (acid ?)
*Shanovite	$\text{Hg}^{2+}_8\text{Sb}^{5+}_2\text{O}_{13}$
Shakhovite	$\text{Hg}^+{}_4(\text{OH})_3\text{Sb}^{5+}\text{O}_3$
3.1d.2.1.2.2.2. (6)-Arsenates and (6)-Antimonates of Zn	
	3.1d.2.1.2.2.2.1. Neutral

- Ordoñezite ZnSb_2O_6 (compare with tapiolite (group); byströmimite (group)
*3.1d.2.1.2.2.2. Basic
- *Sabelliite $(\text{Cu,Zn})_2\text{Zn}[(\text{As,Sb})\text{O}_4](\text{OH})_3$
- 3.1d.2.1.3. (6) - Arsenates and (6) - Antimonates of *p*-metals
- 3.1d.2.1.3.1. (6)- Arsenates and (6) - antimonates of **IVa**-elements (Pb^{2+})
- *Rosiaite PbSb_2O_6
3.1d.2.1.3.1.1. Neutral
- Monimolite $(\text{Pb,Ca})_3\text{Sb}_2\text{O}_8$
3.1d.2.1.3.1.2. Basic (acid)
- Bindheimite $\text{Pb}_2\text{Sb}_2\text{O}_7$
- 3.1d.2.1.3.2. (6)-Arsenates, (6)-antimonates of **Va**-elements
- 3.1d.2.1.3.2.1. (6)-Arsenates, (6)-antimonates of Sb^{3+} and Bi^{3+}
3.1d.2.1.3.2.1.1. Neutral \rightarrow basic (acid)
- Cervantite (compare with stibiotantalite (group)) $\text{Sb}_2\text{O}_4 \rightarrow {}^{(4)}\text{Sb}^{3+}{}^{(6)}\text{Sb}^{5+}\text{O}_4|^{\infty 2}$
- *Clinocervantite $\beta\text{-Sb}_2\text{O}_4$
- Stibiconite** group (compare with romeite (series); partzite (group); bindheimite)
- Stibiconite questionable $\text{Sb}_3\text{O}_6(\text{OH}) \rightarrow |\text{Sb}^{5+}_2\text{O}_6|^{\infty 3}\text{Sb}^{3+}(\text{OH})$
- Bismutostibiconite questionable $\text{Bi}(\text{Sb,Fe})_2\text{O}_7 \rightarrow |(\text{Sb,Fe})_2\text{O}_6|^{\infty 3}\text{BiO}$
- 3.1e. Quasisubtype*: Oxides and hydroxides of **VIa**-cations (Te)
- 3.1e.1. Overclass*: Oxides and hydroxides of Te^{4+}
- 3.1e.1a. Class: Simple oxides and hydroxides of Te^{4+}
- Tellurite** family
- Tellurite TeO_2
- Paratellurite TeO_2
- 3.1e.1b. **Class**: Complex oxides and hydroxides $\text{Te}^{4+} \rightarrow$ Tellurites
- 3.1e.1b.1. Tellurites of *s*- and *d_s*-ations
- 3.1e.1b.1.1. Tellurites M^{3+}
- 3.1e.1b.1.1.1. Tellurites Fe^{3+}
- 3.1e.1b.1.1.1.1. Proper tellurites
- 3.1e.1b.1.1.1.1.1. Neutral
 $\text{Fe}^{3+}_2\text{Te}_3\text{O}_9$
- 3.1e.1b.1.1.1.1.2. Basic and hydroxido-chlorides
 $\text{Fe}^{3+}_2\text{Te}_2(\text{OH})\text{O}_5$
 $\text{H}_3\text{Fe}^{3+}_2\text{Te}_4\text{O}_{12}\text{Cl} \rightarrow \text{Fe}^{3+}_2\text{Te}_4(\text{OH})_3\text{O}_9\text{Cl}$
- 3.1e.1b.1.1.1.1.3. Hydrates
 $\text{Fe}^{3+}_2\text{Te}_3\text{O}_9 \cdot 2\text{H}_2\text{O}$
 $\text{Fe}^{3+}\text{Te}(\text{OH})\text{O}_3 \cdot \text{H}_2\text{O}$
- Blakeite questionable
- Mackayite
- Rodalquilarite
- Emmonsite
- Sonoraite
- 3.1e.1b.1.1.1.2. Tellurito-sulfates 3.1e.1b.1.1.1.2.1. Hydrates
Poughite $\text{Fe}^{3+}_2\text{Te}_2\text{O}_6[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
- 3.1e.1b.1.1.2. Tellurites of Fe^{3+} and Bi^{3+}
- 3.1e.1b.1.1.2.1. Tellurito-tellurates 3.1e.1b.1.1.2.1.1. Hydrates
Yecoraite $\text{Fe}^{3+}_3\text{Bi}_5\text{O}_9(\text{Te}^{4+}\text{O}_3)(\text{Te}^{6+}\text{O}_4)_2 \cdot 9\text{H}_2\text{O}$
*Pinguite $\text{Bi}_6\text{Te}^{4+}_2\text{O}_{13}$

- 3.1e.1b.1.1.3. Tellurites of M^{3+} and M^{2+}
 3.1e.1b.1.1.3.1. Proper tellurites
 3.1e.1b.1.1.3.1.1. Hydrates (basic)
 Eztlite $Pb_3Fe^{3+}_6Te^{4+}_3Te^{6+}(OH)_{10}O_{15}\cdot 8H_2O$
- 3.1e.1b.1.1.3.2. Tellurito-monoalu-monosilicates
 3.1e.1b.1.1.3.2.1. Hydrates (basic)
 Burckhardtite $Pb_2(Fe^{3+}Te^{6+})[AlSi_3O_8]O_6$
- 3.1e.1b.1.1.4. Tellurites of M^{2+}
 3.1e.1b.1.1.4.1. Proper tellurites
 3.1e.1b.1.1.4.1.1. Neutral
 Spiroffite $(Mn,Zn)_2Te_3O_8$
 *Zincspiroffite $Zn_2Te_3O_8$
 Denningite $(Mn,Ca)Te^{4+}_4O_{10}$
 3.1e.1b.1.1.4.1.2. Neutral \rightarrow Hydrates (compounds inclusions)
Zemannite family
 Kinichilite $Mg_{0.5}Mn^{2+}Fe^{3+}(Te^{4+}O_3)_3\cdot 4.5H_2O$
 Zemannite $Mg_{0.5}ZnFe^{3+}(Te^{4+}O_3)_3\cdot 4.5H_2O$
 *Ilirneyite $Mg_{0.5}\{ZnMn^{3+}(TeO_3)_3\}^{\infty 3}\cdot 4.5H_2O$
- 3.1e.1b.1.1.4.2. Tellurito-tellurates
 3.1e.1b.1.1.4.2.1. Neutral
 Carlfriesite $CaTe^{4+}_2Te^{6+}O_8$
 *Walfordite $(Fe^{3+}Te^{6+})Te^{4+}_3O_8$
- 3.1e.1b.1.1.4.3. Tellurito-carbonates
 3.1e.1b.1.1.4.3.1. Neutral
 Mroseite $CaTeO_2[CO_3]$
- 3.1e.1b.1.1.5. Tellurites of M^{2+} and M^+
 3.1e.1b.1.1.5.1. Proper tellurites
 3.1e.1b.1.1.5.1.1. Hydrates
 Keystoneite $Mg_{0.5}(Ni^{2+}Fe^{3+})_{\Sigma 2}(TeO_3)_3\cdot 4.5H_2O$
- 3.1e.1b.1.1.5.2. Tellurito-sulfato-halogenides
 3.1e.1b.1.1.5.2.1. Oxido-tellurito-sulfato-halogenides
 Nabokoite $KCu^{2+}_7Te^{4+}O_4[SO_4]_5Cl$
- 3.1e.1b.2. Tellurites of *d*-cations
 3.1e.1b.2.1. Tellurites of *IVb*-cations (Ti^{4+})
 3.1e.1b.2.1.1. Neutral
 Winstanleyite $TiTe_3O_8$
- 3.1e.1b.2.2. Tellurites of *Ib*-cations
 3.1e.1b.2.2.1. Tellurites of Cu^{2+}
 *3.1e.1b.2.2.1. Proper tellurites
 3.1e.1b.2.2.1.1.1. Neutral
 Rajite $CuTe_2O_5$
 Balyakinite $CuTeO_3$

	3.1e.1b.2.2.1.1.2. Hydrates
	3.1e.1b.2.2.1.2.1.1. Basic
Cesbronite	$\text{Cu}_5\text{Te}_2\text{O}_6(\text{OH})_6 \cdot 2\text{H}_2\text{O}$
*Brumadoite	$\text{Cu}_3(\text{Te}^{6+}\text{O}_4)(\text{OH})_4 \cdot 5\text{H}_2\text{O}$
	3.1e.1b.2.2.1.1.2.2. Neutral
Graemite family	
Graemite	$\text{CuTeO}_3 \cdot \text{H}_2\text{O}$
Teineite	$\text{Cu}(\text{Te},\text{S})\text{O}_3 \cdot 2\text{H}_2\text{O}$
*3.1e.1b.2.2.1.2. Tellurito-arsenates	
*Juabite	$\text{CaCu}^{2+}_{10}(\text{TeO}_3)_4[\text{AsO}_4]_4(\text{OH})_2(\text{H}_2\text{O})_4$
*3.1e.1b.2.2.1.3. Tellurito-halogenides	
	*3.1e.1b.2.2.1.3.1. Basic
*Mojaveite	$\text{Cu}^{2+}_6[\text{T}^{6+}\text{O}_4(\text{OH})_2](\text{OH})_7\text{Cl}$
3.1e.1b.2.2.2. Tellurites of Cu^{2+} and Zn	
3.1e.1b.2.2.2.1. Proper tellurites	
	3.1e.1b.2.2.2.1.1. Basic
Quetzalcoatlite	$\text{Cu}^{2+}_3\text{Zn}_6\text{Te}^{6+}_2\text{O}_{12}(\text{OH})_6 \cdot \text{Ag}_x\text{Pb}_y\text{Cl}_{x+2y}$
*3.1e.1b.2.2.3. Tellurito-arsenato-halogenides	
	*3.1e.1b.2.2.3.1. Hydrates
*Eurekadumpite	$(\text{Cu},\text{Zn})_{16}(\text{TeO}_3)_2(\text{AsO}_4)_3\text{Cl}(\text{OH})_{18} \cdot 7\text{H}_2\text{O}$
3.1e.1b.2.2.2.2. Tellurito-tellurato-halogenides	
	3.1e.1b.2.2.2.2.1. Hydrates
	3.1e.1b.2.2.2.2.1.1. Basic
Tlalocite	$\text{Cu}_{10}\text{Zn}_6\text{Te}^{4+}\text{Te}^{6+}_2(\text{OH})_{25}\text{O}_{11}\text{Cl} \cdot 27\text{H}_2\text{O}$
3.1e.1b.2.2.2.3. Tellurito-tellurato-sulfates	
	3.1e.1b.2.2.2.3.1. Neutral
Tlapallite	$\text{H}_6\text{Ca}_2\text{Cu}_3\text{Te}^{4+}_4\text{Te}^{6+}\text{O}_{18}[\text{SO}_4]$
3.1e.1b.2.2.3. Tellurites of Cu^{2+} and Pb	
Choloalite	$(\text{Pb},\text{Ca})_3(\text{Cu},\text{Sb})_3\text{Te}_6\text{O}_{18}\text{Cl}$
3.1e.1b.2.3. Tellurites of IIb -elements	
3.1e.1b.2.3.1. Tellurites of Hg^+	
	3.1e.1b.2.3.1.1. Neutral
Magnolite	$\text{Hg}^+_2\text{TeO}_3$
3.1e.1b.3. Tellurites of p -cations (Pb^{2+})	
3.1e.1b.3.1. Proper tellurites	
	3.1e.1b.3.1.1. Neutral
Plumbotellurite family	
Plumbotellurite	$\alpha\text{-PbTeO}_3$
Fairbankite	PbTeO_3
*3.1e.1b.3.2. Tellurato-halogenides	

*Telluroperite	$\text{Pb}_3\text{Te}^{4+}\text{O}_4\text{Cl}_2$
3.1e.1b.3.2. Tellurito-tellurates	3.1e.1b.3.2.1. Acid
	3.1e.1b.3.2.2. Hydrates
Oboyerite	$\text{H}_6\text{Pb}_6\text{Te}^{4+}_3\text{Te}^{6+}_2\text{O}_{21}\cdot 2\text{H}_2\text{O}$
3.1e.1b.4. Tellurites of semimetals	
3.1e.1b.4.1. Tellurites of Bi^{3+}	3.1e.1b.4.1.1. Neutral
Smirnite	Bi_2TeO_5
Chekhovichite	$\text{Bi}_2\text{Te}_4\text{O}_{11}$
3.1e.2. Overclass: Oxides and hydroxides of Te^{6+} (all complex) → tellurates (all (6)-tellurates)	
3.1e.2.1. Tellurites of <i>s</i> - and <i>d_s</i> - cations (M^{2+})	3.1e.2.1.1. Neutral
Yafsoanite	$\text{Ca}_3\text{Zn}_3[\text{TeO}_6]_2 \rightarrow$ $\text{Ca}_3\text{Te}_2[\text{ZnO}_4]_3$
	3.1e.2.1.2. Hydrates
Cuzticitic	$\text{Fe}_2\text{TeO}_6\cdot 3\text{H}_2\text{O}$
3.1e.2.2. Tellurates of <i>d</i> -cations	
3.1e.2.2.1. Tellurates of Mn^{4+}	
3.1e.2.2.1.1. Tellurates of Mn^{4+} and Pb	3.1e.2.2.1.1.1. Neutral
Kuranakhite	$\text{PbMn}^{4+}\text{TeO}_6$
	*3.1d.2.2.1.1.2. Hydrates
*Xocolatlite	$\text{Ca}_2\text{Mn}^{4+}_2\text{Te}^{6+}_2\text{O}_{12}\cdot \text{H}_2\text{O}$
3.1e.2.2.2. Tellurates of <i>Ib</i> -cations	
3.1e.2.2.2.1. Tellurates of Cu^{2+}	3.1e.2.2.2.1.1. Basic
Xocomecatlite	$\text{Cu}_3\text{Te}^{6+}\text{O}_4(\text{OH})_4$
*Frankhawthorneite	$\text{Cu}_2\text{Te}^{6+}\text{O}_4(\text{OH})_2$
*Mcalpineite	$\text{Cu}^{2+}_3\text{Te}^{6+}\text{O}_6$
	*3.1d.2.2.2.1.1.1. Hydrates
*Raisaite	$\text{Cu}^{2+}\text{Mg}[\text{Te}^{6+}\text{O}_4(\text{OH})_2]\cdot 6\text{H}_2\text{O}$
*Utahite	$\text{Cu}^{2+}_5\text{Zn}_3(\text{Te}^{6+}\text{O}_4)_4(\text{OH})_8\cdot 7\text{H}_2\text{O}$
*Leisingite	$\text{Cu}^{2+}(\text{Mg,Cu,FeZn})_2\text{Te}^{6+}\text{O}_6\cdot 6\text{H}_2\text{O}$
3.1e.2.2.2.2. Tellurates of Cu^{2+} and Pb	
3.1e.2.2.2.2.1. Basic	
Khinite family	
Khinite	$\text{PbCu}_3\text{Te}^{6+}(\text{OH})_2\text{O}_6$
Parakhinite = khinit-3T	$\text{PbCu}_3\text{Te}^{6+}(\text{OH})_2\text{O}_6$
*Housleyite	$\text{Pb}_6\text{Cu}^{2+}_5\text{Te}^{6+}_4(\text{OH})_2\text{O}_{18}$
*Timroseite	$\text{Pb}_2\text{Cu}^{2+}_5(\text{Te}^{6+}\text{O}_6)_2(\text{OH})_2$
*Paratimroseite	$\text{Pb}_2\text{Cu}^{2+}_4(\text{Te}^{6+}\text{O}_6)_2(\text{H}_2\text{O})_2$
*Andycristiite	$\text{PbCu}^{2+}(\text{Te}^{6+}\text{O}_5)(\text{H}_2\text{O})$
*Eckhardite	$(\text{Ca,Pb})\text{Cu}^{2+}\text{Te}^{6+}\text{O}_5(\text{H}_2\text{O})_2$

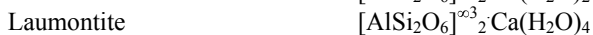
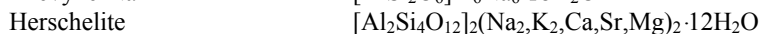
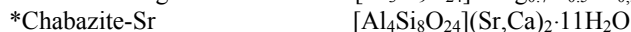
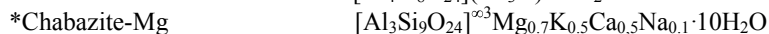
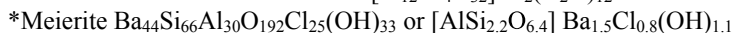
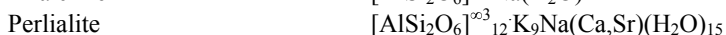
*3.1e.2.2.2.2.3. Tellurato-carbonates	
*3.1e.2.2.2.2.3.1. Basic	
*Agaite	$\text{Pb}_3\text{Cu}^{2+}\text{Te}^{6+}\text{O}_5(\text{OH})_2[\text{CO}_3]$
*3.1e.2.2.2.2.4. Tellurato-sulfates	
*3.1e.2.2.2.2.4.1. Basic	
*3.1e.2.2.2.2.4.1.1. Hydrates	
*Bairdite	$\text{Pb}_2\text{Cu}^{2+}_4(\text{Te}^{6+}\text{O}_5)_2(\text{OH})_2[\text{SO}_4](\text{H}_2\text{O})$
3.1e.2.2.2.3. Tellurates of IIb -cations	
3.1e.2.2.2.3.1. Tellurates of Zn	
3.1e.2.2.2.3.1.1. Tellurates of Zn and Pb	
3.1e.2.2.2.3.1.1.1. Tellurato-arsenates	3.1e.2.2.2.3.1.1.1.1. Basic
Dugganite	$\text{Pb}_3\text{Zn}_3\text{Te}^{6+}_6[\text{AsO}_4]_2$
*Joëlbruggerite	$\text{Pb}_3\text{Zn}_3(\text{Sb}^{5+}, \text{Te}^{6+})\text{O}_5[\text{AsO}_4]_2(\text{OH}, \text{O})$
*3.1e.2.2.3.1.1.2. Tellurato-phosphates	
*3.1e.2.2.3.1.1.2.1. Basic	
*Kuksite	$\text{Pb}_3\text{Zn}_3\text{Te}^{6+}_6[\text{PO}_4]_2$
*3.1e.2.2.3.1.1.2. Tellurato -vanadates	
*3.1e.2.2.3.1.1.2.1. Basic	
*Cheremnykhite	$\text{Pb}_3\text{Zn}_3\text{Te}^{6+}_6[\text{VO}_4]_2$
3.1e.2.3. Tellurates of p -metals	
3.1e.2.3.1. Tellurates of IVa -metals	3.1e.2.3.1.1. Hydrates
*Ottoite	$\text{Pb}_2\text{Te}^{6+}\text{O}_5$
Schieffelinite	$\text{Pb}_{10}\text{Te}_6\text{O}_{20}(\text{OH})_{14}[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
*Chromschiefelinite	$\text{Pb}_{10}\text{Te}_6\text{O}_{20}(\text{OH})_{14}[\text{CrO}_4] \cdot (\text{H}_2\text{O})_5$
*Thorneite	$\text{Pb}_6[\text{Te}^{6+}_2\text{O}_{10}][\text{CO}_3]\text{Cl}_2(\text{H}_2\text{O})$
3.1e.2.4. Tellurates of semimetals (Bi^{3+})	3.1e.2.4.1. Hydrates
Montanite	$\text{Bi}_2\text{TeO}_6 \cdot 2\text{H}_2\text{O}$
3.1f. Quasisubtype*: Oxides and hydroxides of nonmetals (lithophylic) elements	
3.1f.1. Class : Oxides and hydroxides of Si and Ge (silicic and germanium anhydrides, silicic and germanium asids)	
3.1f.1.1. Ionic-covalent crystals	3.1f.1.1.1. Neutral
Stishovite group (compare with rutile, cassiterite)	
Stishovite	$\text{}^{(6)}\text{SiO}_2$
*Mon. (mineral high pressure)	SiO_2
Argutite	$\text{}^{(6)}\text{GeO}_2$
Silice family	
Coesite	$\{\text{SiO}_2\}^{\infty 3}$
β -Tridymite	$\{\text{SiO}_2\}^{\infty 3}$
α -Tridymite	$\{\text{SiO}_2\}^{\infty 3}$
*Orthorhombic	SiO_2
*Seifertite orth.	SiO_2
Cristobalite	$\{\text{SiO}_2\}^{\infty 3}$
β -Quartz	$\{\text{SiO}_2\}^{\infty 3}$

α -Quartz	$\{\text{SiO}_2\}^{\infty 3}$
Lutecine	$\{\text{SiO}_2\}^{\infty 3}$
3.1f.1.2. Globular crystals	3.1f.1.2.1. Hydrates
Opal family	
Opal	$\text{SiO}_2 \cdot n\text{H}_2\text{O}$
Silhydrite	$3\text{SiO}_2 \cdot \text{H}_2\text{O}$
3.1f.1.3. Silico-organic substances	
Melanophlogite	$\text{Si}_{46}\text{O}_{92} \text{C}_2\text{H}_{17}\text{O}_5$
*Chibaite	$\text{SiO}_2 \cdot n(\text{CH}_4, \text{C}_2\text{H}_6, \text{C}_3\text{H}_8, \text{C}_4\text{H}_{10}); (n_{\max} = 3/17)$
3.1f.2. Class: Oxides and hydroxides of B (boric anhydride and boric acids)	
Sassolite family	
Metaborite	HBO_2
*Clinometaborite	$\beta\text{-HBO}_2$
Sassolite	$\text{B}(\text{OH})_3 \rightarrow \text{H}_3\text{BO}_3$
3.1f.3 Class: Oxides and hydroxides of Se (selenium anhydrite)	
Downeyite	SeO_2
3.2. Subtype: Oxosalts (anisodesmical)	
3.2.1. Class: Silicates	
Subclass: Silicates of cations with low FC	
Silicates and aluminosilicates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s -cations	
Silicates and aluminosilicates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s -cations (without Li^+ and Be^{2+})	
Proper silicates and aluminosilicates	
Zero-aluminosilicates (K = 0 Neutral, with compounds inclusions which contain H_2O)	
Cordierite family	
Cordierite series	
Cordierite	$\text{Mg}_2\{\text{Al}_3[(\text{Si}_5\text{Al})_{\Sigma 6}\text{O}_{18}]\}^{\infty 3}$
Sekaninaite	$\text{Fe}^{2+}_2\{\text{Al}_3[(\text{Si}_5\text{Al})_{\Sigma 6}\text{O}_{18}]\}^{\infty 3}$
Indialite	$(\text{Mg}, \text{Fe})_2\{\text{Al}_3[(\text{Si}_5\text{Al})_{\Sigma 6}\text{O}_{18}]\}^{\infty 3}$
*Ferroidialite	$(\text{Fe}, \text{Mg})_2\{\text{Al}_3[(\text{Si}_5\text{Al})_{\Sigma 6}\text{O}_{18}]\}^{\infty 3}$
Feldspar family	
Plagioclase subfamily (Ca-Na-feldspar)	
Anorthite	$\text{Ca}[\text{Al}_2\text{Si}_2\text{O}_8]^{\infty 3} (\text{An}); \text{An}_{90-100}$
*Dmisteinbergite	$\text{Ca}[\text{Al}_2\text{Si}_2\text{O}_8]$
*Svyatoslavite	$\text{Ca}[\text{Al}_2\text{Si}_2\text{O}_8]$
*Lisetite	$\text{Na}_2\text{Ca}[\text{Al}_2\text{Si}_2\text{O}_8]_2$
Bytownite	An_{70-90}
*Maskelynite – it is a glass whis bytownite composition	
Labradorite	An_{50-70}
Andesine	An_{30-50}
Oligoclase	An_{10-30}
*Lingunite	$\text{Na}[\text{AlSi}_3\text{O}_8]$
Na-K-feldspar subfamily	
Albite	$\text{Na}[\text{AlSi}_3\text{O}_8] (\text{Ab}); \text{An}_{0-10}$
*Albite tetragonal	$\text{Na}[\text{AlSi}_3\text{O}_8]$
*Kumdykolite	$\text{Na}[\text{AlSi}_3\text{O}_8]$

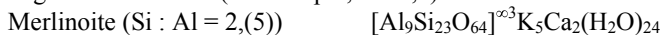
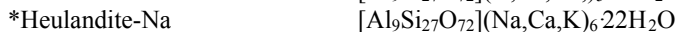
Anorthoclase	$(\text{Na},\text{K})[\text{AlSi}_3\text{O}_8]^{+3}$
Sanidine	$(\text{K},\text{Na})[\text{AlSi}_3\text{O}_8]^{+3}$
Microcline	$\text{K}[\text{AlSi}_3\text{O}_8]^{+3}$
*Rubicline	$\text{Rb}[\text{AlSi}_3\text{O}_8]^{+3}$
Orthoclase	$\text{K}[\text{AlSi}_3\text{O}_8]^{+3}$
*Mineral mon., pseudotet. whis hollandite structure.	$\text{K}[\text{AlSi}_3\text{O}_8]$
*Kokchetavite	$\text{K}[\text{AlSi}_3\text{O}_8]$
K-Ba-feldspar subfamily	
Hyalophane	$(\text{K},\text{Ba})[(\text{Si},\text{Al})\text{Si}_3\text{O}_8]^{+3}$
Celsian	$\text{Ba}[\text{Al}_2\text{Si}_2\text{O}_8]^{+3}$
Paracelsian	$\text{Ba}[\text{Al}_2\text{Si}_2\text{O}_8]^{+3}$
*Filatovite	$\text{K}[(\text{Al},\text{Zn})_2(\text{As},\text{Si})_2\text{O}_8]^{+3}$
Slawsonite	$(\text{Sr},\text{Ca})[\text{Al}_2\text{Si}_2\text{O}_8]^{+3}$
Banalsite	$\text{BaNa}_2[\text{Al}_2\text{Si}_2\text{O}_8]^{+3}_2$
Buddingtonite	$\text{NH}_4[\text{AlSi}_3\text{O}_8]$
Feldspathoid family	
Nepheline subfamily	
Stronalsite	$\text{Na}_2\text{Sr}[\text{AlSiO}_4]^{+3}_4$
Nepheline	$4(\text{Na},\text{K})[\text{AlSiO}_4]^{+3} \rightarrow \text{KNa}_3[\text{AlSiO}_4]^{+3}_4$
Trikalsilite	$(\text{K}_{0.67}\text{Na}_{0.33})[\text{AlSiO}_4]^{+3}$
Panunzite	$(\text{K}_{0.7}\text{Na}_{0.3})[\text{AlSiO}_4]^{+3}$
Kalsilite	$\text{K}[\text{AlSiO}_4]^{+3}$
*Megakalsilite	$\text{K}[\text{AlSiO}_4]$
Kaliophilite	$\text{K}[\text{AlSiO}_4]^{+3}$
Leucite subfamily	
Leucite	$\text{K}[\text{AlSi}_2\text{O}_6]^{+3}$
Ammonioleucite	$\text{NH}_4[\text{AlSi}_2\text{O}_6]^{+3}$
Pollucite	$(\text{Cs},\text{Na})[\text{AlSi}_2\text{O}_6]^{+3} \cdot n\text{H}_2\text{O}$
Scapolite series $(\text{Ca},\text{Na})_4(\text{Si},\text{Al})_{12}\text{O}_{24}(\text{CO}_3,\text{SO}_4,\text{Cl})$	
*Silvialite	$[\text{Al}_6\text{Si}_6\text{O}_{24}] \text{Ca}_4(\text{SO}_4)$ or $[\text{Al}_2\text{Si}_2\text{O}_8]^{+3}_3 \text{Ca}_4(\text{SO}_4)$
Meionite	$[(\text{Si},\text{Al})_4\text{O}_8]_3(\text{Ca},\text{Na})_4(\text{CO}_3,\text{SO}_4,\text{Cl}), \text{Me}_{75-100}$
Mizzonite	Me_{50-75}
Dipyre	Me_{25-50}
Marialite	$[\text{AlSi}_3\text{O}_8]^{+3}_3\text{Na}_4\text{Cl}; \text{Me}_{0-25}$
Cancrinite series	
*Balliranoite	$[\text{Al}_6\text{Si}_6\text{O}_{24}][(\text{Na},\text{K})_6(\text{CO}_3)_2][\text{Ca}_2\text{Cl}_2]$
Cancrinite	$[\text{Al}_6\text{Si}_6\text{O}_{24}][(\text{Na},\text{K})_6(\text{CO}_3)_2][\text{Ca}_2(\text{H}_2\text{O})_2]$
Cancrilsilite	$[\text{Al}_5\text{Si}_7\text{O}_{24}][\text{Na}_5\text{CO}_3(\text{H}_2\text{O})][\text{Na}_2(\text{H}_2\text{O})_2]$
Davyne	$[\text{Al}_6\text{Si}_6\text{O}_{24}][(\text{Na},\text{K})_6(\text{SO}_4)_{0.5}\text{Cl}][\text{Ca}_2\text{Cl}_2]$
*Depmeierite	$[\text{Al}_6\text{Si}_6\text{O}_{24}][\text{Na}_6(\text{PO}_4)(\text{CO}_3)_{0.5-1}(\text{H}_2\text{O})][\text{Na}_2(\text{H}_2\text{O})_2]$
*Hydroxycancrinite	$[\text{Al}_6\text{Si}_6\text{O}_{24}][\text{Na}_6(\text{OH})(\text{CO}_3)][\text{Na}_2(\text{H}_2\text{O})_2]$
*Kyanoxalite	$[\text{Al}_{5-6}\text{Si}_{6-7}\text{O}_{24}][\text{Na}_6(\text{C}_2\text{O}_4)(\text{H}_2\text{O})_3](\text{OH})[\text{Na}_2(\text{H}_2\text{O})_2]$
Microsommitte	$[\text{Al}_6\text{Si}_6\text{O}_{24}][(\text{Na},\text{K})_6(\text{SO}_4)][\text{Ca}_2\text{Cl}_2]$
*Pitiglianoite	$[\text{Al}_6\text{Si}_6\text{O}_{24}][\text{Na}_4\text{K}_2(\text{SO}_4)][\text{Na}_2(\text{H}_2\text{O})_2]$
*Qudrivadavne	$[\text{Al}_6\text{Si}_6\text{O}_{24}][(\text{Na},\text{K})_6\text{Cl}_2][\text{Ca}_2\text{Cl}_2]$
*Carbobystrite	$[\text{Al}_6\text{Si}_6\text{O}_{24}]\text{Na}_8(\text{CO}_3) \cdot 4\text{H}_2\text{O}$
*Farneseite	$[\text{Al}_6\text{Si}_6\text{O}_{24}]_7\text{Na}_{46}\text{Ca}_{10}(\text{SO}_4)_{12} \cdot 6\text{H}_2\text{O}$
*Alloriite	$[\text{Al}_6\text{Si}_6\text{O}_{24}][\text{Na}_5\text{K}_{1.5}\text{Ca}](\text{SO}_4)(\text{OH})_{0.5} \cdot \text{H}_2\text{O}$

*Biachellaite	$[\text{Al}_6\text{Si}_6\text{O}_{24}](\text{Na},\text{Ca},\text{K})_8(\text{OH})_{0.5}(\text{SO}_4)_2 \cdot \text{H}_2\text{O}$
*Kircherite	$[\text{Al}_{12}\text{Si}_{12}\text{O}_{48}](\text{Na}_{10}\text{Ca}_4\text{K}_2)(\text{SO}_4)_4 \cdot 2/3\text{H}_2\text{O}$
*Tounkite	$[\text{Al}_6\text{Si}_6\text{O}_{24}](\text{Na},\text{Ca},\text{K})_8(\text{SO}_4)_2\text{Cl} \cdot 0.5\text{H}_2\text{O}$
Afghanite	$[\text{Al}_{24}\text{Si}_{24}\text{O}_{96}][(\text{Na},\text{K})_{22}\text{Ca}_{10}](\text{SO}_4)_6\text{Cl}_6$
Giuseppettite	$[\text{Si}_{48}\text{Al}_{48}\text{O}_{192}]\text{Na}_{42}\text{K}_{16}\text{Ca}_6(\text{SO}_4)_{10}\text{Cl}_2 \cdot 5\text{H}_2\text{O}$
*Marinellite	$[\text{Al}_{36}\text{Si}_{36}\text{O}_{144}]\text{Na}_{42}\text{Ca}_6(\text{SO}_4)_8\text{Cl}_2 \cdot 6\text{H}_2\text{O}$
Franzinite	$[\text{Si}_{30}\text{Al}_{30}\text{O}_{120}](\text{Na},\text{K})_{30}\text{Ca}_{10}(\text{SO}_4)_{10} \cdot 2\text{H}_2\text{O}$ or $[\text{SiAlO}_4]_{30}(\text{Na},\text{K})_{30}\text{Ca}_{10}(\text{SO}_4)_{10} \cdot 2\text{H}_2\text{O}$
*Fantappieite	$[\text{Al}_{99}\text{Si}_{99}\text{O}_{396}]\text{Na}_{82.5}\text{Ca}_{33}\text{K}_{16.5}(\text{SO}_4)_{33} \cdot 6\text{H}_2\text{O}$
*Bystrite	$[\text{Al}_6\text{Si}_6\text{O}_{24}]\text{Ca}(\text{Na},\text{K})_7(\text{S}_3)_{1.5} \cdot \text{H}_2\text{O}$
Vishneville series	
Wenkite	$[(\text{Si},\text{Al})_{20}\text{O}_{41}]\text{Ba}_4\text{Ca}_6(\text{OH})_2(\text{SO}_4)_3 \cdot \text{H}_2\text{O}$
Liottite	$[\text{Si}_{18}\text{Al}_{18}\text{O}_{72}]\text{Na}_{16}\text{Ca}_8(\text{SO}_4)_5\text{Cl}_4$
Sacrofanite	$[(\text{Si},\text{Al})_{12}\text{O}_{24}](\text{Na},\text{Ca})_9(\text{OH},\text{SO}_4,\text{CO}_3,\text{Cl})_4 \cdot n\text{H}_2\text{O}$
Vishneville	$[(\text{Al}_6\text{Si}_6)\text{O}_{24}]\text{Na}_8(\text{SO}_4) \cdot 2\text{H}_2\text{O}$
Sodalite series	
Sodalite	$[\text{AlSiO}_4]^{3-}_6 \text{Na}_8\text{Cl}_2$
Haiüyne	$[(\text{Si}_3\text{Al}_3)\text{O}_{12}]\text{Na}_3\text{Ca}(\text{SO}_4)$
*Vladimirivanovite	$[\text{Al}_6\text{Si}_6\text{O}_{24}]\text{Na}_6\text{Ca}_2[\text{SO}_4,\text{S}_3,\text{S}_2,\text{Cl}]_2 \cdot \text{H}_2\text{O}$
Lazurite series	
Lazurite	$[(\text{Al}_6\text{Si}_6\text{O}_{24})]\text{Na}_6\text{Ca}_2(\text{SO}_4,\text{S},\text{S}_2,\text{S}_3,\text{Cl},\text{OH})_2$
Nosean	$[(\text{Si}_6\text{Al}_6)\text{O}_{24}]\text{Na}_8(\text{SO}_4) \cdot \text{H}_2\text{O}$
Zeolites family Low-silicic zeolites (Si : Al up 1 to 1,(6))	
Parthéite	$[(\text{Si}_4\text{Al}_4\text{O}_{15})]\text{Ca}_2(\text{OH})_2 \cdot 4\text{H}_2\text{O}$
Thomsonite subfamily (Si : Al = 1)	
Gismondine	$[\text{AlSiO}_4]^{3-}_2 \text{Ca}(\text{H}_2\text{O})_4$
Thomsonite-Ca	$[\text{AlSiO}_4]^{3-}_5 \text{NaCa}_2(\text{H}_2\text{O})_6$
*Thomsonite-Sr	$[\text{AlSiO}_4]^{3-}_5 (\text{Sr},\text{Ca})_2\text{Na} \cdot 6 \cdot 7\text{H}_2\text{O}$
Willhendersonite	$[\text{AlSiO}_4]^{3-}_3 \text{KCa}(\text{H}_2\text{O})_5$
*Willhendersonite-Ca	$[\text{AlSiO}_4]^{3-}_3 \text{CaK}(\text{H}_2\text{O})_5$
Amicite	$[\text{AlSiO}_4]^{3-}_4 \text{K}_2\text{Na}_2(\text{H}_2\text{O})_5$
*Flörkeite	$[\text{AlSiO}_4]_8 \text{K}_3\text{Ca}_2\text{Na} \cdot 12\text{H}_2\text{O}$
*Bellbergite	$[\text{AlSiO}_4]^{3-}_{18} (\text{K},\text{Ba},\text{Sr})_2\text{Sr}_2\text{Ca}_2(\text{Ca},\text{Na})_4 \cdot 30(\text{H}_2\text{O})$
*Tschörtnerite	$[\text{AlSiO}_4]^{3-}_{12} \text{Ca}_4(\text{K},\text{Ca},\text{Sr},\text{Ba})_3\text{Cu}_3(\text{OH})_8 \cdot n\text{H}_2\text{O} \quad n \approx 20$
Scolecite-natrolite subfamily (Si : Al = 1,5)	
Scolecite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{3-}_3 \text{Ca}(\text{H}_2\text{O})_3$
Cowlesite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{3-}_3 \text{Ca}(\text{H}_2\text{O})_{5-6}$
Edingtonite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{3-}_3 \text{Ba}(\text{H}_2\text{O})_4$
Mesolite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{3-}_3 \text{Na}_2\text{Ca}_2(\text{H}_2\text{O})_8$
Gonnardite	$[(\text{Si},\text{Al})_5\text{O}_{10}](\text{Na},\text{Ca})_2 \cdot 3\text{H}_2\text{O}$
Natrolite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{3-}_3 \text{Na}_2(\text{H}_2\text{O})_2$
Paranatrolite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{3-}_3 \text{Na}_2(\text{H}_2\text{O})_3$
Garronite subfamily (Si:Al = 1,(6))	
Garronite-Ca	$[\text{Al}_3\text{Si}_5\text{O}_{16}]^{3-}_2 \text{NaCa}_{2.5}(\text{H}_2\text{O})_{14}$
Garronite-Na	$[\text{Al}_3\text{Si}_3\text{O}_{16}]^{3-}_2 \text{Na}_6 \cdot 8.5\text{H}_2\text{O}$
Phillipsite-Ca	$[(\text{Si}_{10}\text{Al}_6)\text{O}_{32}]\text{Ca}_3 \cdot 12\text{H}_2\text{O}$
*Phillipsite-K	$[(\text{Si}_{10}\text{Al}_6)\text{O}_{32}]\text{K}_6 \cdot 12\text{H}_2\text{O}$
*Phillipsite-Na	$[(\text{Si}_{10}\text{Al}_6)\text{O}_{32}]\text{Na}_6 \cdot 12\text{H}_2\text{O}$
*Unnamed (Si:Al = 1,9)	$[\text{Al}_{11}\text{Si}_{21}\text{O}_{64}]\text{Ca}_5\text{K}_2 \cdot 18.4\text{H}_2\text{O}$

Middle-silicic zeolites (Si : Al up 2 to 2,2)

**Wairakite** subfamily (Si : Al = 2)**Chabazite** series**Gmelinite** subfamily (Al : Si = 2)

High-silicic zeolites (Si : Al up 2,5 to 3,5)

**Stilbite** subfamily (Si : Al = 3)

*Stilbite-Na	$[\text{Al}_9\text{Si}_{27}\text{O}_{72}]\text{Na}_9 \cdot 28\text{H}_2\text{O}$
Goosecreekite	$[\text{AlSi}_3\text{O}_8]^{+3}_2 \text{Ca}(\text{H}_2\text{O})_5$
*Maricopaite	$[\text{Al}_{12}\text{Si}_{36}\text{O}_{99}]\text{Ca}_2\text{Pb}_7 \text{n}(\text{H}_2\text{O}, \text{OH})$
Paulingite-Ca (Si : Al = 3,2)	$[\text{Al}_5\text{Si}_{16}\text{O}_{42}]^{+3}_2 (\text{Ca}, \text{K}, \text{Na}, \text{Ba}, \text{R})_{10} \cdot 34\text{H}_2\text{O}$
*Paulingite-Na	$[\text{Al}_{10}\text{Si}_{35}\text{O}_{90}](\text{Na}_2, \text{K}_2, \text{Ca}, \text{Ba})_5 \cdot 45\text{H}_2\text{O}$
*Paulingite-K	$[(\text{Si}, \text{Al})_{42}\text{O}_{84}](\text{K}, \text{Ca}, \text{Na}, \text{Ba}, \text{R})_{10} \cdot 34\text{H}_2\text{O}$

Stellerite subfamily (Si : Al = 3,5)

Stellerite	$[\text{Al}_2\text{Si}_7\text{O}_{18}]^{+3}_4 \text{Ca}_4 \cdot 28\text{H}_2\text{O}$
Barrerite	$[\text{Al}_2\text{Si}_7\text{O}_{18}]^{+3} \text{Na}_2 \cdot 6\text{H}_2\text{O}$
*Direnzote (Si : Al = 3,6)	$[\text{Al}_{13}\text{Si}_{47}\text{O}_{120}]\text{NaK}_6\text{MgCa}_2 \cdot 36\text{H}_2\text{O}$

Ultra-high-silicic zeolites (Si : Al up 3,8 to 6 and above)

Svetozarite (Si : Al = 3.8)	$[\text{Al}_{10}\text{Si}_{38}\text{O}_{96}](\text{Na}_2, \text{Ca}, \text{K}_2)_5 \cdot 25\text{H}_2\text{O}$
*Boggsite (Si : Al = 4,2)	$[(\text{Al}_{18}\text{Si}_{77})_{296}\text{O}_{192}]\text{Na}_3\text{Ca}_8 \cdot 70\text{H}_2\text{O}$

Dachiardite series (Si : Al = 5)

Sodium dachiardite	$[\text{Al}_8\text{Si}_{40}\text{O}_{96}](\text{Na}_2, \text{Ca}, \text{K}_2)_{4.5} \cdot 26\text{H}_2\text{O}$
Dachiardite-Ca	$[\text{Al}_4\text{Si}_{20}\text{O}_{48}]\text{Ca}_2 \cdot 13\text{H}_2\text{O}$
Dachiardite-K	$[\text{Al}_4\text{Si}_{20}\text{O}_{48}]\text{K}_4 \cdot 13\text{H}_2\text{O}$

Clinoptilolite subfamily (Si : Al = 5)

*Clinoptilolite-Ca	$[\text{Al}_6\text{Si}_{30}\text{O}_{72}]\text{Ca}_3 \cdot 20\text{H}_2\text{O}$
*Clinoptilolite-K	$[\text{Al}_6\text{Si}_{30}\text{O}_{72}]\text{K}_6 \cdot 20\text{H}_2\text{O}$
*Clinoptilolite-Na	$[\text{Al}_6\text{Si}_{30}\text{O}_{72}]\text{Na}_6 \cdot 20\text{H}_2\text{O}$

Tsaregorodtsevite (Si : Al = 5)	$[\text{Si}_4(\text{SiAl})\text{O}_{12}]\text{N}(\text{CH}_3)_4$
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Mordenite subfamily (Si : Al = 5)

Mordenite	$[\text{AlSi}_5\text{O}_{12}]^{+3}_8 (\text{Na}_2, \text{Ca}, \text{K}_2)_4 \cdot 28\text{H}_2\text{O}$
*Terranovaite	$[\text{Si}_{68}\text{Al}_{12}\text{O}_{160}](\text{Na}, \text{Ca})_8 \cdot 29\text{H}_2\text{O}$
*Gottardite (Si : Al = 6,2)	$[\text{Si}_{117}\text{Al}_{19}\text{O}_{272}]\text{Na}_3\text{Mg}_3\text{Ca}_5 \cdot 93\text{H}_2\text{O}$
* Ferrierite subfamily (Si : Al = 6,2)	
*Ferrierite-K	$[\text{Al}_5\text{Si}_{31}\text{O}_{72}]\text{K}_2\text{NaMg} \cdot 18\text{H}_2\text{O}$
*Ferrierite-Na	$[\text{Al}_5\text{Si}_{31}\text{O}_{72}]\text{Na}_3\text{KMg}_{0.5} \cdot 18\text{H}_2\text{O}$
*Ferrierite-Mg	$[\text{Al}_7\text{Si}_{29}\text{O}_{72}]\text{Mg}_{2.5}\text{K}_{0.5}\text{Na}_{0.5}\text{Ca}_{0.5} \cdot 18\text{nH}_2\text{O}$
*Mutinaite (Si : Al = 7,7)	$[\text{Al}_{11}\text{Si}_{85}\text{O}_{192}]\text{Na}_3\text{Ca}_4 \cdot 60\text{H}_2\text{O}$

Basic zero-alumosilicates

Bicchulite family

Bicchulite	$\text{Ca}_2(\text{OH})_2[\text{Al}_2\text{SiO}_6]^{+3}$
Kamaishilite	$\text{Ca}_2(\text{OH})_2[\text{Al}_2\text{SiO}_6]^{+3}$
	Hydrates; neutral
Cymrite	$\text{Ba}[\text{AlSiO}_4]^{+2}_2 \cdot \text{nH}_2\text{O} \quad (\text{n} = 0.5-1)$

Zeroalumosilicato-carbonato-chlorides *Hydrates

*Kampffite	$\text{Ba}_{12}[(\text{Si}_{11}\text{Al}_5)\text{O}_{31}](\text{CO}_3)_8\text{Cl}_5$
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Zerosilicates

	*Hydrates
*Afwillite	$\text{Ca}_3[\text{SiO}_4][\text{SiO}_2(\text{OH})_2] \cdot 2\text{H}_2\text{O}$
	*Hydrates basic
*Makatite	$\text{Na}_2[\text{Si}_4\text{O}_8](\text{OH})_2 \cdot 4\text{H}_2\text{O}$
*Yegorovite	$\text{Na}_4[\text{Si}_4\text{O}_8(\text{OH})_4] \cdot 7\text{H}_2\text{O}$
*Megaciclite	$\text{Na}_8\text{K}[\text{Si}_9\text{O}_{18}](\text{OH})_9 \cdot 19\text{H}_2\text{O}$

Zero-monoalumo- and zero-monosilicates ($0 < K < 1$)



Zero-monoalumosilicates c $K_\Sigma = 0,3$ and $0,(3)$

Neutral



Acid

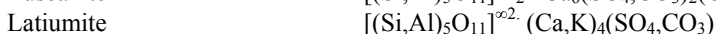


*Zero-monosilicates with $K = 0,3$ *Basic \rightarrow Hydrates

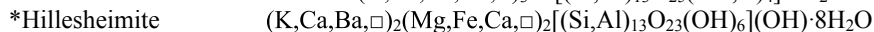
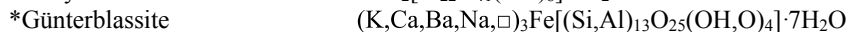


Zero-monoalumosilicates with $K_\Sigma = 0,4$ Neutral \rightarrow Hydrates

Latiumite family



Zero-monoalumosilicates with $K_\Sigma = 0,45$



*Zero-monoalumosilicato-halogenides



*Zero-monoalumosilicates and zero-monosilicates c $K_\Sigma = 0,5$



Zero-monoalumosilicates with $K_\Sigma = 0,5$

Acid zero-monoalumosilicates



*Hydrates



*Zero-monoalumosilicates with $K_\Sigma = 0,57$ *Neutral

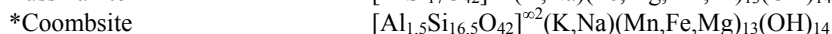
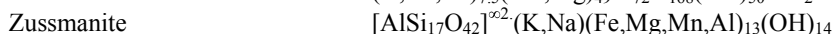
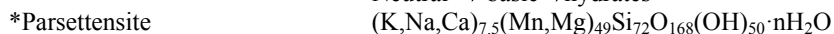


*Hydrates

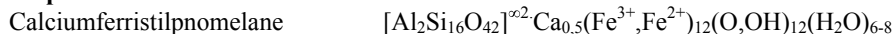


Zero-monoalumosilicates and zero-monosilicates with $K_\Sigma = 0,6$

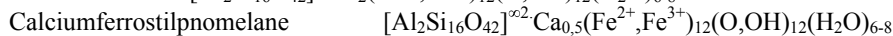
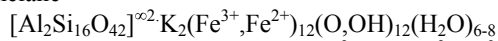
Neutral \rightarrow basic \rightarrow hydrates



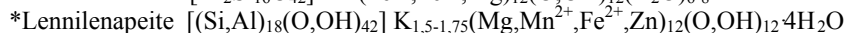
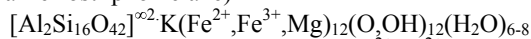
Stilpnomelane series



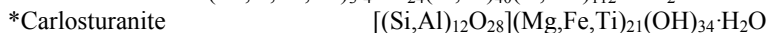
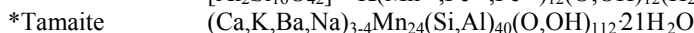
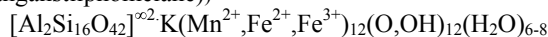
Kaliferristilpnomelane



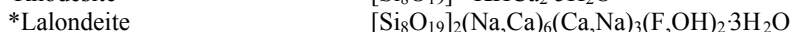
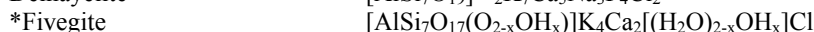
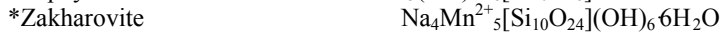
Stilpnomelane (kaliferrostilpnomelane)



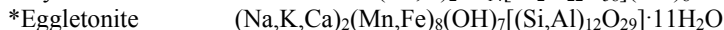
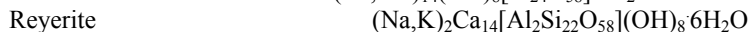
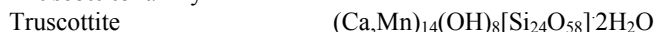
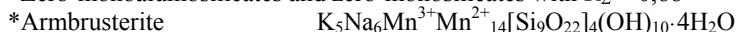
Ganophyllite (manganstilpnomelane)

Zero-monoalumosilicates and zero-monosilicates with $K_{\Sigma} = 0,75$

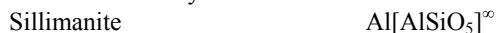
Neutral → basic → hydrates

Delhayelite family*Zero-monoalumosilicates and zero-monosilicates with $K_{\Sigma} = 0,8$ o HydratesZero-monoalumosilicates and zero-monosilicates with $K_{\Sigma} = 0,83$

Hydrates (basic and neutral)

Truscottite family*Zero-monoalumosilicates and zero-monosilicates with $K_{\Sigma} = 0,88$ Monoalumosilicates and monosilicates ($K = 1$)

Monoalumosilicates Neutral

Sillimanite family

Basic alumosilicates hydrates

**Mica** family

Fragile mica subfamily – $(^{4})(\text{Al,Fe}^{3+})$: Si up 3 : 1 to 1 : 1	
Clintonite	$\text{Ca}\{(\text{Mg}_2\text{Al})(\text{OH})_2[\text{Al}_3\text{SiO}_{10}]^{\infty 2}\}^{\infty 2}$
Margarite	$\text{Ca}\{\text{Al}_2\Box(\text{OH})_2[\text{Al}_2\text{Si}_2\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Chernykhite	$\text{BaV}^{3+}_2\Box(\text{OH})_2[\text{Al}_2\text{Si}_2\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Siderophyllite subfamily	
Preiswerkite	$\text{Na}\{\text{Mg}_2\text{Al}(\text{OH})_2[\text{Al}_2\text{Si}_2\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Siderophyllite	$\text{K}\{\text{Fe}^{2+}_2\text{Al}(\text{OH})_2[\text{Al}_2\text{Si}_2\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Anandite subfamily	
Kinoshitalite	$(\text{Ba,K})\{(\text{Mg,Mn})_3(\text{OH})_2[\text{Al}_2\text{Si}_2\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
*Ferrokinochitalite	$\text{BaFe}^{2+}_3(\text{OH})_2[\text{Al}_2\text{Si}_2\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Anandite	$\text{BaFe}^{2+}_3(\text{OH})[(\text{Si}_3\text{Fe}^{3+})\text{O}_{10}]\text{S}$
*Oxykinoshitalite	$\text{BaMg}_2\text{Ti}^{4+}\text{O}_2[(\text{Si}_2\text{Al}_2)\text{O}_{10}]$
Usual mica subfamily – $(^{4})(\text{Al,Fe})^{3+}$: Si ~ 1 : 3	
Paragonite	$\text{Na}\{\text{Al}_2\Box(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
*Na-Sr mica	$\text{Na}_{0,50}\text{Sr}_{0,25}\text{Al}_2(\text{Na}_{0,25}\Box_{0,75})(\text{OH})_2[\text{Al}_{1,25}\text{Si}_{2,75}\text{O}_{10}]$
Muscovite series	
Muscovite	$\text{K}\{\text{Al}_2\Box(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
*Ganterite	$\text{Ba}_{0,5}(\text{Na,K})_{0,5}\{\text{Al}_2(\text{OH})_2[\text{Al}_{1,5}\text{Si}_{2,5}\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
*Chromphyllite	$\text{K}\{\text{Cr}_2\Box(\text{OH},\text{F})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Roscoelite	$\text{K}\{\text{V}_2(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
*Nanpingite	$\text{Cs}\{\text{Al}_2(\text{OH},\text{F})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Tobelite	$\text{NH}_4\{\text{Al}_2(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Phlogopite subfamily	
Wonesite	$(\text{Na,K},\Box)(\text{Mg,Fe,Al})_6(\text{OH},\text{F})_4[(\text{Si,Al})_8\text{O}_{20}]^{\infty 2}\}^{\infty 2}$
Sodium phlogopite	$\text{Na}\{\text{Mg}_3(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Hydroxyl-phlogopite	$\text{K}\{\text{Mg}_3(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Tetraferriphlogopite	$\text{K}\{\text{Mg}_3(\text{OH})_2[(\text{Fe}^{3+}\text{Si}_3)\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Fluorophlogopite	$\text{K}\{\text{Mg}_3(\text{F},\text{OH})_2[\text{AlSi}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
*Oxyphlogopite	$\text{K}(\text{Mg,Ti,Fe})_3(\text{O},\text{F})_2[(\text{Si,Al})_4\text{O}_{10}]$
*Aspidolite	$\text{NaMg}_3(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]$
Manganophyllite	$\text{K}(\text{Mn,Mg,Al})_{2,3}(\text{OH})_2[(\text{Al,Si})_4\text{O}_{10}]$
*Schirozulite	$\text{KMn}^{2+}_3(\text{OH})_2[\text{AlSi}_3\text{O}_{10}]$
Annite	$\text{KFe}^{2+}_3(\text{OH})_2[(\text{Fe}^{3+}\text{Si}_3)\text{O}_{10}]$
Tetraferriannite	$\text{K}\{(\text{Fe}^{2+},\text{Mg})_3(\text{OH})_2[(\text{Fe}^{3+},\text{Al})\text{Si}_3\text{O}_{10}]^{\infty 2}\}^{\infty 2}$
Fluorannite	$\text{KFe}^{2+}_3\text{F}_2[\text{AlSi}_3\text{O}_{10}]$
*Montdorite	$\text{KFe}^{2+}_{1,5}\text{Mn}^{2+}_{0,5}\text{Mg}_{0,5}\Box_{0,5}\text{F}_2[\text{Si}_4\text{O}_{10}]$
*Yangzhumingite	$\text{KMg}_{2,5}\text{F}_2[\text{Si}_4\text{O}_{10}]^{\infty}$
Biotite – micas between, or close to, the annite-phlogopite and siderophellite - eastonite joins; dark micas without lithium	
Chlorite family	
Disepiochlorite subfamily	
Sudoite	$\text{Mg}_2\text{Al}_3(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
*Glagolevite	$\text{NaMg}_6(\text{OH},\text{O})_8[\text{AlSi}_3\text{O}_{10}]\cdot\text{H}_2\text{O}$
Clinochlore series	
Corundophilite = Fe-clinochlor	$(\text{Mg,Fe})_3\{(\text{Mg,Al})_3(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]\}$
Leuchtenbergite = clinochlor	$(\text{Mg,Al})_6(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
Clinochlore	$(\text{Mg}_5\text{Al})(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
Ripidolite	$(\text{Mg,Fe,Al})_6(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
Prochlorite	$\text{Mg}_5\text{Al}(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$

Chamosite	$(\text{Fe,Al,Mg})_6(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
Orthochamosite	$(\text{Fe}^{2+}, \text{Mg, Fe}^{3+})_5\text{Al}(\text{OH, O})_8[\text{AlSi}_3\text{O}_{10}]$
Gonyerite	$\text{Mn}^{2+}_5\text{Fe}^{3+}(\text{OH})_8[\text{Fe}^{3+}\text{Si}_3\text{O}_{10}]$
Pennantite	$\text{Mn}^{2+}_5\text{Al}(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
Nimite	$(\text{Ni, Mg, Al})_6(\text{OH})_8[\text{AlSi}_3\text{O}_{10}]$
Septechlorites subfamily	
Odinite (mon.)	$(\text{Fe}^{3+}, \text{Mg, Al, Fe}^{2+})_{2.5}(\text{OH})_4[(\text{Si, Al})_2\text{O}_5]$
Amesite series	
Amesite	$\text{Mg}_2\text{Al}(\text{OH})_4[\text{AlSiO}_5]$
Brindleyite (nimesite)	$(\text{Ni, Al})_3(\text{OH})_4[(\text{Si, Al})_2\text{O}_5]$
Fraipontite	$(\text{Zn, Al})_3(\text{OH})_4[(\text{Si, Al})_2\text{O}_5]$
Cronstedtite series	
Berthierine	$(\text{Fe}^{2+}, \text{Fe}^{3+}, \text{Al})_3(\text{OH})_4[(\text{Si, Al})_2\text{O}_5]$
Cronstedtite	$(\text{Fe}^{2+}\text{Fe}^{3+})_3(\text{OH})_4[(\text{Si, Fe}^{3+})_2\text{O}_5]$
*Guidottiite	$(\text{Mn}_2\text{Fe}^{3+})(\text{OH})_4[(\text{Si, Fe}^{3+})\text{O}_5]$
Hydromica family	
Vermiculite subfamily	
Vermiculite	$\text{Mg}_{0.7}(\text{Mg, Fe}^{3+}, \text{Al})_6(\text{OH})_4[(\text{Si, Al})_8\text{O}_{20}] \cdot 8\text{H}_2\text{O}$
Brammallite	$(\text{Na, H}_3\text{O})(\text{Al, Mg, Fe})_2(\text{OH})_2[\text{Si, Al})_4\text{O}_{10}]$
Illite	$\text{K}_{0.65}\text{Al}_{2.0}(\text{OH})_2[\text{Al}_{0.65}\text{Si}_{3.35}\text{O}_{10}]$
Hydrobiotite	$\text{K}(\text{Mg, Fe}^{2+})_6(\text{OH})_4[(\text{Si, Al})_8\text{O}_{20}] \cdot n\text{H}_2\text{O}$
*Rudenkoite	$\text{Sr}_3(\text{OH, O})_8\text{Cl}_2[(\text{Si}_{3.5}\text{Al}_{3.5})\text{O}_{10}] \cdot \text{H}_2\text{O}$
Celadonite series	
Celadonite	$\text{KFe}^{3+}(\text{Mg, Fe}^{2+})[\square\text{Si}_4\text{O}_{10}](\text{OH})_2$
*Alumoceladonite	$\text{KAl}(\text{Mg, Fe}^{2+})[\square\text{Si}_4\text{O}_{10}](\text{OH})_2$
*Ferroalumoceladonite	$\text{KFe}^{2+}\text{Al}[\square\text{Si}_4\text{O}_{10}](\text{OH})_2$
*Ferroceladonite	$\text{KFe}^{3+}(\text{Fe}^{2+}, \text{Mg})[\square\text{Si}_4\text{O}_{10}](\text{OH})_2$
*Chromceladonite	$\text{KCr}^{3+}(\text{Mg, Fe}^{2+})[\square\text{Si}_4\text{O}_{10}](\text{OH})_2$
*Manganiceladonite	$\text{KMgMn}^{3+}[\text{Si}_4\text{O}_{10}](\text{OH})_2$
Glaucanite	$(\text{K, Na})(\text{Mg, Fe}^{2+}, \text{Fe}^{3+})(\text{Fe}^{3+}, \text{Al})[\text{Si, Al})_4\text{O}_{10}](\text{OH})_2$
*Corrensite orth., regular interstratification of trioctahedral chlorite with either trioctahedral vermiculite or trioctahedral smectite .	
Smectite family	
Montmorillonite subfamily	
Swinefordite	$\text{Ca}_{0.2}(\text{Li, Al, Mg, Fe})_3(\text{OH, F})_2[(\text{Si, Al})_2\text{O}_5]_2 \cdot n\text{H}_2\text{O}$
Montmorillonite	$(\text{Na, Ca})_{0.3}(\text{Al, Mg})_2(\text{OH})_2[\text{Si}_2\text{O}_5]_2 \cdot n\text{H}_2\text{O}$
*Montmorillonite-Fe	$(\text{Na, Ca})_{0.3}(\text{Fe, Mg})_2(\text{OH})_2[\text{Si}_2\text{O}_5]_2 \cdot n\text{H}_2\text{O}$
*Brinrobertsite	$(\text{Na, K, Ca})_{0.3}(\text{Al, Fe, Mg})_4(\text{OH})_4[(\text{Si, Al})_8\text{O}_{20}] \cdot 3, 5\text{H}_2\text{O}$
Volkonskoite	$(\text{Na, K, Ca})_{0.3}(\text{Al, Mg, Fe})_4(\text{OH})_4[(\text{Si, Al})_8\text{O}_{20}] \cdot 3, 5\text{H}_2\text{O}$
Beidellite	$(\text{Na, Ca})_{0.3}\text{Al}_2(\text{OH})_2[(\text{Si, Al})_4\text{O}_{10}] \cdot n\text{H}_2\text{O}$
Nontronite	$\text{Na}_{0.3}\text{Fe}_2^{3+}(\text{OH})_2[(\text{Si, Al})_4\text{O}_{10}] \cdot n\text{H}_2\text{O}$
*Rectorite	$(\text{Na, Ca})\text{Al}_4(\text{OH})_4[(\text{Si, Al})_8\text{O}_{20}] \cdot 2\text{H}_2\text{O}$
*Yakhontovite	$\text{CaCu}^{2+}_2(\text{OH})_2[\text{Si}_4\text{O}_{10}] \cdot 3\text{H}_2\text{O}$
Saponite subfamily	
Sobotkite	$(\text{K, Ca}_{0.5})_{0.33}(\text{Mg}_{0.66}\text{Al}_{0.33})_3(\text{OH})_2[(\text{Si}_3\text{Al})\text{O}_{10}] \cdot 1-5\text{H}_2\text{O}$
Saponite	$(\text{Ca, Na})_{0.3}(\text{Mg, Fe}^{2+})_3(\text{OH})_2[(\text{Si, Al})_4\text{O}_{10}] \cdot 4\text{H}_2\text{O}$
Ferrisaponite	$\text{Ca}_{0.3}(\text{Fe}^{3+}\text{Mg, Fe}^{2+})_3(\text{OH})_2[(\text{Si, Al})_4\text{O}_{10}] \cdot 4\text{H}_2\text{O}$
*Ferro-saponite	$\text{Ca}_{0.3}(\text{Fe}^{2+}, \text{Mg, Fe}^{3+})_3(\text{OH})_2[(\text{Si, Al})_4\text{O}_{10}] \cdot 4\text{H}_2\text{O}$
Palygorskite-sepiolite family (alumosilicates → silicates)	
Palygorskite subfamily	

Palygorskite	$(\text{Mg,Al})_2(\text{OH})[\text{Si}_4\text{O}_{10}] \cdot 4\text{H}_2\text{O}$
Yofortierite	$(\text{Mn}^{2+}, \text{Mg,Fe}^{3+})_5(\text{OH, H}_2\text{O})_2[\text{Si}_8\text{O}_{20}] \cdot 7\text{H}_2\text{O}$
Tuperssuatsiaite	$\text{Na}_2(\text{Fe}^{3+}, \text{Mn}^{2+})_3(\text{OH})_2[\text{Si}_8\text{O}_{20}] \cdot 4\text{H}_2\text{O}$
*Raite	$\text{Na}_3\text{Mn}^{2+}_3\text{Ti}^{4+}_{0.25}(\text{OH})_2[\text{Si}_8\text{O}_{20}] \cdot 10\text{H}_2\text{O}$
*Windhoekite	$\text{Ca}_2\text{Fe}^{3+}_{2.67}(\text{OH})_4[(\text{Si,Al})_8\text{O}_{20}] \cdot 10\text{H}_2\text{O}$
Sepiolite subfamily	
Sepiolite	$\text{Mg}_4(\text{OH})_2[\text{Si}_6\text{O}_{15}] \cdot 6\text{H}_2\text{O}$
*Ferrisepiolite	$(\text{Fe}^{3+}, \text{Fe}^{2+}, \text{Mg})_4(\text{O, OH})_2[(\text{Si, Fe}^{3+})_6\text{O}_{15}] \cdot 6\text{H}_2\text{O}$
Falcondoite	$\text{Ni}_4(\text{OH})_2[\text{Si}_6\text{O}_{15}] \cdot 6\text{H}_2\text{O}$
Loughlinite	$\text{Na}_2\text{Mg}_3[\text{Si}_6\text{O}_{16}] \cdot 8\text{H}_2\text{O}$
Osumilite family	
Armenite	$\text{BaCa}_2\text{Al}_3[\text{Al}_3\text{Si}_9\text{O}_{30}] \cdot 2\text{H}_2\text{O}$
Osumilite series	
Yagiite	$(\text{Na, K})_3\text{Mg}_4\text{Al}_6[(\text{Si, Al})_{12}\text{O}_{30}]_2$
Osumilite-(Mg)	$(\text{K, Na})(\text{Mg, Fe}^{2+})_2(\text{Al, Fe}^{3+})_3[(\text{Si, Al})_{12}\text{O}_{30}]$
Osumilite	$(\text{K, Na})(\text{Fe, Mg, Mn})^{2+}_2(\text{Al, Fe}^{3+})_3[(\text{Si, Al})_{12}\text{O}_{30}]$
*Trattnerite	$(\text{Mg, Fe}^{2+})_3\text{Fe}^{3+}_2[\text{Si}_{12}\text{O}_{30}]$
Chayesite	$\text{K}(\text{Mg, Fe}^{2+})_2(\text{Mg, Fe}^{2+})_2\text{Fe}^{3+}[\text{Si}_{12}\text{O}_{30}]$
*Unnamed	$\text{Fe}^{2+}_5\text{Mg}^{2+}_5[(\text{Al, Si})_{12.5}\text{O}_{30}]_2$
Monosilicates	
Proper monosilicates	Neutral
Gillespite family	
Gillespite	$\text{BaFe}^{2+}[\text{Si}_4\text{O}_{10}]^{\infty 2}$
Sanbornite	$\text{Ba}[\text{Si}_2\text{O}_5]^{\infty 2}$
*Bigcreekite	$\text{Ba}[\text{Si}_2\text{O}_5] \cdot 4\text{H}_2\text{O}$
Natrosilite	$\text{Na}_2[\text{Si}_2\text{O}_5]^{\infty 2}$
Fenaksite	$\text{K}_2\text{Na}_2\text{Fe}^{2+}_2[\text{Si}_8\text{O}_{20}]^{\infty}$
*Manaksite	$\text{NaKMn}[\text{Si}_4\text{O}_{10}]$
*Tuhualite	$(\text{Na, K})\text{Fe}^{2+}\text{Fe}^{3+}[\text{Si}_6\text{O}_{15}]$
*Kalifersite	$(\text{K, Na})_5\text{Fe}^{3+}_7[\text{Si}_{20}\text{O}_{50}](\text{OH})_6 \cdot 12\text{H}_2\text{O}$
Roedderite series	
Roedderite	$\text{KNa}(\text{Mg, Fe})_5[\text{Si}_{12}\text{O}_{30}]^{\infty}$
Merrihueite	$\text{KNa}(\text{Fe, Mg})_5[\text{Si}_{12}\text{O}_{30}]^{\infty}$
Eifelite	$\text{KNa}_3\text{Mg}_4[\text{Si}_{12}\text{O}_{30}]^{\infty}$
*Shibkovite	$\text{K}(\text{Ca, Mn, Na})_2(\text{K}_{2-x}\square_x)\text{Zn}_3[\text{Si}_{12}\text{O}_{30}]$
*Shirokshinite	$\text{KNaMg}_2[\text{Si}_4\text{O}_{10}]\text{F}_2$
Agrellite	$\text{NaCa}_2\text{F}[\text{Si}_4\text{O}_{10}]^{\infty}$
*Friedrichbeckeite	$\text{K}(\square_{0.5}\text{Na}_{0.5})_2\text{Mg}_2(\text{MgBe}_2)[\text{Si}_{12}\text{O}_{30}]\square$
	Hydrates (basic)
*Cairncrossite ($\text{M}^{2+} : \text{OH} = 4.5$)	$\text{Sr}_2\text{Ca}_{7-x}\text{Na}_{2x}(\text{OH})_2[\text{Si}_4\text{O}_{10}]_4 (\text{H}_2\text{O})_{15-x} (0 \leq x \leq 1)$
*Calcinaksite	$\text{KNaCa}[\text{Si}_4\text{O}_{10}]\text{H}_2\text{O}$
Canasite ($\text{M}^{2+} : \text{OH} = 2$)	$\text{K}_3\text{Na}_3\text{Ca}_5(\text{O, OH, F})_4[\text{Si}_{12}\text{O}_{30}]^{\infty}$
*Fluorcanasite	$\text{K}_3\text{Na}_3\text{Ca}_5(\text{F, OH})_4[\text{Si}_{12}\text{O}_{30}] \cdot \text{H}_2\text{O}$
*Frankamenite	$\text{K}_3\text{Na}_3\text{Ca}_5(\text{OH})\text{F}_3[\text{Si}_{12}\text{O}_{30}] \cdot \text{H}_2\text{O}$
Talc-pyrophyllite family ($\text{M}^{2+} : \text{OH} = 1, 5$)	
*Erlianite	$\text{Fe}^{2+}_4\text{Fe}^{3+}_2(\text{OH})_8[\text{Si}_2\text{O}_5]_3$
Pyrophyllite series	
Pyrophyllite	$\{\text{Al}_2(\text{OH})_2[\text{Si}_2\text{O}_5]^{\infty 2}_2\}^{\infty 2}$

Ferripyrophyllite	$\{\text{Fe}^{3+}_2(\text{OH})_2[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Talc series	
Talc	$\{\text{Mg}_3(\text{OH})_2[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
*Stevensite	$\text{Mg}_3(\text{OH})_2[\text{Si}_4\text{O}_{10}]$
Minnesotaite	$\{(\text{Fe},\text{Mg})_3(\text{OH})_2[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Willemseite = nickel-kerolite	$\{(\text{Ni},\text{Mg})_3(\text{OH})_2[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Kerolite series	
Kerolite	$\{\text{Mg}_3(\text{OH})_2[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}\cdot\text{H}_2\text{O}$
* Tungusite family ($\text{M}^{2+} : \text{OH} = 1$)	
*Tungusite	$\text{Ca}_{14}\text{Fe}^{2+}_9(\text{OH})_{22}[\text{Si}_6\text{O}_{15}]_4$
Pyrosmalite family ($\text{M}^{2+} : \text{OH} = 0,8$)	
Pyrosmalite series	
Pyrosmalite-(Fe)	$(\text{Fe}^{2+},\text{Mn})_8(\text{OH},\text{Cl})_{10}[\text{Si}_6\text{O}_{15}]^{∞2}$
Pyrosmalite-(Mn)	$(\text{Mn}^{2+},\text{Fe})_8(\text{OH},\text{Cl})_{10}[\text{Si}_6\text{O}_{15}]^{∞2}$
Brokenhillite	$(\text{Mn},\text{Fe})_8(\text{OH},\text{Cl})_{10}[\text{Si}_6\text{O}_{15}]^{∞2}$
Mcgillite	$(\text{Mn},\text{Fe})_8(\text{OH})_8\text{Cl}_2[\text{Si}_6\text{O}_{15}]^{∞2}$
Friedelite	$\text{Mn}_8(\text{OH},\text{Cl})_{10}[\text{Si}_6\text{O}_{15}]^{∞2}$
Bementite	$\text{Mn}_7(\text{OH})_8[\text{Si}_6\text{O}_{15}]^{∞2}$
*Innsbruckite	$\text{Mn}_{33}(\text{OH})_{38}[\text{Si}_2\text{O}_5]_{14}$
Serpentine family ($\text{M}^{2+} : \text{OH} = 0,75$)	
Antigorite	$\{\text{Mg}_6(\text{OH})_8[\text{Si}_4\text{O}_{10}]^{∞2}_2\}^{∞2}$
Caryopilite	$\{\text{Mn}_6(\text{OH})_8[\text{Si}_4\text{O}_{10}]^{∞2}_2\}^{∞2}$
Clinochrysotile	$\{\text{Mg}_3(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Lizardite	$\{\text{Mg}_3(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Orthochrysotile	$\{\text{Mg}_3(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Greenalite	$\{(\text{Fe}^{2+},\text{Fe}^{3+})_{2-3}(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Karpinskite	$\{(\text{Mg},\text{Ni})_2(\text{OH})_2[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
*Willemseite	$\{(\text{Ni},\text{Mg})_3(\text{OH})_2[\text{Si}_2\text{O}_5]_2\}$
Nepouite	$\{\text{Ni}_3(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Pecoraite	$\{\text{Ni}_3(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Kaolinite-halloysite family ($\text{M}^{2+} : \text{OH} = 0,75$)	
Kaolinite subfamily	
Kaolinite	$\{\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Dickite	$\{\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Nacrite	$\{\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
*Kellyite	$(\text{Mn}^{2+},\text{Mg},\text{Al})_3(\text{OH})_4[(\text{Si},\text{Al})_2\text{O}_5]$
Halloysite subfamily	
Halloysite-10Å.	$\{\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}\cdot(\text{H}_2\text{O})_2$
*Halloysite-7Å	$\{\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}$
Endellite = halloysite-10Å	$\{\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}\cdot(\text{H}_2\text{O})_2$
Hisingerite	$\{\text{Fe}^{3+}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{∞2}_2\}^{∞2}\cdot(\text{H}_2\text{O})_2$
Grumantite	$\text{Na}[\text{Si}_2\text{O}_4(\text{OH})]^{∞2}\cdot\text{H}_2\text{O}$
Kanemite	$\text{Na}[\text{Si}_2\text{O}_4(\text{OH})]3\text{H}_2\text{O}$
	Basic → silicato-fluorides → Hydrates
Apophyllite family	
Apophyllite series	
Natrofluorapophyllite = apophyllite-(NaF)	$\text{NaCa}_4\text{F}[\text{Si}_4\text{O}_{10}]^{∞2}_2\cdot 8\text{H}_2\text{O}$
Hydroxyapophyllite = apophyllite-(KOH)	$\text{KCa}_4\text{F}[\text{Si}_4\text{O}_{10}]^{∞2}_2\cdot 8\text{H}_2\text{O}$

Fluorapophyllite = apophyllite-(KF)	$\text{KCa}_4(\text{F}, \text{OH})[\text{Si}_4\text{O}_{10}]^{\infty 2} \cdot 8\text{H}_2\text{O}$
Bannisterite	$(\text{Ca}, \text{K}, \text{Na}, \text{Mn}^{2+}, \text{Fe}^{2+})_{10}(\text{OH})_8[\text{Si}_4\text{Al}_{16}\text{O}_{38}]^{\infty 2} \cdot n\text{H}_2\text{O}$
*Gyrolite	$(\text{NaCa}_2)\text{Ca}_{14}(\text{OH})_8[\text{Si}_{23}\text{Al}\text{O}_{60}] \cdot (14+x)\text{H}_2\text{O}$
*Orlymanite	$\text{Ca}_4\text{Mn}^{2+}_3(\text{OH})_6[\text{Si}_8\text{O}_{20}] \cdot 2\text{H}_2\text{O}$
*Cryptophyllite	$\text{K}_2\text{Ca}[\text{Si}_4\text{O}_{10}] \cdot 5\text{H}_2\text{O}$
*Shlykovite	$\text{KCa}[\text{Si}_4\text{O}_9(\text{OH})] \cdot 3\text{H}_2\text{O}$
*Aklimaite	$\text{Ca}_4[\text{Si}_2\text{O}_5(\text{OH})_2](\text{OH})_4 \cdot 5\text{H}_2\text{O}$
Suolunite	$\text{Ca}_2[\text{Si}_2\text{O}_5(\text{OH})_2] \cdot \text{H}_2\text{O}$
Revdite	$\text{Na}_{16}[\text{Si}_{16}\text{O}_{27}(\text{OH})_{26}] \cdot 28\text{H}_2\text{O}$
	Neutral
Nekoite	$\text{Ca}_3[\text{Si}_6\text{O}_{15}]^{\infty 2} \cdot 7\text{H}_2\text{O}$

Mono-mono-disilicates with mixed silicooxygens radical

Basic

Charoite	$(\text{K}, \text{Na})_5(\text{Ca}, \text{Ba}, \text{Sr})_8(\text{OH}, \text{F})[\text{Si}_6\text{O}_{15}]^{\infty 2} [\text{Si}_6\text{O}_{16}] (\text{H}_2\text{O})_n$
Okenite	$\{\text{Ca}_8(\text{H}_2\text{O})_6[\text{Si}_6\text{O}_{15}]^{\infty} \}_2 [\text{Si}_6\text{O}_{16}]^{\infty} \cdot 2\text{Ca}_2(\text{H}_2\text{O})_{12}$

Mono-disilicates (including isomorphous aluminosilicates)

Mono-disilicates with K = 1, 1(6)

Hydrates (basic)

Riversideite family

Tacharanite	$\text{Ca}_8\text{Al}_{1,33}(\text{H}_2\text{O})_9(\text{OH})_6[\text{Si}_{12}\text{O}_{31}]^{\infty 2} (?)$
Riversideite	$\text{Ca}_{10}(\text{H}_2\text{O})_3(\text{OH})_6[\text{Si}_{12}\text{O}_{31}]^{\infty 2}$
Plombierite	$\text{Ca}_{10}(\text{H}_2\text{O})_{18}(\text{OH})_6[\text{Si}_{12}\text{O}_{31}]^{\infty 2}$

Mono-disilicates with K = 1, (3)

Basic

*Denisovite	$(\text{K}, \text{Na})\text{Ca}_2(\text{F}, \text{OH})[\text{Si}_3\text{O}_8]$
*Marshallussmanite	$\text{NaCaMn}(\text{OH})[\text{Si}_3\text{O}_8]$

Jimthompsonite family

Jimthompsonite	$(\text{Mg}, \text{Fe}^{2+})_5(\text{OH})_2[\text{Si}_6\text{O}_{16}]^{\infty}$
Clinojimthompsonite	$(\text{Mg}, \text{Fe}^{2+})_5(\text{OH})_2[\text{Si}_6\text{O}_{16}]^{\infty}$
*Ca-jimthompsonite	$\text{Ca}_2(\text{Mg}, \text{Fe})_8(\text{OH})_4[\text{Si}_6\text{O}_{16}]_2$
	*Hydrates (neutral)
*Shafranovskite	$(\text{Na}, \text{K})_6(\text{Mn}, \text{Fe})^{2+}_3[\text{Si}_9\text{O}_{24}] \cdot 6\text{H}_2\text{O}$

Mono-disilicates with K = 1, (3) + 1, 5

Basic

Chesterite	$(\text{Fe}, \text{Mg})_{17}(\text{OH})_6[\text{Si}_6\text{O}_{16}]^{\infty 2} [\text{Si}_4\text{O}_{11}]^{\infty 2}_2$
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Mono-disilicates with K=1, 4

Acid

Tokkoite	$\text{K}_2[\text{Ca}_4(\text{F}, \text{OH})[\text{Si}_7\text{O}_{18}(\text{OH})]_2]^{\infty} \cdot 2\text{H}_2\text{O}$
(it as isostructural with tinaksite during isomorphism: $\square 2\text{Ca}^{2+}(\text{F}, \text{OH})^- \rightarrow \text{Na}^+\text{Ti}^{4+}\text{O}^{2-}$)	

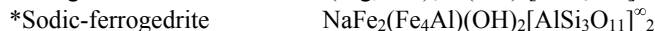
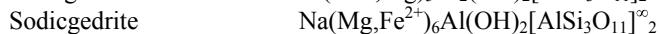
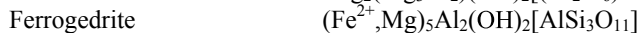
Mono-disilicates with K = 1, 5

Basic

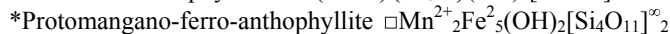
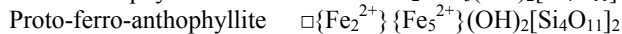
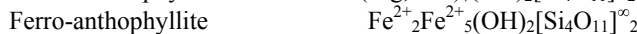
Amphiboles family**Mg, Fe²⁺ - amphiboles** subfamily

Gedrite series

Magnesio-gedrite = gedrite

**Anthophyllite** series

Magnesio-anthophyllite = anthophyllite

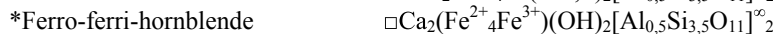
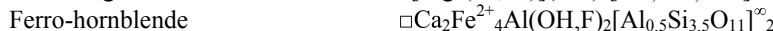
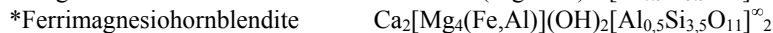
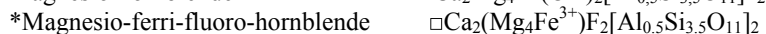
**Cummingtonite** series

Magnesio-cummingtonite = cummingtonite

**Mn-amphiboles** subfamily

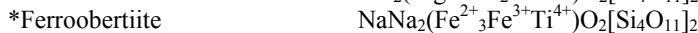
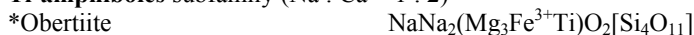
Basic

Dannemorite = manganogrunerite

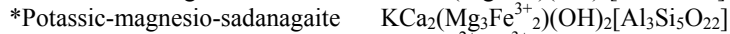
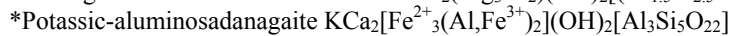
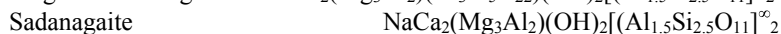
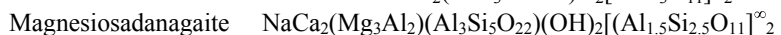
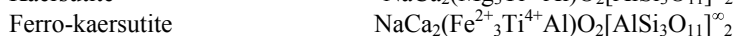
***Mg, Fe, Ca-amphiboles** subfamily**Ca-amphiboles** subfamily**Hornblende** series**Tschermakite** subseries**Hornblende** subseries**Tremolite** subseries (Na+K) в A < 0,5; Ti < 0,5



Ti-amphiboles subfamily (Na : Ca = 1 : 2)



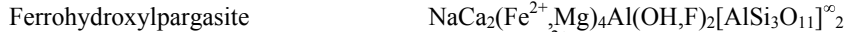
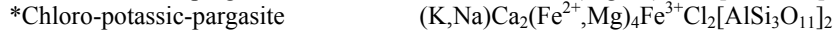
Kaersutite series



Pargasite subfamily (Na : Ca = 1 : 2)



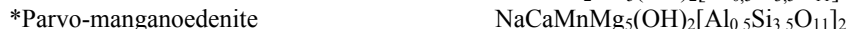
Pargasite series



Hastingsite series

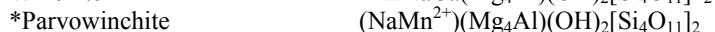


Edenite series



Winchite subfamily (Na : Ca = 1 : 1)

Winchite series



Barroisite	$\square \text{NaCa}(\text{Mg}, \text{Fe}^{2+})_3 \text{Al}_2(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Ferro-barroisite	$\square (\text{NaCa})\text{Fe}^{2+}_3 \text{Al}_2(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Ferri-barroisite	$\square (\text{NaCa})(\text{Mg}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Ferro-ferri-barroisite	$\square (\text{NaCa})(\text{Fe}^{2+}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Glaucophane subfamily (Na₂)	
Glaucophane series	
Glaucophane	$\square \text{Na}_2(\text{Mg}, \text{Fe}^{2+})_3 \text{Al}_2(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Ferro-glaucophane	$\square \text{Na}_2(\text{Fe}^{2+}, \text{Mg})_3 \text{Al}_2(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Crossite series	
Crossite	$\text{Na}_2(\text{Mg}, \text{Fe}^{2+})_3(\text{Al}, \text{Fe}^{3+})_2(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Ribeckite series	
Hydroxylmagnesianriebeckite=magnesianriebeckite	
	$\text{Na}_2(\text{Mg}, \text{Fe}^{2+})_3\text{Fe}^{3+}_2(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Hydroxylriebeckite = riebeckite	$\text{Na}_2(\text{Fe}^{2+}_3\text{Fe}^{3+}_2)(\text{OH}, \text{F})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Fluororiebeckite	$\square \text{Na}_2(\text{Fe}^{2+}_3\text{Fe}^{3+}_2)\text{F}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Magnesianriebeckite	$\square \text{Na}_2(\text{Mg}, \text{Fe}^{2+})_3\text{Fe}^{3+}_2(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Taramite series	
*Aluminomagnesiantaramite	$\text{Na}(\text{Ca}, \text{Na})(\text{Mg}_3\text{Al}_2)(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]^\infty_2$
*Fluoro-alumino-magnesiantaramite	$\text{Na}(\text{Ca}, \text{Na})(\text{Mg}_3\text{Al}_2)\text{F}_2[\text{AlSi}_3\text{O}_{11}]^\infty_2$
Magnesiantaramite	$\text{Na}_2\text{Ca}(\text{Mg}_3\text{AlFe}^{3+})(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]^\infty_2$
Taramite	$\text{Na}(\text{NaCa})(\text{Mg}_3\text{Al}_2)(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]^\infty_2$
*Aluminotaramite	$\text{Na}(\text{Ca}, \text{Na})(\text{Fe}^{2+}_3\text{Al}_2)(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]_2$
*Ferrimagnesiantaramite	$\text{Na}(\text{Ca}, \text{Na})(\text{Mg}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]^\infty_2$
Ferri-taramite	$\text{Na}(\text{CaNa})(\text{Mg}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]_2$
*Ferro-ferri-taramite	$\text{Na}(\text{CaNa})(\text{Fe}^{2+}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{AlSi}_3\text{O}_{11}]_2$
*Chloro-potassic-ferri-magnesiantaramite	$\text{K}(\text{Ca}, \text{Na})(\text{Mg}_3\text{Fe}^{3+}_2)\text{Cl}_2[\text{AlSi}_3\text{O}_{11}]^\infty_2$
Richterite series	
Richterite	$\text{Na}_2\text{Ca}(\text{Mg}, \text{Fe}^{2+})_5(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Potassic-richterite	$\text{K}(\text{Na}, \text{Ca})\text{Mg}_5(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Fluoro-richterite	$\text{Na}(\text{NaCa})\text{Mg}_5\text{F}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Fluoro-potassicrichterite	$\text{KNaCaMg}_5\text{F}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Ferror-richterite	$\text{Na}(\text{NaCa})\text{Fe}^{2+}_5(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Richterite-MgSrK	$(\text{K}, \text{Na})(\text{Ca}, \text{Sr}, \text{Mg}, \text{Na})\text{Na}(\text{Mg}, \text{Na})_5(\text{OH})_2[\text{Si}_4\text{O}_{11}]_2$
Katophorite series	
*Magnesiankatophorite	$\text{Na}(\text{CaNa})(\text{Mg}_4\text{Al})(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
*Ferrikatophorite	$\text{Na}(\text{NaCa})(\text{Fe}^{2+}_4\text{Fe}^{3+})(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Aluminokatophorite	$*\text{Na}_2\text{Ca}(\text{Fe}^{2+}_4\text{Al})(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Katophorite	$*\text{Na}(\text{NaCa})(\text{Mg}^{2+}_4\text{Al})(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
Arfvedsonite subfamily	
Nyboite	$\text{NaNa}_2\text{Mg}_3\text{Al}_2(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]^\infty_2$
*Ferri-nyboite	$\text{NaNa}_2(\text{Mg}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]_2$
*Ferro-ferri-nyboite	$\text{NaNa}_2(\text{Fe}^{2+}_3\text{Fe}^{3+}_2)(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]_2$
*Ferro-nyboite	$\text{NaNa}_2(\text{Fe}^{2+}_3\text{Al}_2)(\text{OH})_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]_2$
*Fluoronyboite	$\text{NaNa}_2(\text{Mg}_3\text{Al}_2)\text{F}_2[\text{Al}_{0,5}\text{Si}_{3,5}\text{O}_{11}]_2$
Eckermannite series	
Eckermannite	$*\text{NaNa}_2(\text{Mg}_4\text{Al})(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Ferroeckermannite	$\text{NaNa}_2(\text{Fe}^{2+}_4\text{Al})(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$

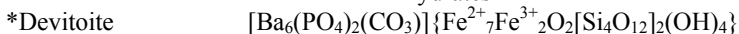
Fluoreckermannite	$\text{Na}_3(\text{Mg}, \text{Fe}^{2+})_4(\text{Al}, \text{Fe}^{3+})(\text{F}, \text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Arfvedsonite series	
*Arfvedsonite	$\text{NaNa}_2(\text{Fe}^{2+}_4\text{Fe}^{3+})(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Magnesioarfvedsonite	$\text{NaNa}_2(\text{Mg}_4\text{Fe}^{3+})(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Potassic-arfvedsonite	$\text{KNa}_2(\text{Fe}^{2+}_4\text{Fe}^{3+})(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Potassic-magnesio-arfvedsonite	$\text{KNa}_2(\text{Mg}, \text{Fe}^{2+})_4\text{Fe}^{3+}(\text{OH}, \text{F})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
*Fluoro-magnesio-arfvedsonite	$\text{NaNa}_2(\text{Mg}_4\text{Fe}^{3+})\text{F}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Hydroxylarfvedsonite = arfvedsonite	$\text{Na}_3(\text{Fe}^{2+}, \text{Fe}^{3+})_4(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Fluorarfvedsonite	$\text{Na}_3(\text{Fe}^{2+}, \text{Mg})_4\text{Fe}^{3+}\text{F}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Kalifluorarfvedsonite	$\text{KNa}_2(\text{Fe}^{2+}_4\text{Fe}^{3+})_2\text{F}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Kozulite = mangano-ferri-eckermanite	$\text{NaNa}_2(\text{Mn}^{2+}_4\text{Fe}^{3+})(\text{OH})_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Mono-disilicato-oxides with K = 1,5	Neutral
*Mangano-mangani-ungarettiite	$\text{NaNa}_2(\text{Mn}^{2+}_2\text{Mn}^{3+}_3)\text{O}_2[\text{Si}_4\text{O}_{11}]^\infty_2$
Mono-disilicates with K = 1,(6)	Neutral
Pellyite	$\text{Ba}_4\text{Ca}_2\text{Fe}_4[\text{Si}_{12}\text{O}_{34}]^\infty$
	Basic and hydrates
Xonotlite family	
Xonotlite	$\text{Ca}_6(\text{OH})_2[\text{Si}_6\text{O}_{17}]^\infty$
Inesite	$\text{Ca}_2\text{Mn}_7(\text{OH})_2(\text{H}_2\text{O})_5[\text{Si}_{10}\text{O}_{28}]^\infty$
Mono-disilicato-oxides with K = 1,6	Basic
Hillebrandite	$\text{Ca}_2(\text{OH})_2[\text{SiO}_3]^\infty$
Deerite	$\text{Fe}^{2+}_6\text{Fe}^{3+}_3(\text{OH})_5[\text{Si}_6\text{O}_{20}]^\infty$
Howieite series	
Taneyamalite	$\text{Na}(\text{Mn}^{2+}, \text{Mg}, \text{Fe}^{3+}, \text{Al})_{12}[\text{Si}_6\text{O}_{17}]_2(\text{O}, \text{OH})_{10}$
Howieite	$\text{Na}(\text{Fe}^{2+}, \text{Fe}^{3+}, \text{Mn}, \text{Al}, \text{Mg})_{12}(\text{O}, \text{OH})_{10}[\text{Si}_6\text{O}_{17}]^\infty_2$
*Mono-disilicato carbonato-chlorides with K = 1,75	*Hydrates
*Fencooperite	$\text{Ba}_6\text{Fe}^{3+}_3[\text{Si}_8\text{O}_{23}][\text{CO}_3]_2\text{Cl}_3 \cdot \text{H}_2\text{O}$
Disilicates (K = 2)	Neutral
Imandrite	$\text{Na}_{12}\text{Ca}_3\text{Fe}^{3+}_2[\text{Si}_6\text{O}_{18}]_2$
*Unnamed	$(\text{Na}_{0.06}\text{Ca}_{0.02}\text{Mg}_{0.71}\text{Fe}_{0.20}\text{Al}_{0.11})_{\Sigma 1.1}[\text{Si}_{0.94}\text{O}_3]$
Pyroxenes family	
Mg-Fe(Mn)- pyroxenes subfamily	
*Akimotoite	$(\text{Mg}, \text{Fe})[\text{SiO}_3]$
Enstatite series (orthopyroxenes)	
Enstatite	$\text{Mg}_2[\text{Si}_2\text{O}_6]^\infty$
Hypersthene = Fe-энстатин	$(\text{Mg}, \text{Fe}, \text{Al})_2[(\text{Si}, \text{Al})_2\text{O}_6]^\infty$
Donpeacorite	$\text{Mg}(\text{Mn}, \text{Mg})[\text{Si}_2\text{O}_6]^\infty$
Clinoenstatite series	
Clinoenstatite	$\text{Mg}_2[\text{Si}_2\text{O}_6]^\infty$
Pigeonite	$(\text{Mg}, \text{Fe}, \text{Ca})(\text{Mg}, \text{Fe})[\text{Si}_2\text{O}_6]^\infty$
Kanoite	$(\text{Mn}^{2+}, \text{Mg})_2[\text{Si}_2\text{O}_6]^\infty$

Clinoferrosilite	$(\text{Fe}, \text{Mg})_2[\text{Si}_2\text{O}_6]^\infty$
*Ferrosilite	$(\text{Fe}^{2+}\text{Mg})_2[\text{Si}_2\text{O}_6]^\infty$
Ca-Na-pyroxenes subfamily	
Augite series	
*Kushiroite	$\text{CaAl}[\text{AlSiO}_6]^\infty$
Esseneite	$\text{CaFe}^{3+}[\text{AlSiO}_6]^\infty$
*Davisite	$\text{CaSc}[\text{AlSiO}_6]$
*Grossmanite	$\text{CaTi}^{3+}[\text{AlSiO}_6]$
Augite	$(\text{Ca}, \text{Na})(\text{Mg}, \text{Fe}, \text{Al})(\text{Si}, \text{Al})_2\text{O}_6]^\infty$
Omphacite	$(\text{Ca}, \text{Na})(\text{Mg}, \text{Fe}^{2+}, \text{Fe}^{3+}, \text{Al})(\text{Si}, \text{Al})_2\text{O}_6]^\infty$
Diopside series	
Diopside	$\text{CaMg}[\text{Si}_2\text{O}_6]^\infty$
Hedenbergite	$\text{CaFe}^{2+}[\text{Si}_2\text{O}_6]^\infty$
Johannesite	$\text{Ca}(\text{Mn}, \text{Fe})^{2+}[\text{Si}_2\text{O}_6]^\infty$
Jervisite	$(\text{Na}, \text{Ca}, \text{Fe}^{2+})(\text{Sc}, \text{Mg}, \text{Fe}^{2+})[\text{Si}_2\text{O}_6]^\infty$
*Na-Mg pyroxene	$(\text{Na}, \text{Mg}, \text{Ca}, \text{Mn})(\text{Mg}, \text{Al}, \text{Cr}, \text{Fe})[\text{Si}_2\text{O}_6]^\infty$
Aegirine series	
Natalyite	$\text{NaV}[\text{Si}_2\text{O}_6]^\infty$
Kosmochlor	$\text{NaCr}[\text{Si}_2\text{O}_6]^\infty$
Aegirine	$\text{NaFe}^{3+}[\text{Si}_2\text{O}_6]^\infty$
Jadeite	$\text{Na}(\text{Al}, \text{Fe}^{3+})[\text{Si}_2\text{O}_6]^\infty$
*Namansilite	$\text{NaMn}^{3+}[\text{Si}_2\text{O}_6]$
*Vladykinite	$\text{Na}_3\text{Sr}_4(\text{Fe}^{2+}\text{Fe}^{3+})[\text{Si}_2\text{O}_6]_4$
Pyroxenoids family	
	Neutral
Rhodonite subfamily	
*Pyroxmangite series	
Pyroxmangite	$\text{Mn}^{2+}[\text{SiO}_3]^\infty$
*Pyroxferroite	$\text{Fe}_7[\text{Si}_7\text{O}_{21}]^\infty$
Rhodonite	$\text{Mn}_5[\text{Si}_5\text{O}_{15}]^\infty$
Bustamite	$\text{CaMn}^{2+}[\text{Si}_2\text{O}_6]^\infty$
*Mendigite	$\text{Mn}_2\text{Mn}_2\text{MnCa}[\text{Si}_3\text{O}_9]_2$
Ferrobustamite	$\text{Ca}_3(\text{Fe}^{2+}, \text{Ca})_3[\text{Si}_3\text{O}_9]^\infty_2$
Wollastonite subfamily	
Wollastonite-1T	$\text{Ca}_3[\text{Si}_3\text{O}_9]^\infty$
Parawollastonite or wollastonite-2M	$\text{Ca}_3[\text{Si}_3\text{O}_9]^\infty$
*Manganoparawollastonite	$\text{Ca}[\text{SiO}_3]$
Wollastonite-7T	$\text{Ca}_3[\text{Si}_3\text{O}_9]^\infty$
Pseudowollastonite (synthetic)	$3\beta\text{s-CaSiO}_3 \rightarrow \text{Ca}_3[\text{Si}_3\text{O}_9]$
Walstromite	$\text{BaCa}_2[\text{Si}_3\text{O}_9]$
Combeite	$\text{Na}_4\text{Ca}_4[\text{Si}_6\text{O}_{18}]$
*Unnamed (synthetic)	$\text{K}_{2,9}\text{Rb}_{0,1}\text{Er}[\text{Si}_3\text{O}_9]$
	Acid pyroxenoids \rightarrow hydrates
*Neotocite	$(\text{Mn}^{2+}, \text{Fe}^{2+})[\text{SiO}_3]\text{H}_2\text{O}$
*Nchwangingite	$\text{Mn}^{2+}_2(\text{OH})_2[\text{SiO}_3]\text{H}_2\text{O}$
*Imogolite	$\text{Al}_2(\text{OH})_4[\text{SiO}_3]$
Babingtonite series	
Babingtonite	$\text{Ca}_2\text{Fe}^{2+}\text{Fe}^{3+}[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$

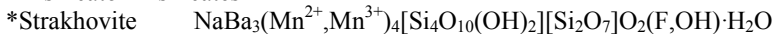
*Scandiobabingtonite	$\text{Ca}_2(\text{Fe}, \text{Mn})\text{Sc}[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$
Manganbabingtonite	$\text{Ca}_2(\text{Mn}, \text{Fe})^{2+}\text{Fe}^{3+}[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$
Marsturite	$\text{NaCaMn}^{2+}_3[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$
*Ruizite	$\text{Ca}_2\text{Mn}^{3+}_2[\text{Si}_4\text{O}_{11}(\text{OH})_4] \cdot 2\text{H}_2\text{O}$
Cascandite	$\text{CaSc}[\text{Si}_3\text{O}_8(\text{OH})]^\infty$
Rosenhahnite	$\text{Ca}_3[\text{Si}_3\text{O}_8(\text{OH})_2]$
*Trabzonite	$\text{Ca}_4[\text{Si}_3\text{O}_9(\text{OH})_2]$
Tobermorite family	
Tobermorite-9A	$\text{Ca}_5[\text{HSi}_3\text{O}_9]^\infty \cdot 2\text{H}_2\text{O}$
Tobermorite-11A = Clinotobermorite	$\text{Ca}_5[\text{Si}_6\text{O}_{17}] \cdot 5\text{H}_2\text{O}$
Tobermorite-14A	$\{\text{Ca}_4[\text{Si}_3\text{O}_8(\text{OH})]_2 \cdot 2\text{H}_2\text{O}\} (\text{Ca} \cdot 5\text{H}_2\text{O})$
*Clinotobermorite	$\text{Ca}_5[\text{Si}_6\text{O}_{17}] \cdot 5\text{H}_2\text{O}$
Pectolite series	
Serandite	$\text{NaMn}^{2+}_2[\text{Si}_3\text{O}_8(\text{OH})]^\infty$
Pectolite	$\text{NaCa}_2[\text{Si}_3\text{O}_8(\text{OH})]^\infty$
*Pectolite M2abc	$\text{Na}(\text{Ca}, \text{Mn}^{2+})_2[\text{Si}_3\text{O}_8(\text{OH})]^\infty$
	Oxido-disilicates
Krinovite series	
Dorrite	$\text{Ca}_4(\text{Mg}_3\text{Fe}^{3+}_9)\text{O}_4[\text{Si}_3\text{Al}_8\text{Fe}^{3+}\text{O}_{36}]$
Wilkinsonite	$\text{Na}_4(\text{Fe}^{2+}_8\text{Fe}^{3+}_4)\text{O}_4[\text{Si}_6\text{O}_{18}]_2$
Krinovite	$\text{Na}_4(\text{Mg}_8\text{Cr}^{3+}_4\text{O}_4)[\text{Si}_6\text{O}_{18}]_2$
	Basic disilicates → hydrates
*Bunnoite	$\text{Mn}^{2+}_6\text{Al}(\text{OH})_3[\text{Si}_6\text{O}_{18}]$
Carpholite series	
Magnesiocarpholite	$\text{MgAl}_2(\text{OH})_4[\text{Si}_2\text{O}_6]^\infty$
Ferrocapholite	$(\text{Fe}, \text{Mg})\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_6]^\infty$
Carpholite	$\text{Mn}^{2+}\text{Al}_2(\text{OH})_4[\text{Si}_2\text{O}_6]^\infty$
*Potassiccarpholite	$(\text{K}, \square)(\text{Mn}^{2+}, \text{Li})_2\text{Al}_4(\text{OH}, \text{F})_8[\text{Si}_2\text{O}_6]_2$
*Vanadiocarpholite	$\text{Mn}^{2+}\text{V}^{3+}\text{Al}(\text{OH})_4[\text{Si}_2\text{O}_6]^\infty$
Gageite series	
Balangeroite	$\text{Mg}_{21}\text{O}_3(\text{OH})_{20}[\text{Si}_2\text{O}_6]^\infty_4$
Gageite- <i>ITc</i>	$\text{Mn}^{2+}_{21}\text{O}_3(\text{OH})_{20}[\text{Si}_2\text{O}_6]^\infty_4$
Gagei- <i>2M</i>	$\text{Mn}^{2+}_{21}\text{O}_3(\text{OH})_{20}[\text{Si}_2\text{O}_6]^\infty_4$
Foshagite	$\text{Ca}_4(\text{OH})_2[\text{Si}_3\text{O}_9]^\infty$
Saneroite	$\text{Na}_{1,15}(\text{H}, \text{Mn}^{2+}, \text{Mn}^{3+})_5(\text{OH})[\text{Si}_{5,5}\text{V}_{0,5}\Sigma_6\text{O}_{18}]$
*Braccoite	$\text{NaMn}^{2+}_5(\text{OH})[\text{Si}_5\text{As}^{5+}\text{O}_{17}(\text{OH})]$
*Cerchiaraitite-(Al)	$\text{Ba}_4\text{Al}_4\text{O}_3(\text{OH})_3[\text{Si}_4\text{O}_{12}][[\text{Si}_2\text{O}_3(\text{OH})_4]\text{Cl}]$
*Cerchiaraitite-(Fe)	$\text{Ba}_4\text{Fe}^{3+}_4\text{O}_3(\text{OH})_3[\text{Si}_4\text{O}_{12}][[\text{Si}_2\text{O}_3(\text{OH})_4]\text{Cl}]$
*Cerchiaraitite-(Mn)	$\text{Ba}_4\text{Mn}^{3+}_4\text{O}_2(\text{OH})_4^+[\text{Si}_4\text{O}_{12}][[\text{Si}_2\text{O}_3(\text{OH})_4]\text{Cl}_2]$
Verplanckite family	
Verplanckite	$[(\text{Mn}^{3+}, \text{Ti}, \text{Fe}^{3+})_6(\text{OH}, \text{O})_2[\text{Si}_4\text{O}_{12}]_3]^\infty \cdot \text{Ba}_{12}(\text{OH}, \text{H}_2\text{O})_7\text{Cl}_9$
Muirite	$\text{Ba}_{10}\text{Ca}_2\text{Mn}^{2+}\text{TiSi}_{10}\text{O}_{30}(\text{OH}, \text{Cl}, \text{F})_{10}$
*Hubeite	$\text{Ca}_2\text{Mn}^{2+}\text{Fe}^{3+}[\text{Si}_4\text{O}_{12}(\text{OH})](\text{H}_2\text{O})_2$
*Bavsiite	$\text{Ba}_2\text{V}_2\text{O}_2[\text{Si}_4\text{O}_{12}]$
	Hydrates; acid; acid-basic
Santaclaraite	$\text{CaMn}_4(\text{H}_2\text{O})(\text{OH})[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$
*Middendorfitite	$\text{K}_3\text{Na}_2\text{Mn}_5[\text{Si}_{12}(\text{O}, \text{OH})_{36}] \cdot 2\text{H}_2\text{O}$
Krauskopfitite	$\text{Ba}_2(\text{H}_2\text{O})_4[\text{Si}_4\text{O}_8(\text{OH})_4]^\infty$
*Jennite	$\text{Ca}_9(\text{OH})_6[\text{Si}_6\text{O}_{18}] \cdot 8\text{H}_2\text{O}$

*Oxido-phosphato-carbonato-disilicates

Hydrates



*Disilicato-Trisilicates



Trisilicates (K = 3)

Proper trisilicates

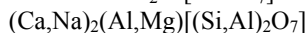
Neutral

Melilite group

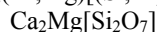
Gehlenite



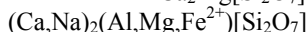
Melilite



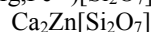
Akermanite



*Alumoakermanite



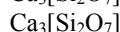
Hardystonite

**Rankinite** family

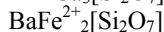
Rankinite



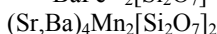
Kilchoanite



Andremeyerite



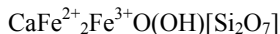
Taikanite



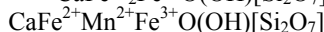
Basic

Ilvaite family

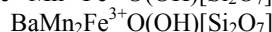
Ilvaite



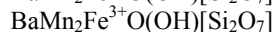
*Manganilvaite



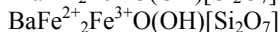
Orthoericssonite



Ericssonite



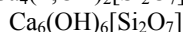
*Ferroericssonite

**Cuspidine** family

Cuspidine



Jaffeite

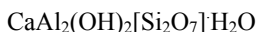


Hydrates

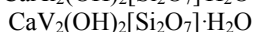
Basic

Lawsonite family

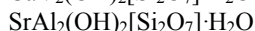
Lawsonite



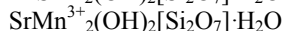
*Cortesognoite



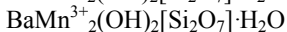
*Itoigawaite



*Hennomartinite

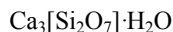


*Noélbessonite



Neutral

Killalaite



*Trisilicato-chlorides

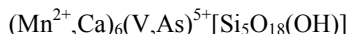
*Rusinovite



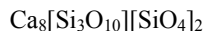
Trisilicato-tetrasilicates

*Trisilicato-tetrasilicates whis K=3,2

*Medaite

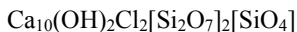


*Pavlovskite

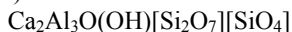
Trisilicato-tetrasilicates with Si₂O₇ : SiO₄ = 2 : 1

Hydroxido-silicato-chlorides

Rustumite

Trisilicato-tetrasilicates with Si₂O₇ : SiO₄ = 1 : 1 Basic**Epidote** family (compare with allanite (series))

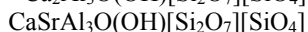
Zoisite

**Epidote** series

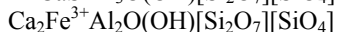
Clinozoisite



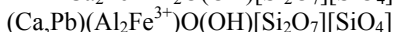
*Niigataite



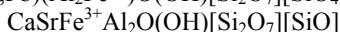
Epidote



*Epidote-(Pb)



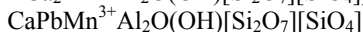
*Epidote-(Sr)



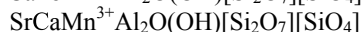
Piemontite



*Piemontite-(Pb)



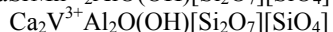
*Piemontite-(Sr)



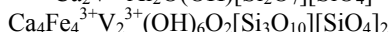
*Manganпьемонтит-(Sr) = *Tweedillite



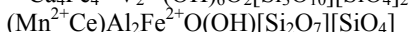
Mukhinit



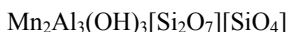
*Cassagnaite



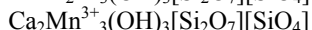
*Uedaite-(Ce)

**Sursassite** series

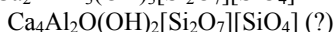
Sursassite



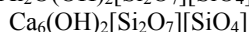
Macfallite



Cebollite



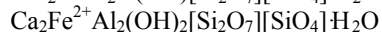
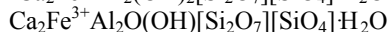
Dellaite



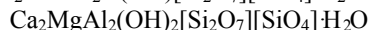
Hydrates

Pumpellyite series

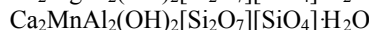
*Pumpellyite-(Al)

Pumpellyite-(Fe²⁺)*Pumpellyite-(Fe³⁺)

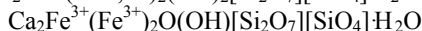
*Pumpellyite-(Mg)



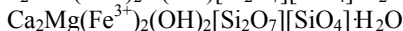
Pumpellyite-(Mn)



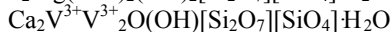
Shuiskite

Julgoldite-(Fe²⁺)*Julgoldite-(Fe³⁺)

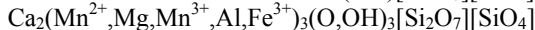
*Julgoldite-(Mg)



*Poppiite

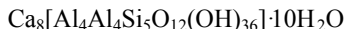


*Okhotskite

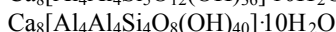
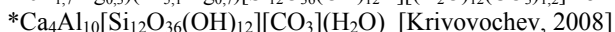


Trisilicato-tetrasilicates with K=3,4 *Hydrates

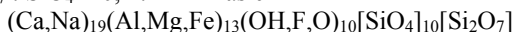
*Vertumnite



*Strätlingite

*Aerinite (Ca_{5,1}Na_{0,5})(Fe³⁺AlFe²⁺_{1,7}Mg_{0,3})(Al_{5,1}Mg_{0,7})[Si₁₂O₃₆(OH)₁₂H][H₂O]₁₂(CO₃)_{1,2} orTrisilicato-tetrasilicates with Si₂O₇ : SiO₄ = 0,4 : 1 Basic

Vesuvianite



*Alumovesuvianite	$\text{Ca}_{19}\text{Al}(\text{Al}_{10}\text{Mg}_2)\text{O}(\text{OH})_9[\text{Si}_2\text{O}_7]_4[\text{SiO}_4]_{10}$
*Fluorvesuvianite	$\text{Ca}_{19}(\text{Al},\text{Mg})_{13}\text{O}(\text{F},\text{OH})_9[\text{Si}_2\text{O}_7]_4[\text{SiO}_4]_{10}$
*Manganovesuvianite	$(\text{Ca},\text{Na},\square)_{19}(\text{Al},\text{Mg},\text{Fe}^{3+})_{13}(\square,\text{B},\text{Al},\text{Fe}^{3+})_5(\text{OH},\text{F},\text{O})_{10}[\text{Si}_2\text{O}_7]_4[\text{SiO}_4]_{10}$
*Wiluite	$\text{Ca}_{19}(\text{Al},\text{Mg},\text{Fe},\text{Ti})_{13}(\text{B},\text{Al},\square)_5(\text{O},\text{OH})_{10}[\text{Si}_2\text{O}_7]_4[\text{SiO}_4]_{10}$
*Трисиликато-тетрасиликато-фосфаты (K = 3,(3))	
*Lavoisierite	$\text{Mn}^{2+}_8[\text{Al}_{10}(\text{Mn}^{3+}\text{Mg})](\text{OH})_{12}[(\text{Si}_{11}\text{P})\text{O}_{44}]$

Tetrasilicates (orthosilicates) (K = 4) Neutral

Garnet series

Knorringite	$\text{Mg}_3\text{Cr}_2[\text{SiO}_4]_3$
Pyrope	$\text{Mg}_3\text{Al}_2[\text{SiO}_4]_3$
*Menzerite-(Y)	$\text{CaY}_2\text{Mg}_2[\text{SiO}_4]_3$
Almandine	$\text{Fe}^{2+}_3\text{Al}_2[\text{SiO}_4]_3$
Spessartine	$\text{Mn}^{2+}_3\text{Al}_2[\text{SiO}_4]_3$
Majorite	$\text{Mg}_3(\text{MgSi})[\text{SiO}_4]_3$
*Eringaite	$\text{Ca}_3\text{Sc}_2[\text{SiO}_4]_3$
Grossular	$\text{Ca}_3\text{Al}_2[\text{SiO}_4]_3$
*Irinarassite	$\text{Ca}_3\text{Sn}_2\text{Al}_2\text{SiO}_{12}$ или $\text{Ca}_3[\text{Al}_{2/3}\text{Sn}_{2/3}\text{Si}_{1/3}\text{O}_4]_3$
Calderite	$(\text{Mn}^{2+},\text{Ca})_3(\text{Fe}^{3+},\text{Al})_2[\text{SiO}_4]_3$
Andradite	$\text{Ca}_3\text{Fe}^{3+}_2[\text{SiO}_4]_3$
*Ti-andradite	$\text{Ca}_3\text{Ti}^{4+}_2[(\text{Fe}^{3+}_{0.66}\text{Si}_{0.33})\text{O}_4]_3$
Schorlomite	$\text{Ca}_3\text{Ti}^{4+}_2(\text{Fe}^{3+}_2\text{Si})\text{O}_{12}$
*Morimotoite	$\text{Ca}_3\text{TiFe}^{2+}[\text{SiO}_4]_3$
*Hutcheonite	$\text{Ca}_3\text{Ti}^{4+}_2(\text{Si}_{0.33}\text{Al}_{0.66})\text{O}_4]_3$
Kimzeyite	$\text{Ca}_3\text{Zr}_2[\text{Al}_2\text{SiO}_{12}]$
*Kerimasite	$\text{Ca}_3\text{Zr}_2(\text{Fe}^{3+}_2\text{Si})\text{O}_{12}]$
Uvarovite	$\text{Ca}_3\text{Cr}_2[\text{SiO}_4]_3$
Goldmanite	$\text{Ca}_3(\text{V},\text{Al},\text{Fe})^{3+}_2[\text{SiO}_4]_3$
*Momoite	$\text{Mn}^{2+}_3\text{V}^{3+}_2[\text{SiO}_4]_3$
Yamatoite	$(\text{Mn}^{2+},\text{Ca})_3(\text{V}^{3+},\text{Al})_2[\text{SiO}_4]_3$
*Toturite	$\text{Ca}_3\text{Sn}_2[(\text{Fe}^{3+}_2\text{Si})\text{O}_{12}]$

Hydrogarnet family

Hydrograndite	$(\text{Ca},\text{Mg},\text{Fe}^{2+})_3(\text{Fe}^{3+},\text{Al})_2[\text{SiO}_4]_2(\text{OH})_4$
*Henritermierite	$\text{Ca}_3(\text{Mn}^{3+},\text{Al})_2[\text{SiO}_4]_2(\text{OH})_4$
*Holstamite	$\text{Ca}_3\text{Al}_2[\text{SiO}_4]_2(\text{OH})_4$
Hibschite (plazolite)	$\text{Ca}_3\text{Al}_2[\text{SiO}_4]_{3-x}(\text{OH})_{4x}$ ($0.2 \leq x \leq 1.5$)
Katoite	$\text{Ca}_3\text{Al}_2[\text{SiO}_4]_{3-x}(\text{OH})_{4x}$ ($1.5 < x \leq 3$)

Olivine family

*Calcio-olivine	$\text{Ca}_2[\text{SiO}_4]$
Wadsleyite	$\beta\text{-(Mg},\text{Fe}^{2+})_2[\text{SiO}_4]$
*Wadsleyite II	$(\text{Mg},\text{Fe})_{11}[(\text{Al},\text{Si})_6(\text{OH})_2\text{O}_{22}]$
Ringwoodite	$(\text{Mg},\text{Fe}^{2+})_2[\text{SiO}_4]$

Forsterite series

Forsterite	$\text{Mg}_2[\text{SiO}_4]$
Fayalite	$\text{Fe}^{2+}_2[\text{SiO}_4]$
Tephroite	$\text{Mn}^{2+}_2[\text{SiO}_4]$
Liebenbergite	$\text{Ni}^{2+}[\text{SiO}_4]$
Laihunite	$\text{Fe}^{2+}\text{Fe}^{3+}_2[\text{SiO}_4]_2$

*Unnamed	$(\text{Na}_{0.08}\text{Ca}_{0.03}\text{Mg}_{0.95}\text{Fe}_{0.26}\text{Al}_{0.15}\text{Si}_{0.25}\square_{0.28})_2[\text{SiO}_4]$
Monticellite family	
Monticellite	$\text{CaMg}[\text{SiO}_4]$
Kirschsteinite	$\text{CaFe}^{2+}[\text{SiO}_4]$
Glaucochroite	$\text{CaMn}^{2+}[\text{SiO}_4]$
Merwinite	$\text{Ca}_3\text{Mg}[\text{SiO}_4]_2$
Bredigite	$(\text{Ca},\text{Ba})\text{Ca}_{13}\text{Mg}_2[\text{SiO}_4]_8$
Larnite	$\beta\text{-Ca}_2[\text{SiO}_4]$
Oxido-tetrasilicates (at that number sulfido-oxido tetrasilicates)	
*Hatrurite	$\text{Ca}_3\text{O}[\text{SiO}_4]$
Kyanite family	
(Sillimanite) see monoalumosilicates, sillimanite (family)	
Andalusite	${}^{(6)}\text{Al}^{(5)}\text{AlO}[\text{SiO}_4]$
Kanonaite	${}^{(6)}(\text{Mn}^{3+},\text{Al})^{(5)}\text{AlO}[\text{SiO}_4]$
Kyanite	${}^{(6)}\text{Al}_2\text{O}[\text{SiO}_4]$
Staurolite family	
Yoderite	$\text{Mg}_2\text{Al}_6\text{O}_2(\text{OH})_2[\text{SiO}_4]_4$
Staurolite	$\text{Fe}_2^{2+}\text{Al}_9\text{Si}_4\text{O}_{23}(\text{OH})$
*Magnesiostaurolite	$\square_4\text{Mg}_4\text{Al}_{16}(\text{Al}_2\square_2)\text{Si}_8\text{O}_{40}[\text{O}_6(\text{OH})_2]$
*Zincostaurolite	$\square_4\text{Zn}_4\text{Al}_{16}(\text{Al}_2\square_2)\text{Si}_8\text{O}_{40}[\text{O}_6(\text{OH})_2]$
Jasmondite	$\text{Ca}_{11}\text{SO}_2[\text{SiO}_4]_4$
Basic oxido-tetrasilicates	
Davreuxite	$\text{Mn}^{2+}\text{Al}_6(\text{OH})_2\text{O}[\text{SiO}_4]_4$
Chloritoid family	
Chloritoid series	
Magnesiochloritoid	$\{\text{Mg}_2\text{Al}(\text{OH})_4\text{Al}_3\text{O}_2[\text{SiO}_4]_2\}^{\infty 2}$
Chloritoid	$\{(\text{Fe}^{2+},\text{Mg})_2\text{Al}(\text{OH})_4\text{Al}_3\text{O}_2[\text{SiO}_4]_2\}^{\infty 2}$
Ottrelite	$\{(\text{Mn}^{2+},\text{Fe}^{2+},\text{Mg})_2\text{Al}(\text{OH})_4\text{Al}_3\text{O}_2[\text{SiO}_4]_2\}^{\infty 2}$
Humite polysomatic series	$\text{M}_{3+n}\text{X}_2[\text{SiO}_4]_{1+0.5n}$, where $\text{M}^{2+} = \text{Mg}^{2+}, \text{Fe}^{2+}, \text{Mn}^{2+}$;
X = F ⁻ , OH ⁻ ; n = 0; 2; 4; 6	
Norbergite	$\text{Mg}_3(\text{F},\text{OH})_2[\text{SiO}_4]$ (n = 0)
Chondrodite group	
Chondrodite	$\text{Mg}_5(\text{F},\text{OH})_2[\text{SiO}_4]_2$ (n = 2)
*Hydroxichondrodite	$\text{Mg}_5(\text{OH})_2[\text{SiO}_4]_2$
*Kumtyubeite	$\text{Ca}_5\text{F}_2[\text{SiO}_4]_2$
Alleghanyite	$\text{Mn}^{2+}_5(\text{OH})_2[\text{SiO}_4]_2$ (n = 2)
Reinhardbraunsite	$\text{Ca}_5(\text{OH},\text{F})_2[\text{SiO}_4]_2$
Ribbeite	$\text{Mn}^{2+}_5(\text{OH})_2[\text{SiO}_4]_2$ (n = 2)
Humite series	
Humite	$(\text{Mg},\text{Fe}^{2+})_7(\text{F},\text{OH})_2[\text{SiO}_4]_3$ (n = 4)
Manganhumite	$(\text{Mn}^{2+},\text{Mg})_7(\text{OH})_2[\text{SiO}_4]_3$ (n = 4)
*Chegemite	$\text{Ca}_7(\text{OH})_2[\text{SiO}_4]_3$
*Fluorchegemite	$\text{Ca}_7\text{F}_2[\text{SiO}_4]_3$
Leucophoenicite	$\text{Mn}^{2+}_7(\text{OH})_2[\text{SiO}_4]_3$ (n = 4)
Clinohumite series	
Titanclinohumite	$(\text{Mg},\text{Fe},\text{Ti})_9\text{F}_2[\text{SiO}_4]_4$ (n = 6)
Clinohumite	$(\text{Mg},\text{Fe}^{2+})_9(\text{F},\text{OH})_2[\text{SiO}_4]_4$ (n = 6)
*Hydroxylclinohumite	$\text{Mg}_9(\text{OH},\text{F})_2[\text{SiO}_4]_4$ (n = 6)
Jerrygibbsite	$\text{Mn}^{2+}_9(\text{OH})_2[\text{SiO}_4]_4$ (n = 6)

Sonolite	$Mn^{2+}_9(OH)_2[SiO_4]_4$ (n = 6)
*Poldervaartite	$Ca(Ca_{0,5}Mn_{0,5})(OH)[SiO_3OH]$
*Olmiite	$CaMn[SiO_3(OH)](OH)$
Welinite family	
Welinite	$Mn^{2+}_3(Mn^{4+}, W)(O, OH)_3[SiO_4]$
Franciscanite	$Mn_3(V^{3+}_x, □_{1-x})(O, OH)_3[SiO_4]$ (x ~ 0.5)
*Vuagnatite	$CaAl(OH)[SiO_4]$
*Mozartite	$CaMn^{3+}(OH)[SiO_4]$
Chantalite	$CaAl_2(OH)_4[SiO_4]$
	Hydrates (basic)
*Spadaite	$Mg[SiO_2(OH)_2] \cdot H_2O$
*Chesnokovite	$Na_2[SiO_2(OH)_2] \cdot 8H_2O$
Kittatinnyite (compare with wallkilldellite (gr.))	$Ca_4Mn^{2+}_2Mn^{3+}_4(OH)_8[SiO_4]_4 \cdot 18H_2O$
*Orientite	$Ca_8Mn^{3+}_{10}(OH)_{10}[Si_3O_{10}]_3[SiO_4]_3 \cdot 4H_2O$
*Oxido-tetrasilicato-halogenides	
*Wadalite	$Ca_6Al_5O_8[SiO_4]_2Cl_3$
*Eltyubyuite	$Ca_{12}Fe^{3+}_{10}Si_4O_{32}Cl_6$ or $Ca_{12}Fe^{3+}_6[(Fe^{3+}_4Si_4)O_{32}]Cl_6$
	Acid → tetrasilicato-fluorides
Bultfonteinite	$Ca_4[SiO_3(OH)]_2F_2 \cdot 2H_2O$
*Tetrasilicato-phosphates	
*Harrisonite	$Ca(Fe, Mg)_6[SiO_4]_2[PO_4]_2$
Silicato-halogenides	
Di-trisilicato-halogenides	
	Basic
Zunyite (K = 2,4)	$Al_{12}(OH)_{14}\{[AlO_4][Si_5O_{16}]\}F_4Cl$
Magbasite (K = 2,(6))	$KBa(Al, Sc)(Mg, Fe^{2+})_6[Si_6O_{20}]F_2$
*Jagoite (K = 2,(6))	$Pb_{18}Fe_4^{3+}[Si_4(Si, Fe^{3+})_6][Pb_4Si_{16}(Si, Fe)_4]O_{82}Cl_6$
Tetrasilicato-halogenides	Basic
Topaz	$Al_2[SiO_4](F, OH)_2$
*Topaz-(OH)	$Al_2[SiO_4](OH, F)_2$
*Podnoginite	$Ca_2[SiO_4]CaF_2$
*Rondorfite	$Ca_8Mg[SiO_4]_4Cl_2$
*Edgrewite	$Ca_9[SiO_4]_4F_{1.2}(OH)_{0.8}$
*Hydroxyledgrewite	$Ca_9[SiO_4]_4(OH)_2$
*Tetrasilicato-oxido-sulphates	
*Gazeevite	$BaCa_6[SiO_4]_2[SO_4]_2O$
*Nabimusaite	$KCa_{12}[SiO_4]_4[SO_4]_2O_2F$
Silicato-borates	
Borosilicates	
Zero-borosilicates ($K_\Sigma = 0$)	Neutral
Danburite	$Ca[Si_2B_2O_8]^{\infty 3} \rightarrow Ca[(Si_2O_7)B_2O]^{\infty 3}$
*Maleevite	$Ba[Si_2B_2O_8]$
*Pekovite	$Sr[Si_2B_2O_8]$

Reedmergnerite	$\text{Na}[\text{Si}_3\text{BO}_8]^{\infty 3} \rightarrow \text{Na}[\text{SiO}_3\text{BO}_5]^{\infty 3}$
*Malinkoite	$\text{Na}[\text{SiBO}_4]$
*Pudrettite	$\text{KNa}_2[\text{Si}_{12}\text{B}_3\text{O}_{30}]$
*Jadarite	$\text{LiNa}[\text{SiB}_3\text{O}_7(\text{OH})]$
*Lisitsynite	$\text{K}[\text{Si}_2\text{BO}_6]$
*Kirchhoffite	$\text{Cs}[\text{Si}_2\text{BO}_6]$
*Zero-monoborosilicates ($K_{\Sigma} = 0,32$) Acid	
*Martinitite	$(\text{Na}, \square, \text{Ca})_{12}\text{Ca}_4[(\text{Si}, \text{S}, \text{B})_{14}\text{B}_2\text{O}_{38}](\text{OH}, \text{Cl})_2\text{F}_2 \cdot 4\text{H}_2\text{O}$
*Zero-monoborosilicates ($K = 0.5$) Basic (hydrates)	
*Steedeite	$\text{NaMn}_2[\text{BSi}_3\text{O}_9](\text{OH})_2$
*Nolzeite	$\text{NaMn}_2[\text{Si}_3\text{BO}_9](\text{OH})_2 \cdot 2\text{H}_2\text{O}$
Zero-monoborosilicates ($K_{\Sigma} = 0,6$) Acid	
Searlesite	$\text{Na}[(\text{Si}_2\text{O}_5\text{B}(\text{OH})_2)]^{\infty 2}$
*Okayamalite	$\text{Ca}_2[\text{B}_2\text{SiO}_7]$
*Itsiite	$\text{Ba}_2\text{Ca}[\text{BSi}_2\text{O}_7]_2$
*Zero-monoborosilicates ($K = 0.75$) Basic	
*Odigitriaite	$\text{CsNa}_5\text{Ca}_5[\text{Si}_{14}\text{B}_2\text{O}_{38}]\text{F}_2$
*Zero-monoborosilicates ($K_{\Sigma} = 0,9$) Basic (hydrates)	
*Kasatkinitite	$\text{Ba}_2\text{Ca}_8[\text{B}_5\text{Si}_8\text{O}_{32}](\text{OH})_3 \cdot 6\text{H}_2\text{O}$
Monoborosilicates ($K_{\Sigma} = 1$) Neutral	
Homilite	$\text{Ca}_2\text{Fe}^{2+}[\text{Si}_2\text{B}_2\text{O}_{10}]^{\infty 2} \rightarrow \text{Ca}_2\text{Fe}^{2+}[(\text{SiO}_4)_2\text{B}_2\text{O}_2]^{\infty 2}$
*Boromullite	$\text{Al}_8\text{O}_9[\text{AlBSi}_2\text{O}_{10}]$
Acid	
Datolite family	
Datolite	$\text{Ca}[(\text{SiO}_4)\text{BOH}]^{\infty 2}$
Bakerite	$\text{Ca}_4[\text{Si}_3\text{B}_5\text{O}_{15}(\text{OH})_5]^{\infty 2} \rightarrow \text{Ca}_4[(\text{SiO}_4)_3(\text{BO}_3\text{OH})(\text{BOH})_4]^{\infty 2}$
*Zero-monoborosilicat-fluorides	
*Kapitsaite-(Y)	$(\text{Ba}, \text{Pb})_4(\text{Y}, \text{Ca})_2[\text{Si}_8\text{B}_4\text{O}_{28}]\text{F}$
*Khvorovite	$\text{Pb}^{2+}_4\text{Ca}_2[\text{Si}_8\text{B}_2(\text{S}, \text{B})\text{O}_{28}]\text{F}$
*Mono-diborosilicates ($K_{\Sigma} = 1,7$)	
*Piergorite-(Ce)	$\text{Ca}_8\text{Ce}_2(\text{Al}_{0,5}\text{Fe}^{3+}_{0,5})(\square\text{Li}, \text{Be})_2[\text{Si}_6\text{B}_8\text{O}_{36}](\text{OH})_2$
*Vistepite	$\text{Mn}^{2+}_5\text{Sn}^{4+}[\text{B}_2\text{Si}_5\text{O}_{20}]$
*Mono-diborosilicates ($K = 1,8$) Hydrates	
*Oyelite	$\text{Ca}_{10}[\text{B}_2\text{Si}_8\text{O}_{29}] \cdot 12\text{H}_2\text{O}$
Diborosilicates ($K_{\Sigma} = 2$) Oxido-diborosilicates	
Serendibite	$\text{Ca}_4(\text{Mg}_6\text{Al}_6)\text{O}_4[\text{Si}_6\text{B}_3\text{Al}_3\text{O}_{36}]$
(compare with aenigmatite (family)) Basic diborosilicates	
Axinite series	

*Axinite-(Mg) = magnesioaxinite	$\{\text{Ca}_2\text{MgAl}_2(\text{OH})[(\text{Si}_2\text{O}_7)_2\text{BO}]_2\}^{\infty 2}$
*Axinite-(Fe)	$\{\text{Ca}_2\text{FeAl}_2(\text{OH})[(\text{Si}_2\text{O}_7)_2\text{BO}]_2\}^{\infty 2}$
*Axinite-(Mn)	$\{\text{Ca}_2(\text{Mn,Fe})\text{Al}_2(\text{OH})[(\text{Si}_2\text{O}_7)_2\text{BO}]_2\}^{\infty 2}$
Tinzenite	* $\text{CaMn}^{2+}_4\text{Al}_4(\text{OH})_2[(\text{Si}_2\text{O}_7)_4\text{B}_2\text{O}_2]$
	Neutral → acid diborosilicato-chlorides
Taramellite family	
Taramellite	$\text{Ba}_4(\text{Fe}^{3+}, \text{Ti, Fe}^{2+}, \text{Mg, V}^{3+})_4[(\text{Si}_8\text{B}_2\text{O}_{27})\text{O}_2\text{Cl}_x]$
Nagashimalite	$\text{Ba}_4(\text{V}^{3+}, \text{Ti})_4[(\text{Si}_8\text{B}_2\text{O}_{27})(\text{O, OH})_2\text{Cl}]$
Titantaramellite	$\text{Ba}_4(\text{Ti, Fe}^{3+}, \text{Fe}^{2+}, \text{Mg})_4[(\text{Si}_8\text{B}_2\text{O}_{27})\text{O}_2\text{Cl}_{0-1}]$
Di-tri-borosilicates ($2 < K_{\Sigma} < 3$)	Basic
Kornerupine	$\text{Mg}_3\text{Al}_6(\text{OH})\text{O}_4[(\text{Al, Si})_2(\text{Si, B})\text{O}_{10}][\text{Si}_2\text{O}_7]$
*Prismatine	$\text{Mg}_3\text{Al}_6(\text{OH})\text{BO}_7[\text{Si}_2\text{O}_7]_2$
Silicato-(4)-borate	
Zero-silicato-(4)-borates	Acid zero-silicato-(4)-borato-chlorides
Kalbarsite	$[\text{Al}_2\text{Si}_3\text{O}_{10}]^{\infty 3}_2[\text{B}(\text{OH})_4]\text{K}_6\text{Cl}$
Silicato-(3)-borates	
Disilicato-(3)-borates	
Disilicato-(3)-borates ($K_{\text{Si}} = 2$)	Basic
Tourmaline series (compare with elbaite (series))	
Olenite	$\text{NaAl}_3\text{Al}_6\text{O}_3\text{F}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Luinaite-(OH)	$(\text{Na}, \square)(\text{Fe}^{3+}, \text{Mg})_3\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Buergerite = fluor-buergerite	$\text{NaFe}^{3+}_3\text{Al}_6\text{O}_3\text{F}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Povondraite	$\text{NaFe}^{3+}_3\text{Fe}^{3+}_6\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Chromo-alumino-povondraite	$\text{NaCr}_3(\text{Al}_4\text{Mg}_2)\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Dravite	$\text{NaMg}_3\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Oxy-dravite	$\text{Na}(\text{Al}_2\text{Mg})(\text{Al}_5\text{Mg})\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Fluor-dravite	$\text{NaMg}_3\text{Al}_6(\text{OH, F})_{3+1}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Vanadiodravite	$\text{NaMg}_3\text{V}_6(\text{OH, F})_{3+1}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Vanadio-oxy-dravite	$\text{NaV}_3(\text{V}_4\text{Mg}_2)(\text{OH})_3\text{O}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Oxy-vanadium-dravite	$\text{NaV}_3(\text{V}_4\text{Mg}_2)(\text{OH})_3\text{O}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Vanadio-oxy-chromium dravite	$\text{NaV}_3(\text{Cr}_4\text{Mg}_2)(\text{OH})_3\text{O}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Chromdravite	$\text{NaMg}_3\text{Cr}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Oxy-chromium-dravite	$\text{NaCr}_3(\text{Cr}_4\text{Mg}_2)\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Schorl	$\text{NaFe}^{2+}_3\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Fluor-schorl	$\text{NaFe}^{2+}_3\text{Al}_6(\text{OH})_3\text{F}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Oxy-schorl	$\text{NaFe}^{2+}_3\text{Al}_6(\text{OH})_3\text{O}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Bosiite	$\text{NaFe}^{3+}_3(\text{Al}_4\text{Mg}_2)(\text{OH})_3\text{O}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Ferridravite	$\text{NaFe}^{3+}_3(\text{Mg}_2\text{Fe}_4^{3+})(\text{OH})_3\text{O}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*K-and O-dominate dravite	$\text{KFe}^{3+}_3(\text{Mg}_2\text{Fe}_4^{3+})\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Tsilaisite	$\text{Na}(\text{Mn}^{2+})_3\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Uvite	$\text{Ca}(\text{Mg, Fe}^{2+})_3\text{Al}_5\text{Mg}(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Lucchesiite	$\text{CaFe}^{2+}_3\text{Al}_6\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Feruvite	$\text{Ca}(\text{Fe, Mg})_3\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Adachiite	$\text{CaFe}^{2+}_3\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_5\text{AlO}_{18}][\text{BO}_3]_3$
*Foitite	$(\square, \text{Na})(\text{Fe}_2^{2+}\text{Al})\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Magnesio-foitite	$\square(\text{Mg}_2\text{Al})\text{Al}_6(\text{OH})_4[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Capranicaite	$(\text{K}, \square)\text{CaNaAl}_4[\text{Si}_2\text{O}_6][\text{BO}_3]_4$

Di-tri-alumosilicatj-(3)-borato-carbonates Acid

*Harkerite $\text{Ca}_{12}\text{Mg}_4\text{Al}[\text{SiO}_4]_4[\text{BO}_3]_3[\text{CO}_3]_5 \cdot \text{H}_2\text{O}$

Tetrasilicato-(3)-borates

Oxido-tetrasilicato-(3)-borates

Dumortierite $\text{Al}_7\text{O}_3[\text{SiO}_4]_3[\text{BO}_3]$

*Magnesiodumortierite $\text{MgAl}_6\text{O}_3[\text{SiO}_4]_3[\text{BO}_3]$

*Werdingite $(\text{Mg}, \text{Fe}^{2+})_2\text{Al}_{14}\text{B}_4\text{Si}_4\text{O}_{37} = (\text{Mg}, \text{Fe}^{2+})_2\text{Al}_{14}\text{O}_9[\text{SiO}_4]_4[\text{BO}_3]_4$

*Fe analog werdingite $(\text{Fe}^{2+}, \text{Mg})_2\text{Al}_{14}\text{O}_9[\text{SiO}_4]_4[\text{BO}_3]_4$

*Boralsilite $\text{Al}_{16}\text{B}_6\text{Si}_2\text{O}_{37} = \text{Al}_{16}\text{O}_{11}[\text{SiO}_4]_2[\text{BO}_3]_6$

*Holtite $(\text{Ta}, \square)\text{Al}_6\text{O}_3[\text{SiO}_4]_3[\text{BO}_3]$

*Nioboholtite $(\text{Nb}_{0.6}\square_{0.4})\text{Al}_6\text{O}_3[\text{SiO}_4]_3[\text{BO}_3]$

*Titanoholtite $(\text{Ti}_{0.75}\square_{0.25})\text{Al}_6\text{O}_3[\text{SiO}_4]_3[\text{BO}_3]$

Grandidierite $^{(5)}\text{Mg}^{(6)}\text{Al}_2^{(5)}\text{AlO}_2[\text{SiO}_4][\text{BO}_3]$

*Ominelite $(\text{Fe}, \text{Mg})\text{Al}_2\text{AlO}_2[\text{SiO}_4][\text{BO}_3]$

Borosilicato-(4)-(3)-borates Acid

Howlite $\text{Ca}_2(\text{OH})_5\text{SiB}_5\text{O}_9 \rightarrow \text{Ca}_2\{[\text{SiB}_2\text{O}_5(\text{OH})_3]^\infty\text{B}_3\text{O}_4(\text{OH})_3\}^{\infty 3}$

Garrelsite $\text{NaBa}_3(\text{OH})_4\text{Si}_2\text{B}_7\text{O}_{16} \rightarrow \text{CaBa}_3(\text{OH})_2[(\text{SiO}_4)_2^{(4)}\text{B}_2\text{O}_2\text{OH}_2]^\infty\text{B}_5\text{O}_6^{\infty 2}$

*Hundholmenite-(Y) $\text{Y}_{15}\text{AlCa}_x(\text{As}^{3+})_{1-x}(\text{Si}, \text{As}^{5+})\text{Si}_6\text{B}_3(\text{O}, \text{F})_{48}$

Silicato-phosphates

Disilicato-phosphates

Neutral

Phosinaite family

Clinophosinaite $\text{Na}_3\text{Ca}[\text{SiO}_3][\text{PO}_4]$

Phosinaite-(Ce) $\text{Na}_{13}\text{Ca}_2\text{Ce}[\text{SiO}_3]_4[\text{PO}_4]_4$

Tetrasilicato-phosphates

Neutral $\text{Ca}_3\text{Al}_{7.7}\text{Si}_3\text{P}_4\text{O}_{23.5}(\text{OH})_{14.1} \cdot 8\text{H}_2\text{O}$

Nagelschmidite $\text{Ca}_7[\text{SiO}_4]_2[\text{PO}_4]_2$

*Silicocarnotite $\text{Ca}_5[(\text{SiO}_4)(\text{PO}_4)][\text{PO}_4]$

*Flamite $(\text{Ca}, \text{Na}, \text{K})_2[(\text{Si}, \text{P})\text{O}_4]$

Hydrates

Perhamite $\text{Ca}_3\text{Al}_{7.7}\text{Si}_3\text{P}_4\text{O}_{23.5}(\text{OH})_{14.1} \cdot 8\text{H}_2\text{O}$

*Krásnoite $\text{Ca}_3\text{Al}_{7.7}\text{Si}_3\text{P}_4\text{O}_{23.5}(\text{OH})_{12.1}\text{F}_2 \cdot 8\text{H}_2\text{O}$

*Tetrasilicato-phosphato-halogenides

*Zadovite $\text{BaCa}_6[(\text{SiO}_4)(\text{PO}_4)][\text{PO}_4]_2\text{F}$

*Silicato-arsenates

*Mono-disilicato-arsenates (K=1,(6))

*Basic

*Johninnesite $\text{Na}_2\text{Mn}^{2+}_9(\text{Mg}, \text{Mn}^{2+})_7(\text{OH})_8[\text{Si}_6\text{O}_{17}]_2[\text{AsO}_4]_2$

*Disilicato-arsenates

*Hydrates

*Tiragalloite $\text{Mn}^{2+}_4[\text{Si}_3\text{O}_8(\text{OH})][\text{AsO}_4]$

Zero-monosilicato-carbonates

Hydrates

Carletonite $\text{KNa}_4\text{Ca}_4(\text{F}, \text{OH})(\text{H}_2\text{O})[\text{Si}_8\text{O}_{18}]^{\infty 2}[\text{CO}_3]_4$

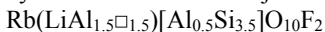
*Monosilicate-carbonates	*Hydrates	
*Niksergievite		$Ba_2Al_3[(Si,Al)_4O_{10}][CO_3](OH)_6 \cdot nH_2O$
*Monosilicato-carbonato-halogenides		
	*Основные	
*Hanjiangite		$Ba_2Ca(V^{3+}Al)(OH)_2[Si_3AlO_{10}]F[CO_3]_2$
Disilicate-carbonates	Basic	
Fukalite		$Ca_4(OH,F)_2[Si_2O_6]^{\infty}[CO_3]$
	Hydrates	
Scawtite		$Ca_7(H_2O)_2[Si_6O_{18}][CO_3]$
Trisilicate-carbonates Neutral		
Tilleyite		$Ca_5[Si_2O_7][CO_3]_2$
Tetrasilicate-carbonates	Neutral	
Spurrite family		
Spurrite		$Ca_5[SiO_4]_2[CO_3]$
*Galuskinitite		$Ca_7[SiO_4]_3[CO_3]$
Silicate-sulfates		
Tetrasilicate-sulfates	Neutral	
*Ternesite		$Ca_5[SiO_4]_2[SO_4]$
	Basic	
Ellestadite series (compare with apatite (family))		
Ellestadite-(OH)		$Ca_{10}(OH)_2[SiO_4]_3[SO_4]_3$
Ellestadite-(F)		$Ca_{10}F_2[SiO_4]_3[SO_4]_3$
*Ellestadite-(Cl)		$Ca_2Cl_2[SiO_4]_3[SO_4]_3$
	Hydrates	
Chessexite		$(Na,K)_4Ca_2(Mg,Zn)_3Al_8(OH)_{10}[SiO_4]_2[SO_4]_{10} \cdot 40H_2O$
Silicates of Li		
Proper silicates of Li		
Zeroalumosilicates (K = 0)	Neutral	
Eucryptite		${}^{(4)}Li[AlSiO_4]^{\infty 3}$
Petalite		${}^{(4)}Li[AlSi_4O_{10}]^{\infty 3}$
Virgilite		$Li[AlSi_2O_6]^{\infty 3}$
Bikitaite		$Li[AlSi_2O_6]^{\infty 3} \cdot H_2O$
Monoalumo-and monosilicates (K = 1)		
	Neutral *and hydrates	
Emeleusite family (compare with osumilite (family))		
Emeleusite		$Na_4Li_2Fe^{3+}_2[Si_{12}O_{30}]^{\infty}$
Sugilite		$KNa_2(Fe^{3+}, Mn^{2+}, Al)_2Li_3[Si_{12}O_{30}]^{\infty}$
*Silinaite		$NaLi[Si_2O_5] \cdot 2H_2O$
	Basic	
Lithium mica family		
Fragile lithium mica subfamily		
Ephesite		$Na\{LiAl_2(OH)_2[AlSiO_5]^{\infty 2}_2\}^{\infty 2}$

Usual lithium mica subfamily**Lepidolite** series

Hydroxyllepidolite, Fluorlepidolite a Li-rich micas in, or close to, the so-called

Polyolithionite-Trilithionite join.

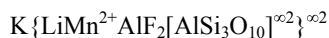
*Voloshinite



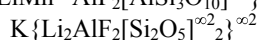
*Zinnwaldite is series by Fleischer's, 2014.

*Zinnwaldite 1M, 2M, 3T polytyps

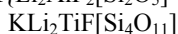
Masutomilite



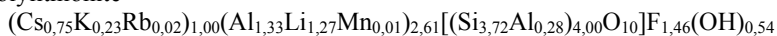
Polyolithionite



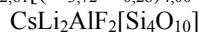
*Orlovite



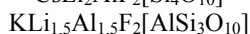
*Cs-polyolithionite



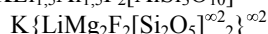
*Sokolovaite



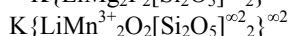
*Trilythionite



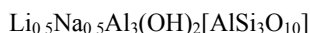
Tainiolite



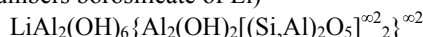
Norrishite

***Saliotite** family

*Saliotite

**Lithium chlorite** family (in what numbers borosilicate of Li)

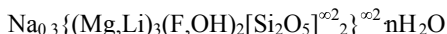
Cookeite

*Borocookeite $\text{LiAl}_4(\text{OH})_8[\text{BSi}_3\text{O}_{10}] = \text{LiAl}_2(\text{OH})_6\text{Al}_2(\text{OH})_2[\text{BSi}_3\text{O}_{10}]$

Manandonite

**Lithium smectite** family

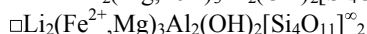
Hectorite

Mono-dialumosilicates ($1 < K < 2$) Basic**Lithium amphibole** family**Holmquistite** series

Magnesioclinoholmquistite



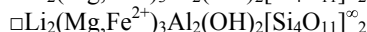
Ferroclinoholmquistite

**Clino-holmquistite** series

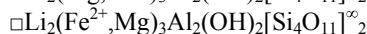
Magnesioclinoholmquistite



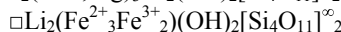
Clino-holmquistite



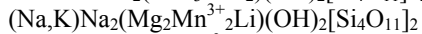
Ferroclinoholmquistite



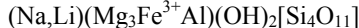
*Ferriclinoferroholmquistite



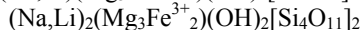
*Kornite



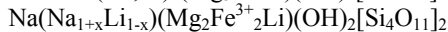
*Ottoliniite



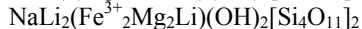
*Ferri-ottoliniite



*Ferriwhittakerite



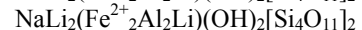
*Sodic-ferripedrizite



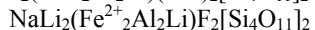
*Sodic-ferri-ferropedrizite



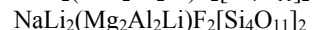
*Ferropedrizite



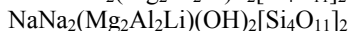
*Fluoro-sodic-ferropedrizite



*Fluoro-sodic-pedrizite



*Leakeite



*Ferroleakeite	$\text{NaNa}_2(\text{Fe}_2\text{Al}_2\text{Li})(\text{OH})_2[\text{Si}_4\text{O}_{11}]_2$
*Potassic-leakeite	$\text{KNa}_2(\text{Mg}_2\text{Al}_2\text{Li})(\text{OH})_2[\text{Si}_4\text{O}_{11}]_2$
*Fluoroleakeite	$\text{NaNa}_2(\text{Mg}_2\text{Al}_2\text{Li})\text{F}_2[\text{Si}_4\text{O}_{11}]_2$
*Fluoro-aluminoleakeite	$\text{NaNa}_2(\text{Mg}_2\text{Al}_2\text{Li})\text{F}_2[\text{Si}_4\text{O}_{11}]_2$
*Oxo-mangani-leakeite	$\text{NaNa}_2(\text{Mn}^{3+}_4\text{Li})\text{O}_2[\text{Si}_4\text{O}_{11}]_2$
*Lunijianlaite	$\text{Li}(\text{OH})_{10}[\text{Al}_{3.5}\text{Si}_{3.5}\text{O}_{20}]$
Disilicates ($K = 2$)	Neutral
Spodumene (compare with pyroxene (family))	$\text{LiAl}[\text{Si}_2\text{O}_6]^\infty$
*Watatsumiite	$\text{KNa}_2\text{LiMn}_2\text{V}^{4+}_2[\text{Si}_2\text{O}_6]_4$
*Balestraitite	$\text{KLi}_2\text{V}^{5+}[\text{Si}_2\text{O}_6]_2$
	Acid
Nambulite series (compare with marsturite (group); pyroxenoids (family))	
Nambulite	$\text{NaLiMn}_8[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty_2$
Natronambulite	$(\text{Na},\text{Li})(\text{Mn},\text{Ca})_4[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$
*Tanohataite	$\text{LiMn}_2[\text{Si}_3\text{O}_8(\text{OH})]$
Lithiomarsturite	$\text{LiCa}_2\text{Mn}_2[\text{Si}_5\text{O}_{14}(\text{OH})]^\infty$
	Basic
Balipholite	$\text{LiBaMg}_2\text{Al}_3(\text{OH})_4\text{F}_4[\text{Si}_2\text{O}_6]_2$
*Katayamalite	$\text{KLi}_3\text{Ca}_7\text{Ti}_2(\text{OH})_2[\text{Si}_6\text{O}_{18}]_2$
*Aleksandrovite	$\text{KLi}_3\text{Ca}_7\text{Sn}_2\text{F}_2[\text{Si}_6\text{O}_{18}]_2$
Silicato-borates	
Borosilicates	
Monoborosilicates $K_\Sigma = 1$	Basic
Manandonite	$\text{Li}_2\text{Al}_2(\text{OH})_6\{\text{Al}_2(\text{OH})_2[\text{Si}_2\text{AlBO}_{10}]^{\infty 2}\}_2$
Silicato-(3)-borates	
Disilicato-(3)-borates	Basic
Elbaite series (compare with tourmaline (series))	
Liddicoatite = fluor-liddicoatite	
*Fluor-liddicoatite	$\text{Ca}(\text{Li}_3\text{Al})\text{Al}_6(\text{OH})_3\text{F}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Elbaite	$\text{Na}(\text{Li}_{1.5}\text{Al}_{1.5})\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Fluorelbaite	$\text{Na}(\text{Li}_{1.5}\text{Al}_{1.5})_{\Sigma 3}\text{Al}_6(\text{OH})_3\text{F}[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Rossmanite	$\square(\text{LiAl}_2)\text{Al}_6(\text{OH})_3(\text{OH})[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Oxyrossmanite	$\square(\text{Li}_{0.5}\text{Al}_{2.5})\text{Al}_6\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
*Darrellhenryite	$\text{Na}(\text{LiAl}_2)\text{Al}_6\text{O}(\text{OH})_3[\text{Si}_6\text{O}_{18}][\text{BO}_3]_3$
Beryllium silicates	
Proper beryllium silicates	Hydrates
Beryllite	$\text{Be}_3(\text{OH})_2[\text{SiO}_4]\cdot\text{H}_2\text{O}$
Beryllsilicates	
Zero-beryllsilicates ($K_\Sigma = 0$)	
Zero-beryllsilicates with $\text{Be}_\Sigma : \text{Si} > 1$	Neutral
Phenakite	$\text{Be}[\text{BeSiO}_4]^\infty_3$
	Acid
Bertrandite	$\text{Be}_3[\text{Be}_5(\text{OH})_4(\text{Si}_2\text{O}_7)_2]^\infty_3$

*Sphaerobtrandite	$\text{Be}_3[\text{Be}_5(\text{OH})_4(\text{Si}_2\text{O}_7)_2]^{\infty 3}$
Zero-berylsilicates with (Be,Al) : Si = 1	Neutral
Trimerite	$\text{CaMn}^{2+}_2[\text{BeSiO}_4]_3$
Liberite	$\text{Li}_2\text{Be}[\text{SiO}_4]$
Helvine series	
Danalite	$[\text{BeSiO}_4]_6 \text{Fe}_8\text{S}_2$
Helvine	$[\text{BeSiO}_4]_6 \text{Mn}_8\text{S}_2$
Genthelvite	$[\text{BeSiO}_4]_6 \text{Zn}_8\text{S}_2$
*Zero-berylsilicates with (Be,Al) : Si = 0,75	Hydrates
*Alflarsenite	$\text{NaCa}_2[\text{Be}_3\text{Si}_4\text{O}_{13}(\text{OH})] \cdot 2\text{H}_2\text{O}$
Zero-berylsilicates with (Be,Al) : Si = 0,5	Neutral
Beryl series	
Beryl	$\text{Al}_2[\text{Be}_3(\text{Si}_6\text{O}_{18})]^{\infty 3}$
*Pezzottaite	$\text{CsAl}_2[(\text{Be}_2\text{Li})(\text{Si}_6\text{O}_{18})]$
Bazzite	$(\text{Sc,Al})_2[\text{Be}_3(\text{Si}_6\text{O}_{18})]^{\infty 3}$
Chkalovite	$\text{Na}_2[\text{Be}(\text{Si}_2\text{O}_6)]^{\infty 3}$
Tugtupite	$[\text{BeAlSi}_4\text{O}_{12}]^{\infty 3} \cdot \text{Na}_4\text{Cl}$
	*Hydrates
*Stoppanite	$\text{Fe}^{3+}_3(\text{Fe}^{2+}, \text{Mg})\text{Na}[\text{Be}_3(\text{Si}_6\text{O}_{18})]^{\infty 3} \cdot 2(\text{H}_2\text{O})_2$
Zero-berylsilicato-fluorides with (Be,Al) : Si = 0,7	
Meliphanite family	
Meliphanite	$(\text{Na,Ca})_4\text{Ca}_4(\text{F,O})_4[\text{Be}_4\text{AlSi}_7\text{O}_{24}]$
Zero-berylsilicato-fluorides with (Be,Al) : Si = 0,5	
Leucophanite	$\text{Ca}_4\text{Na}_4\text{F}_4[\text{Be}_4\text{Si}_8\text{O}_{24}]$
Zero-berylsilicates with (Be,Al) : Si < 0,5	Neutral
*Oftedalite	$\text{K}(\text{Cs,Ca,Mn}^{2+})_2[\text{Be}_3\text{AlSi}_{11}\text{O}_{30}]$
*Agakhanovite-(Y)	$\text{YCa}\square_2\text{K}[\text{Be}_3\text{Si}_{12}\text{O}_{30}]$
Zero-berylsilicates with (Be,Al) : Si < 0,5	Neutral → hydrates
Epididymite family	
Epididymite	$\text{Be}[\text{Be}_3(\text{Si}_6\text{O}_{15})_2]^{\infty 3} \cdot \text{Na}_4(\text{H}_2\text{O})_2$
Eudidymite	$\text{Be}[\text{Be}_3(\text{Si}_6\text{O}_{15})_2]^{\infty 3} \cdot \text{Na}_4(\text{H}_2\text{O})_2$
Milarite	$\text{KCa}_2[\text{Be}_2\text{Al}(\text{Si}_{12}\text{O}_{30})]^{\infty 3} \cdot (\text{H}_2\text{O})_{0,5}$
*Almarudite	$\text{K}(\square, \text{Na})_2(\text{Mn,Fe,Mg})_2[(\text{Be,Al})_3(\text{Si}_{12}\text{O}_{30})]$
*Eirikite	$\text{KNa}_6[\text{Be}_2(\text{Al}_3\text{Si}_{15})\text{O}_{39}\text{F}_2]$
Lovdarite	$\text{K}_4\text{Na}_{12}[\text{Be}_8\text{Si}_{28}\text{O}_{72}] \cdot 18\text{H}_2\text{O}$
*Nabesite	$\text{Na}_2[\text{BeSi}_4\text{O}_{10}] \cdot 4\text{H}_2\text{O}$

Zero-monoberylsilicates ($0 < K_{\Sigma} < 1$)

Zero-monoberylsilicates with $K_{\Sigma} = 0,1$

*Neutral

*Telyushenkoite		$\text{CsNa}_6[\text{Be}_2(\text{Al}_3\text{Si}_{15})\text{O}_{39}\text{F}_2]$
Leifite		$\text{NaNa}_6[\text{Be}_2\text{Al}_3\text{Si}_{15}\text{O}_{39}\text{F}_2]$
Zero-monoberyllosilicates with $K_\Sigma = 0,3$		
Bavenite		$\text{Ca}_4[\text{Be}_2(\text{OH})_2\text{Al}_2(\text{Si}_3\text{O}_{10})(\text{Si}_6\text{O}_{16})^{\infty 1\infty 3}]$ Hydrates (acid)
Chiavennite		$\text{CaMn}[\text{Be}_2\text{Si}_5\text{O}_{13}(\text{OH})_2] \cdot 2\text{H}_2\text{O}$
*Ferrochiavennite		$\text{Ca}_{1-2}\text{Fe}[\text{Be}_2\text{Si}_5\text{O}_{13}(\text{OH})_2] \cdot 2\text{H}_2\text{O}$
*Roggianite		$\text{Ca}_2[\text{BeAl}_2\text{Si}_4\text{O}_{13}(\text{OH})_2] \cdot 2,5\text{H}_2\text{O}$
Zero-monoberyllosilicates with $K_\Sigma = 0,(6)$ Neutral		
Gugiaite family		
Gugiaite		$\text{Ca}_2[\text{Be}(\text{Si}_2\text{O}_7)]^{\infty 2}$
Jeffreyite		$(\text{Ca},\text{Na})_2[(\text{Be},\text{Al})\text{Si}_2(\text{O},\text{OH})_7]^{\infty 2}$
Barylite		$\text{Ba}[\text{Be}_2(\text{Si}_2\text{O}_7)]^{\infty 3}$
*Clinobarylite		$\text{Ba}[\text{Be}_2\text{Si}_2\text{O}_7]$
Zero-monoberyllosilicates with $K_\Sigma = 0,8$ Acid		
Aminoffite family		
Harstigitte		$\text{Ca}_6\text{Mn}[\text{Be}_2(\text{OH})\text{Si}_3\text{O}_{11}]^{\infty 2}_2$
Aminoffite		$\text{Ca}_3[\text{Be}_2(\text{OH})_2\text{Si}_3\text{O}_{10}]$
Monoberyllosilicates ($K_\Sigma = 1$) Acid		
Euclase		$\text{Al}[\text{Be}(\text{OH})(\text{SiO}_4)]^\infty$
Bityite		$\text{Ca}\{\text{LiAl}_2(\text{OH})_2[(\text{BeAl})\text{Si}_2\text{O}_{10}]^{\infty 2}\}_2^{\infty 2}$
Diberyllosilicates ($K_\Sigma = 2$) Beryllosilicato-fluorides		
Hsianghualite		$\text{Ca}_3\text{Li}_2[\text{Be}_3\text{Si}_3\text{O}_{12}]^{\infty 3}\text{F}_2$
*Khmaralite		$\text{Mg}_4(\text{Mg}_3\text{Al}_9)\text{O}_4[\text{Si}_5\text{Be}_2\text{Al}_5\text{O}_{36}]$
*Di-triberillosilicates		
Silicates and aluminosilicates of Sn^{4+}		
Proper silicates and aluminosilicates		
*Zero-monoberyllosilicates ($K = 1,25$)		
*Eakerite		$\text{Ca}_2\text{Sn}^{4+}[\text{Al}_2\text{Si}_6\text{O}_{18}](\text{OH})_2 \cdot 2\text{H}_2\text{O}$
Monosilicates ($K = 1$) Neutral		
Brannockite (compare with osumilite (family))		$\text{KLi}_3\text{Sn}^{4+}_2[\text{Si}_{12}\text{O}_{30}]^\infty$
Disilicates ($K = 2$) Neutral		
Pabstite (compare with benitoite (group))		$\text{Ba}(\text{Sn},\text{Ti})^{4+}[\text{Si}_3\text{O}_9]$
Hydrates		
Stokesite		$2\text{CaSnSi}_3\text{O}_9 \cdot 2\text{H}_2\text{O} \rightarrow \text{Ca}_2\text{Sn}^{4+}_2[\text{Si}_6\text{O}_{18}]^\infty \cdot 4\text{H}_2\text{O}$
*Trisilicates ($K = 3$)		
*Kristiansenite		$\text{Ca}_2\text{ScSn}[\text{Si}_2\text{O}_7][\text{Si}_2\text{O}_6\text{OH}]$

Tetrasilicates (K = 4)	Oxido-tetrasilicates
Malayaite (compare with titanite (group))	$\text{Ca}[\text{Sn}^{4+}\text{O}[\text{SiO}_4]]^{\infty 2}$
Beryllosilicates of Sn	
Zero-monoberyllosilicates ($K_{\Sigma} = 0,25$)	
	Hydrates
Sorensenite	$\text{Na}_4\text{Sn}^{4+}[\text{Be}_2(\text{Si}_3\text{O}_9)_2]^{\infty 3} \cdot 2\text{H}_2\text{O}$
Mono-diberyllosilicates ($K_{\Sigma} = 1,2$) Acid	
Sverigeite	$\text{NaMn}^{2+}_2\text{Sn}^{4+}[\text{Be}_2\text{Si}_3\text{O}_{12}(\text{OH})]$

Silicates of Zn^{2+} , Pb^{2+} , As^{3+} , Sb^{3+} и Sb^{5+} paragenetic association of Franklin and Sterling Hill, New Jersey, USA, Langban and Jacobsberg, Sweden.

Minerals of Zn

Zero-mono(zinc)alumosilicates	Acid-neutral
Minchillite (compare with reyerite, truscottite)	$(\text{K}, \text{Na})_{2-3}\text{Ca}_{28}(\text{OH})_{12}[(\text{Zn}_5\text{Al}_4\text{Si}_{40})\text{O}_{112}(\text{OH})_4]$

*Mono-disilicates	*Hydrates
*Gaultite	$\text{Na}_4\text{Zn}_2[\text{Si}_7\text{O}_{18}] \cdot 5\text{H}_2\text{O}$

Disilicates	Neutral
Petedunnite	$\text{CaZn}[\text{Si}_2\text{O}_6]^{\infty}$

Trisilicates	Neutral
Hardystonite (compare with melilite)	$\text{Ca}_2\{^{(4)}\text{Zn}[\text{Si}_2\text{O}_7]\}^{\infty 2}$

*Tri-tetrasilicates	
*Scheuchzerite (K = 3.8)	$\text{Na}(\text{Mn}, \text{Mg}, \text{Zn})_9[\text{VSi}_9\text{O}_{28}(\text{OH})](\text{OH})_3$

Tetrasilicates	
Proper tetrasilicates	Neutral
Willemite	$\{^{(4)}\text{Zn}_2[\text{SiO}_4]\}^{\infty 3}$
*Xingsaoite = Co-willemite)	$(\text{Zn}, \text{Co})_2[\text{SiO}_4]$
Larsenite group (CN $\text{Zn}^{2+} = 6$)	
Esperite	$\text{Ca}_2\text{PbZn}_3[\text{SiO}_4]_3$
Larsenite	$\text{PbZn}[\text{SiO}_4]$

Basic

Hodgkinsonite family

Gerstmannite	$(\text{Mn}, \text{Mg})(\text{OH})_2\{^{(4)}\text{Mg}^{(4)}\text{Zn}[\text{SiO}_4]\}^{\infty 2}$
Hodgkinsonite	$\text{Mn}(\text{OH})_2\{^{(4)}\text{Zn}_2[\text{SiO}_4]\}^{\infty 2}$
*Franklinfurnaceite	$\text{Ca}_2\text{Fe}^{3+}\text{Mn}^{3+}\text{Mn}^{2+}_3[\text{Zn}_2\text{Si}_2\text{O}_{10}](\text{OH})_8$
	Hydrates
Clinohedrite	$\text{Ca}\{^{(4)}\text{Zn}(\text{H}_2\text{O})[\text{SiO}_4]\}^{\infty 2}$

Tetrasilicato-arsenates

Basic

Holdenite family

Holdenite	$(\text{Mn}, \text{Mg})_6\text{Zn}_3(\text{OH})_8[\text{SiO}_4][\text{AsO}_4]_2$
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Kolicite		$Mn_7Zn_4(OH)_8[SiO_4]_2[AsO_4]_2$
*Tetrasilicato -arsenito- arsenates	Основные	
*Mecgovernite		$Zn_3(Mn^{2+}, Mg)_{42}(OH)_{40}[SiO_4]_8[As^{3+}O_3]_2[As^{5+}O_4]_4$
Minerals of Pb		
*Zerosilicates c K = 0		
*Plumbotsumite		$Pb_5[Si_4O_8](OH)_{10}$
*Zero-monosilicates with K = 0,9		
*Wickenburgite		$Pb_3CaAl[AlSi_{10}O_{27}] \cdot (H_2O)_4$
*Monosilicates with K = 1	Hydrates	
*Plumbophyllite		$Pb_2[Si_4O_{10}] \cdot H_2O$
*Mono-disilicates with K = 1,6	Hydrates	
*Luddenite		$Pb_2Cu^{2+}_2[Si_5O_{14}] \cdot 14H_2O$
*Mono-disilicato-(3)-borato-oxido-carbonates K = 1,6		
*Britvinite		$Pb_{14}Mg_9[Si_{10}O_{28}][BO_3]_4[CO_3]_2F_2(OH)_{12}$
Disilicates		
Proter disilicates	Neutral	
Margarosanite		$Pb(Ca, Mn)_2[Si_3O_9]$
Disilicato-sulfates		
Roebingite	Hydrates	$Pb_2Ca_6Mn(H_2O)_4(OH)_2[Si_3O_9]_2[SO_4]_2$
Trisilicates		
Barysilite	Neutral	$MnPb_8[Si_2O_7]_3$
Oxido-trisilicates		
Melanotekite series		
Melanotekite		$Pb_2Fe^{3+}_2O_2[Si_2O_7]$
Kentrolite		$Pb_2Mn^{3+}_2O_2[Si_2O_7]$
*Trisilicato-halogenides		
*Nasonite		$Pb_6Ca_4[Si_2O_7]_3Cl_2$
Tri-tetrasilicates		
Hancockite	Basic	$CaPbFe^{3+}Al_2O(OH)[Si_2O_7][SiO_4]$
(compare with epidote (family))		
*Tri-tetrasilicato-oxido-carbonates	Hydrates	
Molybdophyllite (K = 3.6)		$Pb_8Mg_9[Si_{10}O_{30}(OH)_8][CO_3]_3 \cdot H_2O$
Beryllsilicates		
Mono-diberyllsilicates (K _Σ = 1,5)	Basic	
Joersmithite (structure of amphibole)		$PbCa_2(Mg_3Fe_2^{3+}(OH)_2[BeSi_3O_{11}])^\infty_2$

*Tri-tetrasilites (K = 3,4)	$\text{Si}_2\text{O}_7 : \text{SiO}_4 = 2 : 3$	*ОСНОВНЫЕ
*Samfowlerite	$\text{Ca}_{28}\text{Mn}_6\text{Zn}_4(\text{Zn}_{1,5}\text{Be}_{2,5})_{\Sigma 4}\text{Be}_{12}[\text{SiO}_4]_{12}[\text{Si}_2\text{O}_7]_8(\text{OH})_{12}$	
Berylborosilicates		
Zero-monoberylborosilicates ($0 < K_{\Sigma} < 1$) Neutral		
Zero-monoberylborosilicato-fluorides		
Hyalotekite	$\text{Pb}_2\text{Ba}_2\text{Ca}_2[(\text{Be}_{0,5}\text{Si}_{9,5})_{\Sigma 10}\text{B}_2\text{O}_{28}]^{\infty 3}\text{F}$	
*Zero-monoberylborosilicato-halogenides Basic		
*Wawayandaite	$\text{Ca}_6\text{Mn}_2\text{Be}_5[\text{BBe}_4\text{Si}_6\text{O}_{23}](\text{OH},\text{Cl})_{15}$	
Minerals of As and Sb		
Proper silicates		
Disilicates		Basic
Schallerite family		
Schallerite	$(\text{Mn},\text{Fe})_{16}\text{As}^{3+}_3(\text{OH})_{17}[\text{Si}_{12}\text{O}_{36}]$	
Nelenite	$(\text{Mn},\text{Fe})_{16}\text{As}^{3+}_3(\text{OH})_{17}[\text{Si}_{12}\text{O}_{36}]$	
*Långbanite	$\text{Mn}^{2+}_4\text{Mn}^{3+}_9\text{Sb}^{5+}[\text{Si}_2\text{O}_{24}]$	
*Di-triberyllsilicates ($K_{\Sigma} = 2.2$)		
Welshite	$\text{Ca}_4(\text{Mg}_9\text{Sb}^{5+}_3)\text{O}_4[\text{Be}_3\text{Si}_6\text{AlO}_{36}]$	*Oxido-di-triberyllsilicates
Silicato-arsenates		
*Tri-tetrasilicato-arsenates		
*Ardennite-(As)	$\text{Mn}^{2+}_4(\text{Al},\text{Fe}^{3+})_5\text{Mg}[\text{SiO}_4]_2[\text{Si}_3\text{O}_{10}][(\text{As},\text{V})\text{O}_4](\text{OH})_6$	
*Ardennite-(V)	$\text{Mn}^{2+}_4(\text{Al},\text{Fe}^{3+})_5\text{Mg}[\text{SiO}_4]_2[\text{Si}_3\text{O}_{10}][(\text{V},\text{Si},\text{As})\text{O}_4](\text{OH})_6$	
Tetrasilicato-arsenates		
Basic		
Dixenite family		
Dixenite	$\text{CuMn}^{2+}_{14}\text{Fe}^{3+}(\text{As}^{3+}\text{O}_3)_5(\text{OH})_6[\text{SiO}_4]_2[\text{As}^{5+}\text{O}_4]$	
Kraisslite	$\text{Zn}_3(\text{Mn},\text{Mg})_{25}(\text{Fe}^{3+},\text{Al})(\text{As}^{3+}\text{O}_3)_2(\text{OH})_{16}[(\text{Si},\text{As}^{5+})\text{O}_4]_{10}$	
Oxido-tetrasilicato-arsenates		
Parwelite	$\text{Mn}^{2+}_{10}(\text{Sb}^{5+}\text{O}_4)_2[\text{SiO}_4]_2[\text{AsO}_4]_2$	
*Tetrasilicato-antimonates		
*Tegengrenite	$(\text{Mg},\text{Mn})_4(\text{Sb}^{5+}\text{O}_4)[(\text{Mn}^{3+},\text{Si},\text{Ti})\text{O}_4]$	
Silicates of <i>f</i> -elements		
Proper silicates		
*Zero-monosilicates with K = 0,(6)		
*Chiappinoite-(Y)	$\text{Y}_2\text{Mn}[\text{Si}_3\text{O}_7]_4$	
*Zero-monosilicates with K = 0,75 Hydrates		
*Thornasite	$\text{Na}_{12}\text{Th}_3[\text{Si}_8\text{O}_{19}]_4 \cdot 18\text{H}_2\text{O}$	
*Monteregianite -(Y)	$\text{Na}_4\text{K}_2\text{Y}_2[\text{Si}_{16}\text{O}_{38}] \cdot 10\text{H}_2\text{O}$	
Monosilicates (K = 1) Neutral		
Ekanite family		
Ekanite	$\text{Ca}_2\text{Th}[\text{Si}_4\text{O}_{10}]^{\infty 2}_2$	

Iraqite-(La)	$(K_{1-x}\square_x)Ca_2(La,Ce,Th)[Si_4O_{10}]^{\infty}_2$
Steacyite	$(K_{1-x}\square_x)(Na,Ca)_2Th[Si_4O_{10}]^{\infty}_2$ (x = 0,1-0,4)
*Moskvinit-(Y)	$Na_2K(Y,REE)[Si_6O_{15}]$
	Hydrates
*Mendeleevite-(Ce)	$Cs_6(Ce_{22}Ca_6)[Si_{70}O_{175}](OH,F)_{14}(H_2O)_{21}$
*Mendeleevite-(Nd)	$Cs_6(Nd,REE)_{23}Ca_7[Si_{70}O_{175}](OH,F)_{19}(H_2O)_{16}$
*K-mendeleevite-(Ce)	$K_6Cs_6(REE_{22}Ca_6)[Si_{70}O_{175}](OH,F)_{20}(H_2O)$
*Yakovenchukite-(Y)	$K_3NaCaY_2[Si_{12}O_{30}](H_2O)_4$
*Turkestanite	$(K_{1-x}\square_x)(Ca,Na)_2Th[Si_8O_{20}]nH_2O$
*Arapovite	$(K_{1-x}\square_x)(Ca,Na)_2(U,Th)[Si_8O_{20}]H_2O$ (x~0.5)
Sazhinite-(Ce)	$Na_3Ce[Si_6O_{15}]^{\infty}_2 \cdot 6H_2O$
*Sazhinite-(La)	$Na_3La[Si_6O_{15}](H_2O)_2$
Ashcroftine-(Y)	$K_{10}Na_{10}(Y,Ca)_{24}(OH)_4(CO_3)_{16}[Si_{56}O_{140}] \cdot 16H_2O$
Monosilicato-trisilicates (mixed)	Basic
Miserite-(Y)	$K_2Ca_{10}Y_2(OH)_2F_2[Si_{12}O_{30}]^{\infty}[Si_2O_7]_2$
Miserite	$K_2(Ca,Ce)_{12}(OH,F)_4[Si_{12}O_{30}]^{\infty}[Si_2O_7]_2$
Mono-disilicates (1 < K < 2)	Neutral
Nordite-(La)	$Na_6(Sr,Ca)_2(La,Ce)_2(Mn,Zn,Mg)_2[Si_{12}O_{34}]^{\infty}$
*Nordite-(Ce)	$Na_6(Sr,Ca)_2(Ce,La)_2(Mn,Zn,Mg)_2[Si_{12}O_{34}]^{\infty}$
*Manganonordite-(Ce)	$Na_6(Sr,Ba)_2(Ce,La)_2(Mn,Zn,Fe,Mg)_2[Si_{12}O_{34}]^{\infty}$
*Ferronordite-(La)	$Na_3Sr(La,Ce)Fe^{2+}[Si_6O_{17}]^{\infty}$
*Ferronordite-(Ce)	$Na_3SrCeFe^{2+}[Si_6O_{17}]^{\infty}$
	Basic
*Atelisite-(Y)	$Y_4(OH)_8[Si_3O_8]$
Disilicates (K = 2)	Hydrates
*Gerenite-(Y)	$(Ca,Na)_2(Y,Th)_3[Si_6O_{18}]^{\infty} \cdot 2H_2O$
	*Asid
Thorosteenstrupine	$CaThMn^{2+}[Si_4O_{11}(O,F)] \cdot 6H_2O$
Disilicato-trisilicates (K = 2,(6))	Basic
Thalénite-(Y)	$Y_3(OH)[Si_3O_{10}]$
*Fluorthalénite-(Y)	$Y_3F[Si_3O_{10}]$
Trisilicates (K = 3)	
Proper trisilicates	Neutral
Thortveitite family	
Thortveitite group	
Keiviite-(Yb)	$Yb_2[Si_2O_7]$
*Keiviite-(Y)	$(Y,Yb)_2[Si_2O_7]$
Thortveitite-(Sc)	$(Sc,Y)_2[Si_2O_7]$
Yttrialite-(Y)	$Y_2[Si_2O_7]$
*Percleveite-(Ce)	$(Ce,La,Nd)_2[Si_2O_7]$
Oxido-trisilicates	
Perrierite family	
Perrierite-(Ce)	$(Ce,La,Ca,Sr)_4(Fe^{2+},Mg,Mn^{2+})(Ti^{4+},Fe^{3+})_4O_8[Si_2O_7]_2$
*Perrierite-(La)	$(La,Ce,Ca)_4Fe^{2+}(Ti^{4+},Fe^{3+})_4O_8[Si_2O_7]_2$
*Matsubaraite	$Sr_4Ti_5O_8[Si_2O_7]_2$

Chevkinite-(Ce)	$(\text{REE}, \text{Ca})_4\text{Fe}^{2+}_2(\text{Ti}^{3+}, \text{Fe}^{3+})_3\text{O}_8[\text{Si}_2\text{O}_7]_2$
*Dingdaohengite-(Ce)	$(\text{Ce}, \text{La})_4\text{Fe}^{2+}(\text{Ti}, \text{Fe}^{2+}, \text{Mg}, \text{Fe}^{3+})_2\text{Ti}_2\text{O}_8[\text{Si}_2\text{O}_7]_2$
*Maoniupingite-(Ce)	$(\text{Ca}, \text{Ce})_4(\text{Fe}^{3+}\text{TiFe}^{2+}\square)(\text{TiFe}^{3+}\text{Nb})_4\text{O}_8[\text{Si}_2\text{O}_7]_2$
*Cr-chevkinite (Ce, La, Nd, Pr, Th)	$(\text{Ce}, \text{La}, \text{Nd}, \text{Pr}, \text{Th})_4(\text{Mg}, \text{Fe}, \text{Ca})_2\text{Cr}^{3+}_2(\text{Ti}, \text{Al}, \text{Nb})_2\text{O}_8[\text{Si}_2\text{O}_7]_2$
*Polyakovite-(Ce)	$(\text{REE}, \text{Ca})_4(\text{Mg}, \text{Fe}^{2+})(\text{Cr}, \text{Fe}^{3+})_2(\text{Ti}, \text{Nb})_2\text{O}_8[\text{Si}_2\text{O}_7]_2$
Strontiochevkinite	$(\text{Sr}, \text{La}, \text{Ce}, \text{Ca})_4(\text{Fe}^{2+}, \text{Fe}^{3+})(\text{Ti}^{3+}, \text{Zr})_4\text{O}_8[\text{Si}_2\text{O}_7]_2$
*Christofschäferite-(Ce)	$(\text{Ce}, \text{La}, \text{Ca})_4\text{Mn}(\text{Ti}, \text{Fe})_3(\text{Fe}, \text{Ti})\text{O}_8[\text{Si}_2\text{O}_7]_2$
*Fogoite-(Y)	$\text{Na}_3\text{Ca}_2\text{Y}_2\text{TiOF}_3[\text{Si}_2\text{O}_7]_2$
*Stavelotite-(La)	$\text{La}_3\text{Mn}^{2+}_3\text{Cu}(\text{Mn}^{3+}_2\text{Fe}^{3+}\text{Mn}^{4+})\text{O}_{30}[\text{Si}_2\text{O}_7]_6$
Rowlandite-(Y)	Trisilicato-fluorides $\text{Fe}^{2+}\text{Y}_4[\text{Si}_2\text{O}_7]_2\text{F}_2$

Trisilicato-tetrasilicates

Neutral

*Perböite-(Ce)	$(\text{CaCe}_3)(\text{Al}_3\text{Fe}^{2+})\text{O}(\text{OH})_2[\text{Si}_2\text{O}_7][\text{SiO}_4]_3$
*Alnaperböite-(Ce)	$(\text{CaCe}_{2.5}\text{Na}_{0.5})\text{Al}_4\text{O}(\text{OH})_2[\text{Si}_2\text{O}_7][\text{SiO}_4]_3$

Oxido(fluorido)-hydroxido-trisilicato-tetrasilicates

Allanite series (compare with epidote (family))(K = 3, 3)

*Allanite-(La)	$\text{LaCaAl}_2\text{Fe}^{2+}_3\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
Allanite-(Ce) (orthite)	$\text{CaCeAl}_2\text{Fe}^{2+}_3\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Allanite-(Nd)	$\text{CaNdAl}_2\text{Fe}^{2+}_3\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
Allanite-(Y) (yttriumorthite)	$\text{CaYAl}_2\text{Fe}^{2+}_3\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Ferriallanite-(Ce)	$\text{CaCeFe}^{3+}\text{AlFe}^{2+}_2\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Uedaite-(Ce)	$(\text{Mn}^{2+}\text{Ce})(\text{Al}_2\text{Fe}^{2+})\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Dissakisite-(Ce)	$\text{Ca}(\text{Ce}, \text{La})\text{MgAl}_2\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Androsite-(La)	$\text{Mn}^{2+}\text{LaMn}^{2+}\text{Mn}^{3+}\text{AlO}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Manganiandrosite-(Ce)	$\text{Mn}^{2+}\text{CeMn}^{3+}\text{AlMn}^{2+}_2\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Vanadoandrosite-(Ce)	$\text{Mn}^{2+}\text{CeV}^{3+}\text{AlMn}^{2+}_2\text{O}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Åskagenite-(Nd)	$\text{Mn}^{2+}\text{NdAl}_2\text{Fe}^{3+}_2\text{O}_2[\text{Si}_2\text{O}_7][\text{SiO}_4]$
Dollaseite-(Ce)	$\text{Ca}(\text{Ce}, \text{La}, \text{Nd})\text{Mg}_2\text{AlF}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Västmanlandite-(Ce)	$(\text{Ce}, \text{La})_3\text{CaAl}_2\text{Mg}_2\text{F}(\text{OH})_2[\text{Si}_2\text{O}_7][\text{SiO}_4]_3$
*Khristovite-(Ce)	$\text{CaCeMgMn}^{2+}\text{AlF}(\text{OH})[\text{Si}_2\text{O}_7][\text{SiO}_4]$
*Gatelite-(Ce)	$(\text{CaCe}_3)(\text{Al}_3\text{Mg})\text{O}(\text{OH})_2[\text{Si}_2\text{O}_7][\text{SiO}_4]_3$

Tetrasilicates (K = 4)

Neutral → acid

*Unnamed	$\text{CaCe}_2[\text{SiO}_4]_2$
Thorite family	
Thorite	$\text{Th}[\text{SiO}_4]$
*Stetindite-(Ce)	$\text{Ce}^{4+}[\text{SiO}_4]$
Thorogummite	$\text{Th}[(\text{SiO}_4)_{1-x}(\text{OH})_{4x}]$
Coffinite	$\text{U}[\text{SiO}_4] \cdot n\text{H}_2\text{O}$
Huttonite	$\text{Th}[\text{SiO}_4]$
Tombarthite-(Y)	$\text{Y}_4(\text{Si}, \text{H}_4)_4\text{O}_{12-x}(\text{OH})_{4+2x}$
Vyuntspakhkite-(Y)	$\text{Y}(\text{Al}, \text{Si})[\text{SiO}_4](\text{OH}, \text{O})_2$

Acid-basic

Törnebohmite-(Ce)	$(\text{Ce}, \text{La})_2\text{Al}(\text{OH})[\text{SiO}_4]_2$
*Törnebohmite-(La)	$(\text{La}, \text{Ce})_2\text{Al}(\text{OH})[\text{SiO}_4]_2$
Cerite-(Ce)	$(\text{Ce}, \text{La}, \text{Ca})_9(\text{Mg}, \text{Fe}^{3+})(\text{OH})_3[\text{SiO}_4]_3[\text{SiO}_3(\text{OH})]_4$
*Aluminocerite-(Ce)	$(\text{Ce}, \text{La})_9(\text{Al}, \text{Fe}^{3+})(\text{OH})_3[\text{SiO}_4]_3[\text{SiO}_3(\text{OH})]_4$
*Cerite-(La)	$(\text{La}, \text{Ce}, \text{Ca})_9(\text{Fe}^{3+}, \text{Ca}, \text{Mg})(\text{OH})_3[\text{SiO}_4]_3[\text{SiO}_3(\text{OH})]_4$

Britholite series	
Britholite-(Ce)	$(\text{Ce,Ca})_5(\text{OH})[\text{SiO}_4]_3$
Britholite-(Y)	$(\text{Y,Ca})_5(\text{OH})[\text{SiO}_4]_3$
Tetrasilicato-halogenides	
*Fluorbritholite-(Ce)	$(\text{Ce,Ca})_5\text{F}[\text{SiO}_4]_3$
Fluorbritholite-(Y)	$(\text{Y,Ca})_5\text{F}[\text{SiO}_4]_3$
*Fluorcalciobritholite	$(\text{Ca,REE})_5\text{F}[(\text{Si,P})\text{O}_4]_3$
	Basic
Kuliokite-(Y)	$(\text{Y,Yb})_4\text{Al}(\text{OH})_2[\text{SiO}_4]_2\text{F}_5$
Silicates of f-cations with unknown structure	
Umbozerite	$\text{Na}_3\text{Sr}_4\text{Th}[\text{Si}_8\text{O}_{23}\text{OH}]$
Beryllsilicates	
*Zero-monoberylosilicates ($K_\Sigma = 0,3$)	
*Bussyite-(Ce)	$(\text{Ce,REE})_3(\text{Na,H}_2\text{O})_6\text{Mn}[\text{Be}_5\text{Si}_9(\text{O,OH})_{30}]\text{F}_4$
Zero-monoberylosilicates ($K_\Sigma = 0,8$)	
Semenovite-(Ce)	Acid $\text{Na}_8\text{Ca}_2\text{Ce}_2\text{Fe}^{2+}[\text{Be}_6\text{Si}_{14}\text{O}_{40}]\text{F}_4(\text{OH})_4$
Monoberillosilicates	
	Neutral → Acid
Gadolinite series	
Gadolinite-(Ce)	$\text{Ce}_2\text{Fe}^{2+}[\text{BeO}(\text{SiO}_4)]_2^{\infty 2}$
Gadolinite-(Y)	$\text{Y}_2\text{Fe}^{2+}[\text{BeO}(\text{SiO}_4)]_2^{\infty 2}$
Minasgeraisite-(Y)	$\text{CaY}_2[\text{BeO}(\text{SiO}_4)]_2^{\infty 2}$
Hinganite-(Ce)	$(\text{Ce,Y,Yb})[\text{Be}(\text{OH})(\text{SiO}_4)]_2^{\infty 2}$
Hinganite-(Y)	$(\text{Y,Yb,Er})[\text{Be}(\text{OH})(\text{SiO}_4)]_2^{\infty 2}$
Hinganite-(Yb)	$(\text{Yb,Y})[\text{Be}(\text{OH})(\text{SiO}_4)]_2^{\infty 2}$
*Calcybeborosilite-(Y)	$(\text{Y,Ca})_2(\square,\text{Fe}^{2+})[(\text{B,Be})_2(\text{OH,O})(\text{SiO}_4)]_2$
*Tetraberillosilicatesr ($K = 4$)	
*Makarochkinite	$\text{Ca}_2\text{Fe}^{2+}_4\text{Fe}^{3+}\text{TiO}_2[\text{BeAlSi}_4\text{O}_{18}]$
Borosilicates	
Zero-borosilicates	
	Basic
Tritomite-(Ce)	$\text{Ce}_5(\text{OH,O})[(\text{SiO}_4,\text{BO}_4)_3]$
Tritomite-(Y)	$\text{Y}_5(\text{OH,O,F})[(\text{SiO}_4,\text{BO}_4)_3]$
*Zero-monoborosilicates ($K = 0,8$)	
*Perettiite-(Y)	$\text{Y}^{3+}_2\text{Mn}^{2+}_4\text{Fe}^{2+}[\text{Si}_2\text{B}_8\text{O}_{24}]$
Monoborosilicates	
	Neutral
Stillwellite-(Ce)	$(\text{Ce,L a,C a})\text{BSiO}_5 \rightarrow (\text{Ce,L a,C a})_3[(\text{SiO}_3)_3(\text{B}_3\text{O}_6)^\infty]^\infty$
Mono-diborosilicates	
	Basic
Tadzhikite-(Ce)	$\text{Ca}_2(\text{Ca,Y})_2(\text{Ti,Al,Fe}^{3+})(\text{Ce,Y},\square)(\text{OH})_2[\text{Si}_4\text{B}_4\text{O}_{16}(\text{O,OH})_6]$
Tadzhikite-(Y)	$(\text{Ca,Ce})_4(\text{Ti}^{4+},\text{Fe}^{3+},\text{Al})(\text{Y,Ce})_2(\text{OH})_2[\text{B}_4\text{Si}_4\text{O}_{22}]$
	Acid
*Hellandite-(Ce)	$(\text{Ca,REE})_4\text{Ce}_2\text{Al}\square_2(\text{OH})_2[\text{Si}_2\text{B}_2\text{O}_{11}]_2$

Hellandite-(Y)		$(\text{Ca,REE})_4\text{Y}_2\text{Al}\square_2(\text{OH})_2[\text{B}_2\text{Si}_2\text{O}_{11}]_2$
*Mottanait-(Ce)		$\text{Ca}_4(\text{Ce,Ca})_2\text{AlBe}_2\text{O}_2[\text{Si}_2\text{B}_2\text{O}_{11}]_2$
*Ciprianite		$\text{Ca}_4[(\text{Th,U})\text{REE}]_2\text{Al}\square_2(\text{OH})_2[\text{Si}_2\text{B}_2\text{O}_{11}]_2$
*Tri-tetraborosilicates K = 3,(1)		
*Proshchenkoite-(Y)		$\text{Ca}(\text{Y,REE,CaNa,Mn})_{15}(\text{Fe}^{2+}\text{Mn})(\text{P,Si})[\text{Si}_6\text{B}_3\text{O}_{34}]\text{F}_{14}$
*Tri-tetraborosilicates K = 3,(1)		
*Laptevite-(Ce)		$\text{NaFe}^{2+}(\text{REE}_7\text{Ca}_5\text{Y}_3)[\text{SiO}_4]_4[\text{Si}_3\text{B}_2\text{PO}_{18}][\text{BO}_3]\text{F}_{11}$
*Tri-tetraborosilicates K = 3,6		
Okanoganite-(Y)		$(\text{Ca,Na,REE,Th})_{16}\text{Fe}^{3+}[\text{Si}_7\text{B}_3\text{O}_{34}(\text{OH})_4]\text{F}_{10}$
*Tetraborosilicates		
*Vicanite-(Ce)		$(\text{Ca,REE,Th})_{15}\text{As}^{5+}(\text{As}^{3+}_{0,5}\text{Na}_{0,5})\text{Fe}^{3+}[\text{Si}_6\text{B}_4\text{O}_{40}]\text{F}_7$
Borosilicates of <i>f</i> -cations with unknown structure		
Melanocerite-(Ce)		$\text{Ce}_5(\text{OH}_2\text{O})[(\text{SiO}_4,\text{BO}_4)]_3$
Cappelenite-(Y)		$\text{Ba}(\text{Y,Ce})_6[\text{Si}_3\text{B}_6\text{O}_{24}]\text{F}_2$
Silicato-phosphates		
Disilicato-phosphates		
Phosinaite-(Ce)	Neutral	$\text{Na}_{13}\text{Ca}_2\text{Ce}[\text{SiO}_3]_4[\text{PO}_4]_4$
Tetrasilicato-phosphates-sulfates		
Saryarkite-(Y)	Hydrates	$\text{Ca}(\text{Y,Th})\text{Al}_5(\text{OH})_7[\text{SiO}_4]_2[\text{PO}_4][\text{SO}_4]\cdot 6\text{H}_2\text{O}$
*Silicato-phosphato-carbonates		
*Abenakiite-(Ce)		$\text{Na}_{26}\text{REE}_6[\text{SiO}_3]_6[\text{PO}_4]_6[\text{CO}_3]_6(\text{S}^{4+}\text{O}_2)\text{O}$
Silicato-carbonates		
Monosilicato-carbonates		
Caysichite-(Y)	Hydrates	$\text{Y}_4\text{Ca}_3\text{Gd}(\text{OH})[\text{Si}_8\text{O}_{20}][\text{CO}_3]_6\cdot 7\text{H}_2\text{O}$
Disilicato-carbonates		
Kainosite-(Y)	Hydrates	$\text{Ca}_2(\text{Y,Ce})_2[\text{SiO}_3]_4[\text{CO}_3]\text{H}_2\text{O}$
*Trisilicato-carbonates		
*Biraite-(Ce)	Средние	$\text{Ce}_2\text{Fe}^{2+}[\text{Si}_2\text{O}_7][\text{CO}_3]$
Tetrasilicato-carbonates		
Iimoriite-(Y)	Neutral	$\text{Y}_2[\text{SiO}_4][\text{CO}_3]$
Subclass: Silicates of cations with middle FC		
Silicates of V^{4+}		
Monosilicates		
Cavansite family		
Cavansite		$\text{Ca}(\text{V}^{4+}\text{O})[\text{Si}_4\text{O}_{10}]^{2-}\cdot 4\text{H}_2\text{O}$
Pentagonite		$\text{Ca}(\text{V}^{4+}\text{O})[\text{Si}_4\text{O}_{10}]^{2-}\cdot 4\text{H}_2\text{O}$

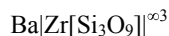
Trisilicates	Neutral $BaV^{4+}Si_2O_7$
Haradaite group	
Haradaite	$SrV^{4+}[Si_2O_7]$
Suzukiite	$BaV^{4+}[Si_2O_7]$
*Tetrasilicates	
	*Oxido-tetrasilicates
*Vanadomalayaite	$Ca\{V^{4+}O[SiO_4]\}^{\infty 2}$
Silicates of Zr → zirconium silicates	
Zirconium silicates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s -cations	
Zirconium silicates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s -cations without Li^+ and Be^{2+}	
Proper zirconium silicates	
Zirconomonosilicates (K = 1)	Neutral
Dalyite	$K_2 Zr[Si_6O_{15}]^{\infty 2} ^{\infty 3}$
	Hydrates
Elpidite family	
Armstrongite	$Ca Zr[Si_6O_{15}]^{\infty 2} ^{\infty 3}(H_2O)_3$
Elpidite	$Na_2 Zr[Si_6O_{15}]^{\infty 2} ^{\infty 3}(H_2O)_3$
*Yusupovite	$Na_2Zr[Si_6O_{15}] \cdot 2.5H_2O$
*Zeravshanite	$Cs_4Na_2Zr_3[Si_6O_{15}]_3(H_2O)_2$
Zirconomono-disilicates (1 < K < 2)	
Zirconomono-disilicates with K = 1,2 Neutral	
Lemoynite	$ CaZr_2[Si_{10}O_{26}]^{\infty 2} ^{\infty 3}(Na,K)_2(H_2O)_{5-6}$
*Natrole moynite	$ Na_4Zr_2[Si_{10}O_{26}]^{\infty 2} ^{\infty 3} \cdot 9H_2O$
Zirconomono-disilicates with K = 1,(3)	
	Hydrates
*Kapustinitite	$Na_{5,5}Mn_{0,25}Zr[Si_6O_{16}](OH)_2$
Terskite	$Na_4Zr[Si_6O_{16}] \cdot 2H_2O$
*Hydroterskite	$Na_2Zr[Si_6O_{12}(OH)_4](OH)_2$
Zirconomono-disilicates with K = 1,5	
	Neutral
Vlasovite	$Na_2 Zr[Si_4O_{11}]^{\infty} ^{\infty 3}$
	*Hydrates
*Tumchaite	$Na_2(Zr,Sn)[Si_4O_{11}] \cdot 2H_2O$
*Zirconomono-disilicates with K = 1,54	
*Rastsvetaevaite	$Na_{27}K_8Ca_{12}Fe_3Zr_6[Si_{52}O_{144}](O,OH)_6Cl_2$
*Zirconomono-disilicates with K = 1,77	
*Aqualite	$(H_3O)_8(Na,R,Sr)_5Ca_6Zr_3[Si_{26}O_{66}(OH)_9]Cl$
Zirconomono-disilicates with K = 1,84	
	Neutral
*Khomyakovite	$Na_{12}Sr_3Ca_6Fe_3WZr_3[Si_{25}O_{73}](O,OH,H_2O)_3(Cl,OH)_2$
*Manganokhomyakovite	$Na_{12}Sr_3Ca_6Mn_3WZr_3[Si_{25}O_{73}](O,OH,H_2O)_3(Cl,OH)_2$
*Raslakite	$Na_{15}Ca_3Fe_3(Na,Zr)_3Zr_3(Si,Nb)[Si_{25}O_{73}](OH,H_2O)_3(Cl,OH)_2$
*Mn analog raslakite	$[Na,H_3O]_{15}[Ca_3Mn]_3Na_3Zr_3(Si,Ti)[Si_{25}O_{72}OH](OH)_2 \cdot 2H_2O$

Zirconodisilicates with (K = 2)

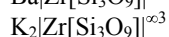
Neutral

Wadeite family

Bazirite



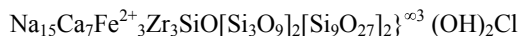
Wadeite



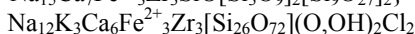
Neutral → acid → hydrates

***Eudialyte**

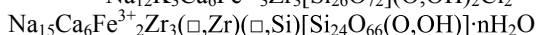
Eudialyte



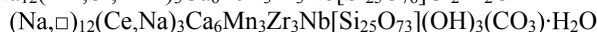
*Davinciite



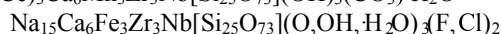
*Ikranite

*Georgbarsanovite $\text{Na}_{12}(\text{Mn},\text{Sr},\text{REE})_3\text{Ca}_6\text{Fe}^{2+}_3\text{Zr}_3\text{Nb}[\text{Si}_{25}\text{O}_{76}]\text{Cl}_2\cdot\text{H}_2\text{O}$

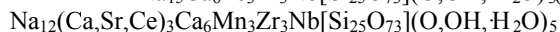
*Zirsilite-(Ce)

*Kentbrooksit $(\text{Na},\text{REE})_{15}(\text{Ca},\text{REE})_6\text{Mn}^{2+}_3\text{Zr}_3\text{Nb}[\text{Si}_{25}\text{O}_{74}]\text{F}_2\cdot 2\text{H}_2\text{O}$ *Carbokentbrooksit $(\text{Na},\square)_{12}(\text{Na},\text{Ce})_3\text{Ca}_6\text{Mn}_3\text{Zr}_3\text{Nb}[\text{Si}_{25}\text{O}_{73}](\text{OH})_3(\text{CO}_3)\cdot\text{H}_2\text{O}$

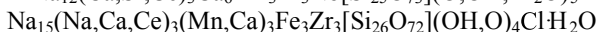
*Ferrokentbrooksit



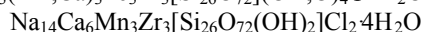
*Andrianovite



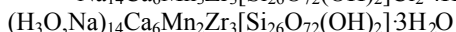
*Voronkovite



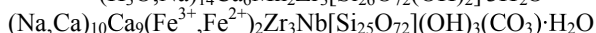
*Manganoeudialyte



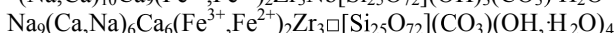
*Ilyukhinite



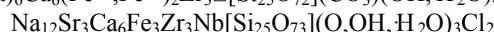
*Golyshevite



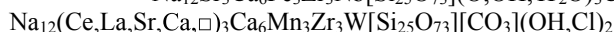
*Mogovidite



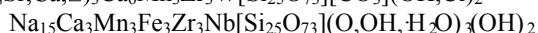
*Taseqite



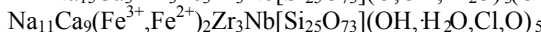
*Johnsenite-(Ce)



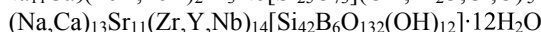
*Oneillite



*Feklichevite



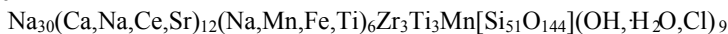
*Bobtreilit



*Labyrinthite



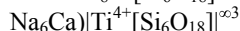
*Dualite

**Lovozerite family**

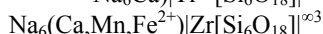
*Townendite



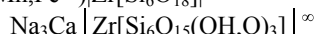
Koashvite



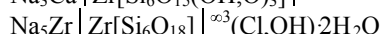
Zirsinalite



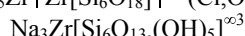
Lovozerite



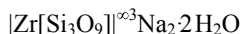
Petarasite



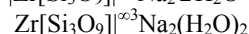
*Litvinskite

**Catapleite family****Catapleite series**

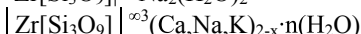
Catapleite



Gaidonnayite



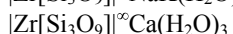
*Calcigaidonnayite



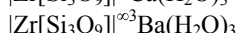
Georgechaoite



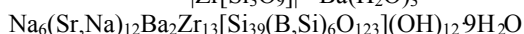
Calciohilairite



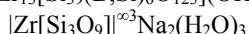
Komkovite



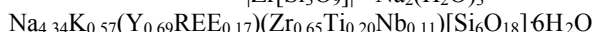
*Rogermitchellite



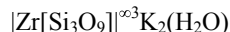
Hilairite



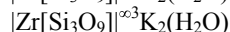
*REE analog hilairite

**Kostylevite family**

Kostylevite



Umbite





Zirconotrisilicates (K = 3)

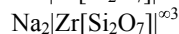
Neutral

Keldyshite family

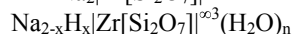
Gittinsite



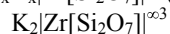
Parakeldyshite



Keldyshite

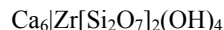


Khibinskite



Basic

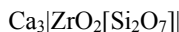
*Dovyrenite



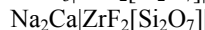
Oxido-hydroxido-zirconotrisilicato-fluorides $(\text{Na}, \text{Ca})_2\text{Ca}_4\text{Zr}(\text{Mn}, \text{Ti}, \text{Fe})(\text{F}, \text{O})_4[\text{Si}_2\text{O}_7]_2$

Baghdadite family

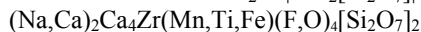
Baghdadite



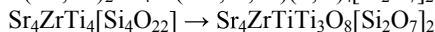
Burpalite



Hiortdahlite



*Rengeite



Tetrasilicates of Zr

Neutral

Zircon series

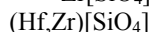
Zircon



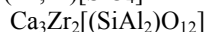
*Reidite



Hafnon

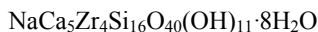


Kimzeyite (compare with garnet (series))



Zirconosilicates with unknown structure

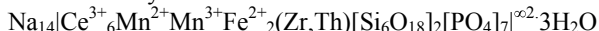
Loudounite



Zirconodisilicato-phosphates

Hydrates

Steenstrupine-(Ce)



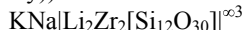
Zirconosilicates of Li

Zirconomonosilicates (K = 1)

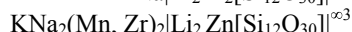
Neutral

Sogdianite family (compare with osumilite (family))

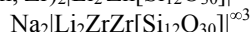
Sogdianite



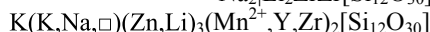
Darapiosite



Zektzerite

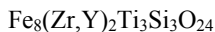


*Dusmatovite

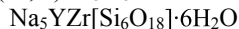


Zirconosilicates of *f*-cations

Tranquillityite



*Sazykinaite-(Y)



Titanosilicates (with niobo- and tantalosilicates)

Titanosilicates of *s*-, *d*_s- and *p*_s-cations

Titanosilicates of *s*-, *d*_s- and *p*_s-cations without Li⁺ and Be²⁺

Proper titanosilicates

*Titano-zero-monosilicates

*Lourenswalsite (K = 0.66)	(K,Ba) ₂ Ti ₄ [(Si,Al,Fe) ₆ O ₁₄](OH) ₁₂
*Oxido-titano-zero-monosilicates (K = 0,86)	
	*Hydrates
*Nafertisite	Na ₃ Fe ²⁺ ₁₀ O ₂ (OH) ₆ [Ti ₂ Si ₁₂ O ₃₄]F·2H ₂ O
Titano-monosilicates (K = 1)	Neutral
Davanite	K ₂ [Ti[Si ₆ O ₁₅] ^{∞2}] ^{∞3}
	*Hydrates
*Ershovite	Na ₄ K ₃ (Fe ²⁺ ,Mn ²⁺ ,Ti) ₂ (OH) ₄ [Si ₈ O ₂₀]4H ₂ O
*Paraershovite	Na ₃ K ₃ Fe ³⁺ ₂ (OH) ₂ [Si ₈ O ₂₀ (OH) ₂](H ₂ O) ₄
Oxido-titanosilicates →	Hydrates
Narsarsukite family	
Narsarsukite	Na ₂ [TiO[Si ₄ O ₁₀] ^{∞1}] ^{∞3}
Penkviksite	Na ₂ [TiO[Si ₄ O ₁₀] ^{∞1}] ^{∞3} ·2H ₂ O
*Intersilite	Na ₆ Mn ²⁺ Ti[Si ₁₀ O ₂₄ (OH)](OH) ₃ ·4H ₂ O
Titanomono-disilicates with mixed silicoxygen anions	Hydrates
Vinogradovite	Na ₄ [(TiO) ₄ [Si ₄ O ₁₀] [∞] [Si ₂ O ₆] ^{∞2}] ^{∞3} ·(H ₂ O,Na,K) ₃
*Paravinogradovite	(Na,□) ₂ (Ti ⁴⁺ ,Fe ³⁺) ₄ [Si ₃ AlO ₁₀][Si ₂ O ₆] ₂ (OH) ₄ ·H ₂ O
*Titanomono-disilicates with K = 1.14	Basic
*Senkevichite	CsNaKCa ₂ TiO[Si ₇ O ₁₈](OH)
*Titanomono-disilicates with K = 1.28	
*Caryochroite	(Na,Sr) ₃ (Fe ³⁺ ,Mg) ₁₀ [Ti ₂ Si ₁₂ O ₃₇](O,OH) ₉ ·8H ₂ O
Titanomono-disilicates (K = 1,4)	Basic
Tinaksite	NaK ₂ Ca ₂ [Ti(OH)[Si ₇ O ₁₉] ^{∞1}] ^{∞2}
*Titano(niobo)mono-disilicates	*Hydrates
*Haineaultite (K = 1,(6))	(Na,Ca) ₅ Ca(Ti,Nb) ₅ [(Si,S) ₁₂ O ₃₄](OH,F) ₈ ·5H ₂ O
*Chivruaiite	Ca ₄ (Ti,Nb) ₅ [Si ₆ O ₁₇] ₂ (OH,O) ₅ ·13-14H ₂ O
Титано(ниобо)моно-дисиликато-хлориды (K = 1,7)	
*Alluaivite	Na ₁₉ (Ca,Mn ²⁺) ₆ (Ti,Nb) ₃ [Si ₂₆ O ₇₄]Cl·2H ₂ O
Titanodisilicates (K = 2)	Neutral
Benitoite	Ba[Ti[Si ₃ O ₉] ^{∞3}] ^{∞3}
	*Hydrates
*Zorite	Na ₆ Ti ₅ [Si ₁₂ O ₃₆](O,OH) ₃ ·11H ₂ O
Oxido-titanodisilicates	
Baotite	Ba ₄ Ti ₄ (Ti,Nb,Fe) ₄ O ₁₆ [Si ₄ O ₁₂]Cl
*Niobobaotite	Ba ₄ (Nb,Ti,Fe) ₈ O ₁₆ [Si ₄ O ₁₂]Cl
Lorenzenite	[Na ₂ Ti ₂ O ₃ [Si ₂ O ₆] ^{∞1}] ^{∞2}
Shcherbakovite	K ₂ NaTi ₂ ⁴⁺ [Si ₄ O ₁₂]O(OH)
Batisite family	
Batisite	Na ₂ BaO ₂ [Ti ₂ [Si ₄ O ₁₂]] ^{∞3}

*Noonkanbahite	$\text{KNaBaO}_2\text{Ti}_2[\text{Si}_4\text{O}_{12}]$
Aenigmatite series (compare with krinovite (series))	
Rhönite	$ \text{Ca}_4, \text{Mg}_8 \text{Ti}_2 \text{O}_4 [(\text{SiAl})_6 \text{O}_{36}]^{\infty} ^{\infty 2}$
Aenigmatite	$ \text{Na}_2 \text{Fe}^{2+}_5 \text{TiO}_2 [\text{Si}_6 \text{O}_{18}]^{\infty} ^{\infty 2}$
*Høgtuvaite	$\text{Ca}_4(\text{Fe}_6^{2+} \text{Fe}_6^{3+})\text{O}_4[\text{Si}_8 \text{Be}_2 \text{Al}_2 \text{O}_{36}]$
	*Hydrates
Kukisvumite	$\text{Na}_6 \text{ZnO}_4 \text{Ti}_2 [\text{Si}_4 \text{O}_{12}] ^{\infty 3} \cdot 2 \cdot 4 \text{H}_2 \text{O}$
*Manganokukisvumite	$\text{Na}_6 \text{MnO}_4 \text{Ti}_2 [\text{Si}_4 \text{O}_{12}] ^{\infty 3} \cdot 2 \cdot 4 \text{H}_2 \text{O}$
Titanodisilicato-fluorides	Basic
Yuksporite	
	$\text{K}_4(\text{Ca}, \text{Na})_{14}(\text{Sr}, \text{Ba})_2(\square, \text{Mn}, \text{Fe})(\text{Ti}, \text{Nb})_4(\text{O}, \text{OH})_4[\text{Si}_6 \text{O}_{17}]_2[\text{Si}_2 \text{O}_7]_3(\text{H}_2 \text{O}, \text{OH})_3$
*Eveslogite	$(\text{Ca}_{25} \text{K}_{24})\text{Ti}_{12}[\text{Si}_4 \text{O}_{12}]_{12}(\text{OH})_{12} \text{F}_{14}$
Labuntsovite family	
Nenadkevichite group	
Nenadkevichite	$\text{Na}_{8-x} \text{Nb}_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 8 \text{H}_2 \text{O}$
*Korobitsynite	$\text{Na}_{8-x} \text{Ti}_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 8 \text{H}_2 \text{O}$
Vuoriyarvite group	
*Vuoriyarvite-K	$(\text{K}, \text{Na}, \square)_{12} \text{Nb}_8[\text{Si}_4 \text{O}_{12}]_4 \text{O}_8 \cdot 12 \cdot 16 \text{H}_2 \text{O}$
*Tsepinite-Ca	$(\text{Ca}, \text{K}, \text{Na})_{2-x}(\text{Ti}, \text{Nb})_2[\text{Si}_4 \text{O}_{12}](\text{OH}, \text{O})_2 \cdot 4 \text{H}_2 \text{O}$
*Tsepinite-K	$(\text{K}, \text{Ba}, \text{Na})_2(\text{Ti}, \text{Nb})_2[\text{Si}_4 \text{O}_{12}](\text{OH}, \text{O})_2 \cdot 3 \text{H}_2 \text{O}$
*Tsepinite-Na	$(\text{Na}, \text{H}_3 \text{O}, \text{K}, \text{Sr}, \text{Ba}, \square)_{12} \text{Ti}_8[\text{Si}_4 \text{O}_{12}]_4(\text{OH}, \text{O})_8 \cdot 12 \cdot 16 \text{H}_2 \text{O}$
*Tsepinite-Sr	$(\text{Sr}, \text{Ba}, \text{K})(\text{Ti}, \text{Nb})_2[\text{Si}_4 \text{O}_{12}](\text{OH}, \text{O})_2 \cdot 3 \text{H}_2 \text{O}$
Paratsepinite group	
*Paratsepinite-Ba	$(\text{Ba}, \text{Na}, \text{K})_{2-x}(\text{Ti}, \text{Nb})_2[\text{Si}_4 \text{O}_{12}](\text{OH}, \text{O})_2 \cdot 4 \text{H}_2 \text{O}$
*Paratsepinite-Na	$(\text{Na}, \text{Sr}, \text{K}, \text{Ca})_2(\text{Ti}, \text{Nb})_2[\text{Si}_4 \text{O}_{12}](\text{O}, \text{OH})_2 \cdot 4 \text{H}_2 \text{O}$
Kuzmenkoite group	
*Kuzmenkoite-Mn	$\text{K}_4 \text{Mn}_2 \text{Ti}_8[\text{Si}_4 \text{O}_{12}]_4(\text{OH}, \text{O})_8 \cdot 10 \cdot 12 \text{H}_2 \text{O}$
*Kuzmenkoite-Zn	$\text{K}_2 \text{ZnTi}_4[\text{Si}_4 \text{O}_{12}]_2(\text{OH})_4 \cdot 6 \cdot 8 \text{H}_2 \text{O}$
*Burovaite-Ca	$(\text{Na}, \text{K})_4 \text{Ca}_2(\text{Ti}, \text{Nb})_8[\text{Si}_4 \text{O}_{12}]_4(\text{OH}, \text{O})_8 \cdot 12 \text{H}_2 \text{O}$
*Lepkhenlmitite-Zn	$\text{Ba}_2 \text{Zn}(\text{Ti}, \text{Nb})_4[\text{Si}_4 \text{O}_{12}]_2(\text{OH}, \text{O})_4 \cdot 7 \text{H}_2 \text{O}$
*Gjerdingenite-Ca	$\text{K}_2 \text{Ca}(\text{Nb}, \text{Ti})_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 6 \text{H}_2 \text{O}$
*Gjerdingenite-Fe	$\text{K}_2 \text{Fe}(\text{Nb}, \text{Ti})_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 6 \text{H}_2 \text{O}$
*Gjerdingenite-Mn	$\text{K}_2 \text{Mn}(\text{Nb}, \text{Ti})_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 6 \text{H}_2 \text{O}$
*Gjerdingenite-Na	$(\text{K}, \text{Na})_2 \text{Na}(\text{Nb}, \text{Ti})_4[\text{Si}_4 \text{O}_{12}]_2(\text{OH}, \text{O})_4 \cdot 5 \text{H}_2 \text{O}$
*Karupmøllerite-Ca	$(\text{Na}, \text{Ca}, \text{K})_2 \text{Ca}(\text{Nb}, \text{Ti})_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 7 \text{H}_2 \text{O}$
Lemleinite group	
*Lemleinite-K	$\text{Na}_4 \text{K}_8 \text{Ti}_8[\text{Si}_4 \text{O}_{12}]_4(\text{O}, \text{OH})_8 \cdot 8 \text{H}_2 \text{O}$
*Lemleinite-Ba	$\text{Na}_4 \text{K}_4 \text{Ba}_{2+x} \text{Ti}_8[\text{Si}_4 \text{O}_{12}]_4(\text{O}, \text{OH})_8 \cdot 8 \text{H}_2 \text{O}$
Labuntsovite group	
*Labuntsovite-Fe	$\text{Na}_4 \text{K}_4 \text{Fe}_2^{2+} \text{Ti}_8[\text{Si}_4 \text{O}_{12}]_4(\text{O}, \text{OH})_8 \cdot 10 \cdot 12 \text{H}_2 \text{O}$
*Labuntsovite-Mg	$\text{Na}_4 \text{K}_4 \text{Mg}_2 \text{Ti}_8 \text{O}_4[\text{Si}_4 \text{O}_{12}](\text{OH})_4 \cdot 10 \cdot 12 \text{H}_2 \text{O}$
*Labuntsovite-Mn	$\text{Na}_4 \text{K}_4 \text{Mn}_2^{2+} \text{Ti}_8 \text{O}_4[\text{Si}_4 \text{O}_{12}]_4(\text{OH})_4 \cdot 10 \cdot 12 \text{H}_2 \text{O}$
Paralabuntsovite group	
*Paralabuntsovite-Mg	$\text{Na}_8 \text{K}_8 \text{Mg}_4 \text{Ti}_{16}[\text{Si}_4 \text{O}_{12}](\text{O}, \text{OH})_{16} \cdot 20 \cdot 24 \text{H}_2 \text{O}$
Organovaitite group	
*Organovaitite-Mn	$\text{K}_2 \text{MnNb}_4[\text{Si}_4 \text{O}_{12}]_2 \text{O}_4 \cdot 5 \cdot 7 \text{H}_2 \text{O}$
*Organovaitite-Zn	$\text{K}_2 \text{Zn}(\text{Nb}, \text{Ti})_4[\text{Si}_4 \text{O}_{12}]_2(\text{O}, \text{OH})_4 \cdot 6 \text{H}_2 \text{O}$
*Parakuzmenkoite-Fe	$(\text{K}, \text{Ba})_8 \text{Fe}_4 \text{Ti}_{16}[\text{Si}_4 \text{O}_{12}]_8(\text{OH}, \text{O})_{16} \cdot 20 \cdot 28 \text{H}_2 \text{O}$
Gutkovaite group	

*Gutkovaite-Mn	$\text{CaK}_2\text{Mn}(\text{Ti},\text{Nb})_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4\cdot 5\text{H}_2\text{O}$
*Alsakharovite-Zn	$\text{NaSrKZn}(\text{Ti},\text{Nb})_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4\cdot 7\text{H}_2\text{O}$
*Neskevaraite-Fe	$\text{NaKK}_2\text{Fe}(\text{Ti},\text{Nb})_4[\text{Si}_4\text{O}_{12}]_2(\text{O},\text{OH})_4\cdot 6\text{H}_2\text{O}$
Astrophyllite family (that is "titanosilicates micas" by N.V.Belov's opinion)	
Niobophyllite	$*\text{K}_2\text{NaFe}_7^{2+}(\text{Nb},\text{Ti})\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{OH})_4(\text{O},\text{F})$
Kupletskite	$\text{K}_2\text{NaMn}^{2+}_7\text{Ti}_2(\text{OH})_4\text{O}_2[\text{Si}_4\text{O}_{12}]_2\text{F}_4$
Astrophyllite	$\text{K}_2\text{NaFe}_7^{2+}\text{Ti}_2(\text{OH})_4\text{O}_2[\text{Si}_4\text{O}_{12}]_2\text{F}$
Magnesioastrophyllite = *Lobanovite	
*Lobanovite	$\text{K}_2\text{Na}(\text{Fe}_4^{2+}\text{Mg}_2\text{Na})\text{Ti}_2(\text{OH})_4\text{O}_2[\text{Si}_4\text{O}_{12}]_2$
*Tarbagataite	$(\text{K}\square)\text{Ca}(\text{Fe}^{2+},\text{Mn})_7\text{Ti}_2(\text{OH})_5\text{O}_2[\text{Si}_4\text{O}_{12}]_2$
*Sveinbergeite	$\text{Ca}(\text{Fe}^{2+}_6\text{Fe}^{3+})\text{Ti}_2(\text{OH})_5\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{H}_2\text{O})_4$
Kupletskite-(Cs)	$\text{Cs}_2\text{NaMn}^{2+}_7\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{OH})_4\text{F}$
Zircophyllite	$\text{K}_2\text{NaMn}^{2+}_7\text{Zr}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{OH})_4\text{F}$
*Ferrozircophyllite	$\text{K}_2\text{Na}(\text{Fe}^{2+},\text{Mn})_7\text{Zr}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{OH})_4\text{F}$
*Niobokupletskite	$\text{K}_2\text{NaMn}_7^{2+}(\text{Nb},\text{Zr},\text{Ti})\text{O}_2[\text{Si}_4\text{O}_{12}]_2(\text{OH})_4(\text{O},\text{F})$
Acid → Hydrates	

Kazakovite family

Kazakovite	$\text{Na}_6\text{Mn} \text{Ti}[\text{Si}_6\text{O}_{18}]^{\infty 3}$
Tisinalite	$\text{Na}_3\text{Mn}^{2+}\text{Ti}[\text{Si}_6\text{O}_{15}(\text{OH})_3]$
Ohmilite	$\text{Sr}_3(\text{Ti},\text{Fe}^{3+})(\text{O},\text{OH})[\text{Si}_4\text{O}_{12}]^{\infty}(\text{H}_2\text{O})_{2-3}$
Strontio-orthojoaquinite series (compare with joaquinite (family))	
Strontio-orthojoaquinite	$\text{Sr}_2\text{Ba}_2(\text{Na},\text{Fe}^{2+})_2 \text{Ti}(\text{O},\text{OH})[\text{Si}_4\text{O}_{12}]^{\infty 2}\cdot 2\text{H}_2\text{O}$
*Bario-orthojoaquinite	$(\text{Ba},\text{Sr})_4\text{Fe}^{2+}_2\text{Ti}_2[\text{Si}_8\text{O}_{26}]\cdot 2\text{H}_2\text{O}$
*Strontiojoaquinite mon.	$\text{Sr}_2\text{Ba}_2(\text{Na},\text{Fe}^{2+})_2 \text{Ti}(\text{O},\text{OH})[\text{Si}_4\text{O}_{12}]^{\infty 2}\cdot 2\text{H}_2\text{O}$

*Titanodi-trisilicates (K = 2.5)

Traskite $\text{Ba}_2\text{Ca}(\text{Fe}^{2+},\text{Mn},\text{Ti})_4(\text{Ti},\text{Fe},\text{Mg})_{12}[\text{Si}_{12}\text{O}_{36}][\text{Si}_2\text{O}_7]_6(\text{O},\text{OH})_{30}\text{Cl}_6$

Titanotrisilicates (K = 3)

Oxido-titanotrisilicates

Belkovite	$\text{Ba}_3 \text{[NbO}_2]_6[\text{Si}_2\text{O}_7]_2]^{\infty 3}$
Fresnoite	$\text{Ba}_2 (^{5}\text{TiO})[\text{Si}_2\text{O}_7]^{\infty 2}$
*Unnamed	$(\text{Ca},\text{Fe})_3\text{TiO}_2[\text{Si}_2\text{O}_7]$
*Batisivite	$\text{BaV}^{3+}_8\text{Ti}_6\text{O}_{22}[\text{Si}_2\text{O}_7]$
*Greenwoodite	$\text{Ba}_{2-x}(\text{V}^{3+}\text{OH})_x\text{V}^{3+}_9(\text{Fe}^{3+},\text{Fe}^{2+})_2\text{O}_{15}[\text{Si}_2\text{O}_7]$
*Kolskyite	$(\text{Ca},\square)\text{Na}_2\text{Ti}_4\text{O}_4[\text{Si}_2\text{O}_7]_2\cdot 7\text{H}_2\text{O}$
*Laurentianite	$[\text{Na}(\text{H}_2\text{O})_2]_3 \text{[NbO}(\text{H}_2\text{O})]_3[\text{Si}_2\text{O}_7]_2$
*Kazanskyite	$\text{BaNa}_3\text{Ti}_2\text{NbO}_2(\text{OH})_2[\text{Si}_2\text{O}_7]_2(\text{H}_2\text{O})_4$

*Titanosilicato-halogenides (fluorides)

*Altsite	$\text{K}_6\text{Na}_3\text{Al}_2\text{Ti}_2\text{Si}_8\text{O}_{26}\text{Cl}_3$
Hydrates	
*Bulgakite	$\text{Li}_2(\text{Ca},\text{Na})\text{Fe}^{2+}_7\text{Ti}_2[\text{Si}_8\text{O}_{24}]\text{O}_2(\text{OH})_4(\text{F},\text{O})(\text{H}_2\text{O})_2$
*Nalivkinitite	$\text{Li}_2\text{NaFe}^{2+}_7\text{Ti}_2[\text{Si}_8\text{O}_{24}]\text{O}_2(\text{OH})_4\text{F}(\text{H}_2\text{O})_2$

*Titanotrisilicato-fluorides (K = 3)

*Roumaite	$(\text{Ca},\text{Na},\text{Ce},\square)_7(\text{Nb},\text{Ti})[\text{Si}_2\text{O}_7]_2(\text{OH})\text{F}_3$
Hydrates	
*Saamite	$\text{Ba}\square\text{Na}_3\text{Ti}_2\text{NbO}_2(\text{OH})_2[\text{Si}_2\text{O}_7]_2(\text{H}_2\text{O})_2$

Oxido-titano (niobo) trisilicato-fluorides

Nacarenite (Ce) $\text{Na}_3\text{Ca}_3(\text{Ce},\text{La})\text{NbO}[\text{Si}_2\text{O}_7]_2\text{F}_3$ *Lileyite $\text{Ba}_2(\text{Na},\text{Fe},\text{Ca})_3\text{MgTi}_2\text{O}_2[\text{Si}_2\text{O}_7]_2\text{F}$

Oxido-hydroxido (fluorido)-titanosilicates

Rosenbuschite $\text{Ca}_6\text{Zr}_2\text{Na}_6\text{ZrTi}[\text{Si}_2\text{O}_7]_4(\text{OF})_2\text{F}_4$ *Hainite $\text{Na}_2\text{Ca}_4(\text{Y},\text{REE})\text{TiO}[\text{Si}_2\text{O}_7]_2\text{F}_3$ *Kochite $\text{Ca}_2\text{MnZrNa}_3\text{Ti}[\text{Si}_2\text{O}_7]_2(\text{OF})\text{F}_2$ **Lamprophyllite family**Janhaugite $\text{Na}_3\text{Mn}_3[(\text{Ti},\text{Zr},\text{Nb})\text{O}(\text{OH},\text{F})[\text{Si}_2\text{O}_7]]^{\infty}_2$ Låvenite $\text{Na}_2\text{Ca}_2\text{Mn}_2[(\text{Zr},\text{Ti})\text{O}(\text{F},\text{OH})[\text{Si}_2\text{O}_7]]^{\infty}_2$ *Normandite $\text{NaCa}(\text{Mn}^{2+},\text{Fe}^{2+})[(\text{Ti},\text{Nb},\text{Zr})\text{O}(\text{F},\text{OH})[\text{Si}_2\text{O}_7]]^{\infty}_2$ *Perraultite $(\text{Na},\text{Ca})_2(\text{Ba},\text{K})_2(\text{Mn},\text{Fe})_8(\text{Ti},\text{Nb})_4\text{O}_4[\text{Si}_2\text{O}_7]_4(\text{OH})_2(\text{OH},\text{F})_4$ *Jinshajiangite $\text{NaBaFe}_4^{2+}\text{Ti}_2\text{O}_2[\text{Si}_2\text{O}_7]_2(\text{OH})_2\text{F}$ Seidozerite $(\text{Na},\text{Ca})_4\text{Mn}_2[\text{Zr}_{0,5}\text{Ti}_{0,5}\text{O}(\text{F},\text{OH})[\text{Si}_2\text{O}_7]]^{\infty}_2$ *Grenmarit $(\text{Na},\text{Ca})_4(\text{Mn},\text{Na})(\text{Zr},\text{Mn})_2(\text{Zr},\text{Ti})\text{O}(\text{F},\text{OH})_4[\text{Si}_2\text{O}_7]_2$ Wöhlerite $\text{Na}_2\text{Ca}_4[\text{Zr}_{0,5}(\text{Nb},\text{Ti})_{0,5}\text{O}(\text{F},\text{OH})_2[\text{Si}_2\text{O}_7]]^{\infty}_2$ *Marianoite $\text{Na}_2\text{Ca}_4(\text{Nb},\text{Zr})_2(\text{O},\text{F})_4[\text{Si}_2\text{O}_7]_2$ *Schüllerite $\text{Na}_2\text{Ba}_2\text{Mg}_2\text{Ti}_2\text{O}_2\text{F}_2[\text{Si}_2\text{O}_7]_2$ *Surkhobite $\text{KBa}_3\text{Ca}_2\text{Na}_2\text{Mn}_{16}\text{Ti}_8\text{O}_8[\text{Si}_2\text{O}_7]_8(\text{OH})_4(\text{F},\text{O},\text{OH})_8$ Bafertisit $^*\text{Ba}_2\text{Fe}_4^{2+}\text{Ti}_2\text{O}_2(\text{OH})_2\text{F}_2[\text{Si}_2\text{O}_7]_2$ *Camarait $\text{Ba}_3\text{Na}(\text{Fe}^{2+},\text{Mn})_8(\text{OH},\text{F})_7\text{Ti}_4\text{O}_4[\text{Si}_2\text{O}_7]_4$ *Ba-Mn titanosilicate $\text{Ba}[\text{Mn}^{2+}_2(\text{OH})]\{\text{TiO}(\text{OH})[\text{Si}_2\text{O}_7]\}$ *Hejmanite $\text{Ba}(\text{Mn}^{2+},\text{Fe}^{2+})_2\{\text{TiO}(\text{OH},\text{F})_2[\text{Si}_2\text{O}_7]\}$ *Vigrishinite $\text{Zn}_2\text{Ti}_{4-x}\text{O}_2(\text{OH},\text{F},\text{O})_2[\text{Si}_2\text{O}_7]_2(\text{H}_2\text{O},\text{OH},\text{F})_4 \quad (x < 1)$ **Lamprophyllite series**Lamprophyllite $(\text{SrNa})\text{Ti}_2\text{Na}_3\text{TiO}_2[\text{Si}_2\text{O}_7]_2(\text{OH})_2$ *Fluorlamprophyllite $\text{Na}_3(\text{SrNa})\text{Ti}_3\text{O}_2\text{F}_2[\text{Si}_2\text{O}_7]_2$ Barytolamprophyllite $(\text{BaK})\text{Ti}_2\text{Na}_3\text{TiO}_2[\text{Si}_2\text{O}_7]_2(\text{OH})_2$ *Emmerichite $\text{Ba}_2\text{Na}(\text{Na},\text{Fe}^{2+})_2(\text{Fe}^{3+},\text{Mg})\text{Ti}_2\text{O}_2\text{F}_2[\text{Si}_2\text{O}_7]_2$ *Nabalamprophyllite $(\text{BaNa})\text{Ti}_2\text{Na}_3\text{TiO}_2[\text{Si}_2\text{O}_7]_2(\text{OH})_2$ *Lamprophyllite orth. $(\text{SrNa})\text{Ti}_2\text{Na}_3\text{TiO}_2[\text{Si}_2\text{O}_7]_2(\text{OH})_2$ **Götzenite group**Götzenite $\text{Ca}_4\text{NaCa}_2\text{Ti}[\text{Si}_2\text{O}_7]_2(\text{OF})\text{F}_2$ Niocalite $\text{Ca}_7[\text{Nb}[\text{Si}_2\text{O}_7]_2\text{O}_3\text{F}]$ *Fersmanite $\text{Ca}_5\text{Na}_3\text{Ti}_3\text{Nb}[\text{Si}_2\text{O}_7]_2\text{O}_8\text{F}_2$ or $\text{Ca}_4(\text{Na},\text{Ca})_4(\text{Ti},\text{Nb})_4[\text{Si}_2\text{O}_7]_2\text{O}_8\text{F}_3$

Hydrates

*Delindeite $\text{Ba}_2\text{Ti}_2(\text{Na}_2\text{F})\text{Ti}[\text{Si}_2\text{O}_7]_2(\text{OH})_2(\text{H}_2\text{O})_2\text{O}_2$ *Chirvinskyite $(\text{Na},\text{Ca})_{13}(\text{Fe},\text{Mn},\text{□})_2(\text{Ti},\text{Zr})_5(\text{OH},\text{O})_{12}[\text{Si}_2\text{O}_7]_4 \cdot 2\text{H}_2\text{O}$

*Oxido-fluorido-phosphato-titanosilicates

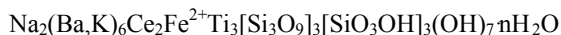
*Sobolevite $\text{Na}_6(\text{Na}_2\text{Ca})(\text{NaCaMn})\text{Na}_2\text{Ti}_2\text{Na}_2(\text{TiMn})[\text{Si}_2\text{O}_7]_2[\text{PO}_4]_4\text{O}_2(\text{OF})\text{F}_2$ *Polyphite $\text{Na}_6(\text{Na}_4\text{Ca}_2)_2\text{Na}_2\text{Ti}_2\text{Na}_2\text{Ti}_2[\text{Si}_2\text{O}_7]_2[\text{PO}_4]_6\text{O}_4\text{F}_4$ *Quadruphite $\text{Na}_{14}\text{Ca}_2\text{Ti}_4\text{O}_4\text{F}_2[\text{Si}_2\text{O}_7]_2[\text{PO}_4]_4$

*Hydroxido (fluorido) Hydrates

*Shkatulkalite $\text{Na}_{10}\text{MnTi}_3\text{Nb}_3(\text{OH})_2\text{F}[\text{Si}_2\text{O}_7]_6 \cdot 12\text{H}_2\text{O}$ **Komarovite series**Komarovite $(\text{Ca},\text{Mn},\text{H})_2[\text{Nb}_2\text{O}_3(\text{OH},\text{F})_2[\text{Si}_2\text{O}_7]]^{\infty}_3(\text{H}_2\text{O})_{3,5}$ Na-komarovite $(\text{Na},\text{Ca},\text{H})_2[\text{Nb}_2\text{O}_3(\text{OH},\text{F})_2[\text{Si}_2\text{O}_7]]^{\infty}_3 \cdot \text{H}_2\text{O}$ or

	$\text{Na}_6\text{CaNb}_6\text{O}_{14}[\text{Si}_4\text{O}_{12}] \cdot 4\text{H}_2\text{O}$
Epistolite	$\text{Na}_2(\text{Nb,Ti})_2\text{O}_2[\text{Si}_2\text{O}_7] \cdot n\text{H}_2\text{O}$
*Zvyaginite	$(\text{Na}\square)\text{Nb}_2\text{Zn}\square_2\text{Ti}[\text{O}(\text{OH})][\text{Si}_2\text{O}_7]_2\text{O}_2[(\text{OH})\text{F}](\text{H}_2\text{O})_5$
Murmanite-lomonosovite family	
Murmanite	$\text{Na}_2\text{Ti}_2\text{Na}_2\text{Ti}_2[\text{Si}_2\text{O}_7]_2\text{O}_4(\text{H}_2\text{O})_4$
*Calciomurmanite	$(\text{Na},\square)_2\text{Ca}(\text{Ti,Mg,Nb})_4\text{O}_2(\text{OH},\text{O})_2[\text{Si}_2\text{O}_7]_2(\text{H}_2\text{O})_4$
*Bykovaite	$(\text{Ba,Na,K})_2(\text{Na,Ti,Mn})_4(\text{Ti,Nb})_2\text{O}_2[\text{Si}_2\text{O}_7]_2(\text{H}_2\text{O},\text{F},\text{OH})_2 \cdot 3.5\text{H}_2\text{O}$
*Nechelustovite	$(\text{Ba,Sr,K})_2(\text{Na,Ti,Mn})_4(\text{Ti,Nb})_2\text{O}_2[\text{Si}_2\text{O}_7]_2(\text{O},\text{H}_2\text{O},\text{F})_2 \cdot 4.5\text{H}_2\text{O}$
Bornemanite	$\text{Na}_6\text{BaTi}_2\text{NbO}_2[\text{Si}_2\text{O}_7]_2[\text{PO}_4](\text{OH})\text{F}$
Vuonnemite	$\text{Na}_6\text{Na}_2\text{Nb}_2\text{Na}_3\text{Ti}[\text{Si}_2\text{O}_7]_2[\text{PO}_4]_2\text{O}_2(\text{OF})$
Lomonosovite	$\text{Na}_6\text{Na}_2\text{Ti}_2\text{Na}_2\text{Ti}_2[\text{Si}_2\text{O}_7]_2[\text{PO}_4]_2\text{O}_4$
Betalomonosovite	$\text{Na}_2\square_4\text{Na}_2\text{Ti}_2\text{Na}_2\text{Ti}_2[\text{Si}_2\text{O}_7]_2[\text{PO}_3(\text{OH})][(\text{PO}_2(\text{OH})_2)_2\text{O}_2(\text{OF})]$
Yoshimuraite	$\text{Ba}_2\text{Mn}_2\text{TiO}[\text{Si}_2\text{O}_7][\text{PO}_4](\text{OH})$
Innelite and polytypes 1T and 2M	$\text{Ba}_4\text{Ti}_2\text{Na}(\text{NaCa})\text{Ti}[\text{O}(\text{OH})][\text{Si}_2\text{O}_7]_2[(\text{SO}_4)(\text{PO}_4)]\text{O}_2$
*Phosphoinnelite	$\text{Na}_3\text{Ba}_4\text{Ti}_3[\text{Si}_2\text{O}_7]_2[\text{PO}_4]_2\text{O}_2\text{F}$
	Basic
Ellenbergerite	$\text{Mg}_6\text{Al}_6\text{Ti}(\text{OH})_{10}[\text{Si}_2\text{O}_7]_4$
*Titanotri-tetrasilicates (K = 3,2)	*Hydrates
*Hogarthite	$(\text{Na,K})_2\text{CaTi}_2[\text{Si}_{10}\text{O}_{26}] \cdot 8\text{H}_2\text{O}$
*Titanotri-tetrasilicates (K = 3,4)	*Hydrates
*Tiettaite	$(\text{Na,K})_{17}\text{FeTiSi}_{16}\text{O}_{29}(\text{OH})_{30} \cdot 2\text{H}_2\text{O}$
Titanotetrasilicates (K = 4)	
Oxido-titanotetrasilicates	
Titanite	$\text{Ca}[\text{TiO}[\text{SiO}_4]]^{\infty 2}$
*Natrotitanite	$(\text{Na}_{0.5}\text{Y}_{0.5})\text{TiO}[\text{SiO}_4]^{\infty 2}$
Natisite	$\text{Na}_2\{^{(5)}\text{TiO}\}[\text{SiO}_4]^{\infty 2}$
*Paranatisite	$\text{Na}_2\{\text{TiO}[\text{SiO}_4]\}$
*Sitinakite	$\text{Na}_2\{\text{Ti}_4\text{O}_5(\text{OH})[\text{SiO}_4]_2\} \cdot \text{K} \cdot 4\text{H}_2\text{O}$
	Hydrates
Mongolite	$\text{Ca}_4(\text{OH})_8[\text{Nb}_6\text{O}_4(\text{OH})_2[\text{SiO}_4]_5]^{\infty 2} \cdot 5-6\text{H}_2\text{O}$
*Ivanyukite-Na	$\text{Na}_2\{\text{Ti}_4\text{O}_2(\text{OH})_2[\text{SiO}_4]_3\} \cdot 6\text{H}_2\text{O}$
*Ivanyukite-K	$\text{K}_2\{\text{Ti}_4\text{O}_2(\text{OH})_2[\text{SiO}_4]_3\} \cdot 9\text{H}_2\text{O}$
*Ivanyukite-Cu	$\text{Cu}\{\text{Ti}_4\text{O}_2(\text{OH})_2[\text{SiO}_4]_3\} \cdot 7\text{H}_2\text{O}$
Titanoborosilicates	
Oxido-and oxido-hydroxido-titanoborosilicates	
Leucosphenite ($K_\Sigma = 0, (6)$)	$\text{Ba}[\text{Na}_4\text{Ti}_2\text{O}_2[\text{Si}_{10}\text{B}_2\text{O}_{28}]^{\infty 2}]^{\infty 2}$
Tianshanite ($K_\Sigma = 1,2$)	$\text{KNa}_9\text{Ba}_6\text{Ca}_2(\text{Mn,Fe})_6(\text{Ti,Nb,Ta})_6(\text{O},\text{OH},\text{F})_{11}[\text{Si}_{36}\text{B}_{12}\text{O}_{114}]^{\infty 2}]^{\infty 2}$
*Titanoborosilicato-phosphates	Hydrates
*Byzantievite	$\text{Ba}_5(\text{Ca,REE,Y})_{22}(\text{Ti,Nb})_{18}(\text{SiO}_4)_4(\text{PO}_4)_4(\text{BO}_3)_9\text{O}_{22}[(\text{OH}),\text{F}]_{43} \cdot 1.5\text{H}_2\text{O}$
Titanosilicates of Li	
Neutral	
*Titanomonosilicates (K = 1)	
*Berezanskite	$\text{KLi}_3\text{Ti}_2[\text{Si}_{12}\text{O}_{30}]$

- *Unnamed $\text{KLi}_3\text{Zn}_2[\text{Si}_{12}\text{O}_{30}]$
- *Titanomono-disilicates (K = 1,4) Hydrates
 *Punkaruavite $\text{Li}\{\text{Ti}_2(\text{OH})_2[\text{Si}_4\text{O}_{11}(\text{OH})]\}_2\cdot 2\text{H}_2\text{O}$
- Oxido-titanomono-disilicates
 Titanomono-disilicates (K = 1,5)
Neptunite series
 Neptunite $\text{KNa}_2[\text{Li}(\text{Fe}^{2+}, \text{Mn})_2\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{11}]^{\infty}_2]^{\infty}_3$
 Manganeptunite $\text{KNa}_2[\text{Li}(\text{Mn}, \text{Fe}^{2+})_2\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{11}]^{\infty}_2]^{\infty}_3$
 *Magnesioneptunite $\text{KNa}_2[\text{Li}(\text{Mg}, \text{Fe}^{2+})_2\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{11}]^{\infty}_2]^{\infty}_3$
- *Titanomono-disilicato-fluorides
 *Faizievite $\text{K}_2\text{Na}(\text{Ca}_6\text{Na})\text{Ti}_4\text{Li}_6\text{F}_2[\text{Si}_4\text{O}_{11}]_6$
- Titanodisilicates (K = 2) Basic
 Baratovite $(\text{K}, \text{Na})\text{Ca}_7\text{Li}_3\text{Ti}_2\text{F}_2[\text{SiO}_3]_{12}$
 *Katayamalite $\text{KLi}_3\text{Ca}_7\text{Ti}_2(\text{OH})_2[\text{Si}_6\text{O}_{18}]_2$
- Oxido-titanodisilicates *Hydrates
 *Lintisite $\text{Na}_3\text{LiTi}_2\text{O}_2[\text{Si}_4\text{O}_{12}]\cdot 2\text{H}_2\text{O}$
- *Titanotrisilicates (K = 3) *Hydrates
 *Eliseevite $\text{Na}_{1.5}\text{Li}[\text{Ti}_2\text{Si}_4\text{O}_{12.5}(\text{OH})_{1.5}]\cdot 2\text{H}_2\text{O}$
- *Titanotrisilicato-carbonates -halogenides
 *Bussenite $\text{Ba}_4(\text{Na}, \square)_2(\text{Fe}^{2+}, \text{Na})_2\text{Ti}_2[\text{Si}_2\text{O}_7]_2(\text{CO}_3)_2\text{O}_2(\text{OH})_2(\text{H}_2\text{O})_2\text{F}_2$
- *Titanotrisilicates Be
 *Odintsovite $\text{K}_2\text{Na}_4\text{Ca}_3\text{Ti}_2\text{Be}_4[\text{Si}_{12}\text{O}_{38}]$
- Titanosilicates of *f*- elements
 Proper titanosilicates
 *Titanomono-disilicates (K = 1,5) *Hydrates
 *Seidite-(Ce) $\text{Na}_4\text{SrCeTi}[\text{Si}_8\text{O}_{22}]\text{F}\cdot 5\text{H}_2\text{O}$
- Titanodisilicates (K = 2)
 Oxido-hydroxido-titanodisilicates Hydrates
Joaquinite family (ср. стронциоджоакинита (с.))
Byelorussite group
 Orthojoaquinite-(Ce) $\text{Ba}_2\text{NaFe}^{2+}\text{Ce}_2(\text{OH}, \text{F})\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2\cdot \text{H}_2\text{O}$
 *Orthojoaquinite-(La) $\text{Ba}_2\text{NaFe}^{2+}\text{La}_2(\text{O}, \text{OH})\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2\cdot \text{H}_2\text{O}$
 Byelorussite-(Ce) $\text{Ba}_2\text{NaMnCe}_2(\text{F}, \text{OH})\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2\cdot \text{H}_2\text{O}$
 Joaquinite-(Ce) $\text{Ba}_2\text{NaFe}^{2+}\text{Ce}_2(\text{OH})\text{Ti}_2\text{O}_2[\text{Si}_4\text{O}_{12}]_2\cdot \text{H}_2\text{O}$
 *K-Ti analog ilimaussite-(Ce)
 $(\text{Ba}, \text{Na}, \text{K}, \text{Ca})_{11-12}(\text{REE}, \text{Fe}, \text{Th})_4(\text{Ti}, \text{Nb})_6[\text{Si}_6\text{O}_{18}]_4(\text{OH})_{12}\cdot 4,5\text{H}_2\text{O}$
 *Pyatenkoite-(Y) $\text{Na}_5(\text{Y}, \text{Dy}, \text{Gd})\text{Ti}[\text{Si}_6\text{O}_{18}]\cdot 6\text{H}_2\text{O}$
- *Titanodo-trisilicates with mixed silicoxygenous anions
 *Diversilite-(Ce) (K = 2,5)



- Titanitrisilicates (K = 3) Basic
Rinkite family (compare götzenite)
 Rinkite $(\text{Ca}_3\text{REE})\text{Na}(\text{Na},\text{Ca})\text{Ti}[\text{Si}_2\text{O}_7]_2(\text{O},\text{F})\text{F}_2$
 *Mosandrite = Lovchorrite $\text{NaCaCeTi}[\text{Si}_2\text{O}_7]\text{O}_2$ (?)
 Hydrates
 *Batievaite-(Y) $\text{Y}_2\text{Ca}_2\text{Ti}(\text{OH})_2[\text{Si}_2\text{O}_7]_2(\text{H}_2\text{O})_4$
- *Titanitrisilicato-oxido-arsenates
 *Cervandonite-(Ce) $(\text{Ce},\text{Nd},\text{La})(\text{Fe}^{3+}, \text{Fe}^{2+}, \text{Ti}^{4+}, \text{Al})_3\text{O}_2[\text{Si}_2\text{O}_7]_{1-x+y}[\text{AsO}_3]_{1+x-y}(\text{OH})_{3x-3y}$
 $x = 0,47, y = 0,31$
- *Titanotri-tetrasilicates with mixed silicoxygenous anions
 *Oxido-titanotri-tetrasilicates *Basic
 Ilmaussite-(Ce) (K = 3,4) $(\text{Ba},\text{Na})_{10}\text{K}_3\text{Na}_{4,5}\text{Ce}_5(\text{Nb},\text{Ti})_6[\text{Si}_{12}\text{O}_{36}][\text{Si}_9\text{O}_{18}(\text{O},\text{OH})_{24}]\text{O}_6$
- Titanotetrasilicates (K = 4)
 Oxido-titanotetrasilicates
 Trimounsite-(Y) $\text{Y}_2[\text{Ti}_2\text{O}_5[\text{SiO}_4]]^{\infty 3}$
- Titanosilicates with unknown structure
 Ilmajokite $(\text{Na},\text{Ce},\text{Ba})_{10}\text{Ti}_5\text{Si}_{14}\text{O}_{22}(\text{OH})_{44}n\text{H}_2\text{O}$
- Titanosilicato-phosphates with unknown structure
 Laplandite-(Ce) $\text{Na}_4\text{CeTiSi}_7\text{O}_{18}(\text{PO}_4)_5\text{H}_2\text{O}$
 *Karnasurtite-(Ce) $(\text{Ce},\text{La},\text{Th})(\text{Ti},\text{Nb})(\text{Al},\text{Fe}^{3+})[(\text{Si},\text{P})_2\text{O}_7](\text{OH})_4\cdot 3\text{H}_2\text{O}$
- Titanosilicato-carbonates
 Titanotetrasilicato-carbonates Hydrates
Tundrite series
 Tundrite-(Ce) $\text{Na}_2\text{Ce}_2\text{TiO}_2[\text{SiO}_4][\text{CO}_3]_2$
 Tundrite-(Nd) $\text{Na}_2\text{Nd}_2\text{TiO}_2[\text{SiO}_4][\text{CO}_3]_2$
- *Titanotetrasilicato-hydrocarbonates *Hydrates
 *Kihlmanite-(Ce) $\text{Ce}_2\text{TiO}_2[\text{SiO}_4][\text{HCO}_3]_2(\text{H}_2\text{O})$
- Subclass: Silicates of chalcophylic elements
 Silicates of **Ib**-cations (Cu^{2+})
 *Zero-monoalumosilicates (K = 0,(6))
 *Kurumsakite $(\text{Zn},\text{Ni},\text{Cu}^{2+})_8\text{Al}_8\text{V}^{5+}_2[\text{Si}_5\text{O}_{35}]\cdot 27(\text{H}_2\text{O})$
- *Zero-monoalumosilicates (K = 0,75) *Hydrates
 *Ajoite $(\text{K},\text{Na})_3\text{Cu}_{20}[\text{Al}_3\text{Si}_{29}\text{O}_{76}](\text{OH})_{16}\cdot 8\text{H}_2\text{O}$
- Monosilicates (K = 1) Neutral
Cuprorivaite family
 Cuprorivaite $\text{CaCu}^{2+}[\text{Si}_4\text{O}_{10}]^{\infty 2}$
 *Effenbergerite $\text{BaCu}^{2+}[\text{Si}_4\text{O}_{10}]$
 *Wesselsite $\text{SrCu}^{2+}[\text{Si}_4\text{O}_{10}]$

Litidionite	$\text{KNaCu}^{2+}[\text{Si}_4\text{O}_{10}]^{\infty 2}$
	Acid-basic
Chrysocolla	$\{\text{Cu}^{2+}_2\text{H}_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{\infty 2}\}^{\infty 2}$
with $(\text{Al,Fe})^{3+}$ in place of Cu^{2+}H^+ : $\{\text{Cu}_{2-x}\text{H}_{2-x}(\text{Al,Fe})_x(\text{OH})_4[\text{Si}_2\text{O}_5]^{\infty 2}\}^{\infty 2}$	
if $x = 2$	$(\text{Al,Fe})_2(\text{OH})_4[\text{Si}_2\text{O}_5]^{\infty 2}\}^{\infty 2}$ (kaolinite)
Mono-disilicates	*Neutral
*Lavinskyite (K = 1,5)	$\text{K}(\text{LiCu})\text{Cu}^{2+}_6[\text{Si}_4\text{O}_{11}]_2(\text{OH})_4$
*Liebauite (K = 1,8)	$\text{Ca}_3\text{Cu}_5[\text{Si}_9\text{O}_{26}]$
	Hydrates
Plancheite (K = 1,5)	$\text{Cu}^{2+}_8(\text{OH})_4[\text{Si}_4\text{O}_{11}]^{\infty 2} \cdot 2\text{H}_2\text{O}$
*Gilalite (K = 1,6)	$\text{Cu}^{2+}_5[\text{Si}_6\text{O}_{17}] \cdot 7\text{H}_2\text{O}$
*Apachite (K = 1,8)	$\text{Cu}^{2+}_9[\text{Si}_{10}\text{O}_{29}] \cdot 11\text{H}_2\text{O}$
Disilicates (K = 2)	Basic
Papagoite	$\text{Ca}_2\text{Cu}^{2+}_2\text{Al}_2(\text{OH})_6[\text{Si}_4\text{O}_{12}]$
Shattuckite	$\text{Cu}^{2+}_5(\text{OH})_2[\text{Si}_2\text{O}_6]^{\infty 2}_2$
	Hydrates
Dioptase	$\text{Cu}_6[\text{Si}_6\text{O}_{18}](\text{H}_2\text{O})_6$
Di-trisilicates (K = 2,(6))	Hydrates
Kinoite	$\text{Ca}_2\{\text{Cu}^{2+}_2(\text{H}_2\text{O})_2[\text{Si}_3\text{O}_{10}]\}^{\infty 3}$
*Trisilicates	
*Scottyite	$\text{BaCu}_2[\text{Si}_2\text{O}_7]$
*Tetrasilicates	*Hydrates
*Stringhamite	$\text{CaCu}^{2+}[\text{SiO}_4] \cdot \text{H}_2\text{O}$
*Unnamed	$\text{Cu}^{2+}_8(\text{OH})_{12}[\text{SiO}_4] \cdot 8\text{H}_2\text{O}$
*Silicato-carbonates	
*Disilicato-carbonates (K = 2)	
*Whelanite	$\text{Cu}^{2+}_2\text{Ca}_6[\text{Si}_6\text{O}_{17}(\text{OH})][\text{CO}_3](\text{OH})_3(\text{H}_2\text{O})_2$
*Silicato-hydrocarbonaro-chlorides	*Basic
*Ashburtonite	$\text{HPb}_4\text{Cu}^{2+}_4[\text{Si}_4\text{O}_{12}](\text{HCO}_3)_4(\text{OH})_4\text{Cl}$
Silicates of IIb -cations	
Silicates of Hg^+	
Trisilicates	Neutral
Edgarbaileyite	$\text{Hg}^+_6[\text{Si}_2\text{O}_7]$
Silicates of Zn → zincosilicates	
Alumosilicates and proper silicates	
Zero-monozincalumosilicates (K = 0,8)	Acid-basic
Minehillite	$(\text{K,Na})_2\text{Ca}_{28}(\text{OH})_{12}[(\text{Zn}_5\text{Al}_4\text{Si}_{40})\text{O}_{112}(\text{OH})_4]$
(compare with reyerite and truscottite)	
Monoalumosilicates (K = 1)	Basic

Hendricksite	$K \{(Zn, Mg, Mn)_3(OH)_2[AlSi_3O_{10}]^{\infty 2}\}$
(compare with subfamily of common mica)	
Baileychlore	$(Fe^{2+}, Mg)_3(OH)_6 \{(Zn, Al)_3(OH)_2[AlSi_3O_{10}]^{\infty 2}\}^{\infty 2}$
(compare with chlorites (family))	
Fraipontite = zinalsite	$\{(Zn, Al)_3(OH)_4[(Si, Al)_2O_5]^{\infty 2}\}^{\infty 2}$
(compare with kaolinite (family))	
*Klöschite	$KNaFe^{2+}_2Zn_3[Si_{12}O_{30}]$
Sauconite series (compare with smectite (family))	
Sauconite	$Na_{0,33} \{Zn_3(OH)_2[(Si, Al)_4O_{10}]^{\infty 2}\}^{\infty 2} (H_2O)_4$
Zincsilite	$Zn_3(OH)_2[Si_4O_{10}] \cdot 4H_2O$
Trisilicates (K = 3)	Hydrates
Hemimorphite	$\{(4)Zn_4(OH)_2[Si_2O_7]\}^{\infty 3} \cdot H_2O$
Junitoite	$CaZn_2[Si_2O_7] \cdot H_2O$
Silicates of Zn with unknown structure	Hydrates
Silicates of IV _a -cations	
Silicates of Pb ²⁺	
Proper silicates	
*Zero-monoalumosilicates (K = 0,4)	
*Rongibbsite	$Pb_2[(AlSi_4)O_{11}](OH)$
*Zero-monoalumosilicates (K = 0,9)	
*Wickenburgite	$Pb_3CaAl[AlSi_{10}O_{27}](H_2O)_3$
*Mono-disilicates (K = 1,3)	Hydrates
*Yangite	$PbMn[Si_3O_8] \cdot H_2O$
*Mono-disilicates (K = 1,5)	Hydrates
*Mathewrogersite	$Pb_7Fe^{2+}GeAl_3[Si_3O_9]_4(OH)_4 \cdot 2H_2O$
Disilicates (K = 2)	Neutral
Plumalsite	$Pb_4Al_2[SiO_3]_7$
Alamosite	$PbSiO_3 \rightarrow Pb_{12}[Si_{12}O_{36}]$
*Disilicato-halogenides	Hydrates
*Hyttjöite	$Pb_{18}Ba_2Ca_5Mn^{2+}_2Fe^{3+}_2[Si_{30}O_{90}]Cl \cdot H_2O$
*Disilicato-trisilicates (K = 2,8)	*Hydrates
*Creaseyite	$Pb_2Cu^{2+}_2Fe^{3+}_2[Si_5O_{17}] \cdot 6H_2O$
*Trisilicato-tetrasilicares (K = 3,(3))	
*Ganomalite	$Pb_9Ca_5Mn[Si_9O_{33}]$
*Silicato-carbonates	
*Mono-silicatocarbonates	Basic
*Surite	$(Pb, Ca)_3Al_2(OH)_3[(Si, Al)_4O_{10}][CO_3]_2 \cdot 0.3H_2O$
	*Hydrates
*Ferrisurite	$(Pb, Ca)_2.4Fe^{3+}_2(OH)_3[Si_4O_{10}][CO_3]_{1.7} \cdot nH_2O$
Silicato-sulfates	

Trisilicato-tetrasilicato-sulfates	Neutral	
Queitite		$\text{Pb}_4\text{Zn}_2[\text{Si}_2\text{O}_7][\text{SiO}_4][\text{SO}_4]$
*Silicato-sulfato-carbonates	*Basic	
*Kegelite		$\text{Pb}_8\text{Al}_4[\text{Si}_4\text{O}_{10}]_2[\text{SO}_4]_2[\text{CO}_3]_4(\text{OH})_8$
Silicato-chromates		
Tetrasilicato-chromates and tetrasilicato-chromato-fluorides	Neutral	
Hemihedrite series		
Iranite		$\text{CuPb}_{10}(\text{OH})_2[\text{SiO}_4]_2[\text{CrO}_4]_6$
Hemihedrite		$\text{ZnPb}_{10}\text{F}_2[\text{SiO}_4]_2[\text{CrO}_4]_6$
Silicato-sulfato-chlorides	Neutral	
Mattheddleite		$\text{Pb}_{10}[\text{SiO}_4]_3[\text{SO}_4]_3\text{Cl}_2$
(compare with wulfenite (series); ellestadite (group); apatite (group))		
Silicates of Va -elements		
Silicates of nonfull-valence Va -cations (As^{3+} , Sb^{3+} and Bi^{3+})		
Proper silicates		
Monosilicates		
Chapmanite	Basic	$\text{Sb}^{3+}\{\text{Fe}^{3+}_2(\text{OH})\text{O}_3[\text{Si}_2\text{O}_5]^{\infty 2}\}^{\infty 2}$
Tetrasilicates	Neutral	
Eulytine		$\text{Bi}_4[\text{SiO}_4]_3$
Bismutoferrite		$\text{Fe}^{3+}_2\text{Bi}[\text{SiO}_4]_2(\text{OH})$
Titanoberyllosilicates		
Titanotriberyllosilicates ($K_\Sigma = 3$)		
Oxido-titanotriberyllosilicates		
Asbecasite		$\text{Ca}_3(\text{Ti},\text{Sn})\text{As}^{3+}_6\text{O}_6[\text{BeSiO}_7]_2$
3.2.1a. Class: Germanates (zone of oxidization of Tsumeb and at France ?)		
Tetragermanates (orthogermanates)	Basic	
Carboirite (compare with chloritoid (family))		$2[\text{Fe}^{2+}\text{Al}_2\text{GeO}_5(\text{OH})_2] \rightarrow \{\text{Fe}^{2+}_2\text{Al}(\text{OH})_4\text{Al}_3\text{O}_2[\text{GeO}_4]_2\}^{\infty 2}$
Germanates (?) with unknown structure		
Bartelkeite		$\text{PbFeGe}[\text{Ge}_2\text{O}_7](\text{OH})_2\text{H}_2\text{O}$
Otjismeite		PbGe_4O_9
(see also sulfates of Ge – itoite, schaurteite, fleischerite)		
3.2.2. Class: Borates		
3.2.2.1. Quasiclass: (4)-Borates of cations with low FC		
(4)-Borates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s - cations		
(4)-Borates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s - cations without Li and Be		
Proper (4)-Borates		
*Zero-monoborates ($K = 0,28$)		
	Asid	

*Jarandolite (Serbianite)	Ca[B ₃ O ₄ (OH) ₃]
Zero-monoborates (K = 0, ₆)	Neutral
Johachidolite	Ca{ ⁽⁶⁾ Al[B ₃ O ₇] ^{∞2} } ^{∞3}
Monoborates (K = 1)	Acid
*Shimazakiite	Ca ₂ B ₂ O ₅
Korzhinskite	CaB ₂ O ₄ ·0.5H ₂ O
Diborates (K = 2)	Acid
Vimsite family	
Vimsite	Ca[B ₂ O ₂ (OH) ₄] [∞]
Uralborite	Ca[B ₂ O ₂ (OH) ₄] [∞]
Triborates (K = 3)	Acid
Pinnoite	Mg[B ₂ O(OH) ₆]
	Hydrates
Pentahydroborite	{Ca[B ₂ O(OH) ₆]} ^{∞2} ·2H ₂ O ₂
Tetraborates (K = 4)	Neutral
Sinhalite	MgAl[BO ₄]
	Acid
*Pseudosinhalite	(Mg,Fe) ₂ Al ₃ B ₂ O ₉ (OH)
Frolovite	{Ca[B(OH) ₄] ₂ } ^{∞2}
	Hydrates
Hexahydroborite	Ca(H ₂ O) ₂ [B(OH) ₄] ₂
Tetraborates and tetraborato-halogenides	Basic- acid
Teepleite	Na ₂ Cl[B(OH) ₄]
(4)-Borato-phosphates	Basic-acid
Seamanite	Mn ₃ (OH) ₂ [B(OH) ₄][PO ₄]
(4)-Borato-arsenates	Acid
Cahnite	Ca ₂ [B(OH) ₄][AsO ₄]
(4)-Borato-carbonates	Hydrates
Carbaborite	Ca ₂ Mg(H ₂ O) ₄ [B(OH) ₄] ₂ [CO ₃] ₂
*Imayoshiite	Ca ₃ Al(OH) ₆ [B(OH) ₄][CO ₃] ₂ ·12H ₂ O
(4)-Borato-sulfates	Basic-acid
Sulfoborite	Mg ₃ (OH,F) ₂ [B(OH) ₄] ₂ [SO ₄]
	Hydrates
Charlesite family	
Charlesite	Ca ₆ (Al,Si) ₂ (OH,O) ₁₂ [B(OH) ₄][SO ₄] ₂ ·26H ₂ O
Sturmanite	Ca ₆ Fe ³⁺ ₂ (OH) ₁₂ [B(OH) ₄][SO ₄] ₂ ·25H ₂ O
*Buryatite	Ca ₃ (Si,Fe ³⁺ ,Al)(OH) ₅ O[B(OH) ₄][SO ₄] ₂ ·12H ₂ O
(4)-Borates Be → beryllo borates	

Zero-monoberyllo-(4)-borates (K = 0,5)

Acid

Rhodizite $\text{KBe}_4\text{Al}_4(\text{B}_{11}\text{Be})\text{O}_{28}$

*Zero-monoberyllo-(4)-borates (K = 0,6(6))

*Londonite $\text{CsBe}_5\text{Al}_4\text{B}_{11}\text{O}_{28}$ (4)-Borates of *f*-cations

(4)-Borato-carbonates

Acid

Moydite-(Y) $\text{Y}[\text{B}(\text{OH})_4][\text{CO}_3]$

(4)-Borates of cations with middle FC

(4)-Borates of Nb and Ta

Neutral

Behierite $\text{Ta}[\text{BO}_4]$ *Schiavinitoite $(\text{Nb}_{0,52}\text{Ta}_{0,48})[\text{BO}_4]$

(4)-Borates of chalcophylic elements

(4)-Borates of Cu

(4)-Borates and (4)-borato-halogenides

Acid

Hemmilite $\text{Ca}_2\text{Cu}^{2+}[\text{B}(\text{OH})_4]_2(\text{OH})_4$ Bandyllite $\text{CuCl}[\text{B}(\text{OH})_4]$ *Jacquesdietrichite $\text{Cu}_2[\text{BO}(\text{OH})_2](\text{OH})_3$

3.2.2.2. Quasiclass: (3)-Borates

(3)-Borates of cations with low FC

(3)-Borates of *s*-, *d_s*- and *p_s*-cations(3)- Borates of *s*-, *d_s*- and *p_s*-cations without Li and Be

Proper (3)-Borates

(3)-Diborates

Neutral

Suanite familySuanite $\text{Mg}_2[\text{B}_2\text{O}_5]$ Kurchatovite $\text{CaMg}[\text{B}_2\text{O}_5]$ Clinokurchatovite $\text{CaMg}[\text{B}_2\text{O}_5]$

Basic

Wiserite $(\text{Mn},\text{Mg})_{14}(\text{OH})_8(\text{Si},\text{Mg})(\text{O},\text{OH})_4\text{Cl}[\text{B}_2\text{O}_5]_4$

Acid

Szaibelyite familySzaibelyite $\text{Mg}_2(\text{OH})[\text{B}_2\text{O}_4(\text{OH})]$ Sussexite $\text{Mn}_2(\text{OH})[\text{B}_2\text{O}_4(\text{OH})]$

Hydrates

Satimolite $\text{KNa}_2\text{Al}_4\text{Cl}_3[\text{B}_2\text{O}_5]_3 \cdot 13\text{H}_2\text{O}$

(3)-Monoborates

Neutral

Kotoite family*Takedaite $\text{Ca}_3[\text{BO}_3]_2$ Kotoite $\text{Mg}_3[\text{BO}_3]_2$ Jimboite $\text{Mn}_3[\text{BO}_3]_2$

Oxido-(3)-monoborates

Warwickite $\text{Mg}(\text{Ti},\text{Fe},\text{Al})_2\text{O}[\text{BO}_3]$ *Yuanfuliite $\text{Mg}(\text{Fe}^{3+},\text{Al})\text{O}[\text{BO}_3]$

Ludwigite series	
Azoprite	$(\text{Mg}, \text{Fe}^{2+})_2(\text{Fe}^{3+}, \text{Ti}, \text{Mg})\text{O}_2[\text{BO}_3]$
Ludwigite	$(\text{Mg}, \text{Fe}^{2+})_2\text{Fe}^{3+}\text{O}_2[\text{BO}_3]$
Bonaccordite	$\text{Ni}_2\text{Fe}^{3+}\text{O}_2[\text{BO}_3]$
Vonsenite	$(\text{Fe}^{2+}, \text{Mg})_2\text{Fe}^{3+}\text{O}_2[\text{BO}_3]$
Fredrikssonite	$\text{Mg}_2\text{Mn}^{3+}\text{O}_2[\text{BO}_3]$
Orthopinakiolite series	
Chestermanite	$\text{Mg}_2(\text{Fe}^{3+}, \text{Mg}, \text{Al}, \text{Sb}^{5+})\text{O}_2[\text{BO}_3]$
Takeuchiite	$(\text{Mg}, \text{Mn}^{2+})_2(\text{Mn}, \text{Fe})^{3+}\text{O}_2[\text{BO}_3]$
Orthopinakiolite	$(\text{Mg}, \text{Mn}^{2+})_2\text{Mn}^{3+}\text{O}_2[\text{BO}_3]$
Pinakiolite	$\text{Mg}_2\text{Mn}^{3+}\text{O}_2[\text{BO}_3]$
(compare with hulsite (group))	Basic
Jeremejevite	$\text{Al}_6\text{F}_3[\text{BO}_3]_5$
Fluoborite (nocerite)	$\text{Mg}_3(\text{F}, \text{OH})_3[\text{BO}_3]$
*Pertsevite-(F)	$\text{Mg}_2\text{F}[\text{BO}_3]$
*Pertsevite-(OH)	$\text{Mg}_2(\text{OH})[\text{BO}_3]$
Karlite	$(\text{Mg}, \text{Al}_x)_7(\text{OH})_4\text{Cl}_{1-x}[\text{BO}_3]_3$
	Acid
Sibirskite	$\text{CaH}[\text{BO}_3]$
	Hydrates
*Parasibirskite	$\text{Ca}_2\text{B}_2\text{O}_5\cdot\text{H}_2\text{O}$
Wightmanite family	
Wightmanite	$\text{Mg}_5(\text{OH})_5\text{O}[\text{BO}_3]_2\cdot 2\text{H}_2\text{O}$
Shabynite	$\text{Mg}_5(\text{OH})_5(\text{Cl}, \text{OH})_2[\text{BO}_3]_4\cdot 2\text{H}_2\text{O}$
Nifontovite	$\text{Ca}_3[\text{BO}(\text{OH})_2]_6\cdot 2\text{H}_2\text{O}$
Olshanskyite	$\text{Ca}_2(\text{OH})[\text{BO}(\text{OH})_2]_3\cdot 3\text{H}_2\text{O}$
*(3)-Borato-halogenides	
*Hydroxylborite	$\text{Mg}_3[\text{BO}_3(\text{OH})_2]\text{F}$
(3)-Borato-carbonates	
(3)-Monoborato-carbonates	
(3)- Monoborato-carbonates with $\text{BO}_3 : \text{CO}_3 = 3 : 1$	
	Basic
Gaufreyite	$\text{Ca}_4\text{Mn}^{3+}_3\text{O}_3[\text{BO}_3]_3[\text{CO}_3]$
(3)-Monoborato-carbonates with $\text{BO}_3 : \text{CO}_3 = 2 : 1$	
	Hydrates (neutral)
Sakhaite	$\text{Ca}_{48}\text{Mg}_{16}\text{Al}[\text{SiO}_3\text{OH}]_4[\text{CO}_3]_{16}[\text{BO}_3]_{28}(\text{H}_2\text{O})_3(\text{HCl})_3$
(3)- Monoborato-carbonates with $\text{BO}_3 : \text{CO}_3 = 1 : 1$	
	Hydrates (acid)
Canavesite	$\text{Mg}_2[\text{BO}_2(\text{OH})][\text{CO}_3]\cdot 5\text{H}_2\text{O}$
(3)-Borato-phosphates	
(3)- Monoborato-phosphates	
Lüneburgite	$\text{Mg}_3[\text{B}(\text{OH})_3]_2[\text{PO}_4]_2\cdot 6\text{H}_2\text{O}$
(3)-Borates of Be	
(3)-Monoborates of Be	
	Basic

Hambergite	$\text{Be}_2(\text{OH})[\text{BO}_3]$
	Hydrates
Berberite	$\text{Be}_2(\text{OH},\text{F})[\text{BO}_3]\text{H}_2\text{O}$
*(3)-Borates <i>f</i> -cations	
*Pepposite-(Ce)	$(\text{Ce},\text{La})(\text{Al}_3\text{O})_{2/3}[\text{B}_4\text{O}_{10}]$
(3)-Borates of cations with middle FC	
(3)-Monoborates of Zr	
Oxido-(3)-monoborates	
Painite	* $\text{CaZrAl}_9\text{O}_{15}[\text{BO}_3]$
(3)-Borates of chalcophylic <i>p</i> -elements	
(3)-Monoborates of Sn^{4+}	Neutral
Nordenskiöldine family	
Tusionite	$\text{MnSn}[\text{BO}_3]_2$
Nordenskiöldine	$\text{CaSn}[\text{BO}_3]_2$
Oxido-(3)-monoborates	
Hulsite series (compare with pinakiolite (group))	
Magnesiuhulsite	$(\text{Mg},\text{Fe})_2(\text{Fe},\text{Sn},\text{Mg})\text{O}_2[\text{BO}_3]$
Hulsite (paigeite)	$(\text{Fe}^{2+},\text{Mg})_2(\text{Fe}^{3+},\text{Sn})\text{O}_2[\text{BO}_3]$
*Aluminomagnesiuhulsite	$\text{Mg}_2(\text{Al}_{1-2x}\text{Mg}_x\text{Sn}_x)\text{O}_2[\text{BO}_3]$ $x = 0,18$
(3)-Monoborates of Sb^{5+}	
Oxido-(3)-monoborates	
Blatterite	$\text{Sb}^{5+}_3(\text{Mn}^{3+},\text{Fe}^{3+})_9(\text{Mn}^{2+},\text{Mg})_{35}\text{O}_{32}[\text{BO}_3]_{16}$
(compare with ludwigite (family))	
3.2.2.3. Quasiclass: (4)-(3)-Borates	
(4)-(3)-Borates of <i>s</i> -, <i>d_s</i> - and <i>p_s</i> - cations	
(4)-(3)- Borates of <i>s</i> -, <i>d_s</i> - and <i>p_s</i> - cations without Li and Be	
Proper (4)-(3)-borates ($x = \text{MO} : \text{B}_2\text{O}_3$)	
(4)-(3)-Borates with $x = 1$	Neutral
Calciborite	$\text{Ca}[\text{B}_2\text{O}_4]^\infty$
	Acid
Fedorovskite series	
Fedorovskite	$\text{Ca}_2\text{Mg}_2(\text{OH})_4[\text{B}_4\text{O}_7(\text{OH})_2]$
Roweit	$\text{Ca}_2\text{Mn}^{2+}_2(\text{OH})_4[\text{B}_4\text{O}_7(\text{OH})_2]$
*Mg-roweit	$\text{Ca}_2(\text{Mn}^{2+},\text{Mg})_2(\text{OH})_4[\text{B}_4\text{O}_7(\text{OH})_2]$
(4)-(3)-Borates with $x = 0,8$	
Priceite family	
Priceite (pandermite)	$\text{Ca}_2(\text{H}_2\text{O})[\text{B}_5\text{O}_7(\text{OH})_5]$
Tertschite	$\text{Ca}_2(\text{H}_2\text{O})_7[\text{B}_5\text{O}_6(\text{OH})_7]$ (?)
(4)-(3)-Borates with $x = 0,(6)$	
Fabianite	Acid
	$\text{Ca}[\text{B}_3\text{O}_5(\text{OH})]^\infty$
	Hydrates
Hydroboracite family	

Colemanite	$\text{Ca}[\text{B}_3\text{O}_4(\text{OH})_3]^\infty \cdot \text{H}_2\text{O}$
Meyerhofferite	$\text{Ca}_2[\text{B}_3\text{O}_4(\text{OH})_3]^\infty \cdot 2\text{H}_2\text{O}$
Hydroboracite	$\text{CaMg}[\text{B}_3\text{O}_4(\text{OH})_3]^\infty \cdot 3\text{H}_2\text{O}$
Inderborite	$\text{CaMg}[\text{B}_3\text{O}_3(\text{OH})_5]^\infty \cdot 6\text{H}_2\text{O}$
Inyoite family	
Inyoite	$\text{Ca}[\text{B}_3\text{O}_3(\text{OH})_5] \cdot 4\text{H}_2\text{O}$
Inderite	$\text{Mg}[\text{B}_3\text{O}_3(\text{OH})_5] \cdot 5\text{H}_2\text{O}$
Kurnakovite	$\text{Mg}[\text{B}_3\text{O}_3(\text{OH})_5] \cdot 5\text{H}_2\text{O}$
Veatchite family	
Veatchite	$\text{Sr}_2[\text{B}_5\text{O}_8(\text{OH})]^\infty \cdot 2[\text{B}(\text{OH})_3] \cdot \text{H}_2\text{O}$
Veatchite-A	$\text{Sr}_2[\text{B}_5\text{O}_8(\text{OH})]^\infty \cdot 2[\text{B}(\text{OH})_3] \cdot \text{H}_2\text{O}$
Veatchite-P	$\text{Sr}_2[\text{B}_5\text{O}_8(\text{OH})]^\infty \cdot 2[\text{B}(\text{OH})_3] \cdot \text{H}_2\text{O}$
Ulexite family	
*Tuzlaite	$\text{NaCa}_2[\text{B}_5\text{O}_8(\text{OH})_2]^\infty \cdot 3\text{H}_2\text{O}$
Probertite	$\text{NaCa}_2[\text{B}_5\text{O}_7(\text{OH})_4]^\infty \cdot 3\text{H}_2\text{O}$
Ulexite	$\text{NaCa}[\text{B}_5\text{O}_6(\text{OH})_6]^\infty \cdot 5\text{H}_2\text{O}$
*(4)-(3)-Borates with $x = 0,56$	
*Studenitsite	$\text{NaCa}_2[\text{B}_9\text{O}_{14}(\text{OH})_4]^\infty \cdot 2\text{H}_2\text{O}$
(4)-(3)-Borates with $x = 0,54$	
Preobrazhenskite	Acid $\text{Mg}_3[\text{B}_{11}\text{O}_{15}(\text{OH})_9]^\infty$
(4)-(3)-Borates with $x = 0,5$	
Halurgite family	Hydrates
Halurgite	$\text{Mg}_2(\text{H}_2\text{O})[\text{B}_4\text{O}_5(\text{OH})_4]_2$
*Hungchaoite	$\text{Mg}(\text{H}_2\text{O})_5[\text{B}_4\text{O}_5(\text{OH})_4] \cdot 2\text{H}_2\text{O}$
Wardsmithite	$\text{Ca}_5\text{Mg}[\text{B}_4\text{O}_5(\text{OH})_4]_6 \cdot 18\text{H}_2\text{O}$
Borax family	
Kernite	$\text{Na}_2(\text{H}_2\text{O})_3[\text{B}_4\text{O}_6(\text{OH})_2]$
Tincalconite	$\text{Na}_2(\text{H}_2\text{O})_3[\text{B}_4\text{O}_5(\text{OH})_4]$
Borax	$\text{Na}_2\text{B}_4\text{O}_5(\text{OH})_4 \cdot 8\text{H}_2\text{O} \rightarrow [\text{Na}(\text{H}_2\text{O})_4]^\infty \cdot 2[\text{B}_4\text{O}_5(\text{OH})_4]$
Aristarainite	$\text{Na}_2(\text{H}_2\text{O})_2 \{ \text{Mg}(\text{H}_2\text{O})_2 [\text{B}_6\text{O}_8(\text{OH})_4]^\infty \}_2$
Kaliborite (paternoite)	$\text{HKMg}_2(\text{H}_2\text{O})_4 [\text{B}_6\text{O}_8(\text{OH})_5]^\infty \cdot 2$
*Alfredstelnzerite	$\text{Ca}_4(\text{H}_2\text{O})_4 [\text{B}_4\text{O}_4(\text{OH})_6]_4 (\text{H}_2\text{O})_{15}$
(4)-(3)-Borates with $x = 0,4$	
Biringuccite family	Hydrates
Biringuccite	$\text{Na}_2(\text{H}_2\text{O})[\text{B}_5\text{O}_8(\text{OH})]^\infty \cdot 2$
Nasinite	$\text{Na}_2(\text{H}_2\text{O})_2[\text{B}_5\text{O}_8(\text{OH})]^\infty \cdot 2$
Ezcurreite	$\text{Na}_2(\text{H}_2\text{O})_2[\text{B}_5\text{O}_7(\text{OH})_3]$
(4)-(3)-Borates with $x = 0,(3)$	
Ameghinite	Acid $\text{Na}[\text{B}_3\text{O}_3(\text{OH})_4]$
Tunellite family	Hydrates
Nobleite	$\text{Ca}(\text{H}_2\text{O})_3[\text{B}_6\text{O}_9(\text{OH})_2]^\infty \cdot 2$
Tunellite	$\text{Sr}(\text{H}_2\text{O})_3[\text{B}_6\text{O}_9(\text{OH})_2]^\infty \cdot 2$
Gowerite	$\text{Ca}(\text{H}_2\text{O})_3[\text{B}_5\text{O}_8(\text{OH})\text{B}(\text{OH})_3]^\infty \cdot 2 \rightarrow \text{Ca}(\text{H}_2\text{O})[\text{B}_6\text{O}_8(\text{OH})_4]^\infty \cdot 3\text{H}_2\text{O}$

Aksaite family

Aksaite	$Mg(H_2O)_2[B_6O_7(OH)_6]$
Mcallisterite	$Mg_2(H_2O)_3[B_6O_7(OH)_6]_2 \cdot 6H_2O$
Admontite	$Mg_2(H_2O)_3[B_6O_7(OH)_6]_2 \cdot 1.5H_2O$
Rivadavite	$Na_6Mg[B_6O_7(OH)_6]_4 \cdot 10H_2O$

(4)-(3)-Borates with $x = 0,28$ Hydrates**Ginorite** family

Ginorite	$Ca_2[B_{14}O_{20}(OH)_6]^{\infty 2} \cdot 5H_2O$
Strontioginorite	$SrCa[B_{14}O_{20}(OH)_6]^{\infty 2} \cdot 5H_2O$

(4)-(3)-Borates with $x = 0,25$ AcidStrontioborite $Sr[B_8O_{11}(OH)_4]^{\infty 2}$ (4)-(3)-Borates with $x = 0,2$ Hydrates**Sborgite** family

Sborgite	$Na(H_2O)_3[B_5O_6(OH)_4]$
Santite	$K(H_2O)_2[B_5O_6(OH)_4]$
*Ramanite-(Cs)	$Cs(H_2O)_3[B_5O_6(OH)_4]$
*Ramanite-(Rb)	$Rb(H_2O)_3[B_5O_6(OH)_4]$
Larderellite	$NH_4(H_2O)[B_5O_7(OH)_2]$
Ammonioborite	$(NH_4)_3(H_2O)_4[B_{15}O_{20}(OH)_8]$

(4)-(3)-Borato-arsenates Hydrates

Teruggite $Ca_4Mg[B_6O_7(OH)_6]_2[AsO_4]_2 \cdot 12H_2O$

(4)-(3)-Borato-carbonates Acid

Borcarite	$Ca_4Mg[B_4O_6(OH)_6][CO_3]_2$
*Numanoite	$Ca_4Cu[B_4O_6(OH)_6][CO_3]_2$

*(4)-(3)-Borato-hydrocarbonates Hydrates

*Qilianshanite $NaH_4[BO_3][CO_3] \cdot 2H_2O$

(4)-(3)-Borato-sulfates

*Vitimite $Ca_6[B_{14}O_{19}(OH)_{14}][SO_4] \cdot 5H_2O$

(4)-(3)- Borato-sulfato-chlorides

Heidornite $Ca_3Na_2Cl[B_5O_8(OH)_2][SO_4]_2$

(4)-(3)-Borato-chlorides

*(4)-(3)- Borato-chlorides $x = 2$ Hydrates*Chelkarite $CaMg[B_2O_4]Cl_2 \cdot 7 H_2O$ (4)-(3)-Borato-chlorides with $x = 1,(3)$ AcidSolongoite $Ca_2[B_3O_4(OH)_4]Cl$ *(4)-(3)-Borato-chlorides with $x = 1,2$ *Brianroulstonite $Ca_3[B_5O_6(OH)_6](OH)Cl_2 \cdot 8H_2O$ (4)-(3)-Borato-chlorides with $x = 1$ Hydrates (acid)

Ekaterinite $\text{Ca}_2[\text{B}_4\text{O}_7(\text{Cl}, \text{OH})_2] \cdot 2\text{H}_2\text{O}$
 Hydrochlorborite $\text{Ca}_2[\text{B}_4\text{O}_4(\text{OH})_7]\text{Cl} \cdot 7\text{H}_2\text{O}$

(4)-(3)-Borato-chlorides with $c x = 0,86$ Neutral

Boracite family

Boracite $\text{Mg}_3[\text{B}_7\text{O}_{13}]\text{Cl} \rightarrow [\text{B}_7\text{O}_{12}]^{\infty 3} \text{Mg}_3\text{OCl}$
 *Trembathite $\text{Mg}_3[\text{B}_7\text{O}_{13}]\text{Cl} \rightarrow [\text{B}_7\text{O}_{12}]^{\infty 3} \text{Mg}_3\text{OCl}$
 Chambersite $\text{Mn}_3[\text{B}_7\text{O}_{13}]\text{Cl} \rightarrow [\text{B}_7\text{O}_{12}]^{\infty 3} \text{Mn}_3\text{OCl}$
 Ericaite $(\text{Fe}, \text{Mg}, \text{Mn})_3[\text{B}_7\text{O}_{13}]\text{Cl} \rightarrow [\text{B}_7\text{O}_{12}]^{\infty 3} (\text{Fe}, \text{Mg}, \text{Mn})_3\text{OCl}$
 Congolite $(\text{Fe}, \text{Mg}, \text{Mn})_3[\text{B}_7\text{O}_{13}]\text{Cl} \rightarrow [\text{B}_7\text{O}_{12}]^{\infty 3} (\text{Fe}, \text{Mg}, \text{Mn})_3\text{OCl}$

(4)-(3)-Borato-chlorides with $x = 0,8$ Acid

Hilgardite family

Hilgardite $\text{Ca}_2[\text{B}_5\text{O}_8(\text{OH})_2]\text{Cl}$
 *Hilgardite-1TC $\text{Ca}_2[\text{B}_5\text{O}_8(\text{OH})_2]\text{Cl}$
 Parahilgardite $\text{Ca}_2[\text{B}_5\text{O}_8(\text{OH})_2]\text{Cl}$
 Cl-tyretskite $(\text{Ca}, \text{Sr})_2[\text{B}_5\text{O}_8(\text{OH})_2]\text{Cl}$
 Tyretskite-1Tc $(\text{Ca}, \text{Sr})_2[\text{B}_5\text{O}_9(\text{OH})]\text{H}_2\text{O}$
 *Hydrates
 *Kurgantaite $\text{CaSr}[\text{B}_5\text{O}_9]\text{Cl} \cdot \text{H}_2\text{O}$

* (4)-(3)-Borato-chlorides with $x = 0,7$

*Pringleite $\text{Ca}_9\text{B}_{26}\text{O}_{34}(\text{OH})_{24}\text{Cl}_4 \cdot 13\text{H}_2\text{O}$ (tric.)
 *Ruitenbergite $\text{Ca}_9\text{B}_{26}\text{O}_{34}(\text{OH})_{24}\text{Cl}_4 \cdot 13\text{H}_2\text{O}$ (mon.)
 *Walkerite $\text{Ca}_{16}(\text{Mg}, \text{Li}, \square)_2[\text{B}_{13}\text{O}_{17}(\text{OH})_{12}]_4\text{Cl}_6 \cdot 28\text{H}_2\text{O}$

* (4)-(3)-Borato-chlorides with $x = 0,4$

Volkovskite *Hydrates $\text{KCa}_4[\text{B}_5\text{O}_8(\text{OH})]_4[\text{B}(\text{OH})_3]_2\text{Cl} \cdot 4\text{H}_2\text{O}$

* (4)-(3) Borato-chlorides with $x = 0,2$

*Penobsquisite *Hydrates $\text{Ca}_2\text{FeCl}[\text{B}_9\text{O}_{13}(\text{OH})_6] \cdot 4\text{H}_2\text{O}$

* (4)-(3)-Borato-chromates

*Iquiqueite $\text{K}_3\text{Na}_4\text{Mg}[\text{B}_{24}\text{O}_{39}(\text{OH})][\text{CrO}_4] \cdot 12\text{H}_2\text{O}$

* (4)-(3)-Borato-chlorides of *f*- cations

* (4)-(3)-Borato-chlorides with $x = 1$ *Hydrates
 *Braitschite-(Ce) $\text{Ca}_6\text{NaCe}_2[\text{B}_6\text{O}_7(\text{OH})_3(\text{O}, \text{OH})_3]_4 \cdot \text{H}_2\text{O}$

* (4)-(3)-Borates chalcophylic elements

* (4)-(3)-Borates Cu
 *Santarosaite CuB_2O_4

* (4)-(3)-Borates Zn

* (4)-(3)-Borato-chlorides Zn
 *Chubarovite $\text{KZn}_2[\text{BO}_3]\text{Cl}_2$

* (4)-(3)-Borates Pb

*Leucostaurite Hydrates $\text{Pb}^{2+}_2[\text{B}_5\text{O}_9]\text{Cl} \cdot 0.5\text{H}_2\text{O}$

3.2.3. **Class:** Carbonates

3.2.3.1. Subclass: Carbonates of cations with low FC

3.2.3.1.1. Carbonates of *s*-, *d*_s- and *p*_s- cations3.2.3.1.1.1 Carbonates of *s*-, *d*_s- and *p*_s- cations without Li⁺ and Be²⁺3.2.3.1.1.1.1. Proper carbonates $x = M^{2+}/[CO_3]$

3.2.3.1.1.1.1.1. Neutral (x = 1)

Calcite group (compare with smithsonite (group))Magnesite Mg[CO₃]Gaspeite (Ni,Mg,Fe)[CO₃]Sphaerocobaltite Co[CO₃]Siderite Fe[CO₃]Rhodochrosite Mn[CO₃]Calcite Ca[CO₃]**Aragonite** group (compare with cerussite (group))Aragonite Ca[CO₃]Strontianite Sr[CO₃]Witherite Ba[CO₃]*Unnamed mon. Ca[CO₃]**Dolomite** group (compare with minrecordite (group))Dolomite CaMg[CO₃]₂Ankerite Ca(Fe,Mg)[CO₃]₂Kutnohorite Ca(Mn,Mg,Fe)[CO₃]₂Benstonite (Ba,Sr)₆Ca₆Mg[CO₃]₁₃Eitelite Na₂Mg[CO₃]₂**Huntite** groupHuntite CaMg₃[CO₃]₄Norsethite BaMg[CO₃]₂**Fairchildite** groupVaterite Ca[CO₃]Fairchildite K₂Ca[CO₃]₂Gregoryite Na₂[CO₃]**Alstonite** familyParalstonite (Ba,Sr)Ca[CO₃]₂*Olekminskite Sr(Sr,Ca,Ba)[CO₃]₂Baryocalcite BaCa[CO₃]₂Alstonite BaCa[CO₃]₂**Shortite** familyShortite Na₂Ca₂[CO₃]₃Nyerereite Na₂Ca[CO₃]₂Natrofairchildite Na₂Ca[CO₃]₂Zemkorite (Na,K)₂Ca[CO₃]₂Bütschliite K₂Ca[CO₃]₂Natrite Na₂[CO₃]

3.2.3.1.1.1.1.2. Basic and carbonato-halogenides

Rouvilleite (M8) (x = 1,1(6)) Na₃Ca(Mn,Ca)F[CO₃]₃Northupite (x = 1,25) Na₃MgCl[CO₃]₂Dawsonite (x = 2) NaAl(OH)₂[CO₃]Nullaginite (x = 2) Ni₂(OH)₂[CO₃]Brenkite (x = 2) Ca₂F₂[CO₃]Tunisite (x = 2,125) NaCa₂Al₄(OH)₈Cl[CO₃]₄

Holdawayite (x = 3)	$Mn_6(OH)_7(Cl,OH)[CO_3]_2$ 3.2.3.1.1.1.1.3. Hydrates
*Alexkhomyakovite	$K_6(Ca_2Na)Cl[CO_3]_5 \cdot 6H_2O$
Kambaldaite (x = 1,1(6))	$NaNi_4(OH)_3[CO_3]_3 \cdot 3H_2O$
Hydromagnesite family (x = 1,25)	
Hydromagnesite	$Mg_5(OH)_2[CO_3]_4 \cdot 4H_2O$
Dypingite	$Mg_5(OH)_2[CO_3]_4 \cdot 5H_2O$
Giorgiosite	$Mg_5(OH)_2[CO_3]_4 \cdot 5H_2O$
Indigirite	$Mg_2Al_2(OH)_2[CO_3]_4 \cdot 15H_2O$
*Widgiemoolthalite	$(Ni,Mg)_5(OH)_2[CO_3]_4 \cdot 4 \cdot 5H_2O$
Dresserite family (x = 2)	
Strontiodresserite	$(Sr,Ca)Al_2(OH)_4[CO_3]_2 \cdot H_2O$
Dresserite	$BaAl_2(OH)_4[CO_3]_2 \cdot H_2O$
Hydrodresserite	$BaAl_2(OH)_4[CO_3]_2 \cdot 3H_2O$
Alumohydrocalcite family (x = 2)	
Alumohydrocalcite	$CaAl_2(OH)_4[CO_3]_2 \cdot 3H_2O$
Para-alumohydrocalcite	$CaAl_2(OH)_4[CO_3]_2 \cdot 6H_2O$
*Kochsadorite	$CaAl_2(OH)_4[CO_3]_2 \cdot H_2O$
Artinite family (x = 2)	
Pokrovskite	$Mg_2(OH)_2[CO_3]$
Artinite	$Mg_2(OH)_2[CO_3] \cdot 3H_2O$
*Chlorartinite	$Mg_2(OH)Cl[CO_3] \cdot 3H_2O$
Otwayite	$(Ni,Mg)_2(OH)_2[CO_3] \cdot H_2O$
Zaratite family (x = 3)	
Zaratite	$Ni_3(OH)_4[CO_3] \cdot 4H_2O$
Defernite	$Ca_6(OH)_7(Cl,OH)_{1-2x}[CO_3]_{2-x}[SiO_4]_x$, where $x \leq 0,5$
Brugnatellite family (x = 7-7,5)	
Hydroscarbroite	$Al_{14}(OH)_{36}[CO_3]_3 \cdot nH_2O$
Scarbroite	$Al_5(OH)_{13}[CO_3] \cdot 5H_2O$
Brugnatellite	$Fe^{3+}Mg_6(OH)_{13}[CO_3] \cdot 4H_2O$
*Quintinite-3T	$Mg_4Al_2(OH)_{12}[CO_3] \cdot 4H_2O$
*Quintinite	$Mg_4Al_2(OH)_{12}[CO_3] \cdot 3H_2O$
Hydrotalcite family (x = 9)	
*Caresite-3T	$Fe_4Al_2(OH)_{12}[CO_3] \cdot 3H_2O$
Hydrotalcite	$Mg_6Al_2(OH)_{16}[CO_3] \cdot 4H_2O$
*Charmarite-3T	$Mn_4Al_2(OH)_{12}[CO_3] \cdot 3H_2O$
Pyroaurite	$Mg_6Fe^{3+}_2(OH)_{16}[CO_3] \cdot 4H_2O$
Desautelsite	$Mg_6Mn^{3+}_2(OH)_{16}[CO_3] \cdot 4H_2O$
Stichtite-3R	$Mg_6Cr^{3+}_2(OH)_{16}[CO_3] \cdot 4H_2O$
*Stichtite-2H = Barbertonite	$Mg_6Cr^{3+}_2(OH)_{16}[CO_3] \cdot 4H_2O$
Takovite	$Ni_6Al_2(OH)_{16}[CO_3] \cdot 4H_2O$
Reevesite	$Ni_6Fe^{3+}_2(OH)_{16}[CO_3] \cdot 4H_2O$
*Fe-reevesite	$Fe^{2+}_4Ni_2(Fe^{3+}_{1,96}Al_{0,03}Cr_{0,01})_2(OH)_{16}[CO_3] \cdot 4H_2O$
Comblainite	$Ni^{2+}_4Co^{3+}_2(OH)_{12}[CO_3] \cdot 3H_2O$
Manasseite group (x = 9)	
Manasseite = hydrotalcite	$Mg_6Al_2(OH)_{16}[CO_3] \cdot 4H_2O$
Sjögrenite = pyroaurite	$Mg_6Fe^{3+}_2(OH)_{16}[CO_3] \cdot 4H_2O$
Coalingite (x = 13)	$Mg_{10}Fe^{3+}_2(OH)_{24}[CO_3] \cdot H_2O$ 3.2.3.1.1.1.1.3.2. Neutral (x = 1)
Lansfordite family	

Lansfordite	$\text{Mg}[\text{CO}_3] \cdot 5\text{H}_2\text{O}$
Baylissite	$\text{K}_2\text{Mg}[\text{CO}_3]_2 \cdot 4\text{H}_2\text{O}$
Monohydrocalcite	$\text{Ca}[\text{CO}_3] \cdot \text{H}_2\text{O}$
Gaylussite family	
Pirssonite	$\text{Na}_2\text{Ca}[\text{CO}_3]_2 \cdot 2\text{H}_2\text{O}$
Gaylussite	$\text{Na}_2\text{Ca}[\text{CO}_3]_2 \cdot 5\text{H}_2\text{O}$
Ikaite group	
Hellyerite	$\text{Ni}[\text{CO}_3] \cdot 6\text{H}_2\text{O}$
Ikaite	$\text{Ca}[\text{CO}_3] \cdot 6\text{H}_2\text{O}$
Natron family	
Thermonatrite	$\text{Na}_2[\text{CO}_3] \cdot \text{H}_2\text{O}$
Natron	$\text{Na}_2[\text{CO}_3] \cdot 10\text{H}_2\text{O}$
*3.2.3.1.1.1.2. Carbonato-borates	*3.2.3.1.1.1.2.1. Hydrates (acid)
*Qilianshanite	$\text{NaH}_4[\text{CO}_3][\text{BO}_3] \cdot 2\text{H}_2\text{O}$
3.2.3.1.1.1.3. Carbonato-phosphates	
*3.2.3.1.1.1.3.2. Carbonato-phosphates with $\text{CO}_3 : \text{PO}_4 \sim 18$	*3.2.3.1.1.1.3.2.1. Hydrates
*Karchevskyite	$\text{Mg}_{18}\text{Al}_9(\text{OH})_{54}\text{Sr}_2[\text{CO}_3]_9(\text{H}_2\text{O})_6(\text{H}_3\text{O})_5$
3.2.3.1.1.1.2.1. Carbonato-phosphates with $\text{CO}_3 : \text{PO}_4 = 1$	3.2.3.1.1.1.2.1.1. Neutral
Bradleyite group	
Bradleyite	$\text{Na}_3\text{Mg}[\text{CO}_3][\text{PO}_4]$
*Crawfordite	$\text{Na}_3\text{Sr}[\text{CO}_3][\text{PO}_4]$
Bonshtedtite	$\text{Na}_3\text{Fe}^{2+}[\text{CO}_3][\text{PO}_4]$
Sidorenkite	$\text{Na}_3\text{Mn}^{2+}[\text{CO}_3][\text{PO}_4]$
3.2.3.1.1.1.2.2. Carbonato-phosphates with $\text{CO}_3 : \text{PO}_4 = 0, (3)$	
Heneuite	$\text{CaMg}_5(\text{OH})[\text{CO}_3][\text{PO}_4]$
3.2.3.1.1.1.4. Carbonato-dihydrophosphato-phosphates	3.2.3.1.1.1.4.1. Hydrates (basic)
Girvasite	$\text{NaCa}_2\text{Mg}_3(\text{OH})_2[\text{CO}_3][\text{PO}_2(\text{OH})_2][\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
3.2.3.1.1.1.5. Carbonato-sulfates	
*3.2.3.1.1.1.5.1. Carbonato-sulfates with $\text{CO}_3 : \text{SO}_4 = 8$	
*3.2.3.1.1.1.5.1.1. Hydrates	
*3.2.3.1.1.1.5.1.1.1. Basic	
*Putnisite	$\text{SrCa}_4\text{Cr}^{3+}_8[\text{CO}_3]_8[\text{SO}_4](\text{OH})_{16} \cdot 23\text{H}_2\text{O}$
3.2.3.1.1.1.5.1. Carbonato-sulfates with $\text{CO}_3 : \text{SO}_4 = 4$	3.2.3.1.1.1.5.1.1. Neutral
Tychite group ($x = 1$)	
Tychite	$\text{Na}_6\text{Mg}_2[\text{CO}_3]_4[\text{SO}_4]$
Ferrotychite	$\text{Na}_6\text{Fe}^{2+}_2[\text{CO}_3]_4[\text{SO}_4]$
*Manganotychite	$\text{Na}_6\text{Mn}^{2+}_2[\text{CO}_3]_4[\text{SO}_4]$

- 3.2.3.1.1.1.5.2. Carbonato-sulfates with $\text{CO}_3 : \text{SO}_4 = 1$
 3.2.3.1.1.1.5.2.1. Hydrates
 3.2.3.1.1.1.5.2.1.1. Basic
 Tatarskite ($x = 2$) $\text{Ca}_6\text{Mg}_2[\text{CO}_3]_2(\text{SO}_4)_2(\text{OH})_4\text{Cl}_4 \cdot 7\text{H}_2\text{O}$
- 3.2.3.1.1.1.5.3. Carbonato-sulfates with $\text{CO}_3 : \text{SO}_4 = 1$
 3.2.3.1.1.1.5.3.1. Neutral
 Burkeite ($x = 1$) $\text{Na}_6[\text{CO}_3][\text{SO}_4]_2$
- 3.2.3.1.1.1.5.3.2. Hydrates
 Rapidcreekite $\text{Ca}_2[\text{CO}_3][\text{SO}_4] \cdot 4\text{H}_2\text{O}$
- 3.2.3.1.1.1.5.4. Carbonato-sulfates with variable ratio $\text{CO}_3 : \text{SO}_4$
 with the proviso that $\text{CO}_3 < \text{SO}_4$
 3.2.3.1.1.1.5.4.1. Basic
 Paraotwayite ($x = 3$) $\text{Ni}(\text{OH})_{2-x}[(\text{SO}_4)(\text{CO}_3)]_{0.5x}$
- 3.2.3.1.1.1.5. Carbonato-sulfates with $\text{CO}_3 : \text{SO}_4 = 1$
 3.2.3.1.1.1.5.1. Carbonato-sulfato-chlorides
 Hanksite ($x = 1,04$) $\text{KNa}_{22}[\text{CO}_3]_2[\text{SO}_4]_9\text{Cl}$
- *3.2.3.1.1.1.6. Carbonato-fluorides
 *Podlesnoite $\text{BaCa}_2[\text{CO}_3]_2\text{F}_2$
 *3.2.3.1.1.1.6.1. Hydrates
 *Sheldrikite $\text{NaCa}_3[\text{CO}_3]_2\text{F}_3 \cdot \text{H}_2\text{O}$
- 3.2.3.1.1.1.7. Carbonato-fluoraluminates
 3.2.3.1.1.1.7.1. Neutral
 Stenonite $\text{Sr}_2\text{AlF}_5[\text{CO}_3] \rightarrow \text{Sr}_2[\text{CO}_3][\text{AlF}_5]^\infty$
 3.2.3.1.1.1.7.2. Hydrates
 Montroyalite $\text{Sr}_4\text{Al}_8(\text{OH},\text{F})_{26}[\text{CO}_3]_3 \cdot 10\text{H}_2\text{O} \rightarrow \text{Sr}_4[\text{CO}_3]_3[\text{Al}_4(\text{OH},\text{F})_{13}]_2 \cdot 10\text{H}_2\text{O}$
- 3.2.3.1.1.1.8. Carbonato-fluoraluminato-hydrocarbonates
 3.2.3.1.1.1.8.1. Neutral
 Barentsite $\text{Na}_7\text{AlF}_4[\text{HCO}_3]_2[\text{CO}_3]_2 \rightarrow \text{Na}_7[\text{HCO}_3]_2[\text{CO}_3]_2[\text{AlF}_4]^\infty$
- 3.2.3.1.1.1.9. Hydrocarbonato-carbonates
 3.2.3.1.1.1.9.1. Hydrocarbonato-carbonates with $\text{HCO}_3 : \text{CO}_3 = 0,(4)$
 3.2.3.1.1.1.9.1.1. Hydrates (basic)
 Sergeevite ($x = 1$) $\text{Ca}_2\text{Mg}_{11}(\text{OH})_4[\text{HCO}_3]_4[\text{CO}_3]_9 \cdot 6\text{H}_2\text{O}$
- 3.2.3.1.1.1.9.2. Hydrocarbonato-carbonates with $\text{HCO}_3 : \text{CO}_3 = 1$
 3.2.3.1.1.1.9.2.1. Hydrates (neutral)
 Trona ($x = 0,75$) $\text{Na}_3[\text{HCO}_3][\text{CO}_3] \cdot 2\text{H}_2\text{O}$
- 3.2.3.1.1.1.9.3. Hydrocarbonato-carbonates with $\text{HCO}_3 : \text{CO}_3 = 3$
 3.2.3.1.1.1.9.3.1. Neutral
 Wegscheiderite ($x = 0,625$) $\text{Na}_5[\text{HCO}_3]_3[\text{CO}_3]$
- 3.2.3.1.1.1.10. Hydrocarbonates

	3.2.3.1.1.1.10.1. Neutral
Nahcolite family (x = 0,5)	
Nahcolite	Na[HCO ₃]
Kalicinite	K[HCO ₃]
Teschemacherite	NH ₄ [HCO ₃]
	3.2.3.1.1.1.9.2. Hydrates (basic)
Nesquehonite (x = 1)	MgOH[HCO ₃]·2H ₂ O
3.2.3.1.1.2. Carbonates of Li	
3.2.3.1.1.2.1. Neutral	
Zabuyelite	Li ₂ [CO ₃]
*3.2.3.1.1.3. Carbonates of Be	
*Niveolanite	NaBe[CO ₃](OH)·2H ₂ O
3.2.3.1.2. Carbonates of <i>f</i> -elements	
	3.2.3.1.2.1. Neutral
Burbankite family (x = 1)	
Sahamallite-(Ce)	(Mg,Fe ²⁺)Ce ₂ [CO ₃] ₄
Carbocernaite	(Ca,Na)(Sr,Ce,Ba)[CO ₃] ₂
Khanneshite	(Na,Ca) ₃ (Ba,Sr,Ce,Ca) ₃ [CO ₃] ₅
Ewaldite	Ba(Ca,Y,Na,K)[CO ₃] ₂ ·2.6H ₂ O
Burbankite	(Na,Ca) ₃ (Sr,Ba,Ce) ₃ [CO ₃] ₅
*Calcioburbankite	Na ₃ (Ca,REE,Sr) ₃ [CO ₃] ₅
Remondite-(Ce)	Na ₃ (Ce,La,Ca,Na,Sr) ₃ [CO ₃] ₅
*Remondite-(La)	Na ₃ (La,Ce,Ca) ₃ [CO ₃] ₅
*Petersenite-(Ce)	Na ₄ REE ₂ [CO ₃] ₅
*Paratooite-(La)	(La,REE,Ca,Na,Sr) ₆ Cu ²⁺ [CO ₃] ₈
	*3.2.3.1.2.1.1. Hydrates
*Shomiokite-(Y)	Na ₃ Y[CO ₃] ₃ ·3H ₂ O
*Lecoqite-(Y)	Na ₃ Y[CO ₃] ₃ ·6H ₂ O
3.2.3.1.2.2. Carbonato-fluorides and basic carbonates	
Baiyuneboite-(Ce)	NaBaCe ₂ F[CO ₃] ₄
Polysomatic series of bastnäsite mM ²⁺ [CO ₃] _n TR(F,OH)[CO ₃] _p H ₂ O or	
M _{2+m} TR _n (F,OH) _n [CO ₃] _{m+n} pH ₂ O, where M ²⁺ = Ca, Sr, Ba; TR = Ce, La, Nd, Y...Th	
with the proviso that 0 < p < 3 (ratio m:n is reported at the name of groups, series, families in round brackets)	
Parisite subseries (m : n = 2)	
*Kukharenkoite-(Ce) = Zhonghuacerite-(Ce) (x = 1,1(6))	Ba ₂ (Ce,REE)F[CO ₃] ₃
*Kukharenkoite-(La)	Ba ₂ (La,REE)F[CO ₃] ₃
Cebaite group (x=1,2)	(m : n = 1,5)
Cebaite-(Ce)	Ba ₃ Ce ₂ F ₂ [CO ₃] ₅
Synchysite family (x = 1,25)	(m : n = 1)
Synchysite-(Nd)	CaNdF[CO ₃] ₂
Synchysite-(Ce)	CaCeF[CO ₃] ₂
*Synchysite-(Ce) tet	CaCeF[CO ₃] ₂
*Synchysite-(Ce) trig	CaCeF[CO ₃] ₂
Synchysite-(Y)	CaYF[CO ₃] ₂

Huanghoite-(Ce)	BaCeF[CO ₃] ₂	
*Qaqqarsukite-(Ce)	BaCeF[CO ₃] ₂	
*Horvathite-(Y)	NaYF ₂ [CO ₃]	
Röntgenite-(Ce) (x = 1,3)	Ca ₂ Ce ₃ F ₃ [CO ₃] ₅	(m : n = 0,(6))
Parisite family (x = 1,(3))	(m : n = 0,5)	
Parisite-(Ce)*	CaCe ₂ F ₂ [CO ₃] ₃	
*Lukechangite-(Ce)	Na ₃ Ce ₂ F[CO ₃] ₄	
Parisite-(Nd)	CaNd ₂ F ₂ [CO ₃] ₃	
Cordylite-(Ce)	NaBaCe ₂ F ₂ [CO ₃] ₄	
*Cordylite-(La)	NaCaBa ₂ La ₃ SrF ₂ [CO ₃] ₈	
Bastnäsite group (x = 1,5)	(only n)	
Bastnäsite-(Ce)	(Ce,La)F[CO ₃]	
Bastnäsite-(Y)	(Y,REE)F[CO ₃]	
*Bastnäsite-(La)	(La,Ce)F[CO ₃]	
Hydroxylbastnäsite-(Ce)	(Ce,La,Nd)(OH,F)[CO ₃]	
*Hydroxylbastnäsite-(La)	(La,Nd)(OH,F)[CO ₃]	
*Hydroxylbastnäsite-(Nd)	(Nd,La)(OH,F)[CO ₃]	
Ancylite subseries (hydrates basic)		
Ancylite group		
Calcio-ancylite-(Ce) (x = 1,25)	(Ca,Sr)Ce(OH)[CO ₃] ₂ ·H ₂ O	(m : n = 1)
*Calcio-ancylite-(Nd)	Ca(Nd,Ce,Gd,Y) ₃ (OH) ₃ [CO ₃] ₄ ·H ₂ O	
Ancylite-(Ce)	SrCe(OH)[CO ₃] ₂ ·H ₂ O	
*Ancylite-(La)	SrLa(OH)[CO ₃] ₂ ·H ₂ O	
*Unnamed-(Nd)	Nd[CO ₃] ₂ [(OH), H ₂ O]	
*Kamphagite-(Y)	Ca ₂ (Y,REE) ₂ (OH) ₂ [CO ₃] ₄ ·3H ₂ O	
*Unnamed (x = 1,42)	(Ca,Sr)((Nd,La,Pr,Sm) ₅ (OH) ₅ [CO ₃] ₁₆ ·H ₂ O	(m:n = 0,2)
*Kozoite-(La)	(La,Nd,Ca)(OH)[CO ₃]	
*Kozoite-(Nd) (x = 1,5)	(Nd,La,Ca)(OH)[CO ₃]	
*Decrespignyite-(Y) (x = 1,75) (m:n = 0,17)	(Y,REE) ³⁺ ₄ Cu ²⁺ [CO ₃] ₄ Cl(OH) ₅ ·2H ₂ O	
*Arisite-(Ce) (x = 1,75) (m:n = 0,33)	NaCe ₂ F[CO ₃] ₂ [F _{2x} (CO ₃) _{1-x}]	
*Arisite-(La)	NaLa ₂ F[CO ₃] ₂ [F _{2x} (CO ₃) _{1-x}]	
Thorbastnäsite-(Ce) (x = 1,5)	ThCeF ₂ [CO ₃] ₂ ·3H ₂ O	
*Lusernaite-(Y)	Y ₄ Al[CO ₃] ₂ (OH) ₁₀ F·6H ₂ O	

3.2.3.1.2.2.1. Hydrates

3.2.3.1.2.2.1.1. Neutral

Lanthanite family (x = 1)

Calkinsite-(Ce)	(Ce,La) ₂ [CO ₃] ₃ ·4H ₂ O
Lanthanite-(Ce)	(Ce,La,Nd) ₂ [CO ₃] ₃ ·8H ₂ O
Lanthanite-(La)	(La,Nd) ₂ [CO ₃] ₃ ·8H ₂ O
Lanthanite-(Nd)	(Nd,La) ₂ [CO ₃] ₃ ·8H ₂ O
Tengerite-(Y)	Y ₂ [CO ₃] ₃ ·2-3H ₂ O

Lokkaite family

Lokkaite-(Y)	CaY ₄ [CO ₃] ₇ ·9H ₂ O
Kimuraite-(Y)	CaY ₂ [CO ₃] ₄ ·6H ₂ O
*Adamsite-(Y)	NaY[CO ₃] ₂ ·6H ₂ O

Mckelveyite family

* According to Can. Min., 2001, v. 39, p.1713 the polytypes of parisite-(Ce): 4H, 8H, 10H, 14H, 16H, 6R₁, 6R₂, 18R, 25R, 30R, 36R, 42R be exist.

*Galgenbergite-(Ce)	$\text{Ca}(\text{Ce}, \text{REE})_2[\text{CO}_3]_4 \cdot 2\text{H}_2\text{O}$
Donnayite-(Y)	$\text{NaCaSr}_3\text{Y}[\text{CO}_3]_6 \cdot 3\text{H}_2\text{O}$
Donnayite-(Y) trig.	$\text{NaCaSr}_3\text{Y}[\text{CO}_3]_6 \cdot 3\text{H}_2\text{O}$
Mckelveyite-(Y)	$\text{Ba}_3\text{Na}(\text{Ca}, \text{U})\text{Y}[\text{CO}_3]_6 \cdot 3\text{H}_2\text{O}$
Tuliokite	$\text{BaNa}_6\text{Th}[\text{CO}_3]_6 \cdot 6\text{H}_2\text{O}$
*3.2.3.1.2.3. Carbonato -sulfato-halogenides	
*Reederite-(Y)	$(\text{Na}, \text{Mn})_{15}\text{Y}_2[\text{CO}_3]_9[\text{SO}_3\text{F}]\text{Cl}$
*3.2.3.1.2.4. Carbonato-hydrocarbonato-sulfato-halogenides	
	*3.2.3.1.2.4.1. Basic
*Mineevite-(Y)	$\text{Na}_{25}\text{Ba}(\text{Y}, \text{Gd}, \text{Dy})_2[\text{CO}_3]_{11}(\text{HCO}_3)_4(\text{SO}_4)_2\text{F}_2\text{Cl}$
3.2.3.1.2.5. Carbonato-phosphates	
Daqingshanite-(Ce)	3.2.3.1.2.5.1. Basic $\text{Sr}_3\text{Ce}[\text{CO}_3]_3[\text{PO}_4]$
*3.2.3.1.2.6. Carbonato-hydrophosphates	
	*3.2.3.1.2.6.1. Hydrates
*Micheelsenite	$(\text{Ca}, \text{Y})_3\text{Al}[\text{HPO}_4, \text{CO}_3][\text{CO}_3](\text{OH})_6 \cdot 12\text{H}_2\text{O}$
*Micheelsenite-(Y)	$\text{Ca}_4\text{Y}_2(\text{Al}, \text{Y}, \text{Dy})_2[(\text{P}, \text{Al})\text{O}_4]_2[\text{CO}_3](\text{OH})_{12} \cdot 25\text{H}_2\text{O}$
*3.2.3.1.2.7. Hydrocarbonates	
	*3.2.3.1.2.7.1. Basic
*Tomasclarkeite-(Y)	$\text{Na}(\text{Y}, \text{REE})(\text{HCO}_3)(\text{OH})_3 \cdot 4\text{H}_2\text{O}$
3.2.3.2. Subclass: Carbonates of cations with middle FC	
3.2.3.2.1. Carbonates of Zr	
Weloganite (x = 1)	3.2.3.2.1.1. Hydrates (neutral) $\text{Sr}_3\text{Na}_2\text{Zr}[\text{CO}_3]_6 \cdot 3\text{H}_2\text{O}$
(compare with mckelveyite)	
3.2.3.2.2. Carbonates of Ti	
Sabinaite (x= 2)	3.2.3.2.2.1. Oxido-carbonates $\text{Na}_4\text{Zr}_2\text{TiO}_4[\text{CO}_3]_4$
3.2.3.2.3. Carbonates of Mn^{4+}	
Jouravskite	3.2.3.2.3.1. Hydrates (neutral) $\text{Ca}_3\text{Mn}^{4+}[\text{CO}_3][\text{SO}_4](\text{OH})_6 \cdot 12\text{H}_2\text{O}$
3.2.3.3. Subklass: Carbonates of chalcophylic cations	
*3.2.3.3a. Carbonates VII ₆ – VIII ₆ cations Основные	
*Chukanovite	$\text{Fe}^{2+}_2(\text{OH})_2[\text{CO}_3]$
3.2.3.3.1. Carbonates of Cu^{2+}	
3.2.3.3.1.1. Proper carbonates	
Azurite (x = 1,5)	3.2.3.3.1.1.1. Basic $\text{Cu}_3(\text{OH})_2[\text{CO}_3]_2$
Malachite family (x = 2)	
Mcguinnessite	$(\text{Mg}, \text{Cu})_2(\text{OH})_2[\text{CO}_3]$
Kolwezite	$\text{CuCo}(\text{OH})_2[\text{CO}_3]$
Glaukosphaerite	$(\text{Cu}, \text{Ni})_2(\text{OH})_2[\text{CO}_3]$
Malachite	$\text{Cu}_2(\text{OH})_2[\text{CO}_3]$
*Huangodoyite	$\text{Na}_2\text{Cu}[\text{CO}_3]_2$
Georgeite (x = 1,(6))	$\text{Cu}_2(\text{OH})_2[\text{CO}_3]$
	3.2.3.3.1.1.2. Hydrates
	3.2.3.3.1.1.2.1. Basic

Callaghanite (x = 4)	$\text{Cu}_2\text{Mg}_2(\text{OH})_6[\text{CO}_3]\cdot 2\text{H}_2\text{O}$
	3.2.3.3.1.1.2.2. Neutral
Chalconatronite (x = 1)	$\text{Na}_2\text{Cu}[\text{CO}_3]_2\cdot 3\text{H}_2\text{O}$
3.2.3.3.1.2. Carbonato-sulfates (0,25:1) Cu^{2+}	
	3.2.3.3.1.2.1. Hydrates (basic)
Nakauriite (x = 1,6)	$\text{Cu}_8(\text{OH})_6[\text{CO}_3][\text{SO}_4]_4\cdot 48\text{H}_2\text{O}$
3.2.3.3.2. Carbonates of Hg^+	3.2.3.3.3.2.1. Hydrates (basic)
Szymańskiite (x = 1,5) $(\text{H}_3\text{O})_8\text{Hg}^+_{16}(\text{Ni},\text{Mg})_6(\text{OH})_{12}[\text{CO}_3]_{12}\cdot 3\text{H}_2\text{O}$	
*Clearcreekite mon.	$\text{Hg}^+[\text{CO}_3](\text{OH})\cdot 2\text{H}_2\text{O}$
*Peterbaylissite orth., pseudo-hex.	$\text{Hg}^+[\text{CO}_3](\text{OH})\cdot 2\text{H}_2\text{O}$
3.2.3.3.3. Carbonates of Zn and Cd	
3.2.3.3.3.1. Proper carbonates	3.2.3.3.3.1.1. Neutral
Smithsonite group (compare with calcite (group))	
Smithsonite (x = 1)	$\text{Zn}[\text{CO}_3]$
Otavite	$\text{Cd}[\text{CO}_3]$
Minrecordite (x = 1)	$\text{CaZn}[\text{CO}_3]_2$
(compare with dolomite (group))	
	3.2.3.3.3.1.2. Basic
Rosasite group (x = 2)	
Rosasite	$(\text{Cu},\text{Zn})_2(\text{OH})_2[\text{CO}_3]$
Zincrosasite	$(\text{Zn},\text{Cu})_2(\text{OH})_2[\text{CO}_3]$
Hydrozincite family (x = 2,5)	
Hydrozincite	$\text{Zn}_5(\text{OH})_6[\text{CO}_3]_2$
*Parádsasvárite	$\text{Zn}_2(\text{OH})_2[\text{CO}_3]$
Aurichalcite	$(\text{Zn},\text{Cu})_5(\text{OH})_6[\text{CO}_3]_2$
Loseyite group (x = 3,5)	
Sclearite	$(\text{Zn},\text{Mg},\text{Mn})_4\text{Zn}_3(\text{OH})_{10}[\text{CO}_3]_2$
Loseyite	$(\text{Mn},\text{Zn})_7(\text{OH})_{10}[\text{CO}_3]_2$
	3.2.3.3.3.1.3. Hydrates (basic)
Claraite (x = 3)	$(\text{Cu},\text{Zn})_3(\text{OH})_4[\text{CO}_3]\cdot 4\text{H}_2\text{O}$
*Zaccagnaite	$\text{Zn}_4\text{Al}_2(\text{OH})_{12}[\text{CO}_3]\cdot 3\text{H}_2\text{O}$
3.2.3.3.3.2. Sulfato-carbonates (0,5:1)	
	3.2.3.3.3.2.1. Basic
*Brianyoungite	$\text{Zn}_{12}[\text{CO}_3]_3[\text{SO}_4](\text{OH})_{16}$
Hauckite (x = 8)	$(\text{Mg},\text{Mn})_{24}\text{Zn}_{18}\text{Fe}^{3+}_3(\text{OH})_{81}[\text{CO}_3]_2[\text{SO}_4]_4$
3.2.3.3.4. Carbonates of Pb^{2+}	
3.2.3.3.4.1. Proper carbonates	3.2.3.3.4.1.1. Neutral
Cerussite (x = 1)	$\text{Pb}[\text{CO}_3]$
(compare with aragonite (group))	
*Sanromanite	$\text{Na}_2\text{CaPb}_3[\text{CO}_3]_5$
	3.2.3.3.4.1.2. Basic and carbonato-chlorides
Hydrocerussite (x = 1,5)	$\text{Pb}_5\text{O}(\text{OH})_2[\text{CO}_3]_3$
Plumbonacrite (x = 1,(6))	$\text{Pb}_5(\text{OH})_2\text{O}[\text{CO}_3]_3$

- Phosgenite (x = 2) $Pb_2Cl_2[CO_3]$
 *Barstowite (x = 4) $Pb_4Cl_6[CO_3]H_2O$
 Schuilingite-(Nd) (x = 1,1(6)) $PbCuNd(OH)[CO_3]_3 \cdot H_2O$
 Gysinite-(Nd) (x = 1,25) $PbNd(OH)[CO_3]_2 \cdot H_2O$
 Dundasite (x = 2) $PbAl_2(OH)_4[CO_3]_2 \cdot H_2O$
 *Petterdite (x = 2) $PbCr_2(OH)_4[CO_3]_2 \cdot H_2O$
- *3.2.3.3.4.1.3. Oxido-carbonates
 *Shannonite $Pb_2O[CO_3]$
- 3.2.3.3.4.2. Carbonato-sulfates
 3.2.3.3.4.2.1. Carbonato-sulfates with $CO_3 : SO_4 = 4$
 3.2.3.3.4.2.1.1. Oxido-hydrates
 Nasledovite (x = 2) $PbMn_3Al_4O_5[CO_3]_4[SO_4] \cdot 5H_2O$
- 3.2.3.3.4.2.2. Carbonato-sulfates with $CO_3 : SO_4 = 2$
 3.2.3.3.4.2.2.1. Basic
Leadhillite family (x = 1,(3))
 Susannite $Pb_4(OH)_2[CO_3]_2[SO_4]$
 Macphersonite $Pb_4(OH)_2[CO_3]_2[SO_4]$
 Leadhillite $Pb_4(OH)_2[CO_3]_2[SO_4]$
- 3.2.3.3.4.2.3. Carbonato-sulfates with $CO_3 : SO_4 = 0,(3)$
 3.2.3.3.4.2.3.1. Basic
 Caledonite (x = 1,75) $Pb_5Cu_2(OH)_6[CO_3][SO_4]_3$
- *3.2.3.3.4.2.4. Oxido-carbonato-sulfato-chlorides $CO_3 : SO_4 : Cl = 1 : 4 : 4$
 *3.2.3.3.4.2.4.1. Basic
 *Philolithite $Pb_{12}O_6Mn(Mg,Mn)_2(Mn,Mg)_4[CO_3]_4[SO_4]Cl_4(OH)_{12}$
- *3.2.3.3.4.2.5. Carbonato-tiosulfates
 *Fassinaite $Pb_2[S^{2+}_2O_3][CO_3]$
- 3.2.3.3.5. Carbonates of As^{3+} , Sb^{3+} and Bi^{3+}
 3.2.3.3.5.1. Oxido- and oxido-carbonato-fluorides
 Beyerite (x = 2) $(Ca,Pb)Bi_2O_2[CO_3]_2$
 Kettnerite (x = 2,5) $CaBiOF[CO_3]$
 Bismutite (x = 3) $CaBiOF[CO_3]$
- 3.2.3.3.5.2. Oxido-hydroxido-carbonates
 Armangite (x = 53) $Mn^{2+}_{26}As^{3+}_{18}(OH)_4O_{50}[CO_3]$
 (rather arsenito-carbonate !!)
- 3.2.3.4. Subclass: Carbonates of light p-anionformers (only Si^{4+})
 3.2.3.4.1. Carbonato-sulfates (1:1)
 3.2.3.4.1.1. Hydrates (basic)
 Thaumassite (x = 2,5) $Ca_3Si(OH)_6[CO_3][SO_4] \cdot 12H_2O$
- 3.2.4. **Class:** Phosphates
 3.2.4.1. Quasiclass: Orthophosphates

3.2.4.1.1. Subclass: Orthophosphates of cations with low FC

3.2.4.1.1.1. Orthophosphates of *s*-, *d*_s- and *p*_s-cations3.2.4.1.1.1.1. Orthophosphates of *s*-, *d*_s- and *p*_s-cations without Li and Be

3.2.4.1.1.1.1.1. Proper orthophosphates 3.2.4.1.1.1.1.1. Neutral

Alluaudite family ($x = \text{MO} : \text{PO}_4 = 1, (3)$)

(compare with berzeliite (family); garnet (series))

Alluaudite	$\text{Na}\square\text{Mn}^{2+}\text{Fe}^{3+}_2[\text{PO}_4]_3$
Ferro-alluaudite	$\text{Na}\square(\text{Fe}^{2+}, \text{Mn}^{2+})\text{Fe}^{3+}_2[\text{PO}_4]_3$
Maghagendorfite	$\text{NaMgMn}^{2+}(\text{Fe}^{2+}, \text{Fe}^{3+})_2[\text{PO}_4]_3$
Hagendorfite	$\text{NaCaMn}^{2+}(\text{Fe}, \text{Mn})^{2+}_2[\text{PO}_4]_3$
Varulite	$\text{NaCaMnMn}^{2+}_2[\text{PO}_4]_3$
Berlinite ($x = 1,5$)	$\{\text{Al}[\text{PO}_4]\}^{\infty 3}$
*Pretulite	$\text{Sc}[\text{PO}_4]$
*Rodolicoite	$\text{Fe}[\text{PO}_4]$
*Grattarolaite	$\text{Fe}_3^{3+}\text{O}_3[\text{PO}_4]$

Purpurite series ($x = 1,5$)

Heterosite	$(\text{Fe}, \text{Mn})^{3+}[\text{PO}_4]$
Purpurite	$(\text{Mn}, \text{Fe})^{3+}[\text{PO}_4]$

Graftonite series ($x = 1,5$)

Farringtonite	$\text{Mg}_3[\text{PO}_4]_2$
Sarcopsidite	$\text{Fe}^{2+}_3[\text{PO}_4]_2$
*Zavaliaite	$(\text{Mn}^{2+}, \text{Fe}^{2+}, \text{Mg})_3[\text{PO}_4]_2$
*Chopinite	$\text{Mg}_3[\text{PO}_4]_2$
Graftonite	$(\text{Fe}^{2+}, \text{Mn}^{2+}, \text{Ca})_3[\text{PO}_4]_2$
Beusite	$(\text{Mn}, \text{Fe}, \text{Ca}, \text{Mg})_3[\text{PO}_4]_2$
*Tuite polymorph of high pressure	$\gamma\text{-Ca}_3[\text{PO}_4]_2$
*Merrillite	$\text{Ca}_9\text{Na}(\text{Mg}, \text{Fe}^{2+})[\text{PO}_4]_7$
*Ferromerrillite	$\text{Ca}_9\text{NaFe}^{2+}[\text{PO}_4]_7$
Stanfieldite ($x = 1,5$)	$\text{Ca}_4(\text{Mg}, \text{Fe}, \text{Mn})_5[\text{PO}_4]_6$
Bobfergusonite ($x = 1,5$)	$\text{Na}_2\text{Mn}_5\text{Fe}^{3+}\text{Al}[\text{PO}_4]_6$
*Manitobaite	$\text{Na}_{16}\text{Mn}_{15}\text{Al}_8[\text{PO}_4]_{30}$
Johnsomervilleite ($x = 1,5$)	$\text{Na}_{10}\text{Ca}_6\text{Mg}_{18}(\text{Fe}, \text{Mn})_{25}[\text{PO}_4]_{36}$

Brianite family ($x = 1,5$)

Panethite	$(\text{Na}, \text{Ca}, \text{K})_2(\text{Mg}, \text{Fe}, \text{Mn})_2[\text{PO}_4]_2$
Brianite	$\text{Na}_2\text{CaMg}[\text{PO}_4]_2$

Natrophilite family ($x = 1,5$)

Mariçite	$\text{NaFe}[\text{PO}_4]$
*Karenwebberite	$\text{Na}(\text{Fe}, \text{Mn})^{2+}[\text{PO}_4]$
Natrophilite	$\text{NaMn}[\text{PO}_4]$
Buchwaldite	$\text{NaCa}[\text{PO}_4]$

Fillowite family ($x = 1,5$)

Fillowite	$\text{Na}_2\text{Ca}(\text{Mn}, \text{Fe})^{2+}_7[\text{PO}_4]_6$
*Chladniite	$\text{Na}_2\text{CaMg}_7[\text{PO}_4]_6$
*Galileiite	$(\text{Na}, \text{K})_2(\text{Fe}, \text{Mn}, \text{Cr})^{2+}_8[\text{PO}_4]_6$
*Unnamed	$(\text{K}, \text{Na})_2(\text{Fe}, \text{Mn}, \text{Cr})^{2+}_8[\text{PO}_4]_6$
Olgite	$(\text{Ba}, \text{Sr})(\text{Na}, \text{Sr}, \text{TR})_2\text{Na}[\text{PO}_4]_2$
*Bario-oligite	$\text{Na}(\text{BaSr})\text{Na}[\text{PO}_4]_2$
Olympite ($x = 1,5$)	$\text{LiNa}_5[\text{PO}_4]_2$

Wyllieite group ($x = 1, (6)$)

Rosemaryite	$\text{NaMn}^{2+}\text{Fe}^{3+}\text{Al}[\text{PO}_4]_3$
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*Ferrosemaryite	$\square\text{NaFe}^{2+}\text{Fe}^{3+}\text{Al}[\text{PO}_4]_3$
Wyllieite	$\text{Na}_2\text{Mn}^{2+}\text{Fe}^{2+}\text{Al}[\text{PO}_4]_3$
Ferrowyllieite	$\text{Na}_2(\text{Fe}^{2+}, \text{Mg})_2\text{Al}[\text{PO}_4]_3$
Qingheite	$\text{Na}_2\text{Mn}^{2+}\text{Mg}(\text{Al}, \text{Fe}^{3+})[\text{PO}_4]_3$
*Qingheite-(Fe ²⁺)	$\text{Na}_2\text{MgFe}^{2+}\text{Al}[\text{PO}_4]_3$
*3.2.4.1.1.1.1.2. Oxido-and phosphato-halogenides	
	*3.2.4.1.1.1.1.2.1. Neutral
*Moraskoite	$\text{Na}_2\text{MgF}[\text{PO}_4]$
	3.2.4.1.1.1.1.2.2. Basic
Melonjosephite (x = 1,5)	$\text{CaFe}^{2+}\text{Fe}^{3+}(\text{OH})[\text{PO}_4]_2$
Arrojadite group (x = 1,58)	
Dickinsonite-(K,Mn,Na)	$\text{K}(\text{Na}, \text{Mn})\text{Na}_3\text{CaAlMn}_{13}[\text{PO}_4]_{12}(\text{OH})_2$
Arrojadite-(BaFe)	$\text{BaFe}(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(BaNa)	$\text{BaNa}_2(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(KFe)	$(\text{KNa})\text{Fe}^{2+}(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(KNa)	$\text{KNa}_5\text{CaFe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(NaFe)	$\text{Na}_2\text{Fe}^{2+}(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(PbFe)	$\text{PbFe}^{2+}(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(SrFe)	$\text{SrFe}^{2+}(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Arrojadite-(SrNa)	$\text{SrNa}_2(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})](\text{OH})_2$
*Fluorarrojadite-(BaFe)	$\text{Na}_2\text{CaBaFe}^{2+}\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})]\text{F}_2$
*Fluorarrojadite-(BaNa)	$\text{BaNa}_2(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})]\text{F}_2$
*Fluorarrojadite-(KNa)	$\text{KNa}_3\text{CaNa}_2\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})]\text{F}_2$
*Fluorarrojadite-(NaFe)	$\text{Na}_2\text{Fe}^{2+}(\text{CaNa}_2)\text{Fe}^{2+}_{13}\text{Al}[\text{PO}_4]_{11}[\text{PO}_3(\text{OH})]\text{F}_2$
Samuelsonite (x = 1,6)	$(\text{Ca}, \text{Ba})\text{Fe}^{2+}_2\text{Mn}^{2+}_2\text{Ca}_8\text{Al}_2(\text{OH})_2[\text{PO}_4]_{10}$
Nefedovite (x = 1,625)	$\text{Na}_5\text{Ca}_4\text{F}[\text{PO}_4]_4$
Apatite family (x = 1,(6))	
Oxyapatite hypothet. minal of apatite series	$\text{Ca}_{10}\text{O}[\text{PO}_4]_6$
Fluorapatite	$\text{Ca}_5\text{F}[\text{PO}_4]_3$
Carbonate-fluorapatite	$\text{Ca}_5(\text{F}, \text{OH})[(\text{PO}_4)_3(\text{CO}_3)]_3$
Hydroxylapatite	$\text{Ca}_5(\text{OH})[\text{PO}_4]_3$
Carbonate-hydroxylapatite	$\text{Ca}_5(\text{OH}, \text{F})[(\text{PO}_4)_3(\text{CO}_3)]_3$
Chlorapatite	$\text{Ca}_5\text{Cl}[\text{PO}_4]_3$
*Clinohydroxylapatite = apatite-(CaOH)-M	$\text{Ca}_5\text{OH}[\text{PO}_4]_3$
*Stronadelphite	$\text{Sr}_5\text{F}[\text{PO}_4]_3$
*Miyahisaite	$(\text{Sr}, \text{Ca})_2\text{Ba}_3\text{F}[\text{PO}_4]_3$
*Alforsite	$\text{Ba}_5\text{Cl}[\text{PO}_4]_3$
Belovite series	
*Belovite-(Ce)	$\text{NaCeSr}_3\text{F}[\text{PO}_4]_3$
*Belovite-(La)	$\text{NaLaSr}_3\text{F}[\text{PO}_4]_3$
*Fluorcapthite	$\text{SrCaCa}_3\text{F}[\text{PO}_4]_3$
Apatite-(SrOH)	$\text{Sr}_5\text{OH}[\text{PO}_4]_3$
Kuannersuite-(Ce)	$\text{Ba}_6\text{Na}_2\text{Ce}_2\text{FCl}[\text{PO}_4]_6$
Goedkenite (x = 1,75)	$(\text{Sr}, \text{Ca})_2\text{Al}(\text{OH})[\text{PO}_4]_2$
(comp. with brackebuschite gr.)	
Arctite	$\text{Na}_5\text{Ca}_7\text{BaF}_3[\text{PO}_4]_6$
*Bearthite	$\text{Ca}_2\text{Al}(\text{OH})[\text{PO}_4]_2$
Trolleite (x = 2)	$\text{Al}_4(\text{OH})_3[\text{PO}_4]_3$
Lazulite group (x = 2)	

Lazulite	$(\text{Mg,Fe}^{2+})\text{Al}_2(\text{OH})_2[\text{PO}_4]_2$
Scorzalite	$(\text{Fe}^{3+},\text{Mg})\text{Al}_2(\text{OH})_2[\text{PO}_4]_2$
Barbosalite	$\text{Fe}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2$
Lipscombite ($x = 2$)	$(\text{Fe},\text{Mn})^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2$
*Staněkite	$\text{Fe}^{3+}(\text{Mn,Fe}^{2+},\text{Mg})\text{O}[\text{PO}_4]$
*Lulzacite	$\text{Sr}_2\text{Fe}^{2+}(\text{Fe}^{2+},\text{Mg})_2\text{Al}_4(\text{OH})_{10}[\text{PO}_4]_4$
Penikisite group ($x = 2$)	
Penikisite	$\text{Ba}(\text{Mg,Fe}^{2+})_2\text{Al}_2(\text{OH})_3[\text{PO}_4]_3$
Kulanite	$\text{BaFe}^{2+}_2\text{Al}_2(\text{OH})_3[\text{PO}_4]_3$
Bjarebyite group ($x = 2$)	
Bjarebyite	$\text{BaMn}_2\text{Al}_2(\text{OH})_3[\text{PO}_4]_3$
Perloffite	$\text{BaMn}_2\text{Fe}^{3+}_2(\text{OH})_3[\text{PO}_4]_3$
*Johntomaite	$\text{BaFe}^{2+}_2\text{Fe}^{3+}_2(\text{OH})_3[\text{PO}_4]_3$
Cirrolite ($x = 2$)	$\text{Ca}_3\text{Al}_2(\text{OH})_3[\text{PO}_4]_3$
Satterlyite group ($x = 2$)	
Holtedahlite	$\text{Mg}_{12}(\text{OH},\text{O})_6(\text{PO}_3,\text{OH},\text{CO}_3)[\text{PO}_4]_5$
Satterlyite	$(\text{Fe},\text{Mg})_{12}(\text{OH},\text{O})_6(\text{PO}_3,\text{OH})[\text{PO}_4]_5$
Althausite group ($x = 2$)	
Althausite	$\text{Mg}_4(\text{OH},\text{O})(\text{F},\text{Cl})[\text{PO}_4]_2$
Thadeuite	$\text{CaMg}_3(\text{OH},\text{F})_2[\text{PO}_4]_2$
Triplite group ($x = 2$)	
Zwieselite	$\text{Fe}^{2+}_2\text{F}[\text{PO}_4]$
Triplite	$\text{Mn}^{2+}_2\text{F}[\text{PO}_4]$
Wagnerite group ($x = 2$)	
Magniotriplite	$(\text{Mg,Fe,Mn})_2\text{F}[\text{PO}_4]$
Wagnerite	$(\text{Mg,Fe}^{2+})_2\text{F}[\text{PO}_4]$
*Wagnerite Ma5bc polytype	$\text{Mg}_2(\text{F},\text{OH})[\text{PO}_4]$
*Hydroxylwagnerite	$\text{Mg}_2(\text{OH})[\text{PO}_4]$
Wolfeite	$(\text{Fe,Mn})^{2+}_2(\text{OH})[\text{PO}_4]$
Tripliodite	$(\text{Mn,Fe})^{2+}_2(\text{OH})[\text{PO}_4]$
Panasqueiraite family ($x = 2$)	
*Isokite	$\text{CaMgF}[\text{PO}_4]$
Panasqueiraite	$\text{CaMg}(\text{OH},\text{F})[\text{PO}_4]$
Lacroixite	$\text{NaAl}(\text{F},\text{OH})[\text{PO}_4]$
Nacaphite ($x = 2$)	$\text{Na}_2\text{CaF}[\text{PO}_4]$
Richellite ($x = 2$)	$\text{CaFe}^{3+}_2(\text{OH},\text{F})_2[\text{PO}_4]_2$
*Jagowerite ($x = 2$)	$\text{BaAl}_2(\text{OH})_2[\text{PO}_4]_2$
Rockbridgeite series ($x = 2, (3)$)	
Rockbridgeite	$(\text{Fe,Mn})^{2+}\text{Fe}^{3+}_4(\text{OH})_5[\text{PO}_4]_3$
Frondelite	$(\text{Mn,Fe})^{2+}\text{Fe}^{3+}_4(\text{OH})_5[\text{PO}_4]_3$
Brazilianite ($x = 2, 5$)	$\text{NaAl}_3(\text{OH})_4[\text{PO}_4]_2$
*Getehouseite ($x = 2, 5$)	$\text{Mn}_5(\text{OH})_4[\text{PO}_4]_2$
Augelite ($x = 3$)	$\text{Al}_2(\text{OH})_3[\text{PO}_4]$
Laubmannite ($x = 3$)	$\text{Fe}^{2+}_3\text{Fe}^{3+}_6(\text{OH})_{12}[\text{PO}_4]_4$
Viitaniemiite ($x = 3$)	$\text{Na}(\text{Ca,Mn})\text{Al}(\text{F},\text{OH})_3[\text{PO}_4]$
*Raadeite ($x = 3, 5$)	$\text{Mg}_7(\text{OH})_8[\text{PO}_4]_2$
*Waterhauseite	$\text{Mn}_7(\text{OH})_8[\text{PO}_4]_2$
*Unnamed	$(\text{Fe,Mn})_3\text{Al}(\text{OH})_6[\text{PO}_4]$
3.2.4.1.1.1.1.3.1. Basic, oxido-phosphato-fluorides	
	3.2.4.1.1.1.1.2.1.1. Hydrates

*Bederite (x = 1,(3))	$\square\text{Ca}_2\text{Mn}^{2+}_2\text{Fe}^{3+}_2\text{Mn}^{2+}_2[\text{PO}_4]_6(\text{H}_2\text{O})_2$
Senegalite	$\text{Al}_2(\text{OH})_3[\text{PO}_4]\text{H}_2\text{O}$
Englishite (x = 1,(6))	$\text{K}_3\text{Na}_2\text{Ca}_{10}\text{Al}_{15}(\text{OH})_7[\text{PO}_4]_{21}\cdot 26\text{H}_2\text{O}$
Landesite (x = 1,69)	$\text{Mn}_9\text{Fe}^{3+}_3(\text{OH})_3[\text{PO}_4]_8\cdot 9\text{H}_2\text{O}$
Giniite (x = 1,75)	$\text{Fe}^{2+}\text{Fe}^{3+}_4(\text{OH})_2[\text{PO}_4]_4\cdot 2\text{H}_2\text{O}$
Xanthoxenite (x = 1,75)	$\text{Ca}_4\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_4\cdot 3\text{H}_2\text{O}$
Overite group (x = 1,75)	
Overite	$\text{CaMgAl}(\text{OH})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
*Juonniite	$\text{CaMgSc}(\text{OH})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
Segelerite	$\text{CaMgFe}^{3+}(\text{OH})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
*Manganosegelerite	$(\text{Mn}^{2+},\text{Ca})(\text{Mn}^{2+},\text{Fe}^{2+},\text{Mg})\text{Fe}^{3+}(\text{OH})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
*Falsterite	$\text{Ca}_2\text{MgMn}^{2+}_2\text{Fe}^{2+}_2\text{Fe}^{3+}_2\text{Zn}_4(\text{OH})_4[\text{PO}_4]_8\cdot 4\text{H}_2\text{O}$
*Ferraioloite (x = 1,75)	$\text{MgMn}^{2+}_4(\text{Fe}^{2+}_{0.5}\text{Al}_{0.5})_4\text{Zn}_4[\text{PO}_4]_8(\text{OH})_4(\text{H}_2\text{O})_{20}$
Lun'okite group (x = 1,75)	
Lun'okite	$\text{MgMnAl}(\text{OH})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
Wilhelmvierlingite	$(\text{Ca},\text{Zn})\text{Mn}^{2+}\text{Fe}^{3+}(\text{OH})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
Whiteite series (x = 1,75)	
Whiteite-(CaFeMg)	$\text{Ca}(\text{Fe},\text{Mn})^{2+}\text{Mg}_2\text{Al}_2(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Whiteite-(CaMnMg)	$\text{CaMn}^{2+}\text{Mg}_2\text{Al}_2(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Whiteite-(CaMnMn)	$\text{CaMn}^{2+}\text{Mn}_2\text{Al}_2(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Whiteite-(MnFeMg)	$(\text{Mn}^{2+},\text{Ca})(\text{Fe},\text{Mn})^{2+}\text{Mg}_2\text{Al}_2(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Jahnsite series (x = 1,75)	
*Jahnsite-(CaMgMg)	$\{\text{Ca}\}\{\text{Mg}\}\{\text{Mg}_2\}\{\text{Fe}_2^{3+}\}(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
*Jahnsite-(CaFeFe)	$\{\text{Ca}\}\{\text{Fe}^{2+}\}\{\text{Fe}_2^{2+}\}\{\text{Fe}_2^{3+}\}(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Jahnsite-(MnMnFe) (Rittmannite)	$\text{MnMnFe}^{2+}_2\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Jahnsite-(MnMnMn)	$\text{Mn}^{2+}\text{Mn}^{2+}\text{Mn}_2^{2+}\text{Fe}_2^{3+}(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Jahnsite-(CaMnMg)	$\text{CaMn}^{2+}\text{Mg}_2\text{Fe}_2^{3+}(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Jahnsite-(CaMnFe)	$\text{CaMn}^{2+}\text{Fe}_2^{2+}\text{Fe}_2^{3+}(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
Jahnsite-(CaMnMn)	$\text{CaMn}^{2+}\text{Mn}_2^{2+}\text{Fe}_2^{3+}(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
*Jahnsite-(NaFeMg)	$\text{NaFe}^{3+}\text{Mg}_2\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_4\cdot 8\text{H}_2\text{O}$
*Gladiusite	$(\text{Fe}^{2+},\text{Mg})_4\text{Fe}^{3+}_2(\text{OH})_{11}[\text{PO}_4]\text{H}_2\text{O}$
Leucophosphite series (x = 1,75)	
Tinsleyite	$\text{KAl}_2(\text{OH})[\text{PO}_4]_2\cdot 2\text{H}_2\text{O}$
*Potassium-rich tinsleyite	$[\text{K}_{1.5}(\text{H}_2\text{O})_{0.5}] [\text{Al}_2(\text{OH})\{(\text{OH})_{0.5}(\text{H}_2\text{O})_{0.5}\}[\text{PO}_4]_2]$
Leucophosphite	$\text{KFe}^{3+}_2(\text{OH})[\text{PO}_4]_2\cdot 2\text{H}_2\text{O}$
Spheniscidite	$(\text{NH}_4,\text{K})(\text{Fe}^{3+},\text{Al})_2(\text{OH})[\text{PO}_4]_2\cdot 2\text{H}_2\text{O}$
Minyulite (x = 1,75)	$\text{KAl}_2(\text{OH},\text{F})[\text{PO}_4]_2\cdot 4\text{H}_2\text{O}$
Natrophosphate (x = 1,75)	$\text{Na}_7\text{F}[\text{PO}_4]_2\cdot 19\text{H}_2\text{O}$
Vashegyite (x = 1,8)	$\text{Al}_{11}(\text{OH})_6[\text{PO}_4]_9\cdot 38\text{H}_2\text{O}$
Calcioferrite family (x = 1,8(3))	
Montgomeryite	$\text{Ca}_4\text{MgAl}_4(\text{OH})_4[\text{PO}_4]_6\cdot 12\text{H}_2\text{O}$
Kingsmountite	$(\text{Ca},\text{Mn})_4(\text{Fe},\text{Mn})^{2+}\text{Al}_4(\text{OH})_4[\text{PO}_4]_6\cdot 12\text{H}_2\text{O}$
Zodacite	$\text{Ca}_4\text{MnFe}^{3+}_4(\text{OH})_4[\text{PO}_4]_6\cdot 12\text{H}_2\text{O}$
Keckite (x = 1,6)	$\text{CaMn}^{2+}(\text{Fe}^{3+}\text{Mn}^{2+})\text{Fe}_2^{3+}(\text{OH})_3[\text{PO}_4]_4\cdot 7\text{H}_2\text{O}$
*Kapundaite	$\text{NaCaFe}^{3+}_4(\text{OH})_3[\text{PO}_4]_4\cdot 5\text{H}_2\text{O}$
Vantasselite (x = 2)	$\text{Al}_4(\text{OH})_3[\text{PO}_4]_3\cdot 9\text{H}_2\text{O}$
Cacoxenite (x = 2)	$\text{AlFe}^{3+}_{24}(\text{OH})_{12}\text{O}_6[\text{PO}_4]_{17}\sim 75\text{H}_2\text{O}$
Kryzhanovskite group (x = 2)	
Kryzhanovskite	$\text{MnFe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2\cdot \text{H}_2\text{O}$
Garyansellite	$(\text{Mg},\text{Fe}^{3+})_3(\text{OH})[\text{PO}_4]_2\cdot 2\text{H}_2\text{O}$

*Angarfite (x = 2)	$\text{NaFe}^{3+}_5(\text{OH})_4[\text{PO}_4]_4 \cdot 4\text{H}_2\text{O}$
Gatumbaite (x = 2)	$\text{CaAl}_2(\text{OH})_2[\text{PO}_4]_2 \cdot \text{H}_2\text{O}$
Isoclasite (x = 2)	$\text{Ca}_2(\text{OH})[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Whitmoreite group (x = 2) (compare with arhurite (group))	
Whitmoreite	$\text{Fe}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
Earlshannonite	$\text{Mn}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
Bermanite (x = 2)	$\text{Mn}^{2+}\text{Mn}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Ercitite (x = 2)	$\text{NaMn}^{3+}(\text{OH})[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Sigloite (x = 2)	$\text{Fe}^{3+}\text{Al}_2(\text{OH})_3[\text{PO}_4]_2 \cdot 7\text{H}_2\text{O}$
Vauxite group (x = 2)	
Vauxite	$\text{Fe}^{2+}\text{Al}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 6\text{H}_2\text{O}$
*Ferrivauxite	$\text{Fe}^{3+}\text{Al}_2(\text{OH})_3[\text{PO}_4]_2 \cdot 5\text{H}_2\text{O}$
*Ferrostrunzite	$\text{Fe}^{3+}\text{Fe}^{3+}_2(\text{OH})_3[\text{PO}_4]_2 \cdot 5\text{H}_2\text{O}$
*Ferrostrunzite	$\text{Fe}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 6\text{H}_2\text{O}$
Strunzite	$\text{Mn}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 6\text{H}_2\text{O}$
Metavauxite group (x = 2)	
Metavauxite	$\text{Fe}^{2+}\text{Al}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Pseudolaueite	$\text{Mn}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Paravauxite group (x = 2)	
Gordonite	$\text{MgAl}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Mangangordonite	$\text{Mn}^{2+}\text{Al}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Kastningite	$(\text{Mn,Fe,Mg})\text{Al}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Nordgauite	$\text{MnAl}_2(\text{F,OH})_2[\text{PO}_4]_2 \cdot 5\text{H}_2\text{O}$
*Kayrobertsonite	$\text{MnAl}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 6\text{H}_2\text{O}$
Paravauxite	$\text{Fe}^{2+}\text{Al}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Ushkovite	$\text{MgFe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Laueite	$\text{Mn}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Kummerite	$\text{Mn}^{2+}\text{Fe}^{3+}\text{Al}(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Ferrolaueite	$\text{Fe}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Stewartite (x = 2)	$\text{Mn}^{2+}\text{Fe}^{3+}_2(\text{OH})_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Kovdorskite (x = 2)	$\text{Mg}_2(\text{OH})[\text{PO}_4]_3 \cdot 3\text{H}_2\text{O}$
Beraunite (x = 2, 2)	$\text{Fe}^{2+}\text{Fe}^{3+}_5(\text{OH})_5[\text{PO}_4]_4 \cdot 4\text{H}_2\text{O}$
Pararobertsite (x = 2, 1(6))	$\text{Ca}_2\text{Mn}^{3+}_3\text{O}_2[\text{PO}_4]_3 \cdot 3\text{H}_2\text{O}$
Wavellite family (x = 2, 25)	
*Kobokoboite	$\text{Al}_6(\text{OH})_6[\text{PO}_4]_4 \cdot 1\text{H}_2\text{O}$
Wavellite	$\text{Al}_3(\text{OH,F})_3[\text{PO}_4]_2 \cdot 5\text{H}_2\text{O}$
Kingite	$\text{Al}_3(\text{OH,F})_3[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Tinticite	$\text{Fe}^{3+}_3(\text{OH})_3[\text{PO}_4]_2 \cdot 3\text{H}_2\text{O}$
*Allanpringite	$\text{Fe}^{3+}_3(\text{OH})_3[\text{PO}_4]_2 \cdot 5\text{H}_2\text{O}$
Gormanite group (x = 2, 25)	
Gormanite	$\text{Fe}^{2+}_3\text{Al}_4(\text{OH})_6[\text{PO}_4]_4 \cdot 2\text{H}_2\text{O}$
*Eleonorite	$\text{Fe}^{3+}_6\text{O}(\text{OH})_4[\text{PO}_4]_4 \cdot 6\text{H}_2\text{O}$
Souzalite	$\text{Mg}_3\text{Al}_4(\text{OH})_6[\text{PO}_4]_4 \cdot 2\text{H}_2\text{O}$
Mitridatite group (x = 2, 17)	
Mitridatite	$\text{Ca}_2\text{Fe}^{3+}_3\text{O}_2[\text{PO}_4]_3 \cdot 3\text{H}_2\text{O}$
Robertsite	$\text{Ca}_2\text{Mn}^{3+}_3\text{O}_2[\text{PO}_4]_3 \cdot 3\text{H}_2\text{O}$
Natrodufenite (x = 2, 25)	$(\text{Na}, \square)(\text{Fe}^{3+}, \text{Fe}^{2+})(\text{Fe}^{3+}, \text{Al})_5(\text{OH})_6[\text{PO}_4]_4 \cdot 2\text{H}_2\text{O}$
Dufenite	$\text{Ca}_{0.5}\text{Fe}^{2+}\text{Fe}^{3+}_5(\text{OH})_6[\text{PO}_4]_4 \cdot 2\text{H}_2\text{O}$
Burangaite	$(\text{Na,Ca})(\text{Fe}^{2+}, \text{Mg})\text{Al}_5(\text{OH}, \text{O})_6[\text{PO}_4]_4 \cdot 2\text{H}_2\text{O}$
*Matioliite	$\text{Na}_2\text{Mg}_2\text{Al}_{10}(\text{OH})_{12}[\text{PO}_4]_8 \cdot 4\text{H}_2\text{O}$

Kidwellite (x = 2,3)	$\text{NaFe}^{3+}_9(\text{OH})_{11}[\text{PO}_4]_6 \cdot 3\text{H}_2\text{O}$
*Meurigitite	$\text{KFe}^{3+}_7(\text{OH})_7[\text{PO}_4]_5 \cdot 8\text{H}_2\text{O}$
*Meurigitite-(Na)	$[\text{Na}(\text{H}_2\text{O})_{2.5}][\text{Fe}^{3+}_8(\text{OH})_7[\text{PO}_4]_6(\text{H}_2\text{O})_4$
Phosphofibrite	$(\text{K}_{0.5}(\text{H}_2\text{O})_3)\text{Fe}_8^{3+}[\text{PO}_4]_6(\text{OH})_{6.5} \cdot 6.5\text{H}_2\text{O}$
Eosphorite series (x = 2,5)	
Childrenite	$(\text{Fe},\text{Mn})^{2+}\text{Al}(\text{OH})_2[\text{PO}_4] \cdot \text{H}_2\text{O}$
Ernstite	$(\text{Mn}^{2+},\text{Fe}^{3+})\text{Al}(\text{OH})_2[\text{PO}_4] \cdot \text{H}_2\text{O}$
Eosphorite	$(\text{Mn},\text{Fe})^{2+}\text{Al}(\text{OH})_2[\text{PO}_4] \cdot \text{H}_2\text{O}$
Foggite (x = 2,5)	$\text{CaAl}(\text{OH})_2[\text{PO}_4] \cdot \text{H}_2\text{O}$
Wardite family (x = 2,5) (compare with turquoise (series); faustite (series))	
Aheylite	$(\text{Fe},\text{Zn})\text{Al}_6(\text{OH})_8[\text{PO}_4]_4 \cdot 4\text{H}_2\text{O}$
Wardite	$\text{NaAl}_3(\text{OH})_4[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Cyrilovite	$\text{NaFe}^{3+}_3(\text{OH})_4[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
*Angastonite	$\text{CaMgAl}_2(\text{OH})_4[\text{PO}_4]_2 \cdot 7\text{H}_2\text{O}$
Millisite (x = 2,6,25)	$(\text{Na},\text{K})\text{CaAl}_6(\text{OH})_9[\text{PO}_4]_4 \cdot 3\text{H}_2\text{O}$
Attakolite (x = 2,6(6))	$(\text{Ca},\text{Sr})\text{Mn}(\text{Al},\text{Fe}^{3+})_4[\text{PO}_4]_3[\text{HSiO}_4](\text{OH})_4$
Goyazite (x = 2,75)	$\text{SrAl}_3(\text{OH})_5[\text{PO}_4]_2 \cdot \text{H}_2\text{O}$
*Springcreekite	$\text{BaV}^{3+}_3[(\text{OH})_5(\text{H}_2\text{O})]_{\Sigma 6}[\text{PO}_4]_2$
Delvauxite (x = 2,75)	$(\text{Ca},\text{Mg})(\text{Fe}^{3+},\text{Al})_4(\text{OH})_8[(\text{PO}_4)_2(\text{SO}_4)_2(\text{CO}_3)]_2(4-6)\text{H}_2\text{O}$
Morinite (x = 2,75)	$\text{NaCa}_2\text{Al}_2(\text{F},\text{OH})_5[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Aldermanite (x = 2,875)	$\text{Mg}_5\text{Al}_{12}(\text{OH})_{22}[\text{PO}_4]_8 \cdot 32\text{H}_2\text{O}$
Fluellite family (x = 3)	
Fluellite	$\text{Al}_2(\text{OH})\text{F}_2[\text{PO}_4] \cdot 7\text{H}_2\text{O}$
Bolivarite	$\text{Al}_2(\text{OH})_3[\text{PO}_4] \cdot (4-5)\text{H}_2\text{O}$
Evansite (x = 4,5)	$\text{Al}_3(\text{OH})_6[\text{PO}_4] \cdot 8\text{H}_2\text{O}$
	3.2.4.1.1.1.1.2.2. Neutral
Variscite family (x = 1,5)	
Variscite	$\text{Al}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
*Serrabrancaite	$\text{Mn}[\text{PO}_4] \cdot \text{H}_2\text{O}$
Strengite	$\text{Fe}^{3+}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
Metavariscite	$\text{Al}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
Phosphosiderite	$\text{Fe}^{3+}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
Kolbeckite	$\text{Sc}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
Koninckite (x = 1,5)	$\text{Fe}[\text{PO}_4] \cdot 3\text{H}_2\text{O}$
*Santabarbaraite	$\text{Fe}^{3+}_3(\text{OH})_3[\text{PO}_4]_2 \cdot 5\text{H}_2\text{O}$
*Pakhomovskiyte	$\text{Co}^{2+}_3[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Fairfieldite group (x = 1,5)	
Cassidyite	$\text{Ca}_2\text{Ni}^{2+}[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Collinsite	$\text{Ca}_2\text{Mg}[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Messelite	$\text{Ca}_2(\text{Fe},\text{Mn})^{2+}[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Fairfieldite	$\text{Ca}_2(\text{Mn},\text{Fe})^{2+}[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
*Hillite	$\text{Ca}_2\text{Zn}[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Phosphoferrite group (x = 1,5)	
Phosphoferrite	$\text{Fe}^{2+}\text{Fe}^{2+}_2[\text{PO}_4]_2 \cdot 3\text{H}_2\text{O}$
*Correianevesite	$\text{Fe}^{2+}\text{Mn}^{2+}_2[\text{PO}_4]_2 \cdot 3\text{H}_2\text{O}$
Reddingite	$\text{Mn}^{2+}\text{Mn}^{2+}_2[\text{PO}_4]_2 \cdot 3\text{H}_2\text{O}$
Ludlamite group (x = 1,5)	
Ludlamite	$\text{Fe}^{2+}_3[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
Metaswitzerite	$(\text{Mn}^{2+},\text{Fe}^{2+})_3[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
Switzerite (x = 1,5)	$(\text{Mn},\text{Fe})^{2+}_3[\text{PO}_4]_2 \cdot 7\text{H}_2\text{O}$

Anapaite (x = 1,5)	$\text{Ca}_2\text{Fe}^{2+}[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
Vivianite family (x = 1,5)	
Bobierrite	$\text{Mg}_3[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Cattiite	$\text{Mg}_3[\text{PO}_4]_2 \cdot 22\text{H}_2\text{O}$
*Rimkorolgit	$\text{BaMg}_5[\text{PO}_4]_4 \cdot 8\text{H}_2\text{O}$
Vivianite group	
Barićite	$(\text{Mg}, \text{Fe}^{2+})_3[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Vivianite	$\text{Fe}^{2+}_3[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Arupite	$\text{Ni}_3[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Metavivianite	$\text{Fe}^{2+}\text{Fe}_2^{3+}(\text{OH})_2[\text{PO}_4]_2 \cdot 6\text{H}_2\text{O}$
Wicksite (x = 1,5)	$\text{NaCa}_2(\text{Fe}, \text{Mn})^{2+}_4\text{MgFe}^{3+}[\text{PO}_4]_6 \cdot 2\text{H}_2\text{O}$
*Phase like to wicksite	$(\text{Ca}, \text{Na})_2(\text{Mn}, \text{Fe}, \text{Mg})_4(\text{Fe}, \text{Al})_2[\text{PO}_4]_6 \cdot 4\text{H}_2\text{O}$
*Tassieite	$(\text{Na}, \square)\text{Ca}_2(\text{Mg}, \text{Fe}^{2+}, \text{Fe}^{3+})_2(\text{Fe}^{3+}, \text{Mg})_2(\text{Fe}^{2+}, \text{Mg})_2[\text{PO}_4]_6 \cdot 2\text{H}_2\text{O}$ or $\text{NaCa}_2\text{Mg}_3\text{Fe}^{2+}_2\text{Fe}^{3+}[\text{PO}_4]_6 \cdot 2\text{H}_2\text{O}$
Nastrophite group (x = 1,5)	
Nastrophite	$\text{Na}(\text{Sr}, \text{Ba})[\text{PO}_4] \cdot 9\text{H}_2\text{O}$
Nabaphite	$\text{NaBa}[\text{PO}_4] \cdot 9\text{H}_2\text{O}$
Dittmarite family (x = 1,5)	
Dittmarite	$(\text{NH}_4)\text{Mg}[\text{PO}_4] \cdot \text{H}_2\text{O}$
Niahite	$(\text{NH}_4)\text{Mn}[\text{PO}_4] \cdot \text{H}_2\text{O}$
*Struvite group (x = 1,5)	
Struvite	$(\text{NH}_4)\text{Mg}[\text{PO}_4] \cdot 6\text{H}_2\text{O}$
*Struvite-(K)	$\text{KMg}[\text{PO}_4] \cdot 6\text{H}_2\text{O}$
*Hazenite	$\text{KNaMg}_2[\text{PO}_4]_2 \cdot 14\text{H}_2\text{O}$
*Bakhchisaraitsevite	$\text{Na}_2\text{Mg}_5[\text{PO}_4]_4 \cdot 7\text{H}_2\text{O}$
*Apexite	$\text{NaMg}[\text{PO}_4] \cdot 9\text{H}_2\text{O}$
*3.2.4.1.1.1.1.3. Orthophosphato-carbonates	*3.2.4.1.1.1.1.3.1. Hydrates
*Krasnovite	$\text{Ba}(\text{Al}, \text{Mg})[(\text{PO}_4), (\text{CO}_3)](\text{OH})_2 \cdot \text{H}_2\text{O}$
*Parwanite	$(\text{Na}, \text{K})(\text{Mg}, \text{Ca})_4\text{Al}_8(\text{OH})_7[\text{PO}_4]_8[\text{CO}_3] \cdot 30\text{H}_2\text{O}$
3.2.4.1.1.1.1.4. Orthophosphato-sulfates	
3.2.4.1.1.1.1.4.1. Orthophosphato-sulfates with $\text{PO}_4 : \text{SO}_4 = 11$	3.2.4.1.1.1.1.4.1.1. Hydrates (basic)
Sasaite	$\text{Al}_6(\text{OH})_3[\text{PO}_4]_5 \cdot 36\text{H}_2\text{O}$
3.2.4.1.1.1.1.4.2. Orthophosphato-sulfates with $\text{PO}_4 : \text{SO}_4 = 5$	3.2.4.1.1.1.1.4.2.1. Hydrates (basic)
Peisleyite	$\text{Na}_2\text{Al}_9(\text{OH})_6[(\text{P}, \text{S})\text{O}_4]_8 \cdot 28\text{H}_2\text{O}$
3.2.4.1.1.1.1.4.3. Orthophosphato-sulfates with $\text{PO}_4 : \text{SO}_4 = 3$	3.2.4.1.1.1.1.4.3.1. Hydrates (basic)
Kribergite	$\text{Al}_5(\text{OH})_4[\text{PO}_4]_3[\text{SO}_4] \cdot 4\text{H}_2\text{O}$
3.2.4.1.1.1.1.4.4. Orthophosphato-sulfates with $\text{PO}_4 : \text{SO}_4 = 1$ (basic)	
Svanbergite	$\text{SrAl}_3(\text{OH})_6[\text{PO}_4][\text{SO}_4]$
*Woodhouseite	$\text{CaAl}_3(\text{OH})_6[\text{PO}_4][\text{SO}_4]$
*Unnamed (Ba, Ca, K, Na, REE, Sr)(Al, Fe) ₃ (OH, F) ₆ [PO ₄][SO ₄]	3.2.4.1.1.1.1.4.4.1. Hydrates (basic)
Diadochite family	

Sanjuanite	$\text{Al}_2(\text{OH})[\text{PO}_4][\text{SO}_4] \cdot 9\text{H}_2\text{O}$
Diadochite	$\text{Fe}^{3+}_2(\text{OH})[\text{PO}_4][\text{SO}_4] \cdot 6\text{H}_2\text{O}$
*Destinezite	$\text{Fe}^{3+}_2(\text{OH})[\text{PO}_4][\text{SO}_4] \cdot 5\text{H}_2\text{O}$
3.2.4.1.1.1.1.4.5. Orthophosphato-sulfates with $\text{PO}_4 : \text{SO}_4 = 0,(6)$	
	3.2.4.1.1.1.1.1.4.5.1. Hydrates (basic)
Hotsonite	$\text{Al}_5(\text{OH})_{10}[\text{PO}_4][\text{SO}_4] \cdot 8\text{H}_2\text{O}$
*3.2.4.1.1.1.1.1.4.6. Orthophosphato-sulfates with $\text{PO}_4 : \text{SO}_4 = 0,5$	
*Rossiantonite	$\text{Al}_3(\text{OH})_2[\text{PO}_4][\text{SO}_4]_2(\text{H}_2\text{O})_{10} \cdot 4\text{H}_2\text{O}$
3.2.4.1.1.1.1.1.5. Orthophosphato-fluoraluminates	
	3.2.3.1.1.1.1.1.5.1. Neutral
Boggildite	$\text{Na}_2\text{Sr}_2[\text{PO}_4][\text{Al}_2\text{F}_9]$
*3.2.4.1.1.1.1.1.5.2. Orthophosphato-sulfato- fluoraluminates	
*3.2.4.1.1.1.1.1.5.2.1. Hydrates	
Mitryaevaite	$\text{Al}_4[\text{PO}_4]_2[(\text{P},\text{S})\text{O}_3(\text{OH},\text{O})]_2\text{AlF}_2(\text{OH})_2 \cdot 14.5\text{H}_2\text{O}$
*3.2.4.1.1.1.1.1.6. Hydro-orthophosphates	
*3.2.4.1.1.1.1.1.6.1. Hydro-orthophosphates with $[\text{HPO}_4] : [\text{PO}_4] = 0,1(6)$	
	*3.2.4.1.1.1.1.1.6.1.1. Neutral
Whitlockite	$\text{Ca}_9(\text{Mg},\text{Fe}^{2+})[\text{PO}_3\text{OH}][\text{PO}_4]_6$
*Strontiowhitlockite	$\text{Sr}_9\text{Mg}[\text{PO}_3\text{OH}][\text{PO}_4]_6$
*Hedegaardiite	$(\text{Ca},\text{Na})_9(\text{Ca},\text{Na})\text{Mg}[\text{PO}_3\text{OH}][\text{PO}_4]_6$
*Bobdownsite	$\text{Ca}_9\text{Mg}[\text{PO}_3\text{F}][\text{PO}_4]_6$
3.2.4.1.1.1.1.1.6.2. Hydro-orthophosphat- halogenides with $[\text{HPO}_4] : [\text{PO}_4] = 0,(3)$	
	3.2.4.1.1.1.1.1.6.2.1. Hydrates
	3.2.4.1.1.1.1.1.6.2.1.1. Neutral (fluorides)
Mcauslanite	$\text{Fe}^{2+}_3\text{Al}_2\text{F}[\text{HPO}_4][\text{PO}_4]_3 \cdot 18\text{H}_2\text{O}$
*3.2.4.1.1.1.1.1.6.3. Hydro-orthophosphates with $[\text{HPO}_4] : [\text{PO}_4] = 0,5$	
	*3.2.4.1.1.1.1.1.6.3.1. Hydrates (basic)
*Matulaite (x = 2)	$\text{Fe}^{3+}\text{Al}_7(\text{OH})_8[\text{PO}_3\text{OH}]_2[\text{PO}_4]_4 (\text{H}_2\text{O})_8 \cdot 8\text{H}_2\text{O}$
3.2.4.1.1.1.1.1.6.4. Hydro-orthophosphates with $[\text{PO}_3(\text{OH})] : [\text{PO}_4] = 1$	
	3.2.4.1.1.1.1.1.6.4.1. Basic
Crandallite group(x = 2,25)	
Crandallite	$\text{CaAl}_3(\text{OH})_6[\text{PO}_3(\text{OH})][\text{PO}_4]$
*Benaute	$\text{SrFe}^{3+}_3(\text{OH})_6[\text{PO}_3(\text{OH})][\text{PO}_4]$
Lusungite	$\text{SrAl}_3(\text{OH})_6[\text{PO}_3(\text{OH})][\text{PO}_4]$
Gorceixite	$\text{BaAl}_3(\text{OH})_6[\text{PO}_3(\text{OH})][\text{PO}_4]$
	3.2.4.1.1.1.1.1.6.4.2. Hydrates
*Mejillonesite	$\text{NaMg}_2(\text{OH})_4[\text{PO}_3(\text{OH})][\text{PO}_4] \cdot \text{H}_2\text{O}$
*Afmite	$\text{Al}_3(\text{OH})_4[\text{PO}_3(\text{OH})][\text{PO}_4](\text{H}_2\text{O})_3 \cdot 8\text{H}_2\text{O}$
*Planerite	$\text{Al}_6(\text{OH})_8[\text{PO}_3(\text{OH})]_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Iangreyite	$\text{Ca}_2\text{Al}_7(\text{OH},\text{F})_{15}[\text{PO}_3(\text{OH})]_2[\text{PO}_4]_2 \cdot 8\text{H}_2\text{O}$
Hureaulite	$\text{Mn}_5[\text{PO}_3(\text{OH})]_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$

*3.2.4.1.1.1.1.6.5. *Hydro-orthophosphates with $[\text{HPO}_4] : [\text{PO}_4] = 1, (3)$

*Wopmayite $\text{Ca}_6\text{Na}_3\text{Mn}[\text{HPO}_4]_4[\text{PO}_4]_3$

*3.2.4.1.1.1.1.6.6. Hydro-orthophosphates with $[\text{HPO}_4] : [\text{PO}_4] = 2$

*Grotoite $\text{NaCaMn}^{2+}_2[\text{PO}_3(\text{OH})]_2[\text{PO}_4]$

3.2.4.1.1.1.1.6.7. Hydro-orthophosphates with $[\text{HPO}_4] : [\text{PO}_4] = 3$

3.2.4.1.1.1.1.6.7.1. Hydrates

Francoanellite $\text{K}_3\text{Al}_5[\text{HPO}_4]_6[\text{PO}_4]_2 \cdot 12\text{H}_2\text{O}$

Taranakite $\text{K}_3\text{Al}_5[\text{HPO}_4]_6[\text{PO}_4]_2 \cdot 18\text{H}_2\text{O}$

*3.2.4.1.1.1.1.6.8. Hydro-orthophosphato-carbonates with $[\text{HPO}_4] : [\text{PO}_4] = 0, (3)$

*Phosphoellenbergerite $\text{Mg}_{14}[\text{PO}_4]_6[(\text{HPO}_4), (\text{CO}_3)]_2(\text{OH})_6$

3.2.4.1.1.1.1.7. Hydrophosphates

3.2.4.1.1.1.1.7.1. Neutral (all with $\text{MO} : \text{HPO}_4 = 1$)

Monetite family

Monetite $\text{Ca}[\text{HPO}_4]$

Nahpoite $\text{Na}_2[\text{HPO}_4]$

Phosphammite $(\text{NH}_4)_2[\text{HPO}_4]$

3.2.4.1.1.1.1.7.2. Hydrates

3.2.4.1.1.1.1.7.2.1. Basic

Sinkankasite $\text{MnAl}(\text{OH})[\text{HPO}_4]_2 \cdot 6\text{H}_2\text{O}$

3.2.4.1.1.1.1.7.2.2. Neutral

Newberyite family

Newberyite $\text{Mg}[\text{HPO}_4] \cdot 3\text{H}_2\text{O}$

Phosphorösslerite $\text{Mg}[\text{HPO}_4] \cdot 7\text{H}_2\text{O}$

Brushite $\text{Ca}[\text{HPO}_4] \cdot 2\text{H}_2\text{O}$

Dorfmanite $\text{Na}_2[\text{HPO}_4] \cdot 2\text{H}_2\text{O}$

*Catalanoite $\text{Na}_2[\text{HPO}_4] \cdot 8\text{H}_2\text{O}$

Hannayite family

Hannayite $(\text{NH}_4)_2\text{Mg}_3[\text{HPO}_4]_4 \cdot 8\text{H}_2\text{O}$

Schertelite $(\text{NH}_4)_2\text{Mg}[\text{HPO}_4]_2 \cdot 4\text{H}_2\text{O}$

Mundrabillaite $(\text{NH}_4)_2\text{Ca}[\text{HPO}_4]_2 \cdot \text{H}_2\text{O}$

*Swaknoite $(\text{NH}_4)_2\text{Ca}[\text{HPO}_4]_2 \cdot \text{H}_2\text{O}$

Stercorite $(\text{NH}_4)\text{Na}[\text{HPO}_4] \cdot 4\text{H}_2\text{O}$

3.2.4.1.1.1.1.8. Hydrophosphato-sulfates

3.2.4.1.1.1.1.8.1. Hydrates

Ardealite $\text{Ca}_2[\text{HPO}_4][\text{SO}_4] \cdot 4\text{H}_2\text{O}$

*Camaronesite $[\text{Fe}^{3+}(\text{H}_2\text{O})_2(\text{PO}_3\text{OH})]_2[\text{SO}_4] \cdot 1-2\text{H}_2\text{O}$

*3.2.4.1.1.1.1.9. Hydro-dihydrophosphates *3.2.4.1.1.1.1.9.1. Hydrates

*Haigerachite $\text{KFe}^{3+}_3[\text{H}_2\text{PO}_4]_6[\text{HPO}_4]_2 \cdot 4\text{H}_2\text{O}$

*Unnamed $\text{KFe}^{3+}_3[\text{H}_2\text{PO}_4]_2[\text{HPO}_4]_4 \cdot 6\text{H}_2\text{O}$

3.2.4.1.1.1.1.10. Dihydrophosphates 3.2.4.1.1.1.1.10.1. Neutral

Biphosphammite group

Archerite $(\text{K}, \text{NH}_4)[\text{H}_2\text{PO}_4]$

Biphosphammitte $(\text{NH}_4, \text{K})[\text{H}_2\text{PO}_4]$

3.2.4.1.1.1.2. Orthophosphates of Li

3.2.4.1.1.1.2.1. Proper orthophosphates 3.2.4.1.1.1.2.1.1. Neutral ($x = 1, 5$)**Sicklerite** series

Ferrisicklerite $\text{Li}_{1-x}(\text{Fe}, \text{Mn})[\text{PO}_4]$

Sicklerite $\text{Li}_{1-x}(\text{Mn}, \text{Fe})[\text{PO}_4]$

Triphylite series

Triphylite $\text{LiFe}^{2+}[\text{PO}_4]$

Lithiophilite $\text{LiMn}^{2+}[\text{PO}_4]$

*Simferite $\text{Li}(\text{MgMn}^{3+}_{0.4}\text{Fe}^{3+}_{0.6})_{\Sigma 2}[\text{PO}_4]_2$

Lithiophosphate $\text{Li}_3[\text{PO}_4]$

*Nalipoite $\text{Li}_2\text{Na}[\text{PO}_4]$

3.2.4.1.1.1.2.1.2. Basic

Griphite ($x = 1, (6)$) $\text{Ca}(\text{Mn}^{2+}, \text{Na}, \text{Li})_6\text{Fe}^{2+}\text{Al}_2(\text{F}, \text{OH})_2[\text{PO}_4]_6$

Palermoite series ($x = 2$)

Bertossaite $(\text{Li}, \text{Na})_2\text{CaAl}_4(\text{OH}, \text{F})_4[\text{PO}_4]_4$

Palermoite $(\text{Li}, \text{Na})_2(\text{Sr}, \text{Ca})\text{Al}_4(\text{OH})_4[\text{PO}_4]_4$

Amblygonite family ($x = 2$)**Amblygonite** series

Amblygonite $(\text{Li}, \text{Na})\text{Al}(\text{F}, \text{OH})[\text{PO}_4]$

Montebrasite $\text{LiAl}(\text{OH})[\text{PO}_4]$

Tavorite $\text{LiFe}^{3+}(\text{OH})[\text{PO}_4]$

3.2.4.1.1.1.2.2. Hydrophosphato-phosphates Li

3.2.4.1.1.1.2.2.1. Basic

Tancoite $\text{Na}_2\text{LiAl}(\text{OH})[\text{HPO}_4][\text{PO}_4]$

*3.2.4.1.1.1.2.3. Phosphato-carbonates

*3.2.4.1.1.1.2.3.1. Basic

*Peatite-(Y) $\text{LiNa}_3(\text{Y}, \text{Na}, \text{Ca}, \text{HREE})_3[\text{PO}_4]_3[\text{CO}_3](\text{F}, \text{OH})_2$

*Ramikite-(Y) $\text{Li}_2\text{Na}_6(\text{Y}, \text{Ca}, \text{REE})_3\text{Zr}_3[\text{PO}_4]_6[\text{CO}_3]_2\text{O}_2(\text{OH}, \text{F})_2$

3.2.4.1.1.1.3. Phosphates of Be → berylllophosphates

3.2.4.1.1.1.3.1. Proper phosphates → berylllophosphates

3.2.4.1.1.1.3.1.1. Neutral ($x = 1, 5$)

Beryllonite $\text{Na}[\text{Be}(\text{PO}_4)]^{\infty}$

Hurlbutite $\text{CaBe}_2[\text{PO}_4]_2 \rightarrow \text{Ca}[\text{Be}_2\text{O}(\text{P}_2\text{O}_7)]^{\infty 3}$

*Stronriohurlbutite $\text{SrBe}_2[\text{PO}_4]_2$

Pahasapaite $(\text{Ca}_{5,5}\text{Li}_{3,6}\text{K}_{1,2}\text{Na}_{0,2}\square_{13,5})\{\text{Li}_8[\text{Be}_{24}(\text{PO}_4)_{24}]^{\infty 3}\}_3^{\infty 3}(\text{H}_2\text{O})_{38}$

3.2.4.1.1.1.3.1.2. Basic ($x = 2$)

Babefphite $\text{Ba}(\text{O}, \text{F})[\text{Be}(\text{PO}_4)]^{\infty 3}$

3.2.4.1.1.1.3.1.3. Acid ($x = 2$)**Herderite** series

Väyrynenite $\text{Mn}[\text{Be}(\text{OH})(\text{PO}_4)]^{\infty 2}$

Hydroxyl-herderite $\text{Ca}[\text{Be}(\text{OH})(\text{PO}_4)]^{\infty 2}$

Fluorherderite $\text{Ca}[\text{Be}(\text{F}, \text{OH})(\text{PO}_4)]^{\infty 2}$

*Herderite $\text{CaBeF}[\text{PO}_4]$

3.2.4.1.1.1.3.1.4. Hydrates

- *Faheyite $\text{MnFe}^{3+}_2\text{Be}_2[\text{PO}_4]_4 \cdot 6\text{H}_2\text{O}$
3.2.4.1.1.1.3.1.4.1. Hydrates (acid)
- Moraesite family**
Moraesite $\text{Be}_2(\text{OH})[\text{PO}_4] \cdot 4\text{H}_2\text{O} \rightarrow$
 $\rightarrow \text{Be}(\text{H}_2\text{O})_4[\text{Be}(\text{OH})(\text{PO}_4)]$
- *Weinebeneite $\text{CaBe}_3(\text{OH})_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O} \rightarrow$
 $\rightarrow \text{CaBe}(\text{H}_2\text{O})_4[\text{Be}(\text{OH})(\text{PO}_4)]_2^\infty$
- Uralolite $\text{Ca}_2\text{Be}_4(\text{OH})_3[\text{PO}_4]_3 \cdot 5\text{H}_2\text{O}$
- Roscherite family**
Zanazziite ($x = 1, 8(3)$) $\text{Ca}_2(\text{Mg}, \text{Fe}^{2+})(\text{Mg}, \text{Fe}^{2+}, \text{Al})_4(\text{OH})_4\text{Be}_4[\text{PO}_4]_6 \cdot 6\text{H}_2\text{O}$
- *Atencioite $\text{Ca}_2\text{Fe}^{2+}\square\text{Mg}_2\text{Fe}^{2+}_2(\text{OH})_4\text{Be}_4[\text{PO}_4]_6 \cdot 6\text{H}_2\text{O}$
- *Footemineite $\text{Ca}_2\text{Mn}^{2+}\square\text{Mn}^{2+}_2\text{Mn}^{2+}_2(\text{OH})_4\text{Be}_4[\text{PO}_4]_6 \cdot 6\text{H}_2\text{O}$
- *Greifensteinite $\text{Ca}_2(\text{Fe}^{2+}, \text{Mn}^{2+})_5(\text{OH})_4\text{Be}_4[\text{PO}_4]_6 \cdot 6\text{H}_2\text{O}$
- Roscherite ($x = 2$) $\text{Ca}_2\text{Mn}_5^{2+}\text{Be}_4(\text{OH})_4[\text{PO}_4]_6 \cdot 6\text{H}_2\text{O}$
- *Ruifrancoite $\text{Ca}_2\square_2(\text{Fe}^{3+}, \text{Mn}^{2+}, \text{Mg})_4(\text{OH})_4(\text{OH}, \text{H}_2\text{O})_2\text{Be}_4[\text{PO}_4]_6 \cdot 4\text{H}_2\text{O}$
- *Gimaräesite $\text{Ca}_2(\text{Zn}, \text{Mg}, \text{Fe})_5(\text{OH})_4\text{Be}_4[\text{PO}_4]_6 \cdot 6\text{H}_2\text{O}$
- 3.2.4.1.1.1.3.2. Hydrophosphato-orthophosphates \rightarrow beryllphosphato-hydrophosphates
(?) 3.2.4.1.1.1.3.2.1. Hydrates
- Fransoletite family**
Fransoletite $\text{Ca}_3\text{Be}_2[\text{HPO}_4]_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O} \rightarrow \text{Ca}_3[\text{HPO}_4]_2[\text{BePO}_4]_2 \cdot 4\text{H}_2\text{O}$
- *Parafransoletite $\text{Ca}_3\text{Be}_2[\text{PO}_3(\text{OH})]_2[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
- Ehrleite $\text{Ca}_2\text{ZnBe}[\text{PO}_3\text{OH}][\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
- 3.2.4.1.1.3.3. Beryllphosphates with unknown structure
3.2.4.1.1.1.3.3.1. Hydrates
- Tiptopite ($x = 2$) $^*\text{K}_2\text{Na}_3\text{Li}_3(\text{OH})_2\text{Be}_6[\text{PO}_4]_6 \cdot \text{H}_2\text{O}$
- Glucine ($x = 2, 5$) $\text{Ca}(\text{OH})_4\text{Be}_4[\text{PO}_4]_2 \cdot 0,5\text{H}_2\text{O}$
- 3.2.4.1.1.2. Phosphates of *f*-elements
3.2.4.1.1.2.1. Proper phosphates 3.2.4.1.1.2.1.1. Neutral ($x = 1, 5$)
- Monazite family**
Monazite series
Monazite-(Ce) $\text{Ce}[\text{PO}_4]$
Monazite-(La) $\text{La}[\text{PO}_4]$
Monazite-(Nd) $\text{Nd}[\text{PO}_4]$
*Монацит-(Sm) $\text{Sm}[\text{PO}_4]$
Cheralite $\text{CaTh}[\text{PO}_4]_2$
Xenotime-(Y) $\text{Y}[\text{PO}_4]$
*Xenotime-(Yb) $\text{Yb}[\text{PO}_4]$
Vitusite-(Ce) $\text{Na}_3\text{Ce}[\text{PO}_4]_2$
*Stornesite-(Y) $\text{Y}\square_2\text{Na}_6(\text{Ca}_5\text{Na}_3)(\text{Mg}, \text{Fe})_{43}[\text{PO}_4]_{36}$
*Deloneite-(Ce) $(\text{Na}_{0,5}\text{REE}_{0,25}\text{Ca}_{0,25})(\text{Ca}_{0,75}\text{REE}_{0,25})\text{Sr}_{1,5}(\text{CaNa}_{0,25}\text{REE}_{0,25})$
 $[\text{PO}_4]_{30,5}(\text{F}, \text{OH})$
- *Karlgezikeite-(Nd) $\text{NaNdCa}_3[\text{PO}_4]_3\text{F}$
- Florencite group** 3.2.4.1.1.2.1.2. Basic ($x = 1, 5$)
Florencite-(Ce) $\text{CeAl}_3(\text{OH})_6[\text{PO}_4]_2$
Florencite-(La) $\text{LaAl}_3(\text{OH})_6[\text{PO}_4]_2$
Florencite-(Nd) $\text{NdAl}_3(\text{OH})_6[\text{PO}_4]_2$
*Florencite-(Sm) $(\text{Sm}, \text{Nd})\text{Al}_3(\text{OH})_6[\text{PO}_4]_2$

Eylettersite	$\text{Th}_{0.75}\text{Al}_3(\text{OH})_6[\text{PO}_4]_2$
	3.2.4.1.1.2.1.3. Hydrates(basic)
Vyacheslavite family (x = 2)	
Vyacheslavite	$\text{U}^{4+}(\text{OH})[\text{PO}_4] \cdot n\text{H}_2\text{O}$
Lermontovite	$\text{U}^{4+}(\text{OH})[\text{PO}_4] \cdot \text{H}_2\text{O}$
	3.2.4.1.1.2.1.3.2. Neutral
Rhabdophane group (x = 1,5)	
Rhabdophane -(Ce)	$\text{Ce}[\text{PO}_4] \cdot \text{H}_2\text{O}$
Rhabdophane -(La)	$\text{La}[\text{PO}_4] \cdot \text{H}_2\text{O}$
Rhabdophane -(Nd)	$\text{Nd}[\text{PO}_4] \cdot \text{H}_2\text{O}$
Rhabdophane-(Y)	$\text{Y}[\text{PO}_4] \cdot \text{H}_2\text{O}$
Grayite	$(\text{Th}, \text{Pb}, \text{Ca})[\text{PO}_4] \cdot \text{H}_2\text{O}$
Brockite	$(\text{Ca}, \text{Th}, \text{Ce}^{3+})[\text{PO}_4] \cdot \text{H}_2\text{O}$
Tristramite	$(\text{Ca}, \text{U}^{4+}, \text{Fe}^{3+})[(\text{PO}_4), (\text{SO}_4)] \cdot 2\text{H}_2\text{O}$
Ningyoite	$(\text{U}^{4+}, \text{Ca}_2[\text{PO}_4]_2) \cdot 1-2\text{H}_2\text{O}$
Churchite-(Y)	$\text{Y}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
Churchite-(Nd)	$\text{Nd}[\text{PO}_4] \cdot 2\text{H}_2\text{O}$
3.2.4.1.2. Subclass: Phosphates of cations with middle FC	
3.2.4.1.2.1. Phosphates of Zr	
3.2.4.1.2.1.1. Proper phosphates	
	3.2.4.1.2.1.1.1. Neutral (x = 1,5)
*Kosnarite	$\text{KZr}_2[\text{PO}_4]_3$
	*3.2.4.1.2.1.1.1.1. Hydrates
Gainesite	$\text{Na}_2\text{Zr}_2\text{Be}[\text{PO}_4]_4 \cdot 1,5\text{H}_2\text{O}$
*Zigrasite	$\text{MgZr}[\text{PO}_4]_2(\text{H}_2\text{O})_4$
*Mahlmoodyite	$\text{FeZr}[\text{PO}_4]_2 \cdot 4\text{H}_2\text{O}$
*McCrillsite	$\text{NaCsZr}_2(\text{Be}, \text{Li})[\text{PO}_4]_4 \cdot 1-2\text{H}_2\text{O}$
*Selwynite	$\text{NaKZr}_2(\text{Be}, \text{Al})[\text{PO}_4]_4 \cdot 2\text{H}_2\text{O}$
	*3.2.4.1.2.1.1.1.2. Hydrates (basic)
*Wycheproofite	$\text{NaAlZr}(\text{OH})_2[\text{PO}_4]_2 \cdot \text{H}_2\text{O}$
3.2.4.1.2.1.2. Phosphato-carbonates	
	3.2.4.1.2.1.2.1. Hydrates (basic)
Voggite	$\text{Na}_2\text{Zr}(\text{OH})[\text{PO}_4][\text{CO}_3] \cdot 2\text{H}_2\text{O}$
3.2.4.1.2.3. Phosphates of Ti	
	3.2.4.1.2.3.1. Basic
Curetonite	$\text{Ba}_4\text{Al}_3\text{Ti}(\text{O}, \text{OH})_4\text{F}[\text{PO}_4]_4$
	3.2.4.1.2.3.1.1. Hydrates (basic)
Mantienneite group	
Mantienneite	$\text{KMg}_2\text{Al}_2\text{Ti}^{4+}(\text{OH})_3[\text{PO}_4]_4 \cdot 15\text{H}_2\text{O}$
Paulkerrite	$\text{K}(\text{Mg}, \text{Mn})_2(\text{Fe}^{3+}, \text{Al})_2\text{Ti}^{4+}(\text{OH})_3[\text{PO}_4]_4 \cdot 15\text{H}_2\text{O}$
*Benyacarite	$(\text{H}_2\text{O}, \text{K})_2\text{Ti}(\text{Mn}, \text{Fe})^{2+}_2(\text{Fe}^{3+}, \text{Ti})_2[\text{PO}_4]_4(\text{O}, \text{F})_2 \cdot 14\text{H}_2\text{O}$
*3.2.4.1.2.3.2. Titano-(niobo)-oxido-dihydrophosphates	
*Tazzoliite	$\text{Ba}_{4-x}\text{Na}_x\text{Ti}_2\text{Nb}_3\text{SiO}_{17}[\text{PO}_2(\text{OH})_2]_x(\text{OH})_{1-2x}; (0 \leq x \leq 0.5)$
3.2.4.1.2.4. Phosphates of Nb and Ta	
	3.2.4.1.2.4.1. Oxido-hydrates
Olmsteadite group	
Olmsteadite	$\text{KFe}^{2+}_2(\text{Nb}, \text{Ta})\text{O}_2[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$
Johnwalkite	$\text{K}(\text{Mn}, \text{Fe}^{3+})_2(\text{Nb}, \text{Ta})\text{O}_2[\text{PO}_4]_2 \cdot 2(\text{H}_2\text{O}, \text{OH})$

- 3.2.4.1.2.5. Phosphates of V^{4+} 3.2.4.1.2.5.1 Oxido-hydrates
 Sincosite $Ca(V^{4+}O)_2[PO_4]_2 \cdot 5H_2O$
 *Bariosincosite $Ba(V^{4+}O)_2[PO_4]_2 \cdot 4H_2O$
 *Cloncurryite $Cu^{2+}V^{4+}Al_4OF_4[PO_4]_4 \cdot 10H_2O$
- 3.2.4.1.3. Subclass: Orthophosphates of chalcophylic elements
 3.2.4.1.3.1. Orthophosphates of Cu
 3.2.4.1.3.1.1. M^{2+}
 3.2.4.1.3.1.1.1. Proper phosphates 3.2.4.1.3.1.1.1.1. Hydrates
 (basic and phosphato-halogenides)
 Nissonite ($x=2$) $Cu_2Mg_2(OH)_2[PO_4]_2 \cdot 5H_2O$
- 3.2.4.1.3.1.2. M^{2+} and M^{3+}
 3.2.4.1.3.1.2.1. Proper phosphates 3.2.4.1.3.1.2.1.1. Основные
 Hentschelite ($x=1,5$) (comp. with lazulite (gr.)) $Cu^{2+}Fe^{3+}_2(OH)_2[PO_4]_2$
 *Zincolibethenite $CuZn(OH)[PO_4]$
 Libethenite $Cu_2(OH)[PO_4]$
 Pseudomalachite $Cu_5(OH)_4[PO_4]_2$
 Reichenbachite $Cu_5(OH)_4[PO_4]_2$
 Ludjibaite $Cu_5(OH)_4[PO_4]_2$
 Cornetite $Cu_3(OH)_3[PO_4]$
 3.2.4.1.3.1.2.1.2. Hydrates (basic)
 *Kunatite $Cu^{2+}Fe^{3+}_2(OH)_2[PO_4]_2 \cdot 4H_2O$
 Petersite-(Y) ($x=2,5$) (comp. with mixite (gr.)) $Cu^{2+}_6(Y,Ce,Nd,Ca)(OH)_6[PO_4]_3 \cdot 3H_2O$
Turquoise series ($x=2,5$) (compare with wardire (family); faustite (series)
 Coeruleolactite $(Ca,Cu)Al_6(OH)_8[PO_4]_4 \cdot (4-5)H_2O$
 Turquoise $CuAl_6(OH)_8[PO_4]_4 \cdot 4H_2O$
 Chalcosiderite $CuFe^{3+}_6(OH)_8[PO_4]_4 \cdot 4H_2O$
 *Bleasdaleite $(Ca,Fe^{3+})_2Cu_5(Bi,Cu)[PO_4]_4 \cdot (H_2O,OH,Cl)_{13}$
 Zapatalite ($x=3$) $Cu_3Al_4(OH)_9[PO_4]_3 \cdot 4H_2O$
 Sieleckiite ($x=4,5$) $Cu_3Al_4(OH)_{12}[PO_4]_2 \cdot 2H_2O$
- *3.2.4.1.3.1.2. Hydro-orthophosphates
 *Calciopetersite $CaCu^{2+}_6(OH)_6[PO_3OH][(PO_4)_2 \cdot 3H_2O]$
- *3.2.4.1.3.1.2.3. Phosphato-oxides *3.2.4.1.3.1.2.3.1. Hydrates
 *Mrázekite $Cu^{2+}_3Bi^{3+}_2(OH)_2O_2[PO_4]_2 \cdot 2H_2O$
- 3.2.4.1.3.1.2.4. Phosphato-sulfates
 *Birchite $Cd_2Cu_2[PO_4]_2[SO_4] \cdot 2H_2O$
- *3.2.4.1.3.1.2.5. Phosphato -halogenides *3.2.4.1.3.1.2.5.1. Hydrates
 *Goldquarryite $(Cu^{2+}, \square)(Cd,Ca)_2Al_3[PO_4]_4F_2(H_2O)_{10}\{(H_2O),F\}_2$
 *Nevadaite $(Cu^{2+} \square AlV^{3+})_{\Sigma 6}\{Al_8[PO_4]_8F_8\}(OH)_2(H_2O)_{22}$
- 3.2.4.1.3.1.3. M^+ and M^{2+}
 3.2.4.1.3.1.3.1. Phosphato-halogenides 3.2.4.1.3.1.3.1.1. Hydrates (basic)
 Sampleite ($x = 1,625$) $NaCaCu_5Cl[PO_4]_4 \cdot 5H_2O$

3.2.4.1.3.2. Orthophosphates of Zn^{2+}

3.2.4.1.3.2.1. Proper phosphates

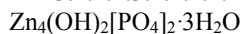
Tarbutite ($x = 2$)

3.2.4.1.3.2.1.1. Basic

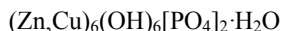


3.2.4.1.3.2.1.2. Hydrates

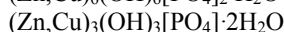
3.2.4.1.3.2.1.2.1. Basic

Spencerite ($x = 2$)**Kipushite** family ($x = 3$)

Kipushite



Veszelyite

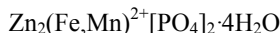


3.2.4.1.3.2.1.2. Neutral

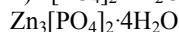
3.2.4.1.3.2.1.2.1. Hydrates

Hopeite family ($x = 1,5$)

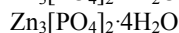
Phosphophyllite



Hopeite



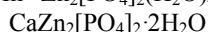
Parahopeite



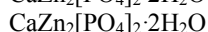
*Nizamoffite



Scholzite

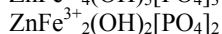


Parascholzite

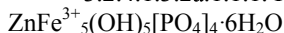
3.2.4.1.3.2a. M^{2+} and M^{3+}

3.2.4.1.3.2a.1. Proper phosphates

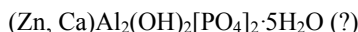
3.2.4.1.3.2a.1.1. Basic

*Plimerite ($x = 2,3$)*Zinclipscornbite ($x = 2$)

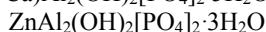
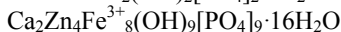
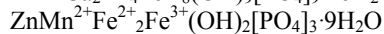
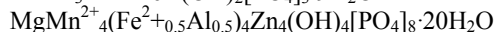
3.2.4.1.3.2a.1.1.1. Hydrates

*Zincoberaunite ($x = 2,125$)**Kleemanite** family ($x = 2$)

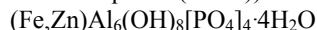
Kehoeite



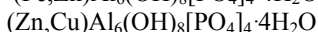
Kleemanite

Jungite ($x=2$)Schoonerite ($x = 1,8(3)$)*Flurlite ($x = 1,8(3)$)*Ferraioloite ($x = 1,75$)**Faustite** series ($x = 2,5$) (compare with turquoise (series))

Aheylite



Faustite



*3.2.4.1.3.2a.2. Phosphato-carbonates

*3.2.4.1.3.2a.2.1. Hydrates(basic)

*Scorpionite



3.2.4.1.3.3. Phosphates of Pb

3.2.4.1.3.3.1. Proper phosphates and phosphato-halogenides

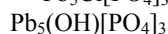
3.2.4.1.3.3.1.1. Basic and phosphato-halogenides

Pyromorphite series ($x = 1,(6)$) (compare with apatite (family); mimetite (group))

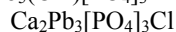
Pyromorphite



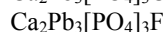
Hydroxylpyromorphite



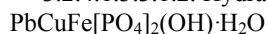
*Phosphohedyphane



*Fluorophosphohedyphane



*3.2.4.1.3.3.1.2. Hydrates (basic)

*Phosphogartrellite ($x = 1,5$)*Kintoreite ($x = 2$)

*Pattersonite $\text{PbFe}_3[\text{PO}_4]_2(\text{OH})_5 \cdot \text{H}_2\text{O}$

3.2.4.1.3.3.2. Hydrophoshato-phosphates

3.2.4.1.3.3.2.1. Basic

Drugmanite ($x=1,75$) $\text{Pb}_2(\text{Fe}^{3+}, \text{Al})(\text{OH})_2[\text{PO}_3(\text{OH})][\text{PO}_4]$
 Plumbogummite ($x=2,75$) $\text{PbAl}_3(\text{OH})_6[\text{PO}_3(\text{OH})][\text{PO}_4]$

3.2.4.1.3.3.3. Hydrophoshato-phosphato-sulfates

3.2.4.1.3.3.3.1. Hydrates (basic)

Orpheite ($x=2,35$) discredited

3.2.4.1.3.3.4. Phosphato-sulfates

3.2.4.1.3.3.4.1. Basic

Tsumebite ($x=1,5$) $\text{Pb}_2\text{Cu}(\text{OH})[\text{PO}_4][\text{SO}_4]$
Hinsdalite group ($x=2,75$) (compare with beudantite (group))
 Hinsdalite $(\text{Pb}, \text{Sr})\text{Al}_3(\text{OH})_6[\text{PO}_4][\text{SO}_4]$
 Corkite $\text{PbFe}^{3+}_3(\text{OH})_6[\text{PO}_4][\text{SO}_4]$

3.2.4.1.3.3.5. Phosphato-chromates

3.2.4.1.3.3.5.1. Basic

Vauquelinite ($x=1,25$) $\text{Pb}_2\text{Cu}(\text{OH})[\text{PO}_4][\text{CrO}_4]$
 Embreyite ($x=1,25$) $\text{Pb}_5[\text{PO}_4]_2[\text{CrO}_4]_2 \cdot \text{H}_2\text{O}$

*3.2.4.1.3.3.6. Phosphato-vanadates

*3.2.4.1.3.3.6.1. Basic

*Bushmakinite $\text{Pb}_2\text{Al}(\text{OH})[\text{PO}_4][\text{VO}_4]$
 *Ferribushmakinite $\text{Pb}_2\text{Fe}^{3+}(\text{OH})[\text{PO}_4][\text{VO}_4]$

*3.2.4.1.3.4. Phosphates of Hg

*3.2.4.1.3.4.1. Proper phosphates

3.2.4.1.3.4.1.1. Basic

*Artsmithite $\text{Hg}_4\text{Al}(\text{OH})_{1+3x}[\text{PO}_4]_{2-x} \quad x = 0,26$

3.2.4.1.3.5. Phosphates of Va-cations (Bi^{3+})

3.2.4.1.3.5.1. Neutral

Ximengite ($x=1,5$) BiPO_4

3.2.4.1.3.4.2. Oxido-hydroxido-phosphates

3.2.4.1.3.5.2.1. Basic

Paulkellerite ($x=4,5$) $\text{Bi}_2\text{Fe}^{3+}(\text{OH})_2\text{O}_2[\text{PO}_4]$
 *Brendelite $(\text{Bi}, \text{Pb})_2\text{Fe}^{3+}(\text{OH})\text{O}_2[\text{PO}_4]$
 *Petitjeanite $\text{Bi}^{3+}_3\text{O}(\text{OH})[\text{PO}_4]_2$
 *Smrkovecité $\text{Bi}_2\text{O}(\text{OH})[\text{PO}_4]$
Waylandite family ($x=3$)
 Zairite $\text{BiFe}^{3+}_3(\text{OH})_6[\text{PO}_4]_2$
 Waylandite $\text{BiAl}_3(\text{OH})_6[\text{PO}_4]_2$
 Hydroxylphosphabismite $\text{Bi}_2(\text{OH})_3[\text{PO}_4]$

*3.2.4.1.3.4.2.2. Hydrates

*Mrázekite $\text{Bi}_2\text{Cu}^{2+}_3(\text{OH})_2\text{O}_2[\text{PO}_4]_2 \cdot 2\text{H}_2\text{O}$

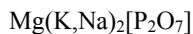
*3.2.4.2. Quasiclass: Pyrophosphates

*3.2.4.2.1. Subclass: Pyrophosphates of s -, d_s - and p_s - cations

*3.2.4.2.1.1. Pyrophosphates of *s*-, *d*_s- and *p*_s- cations without Li and Be

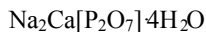
*3.2.4.2.1.1.1. Proper pyrophosphates

*Pyrocoprite

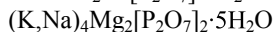


*3.2.4.2.1.1.1.1. Hydrates

Canaphite



*Arnhemite



*3.2.4.2.2. Subclass: Pyrophosphates of chalcophylic elements

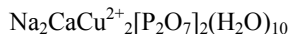
*3.2.4.2.2.1. Pyrophosphates of Cu

*3.2.4.2.2.1.1. M^+ и M^{2+}

*3.2.4.2.2.1.1.1. Proper pyrophosphates

*3.2.4.2.2.1.1.1.1. Hydrates

*Wooldridgeite



*3.2.4.3. Quasiclass: Triphosphates

*3.2.4.3.1. Subclass: Triphosphates of cations with low FC

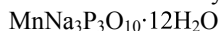
*3.2.4.3.1.1. Triphosphates *s*-, *d*_s- and *p*_s- cations

*3.2.4.3.1.1.1. Triphosphates *s*-, *d*_s- and *p*_s- cations without Li and Be

*3.2.4.3.1.1.1.1. Proper triphosphates

*3.2.4.3.1.1.1.1.1. Hydrates

*Kanonerovite



3.2.4a. Class: Arsenates

3.2.4a.1. Quasiclass: (6)-Arsenates

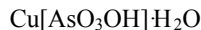
3.2.4a.1.1. (6)-Arsenates of *d*- cations

3.2.4a.1.1.1. (6)-Arsenates of Cu^{2+}

3.2.4a.1.1.1.1. Oxido-(6)-arsenates $x = \text{MO}/[\text{AsO}_4]$

3.2.4a.1.1.1.1.1. Hydrates

Geminite



3.2.4a.1.2. (6)-Arsenates of *p*-cations

3.2.4a.1.2.1. (6)-Arsenates of Pb^{2+}

3.2.4a.1.2.1.1. Neutral

Ludlockite



3.2.4a.2. Quasiclass: (4)-Arsenates (orthoarsenates)

3.2.4a.2.1. Orthoarsenates of cations with low FC

3.2.4a.2.1.1. Orthoarsenates of *s*-, *d*_s- and *p*_s- cations

3.2.4a.2.1.1.1. Orthoarsenates of *s*-, *d*_s- and *p*_s- cations without Li and Be

3.2.4a.2.1.1.1.1. Proper orthoarsenates

3.2.4a.2.1.1.1.1.1. Neutral

*Alarsite



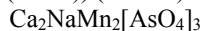
Xanthiosite



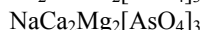
Berzeliite family

Berzeliite series (compare with garnet (series)) ($x = 1.5$)

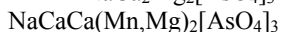
Manganberzeliite



Berzeliite



Caryinite ($x = 1.5$)

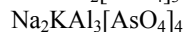


(compare with alluaudite (family))

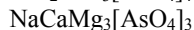
*Arseniopleite ($x = 1.5$)



*Ozerovaite ($x = 1.5$)



*Calciojohillerite ($x = 1.5$)



*Badalovite (x = 1.5)	$\text{Na}_2\text{Mg}_2\text{Fe}^{3+}[\text{AsO}_4]_3$
*Yurmarinite (x = 1.6)	$\text{Na}_7(\text{Fe}^{3+}, \text{Mg}, \text{Cu})_4[\text{AsO}_4]_6$
*Anatolyite (x = 2)	$\text{Na}_6(\text{Ca}, \text{Na})(\text{Mg}, \text{Fe}^{3+})_3\text{Al}[\text{AsO}_4]_6$
*Magnesiohatertite (x = 2.2)	$(\text{Na}, \text{Ca})_2\text{Ca}(\text{Mg}, \text{Fe}^{3+})_2[\text{AsO}_4]_3$

3.2.4a.2.1.1.1.1.1. Hydrates

Scorodite series

Mansfieldite	$\text{Al}[\text{AsO}_4] \cdot 2\text{H}_2\text{O}$
Scorodite	$\text{Fe}^{3+}[\text{AsO}_4] \cdot 2\text{H}_2\text{O}$
Kankite	$\text{Fe}^{3+}[\text{AsO}_4] \cdot 3.5\text{H}_2\text{O}$
Grischunite	$\text{NaCa}_2\text{Mn}^{2+}_5\text{Fe}^{3+}[\text{AsO}_4]_6 \cdot 2\text{H}_2\text{O}$
Sterlinghillite	$\text{Mn}_3[\text{AsO}_4]_2 \cdot 3\text{H}_2\text{O}$
*Parascorodite	$\text{Fe}^{3+}[\text{AsO}_4] \cdot 2\text{H}_2\text{O}$
*Yazganite	$\text{NaFe}^{3+}_2\text{Mg}[\text{AsO}_4]_3 \cdot \text{H}_2\text{O}$

Erythrite family**Erythrite series (compare with vivianite (group))**

Hörnesite	$\text{Mg}_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$
Annabergite	$\text{Ni}_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$
Erythrite	$\text{Co}_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$
Manganese-hörnesite	$(\text{Mn}, \text{Mg})_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$
*Castellarosite	$\text{Mn}^{2+}_3[\text{AsO}_4]_2 \cdot 4.5\text{H}_2\text{O}$
Parasymplesite	$\text{Fe}^{2+}_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$
Symplesite	$\text{Fe}^{2+}_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$
Rauenthalite	$\text{Ca}_3[\text{AsO}_4]_2 \cdot 10\text{H}_2\text{O}$
Phaouxite	$\text{Ca}_3[\text{AsO}_4]_2 \cdot 11\text{H}_2\text{O}$

Roselite family**Roselite series**

Wendwilsonite	$\text{Ca}_2\text{Mg}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Roselite	$\text{Ca}_2\text{Co}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Zincroselite	$\text{Ca}_2\text{Zn}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Gaitite	$\text{Ca}_2\text{Zn}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Brandtite	$\text{Ca}_2\text{Mn}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Parabrandtite	$\text{Ca}_2\text{Mn}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$

Talmessite series

Talmessite	$\text{Ca}_2\text{Mg}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
*Nickeltalmessite	$\text{Ca}_2\text{Ni}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Roselite-bera = betaroselite	$\text{Ca}_2\text{Co}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
Smolianinovite (x = 1,5)	$(\text{Co}, \text{Ni}, \text{Mg}, \text{Ca})_3(\text{Fe}^{3+}, \text{Al})_2[\text{AsO}_4]_4 \cdot 11\text{H}_2\text{O}$

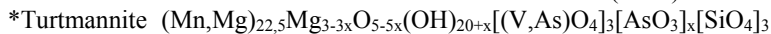
3.2.4a.2.1.1.1.1. Basic

Johnbaumite	$\text{Ca}_5(\text{OH})[\text{AsO}_4]_3$
Fermorite	$\text{Ca}_5(\text{OH})[\text{AsO}_4]_3$
*Grandaite (x = 1.75)	$\text{Sr}_2\text{Al}(\text{OH})[\text{AsO}_4]_2$
Evite (x = 2) (comp. with adamite (gr.))	$\text{Mn}_2(\text{OH})[\text{AsO}_4]$
Adelite family (x = 2) (compare with conichalcite (group); austinite (group))	
Adelite (x = 2)	$\text{CaMg}(\text{OH})[\text{AsO}_4]$
Nickelaustinite	$\text{Ca}(\text{Ni}, \text{Zn})(\text{OH})[\text{AsO}_4]$
*Sewardite	$\text{CaFe}^{3+}_2(\text{OH})_2[\text{AsO}_4]_2$
Sarkinite	$\text{Mn}^{2+}_2(\text{OH})[\text{AsO}_4]$
Arsenoclasite (x = 2,5)	$\text{Mn}^{2+}_5(\text{OH})_4[\text{AsO}_4]_2$
Flinkite (x = 3,5)	$\text{Mn}^{2+}_2\text{Mn}^{3+}(\text{OH})_4[\text{AsO}_4]$
Allactite (x = 3,5)	$\text{Mn}^{2+}_7(\text{OH})_8[\text{AsO}_4]_2$

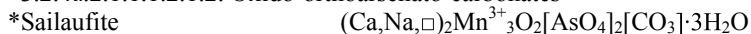
Jarosewichite (x = 4,5)	$Mn^{2+}_3Mn^{3+}(OH)_6[AsO_4]$
*Canosioite	$Ba_2Fe^{3+}(OH)[AsO_4]_2$
	3.2.4a.2.1.1.1.1.2.1. Hydrates
*Cabalzarite	$Ca(Mg,Al,Fe)_2[AsO_4]_2(H_2O,OH)_2$
*Cobaltlotharmeyerite (x = 1,5)	$Ca(Co,Fe^{3+},Ni)_2[AsO_4]_2(OH,H_2O)_2$
*Nickellotharmeyerite (x = 1,5)	$Ca(Ni,Fe^{3+})_2[AsO_4]_2(H_2O,OH)_2$
*Barahonite (Al) (x = 1,88)	$Ca_{12}Al_2(OH)_6[AsO_4]_8 \cdot 6H_2O$
*Barahonite-(Fe)	$Ca_{12}Fe^{3+}_2(OH)_6[AsO_4]_8 \cdot 6H_2O$
*Cobaltarthurite (x = 2)	$Co^{2+}Fe^{3+}_2(OH)_2[AsO_4]_2 \cdot 4H_2O$
*Maghrebite	$MgAl_2(OH)_2[AsO_4]_2 \cdot 8H_2O$
*Bendadaite	$Fe^{2+}Fe^{3+}_2(OH)_2[AsO_4]_2 \cdot 4H_2O$
*Césarferreiraite	$Fe^{2+}Fe^{3+}_2(OH)_2[AsO_4]_2 \cdot 8H_2O$
Camgasite (x = 2)	$CaMg(OH)[AsO_4] \cdot 5H_2O$
*Coralloite (x = 2)	$Mn^{2+}Mn^{3+}_2(OH)_2[AsO_4]_2 \cdot 4H_2O$
*Tapiiaite	$Ca_5Al_2(OH)_4[AsO_4]_4 \cdot 12H_2O$
Alumopharmacosiderite family (x = 2,1(6))	
Alumopharmacosiderite	$KAl_4(OH)_4[AsO_4]_3 \cdot 6,5H_2O$
Pharmacosiderite	$KFe^{3+}_4(OH)_4[AsO_4]_3 (6-7)H_2O$
*Bariopharmacosiderite	$BaFe^{3+}_8(OH)_8[AsO_4]_6 \cdot 10H_2O$
*Hydroniumpharmacosiderite	$(H_3O)Fe^{3+}_4(OH)_4[AsO_4]_3 \cdot 4H_2O$
*Hydroniumpharmacoalumite	$(H_3O)Al_4(OH)_4[AsO_4]_3 \cdot 4H_2O$
*Cesiumpharmacosiderite	$CsFe^{3+}_4(OH)_4[AsO_4]_3 \cdot 4H_2O$
Talliumpharmacosiderite	$TlFe_4[AsO_4]_3 \cdot 4H_2O$
*Bariopharmacoalumite	$Ba_{0,5}Al_4(OH)_4[AsO_4]_3 \cdot 4H_2O$
*Natropharmacoalumite	$NaAl_4(OH)_4[AsO_4]_3 \cdot 4H_2O$
Ferrisymplesite (x = 2,25)	$Fe^{3+}_3(OH)_3[AsO_4]_2 \cdot 5H_2O$
*Kamaricaite (x = 2,25)	$Fe^{3+}_3(OH)_3[AsO_4]_2 \cdot 3H_2O$
*Natropharmacosiderite (x = 2,(3))	$Na_2Fe^{3+}_4(OH)_5[AsO_4]_3 \cdot 7H_2O$
Calcium-pharmacosiderite (x = 2,(3))	$CaFe^{3+}_4(OH)_5[AsO_4]_3 \cdot 5H_2O$
*Ba-Zn-alumofarmacosiderite (x = 2,(3))	$(Ba,K)_{0,5}(Zn,Cu)_{0,5}(Al,Fe)_4(OH)_5[AsO_4]_3 \cdot 5H_2O$
Yukonite (x = 2,375)	$Ca_2Fe^{3+}_5(OH)_7[AsO_4]_4 \cdot 7H_2O$
Akrochordite family (x = 2,5)	
Akrochordite	$MgMn^{2+}_4(OH)_4[AsO_4]_2 \cdot 4H_2O$
Wallkilldellite-Mn	$Ca_2Mn^{2+}_3(OH)_4[AsO_4]_2 \cdot 9H_2O$
*Wallkilldellite-Fe	$(Ca,Cu)_4Fe_6(OH)_8[(As,Si)O_4]_4 \cdot 18H_2O$
Ogdensburgite (x = 2,6)	$(Ca,Zn,Mn)_4Fe^{3+}_6(OH)_{11}[AsO_4]_5 \cdot 5H_2O$
*Esperansaite (x = 2,75)	$NaCa_2Al_2(OH)F_4[AsO_4]_2 \cdot 2H_2O$
Bulachite (x = 3)	$Al_2(OH)_3[AsO_4] \cdot 3H_2O$
*Bettertonite	$Al_6(OH)_9[AsO_4]_3 \cdot 16H_2O$
*Penberthycroftite	$Al_6(OH)_9(H_2O)_5[AsO_4]_3 \cdot 8H_2O$
Liskeardite (x = 4,5)	$(Al,Fe)_3(OH)_6[AsO_4] \cdot 5H_2O$
	3.2.4a.2.1.1.1.2. Oxido-orthoarsenates (neutral)
*Wrightite (x = 2)	$K_2Al_2O[AsO_4]_2$
*Katiarsite (x = 2.5)	$KTiO[AsO_4]$
*Arsenatotitanite (x = 2.5)	$NaTiO[AsO_4]$
Angelellite (x = 3)	$Fe^{3+}_4O_3[AsO_4]_2$
	3.2.4a.2.1.1.1.2.1. Hydrates
Arsenosiderite family (x = 2,1(6))	



3.2.4a.2.1.1.1.2.1.1 Oxido-orthoarsenato-arsenito-silicates (basic)

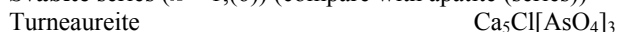


*3.2.4a.2.1.1.1.2.1.2. Oxido-orthoarsenato-carbonates



3.2.4a.2.1.1.1.3. Orthoarsenato-halogenides 3.2.4a.2.1.1.1.3.1. Neutral

Svabite series ($x = 1, (6)$) (compare with apatite (series))

**Durangite** family ($x = 2$)

3.2.4a.2.1.1.1.4. Arsenato-sulfates 3.2.4a.2.1.1.1.4.1. Basic

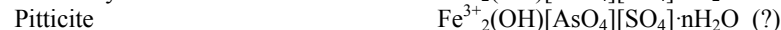
Weilerite family ($x = 2, 75$)

3.2.4a.2.1.1.1.4.1.1. Hydrates

3.2.4a.2.1.1.1.4.1.1.1. As : S = 3



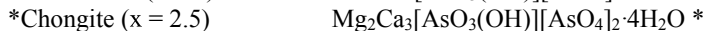
3.2.4a.2.1.1.1.4.1.1.2. As : S = 1

Pitticite family ($x=1,5$)

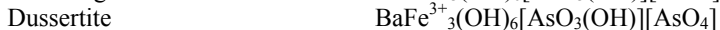
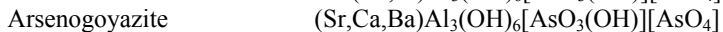
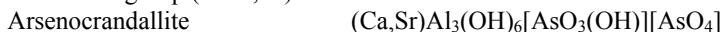
3.2.4a.2.1.1.1.5. Гидроарсенато-арсенаты

*3.2.4a.2.1.1.1.5.1. Гидроарсенато-арсенаты с $\text{AsO}_3\text{OH} : \text{AsO}_4 = 1 : 2$ 

*3.2.4a.2.1.1.1.5.1.1. Кристаллогидраты

3.2.4a.2.1.1.1.5.2. Hydroarsenato-arsenates with $\text{AsO}_3\text{OH} : \text{AsO}_4 = 1 : 1$

3.2.4a.2.1.1.1.5.2.1. Basic

Dussertite group ($x = 2, 75$)

3.2.4a.2.1.1.1.5.2.1.1. Hydrates

Sainfeldite group ($x = 1, 25$)

Villyaellenite	$(\text{Mn,Ca})\text{Mn}_2\text{Ca}_2[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 4\text{H}_2\text{O}$
Irthemite	$\text{Ca}_4\text{Mg}[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 4\text{H}_2\text{O}$
Sainfeldite	$\text{Ca}_5[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 4\text{H}_2\text{O}$
Picropharmacolite family	
Guérinite	$\text{Ca}_5[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 9\text{H}_2\text{O}$
Picropharmacolite	$\text{Ca}_4\text{Mg}[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 11\text{H}_2\text{O}$
Chudobaite group	
Chudobaite	$(\text{Mg,Zn})_5[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 10\text{H}_2\text{O}$
Geigerite	$\text{Mn}_5[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 10\text{H}_2\text{O}$
*Miguelromeroite	$\text{MnMn}_2\text{Mn}_2[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 4\text{H}_2\text{O}$
Ferrarisite	$\text{Ca}_5(\text{H}_2\text{O})_8[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$
*3.2.4a.2.1.1.1.5.3. Hydroarsenato-arsenates with $\text{AsO}_3\text{OH} : \text{AsO}_4 = 2 : 1$	
*Canutite	$\text{NaMn}_3[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]$
	*3.2.4a.2.1.1.1.5.3.1. Hydrates
*Joteite	$\text{Ca}_2\text{CuAl}(\text{OH})_2[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4](\text{H}_2\text{O})_5$
3.2.4a.2.1.1.1.5.4. Hydroarsenato-arsenates with $\text{AsO}_3\text{OH} : \text{AsO}_4 = 4 : 1$	
	3.2.4a.2.1.1.1.5.4.1. Hydrates (neutral)
Mcnearite ($x = 1.1$)	$\text{NaCa}_5[\text{AsO}_3(\text{OH})]_4[\text{AsO}_4] \cdot 4\text{H}_2\text{O}$
3.2.4a.2.1.1.1.6. Hydroarsenato-arsenato-phosphates	
	3.2.4a.2.1.1.1.6.1. Hydrates with $\text{AsO}_3\text{OH} : \text{AsO}_4 : \text{PO}_4 = 2 : 3 : 3$ (neutral)
Walentaite ($x = 1.375$)	$\text{Ca}_4\text{Fe}^{3+}_{12}[\text{AsO}_3(\text{OH})]_4[\text{AsO}_4]_6[\text{PO}_4]_6 \cdot 28\text{H}_2\text{O}$
	3.2.4a.2.1.1.1.6.2. Hydrates with $\text{AsO}_3\text{OH} : \text{AsO}_4 : \text{PO}_4 = 3 : 1 : 1$ (neutral)
Machatschkiite ($x = 1,2$)	$\text{Ca}_6[\text{AsO}_3(\text{OH})]_3[\text{AsO}_4][\text{PO}_4] \cdot 15\text{H}_2\text{O}$
3.2.4a.2.1.1.1.7. Hydroarsenates	
	3.2.4a.2.1.1.1.7.1. Basic
Weilite ($x = 2$)	$\text{Ca}[\text{AsO}_3(\text{OH})]$
*Švenekite	$\text{Ca}[\text{AsO}_2(\text{OH})_2]_2$
	3.2.4a.2.1.1.1.7.2. Hydrates (neutral) ($x=1$)
Haidingerite family	
Cobaltkoritnigite	$(\text{Co,Zn})[\text{AsO}_3(\text{OH})] \cdot \text{H}_2\text{O}$
*Burgessite	$\text{Co}_2(\text{H}_2\text{O})_4[\text{AsO}_3(\text{OH})]_2 \cdot \text{H}_2\text{O}$
Krautite	$\text{Mn}[\text{AsO}_3(\text{OH})] \cdot \text{H}_2\text{O}$
Fluckite	$\text{CaMn}[\text{AsO}_3(\text{OH})]_2 \cdot 2\text{H}_2\text{O}$
Haidingerite	$\text{Ca}[\text{AsO}_3(\text{OH})] \cdot \text{H}_2\text{O}$
Pharmacolite family	
Pharmacolite	$\text{Ca}[\text{AsO}_3(\text{OH})] \cdot 2\text{H}_2\text{O}$
*Magnesiokoritnigite	$\text{Mg}[\text{AsO}_3(\text{OH})] \cdot \text{H}_2\text{O}$
Brassite	$\text{Mg}[\text{AsO}_3(\text{OH})] \cdot 4\text{H}_2\text{O}$
Rösslerite	$\text{Mg}[\text{AsO}_3(\text{OH})] \cdot 7\text{H}_2\text{O}$
3.2.4a.2.1.1.1.6. Dihydroarsenates	
	3.2.4a.2.1.1.1.6.1. Hydrates (neutral) ($x = 0,(3)$)
Kaatialaite	$\text{Fe}[\text{H}_2\text{AsO}_4]_3 \cdot 5\text{H}_2\text{O}$
3.2.4a.2.1.1.2. Orthoarsenates of Be → berylloarsenates	
	3.2.4a.2.1.1.2.1. Acid
Bergslagite	$\text{Ca}[\text{Be}(\text{OH})\text{AsO}_4]^{9/2}$

	3.2.4a.2.1.1.2.2. Hydrates
Bearsite	$\text{Be}[\text{Be}(\text{OH})\text{AsO}_4]_4\text{H}_2\text{O}$
*Okruschite	$\text{Ca}_2\text{Mn}^{2+}_5\text{Be}_4(\text{OH})_4[\text{AsO}_4]_6\cdot 6\text{H}_2\text{O}$
3.2.4a.2.1.2. Orthoarsenates of <i>f</i> -cations	
	3.2.4a.2.1.2.1. Neutral ($x = 1,5$)
Chernovite-(Y) (compare with xenotime (group))	$\text{Y}[\text{AsO}_4]$
*Gasparite-(Ce)	$(\text{Ce}, \text{La}, \text{Nd})[\text{AsO}_4]$
	3.2.4a.2.1.2.2. Basic
Arsenoflorencite-(Ce)	$\text{CeAl}_3(\text{OH})_6[\text{AsO}_4]_2$
*Arsenoflorencite-(La)	$\text{LaAl}_3(\text{OH})_6[\text{AsO}_4]_2$
*Graulichite-(Ce)	$\text{CeFe}^{3+}_3(\text{OH})_6[\text{AsO}_4]_2$
Retzian family	
Retzian -(Ce)	$\text{Mn}_2\text{Ce}(\text{OH})_4[\text{AsO}_4]$
Retzian -(La)	$\text{Mn}_2\text{La}(\text{OH})_4[\text{AsO}_4]$
	3.2.4a.2.1.2.2.1. Hydrates
*Goudeyite ($x = 2,5$)	$(\text{Al}, \text{Y})\text{Cu}^{2+}_6(\text{OH})_6[\text{AsO}_4]_3\cdot 3\text{H}_2\text{O}$
*Agardite-(Ce)	$(\text{Ce}, \text{Ca})\text{Cu}^{2+}_6(\text{OH})_6[\text{AsO}_4]_3\cdot 3\text{H}_2\text{O}$
*Agardite-(La)	$(\text{La}, \text{Ca})\text{Cu}^{2+}_6(\text{OH})_6[\text{AsO}_4]_3\cdot 3\text{H}_2\text{O}$
*Agardite-(Y)	$(\text{Y}, \text{Ca})\text{Cu}^{2+}_6(\text{OH})_6[\text{AsO}_4]_3\cdot 3\text{H}_2\text{O}$
*Agardite-(Nd)	$\text{NdCu}^{2+}_6(\text{OH})_6[\text{AsO}_4]_3\cdot 3\text{H}_2\text{O}$
*3.2.4a.2.1.2.2.1.1. Hydroarsenato-orthoarsenates	
*Plumbogardite	$(\text{Pb}, \text{REE}, \text{Ca})\text{Cu}^{2+}_6(\text{OH})_6[\text{HASO}_4][\text{AsO}_4]_3\cdot 3\text{H}_2\text{O}$
*3.2.4a.2.1.2.2.1.2. Dihydroarsenates	
*Vysokyite	$\text{U}^{4+}[\text{AsO}_2(\text{OH})_2]_4\cdot \text{H}_2\text{O}$
3.2.4a.2.2. Subclass: Orthoarsenates of chalcophylic elements	
3.2.4a.2.2.1. Orthoarsenates of Ag, Cu	
3.2.4a.2.2.1.1. M^+ and M^{2+}	
3.2.4a.2.2.1.1.1. Proper orthoarsenates	
	3.2.4a.2.2.1.1.1.1. Neutral
*Bradaczekite ($x = 1,5$)	$\text{NaCu}_4[\text{AsO}_4]_3$
*Zincobradaczekite	$\text{NaZn}_2\text{Cu}_2[\text{AsO}_4]_3$
Johillerite ($x=1,5$)	$\text{NaCu}(\text{Mg}, \text{Zn})_3[\text{AsO}_4]_3$
*Nickenichite	$\text{Na}_{0,8}\text{Ca}_{0,4}\text{Cu}_{0,4}(\text{Mg}, \text{Fe}^{3+})_3[\text{AsO}_4]_3$
*Hatertite	$\text{Na}_2(\text{Ca}, \text{Na})(\text{Fe}^{3+}, \text{Cu})_2[\text{AsO}_4]_3$
	3.2.4a.2.2.1.1.1.1. Hydrates
Keyite ($x = 1,5$)	$\text{Cu}^{2+}_3(\text{Zn}, \text{Cu}^{2+})_4\text{Cd}_2[(\text{AsO}_4)_6(\text{H}_2\text{O})_2]$
*Erikapohlite	$\text{Cu}^{2+}_3(\text{Zn}, \text{Cu}^{2+}, \text{Mg})_4\text{Ca}_2[(\text{AsO}_4)_6\cdot 2\text{H}_2\text{O}]$
	3.2.4a.2.2.1.1.1.2. Basic
Olivenite series ($x=2$)	
Olivenite	$\text{Cu}_2(\text{OH})[\text{AsO}_4]$
*Zinkolivenite	$\text{CuZn}(\text{OH})[\text{AsO}_4]$
Conichalcite	$\text{CuCa}(\text{OH})[\text{AsO}_4]$
Cornwallite family ($x=2,5$)	
Cornwallite	$\text{Cu}_5(\text{OH})_4[\text{AsO}_4]_2$
Cornubite	$\text{Cu}_5(\text{OH})_4[\text{AsO}_4]_2$
Clinoclase family ($x=3$)	

Clinoclase (x=3)	$\text{Cu}_3(\text{OH})_3[\text{AsO}_4]$
*Gilmarite	$\text{Cu}_3(\text{OH})_3[\text{AsO}_4]$
Arhbarite	$\text{Cu}_2\text{Mg}(\text{OH})_3[\text{AsO}_4]$
	3.2.4a.2.2.1.1.2.1. Hydrates (basic)
*Rollandite (x = 1,5)	$\text{Cu}_3[\text{AsO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Ruffite	$\text{Ca}_2\text{Cu}^{2+}[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$
*Lukrahnite (x = 1,75)	$\text{Ca}(\text{Cu}^{2+}, \text{Zn})(\text{Fe}^{3+}, \text{Zn})[\text{AsO}_4]_2(\text{OH}, \text{H}_2\text{O})_2$
Euchroite family (x=2)	
Strashimirite	$\text{Cu}^{2+}_8(\text{OH})_4[\text{AsO}_4]_4 \cdot 5\text{H}_2\text{O}$
Euchroite	$\text{Cu}_2(\text{OH})[\text{AsO}_4] \cdot 3\text{H}_2\text{O}$
*Guanacoite (x = 2,5)	$\text{Cu}_2\text{Mg}_2(\text{Mg}_{0,5}\text{Cu}_{0,5})(\text{OH})_4[\text{AsO}_4]_2(\text{H}_2\text{O})_4$
Philipsburgite (x=3)	$(\text{Cu}, \text{Zn})_6(\text{OH})_6[(\text{AsO}_4), (\text{PO}_4)]_2 \cdot \text{H}_2\text{O}$
(compare with kipushite (group))	
*Forêtite (x = 5)	$\text{Cu}_2\text{Al}_2(\text{OH}, \text{O}, \text{H}_2\text{O})_6[\text{AsO}_4]$
*3.2.4a.2.2.1.1.2. Orthoarsenato-oxides	
*Ericlaxmanite	$\text{Cu}_4\text{O}[\text{AsO}_4]_2$
*Kozyrevskite	$\text{Cu}_4\text{O}[\text{AsO}_4]_2$
*Popovite	$\text{Cu}_5\text{O}_2[\text{AsO}_4]_2$
*Shchurovskyite	$\text{Cu}_6\text{K}_2\text{CaO}_2[\text{AsO}_4]_4$
*Dmisokolovite	$\text{Cu}_5\text{K}_3\text{AlO}_2[\text{AsO}_4]_4$
*Urusovite	$\text{Cu}^{2+}\text{AlO}[\text{AsO}_4]$
*Edtollite	$\text{Cu}_5\text{K}_2\text{NaFe}^{3+}\text{O}_2[\text{AsO}_4]_4$
*Melanarsite	$\text{Cu}_7\text{K}_3\text{Fe}^{3+}\text{O}_4[\text{AsO}_4]_4$
3.2.4a.2.2.1.1.3. Orthoarsenato-carbonates ($\text{AsO}_4 : \text{CO}_3 = 2 : 1$)	
	3.2.4a.2.2.1.1.3.1. Hydrates (basic)
Tyrolite (x=2)	$\text{Ca}_2\text{Cu}_9(\text{OH})_8[\text{AsO}_4]_4[\text{CO}_3] \cdot 11\text{H}_2\text{O}$
*3.2.4a.2.2.1.1.4. Orthoarsenato-phosphates ($\text{AsO}_4 : \text{PO}_4 = 1 : 1$)	
*Hermannroseite	$\text{CaCu}(\text{OH})[(\text{AsO}_4), (\text{PO}_4)]$
3.2.4a.2.2.1.1.5. Orthoarsenato-sulfates	
*3.2.4a.2.2.1.1.5.1. Orthoarsenato-sulfates with $\text{AsO}_4 : \text{SO}_4 = 1$	
*3.2.4a.2.2.1.1.5.1.1. Orthoarsenato-oxido-sulfates with $\text{AsO}_4 : \text{SO}_4 = 1$	
*Vasilseverginite	$\text{Cu}_9\text{O}_4[\text{AsO}_4]_2[\text{SO}_4]_2$
3.2.4a.2.2.1.1.5.2. Orthoarsenato-sulfates with $\text{AsO}_4 : \text{SO}_4 = 2$	
	3.2.4a.2.2.1.1.5.2.1. Hydrates (basic)
Parnauite (x=3)	$\text{Cu}_9(\text{OH})_{10}[\text{AsO}_4]_2[\text{SO}_4] \cdot 7\text{H}_2\text{O}$
*3.2.4a.2.2.1.1.5.3. Orthoarsenato-sulfates with $\text{AsO}_4 : \text{SO}_4 = 4$	
	*3.2.4a.2.2.1.1.5.3.1. Hydrates
Leogangite	$\text{Cu}^{2+}_{10}(\text{OH})_6[\text{AsO}_4]_4[\text{SO}_4] \cdot 8\text{H}_2\text{O}$
3.2.4a.2.2.1.1.6. Orthoarsenato-chlorides	
	3.2.4a.2.2.1.1.6.1. Hydrates
	*3.2.4a.2.2.1.1.6.1.1. Neutral
*Lemanskiite	$\text{NaCaCu}^{2+}_5\text{Cl}[\text{AsO}_4]_4 \cdot 5\text{H}_2\text{O}$
*Mahnertite	$(\text{Na}, \text{Ca})\text{Cu}^{2+}_3\text{Cl}[\text{AsO}_4]_2 \cdot 5\text{H}_2\text{O}$
*Zdenekite (x = 6,5)	$\text{NaPbCu}_5\text{Cl}[\text{AsO}_4]_4 \cdot 5\text{H}_2\text{O}$

- 3.2.4a.2.2.1.1.6.1.2. Basic
Shubnikovite ($x=1, (6)$) $\text{Ca}_2\text{Cu}_8(\text{OH})\text{Cl}[\text{AsO}_4]_6 \cdot 7\text{H}_2\text{O} (?)$
- *3.2.4a.2.2.1.1.6.2. Oxido-orthoarsenato-chlorides
*Coparsite ($x = 4$) $\text{Cu}_4\text{O}_2[(\text{As}, \text{V})\text{O}_4]\text{Cl}$
*Arsmirandite $\text{Na}_{18}\text{Cu}_{12}\text{Fe}^{3+}\text{O}_8[\text{AsO}_4]_8\text{Cl}_5$
- 3.2.4a.2.2.1.1.7. Hydroarsenato-orthoarsenates
3.2.4a.2.2.1.1.7.1. Hydrates (neutral)
*Pradeite $\text{CoCu}_4[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 9\text{H}_2\text{O}$
Lindackerite ($x=1$) $\text{Cu}_5[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 9\text{H}_2\text{O}$
*Hloušekite $(\text{Ni}, \text{Co})\text{Cu}_4[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 9\text{H}_2\text{O}$
*Ondrušite $\text{CaCu}_4[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 10\text{H}_2\text{O}$
*Klajite $\text{MnCu}_4[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2 \cdot 9-10\text{H}_2\text{O}$
*Zálesiite ($x = 1$) $\text{CaCu}_6\{[\text{AsO}_3(\text{OH})][\text{AsO}_4]_2(\text{OH})_6\} \cdot 3\text{H}_2\text{O}$
*Domerockite $\text{Cu}_4[\text{AsO}_3(\text{OH})][\text{AsO}_4](\text{OH})_3 \cdot \text{H}_2\text{O}$
- 3.2.4a.2.2.1.1.8.1.1. Hydroarsenato-orthoarsenato-oxides
*Braithwaiteite $\text{NaCu}^{2+}_5(\text{Sb}^{5+}, \text{Ti}^{4+})[\text{AsO}_3(\text{OH})]_2\text{O}_2[\text{AsO}_4]_4(\text{H}_2\text{O})_8$
- *3.2.4a.2.2.1.1.9. Hydroarsenates *3.2.4a.2.2.1.1.9.1. Hydrates
*Pushcharovskite $\text{Cu}[\text{AsO}_3\text{OH}] \cdot 1.5\text{H}_2\text{O}$
*Yvonite $\text{Cu}[\text{AsO}_3\text{OH}] \cdot 2\text{H}_2\text{O}$
- *3.2.4a.2.2.1.1.9.1. Hydroarsenato-oxides
*Lapeyreite $\text{Cu}^{2+}_3\text{O}[\text{AsO}_3(\text{OH})]_2 \cdot 0.75\text{H}_2\text{O}$
- 3.2.4a.2.2.1.2. M^{2+} and M^3
*3.2.4a.2.2.1.2.1. Proper orthoarsenares *3.2.4a.2.2.1.2.1.1. Basic
3.2.4a.2.2.1.2.1.1.1. Hydrates
Arthurite ($x=2$) $\text{CuFe}^{3+}_2(\text{OH})_2[\text{AsO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Attikaite ($x=2$) $\text{Ca}_3\text{Cu}^{2+}_2\text{Al}_2(\text{OH})_4[\text{AsO}_4]_4 \cdot 2\text{H}_2\text{O}$
Chenevixite group ($x=2,5$)
Luetheite $\text{Cu}_2\text{Al}_2(\text{OH})_4[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$
Chenevixite $\text{Cu}_2\text{Fe}^{3+}_2(\text{OH})_4[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$
Ceruleite ($x = 3, 125$) $\text{Cu}_2\text{Al}_7(\text{OH})_{13}[\text{AsO}_4]_4 \cdot 1.5\text{H}_2\text{O}$
*Liroconite ($x = 3, 5$) $\text{Cu}_2\text{Al}(\text{OH})_4[\text{AsO}_4] \cdot 4\text{H}_2\text{O}$
- *3.2.4a.2.2.1.2.1.1.1. Hydroarsenato-orthoarsenates
*Radovanite $\text{Cu}^{2+}_2\text{Fe}^{3+}[\text{As}^{5+}\text{O}_4][\text{As}^{3+}\text{O}_2\text{OH}]_2 \cdot \text{H}_2\text{O}$
*Segerstromite $\text{Ca}_3[\text{As}^{3+}(\text{OH})_3]_2[\text{As}^{5+}\text{O}_4]_2$
- 3.2.4a.2.2.1.3. M^{2+}
3.2.4a.2.2.1.3.1. Proper orthoarsenato-phosphates
3.2.4a.2.2.1.3.1.1. Neutral
Lammerite ($x=1,5$) $\text{Cu}_3[\text{AsO}_4]_2$
*Lammerite- β $\text{Cu}_3[\text{AsO}_4]_2$
- 3.2.4a.2.2.1.3.2. Orthoarsenato-sulfates with $\text{AsO}_4 : \text{SO}_4 = 1, (3)$
3.2.4a.2.2.1.3.2.1. Hydrates (basic)

Chalcopyllite (x=3) $\text{Cu}_{18}\text{Al}_2(\text{OH})_{24}[\text{AsO}_4]_4[\text{SO}_4]_3 \cdot 36\text{H}_2\text{O}$

3.2.4a.2.2.1.3.3. Orthoarsenato-chlorides

3.2.4a.2.2.1.3.3.1. Hydrates

Lavendulan series (x=1,625)

Lavendulan $\text{NaCaCu}_5\text{Cl}[\text{AsO}_4]_4 \cdot 5\text{H}_2\text{O}$

Zinclavendulan $\text{NaCa}(\text{Zn,Cu})_5\text{Cl}[\text{AsO}_4]_4(4-5)\text{H}_2\text{O}$

*3.2.4a.2.2.1.3.4. Dihydroarsenato-orthoarsenates

*3.2.4a.2.2.1.3.4.1. Hydrates (neutral)

*Andyrobertsite (x = 1,3) $\text{KCdCu}^{2+}_5[\text{As}(\text{OH})_2\text{O}_2][\text{AsO}_4]_4(\text{H}_2\text{O})_2$

*Calcioandyrobertsite $\text{KCaCu}^{2+}_5[\text{As}(\text{OH})_2\text{O}_2][\text{AsO}_4]_4(\text{H}_2\text{O})_2$

3.2.4a.2.2.2. Orthoarsates of Zn

3.2.4a.2.2.2.1. M^{2+}

3.2.4a.2.2.2.1.1. Proper orthoarsenates

3.2.4a.2.2.2.1.1.1. Neutral

Stranskiite (x=1,5) $\text{Zn}_2\text{Cu}[\text{AsO}_4]_2$

3.2.4a.2.2.2.1.1.2. Basic

Adamite family (x=2)

Paradamite $\text{Zn}_2(\text{OH})[\text{AsO}_4]$

Adamite $\text{Zn}_2(\text{OH})[\text{AsO}_4]$

Cuproadamite $(\text{Cu,Zn})_2(\text{OH})[\text{AsO}_4]$

Austinite $\text{CaZn}(\text{OH})[\text{AsO}_4]$

Nickelaustinite $\text{Ca}(\text{Ni,Zn})(\text{OH})[\text{AsO}_4]$

Cobaltaustinite $\text{Ca}(\text{Co,Zn})(\text{OH})[\text{AsO}_4]$

*Pharmazincite $\text{KZn}[\text{AsO}_4]$

Chlorophoenicite family (x=5)

Magnesiochlorophoenicite $(\text{Mg,Mn})_3\text{Zn}_2(\text{OH},\text{O})_6[\text{AsO}_4]$

Chlorophoenicite $(\text{Mn,Mg})_3\text{Zn}_2(\text{OH},\text{O})_6[\text{AsO}_4]$

Theisite (x=5) $\text{Cu}_5\text{Zn}_5(\text{OH})_{14}[\text{AsO}_4]_2$

3.2.4a.2.2.2.1.1.3. Hydrates

3.2.4a.2.2.2.1.1.3.1. Basic

Legrandite $\text{Zn}_2(\text{OH})[\text{AsO}_4] \cdot \text{H}_2\text{O}$

*Ianbruceite $\text{Zn}_2(\text{OH})(\text{H}_2\text{O})[\text{AsO}_4](\text{H}_2\text{O})_2$

Lotharmeyerite family (x=1,5)

Lotharmeyerite $\text{Ca}(\text{Zn,Mn}^{3+})_2[\text{AsO}_4]_2 \cdot 2\text{H}_2\text{O}$

Manganlotharmeyerite $^\text{Ca}(\text{Mn}^{3+},\text{Zn})_2[\text{AsO}_4]_2(\text{OH})_2$

Ferrilotharmeyerite $^\text{CaFe}^{3+}\text{Zn}[\text{AsO}_4]_2(\text{OH}) \cdot \text{H}_2\text{O}$

3.2.4a.2.2.2.1.1.3.2. Neutral

Köttigite family(x=1,5)

Warikahnite $\text{Zn}_3[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$

Metaköttigite $(\text{Zn,Fe})_3[\text{AsO}_4]_2 \cdot 8(\text{H}_2\text{O},\text{OH})$

Köttigite $\text{Zn}_3[\text{AsO}_4]_2 \cdot 8\text{H}_2\text{O}$

Prosperite $\text{CaZn}_2[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$

*Arsenohopeite (ortho.) $\text{Zn}_3[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$

*Davideloydite (tricl.) $\text{Zn}_3[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}$

3.2.4a.2.2.2.1.2. Hydroarsenates

3.2.4a.2.2.2.1.2.1. Basic

3.2.4a.2.2.2.1.2.2. Hydrates (basic)

Koritnigite (x=1)	$\text{Zn}[\text{AsO}_3(\text{OH})]\cdot\text{H}_2\text{O}$
*3.2.4a.2.2.2.1.3. Hydroarsenato-orthoarsenates	
	*3.2.4a.2.2.2.1.3.1. Hydrates
*Nyholmite (x = 1)	$\text{Cd}_3\text{Zn}_2[\text{AsO}_3(\text{OH})]_2[\text{AsO}_4]_2\cdot\text{H}_2\text{O}$
3.2.4a.2.2.2.2. M^{2+} and M^{3+}	
3.2.4a.2.2.2.2.1. Proper orthoarsenates	
	3.2.4a.2.2.2.2.1.1. Basic
*Wilhelmkleinite (x = 2)	$\text{ZnFe}^{3+}_2(\text{OH})_2[\text{AsO}_4]_2$
Gerdtrammelite (x=4)	$\text{ZnAl}_2(\text{OH})_5[\text{AsO}_4]$
	3.2.4a.2.2.2.2.1.2. Hydrates
	3.2.4a.2.2.2.2.1.2.1. Basic
Ojuelaite (x=2)	$\text{ZnFe}^{3+}_2(\text{OH})_2[\text{AsO}_4]_2\cdot 4\text{H}_2\text{O}$
Mapimite (x=2,1(6))	$\text{Zn}_2\text{Fe}^{3+}_3(\text{OH})_4[\text{AsO}_4]_3\cdot 10\text{H}_2\text{O}$
	3.2.4a.2.2.2.2.1.2.2. Neutral
Fahleite (x=1,5)	$\text{CaZn}_5\text{Fe}^{3+}_2[\text{AsO}_4]_6\cdot 14\text{H}_2\text{O}$
3.2.4a.2.2.2.3. M^+ and M^{2+}	
3.2.4a.2.2.2.3.1. Hydroarsenato-arsenats	
	3.2.4a.2.2.2.3.1.1. Neutral
O'Danielite (x=1,75)	$\text{Na}(\text{Zn},\text{Mg})_3[\text{HAsO}_4]_2[\text{AsO}_4]$
3.2.4a.2.2.3. Orthoarsenates of Hg^+	
	3.2.4a.2.2.3.1.1. Neutral
3.2.4a.2.2.3.1. Proper orthoarsenates	3.2.4a.2.2.3.1.1. Neutral
Chursinite (x=1,5)	$\text{Hg}^+\text{Hg}^{2+}[\text{AsO}_4]$
*3.2.4a.2.2.3.2. Orthoarsenato-chlorides	
	*3.2.4a.2.2.3.2.1. Neutral
*Kuznetsovite	$\text{Hg}^+_2\text{Hg}^{2+}\text{Cl}[\text{AsO}_4]$
*3.2.4a.2.2.4 Orthoarsenates of In	
*3.2.4a.2.2.4.1. Proper orthoarsenates	
	*3.2.4a.2.2.4.1.1. Hydrates
*Yanomamite	$\text{In}[\text{AsO}_4]\cdot 2\text{H}_2\text{O}$
3.2.4a.2.2.5. Orthoarsenates of Pb	
3.2.4a.2.2.5.1. M^{2+}	
3.2.4a.2.2.5.1.1. Proper orthoarsenates	
3.2.4a.2.2.5.1.1.1. Oxido-orthoarsenates	
Jamesite (x=2,85)	$\text{Pb}_2\text{ZnFe}^{3+}_2(\text{Fe}^{3+}_{2,8}\text{Zn}_{1,2})(\text{OH})_8[(\text{OH})_{1,2}\text{O}_{0,8}][\text{AsO}_4]_4$
	3.2.4a.2.2.5.1.1.2. Basic
Tsumcorite family(x=1,5)	
Tsumcorite	$\text{Pb}(\text{Zn},\text{Fe})_2(\text{OH},\text{H}_2\text{O})_2[\text{AsO}_4]_2$
*Cobalttsumcorite	$\text{Pb}(\text{Co},\text{Fe}^{3+})_2(\text{H}_2\text{O},\text{OH})_2[\text{AsO}_4]_2$
*Nickeltsumcorite	$\text{Pb}(\text{Ni},\text{Fe}^{3+})_2(\text{H}_2\text{O},\text{OH})_2[\text{AsO}_4]_2$
Gartrellite	$\text{PbCuFe}^{3+}(\text{OH})[\text{AsO}_4]_2\cdot\text{H}_2\text{O}$
*Zincgartrellite	$\text{Pb}(\text{Zn},\text{Cu},\text{Fe})_2(\text{H}_2\text{O},\text{OH})_2[\text{AsO}_4]_2$
Arsendecloizite family (x=2) (compare with decloizite (family))	
Duftite	$\text{PbCu}(\text{OH})[\text{AsO}_4]$

Arsendecloizite	$\text{PbZn(OH)[AsO}_4\text{]}$
Gabrielsonite	$\text{PbFe}^{2+}(\text{OH})[\text{AsO}_4\text{]}$
Carminite	$\text{PbFe}^{3+}_2(\text{OH})_2[\text{AsO}_4\text{}]_2$
Bayldonite ($x = 2$)	$\text{PbCu}_3(\text{OH})_2[\text{AsO}_4\text{}]_2$
*Segnitite ($x = 2,75$)	$\text{PbFe}^{3+}_3\text{H(OH)}_6[\text{AsO}_4\text{}]_2$
	3.2.4a.2.2.5.1.1.3. Hydrates
	3.2.4a.2.2.5.1.1.3.1. Basic
Mawbyite ($x=1,5$)	$\text{Pb(Fe}^{3+},\text{Zn)}_2[\text{AsO}_4\text{}]_2(\text{OH},\text{H}_2\text{O})_2$
*Longbanshuttanite	$\text{Pb}_2\text{Mn}_2\text{Mg(OH)}_4[\text{AsO}_4\text{}]_2\cdot 6\text{H}_2\text{O}$
	3.2.4a.2.2.5.1.1.3.2. Neutral

Arsenbrackebuschite family

Arsenbrackebuschite ($x=1,5$)	$\text{Pb}_2(\text{Fe,Zn})[\text{AsO}_4\text{}]_2\cdot\text{H}_2\text{O}$
*Feinglosite	$\text{Pb}_2(\text{Zn,Fe})[(\text{As,S})\text{O}_4\text{}]_2\cdot\text{H}_2\text{O}$
Thometzekite	$\text{Pb(Cu,Zn)}_2[\text{AsO}_4\text{}]_2\cdot 2\text{H}_2\text{O}$
Helmutwinklerite	$\text{PbZn}_2[\text{AsO}_4\text{}]_2\cdot 2\text{H}_2\text{O}$
*Rappoldite	$\text{Pb(Co,Ni)}_2[\text{AsO}_4\text{}]_2\cdot 2\text{H}_2\text{O}$

3.2.4a.2.2.5.1.2. Orthoarsenato-sulfates ($\text{AsO}_4 : \text{SO}_4 = 1$)

3.2.4a.2.2.5.1.2.1. Basic

Arsentsumebite ($x=1,5$)	$\text{CuPb}_2(\text{OH})[\text{AsO}_4][\text{SO}_4]$
(compare with brackebuschite (group))	

3.2.4a.2.2.5.1.3. Orthoarsenato-chromates ($\text{AsO}_4 : \text{CrO}_4 = 1$)

3.2.4a.2.2.5.1.3.1. Basic

Fornacite ($x=1,5$)	$\text{Cu}^{2+}\text{Pb}^{2+}_2(\text{OH})[\text{AsO}_4][\text{CrO}_4]$
*Molybdoformacite	$\text{CuPb}_2(\text{OH})[\text{AsO}_4][\text{MoO}_4]$

3.2.4a.2.2.5.1.4. Orthoarsenato-chlorides 3.2.4a.2.2.5.1.4.1. Neutral

Mimetite family ($x = 1,(6)$) (compare with apatite (gr.); pyromorphite (gr.); vanadinite (gr.))

Hedyphane	$\text{Pb}_3\text{Ca}_2\text{Cl}[\text{AsO}_4\text{}]_3$
Mimetite	$\text{Pb}_5\text{Cl}[\text{AsO}_4\text{}]_3$
*Clinomimetite synonym of Mimetite-M	$\text{Pb}_5\text{Cl}[\text{AsO}_4\text{}]_3$
*Vanackerite	$\text{Pb}_4\text{CdCl}[\text{AsO}_4\text{}]_3$
Nealite ($x=2,5$)	$\text{Pb}_4\text{Fe}^{2+}\text{Cl}_4[\text{AsO}_4\text{}]_2\cdot 2\text{H}_2\text{O}$

3.2.4a.2.2.5.1.5. Oxido-orthoarsenato-chlorides

Sahlinite ($x = 2,3$)	$\text{Pb}_{14}\text{O}_9\text{Cl}_4[\text{AsO}_4\text{}]_2$
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3.2.4a.2.2.5.1.6. Hydroarsenates	3.2.4a.2.2.5.1.6.1. Neutral
Schultenite ($x = 1$)	$\text{Pb}[\text{AsO}_3(\text{OH})]$

3.2.4a.2.2.5.2. M^{2+} and M^{3+}

3.2.4a.2.2.5.2.1. Proper orthoarsenates

3.2.4a.2.2.5.2.1.1. Oxido-orthoarsenates

3.2.4a.2.2.5.2.1.2. Orthoarsenato-sulfates ($\text{AsO}_4 : \text{SO}_4 = 1$)

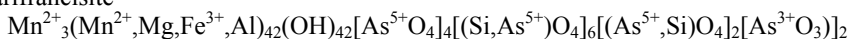
3.2.4a.2.2.5.2.1.2.1. Basic

Beudantite group ($x=2,75$)

Hidalgoite	$\text{PbAl}_3(\text{OH})_6[\text{AsO}_4][\text{SO}_4]$
Beudantite	$\text{PbFe}^{3+}_3(\text{OH})_6[\text{AsO}_4][\text{SO}_4]$

- *Gallobaudantite $\text{PbGa}^{3+}_3(\text{OH})_6[\text{AsO}_4][\text{SO}_4]$
- 3.2.4a.2.2.5.2.1.3. Hydroarsenato-arsenates 3.2.4a.2.2.5.2.1.3.1. Basic
 Philipsbornite ($x=2.75$) $\text{PbAl}_3(\text{OH})_6[\text{AsO}_3(\text{OH})][\text{AsO}_4]$
- 3.2.4a.2.2.6. Orthoarsenates of Va cations
- 3.2.4a.2.2.6.1. Orthoarsenates of Bi^{3+} 3.2.4a.2.2.6.1.1. Neutral
 Rooseveltite ($x=1,5$) $\alpha\text{-Bi}[\text{AsO}_4]$
 *Tetraroseveltite $\beta\text{-Bi}[\text{AsO}_4]$
- 3.2.4a.2.2.6.2. Hydroxido-oxido-arsenates
- Preisingerite ($x=2,25$) (compare with schumacherite (gr.)) $\text{Bi}_3(\text{OH})\text{O}[\text{AsO}_4]_2$
 Atelestite ($x=3$) $\text{Bi}_2(\text{OH})\text{O}[\text{AsO}_4]$
 *Arsenowaylandite ($x=3$) $\text{BiAl}_3(\text{OH})_6[\text{AsO}_4]_2$
 3.2.4a.2.2.6.1.2.1. Basic
 Arsenobismite ($x=3$) $\text{Bi}_2(\text{OH})_3[\text{AsO}_4]$
 *Neustädteite ($x=3$) $\text{Bi}_2\text{Fe}^{3+}\text{Fe}^{3+}\text{O}_2(\text{OH})_2[\text{AsO}_4]_2$
 *Cobaltneustädteite $\text{Bi}_2\text{Fe}^{3+}\text{Co}^{2+}\text{O}(\text{OH})_3[\text{AsO}_4]_2$
 *Medenbachite $\text{Bi}_2\text{Fe}^{3+}\text{Cu}^{2+}\text{O}(\text{OH})_3[\text{AsO}_4]_2$
 3.2.4a.2.2.6.1.2.2. Hydrates (basic)
 Mixite ($x=2,5$) (compare with agardite (group)) $\text{Cu}_6\text{Bi}(\text{OH})_6[\text{AsO}_4]_3 \cdot 3\text{H}_2\text{O}$
 Juanitaite $(\text{Cu,Ca,Fe})_{10}\text{Bi}(\text{OH})_{11}[\text{AsO}_4]_4 \cdot 2\text{H}_2\text{O}$
 Schneeberegite $\text{BiCo}_2(\text{OH})[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}_2$
 Nickelschneeberegite $\text{BiNi}_2(\text{OH})[\text{AsO}_4]_2 \cdot \text{H}_2\text{O}_2$
 *Bouazzerite $\text{Bi}_6(\text{Mg,Cu})_{11}\text{Fe}^{3+}_{14}\text{O}_{12}(\text{OH})_4[\text{AsO}_4]_{18} \cdot 86\text{H}_2\text{O}$
- 3.2.4a.2.2.6.2. Orthoarsenates of Sb^{3+}
- *3.2.4a.2.2.6.2.1. Proper orthoarsenates *3.2.4a.2.2.6.2.1.1. Hydrates
 *Whitecapsite $\text{H}_{16}\text{Fe}^{2+}_5\text{Fe}^{3+}_{14}\text{Sb}^{3+}_6\text{O}_{16}[\text{AsO}_4]_{18} \cdot 120\text{H}_2\text{O}$
- 3.2.4a.2.2.6.2.2. Oxido-arsenates
 Manganostibite ($x=3,5$) $\text{Mn}_7\text{Sb}(\text{As,Si})\text{O}_{12} \rightarrow [^{(6)}(\text{Mn}_5\text{Sb})_{\Sigma 6}\text{O}_2][^{(4)}[\text{Mn}_2(\text{As,Si})_{\Sigma 3}\text{O}_{10}]$
- 3.2.4a.2.2.6.3. Orthoarsenates of As^{3+}
- 3.2.4a.2.2.6.3.1. Proper orthoarsenates 3.2.4a.2.2.6.3.1.1. Oxido-arsenates
 Aerugite ($x=3,9$) $\text{Ni}^{2+}_{18}\text{As}^{3+}_{12}[\text{AsO}_4]_5$
 Hematolite ($x=8,25$) $(\text{Mn,Mg,Al})_{15}(\text{As}^{3+}\text{O}_3)(\text{OH})_{23}[\text{AsO}_4]_2$
 *Arakiite $(\text{Zn,Mn}^{2+})(\text{Mn}^{2+},\text{Mg})_{12}(\text{Fe,Al})_2(\text{As}^{3+}\text{O}_3)(\text{OH})_{23}[\text{AsO}_4]_2$
 3.2.4a.2.2.6.3.1.2. Hydrates (basic)
 Synadelphite ($x=5,25$) $(\text{Mn,Mg,Ca,Pb})_9(\text{As}^{3+}\text{O}_3)(\text{OH})_9[\text{AsO}_4]_{12} \cdot 2\text{H}_2\text{O}$
- 3.2.4a.2.2.6.3.3. Orthoarsenato-chlorides 3.2.4a.2.2.6.3.2.1. Hydrates (basic)
 Richelsdorffite ($x=2,125$) $\text{Ca}_2\text{Cu}^{2+}_5\text{Sb}^{5+}(\text{OH})_6\text{Cl}[\text{AsO}_4]_4 \cdot 6\text{H}_2\text{O}$
- *3.2.4a.3. Quasiclass: Pyroarsenates
- *Petewilliamsite $(\text{Ni,Cu})_{30}[\text{As}_2\text{O}_7]_{15}$
 *3.2.4a.3.1.1. Basic
 *Theoparacelsite $\text{Cu}^{2+}_3(\text{OH})_2[\text{As}_2\text{O}_7]$
- *3.2.4a.4. Quasiclass: Orthoarsenato-arsenites (basic)

*Carlfrancisit

*3.2.46. **Class:** Arsenites

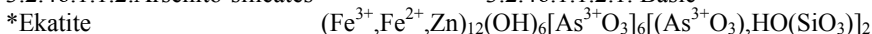
*3.2.46.1. Subclass: Arsenites of cations with low FC

*3.2.46.1.1. Arsenites of *s*-, *d*_s- and *p*_s- cations

*3.2.46.1.1.1. Arsenito-oxides



3.2.46.1.1.2. Arsenito-silicates 3.2.46.1.1.2.1. Basic



*3.2.46.1.1.3. Арсениито-бораты (основные)



*3.2.46.1.1.4. Arsenito-sulfates



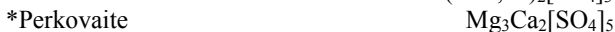
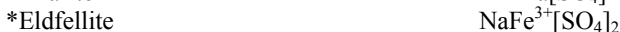
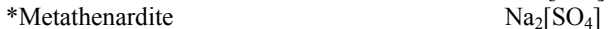
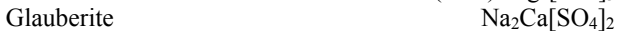
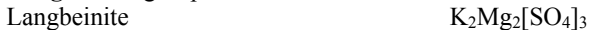
*3.2.46.1.1.5. Arsenito-halogenides *3.2.46.1.1.5.1. Basic

3.2.5. **Class:** Sulfates

3.2.5.1. Subclass: Sulfates of cations with low FC

3.2.5.1.1. Sulfates of *s*-, *d*_s- and *p*_s- cations

3.2.5.1.1.1. Proper sulfates 3.2.5.1.1.1.1. Neutral

**Barite** group (compare with anglesite (group); hashemite (group))**Langbeinite** group**Kalistrontite** group**Godovikovite** group

Godovikovite	$\text{NH}_4\text{Al}[\text{SO}_4]_2$
*Pyracmonite	$(\text{NH}_4)_3\text{Fe}^{3+}[\text{SO}_4]_3$
*Aluminopyracmonite	$(\text{NH}_4)_3\text{Al}[\text{SO}_4]_3$
Sabieite	$\text{NH}_4\text{Fe}^{3+}[\text{SO}_4]_2$
Mascagnite	$(\text{NH}_4)_2[\text{SO}_4]$
*Bubnovaite	$\text{K}_2\text{Na}_8\text{Ca}[\text{SO}_4]_6$
	*3.2.1.1.1.1. Acids
*Ivsite	$\text{Na}_3\text{H}[\text{SO}_4]_2$
	3.2.5.1.1.1.2. Oxido-sulfates
Ye'elimite (x = 13)	$\text{Ca}_4\text{Al}_6\text{O}_{12}[\text{SO}_4]$
	3.2.5.1.1.1.3. Basic and sulfato-halogenides
D'Ansite group (x = 1,15)	
D'Ansite	$\text{Na}_{21}\text{MgCl}_3[\text{SO}_4]_{10}$
*D'Ansite-(Fe)	$\text{Na}_{21}\text{FeCl}_3[\text{SO}_4]_{10}$
*D'Ansite-(Mn)	$\text{Na}_{21}\text{MnCl}_3[\text{SO}_4]_{10}$
Cesanite (x = 1,1(6))	$\text{Na}_3\text{Ca}_2(\text{OH})[\text{SO}_4]_3$
*Shuvalovite	$\text{K}_2\text{NaCa}_2\text{F}[\text{SO}_4]_3$
*Krashennikovite	$\text{KNa}_2\text{CaMgF}[\text{SO}_4]_3$
*Aiolosite	$\text{Na}_2(\text{Na}_2\text{Bi})\text{Cl}[\text{SO}_4]_3$
*Kononovite	$\text{NaMgF}[\text{SO}_4]$
Alunite group (x = 1,25) (compare with argentojarosite; plumbojarosite)	
Natroalunite	$\text{NaAl}_3(\text{OH})_6[\text{SO}_4]_2$
Minamiite	$(\text{Na,Ca,}\square)\text{Al}_3(\text{OH})_6[\text{SO}_4]_2$
*Huangite	$\text{Ca}_{0.5}\text{Al}_3(\text{OH})_6[\text{SO}_4]_2$
Alunite	$\text{KAl}_3(\text{OH})_6[\text{SO}_4]_2$
*Termessaite	$\text{K}_2\text{AlF}_3[\text{SO}_4]$
*Termessaite-(NH ₄)	$(\text{NH}_4)_2\text{AlF}_3[\text{SO}_4]$
*Walhierite	$\text{BaAl}_6(\text{OH})_{12}[\text{SO}_4]_4$
*Ammonioalunite	$(\text{NH}_4)\text{Al}_3(\text{OH})_6[\text{SO}_4]_2$
*Adranosite-(Al)	$(\text{NH}_4)_4\text{NaAl}_2\text{Cl}(\text{OH})_2[\text{SO}_4]_4$
*Adranosite-(Fe)	$(\text{NH}_4)_4\text{NaFe}_2\text{Cl}(\text{OH})_2[\text{SO}_4]_4$
Schlossmacherite	$(\text{H}_3\text{O})\text{Al}_3(\text{OH})_6[\text{SO}_4]_2$
Natrojarosite	$\text{NaFe}^{3+}_3(\text{OH})_6[\text{SO}_4]_2$
Jarosite	$\text{KFe}^{3+}_3(\text{OH})_6[\text{SO}_4]_2$
Ammoniojarosite	$\text{NH}_4\text{Fe}^{3+}_3(\text{OH})_6[\text{SO}_4]_2$
Hydronium-jarosite	$(\text{H}_3\text{O})\text{Fe}^{3+}_3(\text{OH})_6[\text{SO}_4]_2$
*Dorallcharite	$\text{Tl}_{0.8}\text{K}_{0.2}\text{Fe}^{3+}_3(\text{OH})_6[\text{SO}_4]_2$
Sulphohalite polysomatic series $n(\text{Na}_3\text{X}[\text{SO}_4])$ with the proviso that X = Cl, F	
Kogarkoite	$\text{Na}_3\text{F}[\text{SO}_4]$ (n=1)
Sulphohalite	$\text{Na}_6\text{ClF}[\text{SO}_4]_2$ (n=2)
Galeite	$\text{Na}_{15}\text{ClF}_4[\text{SO}_4]_5$ (n=5)
Schairerite	$\text{Na}_{21}\text{ClF}_6[\text{SO}_4]_7$ (n=7)
	3.2.5.1.1.1.4. Hydrates
	3.2.5.1.1.1.4.1. Basic (in that number oxido-sulfates)
Metavoltine (x = 1,1(6))	$\text{K}_2\text{Na}_6\text{Fe}^{2+}\text{Fe}^{3+}_6\text{O}_2[\text{SO}_4]_{12} \cdot 18\text{H}_2\text{O}$
*Alcaparrosait (x = 1,25)	$\text{K}_3\text{Ti}^{4+}\text{Fe}^{3+}_3\text{O}[\text{SO}_4]_4 \cdot 2\text{H}_2\text{O}$
Copiapite group (x = 1,25)	
Aluminocopiapite	$\text{Fe}^{3+}_4\text{Al}(\text{OH})\text{O}[\text{SO}_4]_6 \cdot 20\text{H}_2\text{O}$
Ferricopiapite	$\text{Fe}^{3+}_4(\text{Fe}^{3+}_{2/3}\square_{1/3})(\text{OH})_2[\text{SO}_4]_6 \cdot 20\text{H}_2\text{O}$
Magnesiocopiapite	$\text{MgFe}^{3+}_4(\text{OH})_2[\text{SO}_4]_6 \cdot 20\text{H}_2\text{O}$

*Botryogen	$\text{MgFe}^{3+}(\text{OH})[\text{SO}_4]_2 \cdot 7\text{H}_2\text{O}$
Copiapite	$(\text{Fe}^{2+}, \text{Mg})\text{Fe}^{3+}_4(\text{OH})_2[\text{SO}_4]_6 \cdot 19\text{H}_2\text{O}$
Calciocopiapite	$\text{CaFe}^{3+}_4(\text{OH})_2[\text{SO}_4]_6 \cdot 19\text{H}_2\text{O}$
*Volaschioite	$\text{Fe}^{3+}_4\text{O}_2(\text{OH})_6[\text{SO}_4] \cdot 2\text{H}_2\text{O}$
Sideronatrite family (x = 1,25)	
Metasideronatrite	$\text{Na}_2\text{Fe}^{3+}(\text{OH})[\text{SO}_4]_2 \cdot \text{H}_2\text{O}$
Sideronatrite	$\text{Na}_2\text{Fe}^{3+}(\text{OH})[\text{SO}_4]_2 \cdot 3\text{H}_2\text{O}$
Clinoungemachite (x = 1,25)	$\text{K}_3\text{Na}_9\text{Fe}^{3+}(\text{OH})_3[\text{SO}_4]_6 \cdot 9\text{H}_2\text{O}$
Clairite (x = 1,375)	$(\text{NH}_4)_2\text{Fe}^{3+}_3(\text{OH})_3[\text{SO}_4]_4 \cdot 3\text{H}_2\text{O}$
*Caminité	$\text{Mg}_7(\text{OH})_4[\text{SO}_4]_5 \cdot \text{H}_2\text{O}$
Hohmannite family (x = 1,5)	
Metahohmannite	$\text{Fe}^{3+}(\text{OH})[\text{SO}_4] \cdot 1,5\text{H}_2\text{O}$
Butlerite	$\text{Fe}^{3+}(\text{OH})[\text{SO}_4] \cdot 2\text{H}_2\text{O}$
Parabutlerite	$\text{Fe}^{3+}(\text{OH})[\text{SO}_4] \cdot 2\text{H}_2\text{O}$
Amarantite	$\text{Fe}^{3+}(\text{OH})[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Hohmannite	$\text{Fe}^{3+}(\text{OH})[\text{SO}_4] \cdot 3,5\text{H}_2\text{O}$
Fibroferrite family (x = 1,5)	
*Riotintoite	$\text{Al}(\text{OH})[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Jurbanite	$\text{Al}(\text{OH})[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
Rostite	$\text{Al}(\text{OH}, \text{F})[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
Fibroferrite	$\text{Fe}^{3+}(\text{OH})[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
Slavikite (x = 1,36)	$(\text{H}_3\text{O})_3\text{Mg}_6\text{Fe}^{3+}_{15}(\text{OH})_{18}[\text{SO}_4]_{21} \cdot 98\text{H}_2\text{O}$
Svyazhinite (x = 1,25)	$(\text{Mg}, \text{Mn})(\text{Al}, \text{Fe}^{3+})\text{F}[\text{SO}_4]_2 \cdot 14\text{H}_2\text{O}$
Uklonskovite (x = 2,5)	$\text{NaMg}(\text{OH}, \text{F})[\text{SO}_4] \cdot 2\text{H}_2\text{O}$
*Kottenheimite	$\text{Ca}_6\text{Si}_2(\text{OH})_{12}[\text{SO}_4]_4 \cdot 24\text{H}_2\text{O}$
*Kottenheimite hexag.	$\text{Ca}_3\text{Si}(\text{OH})_6[\text{SO}_4]_2 \cdot 12\text{H}_2\text{O}$
*Laaherite mon.	$\text{Ca}_3\text{Si}(\text{OH})_6[\text{SO}_4]_2 \cdot 12\text{H}_2\text{O}$
Aluminite family (x = 3)	
*Mangazeite	$\text{Al}_2(\text{OH})_4[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Meta-aluminite	$\text{Al}_2(\text{OH})_4[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
Aluminite	$\text{Al}_2(\text{OH})_4[\text{SO}_4] \cdot 7\text{H}_2\text{O}$
Ettringite family (x = 3)	
Ettringite	$\text{Ca}_6\text{Al}_2(\text{OH})_{12}[\text{SO}_4]_3 \cdot 26\text{H}_2\text{O}$
Bentorite	$\text{Ca}_6(\text{Cr}, \text{Al})_2(\text{OH})_{12}[\text{SO}_4]_3 \cdot 26\text{H}_2\text{O}$
Zaherite (x = 3,6)	$\text{Al}_{12}(\text{OH})_{26}[\text{SO}_4]_5 \cdot 20\text{H}_2\text{O}$
Wermlandite family (x = 4.0-5.5)	
Mountkeithite (x = 4)	$\text{Mg}_{11}\text{Fe}_3^{3+}[\text{SO}_4]_{3,5}(\text{OH})_{24} \cdot 11\text{H}_2\text{O}$
Wermlandite	$\text{Mg}_8\text{Al}_2(\text{OH})_{18}[\text{SO}_4]_2 \cdot 12\text{H}_2\text{O}$
Motukoreaite	$\text{NaMg}_6\text{Al}_3(\text{OH})_{18}[\text{SO}_4]_2 \cdot 7\text{H}_2\text{O}$
Basaluminite family (x = 5-5.5)	
Basaluminite	$\text{Al}_4(\text{OH})_{10}[\text{SO}_4] \cdot 4\text{H}_2\text{O}$
Felsöbányaite	$\text{Al}_4(\text{OH})_{10}[\text{SO}_4] \cdot 4\text{H}_2\text{O}$
Hydrobasaluminite	$\text{Al}_4(\text{OH})_{10}[\text{SO}_4] \cdot 9\text{H}_2\text{O}$
*Nikischerite (x = 5,5)	$\text{Fe}^{2+}_6\text{Al}_3(\text{OH})_{18}[\text{Na}(\text{H}_2\text{O})_6][\text{SO}_4]_2 \cdot 6\text{H}_2\text{O}$
Shigaite (x = 5,5)	$*\text{Mn}^{2+}_6\text{Al}_3(\text{OH})_{18}[\text{Na}(\text{H}_2\text{O})_6][\text{SO}_4]_2 \cdot 6\text{H}_2\text{O}$
Carrboydite (x = 6)	$(\text{Ni}_{1-x}\text{Al}_x)[\text{SO}_4]_{x/2}(\text{OH})_2 \cdot n\text{H}_2\text{O}$ (x < 0.5, n > 3x/2)
*Kuzelite (x = 7)	$\text{Ca}_4\text{Al}_2(\text{OH})_{12}[\text{SO}_4] \cdot 6\text{H}_2\text{O}$
Jamborite family (x = 9)	
Jamborite	$\text{Ni}^{2+}_{1-x}\text{Co}_x^{3+}(\text{OH})_{2-x}[\text{SO}_4]_x \cdot n\text{H}_2\text{O}$ where [x ≤ 1/3; n ≤ (1-x)]
Honessite	$(\text{Ni}_{1-x}\text{Fe}_x^{3+})(\text{OH})_2[\text{SO}_4]_{x/2} \cdot n\text{H}_2\text{O}$ (x < 0.5, n < 3x/2)

Hydrohonesite $(\text{Ni}_{1-x}\text{Fe}_x^{3+})(\text{OH})_2[\text{SO}_4]_{x/2}n\text{H}_2\text{O}$ ($x < 0.5$, $n > 3x/2$)

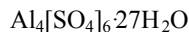
Copper-aluminium analog of honessite

Copper-aluminium analog of hydrohonesite

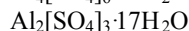
3.2.5.1.1.1.4.2. Neutral ($x = 1$)

Alunogen family

Meta-alunogen

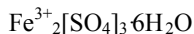


Alunogen

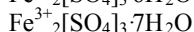


Coquimbite family

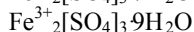
Lausenite



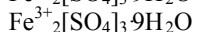
Kornelite



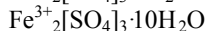
Paracoquimbite



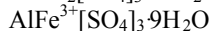
Coquimbite



Quenstedtite



*Aluminocoquimbite

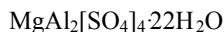


Römerite

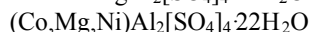


Halotrichite group

Pickeringite



*Wupatkiite



Halotrichite



Apjohnite



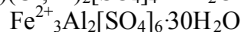
Bilinite



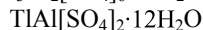
Redingtonite



*Caichengyunite



*Lanmuchangite

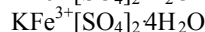


Goldichite family

Krausite

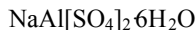


Goldichite



Tamarugite family

Tamarugite



Amarillite

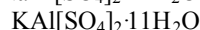


Mendozite group

Mendozite

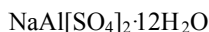


Kalinite

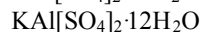


Alum group

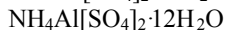
Sodium alum



Potassium alum



Tschermigite



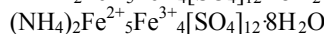
Lonecreekite



Voltaite



*Ammoniovoltaite



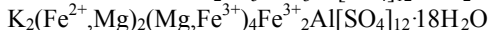
*Ammoniomagnesiovoltaite



*Zincovoltaite



*Pertlikite

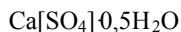


Ferrinatrite

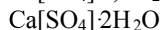


Gypsum family

Bassanite



Gypsum



*Omongwaite



Kieserite family (compare with gunningite (series))

Kieserite



*Cobaltkieserite	$\text{Co}[\text{SO}_4]\cdot\text{H}_2\text{O}$
Dwornikite	$\text{Ni}[\text{SO}_4]\cdot\text{H}_2\text{O}$
Szomolnokite	$\text{Fe}[\text{SO}_4]\cdot\text{H}_2\text{O}$
Szmikite	$\text{Mn}[\text{SO}_4]\cdot\text{H}_2\text{O}$
Sanderite	$\text{Mg}[\text{SO}_4]\cdot 2\text{H}_2\text{O}$
Rozenite family (compare with boyleite (family))	
Starkeyite	$\text{Mg}[\text{SO}_4]\cdot 4\text{H}_2\text{O}$
* β -starkeyite	$\text{Mg}[\text{SO}_4]\cdot 4\text{H}_2\text{O}$
*Cranswickite	$\text{Mg}[\text{SO}_4]\cdot 4\text{H}_2\text{O}$
Aplowite	$\text{Co}[\text{SO}_4]\cdot 4\text{H}_2\text{O}$
Rozenite	$\text{Fe}[\text{SO}_4]\cdot 4\text{H}_2\text{O}$
Pentahydrate group (compare with chalcantite (group))	
Pentahydrate	$\text{Mg}[\text{SO}_4]\cdot 5\text{H}_2\text{O}$
Siderotil	$\text{Fe}[\text{SO}_4]\cdot 5\text{H}_2\text{O}$
Jokokuite	$\text{Mn}[\text{SO}_4]\cdot 5\text{H}_2\text{O}$
*Chvaleticeite	$\text{Mn}[\text{SO}_4]\cdot 6\text{H}_2\text{O}$
Hexahydrate family(ср.вианкита (гр.))	
Hexahydrate group	
Hexahydrate	$\text{Mg}[\text{SO}_4]\cdot 6\text{H}_2\text{O}$
Retgersite	$\text{Ni}[\text{SO}_4]\cdot 6\text{H}_2\text{O}$
Moorhouseite group	
Nickelhexahydrate	$\text{Ni}[\text{SO}_4]\cdot 6\text{H}_2\text{O}$
Moorhouseite	$\text{Co}[\text{SO}_4]\cdot 6\text{H}_2\text{O}$
Ferrohexahydrate	$\text{Fe}[\text{SO}_4]\cdot 6\text{H}_2\text{O}$
Epsomite group	
Epsomite	$\text{Mg}[\text{SO}_4]\cdot 7\text{H}_2\text{O}$
Morenosite	$\text{Ni}[\text{SO}_4]\cdot 7\text{H}_2\text{O}$
Tauriscite	$\text{Fe}[\text{SO}_4]\cdot 7\text{H}_2\text{O}$
Melanterite group	
Bieberite	$\text{Co}[\text{SO}_4]\cdot 7\text{H}_2\text{O}$
Melanterite	$(\text{Fe},\text{Mg})[\text{SO}_4]\cdot 7\text{H}_2\text{O}$
Mallardite	$\text{Mn}[\text{SO}_4]\cdot 7\text{H}_2\text{O}$
Polyhalite family	
Görgeyite	$\text{K}_2\text{Ca}_5[\text{SO}_4]_6\cdot\text{H}_2\text{O}$
Polyhalite	$\text{K}_2\text{MgCa}_2[\text{SO}_4]_4\cdot 2\text{H}_2\text{O}$
Syngenite	$\text{K}_2\text{Ca}[\text{SO}_4]_2\cdot\text{H}_2\text{O}$
Eugsterite family	
Eugsterite	$\text{Na}_4\text{Ca}[\text{SO}_4]_3\cdot 2\text{H}_2\text{O}$
Hydroglauberite	$\text{Na}_{10}\text{Ca}_3[\text{SO}_4]_8\cdot 6\text{H}_2\text{O}$
Blödite family	
Blödite	$\text{Na}_2\text{Mg}[\text{SO}_4]_2\cdot 4\text{H}_2\text{O}$
*Cobaltblödite	$\text{Na}_2\text{Co}[\text{SO}_4]_2\cdot 4\text{H}_2\text{O}$
*Manganoblödite	$\text{Na}_2\text{Mn}[\text{SO}_4]_2\cdot 4\text{H}_2\text{O}$
Nickelblödite	$\text{Na}_2(\text{Ni},\text{Mg})[\text{SO}_4]_2\cdot 4\text{H}_2\text{O}$
Wattevillite	$\text{Na}_2\text{Ca}[\text{SO}_4]_2\cdot 4\text{H}_2\text{O} (?)$
Leonite	$\text{K}_2\text{Mg}[\text{SO}_4]_2\cdot 4\text{H}_2\text{O}$
Löweite	$\text{Na}_{12}\text{Mg}_7[\text{SO}_4]_{13}\cdot 15\text{H}_2\text{O}$
Konyaite	$\text{Na}_2\text{Mg}[\text{SO}_4]_2\cdot 5\text{H}_2\text{O}$
Picromerite group	
Picromerite	$\text{K}_2\text{Mg}[\text{SO}_4]_2\cdot 6\text{H}_2\text{O}$

*Nickelpicromerite	$K_2Ni[SO_4]_2 \cdot 6H_2O$
Boussingaultite	$(NH_4)_2Mg[SO_4]_2 \cdot 6H_2O$
Nickelboussingaultite	$(NH_4)_2(Ni,Mg)[SO_4]_2 \cdot 6H_2O$
Mohrite	$(NH_4)_2Fe^{2+}[SO_4]_2 \cdot 6H_2O$
*Mereiterite	$K_2Fe^{2+}[SO_4]_2 \cdot 4H_2O$
Mirabilite	$Na_2[SO_4] \cdot 10H_2O$
Koktaite	$(NH_4)_2Ca[SO_4]_2 \cdot H_2O$
Lecontite	$Na(NH_4,K)[SO_4] \cdot 2H_2O$
*3.2.5.1.1.2. Sulfato-borates	
*Tatarinovite	$Ca_3Al[SO_4](OH)_6[B(OH)_4] \cdot 12H_2O$
*3.2.5.1.1.3. Sulfato-orthophosphato-halogenides	
*3.2.5.1.1.3.1. Hydrates	
*Arangasite	$Al_2[SO_4][PO_4]F$
3.2.5.1.1.4. Sulfato-nitrates	
3.2.5.1.1.4.1. Sulfato-nitrates with $SO_4 : NO_3 = 3$	
3.2.5.1.1.4.1.1. Hydrates (acid)	
Ungemachite group	
Ungemachite	$K_3Na_8Fe^{3+}[SO_4]_6[NO_3]_2 \cdot 6H_2O$
Humberstonite	$K_3Na_7Mg_2[SO_4]_6[NO_3]_2 \cdot 6H_2O$
*3.2.5.1.1.4.2. Sulfato-nitrates with $SO_4 : NO_3 = 2$	
3.2.5.1.1.4.2.1. Hydrates	
*Witzkeite	$Na_4K_4Ca[SO_4]_4[NO_3]_2 \cdot 2H_2O$
3.2.5.1.1.4.3. Sulfato-nitrates with $SO_4 : NO_3 = 1$	
3.2.5.1.1.4.3.1. Hydrates (basic)	
Darapskite	$Na_3[SO_4][NO_3] \cdot H_2O$
3.2.5.1.1.4.4. Sulfato-nitrates with $SO_4 : NO_3 = 0,1(6)$	
3.2.5.1.1.4.4.1. Hydrates (basic)	
Mbobomkulite	$(Ni,Cu^{2+})Al_4(OH)_{12}[NO_3,SO_4]_2 \cdot 3H_2O$
*3.2.5.1.1.5. Sulfato-halogenides	
*3.2.5.1.1.5.1. Hydrates	
*Khademite	$Al[SO_4]F \cdot 5H_2O$
*Vlodavetsite	$Ca_2Al[SO_4]_2F_2Cl \cdot 4H_2O$
*Vendidaite	$Al_2[SO_4](OH)_3Cl \cdot 6H_2O$
*Wilcoxite	$MgAl[SO_4]_2F \cdot 18H_2O$
Xitieshanite (x = 1,5)	$Fe^{3+}[SO_4]Cl \cdot 6H_2O$
Kainite (x = 1,5)	$KMg[SO_4]Cl \cdot 3H_2O$
3.2.5.1.1.6. Sulfato-iodates	
3.2.5.1.1.6.1. Neutral	
Hectorfloresite	$Na_9[SO_4][IO_3]$
*3.2.5.1.1.6.1.1. Hydrates	
*Fuenzalidaite	$K_6Na_4Na_6Mg_{10}[SO_4]_{12}[IO_3]_{12} \cdot 12H_2O$
3.2.5.1.1.7. Sulfato-fluoraluminates	
3.2.5.1.1.7.1. Hydrates (acid)	
*Meniaulovite	$Ca_4AlSi[SO_4]F_{13} \cdot 12H_2O$

Creedite $\text{Ca}_3[\text{SO}_4][\text{Al}_2\text{F}_8(\text{OH})_2] \cdot 2\text{H}_2\text{O}$

3.2.5.1.1.8. Acid sulfates (hydrosulfates)

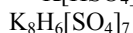
3.2.5.1.1.8.1. Proper hydrosulfates 3.2.5.1.1.8.1.1. Neutral

Mercallite family

Mercallite

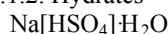


Misenite



3.2.5.1.1.8.1.2. Hydrates

Matteuccite



3.2.5.1.1.8.2. Hydrosulfato-sulfates

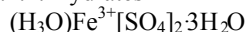
3.2.5.1.1.8.2.1. Neutral

Letovicite

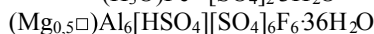


3.2.5.1.1.8.2.2. Hydrates

Rhombochase

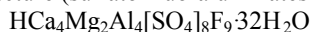


*Cossaite



3.2.5.1.1.9. Sulfates with unknown structure (sulfato-fluoraluminates ?)

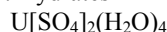
Lannonite



3.2.5.1.2. Sulfates of *f*-elements

*3.2.5.1.2.1. Hydrates

*B  hounekite



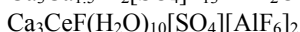
3.2.5.1.2.2. Sulfato-fluoraluminates (0,5:1) 3.2.5.1.2.2.1. Hydrates (basic)

Chukhrovite group

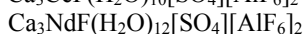
*Chukhrovite-(Ca)



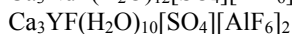
Chukhrovite-(Ce)



*Chukhrovite-(Nd)

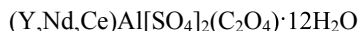


Chukhrovite-(Y)

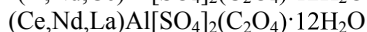


*3.2.5.1.2.3. Sulfato-oxalates

*Levinsonite-(Y)



*Zugshunsite-(Ce)

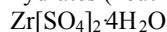


3.2.5.2. Subclass: Sulfates of cations with middle FC

3.2.5.2.1. Sulfates of Zr

3.2.5.2.1.1. Hydrates (neutral)

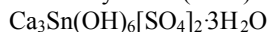
Zircosulfate



*3.2.5.2.2. Sulfates of Sn

*3.2.5.2.2.1. Hydrates (basic)

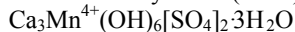
*Genplesite



3.2.5.2.3. Sulfates of Mn^{4+}

3.2.5.2.3.1. Hydrates (basic)

Despujolsite



3.2.5.2.4. Sulfates of V^{4+}

3.2.5.2.4.1. Средние

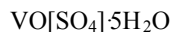
*Pauflerite



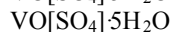
3.2.5.2.4.1.1. Hydrates (oxido)

Minasragrite family

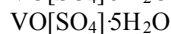
Minasragrite



*Orthominasragrite



*Anorthominasragrite



Stanleyite	$\text{VO}[\text{SO}_4] \cdot 6\text{H}_2\text{O}$
*Bobjonessite	$\text{VO}[\text{SO}_4] (\text{H}_2\text{O})_3$
*Karpovite	$\text{Ti}_2\text{VO}[\text{SO}_4]_2 (\text{H}_2\text{O})$
*Evdokimovite	$\text{Ti}_4[\text{VO}]_3[\text{SO}_4]_5 (\text{H}_2\text{O})_5$

3.2.5.3. Sulfates of chalcophylic elements

3.2.5.3.1. Sulfates of Ag^+	3.2.5.3.1.1. Basic
Argentojarosite (comp. with alunite (gr.))	$\text{AgFe}^{3+}_3(\text{OH})_6[\text{SO}_4]_2$

3.2.5.3.2. Sulfates of Cu	3.2.5.3.2.1. Neutral
Chalcocyanite ($x = 1$)	$\text{Cu}[\text{SO}_4]$
*Dravertite ($x = 1$)	$\text{CuMg}[\text{SO}_4]_2$
*Saranchinaite	$\text{NaCu}[\text{SO}_4]_2$

	3.2.5.3.2.2. Oxido-sulfates
*Cryptochalcite ($x = 1,2$)	$\text{K}_2\text{Cu}_5\text{O}[\text{SO}_4]_5$
*Cesiodimite ($x = 1,2$)	$\text{CsKCu}_5\text{O}[\text{SO}_4]_5$
*Fedotovite ($x = 1,3$)	$\text{K}_2\text{Cu}_3\text{O}[\text{SO}_4]_3$
*Wulffite ($x = 1,5$)	$\text{K}_3\text{NaCu}_4\text{O}_2[\text{SO}_4]_4$
*Parawulffite ($x = 1,5$)	$\text{K}_5\text{Na}_3\text{Cu}_8\text{O}_4[\text{SO}_4]_8$
Klyuchevskite ($x = 1,5$)	$\text{K}_3\text{Cu}_3\text{Fe}^{3+}\text{O}_2[\text{SO}_4]_4$
*Alumoklyuchevskite ($x = 1,5$)	$\text{K}_3\text{Cu}_3\text{AlO}_2[\text{SO}_4]_4$
*Eleomelanit ($x = 1,5$)	$(\text{K}_2\text{Pb})\text{Cu}_4\text{O}_2[\text{SO}_4]_4$
Dolerophanite ($x = 2$)	$\text{Cu}_2\text{O}[\text{SO}_4]$

	3.2.5.3.2.3. Basic and sulfato-halogenides
Piypite ($x = 1,08$)	$\text{K}_4(\text{Na,Cu})\text{Cu}_4\text{O}_2\text{Cl}[\text{SO}_4]_4$
Kamchatkite ($x = 1,75$)	$\text{KCu}_3\text{OCl}[\text{SO}_4]_2$
Chlorothionite ($x = 2$)	$\text{K}_2\text{CuCl}_2[\text{SO}_4]$
Antlerite ($x = 3$)	$\text{Cu}_3(\text{OH})_4[\text{SO}_4]$
Brochantite ($x = 4$)	$\text{Cu}_4(\text{OH})_6[\text{SO}_4]$
*Grandviewite ($x = 8,25$)	$\text{Cu}_3\text{Al}_9(\text{OH})_{29}[\text{SO}_4]_6$
	3.2.5.3.2.4. Hydrates

Cuprocopiapite group

Cuprocopiapite ($x = 1,1(6)$)	$\text{Cu}^{2+}\text{Fe}^{3+}_4(\text{OH})_2[\text{SO}_4]_6 \cdot 20\text{H}_2\text{O}$
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(compare with copiapite (group))

Aubertite family ($x = 1,25$)

Magnesiaaubertite	$(\text{Mg,Cu})\text{AlCl}[\text{SO}_4]_2 \cdot 14\text{H}_2\text{O}$
Aubertite	$\text{Cu}^{2+}\text{AlCl}[\text{SO}_4]_2 \cdot 14\text{H}_2\text{O}$
Guildite	$\text{Cu}^{2+}\text{Fe}^{3+}(\text{OH})[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$
Natrochalcite ($x = 1,25$)	$\text{NaCu}^{2+}_2(\text{OH})[\text{SO}_4]_2 \cdot \text{H}_2\text{O}$
*Kaliochalcite	$\text{KCu}_2(\text{OH})[\text{SO}_4]_2(\text{H}_2\text{O})$

Devilline family ($x = 2,5$)

Devilline	$\text{CaCu}^{2+}_4(\text{OH})_6[\text{SO}_4]_2 \cdot 3\text{H}_2\text{O}$
*Vonbezingite	$\text{Ca}_6\text{Cu}^{2+}_3(\text{OH})_{12}[\text{SO}_4]_3 \cdot 2\text{H}_2\text{O}$
*Lautenthalite	$\text{Cu}^{2+}_4\text{Pb}(\text{OH})_6[\text{SO}_4]_2 \cdot 3\text{H}_2\text{O}$
Campigliaite	$\text{Cu}^{2+}_4\text{Mn}^{2+}(\text{OH})_6[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Niedermayrite	$\text{Cu}^{2+}_4\text{Cd}^{2+}(\text{OH})_6[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Edwardsite	$\text{Cu}^{2+}_3\text{Cd}^{2+}_2(\text{OH})_6[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$

Langite family ($x = 4$)

Posnjakite	$\text{Cu}_4(\text{OH})_6[\text{SO}_4] \cdot \text{H}_2\text{O}$
Langite	$\text{Cu}_4(\text{OH})_6[\text{SO}_4] \cdot 2\text{H}_2\text{O}$

Wroewolfeite	$\text{Cu}_4(\text{OH})_6[\text{SO}_4] \cdot 2\text{H}_2\text{O}$
*Kobayashveite	$\text{Cu}^{2+}_5(\text{OH})_6[\text{SO}_4]_2 \cdot 2\text{H}_2\text{O}$
*Redgillite	$\text{Cu}^{2+}_6(\text{OH})_{10}[\text{SO}_4] \cdot \text{H}_2\text{O}$
*Montetrisaite	$\text{Cu}^{2+}_6(\text{OH})_{10}[\text{SO}_4] \cdot \text{H}_2\text{O}$
Chalcoalumite (x = 7)	$\text{CuAl}_4(\text{OH})_{12}[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Cyanotrichite group (x = 7)	
Cyanotrichite	$\text{Cu}^{2+}_4\text{Al}_2(\text{OH})_{12}[\text{SO}_4] \cdot 2\text{H}_2\text{O}$
Carbonate-cyanotrichite	$\text{Cu}^{2+}_4\text{Al}_2(\text{OH})_{12}[(\text{CO}_3)_3(\text{SO}_4)] \cdot 2\text{H}_2\text{O}$
Woodwardite	$(\text{Cu}^{2+}, \text{Al})_9(\text{OH})_{18}[\text{SO}_4]_2 \cdot n\text{H}_2\text{O}$
*Hydrowoodwardite	$[\text{Cu}^{2+}_{1-x}\text{Al}_x(\text{OH})_2][(\text{SO}_4)_{x/2}(\text{H}_2\text{O})_n] \quad x < 0.5, n > 3x/2n$
*Camerolaite	$\text{Cu}_6\text{Al}_3(\text{OH})_{18}(\text{H}_2\text{O})_2[\text{SO}_4][\text{Sb}(\text{OH})_6]$
Spangolite (x = 7,5)	$\text{Cu}^{2+}_6\text{Al}(\text{OH})_{12}\text{Cl}[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Connellite (x = 19)	$\text{Cu}^{2+}_{19}(\text{OH})_{32}\text{Cl}_4[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
	3.2.5.3.2.4.2. Neutral
Ransomite (x = 1)	$\text{Cu}^{2+}\text{Fe}^{3+}_2[\text{SO}_4]_4 \cdot 6\text{H}_2\text{O}$
Chalcantite family (x = 1) (compare with pentahydrate; melanterite (group))	
Bonattite	$\text{Cu}[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Chalcantite	$\text{Cu}[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
Boothite	$\text{Cu}[\text{SO}_4] \cdot 7\text{H}_2\text{O}$
Kröhnkite (x = 1)	$\text{Na}_2\text{Cu}[\text{SO}_4]_2 \cdot 2\text{H}_2\text{O}$
Leightonite (x = 1)	$\text{K}_2\text{Ca}_2\text{Cu}[\text{SO}_4]_4 \cdot 2\text{H}_2\text{O}$
Cyanochroite (x = 2)	$\text{K}_2\text{Cu}[\text{SO}_4]_2 \cdot 6\text{H}_2\text{O}$
(compare with picromerite (group))	
*Alpersite	$(\text{Mg}, \text{Cu})[\text{SO}_4] \cdot 7\text{H}_2\text{O}$
3.2.5.3.3. Sulfates of Hg^{2+}	3.2.5.3.3.1. Oxido (nitrido)-sulfates
Schuetite family	
Schuetite	$\text{Hg}^{2+}_3\text{O}_2[\text{SO}_4]$
Gianellaite	$\text{Hg}^{2+}_4\text{N}_2[\text{SO}_4](\text{H}_2\text{O})_x$
3.2.5.3.4. Sulfates of Zn	
*3.2.5.3.4.1. Proper sulfates	*3.2.5.3.4.1.1. Neutral
Zincosite	$\text{Zn}[\text{SO}_4]$
	3.2.5.3.4.1.2. Hydrates
Gunningite family (comp. with kieserite (family))	
Gunningite	$\text{Zn}[\text{SO}_4] \cdot \text{H}_2\text{O}$
Poitevinite	$(\text{Cu}, \text{Fe}, \text{Zn})[\text{SO}_4] \cdot \text{H}_2\text{O}$
Boyleite family (comp. with rozenite (gr.))	
Boyleite	$\text{Zn}[\text{SO}_4] \cdot 4\text{H}_2\text{O}$
Ilesite	$(\text{Mn}, \text{Zn})[\text{SO}_4] \cdot 4\text{H}_2\text{O}$
Bianchite	$\text{Zn}[\text{SO}_4] \cdot 6\text{H}_2\text{O}$
Goslarite family	
Goslarite	$\text{Zn}[\text{SO}_4] \cdot 7\text{H}_2\text{O}$
Zinc-melanterite	$(\text{Zn}, \text{Cu}, \text{Fe}^{2+})[\text{SO}_4] \cdot 7\text{H}_2\text{O}$
*Changoite (x = 1)	$\text{Na}_2\text{Zn}[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$
*Lishizhenite (x = 1)	$\text{ZnFe}^{3+}_2[\text{SO}_4]_4 \cdot 14\text{H}_2\text{O}$
Dietrichite (x = 1)	$\text{ZnAl}_2[\text{SO}_4]_4 \cdot 22\text{H}_2\text{O}$
3.2.5.3.4.1.3. Basic	3.2.5.3.4.1.3.1. Hydrates
Zincocopiapite (x = 1,1(6))	$\text{ZnFe}^{3+}_4(\text{OH})_2[\text{SO}_4]_6 \cdot 18\text{H}_2\text{O}$
*Chaidamuite (x = 1,25)	$\text{ZnFe}^{3+}(\text{OH})[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$

Ktenasite family

Serpierite	$\text{Ca}(\text{Cu},\text{Zn})_4(\text{OH})_6[\text{SO}_4]_2 \cdot 3\text{H}_2\text{O}$
*Orthoserpierite	$\text{Ca}(\text{Cu},\text{Zn})_4(\text{OH})_6[\text{SO}_4]_2 \cdot 3\text{H}_2\text{O}$
Ktenasite	$(\text{Cu},\text{Zn})_5(\text{OH})_6[\text{SO}_4]_2 \cdot 6\text{H}_2\text{O}$
*Christelite	$\text{Zn}_3\text{Cu}_2(\text{OH})_6[\text{SO}_4]_2 \cdot 4\text{H}_2\text{O}$

Schulenbergite family

Schulenbergite (x = 3,5)	$(\text{Cu},\text{Zn})_7(\text{OH})_{10}[(\text{SO}_4)_5(\text{CO}_3)]_2 \cdot 3\text{H}_2\text{O}$
Ramsbeckite (x = 3,75)	$(\text{Cu},\text{Zn})_{15}(\text{OH})_{22}[\text{SO}_4]_4 \cdot 6\text{H}_2\text{O}$
*Osakaite	$\text{Zn}_4(\text{OH})_6[\text{SO}_4] \cdot 5\text{H}_2\text{O}$
*Lanshtainite (x = 4)	$\text{Zn}_4(\text{OH})_6[\text{SO}_4] \cdot 3\text{H}_2\text{O}$
Namuwite (x = 4)	$(\text{Zn},\text{Cu})_4(\text{OH})_6[\text{SO}_4] \cdot 4\text{H}_2\text{O}$
Zincaluminite (x = 5,5)	$(\text{Zn},\text{Al})_9(\text{OH})_{18}[\text{SO}_4]_2 \cdot n\text{H}_2\text{O}$
Glaucozerinite (x = 6,(3))	$\text{Zn}_{1-x}\text{Al}_x(\text{OH})_2[\text{SO}_4]_{x/2} \cdot n\text{H}_2\text{O}$ (x < 0.5, n > 3x/2)
*Natroglaucocerinite	$[\text{Zn}_{8-x}\text{Al}_x(\text{OH})_{16}][(\text{SO}_4)_{x/2+y/2}\text{Na}_y(\text{H}_2\text{O})_6]$
*Zincowoodvardite	$[\text{Zn}_{1-x}\text{Al}_x(\text{OH})_2][(\text{SO}_4)_{x/2}(\text{H}_2\text{O})_n]$ (x < 0.5, n > 3x/2)
*Kyrgyzstanite (x = 7.0)	$\text{ZnAl}_4(\text{OH})_{12}[\text{SO}_4] \cdot 3\text{H}_2\text{O}$

Torreyite family (x = 6,5)

Torreyite	$(\text{Mg},\text{Mn})_9\text{Zn}_4(\text{OH})_{22}[\text{SO}_4]_2 \cdot 8\text{H}_2\text{O}$
Lawsonbauerite	$(\text{Mn},\text{Mg})_9\text{Zn}_4(\text{OH})_{22}[\text{SO}_4]_2 \cdot 8\text{H}_2\text{O}$

Mooreite family (x = 7,5)

Mooreite	$\text{Mg}_9\text{Zn}_4\text{Mn}_2(\text{OH})_{26}[\text{SO}_4]_2 \cdot 8\text{H}_2\text{O}$
*3.2.5.3.4.2. Sulfato-halogenides	*3.2.5.3.4.2.1. Neutral
*Belousovite (x = 1)	$\text{KZnCl}[\text{SO}_4]$
	*3.2.5.3.4.2.2. Basic
*Gordaite (x = 4,5)	$\text{NaZn}_4(\text{OH})_6\text{Cl}[\text{SO}_4] \cdot 6\text{H}_2\text{O}$
*Thérèse magnanite (x = 4,5)	$\text{NaCo}_4(\text{OH})_6\text{Cl}[\text{SO}_4] \cdot 6\text{H}_2\text{O}$
*Guarinoite (x = 6)	$(\text{Zn},\text{Co},\text{Ni})_6(\text{OH},\text{Cl})_{10}[\text{SO}_4] \cdot 5\text{H}_2\text{O}$

***3.2.5.3.5. Sulfates of Tl^+**

*Markhininite	$\text{Tl}^+\text{Bi}^{3+}[\text{SO}_4]_2$
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3.2.5.3.6. Sulfates of Tl^{3+}

Monsmedite = voltaite with Tl

3.2.5.3.6.1. Hydrates (neutral)**3.2.5.3.7. Sulfates of Pb^{2+}**

Anglesite (comp. with barite (gr.))	$\text{Pb}[\text{SO}_4]$
Palmierite	$(\text{K},\text{Na})_2\text{Pb}[\text{SO}_4]_2$

3.2.5.3.7.1. Neutral**3.2.5.3.7.2. Basic and oxido-sulfates, sulfato-halogenides**

Caracolite (x = 1,1(6))	$\text{Na}_3\text{Pb}_2\text{Cl}[\text{SO}_4]_3$
Wherryite (x = 1,5)	$\text{Pb}_7\text{Cu}_2(\text{OH})_2[\text{SO}_4]_4[\text{SiO}_4]_2$

Linarite family (x = 2)

Lanarkite	$\text{Pb}_2\text{O}[\text{SO}_4]$
Grandreefite	$\text{Pb}_2\text{F}_2[\text{SO}_4]$
Linarite	$\text{PbCu}^{2+}(\text{OH})_2[\text{SO}_4]$
Plumbojarosite (x = 2,5)	$\text{PbFe}^{3+}_6(\text{OH})_{12}[\text{SO}_4]_4$
Osarizawaite (x = 2,5)	$\text{PbCuAl}_2(\text{OH})_6[\text{SO}_4]_2$
Chenite (x = 2,5)	$\text{Pb}_4\text{Cu}(\text{OH})_6[\text{SO}_4]_2$
*Beaverite-(Zn) (x = 2,5)	$\text{PbFe}^{3+}_2\text{Zn}(\text{OH})_6[\text{SO}_4]_2$
Beaverite (x = 2,75)	$\text{Pb}(\text{Fe},\text{Cu},\text{Al})_3(\text{OH},\text{H}_2\text{O})_6[\text{SO}_4]_2$

*Krivovichevite (x = 4,5)	$\text{Pb}_3\text{Al}(\text{OH})_7[\text{SO}_4]$
Elyite (x=5)	$\text{Pb}_4\text{Cu}(\text{OH})_8[\text{SO}_4]$
Pseudograndreefite (x = 6)	$\text{Pb}_6\text{F}_{10}[\text{SO}_4]$
Sundiusite (x = 10)	$\text{Pb}_{10}\text{O}_8\text{Cl}_2[\text{SO}_4]$
*Symesite	*3.2.5.3.6.2.1. Hydrates $\text{Pb}_{10}\text{O}_7\text{Cl}_4[\text{SO}_4]\cdot\text{H}_2\text{O}$
*3.2.5.3.7.3. Oxido-thiosulphates	*3.2.5.3.7.3.1. Basic
*Sidpietersite	$\text{Pb}^{2+}_4(\text{S}^{6+}\text{O}_3\text{S}^{2-})\text{O}_2(\text{OH})_2$
*Steverustite	*3.2.5.3.7.3.2. Hydrates $\text{Pb}^{2+}_5\text{Cu}^+(\text{S}^{6+}\text{O}_3\text{S}^{2-})_3(\text{OH})_5\cdot 2\text{H}_2\text{O}$
*3.2.5.3.7.4. Sulfato-arsenates	*3.2.5.3.7.4.1. Hydrates (basic)
*Mallestigite (x = 2,75)	$\text{Pb}_3\text{Sb}(\text{OH})_6[(\text{SO}_4),(\text{AsO}_4)]\cdot 3\text{H}_2\text{O}$
3.2.5.3.8. Sulfates of Ge^{4+}	3.2.5.3.8.1. Basic
Itoite (x = 2,5)	$\text{Pb}_3^{(6)}\text{Ge}^{4+}(\text{OH})_2\text{O}_2[\text{SO}_4]_2$
Fleischerite family (x = 2,5)	3.2.5.3.8.2. Hydrates (basic)
Schaurteite	$\text{Ca}_3^{(6)}\text{Ge}^{4+}(\text{OH})_6[\text{SO}_4]_2\cdot 3\text{H}_2\text{O}$
Fleischerite	$\text{Pb}_3\text{Ge}^{4+}(\text{OH})_6[\text{SO}_4]_2\cdot 3\text{H}_2\text{O}$
*3.2.5.3.8.2.1. Sulfato-carbonates	
*Carraraite	$\text{Ca}_3\text{Ge}(\text{OH})_6[\text{SO}_4][\text{CO}_3]\cdot 12\text{H}_2\text{O}$
3.2.5.3.9. Sulfates of As^{3+} , Sb^{3+} , Bi^{3+}	*3.2.5.9.1. Neutral
*Markhininite	$\text{Tl}^+\text{Bi}^{3+}[\text{SO}_4]_2$
*Riomarinaite (x = 1.5)	*3.2.5.3.9.2. Basic and hydrates $\text{Bi}^{3+}(\text{OH})[\text{SO}_4]\cdot\text{H}_2\text{O}$
*3.2.5.3.9.3. Oxido-sulfates	*3.2.5.3.9.3.1. Neutral
*Coquandite	$\text{Sb}^{3+}_6\text{O}_8[\text{SO}_4]\cdot\text{H}_2\text{O}$
Kleibelsbergite (x = 6)	*3.2.5.3.9.3.1. Basic and hydrates $\text{Sb}^{3+}_4\text{O}_4(\text{OH})_2[\text{SO}_4]$
*Tavagnascoite	$\text{Bi}_4\text{O}_4(\text{OH})_2[\text{SO}_4]$
*Cannonite	$\text{Bi}^{3+}_2\text{O}(\text{OH})_2[\text{SO}_4]$
Peretaite (x = 3,5)	$\text{CaSb}^{3+}_4\text{O}_4(\text{OH})_2[\text{SO}_4]_2\cdot 2\text{H}_2\text{O}$
3.2.6. Class: Sulfites	
3.2.6.1. Subclass: Sulfites of cations with low FC	
3.2.6.1.1. Sulfites of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s - cations	3.2.6.1.1.1. Hydrates (neutral)
Hannebachite	$\text{Ca}[\text{SO}_3]\cdot 0,5\text{H}_2\text{O}$
*Gravegliaitite	$\text{Mn}^{2+}[\text{SO}_3]\cdot 3\text{H}_2\text{O}$
*3.2.6.1.2. Sulfito-sulfates	*3.2.6.1.2.1. Hydrates
*Orschallite	$\text{Ca}_3[\text{SO}_3]_2[\text{SO}_4]\cdot 12\text{H}_2\text{O}$
*Hielscherite	$\text{Ca}_3\text{Si}(\text{OH})_6[\text{SO}_3][\text{SO}_4]\cdot 11\text{H}_2\text{O}$
3.2.6.2. Subclass: Sulfites of chalcophylic cations	3.2.6.2.1. Neutral

Scotlandite

3.2.6a. **Class:** Selenates3.2.6a.1. Subclass: Selenates of chalcophylic cations (Pb²⁺)

3.2.6a.1.1. Proper selenates

3.2.6a.1.1.1. Neutral

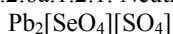
Kerstenite



3.2.6a.1.2. Selnato-sulfates (1 : 1)

3.2.6a.1.2.1. Neutral

Olsacherite



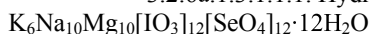
*3.2.6a.1.3. Selenato-iodates

3.2.6a.1.3.1. Proper

*3.2.6a.1.3.1.1. Complex

3.2.6a.1.3.1.1.1. Hydrates

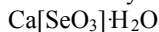
*Carlosruizite

3.2.6b. **Class:** Selenites

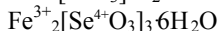
3.2.6b.1. Subclass: Selenites of cations with low FC

3.2.6b.1.1. Selenites of *s*-, *d*_s- and *p*_s- cations 3.2.6b.1.1.1. Hydrates (neutral)

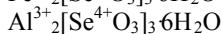
*Nestolaite



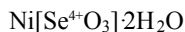
Mandarinioite



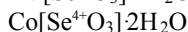
*Alfredopetrovite

**Ahlfeldite** group

Ahlfeldite



Cobaltomenite



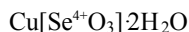
3.2.6b.2. Subclass : Selenites of chalcophylic elements

3.2.6b.2.1. Selenites of Cu²⁺

3.2.6b.2.1.1. Hydrates (neutral)

Chalcomenite family

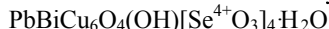
Chalcomenite



*3.2.6b.2.1.2. Selenito-oxides

*3.2.6b.2.1.2.1. Basic and hydrates

*Favreauxite



*3.2.6b.2.1.3. Selenito-sulfates

*3.2.6b.2.1.3.1. Basic and hydrates

*Pauladamsite



*3.2.6b.2.1.4. Selenito-oxido-halogenides

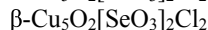
*Ilinskite



*Georgbokiite



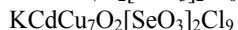
*Parageorgbokiite



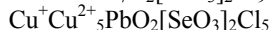
*Nicksobolevite



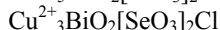
*Burnsite



*Allochalcoseelite



*Francisite



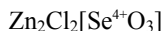
3.2.6b.2.2. Selenites of Zn

*Zincomenite



3.2.6b.2.2.1. Basic selenites and selenito-halogenides

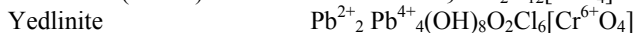
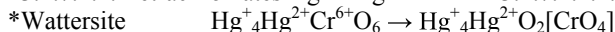
Sophiite = softite



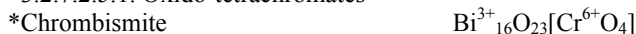
*3.2.6b.2.2.2. Oxido-selenito-halogenides

*Chloromenite	$\text{Cu}_9\text{O}_2[\text{Se}^{4+}\text{O}_3]_4\text{Cl}_6$
*Prewittite	$\text{KPb}_{1.5}\text{ZnCu}^{2+}_6\text{O}_2[\text{Se}^{4+}\text{O}_3]_2\text{Cl}_{10}$
3.2.6b.2.3. Selenites of Pb^{2+}	
3.2.6b.2.3.1. Proper selenites	3.2.6b.3.2.3.1.1. Neutral
Molybdomenite	$\text{Pb}[\text{Se}^{4+}\text{O}_3]$
	*3.2.6b.2.3.2. Oxido-selenites
	$\text{Pb}_3\text{O}_2[\text{Se}^{4+}\text{O}_3]$
*Plumboselite	3.2.6b.2.3.3. Selenito-selenates (1 : 1)
	3.2.6b.2.3.2.1. Basic
Schmiederite	$\text{Pb}_2\text{Cu}^{2+}_2(\text{OH})_4[\text{Se}^{4+}\text{O}_3][\text{Se}^{6+}\text{O}_4]$
	*3.2.6b.2.3.4. Selenito-sulfates (1:1)
*3.2.6b.2.3.4. Selenito-sulfates (1:1)	*3.2.6b.2.3.4.1. Основные
*Munakataite	$\text{Pb}_2\text{Cu}^{2+}_2(\text{OH})_4[\text{Se}^{4+}\text{O}_3][\text{S}^{6+}\text{O}_4]$
	*3.2.6b.2.3.5. Selenito-chlorides
*3.2.6b.2.3.5. Selenito-chlorides	*3.2.6b.2.3.5.1. Средние
*Sarrabusite	$\text{Pb}_5\text{Cu}^{2+}\text{Cl}_4[\text{Se}^{4+}\text{O}_3]_4$
	*3.2.6b.2.3.5.2. Basic
*Unnamed	$\text{Pb}_4\text{Cu}^{2+}\text{Cl}_3[\text{Se}^{4+}\text{O}_3]_3(\text{OH})$
	*3.2.6b.2.3.5.3. Hydrates
*Orlandite	$\text{Pb}_3\text{Cl}_4[\text{Se}^{4+}\text{O}_3]\cdot\text{H}_2\text{O}$
3.2. 7. Class: Chromates	
3.2.7.1. Subclass: Chromates of cations with low FC	
3.2.7.1.1. Chromates of <i>s</i> -, <i>d</i> _s - and <i>p</i> _s - cations	
3.2.7.1.1.1. Proper chromates	
3.2.7.1.1.1.1. Trichromates (bichromates)	3.2.7.1.1.1.1.1. Neutral
Lopezite	$\text{K}_2[\text{Cr}_2\text{O}_7]$
3.2.7.1.1.1.2. Tetrachromates	3.2.7.1.1.2.1. Neutral
Chromatite	$\text{Ca}[\text{CrO}_4]$
Hashemite (compare with barite (group))	$\text{Ba}[(\text{Cr},\text{S})\text{O}_4]$
Tarapacáite	$\text{K}_2[\text{CrO}_4]$
	*3.2.7.1.1.1.2.1.1. Hydrates
*Unnamed	$\text{Ca}[\text{CrO}_4]\cdot 2\text{H}_2\text{O}$
3.2.7.1.1.2. Tetrachromato-iodates (0,5:1)	3.2.7.1.1.2.1. Neutral hydrates
Dietzeite	$\text{Ca}_2[\text{CrO}_4][\text{IO}_3]_2\cdot\text{H}_2\text{O}$
3.2.7.2. Subclass: Chromates of chalcophylic elements	
3.2.7.2.1. Tetrachromates of Pb^{2+}	3.2.7.2.1.1. Neutral
Crocoite	$\text{Pb}[\text{CrO}_4]$
	*3.2.7.2.1.2. Oxido-tetrachromates
*Reynoldsite	$\text{Pb}^{2+}_2\text{Mn}^{4+}_2\text{O}_5[\text{CrO}_4]$
	*3.2.7.2.1.3. Tetrachromato-silicates
*3.2.7.2.1.3. Tetrachromato-silicates	*3.2.7.2.1.3.1. Basic hydrates
*Maquartite	$\text{Pb}^{2+}_3\text{Cu}^{2+}(\text{OH})_4[\text{CrO}_4][\text{SiO}_3]\cdot 2\text{H}_2\text{O}$

*3.2.7.2.1.4. Тетрахроматы-галогениды

3.2.7.2.2. Tetrachromates Pb^{4+} 3.2.7.2.2.1. Oxido-and tetrachromato-halogenides*3.2.7.2.3. Tetrachromates Hg^{2+} *3.2.7.2.4. Tetrachromates Hg^+ и Hg^{2+} *3.2.7.2.4.1. Oxido-tetrachromates*3.2.7.2.5. Tetrachromates Bi^{3+}

*3.2.7.2.5.1. Oxido-tetrachromates



3.2.8. Class: Nitrates

3.2.8.1. Subclass: Nitrates of cations with low FC

3.2.8.1.1. Nitrates of *s*-, *d*_s- and *p*_s-cations

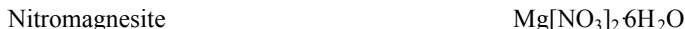
3.2.8.1.1.1. Neutral



3.2.8.1.1.2. Basic hydrates



3.2.8.1.1.2.1.1. Neutral



3.2.8.2. Subclass: Nitrates of chalcophylic elements

3.2.8.2.1. Nitrates of Cu^{2+}

3.2.8.2.1.1. Neutral



3.2.8.2.1.2. Basic

3.2.8.2.1.1. Basic



3.2.8.2.1.3. Hydrates (basic)

3.2.8a. **Class:** Iodates

3.2.8a.1. Subclass: Iodates of cations with low FC

3.2.8a.1.1. Iodates of *s*-, *d*_s- and *p*_s- cations

3.2.8a.1.1.1. Neutral



Brüggenite	3.2.8a.1.1.2. Hydrates (neutral) Ca[IO ₃] ₂ H ₂ O
*3.2.8a.1.2. Iodato-chromates *Georgeericksenite	*3.2.8a.1.2.1. Hydrates Na ₆ CaMg[IO ₃] ₆ [CrO ₄] ₂ (H ₂ O) ₁₂
3.2.8a.2. Subclass: Iodates of chalcophylic elements	
3.2.8a.2.1. Iodates of Cu ²⁺	3.2.8a.2.1.1. Basic
Salesite	Cu(OH)[IO ₃]
	3.2.8a.2.1.2. Hydrates
Bellingerite	Cu ₃ [IO ₃] ₆ ·2H ₂ O
3.2.8a.2.2. Iodates of Pb ²⁺	3.2.8a.2.2.1. Iodato-halogenides
Seeligerite	Pb ₃ OCl ₃ [IO ₃]
*3.2.8b. Class: Iodites	
*3.2.8b.1. Subclass: Iodites of chalcophylic elements	
*3.2.8b.1.1. Iodites Pb ²⁺	
*3.2.8b.1.1.1. Hydroxido-oxido-iodito-chalogenides	
Schwartzembergite	Pb ²⁺ ₅ I ³⁺ ₃ O ₆ H ₂ Cl ₃ → Pb ²⁺ ₅ (OH) ₂ O ₂ Cl ⁺ ₃ [I ³⁺ O ₂]

3.2.8c. **Class:** Rhodonates (tiocyanates)

4. TYPE: MINERALS WITH PRINCIPAL COVALENT-IONIC AND IONIC BOND – HALOGEN COMPAUNDS: HALOGENIDES (ISODESMICAL) → HALOGENSALTS (ANISODESMICAL)

4.1. SUBTYPE: HALOGENIDES (ISODESMICAL)

4.1.1. **Class:** Fluorides

4.1.1.1. Fluorides of *s*-, *d*_s- and *p*_s- cations

4.1.1.1.1. Fluorides of *s*-, *d*_s- and *p*_s- cations without Li and Be

4.1.1.1.1.1. Proper fluorides

4.1.1.1.1.1.1. Simple

Sellaite

4.1.1.1.1.1.1.1. Neutral

MgF₂

Fluorite group

Fluorite

CaF₂

Frankdicksonite

BaF₂

*Strontiofluorite

SrF₂

Villiaumite group

Villiaumite

NaF

Carobbiite

KF

*Oskarssonite

AlF₃

*4.1.1.1.1.1.2. Hydrates

*Rosenbergite

AlF[F_{0,5}(H₂O)_{0,5}]₄·H₂O

4.1.1.1.1.1.2. Complex

4.1.1.1.1.1.2.1. Neutral

Neighborite

NaMgF₃

*Yakobssonite

CaAlF₅

*Karasugite

SrCa[Al(F,OH)₇]

*Calcioaravaipaite

PbCa₂AlF₉

4.1.1.1.1.2. Fluorido-hexafluoraluminates

4.1.1.1.1.2.1. Neutral

Weberite family

Weberite	$\text{Na}_2\text{MgAlF}_7 \rightarrow \text{Na}_2\{\text{MgF}[\text{AlF}_6]\}^{\infty 3}$
Usovite	$\text{Ba}_2\text{CaMgAl}_2\text{F}_{14} \rightarrow \text{Ba}_2\{\text{CaMgF}_2[\text{AlF}_6]_2\}^{\infty 3}$
*Bøgvadite	$\text{Na}_2\text{SrBa}_2\text{Al}_4\text{F}_{20} \rightarrow \text{Na}_2\{\text{SrBa}_2\text{AlF}_2[\text{AlF}_6]_3\}$
*Coulsellite	$\text{CaNa}_3\text{Mg}_3\text{AlF}_{14} \rightarrow \text{Na}_3\{\text{CaMg}_3\text{F}_8[\text{AlF}_6]\}$ 4.1.1.1.2.2. Hydrates
Carlhintzeite	$\text{Ca}_2\text{AlF}_7\text{H}_2\text{O} \rightarrow \text{Ca}\{\text{CaF}[\text{AlF}_6]\}^{\infty 3}\text{H}_2\text{O}$
*Leonardsenite	$\text{MgAlF}_5\cdot 2\text{H}_2\text{O}$

*4.1.1.1.3. Fluorido-chlorides

*Rorisite	CaFCI
*Zhangpeishanite	BaFCI

4.1.1.1.2. Fluorides of Li

4.1.1.1.2.1. Simple	4.1.1.1.2.1.1. Neutral
Griceite	LiF

*4.1.1.1.2.2. Fluorido-hexafluoraluminates Li

*4.1.1.1.2.2.1. Complex	*4.1.1.1.2.2.1.1. Neutral
*Simmonsite	$\text{Na}_2\text{Li}[\text{AlF}_6]$

4.1.1.2. Fluorides of *f*-cations

4.1.1.2.1. Simple	4.1.1.2.1.1. Neutral
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Fluocerite series

Fluocerite-(Ce)	CeF_3
Fluocerite-(La)	LaF_3
*Waimirite-(Y)	YF_3
4.1.1.2.2. Complex	4.1.1.2.2.1. Neutral
Tveitite-(Y)	$(\text{Y},\text{Na})_6(\text{Ca},\text{Na},\text{REE})_{12}(\text{Ca},\text{Na})\text{F}_{42}$
*Zajacite-(Ce) = gagarinite-(Ce)	NaCaCeF_6
Gagarinite-(Y)	NaCaYF_6
*Polezhaevaite-(Ce)	NaSrCeF_6

*4.1.1.2.3. Oxido-fluorides

*Håleniusite-(La)	(La,Ce)OF
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*4.1.1.3. Fluorides of chalcophilic cations

*4.1.1.3.1. Fluorides of **Ib**-elements*4.1.1.3.1.1. Fluorides of Cu^{2+}

*Khaidarkanite	$\text{Cu}_4\text{Al}_3(\text{OH})_{14}\text{F}_3\cdot 2\text{H}_2\text{O}$
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*4.1.1.3.2. Fluorides of IVa-elements

*4.1.1.3.2.1. Fluorides Pb^{2+}

*4.1.1.3.2.1.1. Simple

*Fluorocronite	PbF_2
	*4.1.1.3.2.1.1.1. Основные
*Artroite	$\text{PbAl}(\text{OH})_2\text{F}_3$

*4.1.1.3.2.1.2. Fluorido-chlorides

*Laurelite	$\text{Pb}_7\text{F}_{12}\text{Cl}_2$
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*4.1.1.3.2.1.2.1. Fluorido-oxido-chlorides

*Rumseyite $[\text{Pb}_2\text{OF}]\text{Cl}$ 4.1.2. **Class:** Chlorides and bromides

4.1.2.1. Chlorides of cations with low FC

4.1.2.1.1. Chlorides of *s*-, *d*_s- and *p*_s- cations

4.1.2.1.1.1. Simple

4.1.2.1.1.1.1. Neutral

Molysite FeCl_3
 Lawrencite FeCl_2
 Scacchite MnCl_2
 *Chloromagnesite (disputable) MgCl_2
 *Chlorocalcite KCaCl_3

Halite group

Halite NaCl
 Sylvite KCl
 Salammoniac NH_4Cl

4.1.2.1.1.1.2. Basic

Kempite $\text{Mn}_2(\text{OH})_3\text{Cl}$
 *Hibbingite $\gamma\text{-Fe}^{2+}_2(\text{OH})_3\text{Cl}$

4.1.2.1.1.1.3. Hydrates

Hydrophilite = antarcticite or sinjarite $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$
 *Ghilaraite $\text{CaCl}_2 \cdot 4\text{H}_2\text{O}$

4.1.2.1.1.1.3.1. Basic

Cadwaladerite ($x = 1,5$) $\text{Al}(\text{OH})_2\text{Cl} \cdot 4\text{H}_2\text{O}$
 Korshunovskite ($x = 2$) $\text{Mg}_2(\text{OH})_3\text{Cl}_{3,5-4}\text{H}_2\text{O}$
 *Nepskoeite ($x = 4$) $\text{Mg}_4(\text{OH})_7\text{Cl} \cdot 6\text{H}_2\text{O}$

Chloraluminite family

Chloraluminite $\text{AlCl}_3 \cdot 6\text{H}_2\text{O} \rightarrow [\text{Al}(\text{H}_2\text{O})_6]\text{Cl}_3$
 Rokühnite $\text{FeCl}_2 \cdot 2\text{H}_2\text{O} \rightarrow [{}^{(6)}\text{FeCl}_2(\text{H}_2\text{O})_2]^\infty$
Bischofite group
 Bischofite $\text{MgCl}_2 \cdot 6\text{H}_2\text{O} \rightarrow [\text{Mg}(\text{H}_2\text{O})_6]\text{Cl}_2$
 Nickelbischofite $\text{NiCl}_2 \cdot 6\text{H}_2\text{O} \rightarrow [\text{Ni}(\text{H}_2\text{O})_6]\text{Cl}_2$
 Sinjarite $\text{CaCl}_2 \cdot 2\text{H}_2\text{O} \rightarrow [\text{Ca}(\text{H}_2\text{O})_2\text{Cl}_2]^\infty$
 Hydrohalite $\text{NaCl} \cdot 2\text{H}_2\text{O}$

4.1.2.1.1.2. Complex

4.1.2.1.1.2.1. Basic

*Koenenite $\text{Na}_4\text{Mg}_9\text{Al}_4(\text{OH})_{22}\text{Cl}_{12}$
 *Kuliginite ($x = 2$) $\text{Fe}^{2+}_3\text{Mg}(\text{OH})_6\text{Cl}_2$

Chlormagaluminite group

4.1.2.1.1.2.1.1. Hydrates

Chlormagaluminite $(\text{Mg}, \text{Fe}^{2+})_4\text{Al}_2(\text{OH})_{12}\text{Cl}_2 \cdot 2\text{H}_2\text{O}$
 Hydrocalumite $\text{Ca}_2\text{Al}(\text{OH})_6(\text{Cl}, \text{CO}_3, \text{OH}) \cdot 2\text{H}_2\text{O}$
 *Iowaite ($x = 4$) $\text{Mg}_6\text{Fe}^{3+}_2(\text{OH})_{16}\text{Cl}_2 \cdot 4\text{H}_2\text{O}$
 *Woodallite ($x = 4$) $\text{Mg}_6\text{Cr}_2(\text{OH})_{16}\text{Cl}_2 \cdot 4\text{H}_2\text{O}$
 *Kopeyskite $(\text{NH}_4)_2(\text{Fe}, \text{Al}, \text{Ca}, \text{Mg})(\text{Cl}, \text{OH})_5 \cdot \text{H}_2\text{O}$

4.1.2.1.1.2.1.1.1. Neutral

Tachyhydrite $\text{CaMg}_2\text{Cl}_6 \cdot 12\text{H}_2\text{O}$
 Carnallite $\text{KMgCl}_3 \cdot 6\text{H}_2\text{O} \rightarrow \text{K}[\text{Mg}(\text{H}_2\text{O})_6]\text{Cl}_3$

4.1.2.2. Chlorides, bromides, iodides of chalcophylic elements

4.1.2.2.1. Chlorides, bromides, iodides of **Ib**-elements4.1.2.2.1.1. Chlorides, bromides, iodides of Cu^+ , Ag^+ , Hg^+

4.1.2.2.1.1.1. Simple 4.1.2.2.1.1.1.1. Neutral

Nantokite group

Nantokite

**Chlorargyrite** group

Chlorargyrite



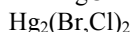
Bromargyrite



Calomel

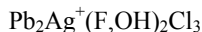


*Kuzminite



4.1.2.2.1.1.2. Complex

4.1.2.2.1.1.2.1. Basic

Bidauxite ($x = 1$)4.1.2.2.1.2. Chlorides of Cu^{2+}

4.1.2.2.1.2.1. Simple

4.1.2.2.1.2.2. Neutral

Tolbachite



*Sanguite



4.1.2.2.1.2.1.2. Basic

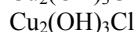
*Belloite

**Atacamite** family

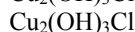
Atacamite



*Clinoatacamite



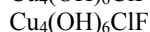
Botallackite



*Fejerite



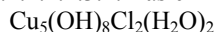
Claringbullite



4.1.2.2.1.2.1.3. Hydrates

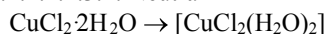
4.1.2.2.1.2.1.3.1. Basic

*Bobkingite



4.1.2.2.1.2.1.3.1. Neutral

Eriochoalcite



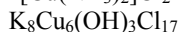
4.1.2.2.1.1.2. Complex

*4.1.2.2.1.1.2.1. Neutral

*Ammineite



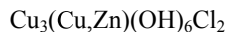
*Romanorlovite



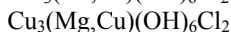
4.1.2.2.1.1.2.2. Основные

Сем. **параатакамит** ($x = 2$)

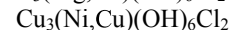
Paratacamite



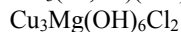
*Параатакамит-(Mg)



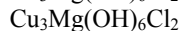
*Параатакамит-(Ni)



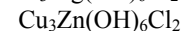
*Haydeelite



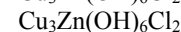
*Tondiite



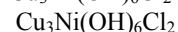
*Gerbertsmithite



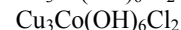
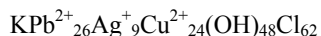
*Kapellasite



*Gillardite



*Leverettite

**Boleite** familyBoleite ($x = 0,9$)

Pseudoboleite	$Pb_{31}Cu^{2+}_{24}(OH)_{48}Cl_{62}$
Percylite = boleite + pseudoboleite (?)	$PbCu(OH)_2Cl_2$ (?)
Diaboleite (x = 1,5)	$\{Pb_2Cu(OH)_4Cl_2\}^{\infty 2}$
	*4.1.2.2.1.1.2.2.1. Hydrates
Cumengite (x = 1)	$Pb_{21}Cu_{20}(OH)_{40}Cl_{42} \cdot 6H_2O$
*Feodosiyite	$Cu_{11}Mg_2(OH)_8Cl_{18} \cdot 16H_2O$
*Centennialite	$CaCu_3(OH)_6Cl_2 \cdot nH_2O$ (n = 0.7)
*Avdoninite	$K_2Cu_5(OH)_4Cl_8 \cdot 2H_2O$
*Dioskouriite	$CaCu_4(OH)_4Cl_6 \cdot 4H_2O$
*Chrysothallite	$K_6Cu_6Tl^{3+}(OH)_4Cl_{17} \cdot H_2O$
*Chanabayaite	$Cu(N_3C_2H_2)(NH_3)Cl \cdot 0.25H_2O$
*4.1.2.2.1.1.3. Oxido-chlorides	
*4.1.2.2.1.1.3.1. Basic	
Chloroxiphite (x = 2)	$Pb_3Cu(OH)_2O_2Cl_2$
*Fuettererite	$Pb_3Cu^{2+}_6Te^{6+}O_6(OH)_7Cl_5$
4.1.2.2.2. Chlorides of IIb -elements	
4.1.2.2.2.1. Chlorides of Zn	
*4.1.2.2.2.1.1. Средние	
*Flinteite	K_2ZnCl_4
*Mellizinkalite	$K_3Zn_2Cl_7$
*Amminite	$[Zn(NH_3)_2]Cl_2$
	4.1.2.2.2.1.2. Hydrates (basic)
*Cryobostryxite	$ZnKCl_3 \cdot 2H_2O$
Simonkolleite	$Zn_5(OH)_8Cl_2 \cdot H_2O \rightarrow [^{(4;6)}Zn_5(OH)_8]^{\infty 2}Cl_2 \cdot \infty 2 \cdot H_2O$
*4.1.2.2.2.2. Chlorides of Hg	
*4.1.2.2.2.2.1. Oxido-chlorides of Hg	
*Hanawaltite	$Hg^+_6Hg^{2+}Cl_2O_3$
*4.1.2.2.3. Хлориды IIIa -элементов	
*4.1.2.2.3.1. Хлориды Tl	
*4.1.2.2.3.1.1. Neutral	
*4.1.2.2.3.1.1.1. Simple	
*Lafossaite	$TlCl$
*4.1.2.2.3.1.1.2. Complex	
*Steropesite	Tl_3BiCl_6
*Hephaistosite	$TlPb_2Cl_5$
4.1.2.2.4. Chlorides of IVa -elements	
4.1.2.2.4.1. Chlorides of Pb^{2+}	
4.1.2.2.4.1.1. Simple	
4.1.2.2.4.1.1.1. Neutral	
Cotunnite family	
Matlokite	$PbClF$
Cotunnite	$PbCl_2$
4.1.2.2.4.1.1.2. Basic and hydrates	
Penfieldite (x = 0,(6))	$Pb_2(OH)Cl_3$
Fiedlerite (x = 0,75)	$Pb_3F(OH)Cl_4 \cdot H_2O$
Laurionite family (x = 1)	
Laurionite	$Pb(OH)Cl$

Paralaurionite	Pb(OH)Cl
4.1.2.2.3.1.2. Complex	4.1.2.2.3.1.2.1. Neutral
*Challacolloite	KPb ₂ Cl ₅
Pseudocotunnite	K ₂ PbCl ₄ (?)
*Brontesite	(NH ₄) ₃ PbCl ₅
	*4.1.2.2.4.1.2.2. Basic
*4.1.2.2.5. Oxido-chlorides Pb	
*4.1.2.2.5.1. Simple	*4.1.2.2.5.1.1. Basic
*Blixite (x = 2)	*Pb ₈ O ₅ (OH) ₂ Cl ₄
*4.1.2.2.5.2. Complex	*4.1.2.2.5.2.1. Basic
*Rickturneite	Pb ₇ O ₄ [Mg(OH) ₄](OH)Cl ₃
*Hereroite [Pb ₃₂ (O,□) ₂₁][AsO ₄] ₂ [(Si,As,V,Mo)O ₄] ₂ Cl ₁₀	
	*4.1.2.2.5.2.1.1. Hydrates
*Vladkrivovichevite [Pb ₃₂ O ₁₈][Pb ₄ Mn ₂ O][BO ₃] ₈ Cl ₁₄ ·2H ₂ O	
*4.1.2.2.6. Fluorides, chlorides IV <i>a</i> -elements	
*4.1.2.2.6.1. Fluorides, chlorides Bi ³⁺	
*4.1.2.2.6.1.1. Simple	
*4.1.2.2.6.1.2. Complex	
*Argesite	(NH ₄) ₇ Bi ³⁺ ₃ Cl ₁₆
4.1.2a. Class: Iodides	
*Unnamed	RhI ₃
Marshite series	
Marshite	CuI
*Marshite cuprous	CuI
Miersite	(Ag,Cu)I
Iodargyrite	AgI
*Iodargyrite 2H	AgI
Tocornalite	(Ag,Hg)I
*Coccinite	HgI ₂
*Moschelite	Hg ₂ I ₂

4.2. SUBTYPE: HALOGENOSALTS (ANISODESMICAL) (WITH HEXACYANOFERRATES AND HEXATHIOCYANATES, RHODONIDES)

4.2a. *QUASISUBTYPE* *HALOGENOSALTS WITH *d*-CATION-COMPLEXFORMERS

4.2a.1. **Class:** Chloroferrites and chlorocuprites (only *s*- cations and NH₄⁺)

4.2a.1.1. Chlorooxidopolycuprites

Ponomarevite

4.2a.1.1.1. Neutral

K₄[Cu²⁺₄OCl₁₀]

4.2a.1.2. Hexachlorocuprites

Mitscherlichite

4.2a.1.2.1. Neutral chloroaquacuprites*

K₂[Cu²⁺Cl₄(H₂O)₂]

4.2a.1.3. Rhodanidocobaltites

4.2a.1.3.1. Tetrarhodanidocobaltites II

* Partical "aqua" in complex anion's name of halogenosalt means, that at least one of its ligands is ·H₂O; particles "oxo" and "hydroxo" means, that as ligands with halogen-ions appear O²⁻ - or OH⁻ -ions respectively.

- 4.2a.1.3.1.1. Hydrates (neutral)
 Julienite $\text{Na}_2[\text{Co}(\text{SCN})_4] \cdot 8\text{H}_2\text{O}$
- 4.2a.2. **Class:** Hexachloroferrates and hexachloromanganates (only *s*- cations)
 4.2a.2.1. Hexachloroferrates II and hexachloromanganates II
 4.2a.2.1.1. Neutral
- Rinneite** group
 Rinneite $\text{K}_3\text{Na}[\text{Fe}^{2+}\text{Cl}_6]$
 *Saltonseaitite $\text{K}_3\text{Na}[\text{Mn}^{2+}\text{Cl}_6]$
 Chlormanganokalite $\text{K}_4[\text{Mn}^{2+}\text{Cl}_6]$
 Douglasite $\text{K}_2[\text{Fe}^{2+}\text{Cl}_4(\text{H}_2\text{O})_2]$
- 4.2a.2.2. Hexachloroferrates III
 4.2a.2.2.1. Chloroquaaferrates III (neutral)
Kremersite group
 Erythrosiderite $\text{K}_2[\text{Fe}^{3+}\text{Cl}_5(\text{H}_2\text{O})]$
 Kremersite $(\text{NH}_4, \text{K})_2[\text{Fe}^{3+}\text{Cl}_5(\text{H}_2\text{O})]$
- 4.2b. Quasisubtype*: Halogenosalts with *p*- anion-complexformers
- 4.2b.1. **Class:** Fluoroaluminates (only *s*- cations)
 4.2b.1.1. Hexafluoropolyaluminates 4.2b.1.1.1. Neutral (*s*-cations)
 Chiolite $\text{Na}_5[\text{Al}_3\text{F}_{14}]^{\infty 2}$
 *Ralstonite $\text{NaMg}[\text{Al}_3\text{F}_8(\text{OH})_4] \cdot \text{H}_2\text{O}$
 Prosopite $\text{Ca}[\text{Al}_2\text{F}_4(\text{OH})_4]$
- Jarlite** group
 Calcjarlite $\text{Na}_2(\text{Ca}, \text{Sr}, \text{Na}, \square)_{14}\text{Al}_{12}\text{Mg}_2(\text{F}, \text{OH})_{64}(\text{OH})_4$
 Jarlite $\text{Na}_2(\text{Sr}, \text{Na})_{14}\text{Mg}_2\text{Al}_{12}\text{F}_{64}(\text{OH}, \text{H}_2\text{O})_4$
 *Jørgensenite $\text{Na}_2(\text{Sr}, \text{Ba})_{14}\text{Na}_2\text{Al}_{12}\text{F}_{64}(\text{OH}, \text{F})_4$
- 4.2b.1.2. Hexafluoroaluminates
 4.2b.1.2.1. Hexafluoroaluminates of *s*-, *d*₅- and *p*₅-ations
 4.2b.1.2.1.1. Hexafluoroaluminates of *s*-, *d*₅- and *p*₅-ations without Li and Be
 4.2b.1.2.1.1.1. Proper hexafluoroaluminates 4.2b.1.2.1.1.1.1. Neutral
- Cryolite** family
 Cryolite $\text{Na}_3[\text{AlF}_6]$
 Elpasolite $\text{K}_2\text{Na}[\text{AlF}_6]$
 4.2b.1.2.1.1.1.2. Hydrates
- Thomsenolite** family
 Thomsenolite $\text{NaCa}[\text{AlF}_6] \cdot \text{H}_2\text{O}$
 Pachnolite $\text{NaCa}[\text{AlF}_6] \cdot \text{H}_2\text{O}$
- 4.2b.1.2.1.1.2. Fluorohydroxyaluminates 4.2b.1.2.1.1.2.1. Hydrates
 Yaroslavite $\text{Ca}_3[\text{AlF}_5(\text{OH})]_2 \cdot \text{H}_2\text{O}$
 *Ralstonite-like $\text{Na}_3\text{CaMg}_3\{\text{AlF}_{12}[(\text{OH}), \text{O}, \text{F}]_2\}$
- 4.2b.1.2.1.1.3. Fluorohydroxaquaaluminates 4.2b.1.2.1.1.3.1. Neutral
Gearksutite family
 Gearksutite $\text{Ca}[\text{AlF}_4(\text{OH})(\text{H}_2\text{O})]_2^{\infty 2}$

Tikhonkovite	$\text{Sr}[\text{AlF}_4(\text{OH})(\text{H}_2\text{O})]^{2-}$
Acuminite	$\text{Sr}[\text{AlF}_4(\text{OH})(\text{H}_2\text{O})]^{2-}$

4.2b.1.2.1.2. Hexafluoroaluminates of Li 4.2b.1.2.1.2. Neutral

Cryolithionite family

Colquiriite	$\text{CaLi}[\text{AlF}_6]$
Cryolithionite	$\text{Na}_3\text{Li}_3[\text{AlF}_6]_2$

4.2b.2. **Class:** Fluoroborates (only *s*- cations)

4.2b.2.1. Neutral

Ferruccite family

Ferruccite	$\text{Na}[\text{BF}_4]$
Avogadrite	$(\text{K}, \text{Cs})[\text{BF}_4]$
*Barberiite	$(\text{NH}_4)[\text{BF}_4]$

4.2b.3. **Class:** Fluorosilicates (only *s*- cations and NH_4^+)

4.2b.3.1. Neutral

Malladrite family

Malladrite	$\text{Na}_2[\text{SiF}_6]$
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Hieratite group

Hieratite	$\text{K}_2[\text{SiF}_6]$
Cryptohalite	$(\text{NH}_4)_2[\text{SiF}_6]$
Bararite	$(\text{NH}_4)_2[\text{SiF}_6]$
*Demartinite	$\text{K}_2[\text{SiF}_6]$
*Heklaite	$\text{KNa}[\text{SiF}_6]$
*Knasibfite	$\text{K}_3\text{Na}_4[\text{SiF}_6]_3[\text{BF}_4]$

4.2b.4. **Class:** Chloroaluminates (only *s*- cations)*4.2b.5. **Knacc:** Hexachlorostannates

*Panichiite	$(\text{NH}_4)_2[\text{SnCl}_6]$
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5. TYPE: CARBON, ITS COMPOUNDS (WITHOUT CARBONATES) AND RELATED SUBSTANCES

5a. **Quasitype*:** Inorganic compounds (without carbonates) and related substances

5a.1. SUBTYPE: NATIVE MINERALS

Native carbon family

Graphite	C
Lonsdaleite	C
Chaoite	C
Diamond	C
*Carbon cubic	C
Schungite	C
Silicium group	
Silicium	Si
Germanium	Ge

5a.2. SUBTYPE: MINERALS WITH PRINCIPAL COVALENT AND METALLIC-COVALENT BOND - CARBIDES AND RELATED SUBSTANCES - SILICIDES, NITRIDES AND PHOSPHIDES

5a.2.1. **Class:** Carbides

5a.2.1.1. Carbides of **IVa**-elements

Moissanite-6H	SiC
<i>Moissanite -5H</i>	
<i>Moissanite -15R</i>	
<i>Moissanite -33R</i>	
<i>Moissanite -beta</i>	

5a.2.1.2. Carbides of centrosymmetrical **d**- elements

5a.2.1.2.1. Carbides of VIIIb - elements	Simple
Haxonite	(Fe,Ni) ₂₃ C ₆
Cohenite group (?)	
Cohenite	(Fe,Ni,Co) ₃ C
Unnamed 448	(Mn,Fe) ₃ (C,Si)
Chalypite	Fe ₂ C

*5a.2.1.2.2. Carbides of **VIIIb** и **VIb**- elements

*Isovite	(Cr,Fe) ₂₃ C ₆
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5a.2.1.2.2. Carbides of **VIb**-elements

Unnamed 241	Simple Cr ₂ C
Tongbaite	Cr ₃ C ₂

5a.2.1.2.3. Carbides of **IVb**- elements

Khamrabaevite series (?)	Simple
Khamrabaevite	(Ti,V,Fe)C
Unnamed 330	(V,Ti)C

5a.2.1.3. Carbides of noncentrosymmetrical **d**- elements*5a.2.1.3.1. Carbides of **VIIb**- elements

*Carbide Mn	Mn ₃ C
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5a.2.1.3.2. Carbides of **VIIIb**-elements

Complex

5a.2.1.3.3. Carbides of **VIb**-elements

Unnamed 290	Simple WC
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5a.2.1.3.4. Carbides of **Vb**-elements

Tantalcarbi	Simple (Ta,Nb)C
*Niobocarbide	(Nb,Ta)C

5a.2.1a. **Class:** Silicides5a.2.1a.1. Silicides of noncentrosymmetrical **d**- elements5a.2.1a.1.1. Silicides of **VIIIb**-elements

*Palladosilicide	Simple Pd ₂ Si
Unnamed 449	(Mn,Si,Fe)

Suessite family (x = M : X = 3)

Suessite	(Fe,Ni) ₃ Si
Gupeiite	Fe ₃ Si
Unnamed 025	(Cr,Fe) ₃ Si
Perryite (x = 2.(6))	(Ni,Fe) ₈ (Si,P) ₃

*Unnamed	Fe ₂ Si
*Hapkeite	Fe ₂ Si
*Mavlyanovite(x = 1.(6))	(Mn,Fe) ₅ Si ₃
Xifengite (x = 1.(6))	Fe ₃ Si ₃
*Naquite (tetr.) (x = 1)	FeSi
*Linzhiite	FeSi ₂
Unnamed 424 (x = 0.43)	FeSi _{2,3}
*Luobusaite (x = 0.42)	Fe _{0,84} Si ₂
	Complex
Unnamed 028 (x = 1)	FeTiSi ₂
*Zangboite	FeTiSi ₂
5a.2.1a.2. Silicides of <i>s</i> - elements	
5a.2.1a.3 Silicides of IIa - elements	Simple
Unnamed 024	Mg ₂ Si
5a.2.2. Class: Nitrides	
*5a.2.2.1. Nitrides <i>p</i> - elements	
*Qingsongite	BN
5a.2.2.2. Nitrides (nitrido-oxides) IVa - elements	
	Simple
Sinoite	Si ₂ N ₂ O
*Nierite	Si ₃ N ₄
5a.2.2.2.1. Nitrides of centrosymmetrical <i>d</i> - elements	
5a.2.2.2.1.1. Nitrides of VIIIb - elements	
	Simple
Roaldite	Fe ₄ N
Siderazot	Fe ₅ N ₂
5a.2.2.2.1.2. Nitrides of VIb - elements	
	Simple
Carlsbergite	CrN
5a.2.2.2.1.3. Nitrides of IVb - elements	
	Simple
Osbornite	TiN
5a.2.2.2.2. Nitrides of noncentrosymmetrical <i>d</i> - elements	
5a.2.2.2.2.1. Nitrides of IIb - elements	
	Compounds inclusions
Mosesite family	
Mosesite	Hg ₂ N ^{∞3} ·(Cl,SO ₄ ,MoO ₄ ,CO ₃)·H ₂ O
Kleinite	Hg ₂ N ^{∞3} ·(Cl,SO ₄)(H ₂ O) _n
5a.2.2a. Class: Phosphides	
5a.2.2a.1. Phosphides of centrosymmetrical <i>d</i> - elements	
5a.2.2a.1.1. Phosphides of VIIIb - elements	
	Simple
*Melliniite	(Ni,Fe) ₄ P
*Murashkoite	FeP
*Zuktamrurite	FeP ₂
Schreibersite series	
Rhabdite	Ni ₃ P

Schreibersite	(Fe,Ni) ₃ P
*Nickelphosthite	(Ni,Fe) ₃ P
Barringerite	(Fe,Ni) ₂ P
*Allabogdanite	(Ni,Fe) ₂ P
*Transjordanite	Ni ₂ P
5a.2.2a.1.2. Phosphides of IVb -elements.	Simple
Unnamed 027	TiP
	*Complex
*Florenskyite	FeTiP
*Andreyivanovite	Fe(Cr,Fe,V,Ti)P
*5a.2.2a.1.3. Phosphides of VIb - elements	Complex
*Monipite	MoNiP

5b. Quasitype*: Organic carbon compounds (minerals with principal van der Waals forces bond)

5b.1. SUBTYPE: SALTS OF ORGANIC ACIDS

5b.1.1. **Class:** Salts of benzopolycarbonic acids (C₆H_{6-n}(COOH)_n; n=6)

5b.1.1.1. Hydrates (neutral)

Mellite Al₂[C₆(COO)₆]·16H₂O

5b.1.2. **Class:** Salts of citric acid (citrates)

5b.1.2.2.1. Hydrates

5b.1.2.2.1.1. Oxido-citrates

Pigotite Al₄O₃[C₆H₅O₇]₃·13H₂O

5b.1.2.2.1.2. Neutral

Earlandite Ca₃[C₆H₅O₇]₂·4H₂O

5b.1.3. **Class:** Salts of acetic acid (acetates)

*Ca-acetic Ca[CH₃COO]·H₂O

*Hoganite C₄H₈O₅Cu → Cu[CH₃COO]₂·H₂O

*Paceite C₈H₂₄O₁₄CaCu → CaCu[CH₃COO]₄·6H₂O

5b.1.3.1. Acetato-chlorides

5b.1.3.1.1. Hydrates (neutral)

Calclacite CaCl[CH₃COO]·5H₂O

5b.1.4. **Class:** Salts of oxalic acid (oxalates)

5b.1.4.1. Salts of oxalic acid (oxalates) *s*-, *d*-, *ps*-cations

*5b.1.4.1.1. Neutral

*Natroxalate Na₂[C₂O₄]

*Antipinite KNa₃Cu₂[C₂O₄]₄

5b.1.4.1.2. Hydrates (neutral)

Zhemchuzhnikovite series

Zhemchuzhnikovite

NaMg(Al,Fe³⁺)[C₂O₄]₃·(8-9)H₂O

Stepanovite

NaMgFe³⁺[C₂O₄]₃·(8-9)H₂O

Minguzzite

K₃Fe³⁺[C₂O₄]₃·3H₂O

Weddellite family

Glushinskite

Mg[C₂O₄]·2H₂O

Humboldtine

Fe²⁺[C₂O₄]·2H₂O

Weddellite	$\text{Ca}[\text{C}_2\text{O}_4] \cdot 2\text{H}_2\text{O}$
*Caoxite	$\text{Ca}[\text{C}_2\text{O}_4] \cdot 3\text{H}_2\text{O}$
Whewellite	$\text{Ca}[\text{C}_2\text{O}_4] \cdot \text{H}_2\text{O}$
Oxammite	$(\text{NH}_4)_2[\text{C}_2\text{O}_4] \cdot \text{H}_2\text{O}$

*56.1.4.2. Salts of oxalic acid (oxalates) *f*- elements

*56.1.4.2.1. Hydrates

*Deveroite-(Ce)	$\text{Ce}_2[\text{C}_2\text{O}_4]_3 \cdot 10\text{H}_2\text{O}$
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5b.1.4.3. Salts of chalcophylic elements (Cu^{2+}) 5b.1.4.1.1.1. Hydrates (neutral)

Moolooite	$\text{Cu}[\text{C}_2\text{O}_4] \cdot n\text{H}_2\text{O}$
Wheatleyite	$\text{Na}_2\text{Cu}^{2+}[\text{C}_2\text{O}_4]_2 \cdot 2\text{H}_2\text{O}$
*Lindbergite	$\text{Mn}^{2+}[\text{C}_2\text{O}_4] \cdot 2\text{H}_2\text{O}$

*5b.1.4.3. Oxalato-chlorides

*Novgorodovaite	$\text{Ca}_2[\text{C}_2\text{O}_4]\text{Cl}_2 \cdot 2\text{H}_2\text{O}$
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*5b.1.4.4. Oxalato-sulfates

*Coskrenite-(Ce)	$(\text{Ce}, \text{Nd}, \text{La})_2[\text{SO}_4]_2[\text{C}_2\text{O}_4] \cdot 8\text{H}_2\text{O}$
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*5b.1.5. Salts of formic acids (formates)

*Formicaite	$\text{Ca}[\text{COOH}]_2$
*Dashkovaite	$\text{Mg}[\text{COOH}]_2 \cdot 2\text{H}_2\text{O}$

*56.1.6. Salts of methylsulfonic acid $\text{CH}_3\text{SO}_3\text{H}$ (methylsulfonates)

*Ernstburkeite	$\text{Mg}(\text{CH}_3\text{SO}_3)_2 \cdot 12\text{H}_2\text{O}$
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5b.2. SUBTYPE: HYDROCARBONS AND RELATED COMPAUNDS

5b.2.1. **Class:** Hydrocarbons cyclic (in the order of decreasing $x = \text{H} : \text{C}$)**Evenkite** family

Evenkite (n-tetracosene)	$\text{C}_{24}\text{H}_{48}$ ($x = 2$)
Fichtelite	$\text{C}_{19}\text{H}_{34}$ ($x = 1, (8)$)
*Dinite	$\text{C}_{20}\text{H}_{36}$ ($x = 1, 8$)
Hartite	$\text{C}_{20}\text{H}_{34}$ ($x = 1, 7$)
Simonellite	$\text{C}_{19}\text{H}_{24}$ ($x = 1, 26$)

(1,1-dimethyl-7-isopropyl-1,2,3,4-tetrahydrophenanthrene)

Phylloretine	$\text{C}_{18}\text{H}_{18}$ ($x = 1$)
Kratochvilite	$\text{C}_{13}\text{H}_{10}$ ($x = 0, 77$)
*Ravatite	$\text{C}_{14}\text{H}_{10}$ ($x = 0, 7$)
Idrialite (dimethylbenzphenanthrene)	$\text{C}_{22}\text{H}_{14}$ ($x = 0, 64$)
Karpatite = Carpathite	$\text{C}_{24}\text{H}_{12}$ ($x = 0, 5$)

5b.2.2. **Class:** Hydrocarbons oxygenbearing (in the order of increasing $\text{O} : \text{C}$)

*Lidinite	$\text{C}_{27}\text{H}_{46}\text{O}$
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Hoelite family

Refikite (δ -13-dihydro-d-pimaric acid)	$\text{C}_{20}\text{H}_{32}\text{O}_2$
Hoelite (anthraquinone)	$\text{C}_{14}\text{H}_8\text{O}_2$
Flagstaffite (cis-terpin hydrate)	$\text{C}_{10}\text{H}_{18}(\text{OH})_2 \cdot \text{H}_2\text{O} \rightarrow \text{C}_{10}\text{H}_{22}\text{O}_3$
Sapperit (cellulose)	$\text{C}_6\text{H}_{10}\text{O}_5 \cdot n\text{H}_2\text{O}$

5b.2.3. **Class:** Nitrogenbearing organic compounds**Abelsonite** family

Abelsonite (nickel porphyrine)	$C_{31}H_{32}N_4Ni$
Kladnoite (phthalimide)	$C_6H_4(CO_2)NH$
Acetamide	CH_3CONH_2
Guanine	$C_5H_3(NH_2)N_4O$
Uricite (2,6,8-trihydroxypurine)	$C_5H_4N_4O_3$
*Tinnunculite	$C_5H_4N_4O_3 \cdot 2H_2O$
Urea	$CO(NH_2)_2$

5b.3. SUBTYPE: MIXTURES OF ORGANIC SUBSTANCES INCLUDING AMBER AND RELATED SUBSTANCES

Kerite

Asphalt

Ozokerite

Amber

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