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NOMENCLATURE OF THE MICAS

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Abstract

End-members and species, defined with permissible ranges of composition, are presented for the true micas, the brittle micas, and the interlayer-deficient micas. The determination of the crystallochemical formula for different available chemical data is outlined, and a system of modifiers and suffixes is given to allow the expression of unusual chemical substitutions or polytypic stacking arrangements. Tables of mica synonyms, varieties, ill-defined materials, and a list of names formerly or erroneously used for micas are presented. The Mica Subcommittee was appointed by the Commission on New Minerals and Mineral Names of the International Mineralogical Association. The definitions and recommendations presented were approved by the Commission.

Keywords: mica nomenclature, brittle micas, interlayer-deficient micas, species, end members.

Sommaire

Les pôles des diverses espèces de mica sont ici définis, ainsi que les intervalles de composition permis, ceci pour les vrais micas, les micas cassants, et les micas déficitaires dans la position interfeuillet. On décrit la détermination de la formule cristallochimique à partir des diverses données chimiques disponibles; un système de qualificatifs et de suffixes permet d'exprimer des vecteurs de substitution peu courants et des agencements d'empilement polytypique. Sont inclus un tableau de synonymes, une liste de variétés et de matériaux méconnus, ainsi qu'une liste de noms désuets ou erronnés utilisés pour décrire les micas. Le comité de nomenclature des micas a été mandaté par la Commission des nouveaux minéraux et des noms de minéraux de l'Association internationale de Minéralogie. Les définitions et recommandations de ce comité ont été approuvées par la Commission.

Keywords: nomenclature des micas, micas cassants, micas déficitaires dans la position interfeuillet, espèces, pôles.

Definition

Micas are phyllosilicates in which the unit structure consists of one *octahedral sheet* (*Os*) between two opposing *tetrahedral sheets* (*Ts*). These sheets form a *layer* that is separated from adjacent layers by planes of non-hydrated *interlayer cations* (*I*). The sequence is: ... *I Ts Os Ts I Ts Os Ts* ... The tetrahedral sheets have composition T_2O_5, and tetrahedra are linked by sharing each of three corners (= basal atoms of oxygen) to a neighboring tetrahedron; the fourth corner (= apical atom of oxygen) points in one direction for a given tetrahedral sheet. The coordinating anions around octahedrally coordinated cations (*M*) consist of apical atoms of oxygen of adjacent tetrahedral sheets and anions *A*. The coordination of interlayer cations is nominally twelve-fold, and their charge should not be less than 0.6 per formula. The simplified formula can be written as:

$$I\ M_{2\text{-}3}\ \square_{1-0}\ T_4\ O_{10}\ A_2,$$

where *I* is commonly Cs, **K**, **Na**, NH_4, Rb, Ba, **Ca**,

M is commonly **Li**, **Fe** (di- or trivalent), **Mg**, Mn (di- or trivalent), Zn, **Al**, Cr, V, **Ti**,

☐ represents a vacancy,

T is commonly Be, **Al**, B, **Fe** (trivalent), **Si**, and

A is commonly Cl, **F**, **OH**, O (oxy-micas), S.

(The most frequently encountered elements are set in bold face; note that other substitutions are possible). The number of formula units, *Z*, may vary depending on the structure, but is equal to 2 in a 1*M* structure.

Subdivisions

Depending on the interlayer cation, the micas are subdivided into *true micas* (if • 50% *I* cations present are monovalent) or *brittle micas* (if > 50% *I* cations present are divalent); if the formula exhibits < 0.85 and • 0.6 positive interlayer charges, it represents an interlayer-cation-deficient mica or, stated in an abbreviated form, an *interlayer-deficient mica*. In special cases (*e.g.,* wonesite), the interlayer charge may be lower than 0.6 provided the material does not have swelling or expanding capabilities. The 0.85 charge divide holds for dioctahedral micas. To date, there are insufficient data to define an analogous limit in trioctahedral micas.

Regardless of the mica subgroup, it is *dioctahedral* if it contains less than 2.5 octahedral cations (*M*) per formula unit; micas with •2.5 octahedral cations are *trioctahedral*. Micas with intermediate octahedral occupancies occur frequently, but no provision is made for any other divisions or terms (*e.g.*, "2 octahedral"); the use of such terms is discouraged. Also discouraged is the division of micas into "disilicic", "trisilicic", and "tetrasilicic" according to the number of silicon atoms per formula.

Octahedrally coordinated *M* cations may be distributed over three crystallographic positions (octahedral ordering) or two positions in structures with the *C*2/*m* space group. Because of this ordering, some end-member formulas do not conform to the "chemical" 50% rule of Nickel (1992). To a lesser extent, the same applies to tetrahedrally coordinated *T* cations.

PRINCIPLES OF CLASSIFICATION

The present classification is based on the chemical composition of micas and embodies generalizations derived from crystal-structure determinations. The inclusion of physical determinative properties as classification criteria was avoided because these properties cannot unambiguously differentiate members of the micas. Moreover, the approach adopted here reflects the belief that mica classification should be based on easily accessible chemical data and a minimum of physical measurements.

The crystallochemical formula should be based on chemical data, density, and cell data. If chemical data only are available, the recommended procedure to calculate a formula is as follows: (1) If there is a reliable determination of H_2O, the formula should be based on twelve O + F atoms. (2) If there is no determination of H_2O, as in electron-microprobe analyses, an idealized anion group must be assumed, and the formula should be based on 22 positive charges. (3) If there is no determination of H_2O and there are grounds to suspect that a *later* oxidation of iron in the mica caused deprotonation of the anion group, the formula should be based on 22 + z positive charges, where z is the quantity of trivalent iron (Stevens 1946, Foster 1960, Rimsaite 1970). It should be noted that lithium, concentrations of which cannot be determined with current electron-microprobe techniques, is commonly overlooked in wet-chemical analyses because of its low molecular weight. Also, failure to establish the concentration of lithium has caused a number of erroneous identifications.

END MEMBERS

End-member names given below are associated with formulas containing the most frequently encountered *A* anion only. End members in which other *A* anions dominate should be designated with the prefixes "fluoro" (*e.g.*, in muscovite), "hydroxy" (*e.g.*, in polylithionite), or "oxy" (*e.g.*, in annite). When such phases are found in nature, their proposed new mineral status and name should nonetheless be submitted for approval to the Commission on New Minerals and Mineral Names, IMA.

This report contains end-member formulas that are stoichiometric on the scale of the asymmetric part of the unit cell. Those mica species that do not meet this requirement (such as those in which the main end-members are not yet clear) appear as "species that are not end members". To express chemical variation in compositional plots, hypothetical end-members may be employed. However, because these end members have not been documented as mineral species, they may not receive mineral-like names, and only formulas or formula-like expressions should be used in such plots. Experimental determinations of miscibility limits in natural mica series will help in establishing species and in positioning boundaries between them.

Lists of valid names for true, brittle, and interlayer-deficient micas appear in Tables 1, 2, and 3, respectively. The compositional space for some dioctahedral interlayer-deficient and true micas is shown in Figure 1.

TABLE 1. TRUE MICAS: END-MEMBER FORMULAS AND TYPICAL RANGES FOR MINERAL SPECIES

DIOCTAHEDRAL			
muscovite			$K\,Al_2\square\,AlSi_3\,O_{10}\,(OH)_2$
	^{IV}Si: 3.0 – 3.1	^{VI}Al: 1.9 – 2.0	K: 0.7 – 1.0 ($I \geq 0.85$)
	$^{VI}R^{2+}/(^{VI}R^{2+} + {}^{VI}R^{3+})$: < 0.25	$^{VI}Al/(^{VI}Al + {}^{VI}Fe^{3+})$: 0.5 – 1.0	
aluminoceladonite			$K\,Al(Mg,Fe^{2+})\square\,Si_4\,O_{10}\,(OH)_2$
	$^{VI}R^{2+}/(^{VI}R^{2+} + {}^{VI}R^{3+}) \geq 0.25$	$^{VI}Al/(^{VI}Al + {}^{VI}Fe^{3+})$: 0.5 – 1.0	
	$Mg/(Mg + {}^{VI}Fe^{2+}) > 0.5$		
ferro-aluminoceladonite			$K\,Al(Fe^{2+},Mg)\square\,Si_4\,O_{10}\,(OH)_2$
	$^{VI}Al/(^{VI}Al + {}^{VI}Fe^{3+})$: 0.5 – 1.0	$Mg/(Mg + {}^{VI}Fe^{2+}) \leq 0.5$	
celadonite			$K\,Fe^{3+}(Mg,Fe^{2+})\square\,Si_4\,O_{10}\,(OH)_2$
	$^{VI}R^{2+}/(^{VI}R^{2+} + {}^{VI}R^{3+}) \geq 0.25$	$^{VI}Al/(^{VI}Al + {}^{VI}Fe^{3+}) < 0.5$	
	$Mg/(Mg + {}^{VI}Fe^{2+}) > 0.5$		
ferroceladonite			$K\,Fe^{3+}(Fe^{2+},Mg)\square\,Si_4\,O_{10}\,(OH)_2$
	$^{VI}Al/(^{VI}Al + {}^{VI}Fe^{3+}) < 0.5$	$Mg/(Mg + {}^{VI}Fe^{2+}) \leq 0.5$	
roscoelite			$K\,V_2\square\,AlSi_3\,O_{10}\,(OH)_2$
chromphyllite			$K\,Cr_2\square\,AlSi_3\,O_{10}\,(OH)_2$
boromuscovite			$K\,Al_2\square\,BSi_3\,O_{10}\,(OH)_2$
paragonite			$Na\,Al_2\square\,AlSi_3\,O_{10}\,(OH)_2$
	K < 0.15	Ca < 0.11	
nanpingite			$Cs\,Al_2\square\,AlSi_3\,O_{10}\,(OH)_2$
tobelite			$(NH_4)\,Al_2\square\,AlSi_3\,O_{10}\,(OH)_2$
TRIOCTAHEDRAL			
annite			$K\,Fe^{2+}_3\,AlSi_3\,O_{10}\,(OH)_2$
phlogopite			$K\,Mg_3\,AlSi_3\,O_{10}\,(OH)_2$
siderophyllite			$K\,Fe^{2+}_2Al\,Al_2Si_2\,O_{10}\,(OH)_2$
eastonite			$K\,Mg_2Al\,Al_2Si_2\,O_{10}\,(OH)_2$
hendricksite			$K\,Zn_3\,AlSi_3\,O_{10}\,(OH)_2$
	Zn > 1.5		
montdorite*			$KFe^{2+}_{1.5}Mn^{2+}_{0.5}Mg_{0.5}\square_{0.5}\,Si_4\,O_{10}\,F_2$
tainiolite			$K\,LiMg_2\,Si_4\,O_{10}\,F_2$
polylithionite			$K\,Li_2Al\,Si_4\,O_{10}\,F_2$
trilithionite*			$K\,Li_{1.5}Al_{1.5}\,AlSi_3\,O_{10}\,F_2$
masutomilite			$K\,LiAlMn^{2+}\,AlSi_3\,O_{10}\,F_2$
	Mn^{2+}: 1.0 – 0.5	Li: 1.0 – 1.5	
	Si: 3.0 – 3.5	^{IV}Al: 1.0 – 0.5	
norrishite			$K\,LiMn^{3+}_2\,Si_4\,O_{12}$
tetra-ferri-annite			$K\,Fe^{2+}_3\,Fe^{3+}Si_3\,O_{10}\,(OH)_2$
tetra-ferriphlogopite			$K\,Mg_3\,Fe^{3+}Si_3\,O_{10}\,(OH)_2$
aspidolite			$Na\,Mg_3\,AlSi_3\,O_{10}\,(OH)_2$
preiswerkite			$Na\,Mg_2Al\,Al_2Si_2\,O_{10}\,(OH)_2$
ephesite			$Na\,LiAl_2\,Al_2Si_2\,O_{10}\,(OH)_2$

Note: species that are not end members are denoted with an asterisk. Compositional limits are expressed in atoms per formula unit (*apfu*).

TABLE 2. BRITTLE MICAS: END-MEMBER FORMULAS AND TYPICAL RANGES FOR MINERAL SPECIES

	DIOCTAHEDRAL	
margarite		Ca $Al_2\square$ Al_2Si_2 O_{10} $(OH)_2$
I: Ca, Na	*M*: Al, Li, □ > Li	*T*: Al, Si, Be
chernykhite		Ba $V_2\square$ Al_2Si_2 O_{10} $(OH)_2$
M: V, Al, Fe, Mg		
	TRIOCTAHEDRAL	
clintonite		Ca Mg_2Al Al_3Si O_{10} $(OH)_2$
I: Ca, Na, K	*M*: Mg, Fe^{2+}, Al, Fe^{3+}, Mn	*T*: Al, Si, Fe^{3+}
bityite		Ca $LiAl_2$ $BeAlSi_2$ O_{10} $(OH)_2$
$^{VI}Li > {}^{VI}\square$		
anandite		Ba $Fe^{2+}{}_3$ $Fe^{3+}Si_3$ O_{10} S(OH)
I: Ba, K, Na	*M*: Fe^{2+}, Mg, Fe^{3+}, Mn, Al	*A*: S > (OH, Cl, F)
kinoshitalite		Ba Mg_3 Al_2Si_2 O_{10} $(OH)_2$
I: Ba + K ≈ 1.0	*M*: Mg, Mn^{2+}, Mn^{3+}, Al, Fe, Ti	*A*: OH, F

Compositional limits are expressed in atoms per formula unit (*apfu*).

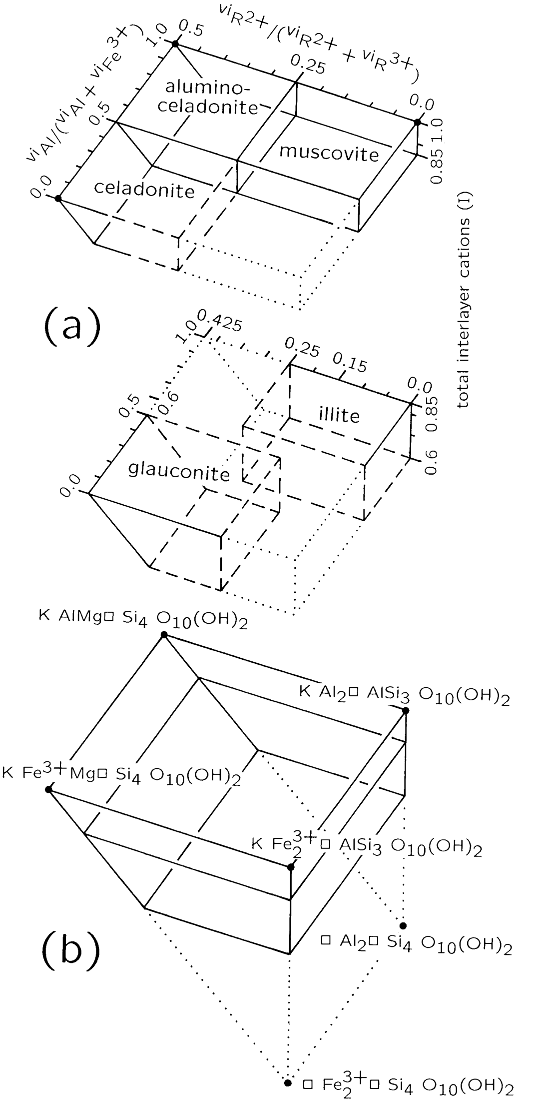

FIG. 1. A three-dimensional plot illustrating the relation of some true dioctahedral micas to interlayer-deficient dioctahedral micas. a. Two slabs cut from the chemographic volume (b) shown in terms of formulas (small solid circles). Dashed lines indicate approximate borders, dotted lines complete the solid. The ratio $^{VI}R^{2+}/(^{VI}R^{2+} + {}^{VI}R^{3+})$ is equal to *x*/2 (Table 3) for micas with 2.0 octahedral cations. End-member formulas in (a) are shown by solid circles. Glauconite with Na > K should be referred to as "natroglauconite".

MODIFIERS AND SUFFIXES

Chemical deviations from end-member compositions may be expressed by adjectival modifiers. These must be based on actual determinations to support the claim. The usage of adjectival modifiers is not mandatory. Modifiers like "rubidian" should be used only if the element in question exceeds 10%, but not 50%, of the real occupancy of the respective position in the end-member formulas involved. Thus, a rubidian muscovite may contain between 0.1 and 0.5 Rb atoms per formula unit. If an element can enter more than one coordination, a further differentiation is possible, such as "tetra-ferrian" or "octa-ferrian". If the concentration of an element is less than that necessary for the assignment of a modifier, and if the author wishes to acknowledge its presence, he or she may use a modifier such as "rubidium-containing". The latter type of modifier should be used also if the analysis is incomplete, thus preventing the calculation of a complete crystallo-chemical formula.

For cases where a polytype determination has been made, the name may be suffixed with an appropriate polytype symbol (Nickel 1993), *e.g.*, muscovite-3*T*. There are two universal systems of polytype symbolism, both based on the modified Gard notation: one presented jointly by IMA and IUCr (Bailey *et al.* 1978), and another, more generalized, by IUCr (Guinier *et al.* 1984). Because of international acceptance and common usage, the Ramsdell symbolism is preferred for the micas unless exact stacking sequences or other special information need clarification; for the latter cases, see Ross *et al.* (1966), Takeda & Sadanaga (1969), Zvyagin (1964, 1967), Zvyagin *et al.* (1979), or Dornberger-Schiff & Ďurovič (Ďurovič 1981). When using the other systems or when using symbolism that is not commonly known, the author must reference its source or, preferably, specify the stacking sequence

TABLE 3. INTERLAYER-DEFICIENT MICAS: REPRESENTATIVE FORMULAS AND RANGES

DIOCTAHEDRAL§	
idealized general formula	$(K,Na)_{x+y}\ (Mg,Fe^{2+})_x(Al,Fe^{3+})_{2-x}\square\ Si_{4-y}(Al,Fe^{3+})_y\ O_{10}\ (OH)_2$
$0.6 \leq x+y < 0.85$ $Mg > Fe^{2+}$	${}^{IV}Al > {}^{IV}Fe^{3+}$
illite (a series name)	$K_{0.65}\ Al_{2.0}\square\ Al_{0.65}Si_{3.35}\ O_{10}\ (OH)_2$
${}^{VI}R^{2+}/({}^{VI}R^{2+} + {}^{VI}R^{3+}) \leq 0.25$	${}^{VI}Al/({}^{VI}Al + {}^{VI}Fe^{3+}) \geq 0.6$
glauconite (a series name)	$K_{0.8}\ R^{3+}{}_{1.33}R^{2+}{}_{0.67}\square\ Al_{0.13}Si_{3.87}\ O_{10}\ (OH)_2$
${}^{VI}R^{2+}/({}^{VI}R^{2+} + {}^{VI}R^{3+}) \geq 0.15$	${}^{VI}Al/({}^{VI}Al + {}^{VI}Fe^{3+}) \leq 0.5$
brammalite (a series name)	$Na_{0.65}\ Al_{2.0}\square\ Al_{0.65}Si_{3.35}\ O_{10}\ (OH)_2$
TRIOCTAHEDRAL	
wonesite*	$Na_{0.5}\square_{0.5}\ Mg_{2.5}Al_{0.5}\ AlSi_3\ O_{10}\ (OH)_2$

Note: * wonesite is not an end member. Compositional limits are expressed in atoms per formula unit (*apfu*). § See also Figure 1; $I = x + y$.

represented by the symbols used. A review of polytypes in micas found to date can be found in Baronnet (1980), Bailey (1984), or Takeda & Ross (1995).

SERIES NAMES AND LISTS OF INVALID NAMES

This report also includes series names intended to designate incompletely investigated micas that are to be used by field geologists or petrographers (Table 4). Such names (*e.g.*, "biotite") are defined only in some series, thus in fact sanctioning a practice that is common already. Assigning a name to an incompletely investigated layer silicate may be risky, and it should be preceded by at least optical examination. Once such material has been studied in detail, end-member names should be preferred, with or without modifiers and suffixes. Series names are not to be associated with varietal modifiers.

TABLE 4. SERIES NAMES USED IN MICA NOMENCLATURE

biotite	trioctahedral micas between, or close to, the annite – phlogopite and siderophyllite – eastonite joins; dark micas without lithium
glauconite	dioctahedral interlayer-deficient micas with composition defined in Table 3
illite	dioctahedral interlayer-deficient micas with composition defined in Table 3
lepidolite	trioctahedral micas on, or close to, the trilithionite – polylithionite join; light micas with substantial lithium
phengite	potassic dioctahedral micas between, or close to, the joins muscovite – aluminoceladonite and muscovite – celadonite
zinnwaldite	trioctahedral micas on, or close to, the siderophyllite – polylithionite join; dark micas containing lithium

Hendricksite, *chernykhite*, *montdorite*, and *masutomilite* should be added to these names if future research substantiates the existence of solid solutions terminated by two end members, such as $K\ Zn_3\ AlSi_3\ O_{10}\ (OH)_2$ and $K\ Mn^{2+}{}_3\ AlSi_3\ O_{10}\ (OH)_2$. The first of those, now listed as end-member hendricksite, should then be renamed to "zincohendricksite", whereas the second should become "manganohendricksite". The same pattern should apply in all cases given.

Names whose usage is discouraged were divided into synonyms and varieties (Table 5), ill-defined materials and mixtures (Table 6), and names formerly or erroneously used for micas (Table 7).

JUSTIFICATION

This paragraph summarizes grounds for some of the Mica Subcommittee's decisions.

• **Aluminoceladonite**. The alternative term for this mica, *leucophyllite*, was considered unjustified because it invites confusion with an identical rock-name and because the type-locality leucophyllite (Starkl 1883) is too low in alkalis to represent a mica.

• **Aspidolite**. The Subcommittee voted to resurrect the name *aspidolite* (von Kobell 1869), which represented an old description of what was in more recent years referred to as *sodium phlogopite* (Schreyer *et al.* 1980). It must be pointed out that no one ever applied formally for the mineral name *sodium phlogopite*.

• **Brammallite**. A reasoning similar to that concerning *illite* has led the Subcommittee to list it as a series name. A more precise end-member nomenclature might develop at a later time.

• **Divisions within the interlayer-deficient micas**. In the subgroup of interlayer-deficient micas, some divisions comply with Nickel's (1992) nomenclature for mineral solid-solutions, but some do not. The non-50% limits adopted by the Subcommittee as divides between volumes in interlayer-deficient micas are essentially those of Bailey *et al.* (1979).

• **Illite**. This name has been used relatively vaguely, and the Subcommittee found it suitable as a series name for a relatively large volume in compositional space, as a counterpart to *glauconite*.

• **Interlayer-deficient micas** *versus* **hydromicas**. The Subcommittee was unable to find any *hydromica* that has an excess of H_2O over the equivalent of $(OH,F)_2$ and could not be interpreted as a *mixed-layer structure* (such as biotite – vermiculite, illite – smectite). At the same time, all micas described as *hydromicas* exhibit a deficiency in the interlayer cation position. Accordingly, the Subcommittee opted to abandon the subgroup name *hydromicas* and replace it with *interlayer-cation-deficient micas* or, in an abbreviated form, *interlayer-deficient micas*.

• **Phengite**. Phengite was elevated to a series name for solid solutions involving muscovite, aluminoceladonite, and celadonite.

TABLE 5. SYNONYMS (s) AND VARIETIES (v) THAT HAVE BEEN USED IN NAMING MICAS*

adamsite	=	muscovite
alurgite (v)	=	manganoan muscovite, manganoan illite
ammochrysos	=	muscovite
ammonium hydromica (s)	=	tobelite
ammonium muscovite (s)	=	tobelite
amphilogite (s)	=	muscovite
anomite	=	biotite
astrolite (s)	=	muscovite
barium phlogopite (v)	=	phlogopite
barytbiotite (v)	=	phlogopite
biaxial mica	=	muscovite
bowleyite (s)	=	bityite
brandisite (v)	=	clintonite
bronzite (Finch) (v)	=	clintonite
caesium-biotite (v)	=	biotite
calciobiotite (v)	=	biotite
calciotalc (v)	=	clintonite
cat gold	=	muscovite
cat silver	=	muscovite
chacaltocite	=	muscovite
chlorophanerite	=	glauconite
chrombiotite (v)	=	biotite
chrome mica (s)	=	chromian muscovite, chromian phengite
Chromglimmer (s)	=	chromian muscovite, chromian phengite
chromochre	=	chromian muscovite
chrysophane	=	clintonite
clingmanite (s)	=	margarite
colomite	=	roscoelite
common mica	=	muscovite
corundellite (s)	=	margarite
cossaite (v)	=	paragonite
cryophyllite (v)	=	zinnwaldite, ferroan trilithionite, ferroan polylithionite
damourite	=	muscovite
didrimite	=	muscovite
didymite	=	muscovite
diphanite (s)	=	margarite
disterrite (v)	=	clintonite
dysintribite	=	muscovite
emerylite (s)	=	margarite
euchlorite (s)	=	biotite
ferriannite (s)	=	tetra-ferri-annite
ferribiotite (v)	=	biotite
ferri-phengite (v)	=	ferrian muscovite
ferriphlogopite (v)	=	ferrian phlogopite, tetra-ferriphlogopite
ferrititanbiotite (v)	=	biotite
ferriwodanite (v)	=	biotite
ferriwotanite (v)	=	biotite
ferroferrimargarite (v)	=	margarite
ferro-ferri-muscovite (s)	=	ferrian annite
ferromuscovite (v)	=	biotite
ferro-phlogopite (v)	=	ferroan phlogopite
ferrophlogopite (v)	=	ferroan phlogopite
flogopite (s)	=	phlogopite
fluortainiolite (s)	=	tainiolite
Frauenglas	=	muscovite
fuchsite	=	chromian muscovite
gaebhardite[1]	=	chromian muscovite
gilbertite	=	muscovite
goeschwitzite	=	illite
grundite	=	illite
gümbellite	=	illite-$2M_2$
haughtonite (v)	=	biotite
heterophyllite (v)	=	biotite
holmesite	=	clintonite
holmite	=	clintonite
hydromicas (s)	=	interlayer-deficient micas
hydromuscovite	=	illite
hydroparagonite (s)	=	brammallite
hydroxyl-annite (s)	=	annite
hydroxyl-biotite (s)	=	biotite
iron-sericite (v)	=	ferrian illite
iron mica[2]	=	annite, siderophyllite, biotite
irvingite (v)	=	lithian muscovite
Isinglas	=	muscovite
Kaliglimmer	=	muscovite
killinite	=	illite
kmaite (s)	=	celadonite, ferrian celadonite
lepidomelane (v)	=	annite, siderophyllite, tetra-ferri-annite, biotite
lepidomorphite	=	phengite
leucophyllite (s)	=	aluminoceladonite
lilalite (s)	=	lepidolite
Lilalith (s)	=	lepidolite
lime mica (s)	=	margarite
lithia mica (s)	=	lepidolite, zinnwaldite
Lithioneisenglimmer (s)	=	zinnwaldite
Lithionglimmer (s)	=	lepidolite
Lithionit (s)	=	lepidolite
lithionite (s)	=	lepidolite
lithionitesilicat (s)	=	lepidolite
lithium muscovite (s)	=	trilithionite, lithian muscovite
lithium phengite (v)	=	lithian muscovite
macrolepidolite (s)	=	lepidolite
magnesia mica (s)	=	phlogopite
magnesiomargarite (v)	=	clintonite
magnesium sericite (v)	=	magnesian illite
manganese mica (v)	=	biotite
manganese muscovite	=	manganoan muscovite
manganglauconite (v)	=	glauconite
mangan-muscovite	=	manganoan muscovite
manganmuscovite	=	manganoan muscovite
manganophyll (v)	=	biotite
manganophyllite (v)	=	biotite
manganphlogopite (v)	=	manganoan phlogopite
margarodite	=	muscovite
Marienglas	=	muscovite
mariposite (s)	=	chromian phengite, chromian muscovite
marsjatskite	=	glauconite
marsyatskite	=	glauconite
meroxene (v)	=	biotite
metasericite	=	muscovite
microlepidolite	=	lepidolite
monrepite (s)	=	ferrian annite
Na brittle mica (s)	=	preiswerkite
Na-eastonite (s)	=	preiswerkite
nacrite (Thomson) (s)	=	muscovite
natrium illite (s)	=	brammallite
natro-alumobiotite (v)	=	biotite, sodian siderophyllite
natro-ferrophlogopite (v)	=	biotite, sodian phlogopite
natronbiotite (v)	=	biotite
natronphlogopite (v)	=	sodian phlogopite
natronmargarite (s)	=	calcic paragonite, calcic ephesite
nickel phlogopite (v)	=	nickeloan phlogopite
oblique mica	=	muscovite
odenite	=	biotite
Odinit	=	biotite
Odith	=	biotite
oellacherite	=	barian muscovite
oncophyllite	=	muscovite
Onkophyllit	=	muscovite
paucilithionite (s)	=	trilithionite
pearl-mica (s)	=	margarite
Perlglimmer (s)	=	margarite
picrophengite (v)	=	magnesian muscovite
poly-irvingite (v)	=	lepidolite
potash margarite (v)	=	margarite
potash mica	=	muscovite
pregrattite (s)	=	paragonite
protolithionite (v)	=	zinnwaldite, lithian annite, lithian siderophyllite
pycnophyllite	=	fine-grained muscovite or illite
Pyknophyllit	=	fine-grained muscovite or illite
Rabenglimmer (s)	=	zinnwaldite
Rhombenglimmer (v)	=	phlogopite, biotite
rhombic mica (v)	=	phlogopite, biotite
sandbergite	=	barian muscovite
sarospatakite	=	illite
scale stone (s)	=	lepidolite
schernikite	=	muscovite
Schuppenstein (s)	=	lepidolite
seladonite (s)	=	celadonite
seybertite (v)	=	clintonite
shilkinite (v)	=	ferroan muscovite, ferroan illite
siderischer-Fels-Glimmer (s)	=	lepidolite
skolite (s)	=	glauconite
soda glauconite (v)	=	glauconite
soda margarite (s)	=	calcic paragonite, calcic ephesite
soda mica (s)	=	paragonite
sodium illite (s)	=	brammallite
sodium phlogopite (s)	=	aspidolite
sterlingite	=	muscovite
svitalskite (v)	=	celadonite
taeniolite (s)	=	tainiolite
talcite	=	muscovite
titanbiotite (v)	=	biotite
Titanglimmer (v)	=	biotite
titanmica (v)	=	biotite
titanobiotite (v)	=	biotite
valuevite (v)	=	clintonite
vanadium mica (s)	=	roscoelite
Vanadinglimmer (s)	=	roscoelite
verdite	=	chromian muscovite
Verona earth (s)	=	celadonite
veronite (s)	=	celadonite
voron'ya slyuda (v)[3]	=	zinnwaldite, lithian annite, lithian siderophyllite
walouewite (v)	=	clintonite
waluewite (v)	=	clintonite
Walujewit (v)	=	clintonite
wodanite (v)	=	biotite
wotanite (v)	=	biotite
xanthophyllite (v)	=	clintonite
zweiaxiger Glimmer	=	muscovite

Names in the left column should be abandoned in favor of those in the right. The absence of a symbol in parentheses indicates cases where it could not be decided whether the name is a synonym or a variety. [1] The mineral *gebhardite* has the formula $Pb_8O(As_2O_5)_2Cl_6$. [2] Also has been used to refer to hematite. [3] "Raven mica" or "crow mica" in Russian.

TABLE 6. ILL-DEFINED MATERIALS AND MIXTURES*

achlusite	a sodium mica ?
antrophyllite	a mica ?
avalite	chromian illite or a mineral mixture
baddeckite	muscovite and hematite
bardolite	interstratified biotite and vermiculite ?
basonite	interstratified biotite and vermiculite
bastonite	interstratified biotite and vermiculite
bravaisite	illite and montmorillonite
buldymite	biotite and vermiculite or interlayer-deficient biotite
caswellite	mica and manganoan andradite
cataspilite	alteration product with dominant muscovite
catlinite	muscovite and pyrophyllite
chacaltaite	illite pseudomorph after cordierite
cymatolite	muscovite and albite
dudleyite	a smectite ?
ekmanite	a smectite ?
epichlorite	an altered chlorite ?
epileucite	muscovite and K-feldspar pseudomorph after cordierite
episericite	illite ?
eukamptite	altered biotite
euphyllite	paragonite and muscovite or paragonite
gigantolite	muscovite and cordierite
hallerite	paragonite and lithian muscovite
helvetan	decomposed biotite
hexagonal mica	a mica ?
hydrophlogopite	interstratified phlogopite and vermiculite
hydropolylithionite	an altered lepidolite ?
iberite	altered cordierite and zeolite
ivigtite	muscovite ? sodian ferruginous mica ?
kryptotile	probably not a mica
ledikite	interstratified biotite and vermiculite
lesleyite	a variety of margarite or a mineral mixture
leverrierite	probably not a mica
mahadevite	an Al-rich biotite ?
Melanglimmer	biotite ? stilpnomelane ? cronstedtite ?
metabiotite	weathering product of biotite
Mg-illite-hydromica	interstratified phlogopite and vermiculite
minguetite	interstratified biotite and vermiculite ?
oncosine	muscovite ± quartz ± other phases
Onkosin	muscovite ± quartz ± other phases
onkosine	muscovite ± quartz ± other phases
pattersonite	interstratified biotite and vermiculite
philadelphite	decomposition product of biotite, a vermiculite ?
pholidolite	phlogopite ? saponite ?
pinite	pseudomorph mostly of mica after cordierite, nepheline, or scapolite
pseudobiotite	interstratified biotite and vermiculite or interlayer-deficient biotite
pterolite	decomposition product of hornblende consisting of mica and alkali pyroxene
rastolyte	altered biotite or interlayer-deficient biotite
rubellan	altered biotite or interlayer-deficient biotite, vermiculite ?
sericite	fine-grained aggregate of mica-like phases
spodiophyllite	possibly a mica related to tainiolite
trioctahedral illite	interstratified biotite and vermiculite
uniaxial mica	a biotite ?
vaalite	a vermiculite ?
voigtite	weathering product of biotite or interlayer-deficient biotite
waddoite	a mica ?

* Usage of these names is discouraged unless the ill-defined micas are substantiated by new research.

TABLE 7. NAMES FORMERLY OR ERRONEOUSLY USED FOR MICAS

agalmatolite	pyrophyllite or a mixture with dominant pyrophyllite
allevardite	rectorite
bannisterite	related to islandlike modulated 2:1 layer silicates
Bildstein	pyrophyllite or a mixture with dominant pyrophyllite
chalcodite	stilpnomelane
Fe muscovite	invalid name, hypothetical end-member
ferrimuscovite	invalid name, hypothetical end-member
ferrophengite	invalid name, hypothetical end-member
ferrostilpnomelane	stilpnomelane
ganophyllite	modulated 2:1 layer silicate
hydrobiotite	regular 1:1 interstratification of biotite and vermiculite
iron muscovite	invalid name, hypothetical end-member
kerrite	vermiculite
maconite	related to vermiculite
manandonite	boron-rich serpentine
pagodite	pyrophyllite or a mixture with dominant pyrophyllite
parsettensite	modulated 2:1 layer silicate
stilpnochlorane	nontronite
tarasovite	regular 3:1 interstratification of dioctahedral mica and smectite

Note that some entries listed in the left-hand column are names of valid species; these names are not to be considered discredited because they appear in this table.

• **Species that are not end members**. The Subcommittee voted to consider as end members only formulas that are stoichiometric on the scale of the asymmetric part of the unit cell. This principle ruled out a number of micas; the Subcommittee decided it would be best to refer to nonstoichiometric micas that have a fairly constant and recurring composition as "*species that are not end members*". The micas so designated are *montdorite*, *trilithionite* and *wonesite*.

• **Synonyms (s) and varieties (v)**. The list is based on tabulations of Heinrich *et al.* (1953) and Hey (1962, 1963), modified and supplemented. Labels "(s)" or "(v)" could only be attached where there was sufficient information. If a series name appears to the right of a variety rather than a species name, it is because no more precise information is available.

• **Tainiolite**. The Subcommittee prefers the original spelling *tainiolite* to *taeniolite*. The spelling of Flink (1899) was based on Greek words ταινία (a band or strip) and λίθος (a stone). It should be noted that the Russian spelling has always been **тайниолит**.

• **Tetra-ferri-annite**. Inasmuch as Wahl's (1925) analytical results do not make the case for $^{IV}Fe^{3+}$ sufficiently strongly, his *monrepite* was rejected as an end member, with *tetra-ferri-annite* taking its place. Parallel with it is the name *tetra-ferriphlogopite*.

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References

BAILEY, S.W. (1984): Classification and structures of the micas. *In* Micas (S.W. Bailey, ed.). *Rev. Mineral.* **13**, 1-12.

________, BRINDLEY, G.W., KODAMA, H. & MARTIN, R.T. (1979): Report of the Clay Minerals Society Nomenclature Committee. *Clays Clay Minerals* **27**, 238-239.

________, FRANK-KAMENETSKII, V.A., GOLDSZTAUB, S., KATO, A., PABST, A., SCHULZ, H., TAYLOR, H.F.W., FLEISCHER, M. & WILSON, A.J.C. (1978): Report of the International Mineralogical Association (IMA) – International Union of Crystallography (IUCr) Joint Committee on Nomenclature. *Can. Mineral.* **16**, 113-117.

BARONNET, A. (1980): Polytypism in micas: a survey with emphasis on the crystal growth aspect. *In* Current Topics in Materials Science **5** (E. Kaldis, ed.). North-Holland Publ. Co., Amsterdam, The Netherlands (447-548).

ĎUROVIČ, S. (1981): OD-Charakter, Polytypie und Identifikation von Schichtsilikaten. *Fortschr. Mineral.* **59**, 191-226.

FLINK, G. (1899): Tainiolite. *In* Mineraler fra Julianehaab indsamlede af G. Flink 1897 (G. Flink, O.B. Bøggild & C. Winther). *Meddelelser Grønl.* **24**, 115-120.

FOSTER, M.D. (1960): Interpretation of the composition of trioctahedral micas. *U.S. Geol. Surv., Prof. Pap.* **354-B**, 11-49.

GUINIER, A., BOKIJ, G.B., BOLL-DORNBERGER, K., COWLEY, J.M., ĎUROVIČ, S., JAGODZINSKI, H., KRISHNA, P., DE WOLFF, P.M., ZVYAGIN, B.B., COX, D.E., GOODMAN, P., HAHN, T., KUCHITSU, K. & ABRAHAMS, S.C. (1984): Nomenclature of polytype structures. Report of the International Union of Crystallography Ad-Hoc Committee on the Nomenclature of Disordered, Modulated and Polytype Structures. *Acta Crystallogr.* **A40**, 399-404.

HEINRICH, E.W., LEVINSON, A.A., LEVANDOWSKI, D.W. & HEWITT, C.H. (1953): Studies in the natural history of micas. *Engineering Research Institute, University of Michigan, Ann Arbor, Project* **M978**.

HEY, M.H. (1962): *An Index of Mineral Species & Varieties Arranged Chemically*. British Museum, London, U.K.

________ (1963): *Appendix to the Second Edition of An Index of Mineral Species and Varieties Arranged Chemically*. British Museum, London, U.K.

VON KOBELL, F. (1869): Ueber den Aspidolith, ein Glied aus der Biotit- und Phlogopit-Gruppe. *Sitzungsber. königl. bayer. Akad. Wiss. München* **1869**(I), 364-366.

NICKEL, E.H. (1992): Solid solutions in mineral nomenclature. *Can. Mineral.* **30**, 231-234.

________ (1993): Standardization of polytype suffixes. *Can. Mineral.* **31**, 767-768.

RIMSAITE, J. (1970): Structural formulae of oxidized and hydroxyl-deficient micas and decomposition of the hydroxyl group. *Contrib. Mineral. Petrol.* **25**, 225-240.

ROSS M., TAKEDA, H. & WONES, D.R. (1966): Mica polytypes: systematic description and identification. *Science* **151**, 191-193.

SCHREYER, W., ABRAHAM, K. & KULKE, H. (1980): Natural sodium phlogopite coexisting with potassium phlogopite and sodian aluminian talc in a metamorphic evaporite sequence from Derrag, Tell Atlas, Algeria. *Contrib. Mineral. Petrol.* **74**, 223-233.

STARKL, G. (1883): Ueber neue Mineralvorkommnisse in Oesterreich. *Jahrb. kaiserl.-königl. geol. Reichsanst. Wien* **33**, 635-658.

STEVENS, R.E. (1946): A system for calculating analyses of micas and related minerals to end members. *U.S. Geol. Surv., Bull.* **950**, 101-119.

TAKEDA, H. & ROSS, M. (1995): Mica polytypism: identification and origin. *Am. Mineral.* **80**, 715-724.

________ & SADANAGA, R. (1969): New unit layers for micas. *Mineral. J.* (*Japan*) **5**, 434-449.

WAHL, W. (1925): Die Gesteine des Wiborger Rapakiwigebietes. *Fennia* **45**, 83-88.

ZVYAGIN, B.B. (1964): *Злектронография и Структуная Кристаллография Глинистых Минералов*. Nauka, Moscow, Russia (in Russ.).

________ (1967): *Electron-Diffraction Analysis of Clay Mineral Structures.* Plenum Press, New York, N.Y.

________, VRUBLEVSKAYA, Z.V., ZHUKHLISTOV, A.P., SIDORENKO, O.V., SOBOLEVA, S.V. & FEDOTOV, A.F. (1979): *Высоковольтная Здектронография в Исследовании Слоистых Минералов* (*High-Voltage Electron Diffraction in the Study of Layered Minerals*). Nauka, Moscow, Russia (in Russ.).

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