

**INTERNATIONAL MINERALOGICAL ASSOCIATION (IMA)
COMMISSION ON CLASSIFICATION OF MINERALS (CCM)**

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To all members of the Commission

Dear friends,

please find attached:

Comments to the ***Draft Proposal : Draft Discussion Paper on criteria to establish mineral groups (or families)*** ; the same draft was submitted also to the members of the CNMMN. The authors have prepared a revised version taking into account the comments; it is here attached. The authors intend to propose these documents for a joint discussion between CNMMN and CCM in occasion of M&M4 (Melbourne, 4-7 December 2000). However, written comments are welcome, particularly from those members who cannot attend M&M4.

With best wishes

Dmitry Pushcharovsky

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Draft Discussion Paper on criteria to establish mineral groups (or families)

Comments from members of the CNMMN and CCM and others

(I) - I'm happy to see that some colleagues opened the discussion on the mineral groups. The starting ideas put forward by them suggest that not only the problem of the mineral groups should be discussed but also the whole hierarchy of the mineralogical nomenclature. Should isostructural mean that the minerals belong to the same group? See quartz and berlinite. I think it is necessary to look both up and down from the mineral species and then to try to define the mineral groups. The problem of mineral sub-species seems to me to be unavoidable.

(II) - (1) What is "substantial"? Is it possible to reach a more exact definition? Cf. Point 6. (2) I think that the existence of two isostructural species may be enough to define a group with full reason. (3) I suppose oldER is a misprint for oldEST. By the way, a given mineral may be oldest (i.e. earlier known) than its present name, e.g. calcite is a pretty old species, but its currently used name was given only in 1836). I suppose, that groups can be named after non-species names as a matter of course (e.g. tourmaline, olivine etc.). (6) One has to be careful with going into systematics. Do pyroxenes represent a group in the sense of Point 1? Or are they a "higher" systematic unit? Say "supergroup" (superfamily)? I don't think that we are able to avoid some subjectivity in this respect. - (General comments/questions) - A clear and unambiguous usage of the terms is essential. E.g. in Fleischer's Glossary one can find apophyllite group, barite group, mica group, zeolite group, which represent obviously different kinds of groups. What is the relation of series (a., forsterite-fayalite, b., different kinds of sulphosalt series etc.) to groups?

(III) - I agree completely with the ideas 1, 3, 4, 5 and 6. About 2, I think that one mineral is sufficient to define a group. Thus, it will be possible to classify all the minerals in groups.

(IV) - Generally I support the present contents of draft discussion paper. I have an opinion to column 2. The sense of group is "a number of things, etc." Does "a number of" mean two or three? No, I do not think so, therefore, a group should include more than four species.

(V) - We once before started on this exercise when Peter Bayliss was Chairman of the CCM. I find it strange that mineral families are mentioned in the title of the discussion paper, but are not discussed in the text. For instance, to my mind, the zeolites do not belong to a group but to a family of minerals. Basic criteria for a group: isostructurality (or closely related structures) and identical kind of anion (excluding OH, F, Cl). There must be three or more minerals to define a group (two are not enough!). I am afraid that I do not quite understand paragraph 5 ("expedite the approval", "some of the properties could be regarded as less important" ?). Subgroups like ortho- and clinopyroxenes are useful. But if pyroxenes are a group, strict isostructurality cannot be required as a criterion.

(VI) - I think it would be better if you include a short preamble with some explanations and examples because, before to discuss, we need to know reasons and supposed results of this discussion. Why to waste a lot of time and energy if we do not know the goals. First, what be a full sequence of subdivisions in your classification of minerals after this discussion? In what way and why will it differ from systems by Dana, Strunz, Povarennyk, Lima-da Faria, Boki? Second, I found nothing new in your criteria, and what will you change in groups in systems of minerals

mentioned above? Could you include some examples into an introduction before your starting ideas?

(VII) - The question of the distribution of species into mineral groups is indeed very important. It is in fact a dual problem which includes the formal definition of a group as well as the use of a logical nomenclature into the group. Further comments: (1) First point of the proposal 9/99: As you mention, at a structural point of view, halite and periclase belong to the same group although chemically very different. The definition of a group is indeed different for a mineralogist and for a crystallographer. If we choose spinel as an example, the mineralogist considers only the metal oxides with general formula M_3O_4 : magnetite, hercynite, gahnite, spinel s.s., but the crystallographer may also include into the spinel group sulfides of the linnaeite structural group with general formula $(M'M'')_3(S,As)_4$ such as carrollite and violarite. The problem is the same concerning garnets. For the crystallographers, a mineral can be considered as a garnet even if Si is not present in its chemical composition. (2) In isostructural series of 2 or more minerals, the nomenclature is highly fancyful. Example of the crandallite group: It appears clearly that arsenocrandallite is the As equivalent of crandallite containing P. But in the same group, plumbogummite is the P equivalent of philipsbornite (As) without any relation between the names. Example of the olivine group: 4 minerals belong to this group: fayalite, forsterite, tephroite and liebenbergite. Not any species recall the name of the group whereas the name olivine is generally the only one that can be given by a first examination on the field.

(VIII) - I read it carefully and I do not think that I can reply on these starting ideas (1-6). I fully agree with this idea as a whole, but I see as the principal problem to discuss hierarchy of mineral "groups" first. We have currently mineral groups which differ significantly in their status; e.g. Zeolite group with minerals highly variable in symmetry and chemistry, on one side and e.g. olivine group which includes strictly isostructural minerals, on the other side (see Mandarino 1999). I am convinced that definitions of mineral "groups" (e.g. family, group, subgroup, series) must be discussed first although some of the given starting ideas are closely related to this problem.

(IX) - I am in general sympathy with the objectives of this proposal, but I am also aware that there will be practical difficulties requiring very careful wording. Nature has developed without concern for natural boundaries that may happen to be convenient for human systematists! During the work of the zeolite sub-committee, we had some discussions on these matters. Do the zeolites constitute a group and what terms are available for sub-groupings of zeolites? Zeolite minerals have essential structural features in common, but include very different structures. There was some attraction to the term "family" for the zeolites as a whole, and "group" for individual structure types, such as the analcime structure type, which includes pollucite and leucite. But in other branches of science, a Family is a subdivision of a Group, so it would be confusing to introduce the term Family. Group and Sub-group might have been acceptable, but a much wider range of structure types would be included in an all-inclusive zeolite group than in other conventional mineral groups. We decided the problem was not for us to resolve, and we carefully avoided any term for the zeolites as a whole in our report, other than "zeolite minerals". We defined what we meant by that. Within the zeolites we referred to "structure types" and to "series" where zeolites having the same topologically distinctive framework of tetrahedra display a substantial range of composition in which different extra-framework cations may be the most abundant in atomic proportions. Such series consist of two or more species distinguished by the most abundant extra-framework cation.

(X) - I certainly concur with this proposal. Minimum number of species to form a group must be three. Please have Marco and Dmitry check out the latest PDF Alphabetical Indexes (Inorganic Phases) Sets 1-49 soft cover book. Towards the back (page 937 to 972) is the Mineral Classification Index which has been approved for publication by ICDD. This listing is also present (in a more

limited fashion) in the most recent CR-ROM version of the PDF Database. There are certainly differences between this compilation and that of Mandarino (1999).

(XI) - (1) If we like to make a system of mineralogy we have to make agreement what is the basis of this system. I think that our knowledge about minerals collected, I would say, through the centuries make possible to organize this system very rationally. First of all we have many works on this field, and I would like to stress very important work condensed in Dana's system. They actually realized that there are some principles in mineralogy. All of the minerals we can divide in CLASSES. Classes are based on chemical diversity. Minerals could be elements, sulphides (including tellurides, selenides), oxides (someone can discuss if hydroxides are oxydes or not), Once when we have agreement about the classes we can think about the additional division. This could be based on the stoichiometry. This is a way how we can obtain mineral TYPES. All minerals with the same element ratio within the class will form the same type of minerals. All minerals within the same type will form the GROUP if they are isostructural. This is a way to form groups if there are more than one mineral with the same type of structure. (2) Minerals from the different classes could have the same structural type, but they are members of different groups. (3) This is OK! (4) This is a fact which can happened, but there are many different examples: like the minerals which have completely new structural type. I do not understand what do the authors want to say with this paragraph. This is essential that we define the differences between the minerals. What should mineralogists from the end of the last century say about the differences between the phyllosilicates? (5) Groups define many things: class (chemical connection), type (stoichiometry), and structural type. On these properties some physical properties would also be placed in some interval, which one can expect. This will certainly help to people who would like to describe new species for comparison. But than some different groups must became the same group, like pyrochlore and stibiconite groups. They are different just on the basis of different origin (but even that not always!). (6) I do not see any real reason for defining orto- and clinopyroxenes as two subgroups. They can be also two groups, two closely related groups, but groups. Maybe, the above example (stibiconite-pyrochlore) could be subgroups? A question for discussion!

(XII) - (1) Isostructurality is the fundamental criterion when assigning a mineral to a group. Minor deviations must be allowed however, *e.g.* in local or overall symmetry (different point groups or space groups), but the topological framework (*i.e.*, the polyhedral elements and their connectivity) should remain the same. An good example is the clinopyroxenes and orthopyroxenes, which constitute the pyroxene group. Another important criterion is the common anion. However, we should tolerate that a smaller fraction of the anions are substituted. For example, w stite (with vacancies in a number of the anion sites) is still considered a member of the periclase group. Richterite and fluoro-richterite both belong to the amphibole group. (2) Two members are enough to establish a new mineral group. (3) As a general rule, the oldest known species within the group should give its name to it. There might be exceptions, *e.g.*, in cases when we have special names for the groups, which are not valid mineral species themselves (feldspar, amphibole etc.). Historical names should be retained. (4) A few "groups", *e.g.* the zeolites, are too broadly defined to fit the modern definition of a group. In those cases one of the terms "supergroup" or "family" might be introduced. (5) Very few physical properties are the same along a mineral series (except for the crystal symmetry), and must therefore be determined independently for each (end) member. However, authors of new-mineral proposals should be encouraged to indicate assignment to a mineral group when appropriate. (6) Some subgroups are already established and should be retained. In certain cases it would be convenient to distinguish between structural subgroups (clinoamphiboles *vs.* orthoamphiboles) and chemical subgroups (*e.g.* calcic *vs.* sodic amphiboles).

(XIII) - In general: I was always greatly in favour of mineral groups, This is the only possibility to \pm correctly name a mineral in such highly complex solid solution series as they more and more

occur among proposals for new minerals. And, honestly, in many cases such an extremely time consuming identification work is not worth while. (1) - I don't think that member within a group should be summed up according to isostructurality (isotypism), only. In my eyes, they at least should be chemically related to such a degree that partial substitution may occur, the most important criterion, of course, being isomorphism (solid solution series). (2) Two minerals may define a mineral group, of course. (3) I agree. (4) Compare my "in general" statement. (5) If possible, yes. However, in many cases this knowledge is gained only from a complete structure determination (hitherto not yet a condition for the submission of a proposal, and in many cases not feasible). (8) Yes, perhaps, but only large mineral groups with numerous members (as in pyroxenes, amphiboles, etc.).

(XIV) — *Group Criteria* — Both structural and chemical criteria should be used in the formulation of a group. From the standpoint of structure, the minerals in a group should be (nearly) isostructural or have structures that are topologically identical. Thus polymorphs, such as those of analcime, that have different crystallographic symmetries, but are topologically identical, would all be accommodated within one group. However, dimorphs such as calcite-aragonite, pyrite-marcasite and sphalerite-wurtzite would be allocated to separate groups. On these criteria, calcite and dolomite, which are topologically similar, would be assigned to the same group, but if it is important to stress cation ordering, then they could be assigned to separate groups. From the standpoint of chemistry, the minerals in a group should have the same principal anion or crystallochemically similar anions from the same column of the Periodic Table of the Elements. Thus berlinite (AlPO_4) and alarsite (AlAsO_4) would be assigned to the same group because they are isostructural, and P and As have similar crystallochemical behaviours. However, halite, galena and periclase would not be assigned to the same group because Cl, S and O are crystallochemically dissimilar. — *Size of Group* — A group should comprise two or more members. If a group established under the above criteria is excessively large, e.g. the amphiboles, then the minerals could be split up into smaller units on the basis of cation predominance in specified structural sites, each unit being called a group, and the aggregation of groups being called a family. — *Name of Group* - A group should normally be named after the oldest member of the group, but only if the crystal structure of that mineral has been determined. However, historical precedence should be maintained, so that, for example, the name garnet is retained as a group name even though it is not regarded as a species *sensu stricto*. — *General Comment*— Professor Hugo Strunz has been working on a chemical-structural classification of all mineral species for about 60 years, and has published this work in a number of editions of *Mineralogische Tabellen*. An updated English edition of this work, to be entitled *Strunz Mineralogical Tables*, is currently in press. In this book, mineral species are allocated to groups according to the above criteria. It is respectfully suggested that consideration be given to using the classification scheme in the book as the basis for a CNMMN group classification.

(XV) — 1. Minerals belonging to the same group are isostructural or have similar or related structures. Ortho- and clinopyroxenes belong to the pyroxenes group. Their structures are similar and related, not isostructural. 2. Minerals belonging to the same subgroup are isostructural (e.g.: pyroxenes = group; ortho- and clinopyroxenes = subgroups). 3. At least two minerals are necessary to define a group.

(XVI) - (1) It is not very clear why it is suggested to discuss one part of a classification (for example, one taxon) a group or a family occupying an intermediate position in the classification, when previous and following taxons are not defined. Discussion of any classification must be begun from the last taxon or the initial one. A kingdom (or a set) of minerals will be an initial taxon for mineralogy and a mineral species (or a mineral) will be the last one. A group is not a taxon of the mineral classification, this term is used in different meanings by various authors. This term is not at all a synonym of a family term, which is an ordinary taxon of biological classifications. By

the way, it is reasonable to use the same terms for naming taxons in mineralogy that are used in the biological classifications, as in both cases they classify the objects existing independently on a human being s activity. The major part of the up-to-date classifications is connected just with human activity, for example, for machine or apparatus details, goods and so on. The group term is absent in the biological classifications. It is better to keep this term for description of groups of objects being related to different sectors of the classifications. For example, to animals inhabiting within these or those geographical boundaries or having the similar attributes of life, for instance, parasites and so on; analogical mineral groups, for example, being met in this or that deposit or a mineral group in this or that rock and so on. (2) From said above it is possible to answer unambiguously the second question of the questionnaire received. Every mineral species belongs to this or that family. If there is one mineral in the given family then its family can be not shown. If there are two or more of them, then it is expediently to show their family characteristic. A family taxon is in the interval between class and species taxons, therefore its properties (attributes) in the above taxons (for example, in the classes) can be the same. Minerals of various classes cannot be united in one family, and the fact that their families can have the same properties (attributes) is not important. This state includes an answer for the first question why halite and periclase cannot belong to one group, i.e. one family. These minerals belong to different classes: halite belongs to the chloride class and periclase belongs to the oxide class. (3) As a group notion is not defined in mineralogy by any way, so a full arbitrariness exists in the use of this term. It was said above that minerals from different classes cannot belong to one family (to one group). However, this rule does not work in mineralogy. In Dana s mineralogy (p.373) isostructural minerals with composition LiF, NaF, KF belonging to the fluoride class and minerals with composition NaCl and KCl belonging to the chloride are put in one group. But for example, chlorargyrite - AgCl is considered separately from this group, although it is isostructural to the previous ones. In Strunz s mineralogy besides all these minerals bromargyrite - AgBr, i.e. a mineral of the bromide class, belongs to the same row (a synonym of a group term). Dana unites two last minerals neither a separate group nor a halite group. In mineralogy even the very initial taxons of the classification are not defined till our days. The first two divisions in the mineral classifications being met in up-to-date mineralogical literature are shown below.

Author s name	First division	Second division
A.A.Godovikov (1979)	2 subkingdoms	6 types
A.S.Povarennikh (1966)	4 types	23 classes
A.G.Bulakh et al. (1995)	4 types	20 classes
A.A.Godovikov (1975)	5 types	16 classes
A.G.Betekhtin (1950)	6 sections	18 classes
E.S.Dana (1937)	8 without names	24 without names
H.Strunz (1978)	9 classes	39 orders
E.I.Semenov (1991)	9 classes	57 subclasses
A.N.Winchell, H.Winchell (1953)	10 without names	19 without names
I.Kostov (1971)	12 classes	23 A, B, C...
K.Herlbat, K.Klein (1982)	13 without names	24 without names
I.Kostov (1993)	13 classes	37 without names
E.I. Semenov (1981)	18 classes	118 subclasses
A.M.Clark (1993)	32 without names	
It is offered	7 subkingdoms	21 types

An absolute chaos in the up-to-date mineral classification astonishes. The most surprising is the fact that if the author publishes two classification systems in various periods of time they essentially differ from each other. The author has never said about the purposes of such changes. (Probably, the principle that there are no science about a classification theory, and so I classify as I want, works

subconsciously). Mineralogists did not notice that in the second part of the XX century classification has transformed into independent science with its own mathematic principles. There are two International Journals on classification. In the majority of industrial developed countries there are commissions on classification, the corresponding meetings take place, in particular, International ones and so on. By the way, in spite of a great deal of a chaos in the mineral classification there is the only common attribute for all systems - chemical composition of the minerals (Berzelius, 1824). From that time the mineral classification has been behind from other classifications, for instance, biological ones (more than for 170 years). Using essential attributes is a main principle of any classification. It is often difficult to differ essential attributes from unessential ones. As I have shown in my works, if an attribute bases on any law of nature then it is always an essential one. From our point of view, Periodic System of chemical elements (PSCE) is such a law for mineral classification, and it must be put into a basis of the classification. It is possible to agree with point 3 if to change a group term into a family . (4) Isomorphic mixtures in the cationic part of the composition are discussed here. If a crystal symmetry is high enough (i.e. they belong to a cube or hexagonal syngony) and cations consist of two chemical elements occupying Wyckoff position in the atomic structure then rationality of using 50% limit is without any doubt (for example, in the structures of NaCl, CaF₂ types and so on). However, if a crystal structure belongs to one of the lowest syngonies and a chemical composition of a mineral is complicate enough, therefore cations occupy a few Wyckoff positions (W.p.), for example, two chemical elements occupy one of them, and the rest situate in the other W.p., then the use of 50% limit for such case becomes already more doubtful. May be, in such cases it is better not to divide similar isomorphic mixtures into two mineral species and to consider one of them a variety of the other. See, for example, Betehtin (p.583) and Strunz (p.204). Both authors consider ferberite - FeWO₄, huebnerite - MnWO₄ and wolframite - (Mn,Fe)WO₄ to be the three independent mineral species. However, it is more logical to consider the last by a variety of huebnerite even in the case of Fe content predominance over Mn would be proved in any W.p. occupied by metals. Chemical analysis data can be enough in such cases. It seems to me that concrete discussion of this question is worthy of International attention. In corresponding chapters of our book we use a term of a variety of mineral species in analogical cases. Point 4 is finished by the words: The only way is to perform a chemical analysis . Unfortunately, the chemical analysis cannot answer this question. For unambiguous answer special very precision X-ray (or common diffraction) study is necessary, which is not fulfilled usually, as there is no need in it for usual X-ray determination of crystal atomic structures. The chemical analysis usually gives opportunity to determine only a class . Knowledge of mineral atomic structures is necessary for determination of lower taxons. Point 5 begins by the words: Once the mineral group will be formally defined... If instead of a group term to use terms of a family and genus , then one should agree with proposals of this point. It is impossible to agree with the proposal of point 6 because of a misunderstanding which appears together with an attempt to use a group term. A structural type is a fundamental attribute of a genus taxon, therefore ...a group of closely related but not isostructural minerals... (e.g., pyroxenes) belongs to a higher taxon than a genus, i.e. a family taxon. The group of isomorphic minerals belongs to one genus . The greatest part of questions analogical to ones proposed to the discussion in your letter is stated in the book: G.B.Bokii Systematics of Natural Silicates edited in 1998. See Chapter 1 Main Principles of a Mineral Classification . As I hope, continuation of the principles stated will be published in 2000 in the same publish-house in the book Systematics of Natural Oxides .

(XVII) - In most of the existing classifications, mineral species are assigned to groups according to attributes, the most important of which are the type of chemical formula, structure type or structural motif, chemical class, and occasionally special physical properties. These attributes are used in particular to distinguish the following groups: (a) species with the identical general formula that relate to the same structure type and to a certain chemical class (e.g., alunite and calcite groups); (b) with the identical general formula and structure type but relating to several different chemical

classes (e.g., crandallite and monazite groups); (c) with the identical general formula but relating to several different structure types (e.g. amphibole and lovozerite groups) and to several chemical classes (e.g., apatite group); (d) with a similar type of chemical formula relating to several different but closely related structure types (e.g., astrophyllite and labuntsovite-nenandkevichite groups); and (e) with characteristic structurally controlled physical properties (zeolites, etc.). The group in mineralogy is thus a nonhierarchical term of free use without definite limits and is used to denote sets of species with common attributes of composition, structure, and properties that are specified individually in each classification for each specific group. In the most general terms, a mineral group can be defined as a set of mineral species with some analogy in the chemical composition, structure, and properties. It appears irrational, possibly erroneous, to give the term "group" a narrower meaning, e.g., to restrict it to groups (a) and (b) because it would not only deprive the term its mineralogically widely accepted meaning but would also make it necessary to introduce new alternative terms to denote sets of species of types (c) to (e). It should also be kept in mind that, according to the existing interpretations of this term, individual closely related groups can be assigned to larger divisions, namely families (e.g., murmanite-lomonosovite, feldspar, feldspathoid families, etc.) and can be subdivided (according to symmetry or membership in chemical classes) into subgroups and smaller divisions. Quite informative among the latter are, e.g., the zeolitic "series of isostructural mineral species," each of which has a common root name (e.g., chabasite and clinoptilolite series). I would like to hope that the members of the CNMMN and CCM will exercise great caution in their attitudes to attempts to change the interpretation of the term "group." I believe that until a consensus is attained, it would be best of all to preserve this term in its current wide meaning.

REVISED Draft Discussion Paper on criteria to establish mineral groups (or families)

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It often happens that minerals are said to belong to a certain group, and the concept of mineral group is clear to all of us, when we are speaking of the commonest ones (e.g., garnets, amphiboles, etc.). However, a formal definition of "what is a group" together with a comprehensive list of mineral groups (which should parallel the list of IMA-approved mineral species) is lacking.

The International Mineralogical Association, through its Commission on New Minerals and Mineral Names and Commission on Classification of Minerals, should aim at defining, in a formal way, all mineral groups. The main advantage of the definition of groups should be the immediate recognition of close similarities in most properties for all minerals of the group. However the definition of single groups is a more complicated and special matter and should be left open to future contributions coming from specific specialists of the international mineralogical community.

The preliminary discussion among the members of the CNMMN and CCM Commissions led to the necessity to define the whole hierarchy of mineral classification. In the frame of structural-chemical classification all the minerals are divided on the initial stage on CLASSES according to their chemical diversity (namely, elements, oxides, silicates etc.). SUB-CLASSES are based on the main structural units which are formed by more tightly bounded atoms (rings, chains, sheets etc.). FAMILIES have essential structural features in common but include very different structures (for ex., zeolites, pyroxenoids, biopyriboles etc). Minerals included in the GROUPS (GENUS) are isostructural or have closely related structures and crystallochemically similar anions (thus, for example, berlinite AlPO_4 and alarsite AlAsO_4 are assigned to the same group) in other words they are characterised by close analogy in chemical composition, structure and properties.

Groups can be divided on SUB-GROUPS according to the symmetry (monoclinic vs orthorhombic pyroxenes) or chemical composition (sodium vs calcium amphiboles).

It is here proposed that the criteria for the establishment and the definition of a group

Here are some starting ideas for discussion:

1. A basic criterion for minerals belonging to the same group is the (substantial) isostructurality. There could be exceptions: e.g., it makes no sense to have halite and periclase within the same group. But this could be bypassed by including in each group those minerals with the anions which have similar crystallochemical behaviours.

2. How many minerals are necessary to define a group? at least two? or more?

Most of the members of both Commissions answered that a group should comprise two or more minerals. Some people propose that there must be three or more minerals to define a group and two minerals form series. However the term *series* assumes the formation of solid solution (isomorphism). It is also used to define the polysomatic relationships within certain groups of minerals. In this context we can agree that two minerals are enough to establish a mineral group.

3. Each group should be named after the older mineral belonging to the group. Of course, "historical" names could be maintained (for ex., the name garnet is retained as a group name even though it is not regarded as a species *sensu stricto*).

4. We see that most of the new minerals being defined today are closely related to already known species: just as an example, in one of the recent memorandum of CNMMN the proposed new mineral manganonaujakasite (99-031) is in all similar to naujakasite but in the Mn/Fe ratio (Mn > Fe in the former, Fe < Mn in the latter). All physical and optical properties, the X-ray powder pattern, cell parameters, etc., does not allow the unambiguous distinction. The only way is to perform a chemical analysis.

5. Once the mineral groups will be formally defined, the belonging of any proposed new mineral to a group will be indicated in the proposal. This could make easier the approval, and maybe some of the properties could be regarded as less important (since they are not diagnostic and not useful for the distinction of the different members of the group). Perhaps those properties could be defined once and can be considered as the characteristic of the whole group.

6. As a further step, we could aim at defining also subgroups within a group: in our opinion, subgroups should be useful to keep in the same comprehensive group minerals which are closely related, but not isostructural (e.g.: pyroxenes = group; ortho- and clinopyroxenes = subgroups). In certain cases it would be convenient to distinguish between structural subgroups (clinoamphiboles vs. orthoamphiboles) and chemical subgroups (e.g. calcic vs. sodic amphiboles).