

DISCUSSIONS AND RECOMMENDATIONS CONCERNING THE NOMENCLATURE OF CLAY MINERALS AND RELATED PHYLLOSILICATES*

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ABSTRACT

ATTEMPTS to find a generally acceptable scheme of classification and nomenclature for clay minerals by the nomenclature committees of The Clay Minerals Society (C.M.S.), the Comité International pour l'Étude des Argiles (C.I.P.E.A.), and the International Mineralogical Association (I.M.A.) are summarized. The C.M.S. committee has been working on this problem continuously since 1961 and has transmitted its views to C.I.P.E.A., first at the time of the Stockholm meeting, 1963, and subsequently, in more detail, after receiving the first draft of the C.I.P.E.A. proposals. The C.I.P.E.A. committee held discussions in Stockholm, 1963, and subsequently submitted a first draft to 32 nations; from the replies received, a final draft of the C.I.P.E.A. proposals was prepared and submitted to the I.M.A. in 1964. The report from the I.M.A. was made available in August, 1965.

INTRODUCTION

FOR many years discussions have taken place, both nationally and internationally, concerning the nomenclature and classification of clay minerals and related phyllosilicates. In the United States a nomenclature committee, with the writer as chairman, was set up in 1961 by the Clay Minerals Committee of the National Research Council and was continued by The Clay Minerals Society to consider these questions. It is appropriate now to report on the progress which has been made and on the recent discussions and recommendations by the nomenclature committees of C.I.P.E.A. (Comité International pour l'Étude des Argiles) and of the International Mineralogical Association (I.M.A.). The membership of The Clay Minerals Society nomenclature committee has varied from the time of its inception, in accordance

* Extensive references (almost quotations), to the C.I.P.E.A. clay mineral nomenclature proposals and to the I.M.A. report are made with the approval respectively of Dr. R. C. Mackenzie and Dr. M. Fleischer.

† Chairman of The Clay Minerals Society nomenclature committee.

with the general policies of the Society and of its predecessor, the Clay Minerals Committee of the National Research Council, and the following have served on it: S. W. Bailey, T. F. Bates, G. W. Brindley (Chairman), G. T. Faust, S. A. Forman, R. E. Grim, J. C. Hathaway, M. L. Jackson, A. A. Levinson, C. I. Rich, C. S. Ross, with M. Fleischer also present on one occasion. The writer, as chairman of the committee, records his deep appreciation of the invaluable cooperation of all members at all times, despite some strongly held differences of opinion.

The present survey need go no further back than the 11th National Conference on Clays and Clay Minerals, held August 13–17, 1962, in Ottawa, Canada, when S. A. Forman presented a paper on the nomenclature of clays and layer silicate minerals, which was followed by a long discussion in which few agreements were reached, but at least some of the main disagreements were clearly shown. Differences of opinion arose both on the mineral names themselves (e.g. halloysite versus endellite, montmorillonite versus smectite), and also on the status of the names (e.g. montmorillonite as a group name, a subgroup name, and a species name). The question whether clay mineral nomenclature should be distinct from, or integrated with, the nomenclature used for similar macroscopic phyllosilicates was brought up; in particular, the relation of clay grade micas (illites) to macroscopic micas (muscovite, biotite, . . .) was discussed. Many speakers were concerned with the practical problems arising in the identification and naming of clay minerals. It was evident that if terms are too narrowly defined or require characterizations not generally determinable under the conditions in which clay minerals are studied, they will be usable only in specially favorable circumstances. Subsequent informal discussions between members of the nomenclature committee and others present at the Ottawa meeting indicated that an attempt should be made first to develop a broadly acceptable scheme of clay mineral classification without insistence on particular names, and secondly to consider the most appropriate names to be used within the classification scheme.

WORK OF THE CLAY MINERALS SOCIETY, NOMENCLATURE COMMITTEE, 1962–63

The committee, working along the lines indicated in the previous paragraph, limited their considerations mainly to clay minerals having *regular* layer structures. Discussion was maintained actively throughout the year by correspondence and by the summer of 1963 a broad agreement was reached on a scheme of classification whereby the regular phyllosilicate clay minerals were divided into six (or seven) groups, each comprising a dioctahedral and a trioctahedral subgroup and with each subgroup divided into species. This scheme, shown in detail later, is applicable to both clay-size and macroscopic size crystals. The committee was opposed to the separation at the group level of di- and trioctahedral minerals because this distinction is not always feasible experimentally. The recognition that a clay mineral

belongs to a particular group, then to a subgroup, and lastly is one of a number of species corresponds to successive stages of refinement in the identification process.

Naming the groups and subgroups gave rise to some unresolvable differences of opinion. The use of montmorillonite or of smectite as a group name was argued (a) on the well-established basis that a group is given the name of its most important or most common member, and (b) on the grounds that greater clarity and conciseness is achieved by using a different name for the group. The committee remained almost equally divided on this issue.

The committee also was not unanimous on the position of illite in the scheme of classification. Many considered that it should be mentioned in a footnote reference. The mixed-layered character of many illites placed them outside a classification of regular layer structures.

The results (i.e. the agreements and the disagreements) reached by the C.M.S. committee were sufficiently clear by the summer of 1963 that the chairman was able to report the findings to the nomenclature committee of C.I.P.E.A. in Stockholm, in August 1963.

DISCUSSIONS AND RECOMMENDATIONS OF THE NOMENCLATURE COMMITTEE OF C.I.P.E.A.

These discussions took place in Stockholm, August 1963, at the time of the International Clay Conference. By prior agreement, the following representatives of seven countries participated in the discussions: G. F. Walker (Australia), J. Konta (Czechoslovakia), M. G. Pedro (France), R. C. Mackenzie (Great Britain), G. W. Brindley (U.S.A.), F. V. Chukhrov (U.S.S.R.); T. Sudo (Japan) was unable to be present, but submitted information for consideration.

The majority of representatives agreed that the classification scheme of The Clay Minerals Society committee should be adopted as a basis for discussion. The original scheme was modified slightly by several comments (see later).

The committee was of the unanimous opinion that any proposed final scheme would have little or no effect on the confused state of classification and nomenclature unless approved by the nomenclature committee of I.M.A.

In order to obtain the widest possible support for the C.I.P.E.A. proposals, a summary of the discussions, recommendations, and unresolved problems of the seven representatives listed above was circulated to 32 countries. On the basis of their replies, Mackenzie submitted a memorandum to the chairman of the I.M.A. nomenclature committee, Dr. Michael Fleischer, in December 1964. This memorandum is probably the nearest approach that clay mineralogists throughout the world have yet achieved towards an agreed nomenclature.

MEMORANDUM FROM THE C.I.P.E.A.
NOMENCLATURE COMMITTEE TO THE
NOMENCLATURE COMMITTEE OF I.M.A., DECEMBER, 1964*

1. *Classification Scheme*

Before a satisfactory nomenclature can be evolved, a suitable classification is necessary. Because clay mineralogy is involved in many disciplines, a broadly based classification is required. It is unanimously agreed that any scheme for clay minerals must be compatible with those acceptable for minerals as a whole, and that for layer-lattice clay minerals, one must devise a broad classification for the phyllosilicates as a whole.† The scheme submitted with this proposal, Table 1, was adopted by a large majority of the seven representatives in Stockholm and is generally acceptable to all countries (of the 32 involved) except one. The C.I.P.E.A. committee therefore recommends this general scheme to the I.M.A.

2. *Group Names*

There is considerable disagreement among the 32 countries as to the best manner of naming groups. The main question, generating strong feeling on both sides, concerns montmorillonite-saponite or smectite for the 2:1 minerals with layer charge ~ 0.5 -1.0. The meeting at Stockholm was completely divided on this question. International and national feeling is just as divided. It is therefore recommended that the group name in this instance be left open, in the hope that the most acceptable term, be it montmorillonite-saponite or smectite, will eventually emerge by usage.

3. *The Place of Illite (or Hydromica)*

It seems to be generally considered that this is a useful field term, rather like limonite, but that in future it may be better defined. In the meantime it seems reasonable to include the term only as a footnote reference until further research shows whether it constitutes a valid group separate from the micas, or ought to be included along with interstratified minerals. The C.I.P.E.A. committee recommends that the question of inclusion or non-inclusion of illite in the classification scheme be left open in the meantime, with the footnote reference to take care of the interim situation.

4. *Halloysite versus Endellite*

At Stockholm only one member strongly supported the use of endellite and halloysite. Correspondence with 32 countries shows only two supporters, with almost all other nations favoring halloysite/metahalloysite. Therefore the C.I.P.E.A. committee recommends the terms halloysite and metahalloysite and that the name endellite be dropped.

* This section presents an abbreviated form of the original memorandum.

† I.e. for the phyllosilicates related to clay minerals (G.W.B.).

5. Structural Varieties of Kaolinite

It is agreed that these structural varieties could justifiably be renamed on the basis of the symmetry of the layer stacking sequences (as for muscovites), but in view of the work by Bailey (1963), it seems best at present not

TABLE 1.—PROPOSED CLASSIFICATION SCHEME FOR THE PHYLLOSILICATES
(INCLUDING LAYER-LATTICE CLAY MINERALS)
(as submitted by the C.I.P.E.A. nomenclature committee to the International Mineralogical Association)

Type	Group (x = layer charge)	Subgroup	Species*	
2 : 1	Pyrophyllite-talc $x \sim 0$	Pyrophyllites	Pyrophyllite	
		Talcs	Talc	
	Smectite or Montmorillonite- saponite $x \sim 0.5-1$	Diocahedral smectites or Montmorillonites	Montmorillonite, beidellite, nontronite	
		Triocahedral smectics or Saponites	Saponite, hectorite, sauconite	
	Vermiculite $x \sim 1-1.5$	Diocahedral vermiculite	Diocahedral vermiculite	
		Triocahedral vermiculite	Triocahedral vermiculite	
	Mica† $x \sim 2$	Diocahedral micas	Muscovite, paragonite	
		Triocahedral micas	Biotite, phlogopite	
	Brittle mica $x \sim 4$	Diocahedral brittle micas	Margarite	
		Triocahedral brittle micas	Seybertite, xanthophyllite, brandisite	
	2 : 1 : 1	Chlorite x variable	Diocahedral chlorites	
			Triocahedral chlorites	Pennine, clinocllore, prochlorite
1 : 1	Kaolinite- serpentine $x \sim 0$	Kaolinites	Kaolinite, † halloysite‡	
		Serpentines	Chrysotile, lizardite, antigorite	

* Only a few examples given.

† The status of *illite* (or *hydromica*), *sericite*, etc., must at present be left open since it is not clear whether or at what level they would enter the table: many materials so designated may be interstratified.

‡ See paragraph 5 of *Memorandum to International Mineralogical Association*.

§ See paragraph 4 of *Memorandum to International Mineralogical Association*.

to make a definite decision on the particular symbols to be used. Therefore the C.I.P.E.A. committee proposes that the principle of using a single name followed by appropriate symmetry symbols should be endorsed by the I.M.A. committee, the particular symbols to be considered later.

6. Other Questions Relating to Clay Mineral Nomenclature

The C.I.P.E.A. committee recommends that the I.M.A. committee should not go beyond points 1-5 raised above, since it is intended that clay mineralogists should continue and extend their discussion to other aspects, for example, the chain-lattice minerals, interstratified minerals and amorphous minerals.

COMMENTS BY THE CLAY MINERALS SOCIETY NOMENCLATURE COMMITTEE ON THE C.I.P.E.A. PROPOSAL

Since the final form of the C.I.P.E.A. proposal to the I.M.A. was very close to the scheme submitted by the C.M.S. nomenclature committee, the greater part of the proposal was received with complete approval.

The C.M.S. committee remained almost equally divided on smectite versus montmorillonite-saponite for a group name. The hyphenated names "pyrophyllite-talc" and "kaolinite-serpentine" were accepted unanimously. There was complete agreement for labelling subgroups "dioctahedral-" and "trioctahedral-" when the group name was a single word. It was unanimously agreed that the polymorphic forms of kaolinite should be termed kaolinite-1Tc, kaolinite-D, kaolinite-2M₁ and kaolinite-2M₂, but subsequently it is agreed that further consideration should be given to the qualifying symbols 1Tc, D, 2M₁, 2M₂ in the light of the more recent work by Bailey (1963).

It was unanimously agreed that the use of the names endellite and halloysite should be recommended strongly to the C.I.P.E.A. committee as the most satisfactory way of avoiding confusions. This recommendation, however, was not accepted by other nations.

The relation of illite, and also of such terms as glauconite and sericite, to the proposed classification was carefully considered, and it was agreed that their relation to the proposed scheme must be indicated. It was further agreed that since illite is a term often applied to micaceous minerals having some degree (possibly a considerable degree) of interstratification, it was *not appropriate*, as in the C.I.P.E.A. proposal, to draw attention to illite by an asterisk attached to the group name, mica, and that it would be most logical to place the asterisk after the word "phyllosilicate" in the table heading. The C.M.S. committee endorsed the following statement in the *Glossary of Geology*, Am. Geol. Inst., Washington, D.C. (1957), p. 146:

Illite = Glimmerton (Ger) = Hydromica. Names used for a group of clay minerals abundant in argillaceous sediments. They are intermediate in composition between muscovite and montmorillonite; recent studies have shown that many are made up of interlayered mica and montmorillonite.

Additionally, it was considered that some vermiculite and/or chlorite layers also may be interstratified with such materials.

The C.M.S. committee agreed unanimously on the following statement concerning interstratified minerals:

(1) The Committee approves generally the system described by Brown (1955) for *irregularly interstratified* minerals.

(2) For *regularly interstratified minerals*, the use of the additional word "regular" is preferred, for example, "regular chlorite-vermiculite".

(3) Special names for interstratified minerals are disfavored, though *eventually* the *regular* interstratifications may be given special names.

REPORT OF THE I.M.A. NOMENCLATURE COMMITTEE ON THE C.I.P.E.A. PROPOSAL*

The proposals submitted by R. C. Mackenzie were voted on by the 15 members of the I.M.A. nomenclature committee, consisting of representatives from Austria, Belgium, Bulgaria, Canada, Czechoslovakia, Denmark, Egypt, Finland, France, Great Britain, Japan, Netherlands, Norway, U.S.A., U.S.S.R.

The specific proposals 1-5 were voted on as follows:

1. *Classification scheme*. Is the scheme acceptable? Yes, 13. No, 1. Abstain, 1.

2. *Group names*. Is montmorillonite-saponite or smectite preferred? Montmorillonite-saponite, 8. Smectite, 3. Montmorillonite only, 2. Abstain, 2.

3. *Illite*. Is the present (tentative) treatment of illite approved? Yes, 12. No, 1. Abstain, 1. Yes, but hydromica should be included with mica, 1.

4. *Halloysite versus endellite*. Which terminology is preferred? Endellite-halloysite preferred, 1. Hydrated halloysite-halloysite preferred, 2. Halloysite-metahalloysite preferred, 9. Abstain, 1. One vote was evenly divided between the second and third options. One response preferred hydrated halloysite for the $4\text{H}_2\text{O}$ form, halloysite for a $3\text{H}_2\text{O}$ form, and metahalloysite for the $2\text{H}_2\text{O}$ form.

5. *Renaming the structural varieties of kaolinite, in principle*. Yes, 9 (2 with reservations). No, 5. Abstain, 1.

Dr. M. Fleischer concludes his report by expressing his satisfaction "that the votes showed such clear-cut majorities", and that "there is no objection to . . . circulating these results".

CONCLUDING REMARKS

This survey shows that the efforts of many people in many countries over a period of several years are leading gradually towards an agreed classification and nomenclature for clay minerals. Perhaps only the first and the easiest steps have yet been taken. Interlayered minerals generally and illites

* This statement is essentially as supplied by Michael Fleischer, Chairman.

in particular still call for further discussion and research, and in many cases research should precede discussion. While committees may agree on definitions, classifications, and nomenclature, effective agreement in the long run rests on the willingness of individual clay mineralogists to use the agreed terms and possibly to abandon individual preferences.

REFERENCES

- BAILEY, S. W. (1963) Polymorphism of the kaolin minerals, *Amer. Min.* **43**, 1196–209.
- BROWN, G. (1955) Report of the clay minerals group sub-committee on nomenclature of clay minerals, *Clay Min. Bull.* **2**, 294–300.
- Note added 23. 1. 66: The full text of the Report prepared by R. C. Mackenzie, Chairman, Nomenclature Sub-Committee of C.I.P.E.A., will appear in *Clay Miner.*, **6** (2), 123-6 (1965).