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A SYSTEM OF NOMENCLATURE FOR RARE-EARTH MINERALS

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ABSTRACT

Numerous rare-earth element analogues have been found for well-established rare-earth minerals. In order to prevent a multitude of impractical names, a system of nomenclature is proposed. A group name, e.g., monazite, is suggested for rare-earth minerals for which the rare-earth element distribution has not been determined. A species name, e.g., monazite-(Ce), monazite-(La), etc., is suggested for rare-earth minerals for which the rare-earth element distribution has been determined; the species name is obtained by appending the chemical symbol of the predominant rare-earth element to the group name.

INTRODUCTION

In the past decade determination of the rare-earth element distribution in minerals has received considerable attention, particularly in the Soviet Union. Improved methods of analysis, specifically *x*-ray emission spectrography, optical spectrography, and neutron activation techniques, have made the analysis of hundreds of rare-earth minerals practicable. New data have yielded results which disprove the generally held belief that either cerium or yttrium is the predominant rare-earth element in minerals. These data further indicate that many rare-earth element analogues of well-established rare-earth minerals have already been found. They also suggest that other analogues may be expected to be found with increasing frequency.

Table 1 lists rare-earth element analogues of rare-earth minerals reported in the literature through 1963. By current rules of nomenclature, names for each of these analogues are permissible. This paper describes a system of nomenclature which would eliminate the need for naming analogues of rare-earth minerals. *It is emphasized that this proposal is concerned (1) only with rare-earth minerals, and (2) only with rare-earth element analogues of these minerals.*

DEFINITIONS

1. *Rare-earth Elements:* The 15 elements La through Lu (atomic numbers 57 to 71) as well as yttrium (atomic number 39). Scandium is not included.
2. *Rare-earth Mineral:* A mineral in which any one, or all, of the rare-earth elements are essential constituents. This system of nomenclature is not, concerned with the distribution of the rare-earth elements occurring in minor or trace amounts in, for example, sphene, apatite,

TABLE 1. RARE-EARTH MINERAL ANALOGUES FROM LITERATURE

Group	Pre-dominant Rare-Earth	Species Name; Nomenclature This paper	Selected References	Remarks
Aeschynite-approximately 15 reported specimens in what has been called aeschynite-priorite series have been analyzed for rare-earth elements (often erroneously spelled "eschynite").				
	Ce	aeschynite-(Ce)		usual species
	Nd	aeschynite-(Nd)	Semenov and Barinskii (1958)	alkali syenite pegmatite
	Y	aeschynite-(Y)		previously called priorite
Allanite - approximately 150 reported specimens have been analyzed for rare-earth elements.				
	Ce	allanite-(Ce)		usual species
	La	allanite-(La)	Zhirov *et al.* (1961)	granite pegmatite
			Hugo (1961)	(two) from granulite gneiss, South Africa
	allanite-(Y)		Semenov and Barinskii (1958)	pegmatites
			Neumann and Nilssen (1962)	pegmatite, Sweden (lombaardite)
Bastnaesite - approximately 15 reported specimens have been analyzed for rare-earth elements,				
	Ce	bastnaesite-(Ce)		usual species
	La	bastnaesite-(La)	Vainshtein *et al.* (1961)	carbonatite
Britholite - approximately 14 reported specimens in what has been called britholite-abukumalite series have been analyzed for rare-earth elements.				
	Ce	britholite-(Ce)		usual species
	Y	britholite-(Y)	Pletneva *et al.* (1962)	previously called abukumalite
Davidite - approximately 30 reported specimens have been analyzed for rare-earth elements.				
	La	davidite-(La)		usual species (see Butler and Hall, 1960)
	Ce	davidite-(Ce)	Butler and Hall (1960)	granite pegmatite
			Neumann and Sverdrup (1960)	granite pegmatite
	Y	davidite-(Y)	Zbabin et al. (1963)	a. ufertite from type locality b. contact zone
Gadolinite - approximately 40 reported specimens have been analyzed for rare-earth elements.				
	Y	gadolinite-(Y)		usual species
	Ce	gadolinite-(Ce)	Vainshtein *et al.* (1960)	3 examples from alaskites
Monazite - approximately 200 reported specimens have been analyzed for rare-earth elements.				
	Ce	monazite-(Ce)		usual species
	La	monazite-(La)	Borovskii and Gerasimovskii (1945)	granite

TABLE 1 (continued)

Group	Pre-dominant Rare-Earth	Species Name; Nomenclature This paper	Selected References	Remarks
Nordite - approximately 5 reported specimens have been analyzed for rare-earth elements.				
	Ce	nordite-(Ce)	Balashov and Turanskaya (1960)	pegmatite
			Semenov and Barinskii (1958)	sodalite syenite pegmatite
	La	nordite-(La)	Borovskii and Gerasimovskii (1945)	nepheline syenite
			Gerasimovskii and Turanskaya (1957)	Lovozero massif
Rhabdophane - approximately 8 reported specimens have been analyzed for rare-earth elements.				
	Ce	rhabdophane-(Ce)	usual species	
	Nd			rhabdophane-(Nd)
	Hildebrand, *et at.* (1957)			supergene
Synchysite - apparently only one analysis has been reported for rare-earth elements (often erroneously spelled "synchisite").				
	Ce	no detailed rare-earth analysis found for this most common species		
		synchysite-(Y)	Levinson and Borup (1962)	named "doverite" -- granite pegmatite
Törnebohmite - approximately 2 reported specimens have keen analyzed for rare-earth elements.				
	Ce	törnebohmite-(Ce)	Murata *et al.* (1957)	replaced cerite in pegmatite
	La	törnebohmite-(La)	Svyazhin (1962)	granite pegmatite
Tritomite - approximately 4 reported specimens have been analyzed for rare-earth elements.				
	Ce	tritomite-(Ce)	Jaffe and Molinski (1962)	nepheline syenite pegmatite
	Y	tritomite-(Y)	Jaffe and Molinski (1962)	named "spencite"-- pegmatite

zircon, garnet or clay minerals. Whether or not this system applies to a certain mineral may eventually depend on crystal structure analysis.

3. *Predominant:* The rare-earth element which is most abundant is referred to as predominant. The predominant element is determined on an atomic per cent basis.
4. *Analogue:* The analogue is the mineral which results when a rare-earth element, other than the previously described or the normally expected, predominates. The crystal structure of the analogue and prototype must be the same. Examples: Nd analogue of aeschynite, and Y analogue of synchysite. Both Nd and Y predominate, respectively, over all other rare-earth elements in minerals with the structure of aeschynite and synchysite. Cerium usually is predominant in these minerals.
5. *Group Name: A* group name is the designation given a rare-earth

mineral which has been identified by optical methods, *x*-ray diffraction, or by other methods, but is without detailed chemical analysis of the rare-earth elements. The name monazite, for example, would imply a mineral of that group, but that the proportion of rare-earth elements in the specimen has not been determined.

6. *Species Name:* Whenever the rare-earth element distribution has been determined for a rare-earth mineral, the chemical symbol for the predominant rare-earth element is appended (by means of a hyphen), in parentheses, to the group name; this results in a species name. Examples: monazite-(Ce); monazite-(La); gadolinite-(Ce).

SYSTEM OF NOMENCLATURE

1. If the rare-earth element distribution of a rare-earth mineral is known, the species name, e.g., monazite-(Ce), should be used. If the rare-earth element distribution is not known, the group name, e.g., monazite, should be used.
2. If a rare-earth mineral contains considerable quantities of a rare-earth element which is unusual, or for any reason merits notice, two or more chemical symbols may be placed in the parentheses. In these cases, the " considerable" quantity is not high enough to warrant the species designation, i.e., the respective element is not predominant. For example, a monazite-(Ce) with a considerable amount of samarium would be written as monazite-(Ce, Sm). The first symbol, Ce in this this case, represents the species, whereas Sm is an element which occurs in important amounts.

MISCELLANEOUS TOPICS

1. *Pronunciation*

For the English language, and for many other languages, little difficulty is visualized if the species designation is pronounced as the chemical symbol. For example:

allanite-(Y)	pronounced allanite Y (not allanite yttrium)
gadolinite-(Ce)	pronounced gadolinite Ce (not gadolinite cerium)

In some languages, other methods of pronunciation may be more desirable. In French, for example, monazite-(Ce) might best be pronounced as "monazite ii cerium."

2. *Indexing*

a. Indexing can be done alphabetically, e.g., allanite-(Ce) before allanite-(La). However, in mineralogical and geochemical reference

books, it may be found desirable to index the lower atomic numbered species first.

b. All species names should be indexed following the group name and should not be separated by the introduction of other minerals, headings, categories, etc. For example, an index may read:

allanite
allanite-(Ce)
allanite-(La)
allanite-(Y)

3. Descreditation of Species Names

If an original description of, for example, synchysite-(Y) is found to be in error, any investigator correctly identifying this species of synchysite in the future would use the same species name.

RETROACTIVE

Fortunately, few names have been proposed for the numerous rare-earth mineral analogues recently discovered. Some exceptions are:

1. doverite, for the yttrium analogue of synchysite; Levinson and Borup (1962)
2. spencite, for the yttrium analogue of tritomite; Jaffe and Molinski (1962)

Only two well established Ce-Y rare-earth mineral series are known for which names have been assigned to the end-members:

3. aeschynite -- priorite series
4. britholite -- abukumalite series

The terms doverite, spencite, priorite and abukumalite should be dropped (as well as any other names applied solely to rare-earth element analogues). Respectively, these minerals would be known as synchysite-(Y), tritomite-(Y), aeschynite-(Y), and britholite-(Y). In this way it will be possible to make the system applicable to all rare-earth minerals.

DISCUSSION

Even though only a small percentage of the many rare-earth minerals analyzed show unusual distribution of the rare-earth elements, we can expect analogues of established rare-earth minerals to be described with increasing frequency, particularly among alteration products and supergene minerals. In the case of many rare-earth mineral structures (for example, gadolinite, synchysite, and allanite), for which Ce and Y analogues have already been established, it is theoretically possible, although highly unlikely, for rare-earth analogues of all the rare-earth elements (exclusive of Pm) to be found eventually. Surely mineralogists will not

accept or tolerate 15 names for the allanite structure based on variation in abundance of the rare-earth elements.

Although no direct precedent can be found for the above-proposed system, an analogy to the widely accepted systems of polytype notation used for micas and wurtzite may be noted. In the case of the mica polytypes, the notations 1M, $2M_1$, $2M_2$, 3T, etc., are used to prevent a multitude of impractical names (Smith and Yoder, 1956). For the polytypes of ZnS, Frondel and Palache (1950) have used the notation wurtzite-2H, -4H, -6H, and -15R.

This system of nomenclature has been presented to the Commission on New Minerals and Mineral Names, of the International Mineralogical Association for their consideration. The Commission has approved this system of nomenclature, as well as the dropping of the names doverite, spencite, priorite and abukumalite. Votes were received from representatives of the following countries: Bulgaria, Canada, Czechoslovakia, Denmark, Egypt, Finland, France, Germany Great Britain, Japan, Norway, and the United States.

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