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CNMNC guidelines for the use of suffixes and prefixes in mineral nomenclature, and for the preservation of historical names

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Abstract: New CNMNC guidelines are established, in order to standardize the use of prefixes and suffixes in mineral nomenclature, and to preserve historical names. The recommendations for the use of suffixes are: (I) chemical suffixes have to be in parentheses, except for extra-framework cations; (II) a maximum of three chemical suffixes is allowed; (III) cations and anions should never be used together in the parentheses. For the use of prefixes, the following guidelines were adopted: (I) for common names, prefix-type nomenclature is preferred to facilitate the pronunciation; (II) an unnecessary proliferation of prefixes must be avoided, and a maximum of three chemical prefixes is recommended; (III) it is allowed to use a combination of chemical, structural or other descriptive prefixes; (IV) when Levinson modifiers are used as suffix for REE, then other cations or anions have to be placed as a prefix; (V) in case of polytypes and topologically similar polymorphs, a chemical prefix-type nomenclature is preferred, since the polytype and polymorph symbols have to be suffixes. When possible, the CNMNC recommends to avoid changing names, especially for grandfathered species. Well-established mineral names or names dedicated to localities or persons have to be preserved, except if the species is shown to be not valid. Historical names cannot be changed in order to standardize the nomenclature of a group or supergroup, since mixed nomenclature systems are now accepted by the CNMNC.

Key-words: IMA-CNMNC, new guidelines, prefixes, suffixes, mineral nomenclature, historical mineral names.

1. Introduction

Mineralogical nomenclature is a particularly complex matter, because the procedures to define mineral species have become more elaborate since the development of chemistry in the 18th century, and of X-ray diffraction in the 20th century. During Antiquity, minerals were already observed and described by scientists, but their definitions were exclusively based on some physical properties like colour, streak, lustre, hardness, density, or morphology, for example. A mineral is essentially defined as a naturally occurring solid that has been formed by geological processes, with a well-defined chemical composition and crystallographic properties, and which merits a unique name (Nickel & Grice, 1998).

Mineral names are chosen by authors of new mineral species, according to the guidelines established by Nickel & Grice (1998), and are then voted on by the Commission on New Minerals, Nomenclature and Classification (CNMNC). These names may reflect the morphology of minerals (*e.g.* anatase, axinite, auriacusite, fibroferrite, pyromorphite, staurolite or tetrahedrite), their colour (*e.g.* albite, azurite, chlorite, crocoite, erythrite, euchroite, hematite, lazulite, leucite, orpiment, purpurite or rutile), their chemical composition (*e.g.* anhydrite, arsenopyrite, chalcocite, cobaltite, cuprite, cavansite, fluorapatite, pharmacolite, rutheniridosmine, siderite, sodalite or uraninite), their physical properties (*e.g.* barite, euclase, orthoclase, periclase or scorodite), their use (*e.g.* fluorite, graphite, muscovite, pyrite or pyrolusite), similarity to biological objects (*e.g.* garnet, malachite or oursinite) or some of their structural features (*e.g.* clinoenstatite, clinomimetite, orthoserpierite or parahopeite); they are also frequently given to remember the type locality, geographical or administrative name (*e.g.* andalusite, atacamite, brazilianite, ettringite, ilmenite, lakebogaite, lovozerite, montebrasite, tyrolite or vesuvianite), to honour outstanding scientists by first or family name, or both (*e.g.* bobfergusonite, breithauptite, eskolaite, goethite, haüyne, hurlbutite, mandarinoite, melonjosephite, millerite, moissanite, nielsbohrite, sillimanite or wollastonite) or companies, societies, journals and institutions (*e.g.* afmite, imgreite, minrecordite, museumite, nimite, philolithite or tsumcorite), as well as related to mythology (*e.g.* aegirine, atheneite or neptunite) (*e.g.* Mitchell, 1979). Besides these descriptive

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names, recent CNMNC guidelines allowed one to use chemical prefixes and suffixes in mineral names (Nickel & Grice, 1998; Burke, 2008), thus leading to a hybrid mineralogical nomenclature in which descriptive names, prefixes, and suffixes coexist.

In an attempt to rationalize mineralogical nomenclature, the CNMNC has suggested, in 2008, to progressively evolve towards a suffix-based nomenclature (Burke, 2008), in order to better reflect the chemical complexity occurring in some mineral groups like the labuntsovite group (Chukanov *et al*. 2002), the epidote supergroup (Armbruster *et al*. 2006; Mills *et al*. 2009), or the arrojadite group (Cámara *et al*. 2006; Chopin *et al*. 2006). However, strict applications of these new guidelines have sometimes been negatively understood by the mineralogical community, particularly when historical or well-established names were modified, as for example when hancockite was renamed epidote-(Pb) (Armbruster *et al*. 2006), or when the nomenclature of the apatite-supergroup minerals was modified (Burke, 2008). The latter was revisited in considerable detail for this and several other reasons as outlined by Pasero *et al*. (2010).

During the IMA2010 meeting in Budapest, a discussion was initiated among the CNMNC members, in order to establish firm nomenclature guidelines which will guide the mineralogical community into the appropriate uses of prefix- and suffix-based nomenclature, whilst promoting the preservation of historical and well-established names. Authors of nomenclature or new mineral species proposals are asked to follow these recommendations, but retroactivity will not be applied. Every change in nomenclature has to go through the CNMNC, and is examined on its own merit.

2. General guidelines

In mineral groups or supergroups (see Mills *et al*. 2009), flexibility is allowed by the CNMNC when choosing between suffix- and prefix-based nomenclature systems. The CNMNC has no preference about this choice, and the authors can choose according to the nomenclature of pre-existing mineral species in the group/supergroup, and according to the recommendations given below. Mixed nomenclature systems are allowed, even within mineral groups or supergroups; however, authors should provide strong arguments to support such mixed systems. For new mineral proposals, it is recommended to follow the established nomenclature scheme.

Example: A mixed nomenclature system exists in the jahnsite supergroup, in which jahnsite-(CaMnFe) and whiteite-(CaMnMg) coexist with rittmannite and keckite (Kampf *et al*. 2008).

3. Recommendations for the use of suffixes

The following recommendations have to be applied for the use of chemical suffixes in mineralogical nomenclature:

(I) Chemical suffixes have to be in parentheses, except for extra-framework cations. Extra-framework cations and framework cations cannot be mixed in the suffixes, and if such a situation would occur, we would recommend to use a suffix for the extra-framework cations, and a prefix for the framework cations.
Example: Na and Ca are extra-framework cations in chabazite-Na and chabazite-Ca, whereas they occur in the framework of arrojadite-(KNa) (Chopin *et al*. 2006) and of jahnsite-(CaMnMn) (Grice *et al*. 1990).

(II) A maximum of three chemical suffixes is allowed. The chemical suffixes must appear in the same order as in the chemical formula; generally, they must be classified by decreasing ionic radii.
Example: The nomenclature of the whiteite-jahnsite group is based on a root name followed by parentheses containing three chemical suffixes: whiteite-(CaMnMg), jahnsite-(CaMnMg), and jahnsite-(CaMnMn) are valid names (Kampf *et al*. 2008).

(III) Cations and anions should never be used together in the parentheses. In the case where both anions and cations have to appear in the name, then the anions have to be placed as a prefix.
Example: In the apatite supergroup, the names ''apatite-(CaCl)'' and ''apatite-(CaF)'' were introduced by Burke (2008), but the recent report of the apatite subcommittee has re-validated the previous names chlorapatite and fluorapatite, in which the anions occur as prefixes (Pasero *et al*. 2010). Fluorbritholite-(Y) and fluorbritholite-(Ce) are also valid names of minerals in the apatite supergroup.

Remark: In the apophyllite group, Burke (2008) replaced the names ''fluorapophyllite'', ''hydroxyapophyllite'', and ''natroapophyllite'' by apophyllite-(KF), apophyllite-(KOH), and apophyllite-(NaF), in which cations and anions are grouped in the suffix. We propose here, for the sake of consistency, to re-name these minerals fluorapophyllite-(K), hydroxyapophyllite-(K), and fluorapophyllite-(Na).

4. Recommendations for the use of prefixes

The following recommendations have to be applied for the use of chemical prefixes in mineralogical nomenclature.

(I) For common names, prefix-type nomenclature is preferred to facilitate the pronunciation.
Example: The names ''apatite-(CaOH)'' and ''apatite-(CaF)'' are more difficult to pronounce than the approved names hydroxylapatite and fluorapatite.

(II) An unnecessary proliferation of prefixes must be avoided, and a maximum of three chemical prefixes is recommended. Hyphenated names may be chosen to assist in deciphering the name.
Example: Chromo-alumino-povondraite (Henry *et al*. 2011), fluorphosphohedyphane (Pasero *et al*.

2010), oxycalciopyrochlore, and oxystibiomicrolite (Atencio *et al*. 2010) are valid mineral names.

(III) It is allowed to use a combination of chemical, structural or other descriptive prefixes.
Example: Clinoferroholmquistite (Leake *et al*. 2003), hydroxylclinohumite, strontio-orthojoaquinite, bario-orthojoaquinite, and para-alumohydrocalcite are valid mineral names.

(IV) When Levinson modifiers are used as suffix for REE, then other cations or anions have to be placed as a prefix. A new root-name can also be used.
Example: Manganiandrosite-(Ce), vanadoandrosite-(Ce) (Armbruster *et al*. 2006), fluorbritholite-(Y), fluorbritholite-(Ce) (Pasero *et al*. 2010), arsenoflorencite-(Ce) and arsenoflorencite-(La) (Bayliss *et al*. 2010; Mills *et al*. 2010), calcioancylite-(Ce), hydroxylbastnäsite-(Nd), and nioboaeschynite-(Ce) are valid mineral names.

(V) In case of polytypes and topologically similar polymorphs, a chemical prefix-type nomenclature is preferred, since the polytype and polymorph symbols have to be suffixes. It must be remembered, however, that polytypes and topologically similar polymorphs are not considered as separate mineral species (Nickel & Grice, 1998).
Example: In the apatite supergroup, prefixes are preferred, since the polytypes chlorapatite-*M* and hydroxylapatite-*M* have been reported (Pasero *et al*. 2010). In the alunite supergroup, a prefix-type nomenclature is applied for natroalunite, since the polymorphs natroalunite-1*c* and natroalunite-2*c* exist (Bayliss *et al*. 2010).

5. Preservation of historical and well-established names

When possible, the CNMNC recommends to avoid changing names, especially for grandfathered species. Well-established mineral names or names dedicated to localities or persons have to be preserved, except if the species is shown to be not valid. In this case, a renaming, redefinition or discreditation procedure has to be submitted to the CNMNC. Historical names cannot be changed in order to standardize the nomenclature of a group or supergroup, since mixed nomenclature systems are accepted by the CNMNC (see above). However, modern reorganisation of a group or supergroup may require re-examination of incompletely or ambiguously characterised type material, so that its associated historical name can be redefined to fit with a particular species composition field in the new classification scheme. If this cannot be done, then the name may need to be discredited as a species name, although it may be retained as a group name.

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