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Nomenclature of amphiboles: additions and revisions to the International Mineralogical Association's amphibole nomenclature

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ABSTRACT

The introduction of a fifth amphibole group, the Na-Ca-Mg-Fe-Mn-Li group, defined by $0.50 < {}^{B}(\mathrm{Mg,Fe^{2+},Mn^{2+},Li}) < 1.50$ and $0.50 \leqslant {}^{B}(\mathrm{Ca,Na}) \leqslant 1.50$ a.f.p.u. (atoms per formula unit), with members whittakerite and ottoliniite, has been required by recent discoveries of ${}^{B}(\mathrm{LiNa})$ amphiboles. This, and other new discoveries, such as sodicpedrizite (which, here, is changed slightly, but significantly, from the original idealized formula), necessitate amendments to the IMA 1997 definitions of the Mg-Fe-Mn-Li, calcic, sodic-calcic and sodic groups. The discovery of obertiite and the finding of an incompatibility in the IMA 1997 subdivision of the sodic group, requires further amendments within the sodic group. All these changes, which have IMA approval, are summarized.

KEYWORDS: amphibole nomenclature, sodicpedrizite, whittakerite, ottoliniite, sodic amphiboles, obertiite.

Introduction

AFTER 13 years of conferring, the Subcommittee on Amphiboles of the International Mineralogical Association's Commission on New Minerals and Mineral Names (IMA CNMMN) first published a standard, internationally-agreed amphibole nomenclature in 1978 (IMA78; Leake, 1978). After nine years of further work, the current scheme was agreed and published in 1997 (IMA97; Leake *et al*., 1997). This retained the same four major amphibole groups and classifying parameters as in the 1978 scheme. Since 1997, several new amphibole root names have been approved by IMA, including various Li-rich amphiboles, some of which (e.g. ferriwhittakerite) have made it necessary to institute a new (fifth) amphibole group and to revise slightly the definitions of the previous four groups as formulated in IMA97. In addition, application of IMA97 to several thousand analysed natural

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amphiboles has shown the need to revise slightly the parameters used to subdivide the sodic amphiboles (Mogessie *et al.*, 2001). This account summarizes the IMA-approved additions and revisions to IMA97 but does not repeat the main unchanged parts of IMA97, so this paper needs to be read in conjunction with IMA97.

General classification of the amphiboles

The standard amphibole formula $A_{0-1}B_2C_5T_8O_{22}(OH)_2$ remains unchanged, but the order of allocation of the cations has become even more critical than previously. In addition, some of the cations not considered in IMA97 have since been found to occur occasionally in amphiboles and so a new list follows; the full explanation of procedure is given in IMA97:

(1) Sum *T* to 8.00 using Si, then Al, then Ti.

(2) Sum *C* to 5.00 using any excess Al and Ti from (1) and then successively

Fe^{3+}, V, Cr, Mn^{3+}, Zr, Mg, Zn, Ni, Co, Fe^{2+}, Mn^{2+}, Li

(3) Sum *B* to 2.00 using first any excess above 5.00 from *C*, in the reverse order of (2) starting with Li and then Mn^{2+} etc., and then follow with Ca, Sr, Ba and Na.

(4) Excess above 2.00 in *B* is assigned to *A* in the reverse order of (3), starting with Na and then finally all the K is allocated to *A*.

Until recently, Li was only rarely determined in amphiboles and all Li-rich varieties known belonged either to the orthorhombic holmquistite or the monoclinic clinoholmquistite series [$\square Li_2(Mg_3Al_2)Si_8O_{22}(OH)_2$], being part of the Mg-Fe-Mn-Li group, or they were in the sodic amphibole group, being members of the leakeite [$NaNa_2(LiMg_2Fe^{3+}_2)Si_8O_{22}(OH)_2$] or kornite [$(NaK)Na_2(LiMg_2Mn^{3+}_2)Si_8O_{22}(OH)_2$] species. Other, less Li-rich, Li-bearing amphiboles (Li > 0.25 a.f.p.u. in the standard formula) were denoted by the optional modifier 'lithian', preceding a species name which was determined by the rules formulating and subdividing the four amphibole groups. With the introduction of ion probes, the determination of Li, which electron microprobes cannot do, is now possible. Consequently, Li-rich amphiboles of a new type have been discovered which the IMA97 classification cannot accomodate satisfactorily as they fall between the existing groups.

The 1997 scheme divided the amphiboles into the following four groups, depending on the occupancy of the *B* sites as calculated arithmetically, i.e. there is no consideration of where ions really are because, for most amphibole analyses, this is unknown, as structural studies are rare, although the arithmetic places ions in their most likely sites.

(1) The Mg-Fe-Mn-Li group defined as $^{B}(Ca+Na) < 1.00$ and $^{B}(Mg,Fe^{2+},Mn^{2+},Li) \geqslant 1.00$ a.f.p.u.

(2) The calcic group with $^{B}(Ca+Na) \geqslant 1.00$ and $^{B}Na < 0.50$ a.f.p.u.

(3) The sodic-calcic group with $^{B}(Ca+Na) \geqslant 1.00$, and $0.50 \leqslant {}^{B}Na < 1.50$ a.f.p.u.

(4) The sodic group with $^{B}Na \geqslant 1.50$ a.f.p.u.

At that time, nearly all known members of Group 1 had $^{B}(Mg,Fe^{2+},Mn^{2+},Li) > 1.50$ a.f.p.u. and the calcic and sodic-calcic members had $(Ca+Na) > 1.50$ a.f.p.u. This led to the implicit assumption that the *B* sites of Group 1 contain only a small minority of Ca+Na ions and that there is only a small minority of (Mg+Fe+Mn+Li) ions at the *B* sites of the remaining groups.

The discovery of more or less continous ranges of compositions, involving Li-rich amphiboles, between the Mg-Fe-Mn-Li group on the one hand and the calcic, sodic-calcic and sodic groups on the other hand, makes nonsense of the above limits. Thus, an amphibole with $^{B}(Na_{1.01}Li_{0.99})$ falls in the sodic-calcic group, although it contains no Ca, and one with $^{B}(Ca_{0.52}Na_{0.49}Li_{0.99})$ is classified into the calcic group although Ca is not its dominant *B* cation. If the unchanged IMA97 rules were to be applied to the recently discovered ferriwhittakerite, ideally $Na(NaLi)(LiMg_2Fe^{3+}_2)Si_8O_{22}(OH)_2$ (Oberti *et al.*, 2004*a*), it would sit exactly on the boundary between the Mg-Fe-Mn-Li group and the sodic-calcic group, whereby an analysis with Li > 1.00 a.f.p.u. falls into the first group, but if Li < 1.00 a.f.p.u., it belongs in the second. This sort of naming was explicitly avoided in IMA97. Consequently, the IMA97 definitions need to be modified to take into account the complete solid solution between Li and Na at *B* sites (Oberti *et al.*, 2003). New definitions of the amphibole groups follow.

Group 1. **Where the sum of the L-type ions $^{B}(Mg,Fe,Mn,Li) \geqslant 1.50$ a.f.p.u. then the amphibole is a member of the magnesium-iron-manganese-lithium group**. (L-type ions are divalent Mg, Fe, Mn, Zn, Ni, Co, etc. and Li, as described in IMA97).

Group 2. **Where $^{B}(Mg,Fe^{2+},Mn^{2+},Li) \leqslant 0.50$, $^{B}(Ca,Na) \geqslant 1.00$ and $^{B}Na < 0.50$ a.f.p.u., then the amphibole is a member of the calcic group.**

Group 3. **Where ^{B}(Mg,Fe^{2+},Mn^{2+},Li) $\leqslant$ 0.50, ^{B}(Ca,Na) $\geqslant$ 1.00, and 0.50 $\leqslant$ ^{B}Na < 1.50 a.f.p.u., then the amphibole is a member of the sodic-calcic group.**

Group 4. **Where ^{B}(Mg,Fe^{2+},Mn^{2+},Li) $\leqslant$ 0.50, and ^{B}Na $\geqslant$ 1.50 a.f.p.u., then the amphibole is a member of the sodic group.**

Group 5. A new amphibole group is defined as **'Where 0.50 < ^{B}(Mg,Fe^{2+},Mn^{2+},Li) <1.50 and 0.50 $\leqslant$ ^{B}(Ca,Na) $\leqslant$ 1.50 a.f.p.u., then the amphibole is a member of the sodium-calcium-magnesium-iron-manganese-lithium group'.** This cumbersome title is clearer than any alternative and may be referred to as 'Group 5'. The definitions of the prefixes and modifiers given in IMA97 that are stated to apply to all groups apply to the new group with the addition that the prefix alumino, where ^{C}Al > 1.00 a.f.p.u., (note, not = 1.00 a.f.p.u.) also applies.

Applications of the revised nomenclature

In general, no change is made to the nomenclature of any composition defined as a species in IMA97, but there are regrettable changes to some more recently described species, mainly because a special adjustment was initially approved to the IMA97 use of the prefix 'sodic' in Group 1 in an attempt to avoid instituting a fifth amphibole group. Later, however, as still more Li-rich amphiboles were discovered, the recognition of a Group 5 became unavoidable, and the use of sodic in Group 1 reverted to its IMA97 meaning of total Na > 0.50 a.f.p.u. The IMA rule forbidding validity of root names until they have been found in Nature, when combined with the short time to respond to proposals for new species, makes any coherent systematic approach to a series of closely related species, proposed over several years, difficult. Ideally one would wait a few years until the range of variation was apparent.

Group 1: Mg-Fe-Mn-Li amphiboles

Holmquistite and clinoholmquistite, $\square Li_2(Mg_3Al_2)Si_8O_{22}(OH)_2$, have ^{B}Li $\geqslant$ 1.00 a.f.p.u. but no significant ^{C}Li. The discovery of sodic-ferripedrizite $^{A}Na^{B}Li_2{}^{C}(LiMg_2Fe^{3+}_2)$ $Si_8O_{22}(OH)_2$ (Oberti *et al.*, 2000; Caballero *et al.*, 2002), and the equivalent sodic-ferri-ferropedrizite (Oberti *et al.*, 2004*b*) species in which it is critical to have ^{C}Li $\geqslant$ 0.50 a.f.p.u., to distinguish them from holmquistite and clinoholmquistite, justify the following names

Sodicpedrizite $NaLi_2(LiMg_2Fe^{3+}Al)Si_8O_{22}(OH)_2$
'Sodic-ferropedrizite' $NaLi_2(LiFe^{2+}{}_2Fe^{3+}Al)Si_8O_{22}(OH)_2$

The prefix sodic is derived from the IMA97 rules for the use of prefixes in which sodic applies in Group 1 only, and then only to samples with total Na > 0.50 a.f.p.u. Those with total Na $\leqslant$ 0.50 a.f.p.u. are pedrizite unless K >0.50 a.f.p.u. which is potassicpedrizite. Likewise, the prefix ferri for Fe^{3+} >1.00 a.f.p.u. (not = 1.00), applies to all groups except the sodic amphiboles. All the prefix rules listed in IMA97 remain unchanged. It is recognized that a few samples that only marginally fell into IMA97 Group 1, may now belong to Group 5. The revised classification is shown in Fig. 1. The only substantive change is to Li-rich amphiboles.

Group 2: calcic amphiboles

There are no changes, or additions, of names in this group. Application of the prefix parvo, as described below, necessitates over-riding the new ^{B}(Mg,Fe^{2+},Mn^{2+},Li) $\leqslant$ 0.50 a.f.p.u. rule.

Group 3: sodic-calcic amphiboles

Again there are no changes or additions in this group and the same provision applies to the use of parvo as in the calcic amphiboles.

Group 4: sodic amphiboles

There are no changes deriving from the introduction of Group 5 except for the use of parvo as in the previous groups. However, since IMA97 was published (Leake *et al.*, 1997), extensive tests have been carried out on published amphibole analyses to see how robust the nomenclature is, especially with respect to compositions marginal to the four groups. Mogessie *et al.* (2001) calculated the names of over 500 analysed amphiboles of all types as listed in Deer *et al.* (1997) and they found about four sodic amphibole analyses that could not be classified, as although they were clearly sodic amphiboles, they did not fall into any of the sodic nomenclature diagrams. Consequently, two amendments were made to avoid this. First, the rarely known oxidation state of Mn is made much less crucial than in IMA97 by grouping Mn^{2+} + Mn^{3+} together for the initial classification, although Mn^{3+} contents are still

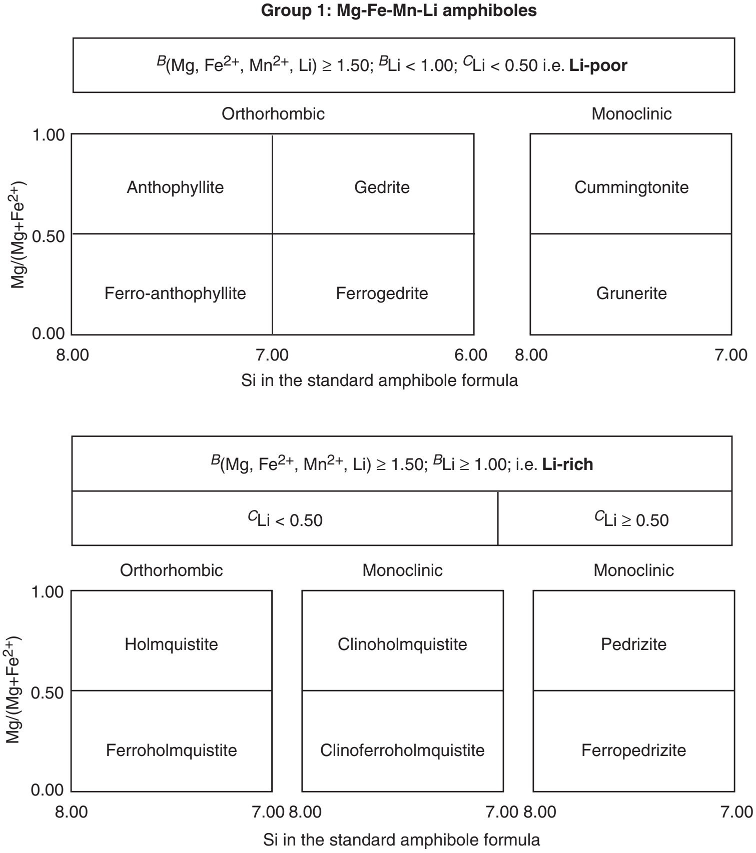

FIG. 1. Classification of the Group 1 amphiboles; Mg-Fe-Mn-Li amphiboles.

required to distinguish kornite from leakeite. Secondly, the classification parameter (Mg + Fe^{2+} + Mn^{2+}) < or > 2.5 a.f.p.u. is completely discarded as it conflicts with other conditions. The result of these changes gives a new sodic amphibole nomenclature diagram. (Fig. 2).

In addition, the new anhydrous sodic species obertiite $NaNa_2(Mg_3Fe^{3+}Ti)Si_8O_{22}O_2$ which is characterized by Ti > 0.50 and (OH + F + Cl) < 1.00 a.f.p.u., has recently been described by Hawthorne *et al.* (2000). As this can be derived from magnesio-arfvedsonite by substitution of Ti and O for Mg and (OH), it appears in the same box as magnesio-arfvedsonite in the Group 4 nomenclature diagram. As Ti > 0.50 a.f.p.u. is an essential aspect of the root name, the prefix titano is not used, nor is the modifier oxygenian because (OH + F + Cl) < 1.00 a.f.p.u. by definition.

Group 5: Na-Ca-Mg-Fe-Mn-Li amphiboles
(I) ^{B}Li > 0.50 a.f.p.u.

The members of this new group that have ^{B}Li > 0.50 a.f.p.u. derive from Oberti *et al.* (2004*a*) finding ferriwhittakerite, $^{A}Na^{B}(NaLi)^{C}(LiMg_2Fe^{3+}_2)Si_8O_{22}(OH)_2$ with A ⩾ 0.50 a.f.p.u. and ferri-ottoliniite, $^{A}\square^{B}(NaLi)^{C}(Mg_3Fe^{3+}_2)Si_8O_{22}(OH)_2$, with A <0.50 a.f.p.u. Both must have ^{B}Li > 0.50 a.f.p.u. Usually there is also significant ^{C}Li. The classification is shown in Fig. 3 and the end-member compositions are listed below.

Whittakerite	$Na(NaLi)(LiMg_2Fe^{3+}Al)Si_8O_{22}(OH)_2$
and	
'Ferrowhittakerite'	$Na(NaLi)(LiFe^{2+}_2Fe^{3+}Al)Si_8O_{22}(OH)_2$

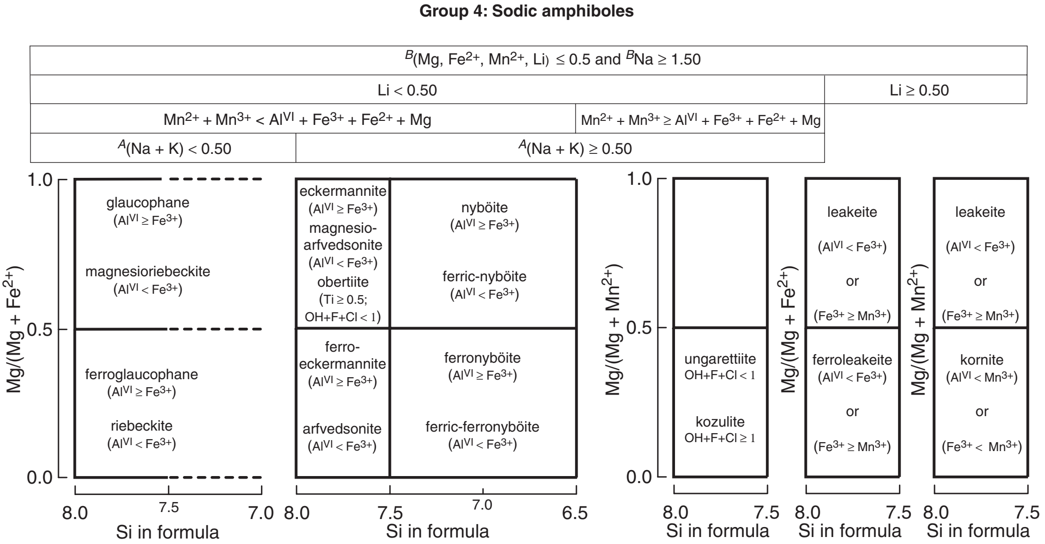

FIG. 2. Classification of the Group 4 amphiboles; sodic amphiboles

Ottoliniite $\square(NaLi)(Mg_3Fe^{3+}Al)Si_8O_{22}(OH)_2$
and
'Ferro-ottoliniite' $\square(NaLi)(Fe^{2+}_3Fe^{3+}Al)Si_8O_{22}(OH)_2$

All the prefixes and modifiers listed and defined in IMA97 apply in the new group, and use of the prefix alumino for $^{C}Al > 1.00$ a.f.p.u. is extended to this group. In accordance with IMA97, the modifier lithian is not used in species defined by the presence of Li.

(2) $^{B}Li \leqslant 0.50$ a.f.p.u.

It is well known that in the calcic and sodic-calcic groups, it is usual for the total of the cations initially allocated to *C* to exceed the limit of 5.00 a.f.p.u. and the excess of the larger ions overspill into *B*. This is particularly common where 'cummingtonite solid solution' in calcic amphiboles occurs. Occasionally, the total (Mg + Fe^{2+} + Mn^{2+} + Li) at B slightly exceeds 0.50 a.f.p.u. although $^{B}Li \leqslant 0.50$ a.f.p.u. This is

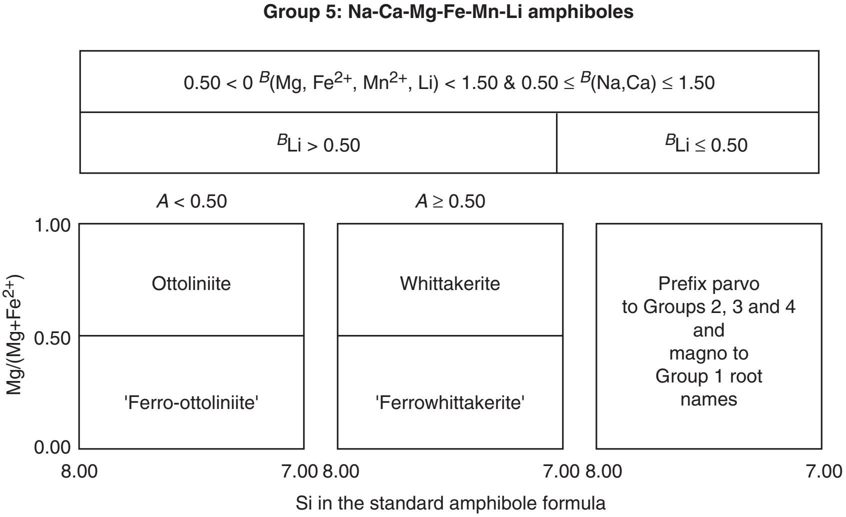

FIG. 3. Classification of the Group 5 amphiboles; Na-Ca-Mg-Fe-Mn-Li amphiboles.

usually due to erroneously low (OH+F+Cl), giving too large a cation total, but there are a few reliable analyses with such excesses above ${}^{B}0.50$ and with ${}^{B}\mathrm{Li} \leqslant 0.50$ a.f.p.u. Such samples only slightly exceed ${}^{B}0.50$ a.f.p.u. because the presently known miscibility limit of such amphiboles is only slightly greater than ${}^{B}0.50$ a.f.p.u. In order to avoid a rash of new root names for such compositions of small cations in *B* (and small or zero Li), the prefix 'parvo' from the Latin for 'small' should be prefixed to the root name derived for a species in the calcic, sodic-calcic or sodic groups, as if Group 5 did not exist, i.e. over-riding in this instance only, the requirement in Groups 2, 3 and 4 for ${}^{B}(\mathrm{Mg,Fe^{2+},Mn^{2+},Li}) \leqslant 0.50$ a.f.p.u. This preserves familiar IMA97 names, makes no distinction as to what the dominant L-type ion is in B, and avoids making new names as a consequence of creating Group 5 to deal with certain Li-rich amphiboles. Thus such analyses are named exactly as they were before Group 5 existed, but with the added prefix 'parvo'. An unusually large ${}^{B}(\mathrm{Mg,Fe,Mn,Li})$ value of ${}^{B}0.74$ a.f.p.u. occurs in the following rare composition, which was in Group 3, but which now falls into Group 5:

$$ {}^{A}(\mathrm{K_{0.03}Na_{0.30}})^{B}(\mathrm{Na_{0.87}Ca_{0.39}Mn_{0.68}Li_{0.06}}) \\ {}^{C}(\mathrm{Mn_{\ 0.27}Mg_{.4.01}Fe^{3+}{}_{0.72}})\ \mathrm{Si_{7.88}Al_{0.12}O_{22}F_{0.40}(OH)_{1.60}} $$

which was reported by Oberti and Ghose (1993). According to IMA97, this is a winchite, or with modifiers, a fluorian manganoan winchite. It now becomes parvowinchite or fluorian manganoan parvowinchite. As the authors interpret it as 'on the verge of exsolution' it may be near to the extreme value of high ${}^{B}(\mathrm{Mg,Fe^{\ 2+},Mn^{2+}})$ in Li-poor Group 5. Similarly, there are rare ${}^{B}\mathrm{Li} \leqslant 0.50$ a.f.p.u. amphiboles which were previously in Group 2, but now fall into Group 5. Thus a most extraordinary calcic amphibole, in its high ${}^{B}(\mathrm{Mn})$, is ${}^{A}(\mathrm{K_{0.02}Na_{0.65}})^{B}(\mathrm{Ca_{1.17}Mn_{0.83}})$ ${}^{C}(\mathrm{Mn_{0.27}Mg_{4.46},Fe^{2+}{}_{0.09},Ti_{0.01}Al_{0.16}})\mathrm{Si_{7.18}Al_{0.82}O_{22}(OH_{1.91}F_{0.09})}$ (Skogby and Rossman, 1991). If this is not a mixture of phases, then it was per IMA97, a mangano-edenite and it now becomes parvo-mangano-edenite. More usually, any excess of ${}^{B}(\mathrm{Mg,Fe^{2+},Mn^{\ 2+}})$ above 0.50 a.f.p.u. in Li-poor (Li < 0.50) calcic amphiboles is trivial.

Equally, to avoid new root names proliferating for rare amphiboles with compositions of ${}^{B}\mathrm{Li} \leqslant 0.50$ a.f.p.u. which were in Group 1, but now fall into Group 5, because of significant ${}^{B}(\mathrm{Ca,Na})$, these should be named as previously with Group 1 root names and prefixes but prefixed 'magno' to indicate the entry of large cations at B position in Group 5.

It should be noted that in the first published use of sodic-ferripedrizite, (Oberti *et al.*, 2000), one of the analysed crystals is sodic-ferripedrizite as above, whereas the second is now ferriwhittakerite, because the ideal formula of pedrizite was later changed to contain ${}^{B}\mathrm{Li_2}$, while ${}^{B}(\mathrm{NaLi})$ became whittakerite or ottoliniite. The second published use of ferripedrizite (Caballero *et al.*, 2000) had ${}^{B}\mathrm{Li_2}$ and is only changed by now being prefixed with sodic as above.

Erratum. In IMA97, Table 2, the modifier ferrian, which applies in all but the sodic group, should have been stated as $0.75 < \mathrm{Fe^{3+}} \leqslant 1.00$ and not 0.99 a.f.p.u.

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References

Caballero, J.M., Oberti, R. and Ottolini, L. (2002) Ferripedrizite, a new monoclinic ^{B}Li amphibole end-member from the Eastern Pedriza Massif, Sierra de Guadarrama, Spain, and a restatement of the nomenclature of the Mg-Fe-Mn-Li amphiboles. *American Mineralogist*, **87**, 976–982.

Deer, W.A., Howie, R.A. and Zussman, J. (1997) *Rock-forming Minerals*, **2B**, *Double-Chain Silicates* (2nd edition), 764 pp. Geological Society, London.

Hawthorne, F.C., Cooper, M.A., Grice, J.D. and Ottolini, L. (2000) A new anhydrous amphibole from the Eifel region, Germany: description and crystal structure of obertiite, $\mathrm{NaNa_2(Mg_3Fe^{3+}Ti^{4+})Si_8O_{22}O_2}$. *American Mineralogist*, **85**, 236–241.

Leake, B.E. (1978) Nomenclature of amphiboles. *Mineralogical Magazine*, **42**, 533–563.

Leake, B.E., Woolley, A.R., Arps, C.E.S., Birch, W.D., Gilbert, M.C., Grice, J.D., Hawthorne, F.C., Kato, A., Kisch, H.J., Krivovichev, V.G., Linthout, K., Laird, J., Mandarino, J.A., Maresch, W.V., Nickel, E.H., Rock, N.M.S., Schumacher, J.C., Smith, D.C., Stephenson, N.C.N., Ungaretti, L., Whittaker, E.J.W. and Youzhi, G. (1997) Nomenclature of amphiboles: Report of the Subcommittee on Amphiboles of the International Mineralogical Association, Commission on New Minerals and Mineral Names. *Mineralogical Magazine*, **61**, 295–321.

Mogessie, A., Ettinger, K., Leake, B.E. and Tessadri, R. (2001) AMPH-IMA97: a hypercard program to determine the name of an amphibole from electron microprobe and wet analyses. *Computers and Geosciences*, **27**, 1169–1178.

Oberti, R. and Ghose, S. (1993) Crystal-chemistry of a complex Mn-bearing alkali amphibole ('tirodite') on the verge of exsolution. *European Journal of Mineralogy*, **5**, 1153–1160.

Oberti, R., Caballero, J.M., Ottolini, L. López-Andrés, S. and Herreros, V. (2000) Sodicferripedrizite, a new monoclinic amphibole bridging the magnesium-iron-manganese-lithium and the sodium-calcium groups. *American Mineralogist*, **85**, 578–585.

Oberti, R., Cámara, F., Ottolini, L. and Caballero, J.M. (2003) Lithium in amphiboles: detection, quantification and incorporation mechanisms in the compositional space bridging sodic and ^{B}Li amphibole. *European Journal of Mineralogy*, **15**, 309–319.

Oberti, R., Cámara, F. and Caballero, J.M. (2004*a*) Ferri-ottoliniite and ferriwhittakerite, two new end-members in the new Group 5 for amphiboles. *American Mineralogist*, **89**, in press.

Oberti, R., Cámara, F., Caballero, J.M. and Ottolini, L. (2004*b*) Sodic-ferri-ferropedrizite and ferri-clinoferroholmquistite. Mineral data and ordering of A-cations in Li-rich amphiboles. *The Canadian Mineralogist*, **43**, in press.

Skogby, H. and Rossman, G.R. (1991) The intensity of amphibole OH bands in the infrared absorption spectrum. *Physics and Chemistry of Minerals*, **18**, 64–68.

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Appendix

Information concerning the etymology, the type locality and the unit-cell parameters of amphibole root name end-members described since IMA97.

Obertiite

Named for R. Oberti of Pavia, Italy.

Type locality: Bellerberg, Laccher See district, Eifel, Germany.

X-ray data: *a* 9.776 Å, *b* 17.919 Å, *c* 5.292 Å. β 104.05º.

Reference: Hawthorne *et al*. (2000).

Ottoliniite

Named for Luisa Ottolini of Pavia, Italy.

Type locality: Fuente Grande, Eastern Pedriza Massif, Sierra de Guadarrama, Central System, Spain.

X-ray data: *a* 9.535 Å, *b* 17.876 Å, *c* 5.234 Å. β 102.54º.

Reference: Oberti *et al*. (2004*a*).

Pedrizite

Named for locality

Type locality: Fuente Grande, Eastern Pedriza Massif, Sierra de Guadarrama, Central System, Spain.

X-ray data: *a* 9.501 Å, *b* 17.866 Å, *c* 5.292 Å. β 102.17º.

Reference: Caballero *et al*. (2002); name first used by Oberti *et al*. (2000). Ferropedrizite is described in Oberti *et al*. (2004*b*).

Whittakerite

Named for Eric J.W. Whittaker of Oxford, England.

Type locality: Fuente Grande, Eastern Pedriza Massif, Sierra de Guadarrama, Central System, Spain.

X-ray data: *a* 9.712 Å, *b* 17.851 Å *c* 5.297 Å. β 103.63º.

Reference: Oberti *et al*. (2004*a*), first used in Oberti *et al*. (2003).