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Alunite supergroup: recommended nomenclature

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ABSTRACT

Minamiite has been discredited and renamed natroalunite-2*c* to show a double unit-cell structure and natroalunite can be designated as natroalunite-1*c* to show a single unit-cell structure. Kintoreite can be designated as kintoreite-1*c* to show the same single unit-cell structure, and IMA 1993-039 is a new superstructure of kintoreite and can be designated as kintoreite-2*c* to show a double unit-cell structure. Beaverite has been renamed beaverite-(Cu). The Zn-bearing beaverite of Sato *et al*. (2008) has been named "beaverite-(Zn)", but data for the mineral have not been approved by the CNMNC. Orpheite has been discredited as P-rich hinsdalite. Proposal 07-D was approved by the CNMNC.

Keywords: nomenclature, alunite, natroalunite, kintoreite, beaverite, orpheite, minamiite

Introduction

Mineral species within the alunite supergroup have the general chemical formulae of $\mathbf{DG}_3(\mathbf{TX}_4)_2\mathbf{X}'_6$ using the symbolism proposed by Smith *et al*. (1998), where **D** is a tetravalent, trivalent, divalent, monovalent cation or partial vacancy; **G** is a trivalent cation and minor divalent cations; **T** is a hexavalent, pentavalent cation and minor Si^{4+}; and **X**/**X′** is O, (OH), minor F and possibly H_2O as shown in Table 1. They have been identified and described over the last two centuries. They are listed in Table 2. Mineral species named after the locality, where the mineral was first discovered include beaverite, corkite, hinsdalite, kemmlitzite, osarizawaite, and weilerite. Mineral species have been named after persons including F.S. Beudant, A.E. Minami, L.F. Svanberg and C.D. Woodhouse; orpheite was named after a mythical singer.

Sulphate and arsenate minerals of the alunite supergroup are mostly formed by weathering in the oxidation zone of polymetallic sulphide deposits. Phosphate minerals of the alunite supergroup are mostly formed by weathering of phosphate minerals such as apatite or rocks such as carbonatites. Extensive reviews of the occurrences are given by Dutrizac and Jambor (2000) and Stoffregen *et al*. (2000).

The parent structure-type has space group $R\bar{3}m$ (no. 166) with very few reported exceptions, all in need of independent confirmation. The crystal structure and crystal chemistry of the alunite supergroup have recently been reviewed and discussed by Botinelly (1976), Kashkay (1976), Lengauer *et al*. (1994), Kolitsch and Pring (2001), Sato *et al*. (2009) and Stoffregen *et al*. (2000), all of whom focused on sulphates. Unusual structures have been reported by Grey *et al.* (2008, 2009) and Mills *et al.* (2008). The nomenclature has been discussed by Scott (1987), Novák *et al.* (1994), Jambor (1995, 1996, 1999, 2000) and Scott (2000).

Difficulties with nomenclature of the alunite supergroup are as follows:

(1) The main problem concerning the classification is how to deal with the presence of divalent and trivalent anionic $\mathbf{TX}_4$ units in the

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TABLE 1. Chemical elements and vacancies that may occur in the **D**, **G**, **T** and **X** crystal-structure sites of mineral species in the alunite supergroup, $\mathbf{DG}_3(\mathbf{TX}_4)_2\mathbf{X}'_6$ are listed in order of decreasing valency.

D: Th; Ce, La, Nd, Bi; Ca, Sr, Ba, Pb, Hg; Na, K, Rb, Ag, Tl, NH_4, H_3O; □.
G: Sn^{4+}; Al, Fe^{3+}, V^{3+}, Cr^{3+}, Ga; Cu^{2+}, Zn^{2+}, Mg.
T: S, Cr^{+6}; P, As, Sb; Si.
X: O; (OH), F; (H_2O).

one crystal structure site: should the end-members be defined on the basis of only one type of anionic $\mathbf{TX}_4$ unit, or could some end-members (particularly those in the phosphate-sulphate and arsenate-sulphate groups) be defined on the basis of one divalent and one trivalent anionic $\mathbf{TX}_4$ unit to maintain electrostatic balance?

Each ternary diagram of SO_4-As$\mathbf{X}_4$-P$\mathbf{X}_4$ in the current CNMMN-approved classification of Scott

TABLE 2. Minerals of the alunite supergroup with theoretical end-member chemical formulae given. The last column shows the approved status of these minerals on the basis of this report. Group nomenclature based on Mills *et al.* (2009), but with -1*c* (single unit cell) and -2*c* (double unit cell) structures are separated for clarity.

Alunite group with -1*c*:		
Schlossmacherite	$(H_3O)Al_3(SO_4)_2(OH)_6$	Retained
Alunite	$KAl_3(SO_4)_2(OH)_6$	Retained
Natroalunite-1*c*	$NaAl_3(SO_4)_2(OH)_6$	Retained
Ammonioalunite	$(NH_4)Al_3(SO_4)_2(OH)_6$	Retained
Osarizawaite	$Pb(Al_2Cu^{2+})(SO_4)_2(OH)_6$	Retained
Argentojarosite	$AgFe_3(SO_4)_2(OH)_6$	Retained
Hydroniumjarosite	$(H_3O)Fe_3(SO_4)_2(OH)_6$	Retained
Jarosite	$KFe_3(SO_4)_2(OH)_6$	Retained
Natrojarosite	$NaFe_3(SO_4)_2(OH)_6$	Retained
Ammoniojarosite	$(NH_4)Fe_3(SO_4)_2(OH)_6$	Retained
Beaverite-(Cu)	$Pb(Fe_2Cu^{2+})(SO_4)_2(OH)_6$	Renamed
"Beaverite-(Zn)"	$Pb(Fe_2Zn)(SO_4)_2(OH)_6$	Potentially new*
Dorallcharite	$TlFe_3(SO_4)_2(OH)_6$	Retained
Plumbogummite group with -1*c*:		
Gorceixite	$BaAl_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Waylandite	$BiAl_3(PO_4)_2(OH)_6$	Retained
Crandallite	$CaAl_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Florencite-(Ce)	$CeAl_3(PO_4)_2(OH)_6$	Retained
Florencite-(La)	$LaAl_3(PO_4)_2(OH)_6$	Retained
Florencite-(Nd)	$NdAl_3(PO_4)_2(OH)_6$	Retained
Plumbogummite	$PbAl_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Goyazite	$SrAl_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Eylettersite	$Th_{0.75}Al_3(PO_4)_2(OH)_6$	Retained
Zaïrite	$BiFe_3(PO_4)_2(OH)_6$	Retained
Benauite	$SrFe_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Kintoreite-1*c*	$PbFe_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Springcreekite	$BaV_3(PO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained

(1987) incorporates five composition fields with some divisions at 25% and 75%. Novák *et al.* (1994) suggested six compositional fields. The unapproved classification of Jambor (1999) based upon the 50% rule (Nickel, 1992) has three composition fields. Scott (2000) suggested that the currently approved system is more informative about the substitutions occurring in the minerals of the alunite supergroup and that it should be retained despite the slightly greater number of mineral names. In reply, Jambor (2000) responded that the classification should be consistent with the CNMMN rules and that "Regardless of the different opinions, it is suggested that some decisions will have to be made by the CNMMN." Recently, the 50% rule has been renamed the dominant-constituent rule (Hatert and Burke, 2008) and has been extended by a dominant-valency rule for certain groups of minerals. Therefore, the five composition fields of Scott (1987) remain the approved nomenclature of the CNMNC. The ternary system has thus been rejected for the alunite supergroup. The accepted scheme has the advantages that the end-members have their own names and it does not proliferate names unduly in the supergroup.

(2) In order to maintain electrostatic balance, a coupled substitution of the chemical elements as listed in Table 1 may occur within and between the **D**, **G**, **T** and **X** crystal-structure sites.

Table 2 (*contd.*)

Dussertite group with 1*c*:		
Arsenogorceixite	$BaAl_3(AsO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
"Arsenowaylandite"	$BiAl_3(AsO_4)_2(OH)_6$	Questionable
Arsenocrandallite	$CaAl_3(AsO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Arsenoflorencite-(Ce)	$CeAl_3(AsO_4)_2(OH)_6$	Retained
Arsenoflorencite-(La)	$LaAl_3(AsO_4)_2(OH)_6$	New
"Arsenoflorencite-(Nd)"	$NdAl_3(AsO_4)_2(OH)_6$	Questionable
Philipsbornite	$PbAl_3(AsO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Arsenogoyazite	$SrAl_3(AsO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Dussertite	$BaFe_3(AsO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Graulichite-(Ce)	$CeFe_3(AsO_4)_2(OH)_6$	Retained
Segnitite	$PbFe_3(AsO_{3.5}(OH)_{0.5})_2(OH)_6$	Retained
Beudantite group with 1*c*:		
Woodhouseite	$CaAl_3(P_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Hinsdalite	$PbAl_3(P_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Orpheite	$PbAl_3(P_{0.5}S_{0.5}O_4)_2(OH)_6$	Discredited
Svanbergite	$SrAl_3(P_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Corkite	$PbFe_3(P_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Weilerite	$BaAl_3(As_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Hidalgoite	$PbAl_3(As_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Kemmlitzite	$SrAl_3(As_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Beudantite	$PbFe_3(As_{0.5}S_{0.5}O_4)_2(OH)_6$	Retained
Gallobeudantite	$PbGa_3(As_{0.5}S_{0.5}O_4)(SO_4)(OH)_6$	Retained
Alunite group with -2*c*:		
Plumbojarosite	$Pb_{0.5}Fe_3(SO_4)_2(OH)_6$	Retained
Walthierite	$Ba_{0.5}Al_3(SO_4)_2(OH)_6$	Retained
Huangite	$Ca_{0.5}Al_3(SO_4)_2(OH)_6$	Retained
Natroalunite-2*c*	$NaAl_3(SO_4)_2(OH)_6$	Renamed
Plumbogummite group with -2c:		
Kintoreite-2*c*	$PbFe_3(PO_{3.5}H_{0.5})_2(OH)_6$	New

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* Subject to approval by the CNMNC.

Chemical varieties should use the chemical-element adjectival modifier as defined by Bayliss *et al.* (2005).

(3) The space group of alunite $R\bar{3}m$ (no. 166) has only one **D**, one **G** and one **T** crystal site with multiplicites of 3, 9 and 6 respectively. The space group aspect $R**$ (nos. 166, 160, 155) indicates that a crystal structure analysis is needed to check if As and S-P are ordered within the **T** crystal-structure site. If such ordering occurs then an intermediate end-member chemical composition in the series is established so that a mineral species name is warranted. Space-group $R\bar{3}m$ (no. 166) indicates that As-S-P are disordered over the **T** crystal structure site, whereas assignment to the lower space-group symmetry of $R3m$ (no. 160) indicates the **T** crystal structure site is divided into two so that As and S-P are ordered.

As P and S are next to each other in the periodic table with similar atomic radii and weights, they are very unlikely to order within the **T** crystal structure site. The crystal structure of woodhouseite reported by Kato (1977) and the crystal structure of svanbergite described by Kato and Miúra (1977) showed that the P and S are disordered. Giuseppetti and Tadini (1987) reported ordering of PO_4^{3-} and SO_4^{2-} in corkite and refined the structure in the non-centrosymmetric space group $R3m$ (no. 160). The latter result has been questioned (Szymanski, 1988; Kharisun *et al.*, 1997; Kolitsch *et al.*, 1999). In fact, the given anisotropic displacement factors for P and S (Giuseppetti and Tadini, 1987) suggest that P has the shape of a very flat disk while the S ellipsoid is twice as long as it is wide. Application of the significance test of Hamilton (1965) demonstrates: 309 independent reflections with 89 variables (12 atoms × 9 parameters − 21 fixed parameters + scale + secondary extinction) refined to 3.6% from 3.7% with 49 variables (7 atoms × 9 parameters − 16 fixed parameters + scale + secondary extinction). $R = 3.7/3.6 = 1.03$; $R_{40,220,0.5} = 1.08$ with $m-n = 89-49$, $b = 309-89$. Therefore, the hypothesis of a lower symmetry is rejected. A crystal-structure determination of corkite from Dernbach has P and S disordered in $R\bar{3}m$ (no. 166) with $R = 2.4\%$ (Kolitsch, unpublished results). Crystal-structure refinements of several other corkites from different localities all confirm the space group $R\bar{3}m$ (no. 166).

On the other hand, the As and S-P pair have significant atomic radii and weight differences so that they may order within the **T** crystal structure site at a low temperature of formation. For instance, the (AsO_4) and (SO_4) anionic units are reported to be ordered in gallobeudantite, $R3m$ (no. 160), with $R = 7.8\%$ (Jambor *et al.*, 1996). This R factor is high compared to disordered As and S in beudantite, $R\bar{3}m$ (no. 166), with $R = 2.6\%$ (Giuseppetti and Tadini, 1989) and $R = 3.7\%$ (Szymanski, 1988), and the assignment to the lower space-group symmetry lacks convincing evidence. Therefore, when no crystal-structure refinement is available, the anions are assumed to be disordered within the **T** crystal-structure site.

The crystal structures of crandallite (Blount, 1974) and gorceixite (Dzikowski *et al.*, 2006) indicate that the extra H to maintain electrostatic balance partially occupies the **X** site in $\mathbf{TX_4}$. The **G** crystal-structure sites in osarizawaite are occupied by (Al_2Cu). The crystal structure described by Giuseppetti and Tadini (1980) showed that Al and Cu are disordered. The crystal-structure sites in beaverite are occupied by (Fe_2Cu). In synthetic plumbojarosite–beaverite, Jambor and Dutrizac (1985) found that Cu^{2+} substitutes for Fe^{3+} over the range of Cu:Fe = 0:100 to Cu:Fe = 33:100. The crystal structure described by Breidenstein *et al.* (1992) showed that Fe and Cu are disordered.

(4) Structural variants have the same root name with a hyphenated suffix that specifies the number and direction of the unit cells. The crystal structure may be one rhombohedral unit cell with symbol $-1c$ ($a \approx 7$ Å and $c \approx 17$ Å) or two rhombohedral unit cells with symbol -2*c* ($a \approx 7$ Å and $c \approx 34$ Å, e.g. plumbojarosite with an ordered arrangement of Pb atoms and vacancies on the **D** site along the *c* axis). A complete list of lattice parameters is published in the Mineral Powder Diffraction File (Bayliss *et al.*, 2001).

(5) Weilerite of Walenta (1966) was discredited by the CNMMN (Hey 1967; Nickel and Mandarino 1987) and then reinstated by Scott (1987). Both major sulphate and arsenate are present in weilerite, but the AsO_4:SO_4 ratio has not been determined. Kemmlitzite of Hak *et al.* (1969) is *REE*-P-rich. The chemical analysis of the type specimen of kemmlitzite does not plot in the area for kemmlitzite. Re-examination of the holotype specimen by Novák *et al.* (1994) showed that kemmlitzite is zoned and inhomogeneous. Beudantite was described by Lévy (1826). The chemical analysis quoted by

TABLE 3. Discredited, obsolete and other unapproved mineral names in the alunite supergroup. Mineral names are based on Bayliss (2000); however, numerous additions and amendments have been made.

almeriita = natroalunite-1*c*
alum-de-Rome, alumen de Tolpa = alunite
alumian, alumianite = natroalunite-1*c*
aluminian lusungite = kintoreite
aluminilite, alumite, Aluminit (Doelter), alum rock, alumstone, alun de Rome, = alunite
alunte = alunite
ammonium alunite = ammonioalunite
antunezite = jarosite
apatélite = hydroniumjarosite
Arsenobismit = preisingerite + atelestite + segnitite or beudantite
arsenoflorencite-(Nd). Questionable; inadequate data
arsenowaylandite. Questionable; inadequate data
bariohitchcockite, barium-hamlinite = gorceixite
beaverite = beaverite-(Cu)
beaudantite = beudantite
bieirosite, bleirosite = corkite
Bischofit (Fischer) = plumbogummite
borgstromite, borgstroemite , Borgströmit = jarosite
boromanite, bowmanite, bowmannite = goyazite
calafatita = alunite
calciowavellite, calcowavellite = crandallite
calcium-jarosite = Ca-rich hydroniumjarosite
camposite = gorceixite
candallite = crandallite
carphosiderite = hydroniumjarosite
cherokine = plumbogummite
ciprusita = natrojarosite
cymolite = alunite + halloysite-7 Å
cyprusite = natrojarosite
davisonite, dennisonite = crandallite + CO_2-rich hydroxylapatite
deltaite = crandallite + hydroxylapatite
dernbachite = corkite
edgarite (Morris) = osarizawaite
erusibite = jarosite?
ferrazite = gorceixite
ferrian-hidalgoit = Fe^{3+}-rich hidalgoite
ferroalunite = Fe^{3+}-rich alunite
florensite = florencite-(Ce)
galafatite = alunite
Ge-beudantite = Ge-rich beudantite
georceixite, geraesite, gorceite, gorceixcita, gosseixite = goreixite
goiaíta, goiasite, goyasita, goyzaite = goyazite
gum lead = plumbogummite
hamlinite = goyazite
Harttit = Ca-rich svanbergite
hinsdaleite = hinsdalite
hitchcockite = plumbogummite
hydronatrojarosite = natrojarosite
hydroniojarosite = hydroniumjarosite
ignafieffite, ignatieffite, ignatievite, Ignatiewit = alunite?
jarosites kalicus = jarosite
Kalkwavellit = crandallite
kalialuminite, kalialunite, kalioalunite, K-alunite = alunite
Karphosiderit = hydroniumjarosite
kauaiite = fine-grained Na-rich alunite
K-jarosite = jarosite
koivinite = florencite
Kolosorukit = Fe^{3+}-poor jarosite
lead jarosite = plumbojarosite
Lemnian earth = halloysite-10 Å ± alunite
leucanterite = jarosite?
lime-wavellite = crandallite
loevigite, loewigite, Löwigit, lowigite = alunite
Lossenit = scorodite + beudantite
lusungite = goyazite
metalunite = dehydrated alunite
minamiite, minamite = natroalunite-2*c*
Modumit (Weisbach) = natrojarosite
moronolite (Shepard) = jarosite
newtonite (Brackett and Williams) = alunite ± kaolinite
Na-alunite = natroalunite-1*c*
NH_4-alunite = ammonioalunite
orpheite = P-rich hinsdalite
osazrizawaite = osarizawaite
Pastrerit = jarosite
Phosphor-Beudantit = corkite
Plagiocitrit = Na-rich alunite
planoferrite = hydroniumjarosite
plomb gomme = plumbogummite
plumboalunite = hypothetical $Pb_{0.5}Al_3(SO_4)_2(OH)_6$
plumbo-argentojarosite = Ag-rich plumbojarosite ± argentojarosite
plumboresinite = plumbogummite
plumbosvanbergite = Pb-rich svanbergite
potassium alunite = alunite
pseudo-apatélite = Al-rich hydroniumjarosite
Pseudobeudantit = corkite
pseudowavellite, Pseudowavellit = crandallite
Raimondit = hydroniumjarosite
sausalite = florencite-(Nd)
Schadeit = colloidal plumbogummite
selenojaročite = Se-rich jarosite
siprusiet = hydroniumjarosite
soda-alunite, sodium alunite = natroalunite-1*c*
sodium-jarosite = natrojarosite
soda-killinite = alunite + jadeite + halloysite-10 Å + illite
sokolovite = goyazite
steipelmannite = florencite-(Ce)
stibiaferrrite = bindheimite + jarosite
strontiohicheockite , strontiohitchcockite = goyazite
sulfatfreier Beudantit = segnitite
sulphate-free weilerite = arsenogorceixite
Th-crandallite = Th-rich crandallite
tikhvinite = svanbergite
timsókö = alunite
trudelite, trudellite = chloraluminite + natroalunite-1*c*
utahite (Arzruni & Damour) = natrojarosite
vegasite = plumbojarosite
viséite = Si-bearing crandallite
woodhousite = woodhouseite

Doelter (1914) from a chemical analysis reported in 1850 is unsatisfactory due to excess Fe and the authenticity of the specimen is questionable. Cotterell and Todhunter (2007) suggest that orpheite is a variety of hinsdalite.

(6) The classification used in Table 2 is taken from Mills *et al.* (2009). The alternative mineral classifications are the crystallographic-chemical classification used in the Powder Diffraction File (Bayliss *et al.*, 2001), chemical-crystallographic classification of Strunz and Nickel (2001), and the chemical classification of Clark (1993).

Recommended nomenclature

Minamiite of Ossaka *et al*. (1982) is discredited and renamed natroalunite-2*c*, as the mineral is a double unit-cell structure that may be caused by ordering in the **D** crystallographic site with a similar chemical composition to natroalunite, which has historical priority. Natroalunite can be designated as natroalunite-1*c* to show a single unit-cell structure. Rather than $-2cR$ of Jambor (1999), $-2c$ was chosen because $-2c$ indicates a double *c* axis unit-cell like baumhauerite-2*a* with a double *a* axis, whereas the symbol *R* may be confused with a polytype nomenclature.

The unnamed rhombohedral mineral $Pb_{0.90}Fe_{2.91}(PO_4)_{1.91}(SO_4)_{0.09}(OH,H_2O)_{5.92}$, from the Schöne Aussicht Mine, Dernbach, Rhineland-Palatinate, Germany, which was withdrawn as a new mineral due to the similarity with kintoreite-1*c* (IMA 1993-039), and recorded in table 7 of Jambor (1999), is called kintoreite-2*c*, as the mineral is a double unit-cell structure caused by ordering in the **D** crystallographic site with a similar chemical composition to that of kintoreite-1*c* of Pring *et al*. (1995). Kintoreite can be designated as kintoreite-1*c* to show a single unit-cell structure.

The Zn-bearing beaverite $Pb(Fe_2Zn)(SO_4)(OH)_6$ of Sato *et al*. (2008) with Fe and Zn disordered requires a mineral-species name based on the dominant-constituent rule. This mineral has been given the name "beaverite-(Zn)"; however, the mineral data have not been submitted and approved by the CNMNC. In order to be consistent, beaverite (Butler and Schaller, 1911) is renamed beaverite-(Cu). The advantages of the chemical-element suffix nomenclature were stated by Bayliss (2007).

"Arsenowaylandite" was not submitted to the CNMMN for approval by Scharm *et al.* (1994) because of inadequate data. The mineral and mineral name are questionable until properly proposed and approved by the CNMNC.

Arsenoflorencite-(La) was noted by Scharm *et al*. (1991) to exist only as compositional zones and rims within complex zoned crystals. The existing data were inadequate to establish the mineral to species level and Scharm *et al*. (1991) did not submit the mineral to the CNMNC for approval before publication. Subsequently, arsenoflorencite-(La) has been approved (IMA 2009-078) and published (Mills *et al*., 2010).

"Arsenoflorencite-(Nd)" was also noted by Scharm *et al*. (1991) as only compositional zones and rims within complex zoned crystals. The existing data were inadequate to establish the mineral to species level and Scharm *et al.* (1991) did not submit the mineral to the CNMNC for approval before publication. The mineral and mineral name are questionable until properly proposed and approved by the CNMNC.

Orpheite of Kolkovski (1971) has been discredited and should be called P-rich hinsdalite (Larsen and Schaller, 1911), which has historical priority. Originally, orpheite was not considered to belong to the alunite supergroup because the chemical analysis did not fit the alunite structure; however, the powder diffraction pattern was indexed on a 1*c* unit cell in PDF 29-765 by Bayliss (1989) to prove that orpheite belongs to the alunite supergroup. A chemical-analytical and single-crystal structure refinement of type orpheite confirmed that orpheite is identical to a P-rich hinsdalite (Mladenova and Kolitsch, unpublished data).

Discredited, obsolete and other unapproved mineral names in the alunite supergroup are listed in Table 3. Mineral names are based on Bayliss (2000); however, numerous additions and amendments have been made.

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