НОВЫЕ ДАННЫЕ О МИНЕРАЛАХ ГРУППЫ ВЕЗУВИАНА: НОВЫЕ ВИДЫ, КРИСТАЛЛОХИМИЯ И НОМЕНКЛАТУРА

Паникоровский Т.Л. (taras.panikorovsky@spbu.ru), Кривовичев С.В.
Санкт-Петербургскоеотделение. Санкт-Петербургский Государственный Университет. Кольское отделение. Геологический институт Кольского научного центра РАН. Апатиты.

NEW DATA ON THE VESUVIANITE-GROUP MINERALS:NEW SPECIES, CRYSTAL CHEMISTRYAND NOMENCLATURE

Panikorovskii T.L., Krivovichev S.V.
Saint Petersburg branch. Saint Petersburg State University, Saint Petersburg, Russia. Kola branch. Geological Institute, Kola Science Centre of RAS. Apatity, Russia

Complex investigations of the crystal chemistry of the vesuvianite-group minerals during last 20 years resulted in the discovery of six new members of the group (Table 1) that differ mostly in the dominant cation in the five-coordinated Y1 site (Panikorovskii et al. 2017a). Symmetry of the minerals of this groupdepends upon the temperature of ther formation and therefore vesuvianites are of sufficient geological and mineralogical interest (Groat et al. 1992; Gnos and Armbruster 2006). In addition, transparent vesuvianite is a gemstone (idocrase), whereas acicular vesuvianite crystals and whiskers show pronounced light-conducting properties (Galuskin et al. 2007, Panikorovskii et al. 2017c). Vesuvianite-group minerals are characterized by the domain structure and their symmetry is defined by the scheme of cation ordering along the four-fold axis [space groups are either tetragonal (*P*4/*nnc*, *P*4/*n*, *P*4*nc*, $P\bar{4}$) or monoclinic (*P*2/*n*, *Pn*), some crystals contain growth sectors showing triclinic distortion].

Table 1

Dominant components in crystallographic sites of vesuvianite-group minerals*.

	*X*1-3	*X*4	*Y*1	*Y*2	*Y*3	*T*1	*T*2	O10	O11	O12	Reference
Vesuvianite	Ca	Ca	Fe^{3+}	Al	Al	-, Al	-	OH	OH	-	Giuseppetti, Mazzi 1983
Fluor-vesuvianite	Ca	Ca	Fe^{2+}	Al	Al	-	-	F	F	-	Britvin et al. 2003
Mangan-vesuvianite	Ca	Ca	Mn^{3+}	Al	Al	-	-	OH	OH	-	Armbruster et al. 2002
Cyprine	Ca	Ca	Cu	Al	Al	-	-	OH	OH	-	Panikorovskii et al. 2017b
Magnesio-vesuvianite	Ca	Ca	Mg	Al	Al	-	-	OH	OH	-	Panikorovskii et al. 2017c
Alumo-vesuvianite	Ca	Ca	Al	Al	Al	-	-	OH	OH	-	Panikorovskii et al. 2017a
Wiluite	Ca	Ca	Mg	Al	Al	B, Al	B	O	O	O	Groat et al. 1998

The general formula of vesuvianite-group minerals can be written as $X2_8X3_8X1_2X4Y1Y2_4Y3_8T_{0-5}(Z_2O_7)_4[(ZO_4)_{10-x}(H_4O_4)_x](W)_9O_{1-3}$, where x < 3, *X* are seven- to nine-coordinated sites (Ca, Na, K, Fe^{2+},*REE*), *X*4 has a square antiprism coordination (Ca, Na), *Y*1 has a square pyramidal coordination (Fe^{3+}, Mg, Al, Fe^{2+}, Cu^{2+}), *Y*2 and *Y*3 have octahedral coordination (Al, Mg, Zn, Fe^{2+}, Fe^{3+}, Mn^{2+}, Mn^{3+}, Ti, Cr, Zn), *T* (B, Fe) is the additional site with a triangular and tetrahedral coordination, whereas ZO_4 (Si, Al, H_4O_4) and Z_2O_7 are ortho- and diorthosilicate groups, respectively, and *W* = OH, F, Cl and minor O. Because the present IMA formula for vesuvianite group minerals has some contradictions (Aksenov et al. 2016) and does not represent cation ordering mechanisms (Armbruster et al. 2002), a new nomenclature that takes into account recently discovered important substitution schemes (Galuskin et al. 2003, Panikorovskii et al. 2016 a,b, 2017a-c) has to be created and approved.

In this work, we reporton the 150 new crystal-structure refinements of vesuvianite-group minerals assisted with mineralogical backgrounds, chemical analysis and spectroscopic measurements for each sample and consider structural evolution, twinning and mechanisms of relaxation of the vesuvianite crystal structure, and discussed a possible nomenclature of the vesuvianite group (Table 1).

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