Aiolosite, Na$_2$(Na$_2$Bi)(SO$_4$)$_3$Cl, a new sulfate isotypic to apatite from La Fossa Crater, Vulcano, Aeolian Islands, Italy

FRANCESCO DEMARTIN, 1,* CARLO MARIA GRAMMACCIOLI, 1 ITALO CAMPOSTRINI, 1 AND TULLIO PILATI 2

1Università degli Studi di Milano, Dipartimento di Chimica Strutturale e Stereochimica Inorganica, via Venezian 21, I-20133 Milano, Italy
2Istituto CNR di Scienze e Tecnologie Molecolari, via Golgi 19, I-20133 Milano, Italy

ABSTRACT

Aiolosite, ideally Na$_4$Bi(SO$_4$)$_3$Cl, or better Na$_2$(Na$_2$Bi)(SO$_4$)$_3$Cl, is a new sulfater mineral isotypic to apatite. It was found in an active medium-temperature intracrater fumarole at La Fossa crater, Vulcano Island, Aeolian archipelago, Sicily, Italy. It occurs as acicular to slender prismatic crystals up to 0.5 mm long in an altered pyroclastic breccia, together with alunite, anhydrite, demicheleite-(Br), demicheleite-(Cl), bismuthinite, and panichiite. The synonymy is hexagonal (class 6/m), space group $P6_3/m$, with $a = 9.626(3)$, $c = 6.880(3)$ Å, $V = 552.1(3)$ Å$^3$, $Z = 2$. The habit is prismatic, terminated by the pinacoid or, more rarely, by a bipyramid. Aiolosite is colorless to white, with white streak; the luster vitreous. It is non-fluorescent. The calculated density is 3.589 g/cm$^3$. The mineral is nonpleochroic, uniaxial (+), $n_{\rho} = 1.59(1)$, $n_{\omega} = 1.60(1)$, mean $n_{\text{calc}} = 1.593$ (589 nm), $n_{\text{obs}} = 1.620$. The chemical analysis gave Na$_2$O 20.65, K$_2$O 0.96, Bi$_2$O$_3$ 32.49, SO$_3$ 41.27, Cl 4.02, Br 0.75, (H$_2$O 0.57 from structure refinement), $–O = (\text{Cl} + \text{Br})$ 0.98 wt%, total 99.73, corresponding to the empirical formula calculated on the basis of 13 anions: Na$_4$(Na$_{0.83}$K$_{0.12}$Bi$_{0.53}$)$_{12}$O$_{38}$S$_{10}$Br$_{10.01}$Cl$_{0.06}$Bi$_{0.06}$(H$_2$O)$_{0.16}$20.92. The crystal structure has been refined to a final $R$ index of 0.048. One of the two independent Ca sites of apatite is exclusively occupied by Na, and the other one by statistically distributed Na and Bi. The SO$_4^{2-}$ anion replaces the PO$_4^{3-}$ anion of apatite; the chloride anion is located in the partially occupied (s.o.f. = 0.81) position at $x = 0$, $y = 0$, $z = 0$. Whenever the chloride position is vacant, the position at $x = 0$, $y = 0$, $z = 1/4$ is occupied by water (s.o.f. = 0.19). The strongest 6 lines in the X-ray powder diffraction pattern [$d_{\text{calc}}$ (Å) (I $hkl$) are: 2.853 (100) (121), 2.775 (85) (112), 3.432 (45) (002), 1.965 (35) (222), 2.306 (25) (310), 4.787 (20) (110). Both the mineral and the mineral name have been approved by the IMA CNMNC (No. 2008-015).

**Keywords:** Aiolosite, apatite structure, new mineral species, bismuth, sulfates, crystal structure, Vulcano Island, Aeolian Islands, Italy

INTRODUCTION

The new mineral aiolosite, Na$_2$(Na$_2$Bi)(SO$_4$)$_3$Cl, was discovered when investigating the fumaroles at La Fossa crater, Vulcano, Aeolian Islands, where a considerable number of new species have been observed in recent years [see for instance Garavelli et al. (1997, 2005), Campobasso et al. (2008), Demartin et al. (2008a, 2008b, 2008c, 2009a, 2009b, 2009c) and references therein]. Here, a description of the new species, as well as its properties and crystal structure, which is related to that of apatite, are reported.

The name of the mineral is from Aiolos (Αιόλος, Latinized to Aeolus), the god ruler of the winds in Greek mythology. The Aeolian Islands (Isole Eolie in Italian) took their name from him. Both the mineral and the mineral name have been approved by the Commission on New Minerals, Nomenclature and Classification of the IMA (no. 2008-015). The holotype is deposited (no. 2008-3) in the Reference Collection of Dipartimento di Chimica Strutturale e Stereochimica Inorganica of Università degli Studi di Milano.

OCURRENCE AND PHYSICAL PROPERTIES

Aiolosite occurs in a medium-temperature (250 °C) intracrater fumarole, as acicular to slender prismatic translucent crystals, up to 0.5 mm long, on altered pyroclastic breccia, together with alunite, anhydrite, bismuthinite, demicheleite-(Br), demicheleite-(Cl), and panichiite (Demartin et al. 2008c, 2009a, 2009c). The crystal habit is prismatic, terminated by the pinacoid or, more rarely, by a bipyramid (see Figs. 1a and 1b). The $c:a$ ratio calculated from the unit-cell parameters is 0.7147. The mineral is colorless to white, the streak is white, and the luster is vitreous. We did not observe any fluorescence, either under SW or LW ultraviolet radiations. Tenacity is brittle. Cleavage and fracture were not observed. The calculated density is 3.589 g/cm$^3$ (from the empirical formula reported below and the unit-cell data). The mineral is nonpleochroic, uniaxial (+), $n_{\rho} = 1.59(1)$, $n_{\omega} = 1.60(1)$, mean $n_{\text{calc}} = 1.593$ (589 nm) by immersion methods in bromoform and monochloronaphthalene, $n_{\text{obs}} = 1.620$ (Gladsone-Dale); 1 – ($K_p/K_C$) = –0.070, fair (Mandarino 1981).

CHEMICAL DATA

Chemical analyses were carried out by means of a JEOL JSM 5500 LV scanning electron microscope, equipped with an XRF EDS 2000 electron microprobe (EDS mode, 20 kV,