Balestraite, KLi$_2$VSi$_4$O$_{10}$O$_2$, the first member of the mica group with octahedral V$^{5+}$

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**ABSTRACT**

A mica-group mineral characterized by a high V content and free of Al was found in the manganiferous beds within the metacherts of the ophiolitic sequences at the Cerchiara mine, Eastern Liguria (Italy), in association with hematite, quartz, and calcite. Chemical and structural characterization supported by Raman data defines this phase as a new mineral species, which is named Balestraite after Corrado Balestra, a prominent Italian amateur mineralogist. Balestraite, ideally KLi$_2$V$^+$_3Si$_4$O$_{10}$O$_2$, is a 1M trioctahedral mica crystallizing in the C$_2$ space group, with $a = 5.2024(5)$ Å, $b = 8.9782(7)$ Å, $c = 9.9972(2)$ Å, $\beta = 100.40(2)^\circ$, $V = 459.3(1)$ Å$^3$, $Z = 2$. The reduction of symmetry from the “ideal” space group C$_2$/m is related to the ordering of V at only one of the two pseudo-symmetric octahedral sites. Vanadium forms very distorted octahedra with a [2+2+2] geometry characteristic of the valence state +5. The Li$_2$V composition of the octahedral sheet, the pure tetrasilicic character of the tetrahedral sheet, and the anhydrous character produce unusual geometrical features for this mica. The occurrence of 5+ as the dominant valence state of V and the virtually complete O$^-$ → OH$^-$ substitution at the O4 site indicate strongly oxidizing conditions of crystallization, which are consistent with balestraite occurring at the boundary between carbonate-bearing veins and hematite bands.

The new mineral and name were approved by the Commission on New Minerals, Nomenclature and Classification, IMA (2013-080).

**Keywords:** Balestraite, new mineral, Li-mica, V-mica, Cerchiara mine, pentavalent vanadium

**INTRODUCTION**

Preliminary chemical analyses of a micaeous mineral found in the manganiferous beds within the metacherts of the ophiolitic sequences at the Cerchiara mine, Eastern Liguria (Italy), showed a composition suggesting a new member of the mica group. In particular, data obtained via energy-dispersive spectrometry (EDS) analyses on a polished section indicated an unusually high V content, and no other transition metal or Al. Muscovite and phillogopite with high V contents have been occasionally reported [e.g., Pan and Fleet (1992), Ankinovich et al. (2001), and Giuliani et al. (2008)]. Until now, however, the only known V-members of the mica group were roscoelite, ideally KV$_3$[Al$_2$Si$_4$O$_{10}$(OH)$_2$] (Brigatti et al. 2003), and chernykhite, ideally BaV$_3$[Al$_2$Si$_4$O$_{10}$(OH)$_2$] (Ankinovich et al. 1973). Thus, owing to the absence of Al, this mineral was worthy of further investigations.

The present paper reports the results of chemical, structural, and spectroscopic studies to define and describe this new mica, which was named balestraite after Corrado Balestra (b. 1962), a prominent Italian amateur mineralogist and an expert of Ligurian minerals. The mineral and its name have been approved by the Commission on New Minerals, Nomenclature and Classification, IMA (2013-080). The holotype material is deposited in the mineralogical collections of the Museo di Storia Naturale, Università di Firenze (Italy), under catalog number 3133/1.

**GEOLOGICAL SETTING, OCCURRENCE, AND PARAGENESIS**

Balestraite was found in the ore body of the Cerchiara mine (~44°11′58″N, 9°42′1″E), which belongs to the well-known Mn district of Eastern Liguria named “Gambatesa district.” The ore body is located near the base of chert sequences (“Diaspri di Monte Alpe” Formation) overlaying Jurassic ophiolites (Cortesogno et al. 1979; Luchetti et al. 1988). The ore consists of rhythmic interlayering of braunite-bearing metasediments (5–15 cm thick) and hematite-rich cherts. According to Cabella et al. (1998), the primary Mn-oxide and hematite-rich cherts formed by fractionation from hydrothermally derived metalliferous siliceous muds during turbiditic re-sedimentation; subsequently, the sedimentary-diagenetic deposits were re-equilibrated under prehnite-pumpellyite facies conditions leading to a braunite + quartz stable assemblage. During this stage, reactions triggered by mobilized fluids along fractures produced Mn-silicate and Mn-carbonate assemblages at the expense of braunite + quartz. Successive decompressional tectonic evolution under decreasing P-T metamorphic conditions induced further concentration of dispersed elements, such as Ba, Sr, As, and V, to allow the genesis of a great variety of new and rare minerals in later exten-

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