NEW MINERALS

Andrianovite, Na$_{12}$ (K,Sr,Ce)$_3$Ca$_6$Mn$_3$Zr$_3$Nb(Si$_{25}$O$_{73}$) (O, H$_2$O,OH)$_5$, a New Potassium-Rich Mineral Species of the Eudialyte Group from the Khibiny Alkaline Pluton, Kola Peninsula, Russia$^1$

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Abstract—This paper presents the description of a new eudialyte-group mineral, which was named andrianovite in honor of Valerii Ivanovich Andrianov (1938–1991), a famous Russian mathematician and crystallographer, who developed the AREN software package for structural study of minerals with variable composition. The new mineral has been found in pegmatite from the Koashva open pit, Khibiny Pluton, Kola Peninsula, as rims 0.1–1.0 mm wide surrounding the crystals of typical eudialyte. Aegirine, sodalite, microcline, natrolite, lomonosovite, lamprophyllite, mosandrite, and villiaumite are associated minerals. Andrianovite is light yellow, with vitreous luster and stepped fracture. It is transparent or turbid, with a white streak. The new mineral slowly breaks down and gelates in 50% HCl and HNO$_3$ at room temperature. It is trigonal, space group R3m. The unit cell dimensions are $a = 14.281(4)$ Å, $c = 30.243(7)$ Å, $V = 5342(4)$ Å$^3$. The strongest reflections in the X-ray powder pattern $[d, hI, k]$ are as follows: 2.98(100)(315), 2.86(94)(404), 4.32(71)(205), 3.22(70)(208), 6.44(60)(104), 3.17(50)(217), 5.71(40)(202), 3.54(38)(027). The chemical composition (electron microprobe, H$_2$O, OH$^-$) is 10.1134/S10757015080808060

INTRODUCTION

Despite the relative abundance of natural sodium minerals of eudialyte group, the absence of potassium analogues in the status of firmly validated mineral species has remained intriguing until recently. Therefore, our findings of two such analogues in Khibiny were remarkable. The first was recently described as rastsvetaevite (Khomyakov et al., 2003), and the second is characterized in detail in this study. The new mineral was named andrianovite in honor of Valerii Ivanovich Andrianov (1938–1991), a famous Russian mathematician and crystallographer, who developed the AREN software package for structural study of minerals with numerous atomic sites of variable composition (Andrianov, 1987).

With the assistance of Andrianov and the AREN software package, the examination of crystal structure...
of eudialyte was followed up (Rastsvetaeva and Andrianov, 1987) and the structure of alluaudite, the first highly ordered mineral of the eudialyte group with a double volume of the unit cell, was resolved (Rastsvetaeva et al., 1990). Later, the structures of many other eudialyte-group minerals were successfully determined using this software package.

MODE OF OCCURRENCE, CHEMICAL COMPOSITION, AND PROPERTIES OF ANDRIANOVITE

Mode of occurrence. Andrianovite was found in the Khibiny alkaline pluton, Kola Peninsula, Russia in one of the blocks of the hyperperalkaline pegmatite exposed in the open pit of the Koashva Apatite Mine. This pegmatite consists of large radiate aggregate of aegirine of a few generations with incorporated irregular segregations of sodalite, microcline, natrolite, lomonosovite, lamprophyllite, mosandrite, villiaumite, and isometric rhombohedral crystals composed of eudialyte and andrianovite.

These crystals, 1–2 cm across, are clearly zoned (Fig. 1), with a core of crimson red eudialyte and a rim 0.1–1.0 mm wide composed of light yellow andrianovite. As a rule, this rim encloses the entire crystal, which becomes sheath-shaped. The sharp interface of andrianovite and eudialyte zones is characterized by abrupt change in color, optical sign, refraction index, and other properties of contacting minerals. Nevertheless, the minerals separated by this boundary commonly have the same crystallographic orientation, which is indicated by their simultaneous extinction in cross polars.

The abundance of inclusions of small villiaumite grains concentrated mainly in the central zone of the crystals and fine needles of aegirine concentrated in rims composed of andrianovite is another characteristic feature of described zonal crystals. The small width of andrianovite rims and abundant aegirine needles hampered the selection of pure material and predetermined minor charges for examination; this circumstance was inevitably reflected in the completeness and accuracy of results.

The most important results of this study are given in Tables 1–3. The major characteristics of andrianovite are compared with those of kentbrooksite, one of the closest analogues of the studied mineral, eudialyte, and rastsvetaeite (Table 1).

Physical properties and optical parameters. Andrianovite is light yellow with vitreous luster. The streak is white. The cleavage is imperfect parallel to (001). The new mineral is brittle, with stepped fracture. The Mohs hardness is 5. The density measured by the microvolumetric method is 2.93(2) g/cm$^3$; the density, calculated on the basis of an empirical formula, is 3.02 g/cm$^3$. Andrianovite is transparent or, more frequently, turbid due to the abundance of fluid inclusions. The occurrence of such inclusions may be a cause of significant difference between measured and calculated density. The new mineral is uniaxial, negative. The refractive indexes determined by immersion method ($\lambda = 589$ nm) are $\alpha = 1.622(2)$, $\varepsilon = 1.617(2)$. Andrianovite is nonpleochroic and nonfluorescent in ultraviolet light ($\lambda = 240–400$ nm). The mineral slowly breaks down and gelates in 50% HCl and HNO$_3$ at room and elevated temperature.

The infrared spectrum of andrianovite (Fig. 2) is distinguished by the following set of absorption bands (cm$^{-1}$; s, m, and w are strong, medium, and weak bands, respectively): 3576w, 3450w, 3106m, 2791w, 1667w, 1610m, 1508m, 1467w, 1395m, 1077s, 1062s, 1016s, 973s, 921s, 739s, 673m, 546m, 526m, 480w,

![Fig. 1. Intergrowth of andrianovite and eudialyte. Magn. 30.](image-url)