Ronneburgite, K$_2$MnV$_4$O$_{12}$, a new mineral from Ronneburg, Thuringia, Germany: Description and crystal structure

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ABSTRACT

Ronneburgite is a new chain vanadate mineral from Ronneburg, Thuringia, Germany. It occurs as reddish-brown crystals of equant, flattened, or short prismatic habit, up to 0.5 mm in length. The crystals have an adamantine luster and are translucent. Ronneburgite is biaxial negative with refractive indices $n_α = 1.925(5)$, $n_β = 1.960(10)$, $n_γ = 1.988(4)$, and $2V_e = 82°$. Electron microprobe analysis (K$_2$O = 16.93, MnO = 12.44, MgO = 0.62, V$_2$O$_5$ = 68.54; total = 98.53 wt%) gives the empirical formula K$_{1.91}$Mn$_{0.93}$Mg$_{0.08}$V$_{4.00}$O$_{11.96}$, which simplifies to K$_2$MnV$_4$O$_{12}$. Ronneburgite is monoclinic, space group P2$_1$/n, with $a = 8.183(3)$, $b = 9.247(3)$, $c = 8.651(2)$ Å, and $β = 109.74(2)°$. The measured density is 2.84 g/cm$^3$; the calculated density for Z = 2 is 2.85 g/cm$^3$. Single-crystal X-ray structure determination (R$_1$ = 0.046 for 1846 reflections) shows that ronneburgite contains infinite vierer-single metavanadate chains [(VO$_3$)$_n$]$^{n-}$ of corner-sharing VO$_4$ tetrahedra along [101]. Although the empirical formula and calculated bond valences indicate that V is 5+ and Mn is 2+, the crystal color, a “poor” structural compatibility index, and Mn-O distances between those expected for Mn$^{2+}$-O and Mn$^{3+}$-O indicate that some Mn$^{3+}$ and V$^{4+}$ ions are present. K$^+$ ions and octahedral Mn$^{n+}$ ions bridge between the metavanadate chains by coordinating to their oxygen atoms.

INTRODUCTION

During a reinvestigation of minerals from the Ronneburg U deposit near Gera, Thuringia, Germany, a reddish-brown mineral (Fig. 1) was found by one of the authors (T.W.) and F. Rüger (Gera). Only a few samples were recovered. A semi-quantitative energy-dispersive X-ray analysis showed the composition to be different from that of any known mineral. Subsequent investigations confirmed that the mineral is a new species. The mineral has been named ronneburgite after the locality. Both mineral and name have been approved by the IMA Commission on New Minerals and Mineral Names prior to publication (vote 98-069). Type material is deposited in the Mineralogical Collection of the Bergakademie Freiberg, Germany, as No. 78908.

OCCURRENCE AND PARAGENESIS

The Ronneburg U deposit was mined from 1949 to 1990. This deposit was Europe’s most productive U-mining field: about 7% of the world’s U production came from the Ronneburg area. The U mineralization is mainly found in Ordovician, Silurian, and Devonian slates and limestones.

The complex mineralogy of the Ronneburg deposit was recently described by Witzke and Rüger (1998), where ronneburgite is mentioned as the unidentified sample “RB 210.” More than 230 mineral species are currently known from the Ronneburg deposit. Ronneburgite was found on the mine dump of the Lichtenberg open-cast pit, which is situated at the southwest margin of Ronneburg, and was active from 1958 to 1977. Ronneburgite is associated with hummerite (KMgV$_5$O$_{14}$·8H$_2$O), gypsum, epsomite, picromerite, hematite, and an unidentified brownish K-Mg-Mn-vanadate. Epsomite and picromerite were formed later than ronneburgite. A few meters from the ronneburgite occurrence, the Ca-vanadate minerals sincosite, simplotite, and straczekite were observed at the mine dump. The Cu-vanadate volborthite was found in the oxidation zone of the Lichtenberg open-cast pit. Ronneburgite is an alteration product, likely to have formed at low temperatures under oxidizing conditions with pH neutral to basic (Evans and White 1987; Schindler et al. 2000). A primary V mineral from Ronneburg is not known to date.

PHYSICAL AND OPTICAL PROPERTIES

Ronneburgite occurs as reddish-brown, equant, flattened or short prismatic crystals up to 0.5 mm in length (Fig. 2). The streak of the mineral is orange brownish. The crystals have an adamantine luster and are translucent. The mineral is brittle, its fracture is irregular, and it shows an indistinct cleavage in