Mathesiusite, K₅(UO₂)₃(SO₄)₄(VO₃)(H₂O)₉, a new uranyl vanadate-sulfate from Jáchymov, Czech Republic

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ABSTRACT

Mathesiusite, K₅(UO₂)₃(SO₄)₄(VO₃)(H₂O)₉, a new uranyl vanadate-sulfate mineral from Jáchymov, Western Bohemia, Czech Republic, occurs on fractures of gangue associated with adolphiaterite, schoepite, čejkaita, zippite, gypsum, and a new unnamed K–UO₂–SO₄ mineral. It is a secondary mineral formed during post-mining processes. Mathesiusite is tetragonal, space group P4/n, with the unit-cell dimensions

a = 14.9704 (10), c = 6.8170 (5) Å, V = 1527.78 (18) Å³, and Z = 2. Acicular aggregates of mathesiusite consist of prismatic crystals up to ~200 μm long and several micrometers thick. It is yellowish green with a greenish white streak and vitreous luster. The Mohs hardness is ~2. Mathesiusite is brittle with an uneven fracture and perfect cleavage on {110} and weaker on {001}. The calculated density based on the empirical formula is 4.02 g/cm³. Mathesiusite is colorless in fragments, uniaxial (−), with ω = 1.634 (3) and ε = 1.597 (3). Electron microprobe analyses (average of 7) provided: K₂O 12.42, SO₄ 18.04, V₂O₅ 4.30, UO₂ 61.46, H₂O 3.90 (structure), total 100.12 (all in wt%). The empirical formula (based on 33 O atoms pfu) is: K₁.₃₃(UO₂)₂(SO₄)₄(V₂O₅)(H₂O)₉. The eight strongest powder X-ray diffraction lines are [d(Å), hkl]: 10.64 (110), 7.486 (200) 9, 6.856 (001) 100, 6.237 (101) 85, 4.742 (310) 37, 3.749 (400) 27, 3.296 (401) 9, and 2.9409 (510) 17. The crystal structure of mathesiusite was solved from single-crystal X-ray diffraction data and refined to Rᵢ = 0.0520 for 795 reflections with I > 3σ(I).

It contains topologically unique heteropolyhedral sheets based on [(UO₂)₃(SO₄)₄(VO₃)]⁺ clusters. These clusters arise from linkages between corner-sharing quartets of uranyl pentagonal bipyramids, which define a square-shaped void at the center that is occupied by V⁵⁺ cations. Each pair of uranyl pentagonal bipyramids shares two vertices of SO₄ tetrahedra. Each SO₄ shares a third vertex with another cluster to form the sheets. The K⁺ cations are located between the sheets, together with a single H₂O group. The corrugated sheets are stacked perpendicular to c. These heteropolyhedral sheets are similar to those in the structures of synthetic uranyl chromates. Raman spectral data are presented confirming the presence of UO₂⁺, SO₄²⁻, and molecular H₂O.

Keywords: Mathesiusite, new mineral, uranyl sulfate, vanadate, crystal structure, Raman spectroscopy, oxidation zone, Jáchymov

INTRODUCTION

In the course of study of the new mineral adolphiaterite, K(UO₂)₃(SO₄)(OH)(H₂O) (Plášil et al. 2012), we discovered another new unnamed uranyl mineral that is closely associated with adolphiaterite. Here we provide a description of this new mineral, mathesiusite, which is another uranyl sulfate from the Jáchymov deposit. It has the chemical composition, K₅(UO₂)₃(SO₄)₄(VO₃) (H₂O)₉, and a unique structure topology among known structures of uranyl minerals. The topology and chemical composition of the new mineral are discussed using the bond-valence approach.

The new mineral honors an evangelical (Lutheran) priest and theologian, Johannes Mathesius (1504–1565), a student of theology and philosophy under the supervision of the famous Martin Luther. From 1532 until his death, Mathesius lived and served in Jáchymov, first as a teacher at the Latin lyceum, then as a pastor in one of the first evangelic churches in the world. He provided significant gains to the natural sciences (especially mineralogy), his most important piece of work being “Sarepta oder Bergpostil,” printed in 1562. The new mineral mathesiusite and the name has been approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA 2013-046). The holotype specimen is deposited in the collections of the Department of Mineralogy and Petrology of the National Museum in Prague, under the catalog number P1P 7/2013.