

## Nitscheite, $(\text{NH}_4)_2[(\text{UO}_2)_2(\text{SO}_4)_3(\text{H}_2\text{O})_2] \cdot 3\text{H}_2\text{O}$ , a new mineral with an unusual uranyl-sulfate sheet

ANTHONY R. KAMPF<sup>1,\*</sup>, TRAVIS A. OLDS<sup>2,†</sup>, JAKUB PLÁŠIL<sup>3</sup>, BARBARA P. NASH<sup>4</sup>, AND JOE MARTY<sup>1</sup>

<sup>1</sup>Mineral Sciences Department, Natural History Museum of Los Angeles County, 900 Exposition Boulevard, Los Angeles, California 90007, U.S.A.

<sup>2</sup>Section of Minerals and Earth Sciences, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213, U.S.A.

<sup>3</sup>Institute of Physics ASCR, v.v.i., Na Slovance 1999/2, 18221 Prague 8, Czech Republic

<sup>4</sup>Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah 84112, U.S.A.

### ABSTRACT

Nitscheite (IMA2020-078),  $(\text{NH}_4)_2[(\text{UO}_2)_2(\text{SO}_4)_3(\text{H}_2\text{O})_2] \cdot 3\text{H}_2\text{O}$ , is a new mineral species from the Green Lizard mine, Red Canyon, San Juan County, Utah, U.S.A. It is a secondary phase found in association with chinleite-(Y), gypsum, pyrite, and Co-rich rietveldite. Nitscheite occurs in subparallel and divergent intergrowths of yellow prisms, up to about 0.3 mm in length. Crystals are elongated on [101] and exhibit the forms {100}, {010}, {001}, and {11 $\bar{1}$ }. The mineral is transparent with vitreous luster and very pale-yellow streak. It exhibits bright green fluorescence under a 405 nm laser. The Mohs hardness is ~2. The mineral has brittle tenacity, curved fracture, and one good cleavage on {010}. The measured density is 3.30(2) g·cm<sup>-3</sup>. The mineral is easily soluble in H<sub>2</sub>O at room temperature. The mineral is optically biaxial (-),  $\alpha = 1.560(2)$ ,  $\beta = 1.582(2)$ ,  $\gamma = 1.583(2)$  (white light);  $2V_{\text{meas}} = 17(1)^\circ$ ; no dispersion; orientation  $X = \mathbf{b}$ ,  $Z \approx [101]$ ; pleochroism  $X$  colorless,  $Y$  and  $Z$  yellow;  $X < Y \approx Z$ . Electron microprobe analysis provided the empirical formula  $(\text{NH}_4)_{1.99}\text{U}_{2.00}\text{S}_{3.00}\text{O}_{21}\text{H}_{10.01}$ . Nitscheite is monoclinic,  $P2_1/n$ ,  $a = 17.3982(4)$ ,  $b = 12.8552(3)$ ,  $c = 17.4054(12)$  Å,  $\beta = 96.649(7)^\circ$ ,  $V = 3866.7(3)$  Å<sup>3</sup>, and  $Z = 8$ . The structure ( $R_1 = 0.0329$  for 4547  $I > 3\sigma I$  reflections) contains  $[(\text{UO}_2)_2(\text{SO}_4)_3(\text{H}_2\text{O})_2]^{2-}$  uranyl-sulfate sheets, which are unique among minerals, with NH<sub>4</sub> and H<sub>2</sub>O groups between the sheets.

**Keywords:** Nitscheite, new mineral, uranyl-sulfate sheet, crystal structure, Raman spectroscopy, Green Lizard mine, Red Canyon, Utah