A Tale of Two Specimens

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Ray DeMark had some specimens of molybdite and sidwillite available at the 2016 New Mexico Mineral Symposium. They had been collected by Ray from the Summit Claim at Cookes Peak in Luna County, New Mexico. The Cookes Peak district had been a producer of lead, zinc, and silver for many years and more recently has produced some exceptional fluorite specimens (Simmons, 2019).

The specimens were nice additions to anyone's New Mexico collection and something not before seen from the district. I obtained two specimens and showed them to Bob Jenkins, who wanted to analyze a bluish mineral associated with the molybdite using Raman spectroscopy at the University of Arizona in Tucson. He gave the specimen to Dr. Hexiong Yang who set it aside after finding out that the bluish mineral might be some kind of phosphate. Five years passed before this molybdite specimen was "rediscovered" and reanalyzed.

Surprisingly, a careful analysis of the specimen labeled molybdite using Raman spectroscopy, SEM/EDS, and single-crystal X-ray diffraction revealed that the presumed molybdite was not, MoO_3. Instead, it is a new mineral species, a hydrated molybdenum trioxide, $MoO_3 \cdot H_2O$, and triclinic in symmetry. The new mineral was named raydemarkite in honor of its collector, which was approved by the IMA-CNMNC in 2022 (Yang et al., 2022).

The discovery of raydemarkite aroused Dr. Yang's curiosity about molybdenum trioxides and he learned more than he ever expected to know. Subsequent investigation revealed that several species had been synthesized in the lab as far back as 1903 (Rosenheim and Davidsohn, 1903). Their α-$MoO_3 \cdot H_2O$ phase created in the lab has now been found in nature as raydemarkite.

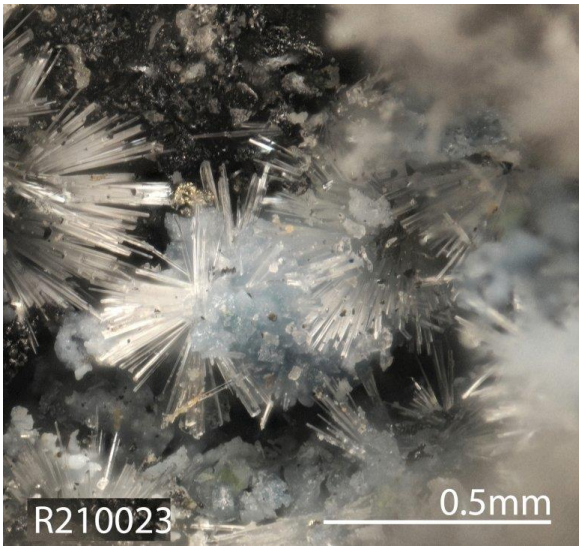

Figure 1. Raydemarkite, Summit Claim, Cookes Peak, Luna County, New Mexico, University of Arizona RRUFF photo.

The other specimen I acquired was labeled sidwillite, which it strongly resembles. However, analysis showed that it is also a new mineral. Instead of sidwillite, $MoO_3 \cdot 2H_2O$, it has the same chemistry as raydemarkite, $MoO_3 \cdot H_2O$, but with a different structure symmetry, monoclinic. This new mineral is dimorphous with raydemarkite and identical to the β-$MoO_3 \cdot H_2O$ phase synthesized by Rosenheim and Davidsohn in 1903. This new mineral was given the name virgilluethite in honor of Dr. Virgil Lueth, which was approved by the IMA-CNMNC in 2023 (Yang et al, 2023).

Subsequent work by several researchers on specimens from Cookes Peak and the Freedom No.2 mine in Utah have established a series of hydrated molybdenum trioxides with varying amounts of water, from two to none. These are not members of a dehydration series, one forming by the dehydration of another.

Instead, they represent species that form under particular circumstances, However, it has been shown that sidwillite can dehydrate easily to virgilluethite when heated to between 60 and 80 degrees Celsius. Both raydemarkite and virgilluethite will dehydrate to become molybdite upon heating between 110 and 160 degrees Celsius.

Fifure 2. Virgilluethite, Summit Claim, Cookes Peak, Luna County, New Mexico, University of Arizona RRUFF photo.

Raydemarkite and virgilluethite were named to honor two outstanding individuals who have done much to further our interest in New Mexico mineralogy. Ray DeMark is a well-known and respected mineral collector, writer, presenter, and museum donor. He is rightly considered to be an authority on New Mexico minerals.

Prior to his retirement in 2021, Dr. Lueth held the position of Sr. Mineralogist /Economic Geologist and Director of the Mineral Museum at NMBGMG, where he has worked since 1994. Virgil has overseen its dramatic growth to the new facility and has encouraged generous gifts to enlarge the collection. He has been instrumental in the continued growth and success of the annual New Mexico Mineral Symposium held each November at New Mexico Tech in Socorro.

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Name	Chemistry	Symmetry	Unit cell vol.
molybdite	MoO_3	Orthorhombic	202 Å^3
raydemarkite	$MoO_3 \cdot H_2O$	triclinic	158 Å^3
sidwillite	$MoO_3 \cdot 2H_2O$	monoclinic	1,538 Å^3
virgilluethite	$MoO_3 \cdot H_2O$	monoclinic	538 Å^3

Name	Chemistry	System	Type Locality
sidwillite	$MoO_3 \cdot 2H_2O$	monoclinic	Lake Como, CO
raydemarkite	$MoO_3 \cdot H_2O$	triclinic	Cookes Peak, NM
virgilluethite	$MoO_3 \cdot H_2O$	monoclinic	Cookes Peak, NM
zhenruite	$MoO_3 \cdot 0.5H_2O$	monoclinic	Freedom #2, UT
tianhiuxinite	$MoO_3 \cdot 0.33H_2O$	hexagonal	Cookes Peak, NM
molybdite	MoO_3	orthorhombic	Czech Republic