Wulfenite Overview

(When Lead and Molybdenum Get a Makeover by Oxygen)

ORANGE WULFENITE ON WHITE BARITE BLADES, BOU ALMADEN, DRAA-TAFILALET, MOROCCO

SHANNON GRAEWIN

Introduction

As we explore the tetragonal system of minerals, wulfenite is a great example to study. It is highly recognizable, beautiful, and collectible although many collectors do not have it represented in their collections. Wulfenite is best known for adding a vibrant pop of orange or other autumnal colors to collections, as this color is difficult to obtain. The best wulfenites in the world tend to come from the southwestern USA and Mexico. Many of the worldwide localities of wulfenite have distinct features or associations, allowing sight recognition of many pieces.

History

Many The first wulfenite was recognized in Annaberg Austria, which is ironic because no one thinks of Austria when discussing worldwide wulfenites today. It was named in 1945 for Franz Xaver Freiherr von Wulfen who was a Serbian Jesuit priest, alpinist, and mineralogist. He studied lead ores in Austria, and I guess everyone felt wulfenite was a better name than the original "plumbum spatosum flavo-rubrum."

Figure 1. Drawing of Franz von Wulfen, namesake of wulfenite

Specimens of wulfenite were bought and sold as early as the 1880s in the USA with A.E.Foote and Ward's Minerals featuring descriptions of it in their sale catalogues. Wulfenite became even more prominent when in 1938, Ed Over found the best wulfenites of all time at the Red Cloud Mine in the Trigo Mountains in west central Arizona. These piece featured nearly red crystals to 5 cm with a great luster and translucency. Nearly the entire find went to the Smithsonian Museum who traded them to other prominent museums of the time. Being featured in museum displays, added to their popularity in the mineral collection world. A second major find which had smaller crystals on matrix was found in 1996 by Wayne Thompson. These specimens did enter the collectible market directly.

Today, wulfenite remains popular, with the main show (Tuscon Gem and Mineral Society or TGMS sponsored) in Tuscon bearing the theme of "Wulfenite is Love" in 2019. Pieces are often expensive, with a premium for older finds that are undamaged.

Chemistry

Wulfenite is a rare collectible species in the Molybdenate / Tungstate group. Its formula is $Pb(MoO_4)$, making it a lead molybdenite. Although lead is relatively common in earth's crust, molybdenite is not. For molybdenite to make hand-sized viewable minerals, it must collect in a large enough concentration, and this only happens in certain locations. Molybdenum forms with 4 oxygens and these work as a single unit. Wulfenite forms a solid solution series with Stolzite, which can look similar, but subtitutes tungsten in place of molybdenum. It can be substituted completely or partially, leading to intermediaries. This substitution with "pure" end members is called a solid solution series.

Figures 2 and 3. Stolzite crystals strongly resembling wulfenite, but with tungsten instead of molybdenum seen on chemical analysis. Left photo is from Wikipedia and the right photo is from MIneralman.com.

As with many minerals in solid solution series, chemical analysis is needed to tell the two apart. However, in many localities, one or the other is known to occur, so assumptions are made once several have been analyzed. In other localities, the crystal can be both species where the composition in mixed (say 50-50%) or where different areas on the crystal are end members (eg. the core is one and the periphery is the other.) Then, the specimen would be labeled Londonite-Rhodizite Series, for example. In general, wulfenite localities are accepted, so this is not a big worry with wulfenite and stolzite.

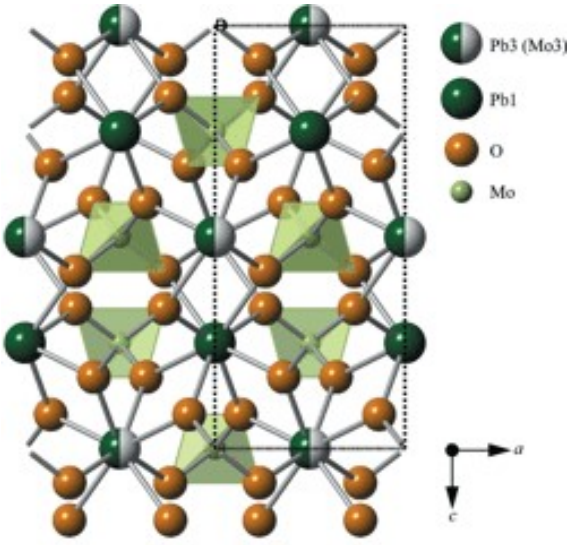

Figure 4. Ball and stick Model of Wulfenite. Semantic Scholar Figure.

Forms of Wulfenite

Wulfenite is in the tetragonal crystal system and can form as either tabular crystals or as bipyramidal crystals, although tabular crystals are much more common. The tabular crystals can be modified leading to beveled corners or edges.

Figure 5. Tabular Wulfenite on Green Mottramite from Ahumado Mine (aka Erupcion Mine), Chihuahua, Mexico. The a and b axis form the sides of the square of the central crystal facing us, while the c-axis is very short as the edge of the crystal. This crystal is unmodified, showing sharp 90 degree corners and straight edges. John Betts specimen and photo.

Figure 6. Another tabular crystal of wulfenite, this one modified by two different pyramids leading to both beveled corners and edges. Red Cloud Mine, Arizona, USA. John Betts photo and specimen.

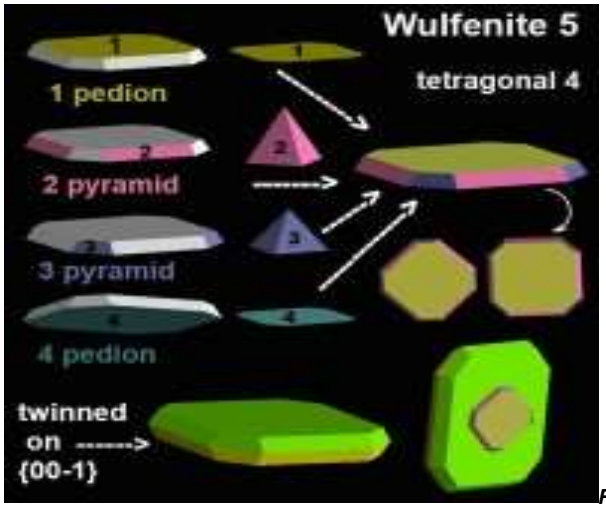

Figure 7. Smorf cartoon showing the modifications to the pure tetragonal form. This demonstrates how nearly perfectly formed and complex the crystal in Figure 6 is, rendering it a "fine" mineral specimen, even though it is only a couple of centimeters

Figure 8. Tabular and gem wulfenite from the San Francisco Mine, Mexico showing modification with only one pyramid leading to thin beveled edges. Note that the corners are still squared off sharply (not modified.) Heritage Auctions Specimen and Photo.

Figure 9. Bipyramidal (prismatic) wulfenite from Ojuela Mine, Mexico, Marin Minerals Specimen, Mike Keim Photo. Bipyramidal wulfenite is rarer, but less expensive than tabular wulfenite.

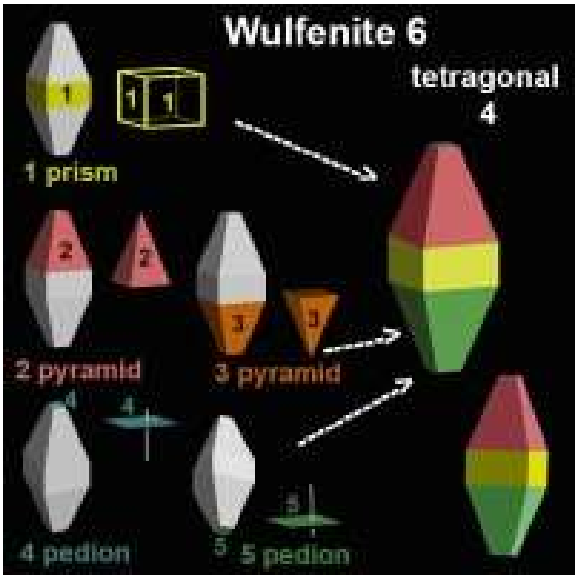

Figure 10. Smorf cartoon reviewing the bipyramidal tetragonal form.

Properties of Wulfenite

Wulfenite is brittle, weak, and extremely fragile so checking pieces for damage to the thin edges and corners is important. Wulfenite tends to form small crystals, so crystals to 5 cm on edge are considered huge and world class. They are usually opaque but can be translucent to completely "window-pane" transparent. Figure 8 is a transparent wulfenite. They are soft with a Mohs Hardness of only 2.5-3. They are about 65% by weight of lead, so they have a very high density with a specific gravity of 6.5-7.0. It is hard to tell this by heft however, as crystals tend to be only a centimeter or two. They have a resinous to greasy luster, which is a lessor luster than what we were seeing in fluorites, although the very best crystals can have top adamantine luster. They are usually easy to recognize due to their vibrant colors of orange, yellow, or even nearly red. They also form in brown shades. They are not radioactive but can fluoresce in SW or LW UV light in yellow, red, or orange.

Formation of Wulfenite

Wulfenites occur as secondary minerals in base metal ore deposits. This means that they are not emplaced by magmatic or metamorphic forces, but instead are created by the weathering and oxidation of primary minerals. In the case of wulfenite, it forms ultimately from galena. Galena is emplaced by mineral rich (hydrothermal) solutions which fill veins or cracks in the host rock. Galena gets exposed to oxygen which is usually from meteoric water (aka rain) percolating down soil and rock or from groundwater table exposure. This causes a breakdown of galena (PbS- lead sulfide) to lead carbonate (Cerussite) and lead sulfate (Anglesite.) These continue to weather and combine with whatever is in the environment. In Arizona, there is molybdenum in higher-than-normal amounts. This leads to small areas of wulfenite formation.

The rich red and orange colors of wulfenite come from trace amounts of chromium impurities. In its perfect theoretical state, wulfenite is clear. Many of the coloration variations of wulfenite are not completely understood. Lead itself or molybdenum may be contributing to the colors in complex ways.

Figure 11. Heavily color zoned "Sandwich" Wulfenite from a limited find at Ojuela Mine, Mexico ~5 years ago. Martin Gruel piece, photo.

Figure 12. A red wulfenite crystal over 5 cm in size from the world famous Ed Over 1938 find, Red Cloud Mine, AZ, USA. Note the scale on the bottom which is 1 inch on the left and 1 cm on the right. Art Montgomery specimen, Rock Currier photo, on Mindat.org

Figure 13. Beautiful Red Crystals on a weathered deep maroon iron oxide matrix is easily recognizable as from the USA classic location of Red Cloud Mine. Marin Minerals Specimen and photo

Figure 14. Beautiful Red Crystals on a weathered deep maroon iron oxide matrix is easily recognizable as from the USA classic location of Red Cloud Mine. Collector's Edge Specimen and Jeff Scovil photo

Figure 15. Thin blades of sunny yellow wulfenite from the Touissit-Bou Beker Area, Oriental Region, Morocco

Figure 16. Evan Jones' Collection of Arizona Wulfenite from many different locations. Note the variety and quality of his world class specialized collection

Figure 17. Spirifer sampling of Three different Arizona, USA Localities. Tom Praszkier specimens and photo