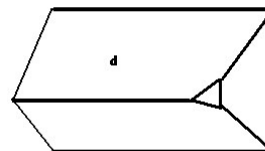


May 1998 Mineral of the Month: Adamite

From the mineral-rich land of Mexico comes our featured mineral, which is one color in “normal” light, and quite another in “invisible” light! We invite you to read on and learn why!

PHYSICAL PROPERTIES

Chemistry: $\text{Zn}_2(\text{AsO}_4)(\text{OH})$ Zinc Arsenate Hydroxide
Class: Phosphates, Arsenates, Vanadates Subclass: Arsenates Dana's: Anhydrous
 Phosphates, etc., Containing Hydroxyl or Halogen
Crystal System: Orthorhombic
Crystal Habits: Usually small, forming druses or encrustations of numerous tightly interlocked individuals with wedge-shaped faces uppermost. Also, radiating growths, partial to full fans, rosettes or spheroids implanted on matrix; striations common along long axis
Color: Usually shades of yellow-green, often intense; also, green, brownish-yellow; rarely, colorless or white; copper-rich adamite is called cuprianadamite and is blue-green; cobalt-rich adamite is violet to rose
Luster: Vitreous to somewhat oily
Transparency: Transparent to translucent
Cleavage: Good cleavage parallel to *d*
Fracture: Poor; brittle
Hardness: 3.5
Specific Gravity: 4.43
Streak: Colorless to faintly colored
Distinctive Features and Tests: Wedge-shaped drusy crystals; color; fluorescence; easily soluble in 1:10 acids
Dana Classification Number: 41.6.6.3



NAME

Pronounced ad'-ām-īt, the name was given it in 1866 for Gilbert-Joseph Adam (1795-1881), the French mineralogist who supplied the first specimens for study, which came from near Chanarcillo, Chile.

COMPOSITION

Adamite is our third featured mineral containing arsenic (a coincidence, we assure you, and not part of any plot to introduce this highly poisonous element into our homes.) In realgar and orpiment, arsenic is in the cation position, while in adamite it serves as the anion, combined with oxygen in what is known as the **arsenate radical**. As a result, it is classified in the phosphates, arsenates, vanadates class of minerals, which is often called the phosphates class for short. The unifying feature of this class is the presence of a radical or complex ion consisting of 4 oxygen atoms attached to a single atom of phosphorous (P), arsenic (As), or vanadium (V). Other well known minerals in this class include turquoise $[\text{Cu}^{2+}\text{Al}_6(\text{PO}_4)_4(\text{OH})_8 \cdot 4\text{H}_2\text{O}]$, variscite $[\text{Al}(\text{PO}_4) \cdot 2\text{H}_2\text{O}]$, and the apatite group, including pyromorphite $[\text{Pb}_5(\text{PO}_4)_3\text{Cl}]$, mimetite $[\text{Pb}_5(\text{AsO}_4)_3\text{Cl}]$, and vanadinite $[\text{Pb}_5(\text{VO}_4)_3\text{Cl}]$. You will recognize minerals of this class by looking at the anion in the chemical formula: (PO_4) , (AsO_4) , or (VO_4) . Minerals in this class, of which there are well over 600, usually occur as small crystals.

Besides the arsenate radical, adamite molecules include two positively charged ions of zinc, the 24th most abundant element in the earth's crust, and one atom of both oxygen and hydrogen combined as the hydroxyl ion (see your March 1998 write-up under “Composition” for more on hydroxyl).

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Adamite is very similar in crystal structure and properties to several other minerals: the aptly named eveite $[\text{Mn}^{2+}_2(\text{AsO}_4)(\text{OH})]$, libethenite $[\text{Cu}^{2+}_2(\text{PO}_4)(\text{OH})]$, olivenite, $[\text{Cu}^{2+}_2(\text{AsO}_4)(\text{OH})]$, and tarbuttite $[\text{Zn}_2(\text{PO}_4)(\text{OH})]$. Some references say that olivenite, libethenite, and adamite form a group, while others say they form a series. Evidently, a consensus remains to be reached. Paradamite, $[\text{Zn}_2(\text{AsO}_4)(\text{OH})]$, is dimorphous with adamite but crystallizes in the triclinic system.

COLLECTING LOCALITIES

The August 1947 edition of *The Mineralogist* proclaims under the headline "Adamite Found": "The spectacular crystallizations of adamite . . . are from the noted Ojuela Mine, Mapimi, Durango, Mexico . . . Recently a small pocket of adamite was encountered in the workings. The mineral was not previously found at this locality and the specimens are notable for their splendor, beauty and crystallization." It goes on to relate how many museums and collectors were adding wonderful specimens to their collections, just as we are this month.

This mine is in the Bufa de Mapimi, about 6 miles southeast of the city of Mapimi, in the northeaster part of the Mexican state of Durango, just south of Chihuahua state. There are many mines in this district, many of which have been worked for gold, silver, lead, zinc, and other ores since the Spaniards conquered Mexico more than 400 years ago! Mina Ojuela is the best known in the area, which has a fascinating history and geology that we will examine when we feature another mineral from the Ojuela Mine.

As your label shows, our specimens come from Level 6, of what the miners call the San Judas Department, or as we might say in English, the St. Jude vein. A visit to the specimen-producing part of the vein would involve three hour plus round trip on dangerous wooden or rope ladders through miles and miles of tunnels.

Were it not for Mina Ojuela, adamite would be a very rare mineral. In the United States, adamite is found at Franklin, Sussex County, NJ; Grandview Mine, AZ; Western Utah Mine, Gold Hill, Clarke Mountains, Tooele County, UT; and Zinc Mine, Mohawk, CA. Notable worldwide localities include Cap Garonne, near Hyères, Var, France; Reichenbach near Lahr, Black Forest, Germany; Mt. Valerio near Campiglia Marittima, Tuscany, Italy; Larium, Greece; the Island of Thasis, Turkey; also, extraordinary specimens come from the famed Tsumeb, Namibia mine.

OTHER INTERESTING FACTS

Crystals of adamite are too small and brittle to be cut for use in jewelry, and though arsenic and zinc are commercially valuable ores, adamite is not considered a suitable source of either. Yet adamite has another reason to draw the attention of mineral lovers worldwide: under shortwave ultraviolet light, many specimens shine a brilliant neon green! Let us consider why.

"Light" is defined as "that which makes it possible to see," which is true, as humans cannot see without it. Light is a form of electromagnetic radiation that acts upon the retina of the human eye, making sight possible. (We will not go into the marvelous intricacy of how our eye works.) This radiation is transmitted from its source at a velocity of about 186,000 miles per second by wavelike motion, and we see objects when wavelengths in the range visible to humans bounce off objects and strike our eyes. But as we see

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The Electromagnetic Spectrum. Chart courtesy of Nasa



from the chart, there are both shorter and longer wavelengths of electromagnetic radiation which fall outside the range visible to us, and how scientists have taken advantage of these invisible waves.

We see mineral specimens (and everything else that is visible) when **photons** (the energy of light, X-rays, gamma rays, etc., is carried by photons) in our visible range bombard the object, causing the electrons orbiting around the countless atoms that make up the object to become excited and to be raised to higher energy levels. When the electrons fall back to their original state, they emit photons of the same wavelength, which are visible to us as various colors, and we see the mineral.

The portion of the electromagnetic spectrum with wavelengths just shorter than those visible to us is called ultraviolet, or UV for short. The range of wavelengths in UV light is from about 10 billionths of a meter to about 400 billionths of a meter. Approximately nine percent of the energy emitted by the sun is ultraviolet, and most of this is blocked by the Earth's ozone layer. Although a small dose of UV light is beneficial to humans, larger doses cause skin cancer and cataracts. For this reason, care must also be exercised when using short wave UV light to view mineral specimens.

What happens when some minerals such as adamite are struck by photons of invisible (to us) ultraviolet light? Again, the orbiting electrons are excited and are raised to a higher energy level, but instead of falling back to their original state, they remain somewhere between at an intermediate state. Because of this, they release photons of a longer wavelength than what they were struck with, often producing light within our visible range! The color produced may be completely different from the "normal" color.

This phenomenon was first observed in 1852 by Sir George G. Stokes, a British physicist. Because he observed it in the mineral fluorite, he called it **fluorescence**, a term still widely used, although the more accurate scientific term is **photoluminescence**. The light given off by the mineral is usually faint, and can often be seen only in darkness or near darkness. There is a time lag involved in this process, which varies somewhat from one fluorescent mineral to the next; in some minerals, the fluorescent color lingers for a short time even after the source of the UV (ultraviolet) light is removed, as some electrons take longer to move back to their original state. This phenomenon is known as **phosphorescence**, and in some substances (not necessarily minerals) can take hours to complete.

Medical literature divides ultraviolet light into three ranges, commonly called short, middle, and long waves. The typical "black light" bulb available for sale in novelty stores emits long wave UV, while the middle wavelength is the kind that affects our skin and causes most of us to tan. The shortwave range has the greatest energy and is harmful to humans. Most minerals that exhibit fluorescence do so in only one of the three ranges, some two, and a few, all three.

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What causes fluorescence in certain minerals? And why does it not always occur in all specimens from the same locality? The presence of impurities that promote fluorescence, known as **activators**, is the answer. Slight traces of various elements present in the crystal structure may allow for greater movement of the excited electrons. Ions of the transition metals, such as chromium, manganese, and uranium, are common activators. Yet, an activator present in too great an amount may prevent fluorescence! Other minerals beside adamite that commonly fluoresce quite strongly are scheelite, ruby, calcite, zircon, sodalite, willemite, and of course, fluorite. Speaking of fluorite, we examined a specimen at a show that fluoresced to such a degree it was visible in daylight, activated by just the normal UV light from our Sun! Some minerals not known to fluoresce will if an activator is present, even in extremely small amounts.

Scientists have found numerous applications for visible light created in such a way. Most visible light is produced by the process of **thermoluminescence**, which creates light and heat. (Ever been burned by a lit light bulb?) Light created by photoluminescence is usually free of heat. This kind of light is produced by neon signs and fluorescent bulbs. Everyday fluorescent lighting is a UV lamp constructed of a type of glass that blocks the UV rays. The inside of the bulb is coated with a thin layer of fluorescent material that produces visible light when struck by UV rays, just as adamite does.

Science has also learned to use phosphorescence to our benefit, and known activators, also called **phosphors**, are incorporated into paint, laundry detergent, and other common products for their phosphorescent effect. UV light is also crucial in DNA analysis, medical phototherapy, detection of food and textile contamination, among many other applications.

Appreciation for this fascinating phenomena has caused a segment of serious collectors to make fluorescent minerals the focus of their collection. These are easily discernible at shows, as they walk around with their ultraviolet lights, sometimes attached to a power belt worn around their waists, scanning all the minerals in each booth!

ABOUT OUR SPECIMENS

The description found under "Crystal Habit" in the Physical Properties section nicely sums up what our specimens are: "Usually small, forming druses or encrustations of numerous tightly interlocked individuals with wedge-shaped faces uppermost. Also, radiating growths, partial to full fans, rosettes or spheroids implanted on matrix; striations common along long axis." Under magnification, we can easily see the terminations, striations and the way the crystals are intergrown. Specimens in our matrix-size range with complete spheroids cost two to three times what ours did; you may enjoy adding one to your collection, if the price seems reasonable. Do you recognize the brown matrix? It is our ubiquitous March 1998 featured mineral, goethite.

So as you enjoy the intricate beauty of your adamite crystals on their earthy matrix, may you marvel how some minerals can be fascinating and beautiful in light both seen and unseen!

References: Mineralogy, John Sinkankas, Van Nostrand Reinhold Company; Dana's Manual of Mineralogy, 18th Edition, Cornelius S. Hurlbut, John Wiley & Sons, Inc.; Dana's New Mineralogy, Richard V. Gaines, et al, John Wiley & Sons, Inc.; 1995 Glossary of Mineral Species, Michael Fleischer & Joseph A. Mandarino, The Mineralogical Record, Inc.; Minerals, George Robinson, Ph.D., Simon & Schuster; The Mineral Kingdom, Paul DeSautels, Madison Square Press; The Mineralogist, August 1947; mina Ojuela, Mapimi, Bob Jones, Rock & Gem, May 1976; Encarta, Microsoft & Funk & Wagnalls; Ultraviolet Products; <http://observe.ivv.nasa.gov/nasa/education/reference/emspec/emspectrum.html>; <http://www.web.wt.net/~daba/Mineral/data/Adamite.html>