

Mineral of the Month Club November 2017

SHATTUCKITE

This month's featured mineral is shattuckite, a relatively rare, bright-blue, basic copper silicate from Namibia. Our write-up explains shattuckite's mineralogy and occurrence, and discusses how mineral species are named.

OVERVIEW

PHYSICAL PROPERTIES:

Chemistry: $\text{Cu}_5(\text{Si}_2\text{O}_6)_2(\text{OH})_2$ Basic Copper Silicate (Copper Silicate Hydroxide)

Shattuckite often contains small amounts of iron, manganese, magnesium, or calcium.

Class: Silicates

Subclass: Inosilicates

Group: Shattuckite

Crystal System: Orthorhombic

Crystal Habits: Usually as acicular-to-thin prismatic crystals, often in radial masses forming sprays, spherules, and botryoidal structures; also massive, fibrous, and compact; sometimes forms pseudomorphs after other oxidized copper minerals.

Color: Light-to-dark blue, occasionally with hints of greenish-blue. Shattuckite is pleochroic: its blue colors vary in intensity with changes in viewing angle.

Luster: Vitreous to silky and dull

Transparency: Translucent to opaque

Streak: Blue

Refractive Index: 1.753-1.815

Cleavage: Perfect in two directions

Fracture and Tenacity: Uneven; brittle.

Hardness: 3.5

Specific Gravity: 4.1

Luminescence: None

Distinctive Features and Tests: The best field marks for shattuckite are acicular crystal shape; blue color; relatively high specific gravity; and exclusive occurrence in oxidized sections of copper deposits in frequent association with malachite [basic copper carbonate, $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$]. Shattuckite can be confused with the chromium-rich variety of diopside [calcium magnesium silicate, $\text{CaMgSi}_2\text{O}_6$] and such oxidized copper minerals as brochantite [basic copper sulfate, $\text{Cu}_4(\text{SO}_4)(\text{OH})_6$], dioptase [hydrous copper silicate, $\text{Cu}_6\text{Si}_6\text{O}_{18}\cdot 6\text{H}_2\text{O}$], plancheite [basic hydrous copper silicate, $\text{Cu}_8(\text{Si}_4\text{O}_{11})_2(\text{OH})_4\cdot \text{H}_2\text{O}$], and chalcantite [hydrous copper sulfate, $\text{CuSO}_4\cdot 5\text{H}_2\text{O}$].

Dana Mineral-Classification Number: 65.1.7.1

NAME: Shattuckite, pronounced SHAT-uhk-ite, is named after its type locality, the Shattuck Mine in Bisbee, Arizona. Shattuckite has also been known as "shattukite." In European literature shattuckite appears as *Shattuckit* and *shattuckita*.

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COMPOSITION & STRUCTURE: Shattuckite contains the elements copper (Cu), silicon (Si), oxygen (O), and hydrogen (H) in the proportions of 48.43 percent copper, 17.12 percent silicon, 34.14 percent oxygen, and 0.31 percent hydrogen. Shattuckite is a member of the silicates, the largest class of minerals, in which silicon and oxygen combine with one or more metals. As a single-chain inosilicate, shattuckite consists of single chains of silica tetrahedra with each tetrahedron sharing two of its oxygen ions with adjacent tetrahedra. Shattuckite crystallizes in the orthorhombic system, which is characterized by three mutually perpendicular axes of different lengths. Minerals that are chemically complex or that have complex bonding arrangements often crystallize in the orthorhombic system. Shattuckite is an idiochromatic (self-colored) mineral, meaning that its color is caused by its essential elements and, to a lesser extent, by the nature of its crystal lattice. The essential element copper is a powerful chromophoric (color-causing) agent for the colors green and blue. Divalent copper ions (cupric, Cu^{2+}) cause shattuckite's crystal lattice to absorb all white-light wavelengths except those within a narrow range of blue, which it reflects as its diagnostic, light-to-dark-blue color. Color variations are due to traces of such accessory elements as iron, manganese, magnesium, or calcium. Iron and manganese impart warmer, greenish hues to the basic blue color. Traces of magnesium and calcium, while not chromophoric themselves, produce paler shades of blue. Shattuckite occurs in arid regions and forms exclusively in the oxidized sections of copper deposits from the secondary precipitation of copper-rich groundwater and/or by the alteration of malachite [basic copper carbonate, $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$].

COLLECTING LOCALITIES: Shattuckite is collected in Namibia, Democratic Republic of the Congo, Republic of the Congo, South Africa, Argentina, Austria, Germany, Greece, Italy, Mexico, England, and the United States (Arizona, California, Nevada, and New Mexico).

HISTORY, LORE & GEMSTONE/TECHNOLOGICAL USES: Because it occurs in shallow deposits of brightly colored, oxidized copper minerals, shattuckite has been known since antiquity. It was not considered a distinct mineral species until the early 1900s when a previously unknown copper-bearing mineral was discovered in the Shattuck Mine in Bisbee, Arizona. Specimens were sent to Dr. Waldemar Theodore Schaller (1882-1967), a United States Geological Survey mineralogist in Washington, D.C., who described them as a new species in 1915. After another mineralogist challenged his findings, Schaller confirmed his observations, republished his description, and named the mineral in 1919. Although most mineralogists agreed with Schaller's conclusions, controversy about the mineral's validity as a species remained until advanced analytical techniques finally put the matter to rest in 1977. Because of its rarity and softness, shattuckite has only limited use as a gemstone. Shattuckite is unsuitable for faceting due to the acicular nature of its crystals and their lack of transparency. However, massive forms are cut and polished into cabochons for use as pendants. The most popular and attractive shattuckite cabochons are composites that show the blue of shattuckite, the green of malachite, and the white of quartz in intricate patterns. Massive shattuckite is sometimes carved into small decorative objects. Collectors value shattuckite specimens for their rarity, bright-blue colors, well-developed, botryoidal structures, and association with other colorful, oxidized copper minerals. Metaphysical practitioners believe that shattuckite is a stone of truth that helps to

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connect with inner realms, communicate with spirit guides, establish harmonious relationships, and heal broken relationships. Due to its rarity, shattuckite has no technological uses as an ore of copper.

ABOUT OUR SPECIMENS: Our shattuckite specimens are from the Omaue Mine near the town of Opuwo in the Kunene Region of far northwestern Namibia. The Omaue Mine is situated on the Kaokoveld Plateau, a mountainous, interior area known for such unusual wildlife as cheetahs, black rhinos, and desert elephants. At an average elevation of 4,000 feet, the Kaokoveld Plateau consists of short, rugged mountain ranges covered with sparse grass and occasional dwarf trees. The capital of the Kunene Region is Opuwo, population 7,500, the only place within thousands of square miles with basic medical facilities and gas stations, along with auto-repair, shopping, hotel, and telecommunication services. The Omaue Mine, located 44 miles south of Opuwo, is part of Camp Aussicht, a small lodge and way station that caters to ecotourists. The Omaue copper deposit, discovered in the early 1900s, consists of veins of quartz and oxidized copper minerals in a limestone host rock. Miners explored the deposit with short tunnels and shallow open pits, but found only limited copper mineralization that did not justify commercial mining. German entrepreneurs Marius and Lottie Steiner acquired the Omaue property in the early 1980s as a source of mineral specimens. Omaue specimens are sold to mineral dealers in the Namibian capital of Windhoek for export to international markets.

COMPREHENSIVE WRITE-UP

COMPOSITION & STRUCTURE

Shattuckite, chemical formula $\text{Cu}_5(\text{Si}_2\text{O}_6)_2(\text{OH})_2$, contains the elements copper (Cu), silicon (Si), oxygen (O), and hydrogen (H) in the proportions of 48.43 percent copper, 17.12 percent silicon, 34.14 percent oxygen, and 0.31 percent hydrogen. Like all molecules, those of shattuckite are made up of a mix of positively charged cations and negatively charged anions. The shattuckite cation consists of five divalent copper ions 5Cu^{2+} with a collective +10 charge. Shattuckite's compound anion contains two radicals, which are groups of different ions that behave as entities in chemical reactions. This compound anion is made up of two silica radicals $2(\text{Si}_2\text{O}_6)^{4-}$, each with two silicon ions 2Si^{4+} and 6 oxygen ions 6O^{2-} that provide a -8 charge, along with two hydroxyl ions $2(\text{OH})^{1-}$ with a -2 charge. This produces a total -10 anionic charge to balance the +10 cationic charge and provide the shattuckite molecule with electrical stability.

Shattuckite is a member of the silicates, the largest class of minerals, in which silicon and oxygen combine with one or more metals. The basic silicate structural unit is the silica tetrahedron $(\text{SiO}_4)^{4-}$, which has four equally spaced oxygen ions positioned at the four corners of a tetrahedron and surrounding a silicon ion. These oxygen ions are bound to the silicon ion by strong covalent bonding. In silicate minerals, silica anions and metal cations bond together like polymers (repeating chains) to form seven types of structures: double tetrahedral silicates (sorosilicates); framework silicates (tectosilicates); sheet silicates (phyllosilicates); independent

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tetrahedral silicates (nesosilicates); ring silicates (cyclosilicates); and single-chain and double-chain silicates (inosilicates).

As a single-chain inosilicate, shattuckite consists of single chains of silica tetrahedra, with each tetrahedron sharing two of its oxygen ions to bond with adjacent tetrahedra. This effectively reduces by one the number of oxygen ions in each tetrahedron to create groups of $(\text{SiO}_3)^{2-}$ units. Shattuckite forms single-width, unbranched chains of molecular units, each unit consisting of two bonded $(\text{SiO}_3)^{2-}$ radicals, an arrangement that is reflected in the $(\text{Si}_2\text{O}_6)^{4-}$ radical. These chains, which are twisted or helical in shape, provide space to accommodate positive ions that balance the two negative charges on each unit produced by the unshared oxygen ions.

The formation of the shattuckite molecule begins when divalent copper ions (cupric, Cu^{2+}) bond ionically to negatively charged oxygen ions O^{2-} . This creates the incomplete double-copper-silicate radical $[\text{Cu}_5(\text{Si}_2\text{O}_6)_2]^{2+}$, which is unstable because of its +2 charge. Two hydroxyl radicals $2(\text{OH})^{-1}$ then bond ionically to complete and electrically balance the shattuckite molecule, which is defined by the $\text{Cu}_5(\text{Si}_2\text{O}_6)_2(\text{OH})_2$. Because unoccupied space remains within the twisted-chain structure, shattuckite can accommodate such accessory ions as those of iron, manganese, magnesium, and calcium.

The single chains within the shattuckite lattice form planes of closely packed oxygen ions that alternate with planes of copper and hydroxyl ions. Because the ionic bonds in the two directions *between* the chains are much weaker than the covalent oxygen-oxygen bonds *within* the chains, shattuckite exhibits perfect cleavage in two directions. If shattuckite had only strong, covalent, oxygen-oxygen bonding, its hardness would approach that of quartz (Mohs 7.0). But its many weak ionic bonds limit its hardness to only Mohs 3.5, making it one of the softest of all silicate minerals. Shattuckite crystallizes in the orthorhombic system, which is characterized by three mutually perpendicular axes of different lengths. Minerals that are chemically complex or that have complex bonding arrangements often crystallize in the orthorhombic system. Shattuckite's substantial density (specific gravity 4.1) is due to the heavy element copper (atomic weight 63.55), which makes up 48.43 percent of its composition.

The Dana mineral-classification number 65.1.7.1 identifies shattuckite as an inosilicate with single-width, unbranched chains (65). The subclassification (1) defines it structurally by its chains of double-silica units $(\text{Si}_2\text{O}_6)^{4-}$. Shattuckite is then assigned to its own group (7) as the first and only member (1).

Shattuckite is an idiochromatic (self-colored) mineral, meaning that its color is caused by its essential elements and, to a lesser extent, by the nature of its crystal lattice. The essential element copper is a powerful chromophoric (color-causing) agent for the colors green and blue. Divalent copper ions (cupric, Cu^{2+}) cause shattuckite's crystal lattice to absorb all white-light wavelengths except those within a narrow range of blue, which it reflects as its diagnostic, light-to-dark-blue colors. This color range is due to the trace presence of such accessory elements as iron, manganese, magnesium, or calcium. Iron and manganese impart warmer, greenish hues to the basic blue color. Traces of magnesium and calcium, while not chromophoric themselves,

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produce paler shades of blue. Shattuckite is pleochroic, exhibiting varying intensities of blue when viewed from different angles. Pleochroism is caused by the differing angular absorption of light in doubly refractive crystals. In shattuckite and other orthorhombic crystals, pleochroism appears as subtle shifts in color intensity when the viewing angle is aligned with each of the three crystallographic axes.

Shattuckite occurs in arid regions and forms exclusively in the oxidized sections of copper deposits from the secondary precipitation of copper-rich groundwater and/or by the alteration of malachite [basic copper carbonate, $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$]. This alteration occurs when acidic, silica-rich solutions contact malachite, removing the carbonate radicals and replacing them with silica radicals. Shattuckite is associated with quartz [silicon dioxide, SiO_2]; malachite; azurite [basic copper carbonate, $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$]; brochantite [basic copper sulfate, $\text{Cu}_4(\text{SO}_4)(\text{OH})_6$]; diopside [hydrous copper silicate, $\text{Cu}_6\text{Si}_6\text{O}_{18}\cdot 6\text{H}_2\text{O}$]; plancheite [basic hydrous copper silicate, $\text{Cu}_8(\text{Si}_4\text{O}_{11})_2(\text{OH})_4\cdot \text{H}_2\text{O}$]; and chalcantite [hydrous copper sulfate, $\text{CuSO}_4\cdot 5\text{H}_2\text{O}$]. Shattuckite also forms pseudomorphs (“false forms”) by replacing certain other oxidized copper minerals, notably malachite, while retaining the external shape of the original mineral.

COLLECTING LOCALITIES

Our shattuckite specimens were collected at the Omaue Mine on the Kaokoveld Plateau in the Kunene Region of Namibia. Shattuckite also occurs at the nearby Old German, Van der Plas, Onderra, Otjihowe, and Otjindeka mines. Other Namibian sources are the Tsumeb Mine at Tsumeb and the Mesopotamia Copper Valley mines, both in the Otjokoto Region. Sources in the Democratic Republic of the Congo include the Shinkolobwe, Mutoshi, Mashamba West, and Shangulowé mines in the Katanga Copper Crescent, Katanga Province. In the Republic of the Congo, shattuckite occurs at Kenge and M’fouati in Bouenza Department. Shattuckite also occurs at the Messina Mine in the Vhembe District, Limpopo Province, South Africa.

Other sources include the Malpaso Quarry at Dumisnil, Colón Department, Córdoba, Argentina; Innerfragant, Hohe Tauern, Carinthia, Austria; Helgoland Island, Schleswig-Holstein, Germany; Vasilikon Mountain, Andros Island, Kykládes Prefecture, Aegean Islands Department, Greece; the Monte Guisi Mine, Domusnovas, Carbonia-Iglesias Province, Sardinia, Italy; the Milpillas Mine, Santa Cruz, Sonora, Mexico; and St. Day United Mines, Gwennap, Cornwall, England.

Most shattuckite localities in the United States are in Arizona and include the Shattuck Mine (type locality) at Bisbee in the Warren Mountains, Cochise County; the New Cornelia Mine at Ajo, Ajo district, Pima County; the Morenci Mine at Morenci, Shannon Mountains, Greenlee County; the Moore Mine Group, New Water Mountains, La Paz County; the Rawhide Mine in Rawhide Wash, Artillery Mountains, Mohave County; and the Florence mines at Florence in the Florence district, the San Manuel Mine at San Manuel in the San Manuel district, and the Mammoth-St. Anthony Mine at Tiger, all in Pinal County. Other sources are the Defense Mine, Lookout district, Argus Mountains, Inyo County, California; the Betty Jo Claim, Nevada district,

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White Pine County, Nevada; and the Magdalena district mines in Socorro County and the Santa Rita copper district in Grant County, both in New Mexico.

JEWELRY & DECORATIVE USES

Because of its rarity and softness, shattuckite has limited use as a gemstone. Shattuckite is unsuitable for faceting due to the delicate, acicular nature of its crystals and their lack of transparency. However, massive forms are cut and polished into cabochons for wear as pendants. The most popular shattuckite cabochons are composites that show the blue of shattuckite, the green of malachite, and the white of quartz in intricate patterns. Pendants mounted in silver with a one-inch-diameter shattuckite cabochon sell for as much as \$100. Massive forms of shattuckite are also carved into small, decorative objects.

Collectors value shattuckite specimens for their rarity, bright-blue colors, well-developed, otryoidal structures, and association with other colorful, oxidized copper minerals. Cabinet-sized specimens of shattuckite can cost as much as \$1,000.

HISTORY & LORE

Because it occurs in accessible, shallow deposits of brightly colored, oxidized copper minerals, shattuckite has been known since antiquity. It was not considered a distinct mineral species, however, until the early 1900s, when an unidentified copper-bearing mineral was discovered in the Shattuck & Arizona Copper Company's Shattuck Mine in Bisbee, Arizona. The Shattuck Mine, which opened in 1905 on a complex, oxidized, multimetal ore body, eventually reached a depth of 5,000 feet, had 20 miles of underground workings, and was a major source of copper, lead, zinc, silver, and gold. By the time it closed in 1947, it had yielded 18 million tons of ore.

The Shattuck Mine quickly became known as an important source of specimens of unusual copper minerals. In 1913, when miners encountered a spectacular "cave" (an underground geode) filled with fine specimens, the mine's chief geologist, avid mineral collector Phillip D. Wilson, personally supervised its exploration. Noting that the cave was linked to a system of small faults, he directed miners to "follow" the faults with narrow drifts. Discovering a bright-blue, copper-bearing mineral that he could not identify, Wilson mailed specimens to Dr. Waldemar Theodore Schaller (1882-1967), a United States Geological Survey mineralogist in Washington, D.C. Schaller described them as a new species and published his findings in 1915. Italian mineralogist Ferruccio Zambonini (1880-1932) immediately challenged Schaller, declaring that the new mineral was actually plancheite [basic hydrous basic copper silicate, $\text{Cu}_8(\text{Si}_4\text{O}_{11})_2(\text{OH})_4 \cdot \text{H}_2\text{O}$], which is similar in composition and crystal structure. When the identification issue grew into an international mineralogical debate, Schaller performed comparative optical tests on both the new mineral and plancheite. Convinced that this mineral did indeed represent a new species, Schaller republished his findings in 1919. Although most

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mineralogists agreed with Schaller's conclusions, some controversy about the mineral's validity remained.

At the time, the mineral-naming procedure was informal, with the lead scientist involved in its study usually choosing a name (see "How Minerals Are Named"). Schaller first proposed the name "wilsonite," after geologist Phillip Wilson who found the type specimens in the Shattuck Mine. However, Wilson refused the honor, perhaps to avoid associating himself with a mineralogical controversy. When another mineralogist proposed the name "schallerite," Schaller himself declined. A "bisbeeite" suggestion was rejected because that name was already informally assigned to another copper-bearing mineral not yet recognized as a species. Schaller finally settled on "shattuckite," after the mine where the type specimens were found.

Analyses conducted by the newly developed X-ray-diffraction method in 1924 further supported Schaller's conclusion that shattuckite and plancheite were different minerals. Nevertheless, the debate continued until advanced analytical techniques finally put the shattuckite-plancheite question to rest in 1977.

A botryoidal specimen of shattuckite appeared on the 1000-African franc postage stamp of the Ivory Coast in 2016. Metaphysical practitioners believe that shattuckite is a stone of truth that helps to connect with inner realms, communicate with spirit guides, establish harmonious relationships, and heal broken relationships.

HOW MINERALS ARE NAMED

When shattuckite, our current Mineral of the Month, was named in 1919, no formal mineral-naming system yet existed (see "History & Lore"). Because mineralogists then recognized only about 1,200 minerals, naming new species did not create much confusion. Today, with more than 5,300 recognized minerals and dozens of new species being described each year, naming has necessarily become an orderly, formal process. Over the centuries, the practice of naming minerals falls into three distinct eras: Antiquity; Tradition and Science; and Modern Science.

Antiquity (prior to 1750): Minerals that were named in antiquity tended to be common species that were mined or collected from surface or shallow mineralogical environments. When new minerals were identified, their discoverer assigned a name that was based on obvious physical properties, uses, or sources. These early names were considered "formalized" if they appeared in a scholarly work or simply became popular in general use. In this prescientific age, the imprecise naming of minerals was plagued with errors and confusion. Many species' names actually referred to varieties of species. As an example, the various crystal habits of pyrite [iron disulfide, FeS₂] were considered separate minerals. And the name "quartz" was assigned to several hard, transparent crystals and gemstones that were unrelated to quartz. Despite such confusion, many mineral names that originated in antiquity nevertheless remain in use today.

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Tradition and Science (1750 to 1958): In the mid-1700s when science began to replace alchemy, the emergence of analytical chemistry and crystallography, together with the identification of growing numbers of chemical elements, accelerated the rate of discovery of new mineral species. The practice of naming these minerals became somewhat more orderly as researchers published descriptions of new minerals in scientific journals for international review and solicited comments from their peers before proposing names. But naming also became competitive, with scientists sometimes rejecting more appropriate names in favor of their own preferences. Nevertheless, these early scientists corrected many naming errors from antiquity. One example is “calamine.” In the mid-1800s, chemical analyses revealed that two different minerals shared the traditional name “calamine.” To clarify the issue, scientists dropped the name “calamine” entirely and assigned the two original “calamine” minerals their current names—smithsonite [zinc carbonate, ZnCO_3] and hemimorphite [zinc silicate, ZnSiO_4].

During the Tradition and Science period, new minerals were often named for their chemical compositions, physical properties, type localities, or major occurrences. Then in 1789, the mineral prehnite [basic calcium aluminum silicate, $\text{Ca}_2\text{Al}_2\text{Si}_3\text{O}_{10}(\text{OH})_2$] was named for a person—Hendrick von Prehn (1733-1785), the late Dutch governor of South Africa. That began a trend of naming new minerals for scientists and other individuals. Mythological figures also became sources of names for new minerals, such as aegerine [sodium iron silicate, $\text{NaFeSi}_2\text{O}_6$], named in 1835 for Ægir, the ancient Norse god of the sea. The mid-1800s saw the introduction of the convention of ending new mineral names in “-ite,” a suffix derived from the Greek word *lithos*, meaning “stone.”

During the 1800s, the number of recognized minerals grew from 200 to more than 1,000. In the early 1900s, the emergence of atomic theory, advanced analytical techniques, and X-ray diffraction analysis again accelerated the rate at which scientists described new minerals. By the 1950s, mineralogists had identified 2,000 minerals, yet no central authority existed to regulate and approve their names.

Modern Science (1959 to present): By 1959, attempts to name the rapidly growing number of new species described each year had become so chaotic that the mineralogical societies of 16 nations joined together to establish the International Mineralogical Association (IMA). The IMA created the Committee on New Minerals and Mineral Names (CNMMN), which would be later renamed to the Commission on New Minerals, Nomenclature and Classification (CNMNC). Since 1959, formal guidelines and a standard review process have regulated the naming of all new minerals. Many earlier names of clearly recognized species, such as pyrite and quartz, were retained and “grandfathered” into this new nomenclature system.

Today, when researchers believe that they have identified a new mineral and that the chemical and physical data supporting their conclusions are valid, they may propose a name. But until the CNMNC determines the chemical and physical validity of the new species and approves the proposed name, it is identified only by a number. The CNMNC specifies that new mineral names end in “-ite” and that they be based upon their chemical composition, physical properties, relationship to other recognized species, type localities where the type specimens were first

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collected, or some deserving person or organization. If the proposed name honors a person, the CNMNC prefers that the individual be someone with significant achievements in the fields of mineralogy, geology, or related sciences. But minerals have also been named for famous people, well-known mineral collectors and dealers, and museum curators. Once the CNMNC recognizes the validity of a new mineral and confirms that its proposed name does not conflict with any of those of the 5,300 currently recognized minerals, the name becomes official.

About 45 percent of all recognized mineral species are named for individuals. Examples, drawing upon our previous Minerals of the Month, include smithsonite [zinc carbonate, ZnCO_3], named for James Smithson (1765-1829), founder of the Smithsonian Institution; and adamite [basic zinc arsenate, $\text{Zn}_2(\text{AsO}_4)(\text{OH})$], named for French mineralogist Gilbert-Joseph Adam (1795-1881). About 23 percent are based on discovery or type localities, such as aragonite [calcium carbonate, CaCO_3], named after Aragon, Spain; and our current Mineral of the Month, shattuckite, named after the Shattuck Mine. Another 14 percent of minerals are named for their chemical composition, such as stibnite [antimony trisulfide, Sb_2S_3], named after the Greek word for antimony; and vanadinite [lead chlorovanadate, $\text{Pb}_5(\text{VO}_4)_3\text{Cl}$], named after the essential element vanadium. About eight percent are based on physical properties, such as azurite [basic copper carbonate, $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$], named for its azure color; and barite, which stems from the Greek word for “weight.” Most of the remaining 12 percent of mineral names were assigned in antiquity, such as silver [native metal, Ag], of unknown origin; and quartz, from the Old German *Quarz*.

TECHNOLOGICAL USES

Because of its rarity, shattuckite has no technological use as an ore of copper.

ABOUT OUR SPECIMENS

Our shattuckite specimens are from the Omaue Mine near the town of Opuwo in the Kunene Region, Namibia. Located in southwestern Africa, Namibia adjoins the Atlantic Ocean on the west, Angola on the north, Botswana on the east, and South Africa on the south. Covering 318,259 square miles, Namibia roughly equals the area of the combined American states of Texas and Oklahoma. Because much of Namibia is arid, inhospitable desert, its population is only 2.2 million, making it the world's second least-densely populated nation after Mongolia. In 1884, Great Britain annexed part of the region to its Cape Colony (now the Republic of South Africa), while Germany claimed adjacent sections as its Südwestafrika (South-West Africa) colony. During World War I, British-controlled South Africa occupied South-West Africa, which is subsequently annexed in 1946. The South-West Africa People's Organization (SWAPO) rebels immediately sought independence through guerilla warfare. In 1968, the United Nations changed the name of South-West Africa to Namibia and appointed an international council to supervise its affairs prior to independence. Fighting between South African troops and SWAPO rebels continued through the 1980s. In 1992, Namibia finally

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received its independence and adopted a Western-style, constitutional government. Today, Namibia's economy is based on farming and ranching, along with diamond, gold, and uranium mining.

The Kunene Region, one of Namibia's 14 federal administrative regions, is located in far northwestern Namibia and borders the Atlantic Ocean on the west, Angola on the north, and the Namibian administrative regions of Omujati, Oshana, Oshikoto, Otzondjupa, and Erongo on the east and south. With an area of 44,500 square miles, the arid, mountainous Kunene Region is roughly equal in area to the American state of Pennsylvania. Inhabited by only 88,000 residents and have a population density of only two people per square mile, the Kunene Region is among southern Africa's wildest and least-populated areas. Electricity serves less than one-quarter of the region's residents and its unimproved gravel roads are often impassable during the brief rainy season.

The Kunene Region was originally known as the "Kaokoveld," a proposed homeland for the Ovahimba people, the region's dominant indigenous culture. Today, "Kaokoveld" refers to both a coastal desert and a large plateau in the mountainous interior, the latter providing habitat for such unusual wildlife as cheetahs, black rhinos, and desert elephants. The Kaokoveld Plateau, average elevation 4,000 feet, consists of rugged mountain ranges covered with sparse grass and occasional dwarf trees. Nomadic tribes tend small herds of cattle, sheep, and goats, or use the little available water for subsistence farming. Opuwo, the Kunene Region's capital, has 7,500 residents and was built as a military headquarters during the SWAPO wars of the 1980s. Despite its small population, Opuwo has great regional importance as the only place in a vast area that offers basic medical facilities and shopping, hotel, telecommunication, auto-repair services.

The Omaue Mine, the source of our shattuckite specimens, is 44 miles or two hours driving time south of Opuwo along the C43 gravel "highway." The mine is part of Camp Aussicht, a small lodge and way station that caters largely to ecotourists. The mine, located at coordinates 18° 41' 37" south latitude and 13° 44' 31" east longitude, is 60 miles south of the Angolan border, 120 miles east of the Atlantic coast, and 400 miles north-northwest of Windhoek, Namibia's national capital.

German prospectors discovered the Omaue copper deposit in the early 1900s. Miners explored the deposit with short tunnels and shallow open pits, but the limited copper mineralization did not justify commercial mining. Although it never shipped ore, the Omaue deposit nevertheless became known for fine specimens of shattuckite, diopside [hydrous copper silicate, $\text{Cu}_6\text{Si}_6\text{O}_{18}\cdot 6\text{H}_2\text{O}$], and malachite [basic copper carbonate, $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$]. German entrepreneurs Marius and Lottie Steiner acquired the property in the early 1980s as a source of specimens. They later opened Camp Aussicht, a campground and small lodge that now provides opportunities for trekking, bird-watching, wildlife viewing, and nature photography, along with guided tours of native villages and the Omaue Mine. The Steiners sell specimens from the Omaue Mine to dealers in Windhoek, who export them to international markets.

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The host rock at the Omaue Mine is the 500-million-year-old Otavi Group limestone. Some 60 million years ago, solutions rich in copper and silica intruded this limestone to emplace a complex vein system of quartz, chalcocite [copper sulfide, Cu_2S], and covellite [copper sulfide, CuS]. Erosion later reduced the surface, exposing the upper part of the vein systems to groundwater and atmospheric oxygen. The copper-sulfide minerals then oxidized into shattuckite, diopside, malachite, azurite [basic copper carbonate, $\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2$], chrysocolla [basic hydrous copper aluminum acid silicate, $(\text{Cu},\text{Al})_2\text{H}_2\text{Si}_2\text{O}_5(\text{OH})_4 \cdot n\text{H}_2\text{O}$], cuprite [copper oxide, Cu_2O], tenorite [copper oxide, CuO], mottamite [basic lead copper vanadate, $\text{PbCuVO}_4(\text{OH})$], and plancheite [basic hydrous copper silicate, $\text{Cu}_8(\text{Si}_4\text{O}_{11})_2(\text{OH})_4 \cdot \text{H}_2\text{O}$].

Your specimen of shattuckite from Namibia's Omaue Mine consists of nicely developed, botryoidal structures of shattuckite on a matrix of massive, gray quartz. The shattuckite spherules have a clean, bright-blue color that indicates a high degree of chemical purity. Using a loupe or magnifying glass to study any fragmented spherules, it may be possible to discern their internal structures of radiating, acicular crystals. The orange-brown or reddish coating or coloration in cracks within the quartz matrix is hematite [iron oxide, Fe_2O_3]. Some specimens may also show small sections of forest-green malachite, emerald-green diopside, and brownish-red cuprite.

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