

November 2012 Mineral of the Month: Cavansite

CAVANSITE

Cavansite, our Mineral of the Month for November, is a rare and colorful calcium oxyvanadium silicate from a classic locality in India. Our write-up explains cavansite's mineralogy and its relatively recent discovery, while providing an overview of the element vanadium.

OVERVIEW

PHYSICAL PROPERTIES

Chemistry: $\text{Ca}(\text{VO})\text{Si}_4\text{O}_{10}\cdot 4\text{H}_2\text{O}$ Hydrus Calcium Oxyvanadium Silicate (Calcium Oxyvanadium Silicate Hydrate, Hydrus Calcium Vanadyl Silicate)

Class: Silicates

Subclass: Phyllosilicates

Group: Cavansite

Crystal System: Orthorhombic

Crystal Habits: Usually as isolated spherical aggregates, tufts, or rosettes of radiating, acicular crystals; less commonly as linear clusters of more distinct, individual crystals; terminations are pointed and often chisel-like, but never sharp; twinning rare. Almost always occurs as inclusions in, or growths on, zeolite minerals. Crystals are small and do not exceed one-half inch in length.

Color: Greenish-blue to deep, vivid blue and "electric" blue.

Luster: Vitreous

Transparency: Sub-transparent to translucent

Streak: Bluish-white

Cleavage: Good to perfect in one direction

Fracture: Conchoidal; brittle.

Hardness: 3.0-4.0, varies directionally.

Specific Gravity: 2.21-2.31

Luminescence: None

Refractive Index: 1.54-1.55

Distinctive Features and Tests: Best field indicators are vivid-blue color; secondary occurrence in vesicles or fractures of basalt and andesite; spherical habit composed of radiating, acicular crystals; and association with zeolite minerals. Cavansite can be confused with the dimorphic mineral pentagonite [hydrus calcium vanadium oxysilicate, $\text{Ca}(\text{VO})\text{Si}_4\text{O}_{10}\cdot 4\text{H}_2\text{O}$].

Dana Classification Number: 74.3.7.1

NAME: The name "cavansite," pronounced "Ca-VAN-site," is derived from an acronym of the first syllables of three of its essential elemental components: **calcium**, **vanadium**, and **silicon**. Cavansite has also been known as "false zeolite." In European literature, cavansite appears as *Cavansit* and *cavansita*.

November 2012 Mineral of the Month: Cavansite

COMPOSITION: Cavansite' molecular weight is made up of 8.88 percent calcium, 11.28 percent vanadium, 24.89 percent silicon, 53.16 percent oxygen, and 1.79 percent hydrogen. Cavansite is member of the silicates, the largest and most abundant class of minerals. Silicates are combinations of silicon and oxygen with one or more metals or semimetals. Cavansite is a phyllosilicate, a term derived from the Greek *phylon*, meaning "leaf," a reference to its micaceous or leaf-like crystal structure of thin sheets.

As indicated by the " $4\text{H}_2\text{O}$ " in its chemical formula $\text{Ca}(\text{VO})\text{Si}_4\text{O}_{10}\cdot 4\text{H}_2\text{O}$, cavansite is a hydrous (or hydrated) mineral, meaning that it has attached molecules of water (H_2O) called "water of hydration." Phyllosilicates are subclassified structurally into two- or three-layer groups. Cavansite exhibits a typical three-layer or "2:1" structure, in which two tetrahedral layers "sandwich" a layer of metal cations. Very weak ionic bonding between the three-layer sheets allow these sheets to slip and separate under only moderate mechanical pressure, explaining cavansite's good-to-perfect, one-directional cleavage and relative softness of Mohs 3.0-4.0. As an idiochromatic or "self-colored" mineral, cavansite's diagnostic, vivid blue color is due to the essential element vanadium that causes the crystal lattice to absorb all visible-light wavelengths except a narrow band of blue, which is reflected as the vivid-blue color that we perceive in cavansite. Cavansite occurs exclusively as a secondary mineral within vesicles of basalt and andesite, both extrusive igneous rocks that form directly from the solidification of lava.

COLLECTING LOCALITIES: Cavansite is a rare mineral found in just four countries: India, the United States, Brazil, and New Zealand. The premier occurrences of cavansite are the Wagholi, Dhoot, and Chavan basalt quarries near Wagholi, Pune District, in the state of Maharashtra in west-central India. In the United States, cavansite is found in Oregon.

HISTORY, LORE & GEMSTONE/TECHNOLOGICAL USES: Cavansite was unknown until 1960, when mineral collectors discovered a bright-blue mineral in a road cut near the Owyhee Dam in Malheur County in east-central Oregon. In 1963, a similar blue mineral was discovered in a quarry near Goble, Columbia County, Oregon, 350 miles northwest of Owyhee. Four years later, X-ray diffraction studies of crystal structure revealed that specimens from both sites crystallized in the orthorhombic system, but had substantially different layered structures and were thus two different minerals. In 1973, the International Mineralogical Association recognized both these new minerals, which were named "cavansite" and "pentagonite." In late 1973, small, vivid-blue cavansite crystals were discovered in a dealer's stock of zeolite specimens in the city of Pune, India. Their source was finally confirmed in 1988 as a quarry near Wagholi, Pune District, Maharashtra, India. The Wagholi Quarry soon yielded larger crystals that attracted great attention at international mineral shows. Cavansite has since been a very popular collectible mineral. Metaphysical practitioners believe that cavansite stimulates intuition, heightens psychic awareness, enhances channeling ability, rids the mind of negative thoughts, and inspires new ideas. It helps in psychic healing by protecting participants during healing sessions. Physically, cavansite is thought to alleviate the discomfort of throat ailments. Because of its brittleness, small crystal size, and rarity, cavansite has only limited use in jewelry. Cavansite jewelry always incorporates the matrix material, usually a zeolite mineral. Cavansite-on-matrix is also tumbled into "healing stones" for metaphysical purposes.

November 2012 Mineral of the Month: Cavansite

ABOUT OUR SPECIMENS: Our cavansite specimens were collected at the Wagholi basalt quarry near the town of Wagholi, Pune District, state of Maharashtra, in the Republic of India. The Maharashtra basalt formations are part of the Deccan Traps, one of the world's largest volcanic regions, an area that covers 200,000 square miles and includes most of Maharashtra and the entire Pune District. The Deccan Traps formed during the late Cretaceous Period some 65 million years ago when massive quantities of magma rose vertically through long, narrow, crustal fissures and faults, extruded onto the surface, and spread in horizontal sheets to form basalt formations thousands of feet thick. As an extrusive (volcanic) igneous rock, basalt forms when magma solidifies at or near the surface. It is a fine-grained rock with little quartz, but large amounts of iron and magnesium minerals that impart a characteristic dark color. Basalt commonly contains vesicles (cavities) that form as gas bubbles in the lava, and amygdules, which are vesicles that later filled with secondary minerals. At the Wagholi Quarry, operations occasionally encounter sections of brecciated basalt containing amygdules filled with both zeolite crystals and vivid blue cavansite. Operations are then temporarily halted while workmen collect specimens. With large and unusually valuable finds, commercial collectors, who pay a fee to quarry owners for the right to collect, are called in to extract specimens. Our specimens were collected in this manner in 2009.

COMPREHENSIVE WRITE-UP

COMPOSITION

The chemical formula $\text{Ca}(\text{VO})\text{Si}_4\text{O}_{10}\cdot 4\text{H}_2\text{O}$ indicates that cavansite contains five elements: calcium (Ca), vanadium (V), silicon (Si), oxygen (O), and hydrogen (H). Cavansite's molecular weight is made up of 8.88 percent calcium, 11.28 percent vanadium, 24.89 percent silicon, 53.16 percent oxygen, and 1.79 percent hydrogen. Although cavansite's composition and structure may appear complex, it is easily understood by remembering that all molecules consist of positively charged cations and negatively charged anions. Cavansite's compound cation, or positively charged ion, is $[\text{Ca}(\text{VO})]^{4+}$, which consists of a calcium ion Ca^{2+} with a +2 charge, a vanadium ion V^{4+} with a +4 charge, and an oxygen ion O^{2-} with a -2 charge. This $[\text{Ca}(\text{VO})]^{4+}$ cation has a cumulative +4 cationic charge. Cavansite's compound anion, or negatively charged ion, is $(\text{Si}_4\text{O}_{10})^{4-}$, which includes four silicon ions 4Si^{4+} and 10 oxygen ions 10O^{2-} that create a cumulative anionic charge of -4. This -4 anionic charge balances the +4 cationic charge to provide the cavansite molecule with electrical stability.

Cavansite is member of the silicates, the largest and most abundant class of minerals. More than 2,000 silicate minerals collectively make up three-quarters of the weight of the Earth's crust. Silicates are combinations of silicon and oxygen with one or more metals or semimetals. The basic building block of all silicates is the silica tetrahedron $(\text{SiO}_4)^{4-}$, in which four equally spaced oxygen ions (4O^{2-}) surround a silicon ion (Si^{4+}). The oxygen ions occupy the four corners of the tetrahedron (a four-faced polyhedron) and surround the silicon ion at the center. Silicate minerals consist of silica anions and metal or semimetal cations that link together like polymers to form seven distinct structures: independent tetrahedral silicates (nesosilicates), double tetrahedral silicates (sorosilicates), framework silicates (tectosilicates), single-chain and double-chain silicates (inosilicates), ring silicates (cyclosilicates), and sheet silicates (phyllosilicates).

November 2012 Mineral of the Month: Cavansite

Cavansite is a phyllosilicate, a term derived from the Greek word *phyllon*, meaning “leaf,” a reference to its micaceous or leaf-like crystal structure of thin sheets. In phyllosilicates, each silica tetrahedron shares three oxygen ions with adjacent tetrahedra, which explains the “Si₄O₁₀” configuration that appears in the cavansite formula Ca(VO)Si₄O₁₀·4H₂O. This arrangement creates a thin sheet structure that extends indefinitely in two directions. Although the charges of the shared oxygen ions are neutralized, the unshared oxygen ion on the apex of each tetrahedron carries a net -1 charge. This attracts positive metal ions (opposite charges attract) to satisfy the collective negative tetrahedral charges and to also bond the sheets together. In cavansite, these metal ions are the calcium ion Ca²⁺ and the oxyvanadium (or vanadyl) ion (VO)²⁺. Because this charged-structural arrangement can accommodate metal ions of many types, sheet silicates are numerous, have a wide range of chemical compositions, and form many solid-solution series. Because the accumulation of metal ions produces a net positive charge, hydroxyl ions (OH)¹⁻ or water molecules (H₂O) occupy the holes among the tetrahedra to electrically balance the molecule.

As indicated by the “·4H₂O” in its chemical formula, Ca(VO)Si₄O₁₀·4H₂O, cavansite is a hydrous (or hydrated) mineral, meaning that it has attached molecules of water (H₂O) called “water of hydration.” Each cavansite molecule has four attached water molecules. In hydrous minerals, attached water molecules do not alter the electrical balance of the parent molecule because the attached water consists not of individual hydrogen and oxygen ions, but of complete, electrically balanced water molecules. Within each water molecule, the collective charge of the double hydrogen cation (2H)²⁺ is balanced by the charge of the single oxygen anion O²⁻. But since the two hydrogen ions are closely grouped within the molecule, rather than geometrically opposed, they retain a residual positive charge. The opposite side of the water molecule, dominated by the large oxygen ion, retains a small negative charge. This dipolar effect enables water molecules to behave as tiny, dipolar magnets that can attach themselves to certain other molecules to create hydrous minerals.

Phyllosilicates are subclassified structurally into two- or three-layer groups. Cavansite exhibits a typical three-layer or “2:1” structure, in which two tetrahedral layers “sandwich” an octahedral layer of metal ions or metal-radical ions (a radical is a combination of different ions that behaves as a chemical entity). In cavansite, the “sandwiched” middle layer contains calcium ions (Ca²⁺) and oxyvanadium (VO)²⁺ ions. Within these sheets, a combination of strong covalent and ionic bonding creates cohesive sheet units. But the ionic attraction *between* the three-layer sheets is so weak that only moderate mechanical pressure can cause the sheets to slip and separate, thus explaining cavansite’s good-to-perfect, one-directional cleavage and relative softness of Mohs 3.0-4.0. Cavansite’s hardness also varies directionally and is least along the direction of the good-to-perfect cleavage plane. Also, phyllosilicate layers do not consist of continuous sheets of tetrahedra, but rather of checkerboard-like arrangements of alternating “strips” of three tetrahedra each that are linked at their corners. This arrangement electrically satisfies three of the oxygen ions on each tetrahedron, leaving one remaining oxygen ion on the apex of each tetrahedron to retain a negative charge. This negative charge attracts the water of hydration. Drawn by their dipolar positive charge, water molecules fill the spaces between the apices of the silica tetrahedra, partially accommodating the remaining negative charge. These water molecules are attached only by hydrogen bonds, a very weak form of bonding created by the

November 2012 Mineral of the Month: Cavansite

attraction of the faintly positive poles of water molecules to other electrons. Stacks of these complex sheets are held together by the “sandwiched” layer of metal cations that satisfy the remaining collective negative charge of the tetrahedral layers.

The Dana classification number of 74.3.7.1 first identifies cavansite as a phyllosilicate with modulated (alternating) layers (74). The subclassification (3) next defines cavansite as a modulated phyllosilicate in which the tetrahedral layers consist of joined tetrahedral strips. Finally, cavansite is a member of the cavansite group of modulated, “joined-strip,” vanadium-containing phyllosilicates (7) as the first (1) of two members.

The other cavansite-group member is pentagonite (Dana classification number 74.3.7.2), which is a dimorphic form of cavansite—a mineral with an identical chemistry but a different crystal symmetry. Cavansite is often confused with pentagonite; both have similar colors, crystallize in the orthorhombic system, and occur in the same zeolitic environments. But their crystal habits are quite different. Cavansite forms isolated, spherical clusters of crystals or, less commonly, linear clusters of more distinct individual crystals in the shape of a “pile of logs.” Cavansite crystals have pointed terminations that are often chisel-like, but never sharp. Pentagonite, on the other hand, does not form spherical clusters, but occurs instead as showy sprays of small, sharply pointed crystals of unequal lengths. Unlike cavansite, pentagonite crystals are transparent, have sharp terminations, and are usually twinned. Cavansite tends to form directly atop stilbite-Ca [hydrous calcium potassium sodium aluminum silicate, $(\text{Ca}_{0.5}, \text{K}, \text{Na})_9(\text{Al}_9\text{Si}_{27}\text{O}_{72} \cdot 28\text{H}_2\text{O})$], while pentagonite usually associates with heulandite-Ca [hydrous calcium sodium potassium aluminum silicate, $(\text{Ca}_{0.5}, \text{Na}, \text{K})_9(\text{Al}_9\text{Si}_{27}\text{O}_{72}) \cdot \sim 24\text{H}_2\text{O}$]. In these depositional sequences, stilbite-Ca crystallizes first and is quickly followed by cavansite. In a later and lower-temperature depositional phase, heulandite-Ca crystallizes and is followed by pentagonite.

As an idiochromatic or “self-colored” mineral, cavansite’s diagnostic, vivid blue color is due to its essential chemical components, and not to any nonessential chromophores (coloring agents). The essential element vanadium has four common oxidation states: V^{2+} , V^{3+} , V^{4+} , and V^{5+} . The +4 oxidation state V^{4+} that is present in cavansite is a powerful blue-pigmenting agent. Vanadium ions cause the cavansite crystal lattice to absorb all visible-light wavelengths except a narrow band of blue, which is reflected as the diagnostic, vivid blue color of cavansite. The intensity and shade of this blue color varies somewhat when other metal ions substitute for vanadium in the crystal lattice. Color zoning is sometimes apparent in cavansite crystals and appears as paler prism colors and more intensely colored terminations.

Cavansite occurs exclusively as a secondary mineral within vesicles (vugs) of basalt and andesite, both extrusive igneous rocks that form directly from the solidification of lava. Basalt is a basic (silica-poor) extrusive igneous rock, while andesite is a closely related rock of intermediate silica content. Vesicles form as gas bubbles in lava. After the lava solidifies, these voids become filled with mineral-rich groundwater that precipitates such secondary minerals as cavansite and dimorphic pentagonite, along with calcite [calcium carbonate, CaCO_3], quartz [silicon dioxide, SiO_2], and the zeolite minerals stilbite-Ca and heulandite-Ca.

Although not technically a zeolite, cavansite does exhibit certain zeolitic properties. Zeolites are defined as hydrated tectosilicates (framework silicates) with structural channels that

November 2012 Mineral of the Month: Cavansite

accommodate attached water molecules that can be lost and regained without altering the crystal structure. While cavansite is not a tectosilicate and therefore not a zeolite, it can lose and regain at least some of its water of hydration without altering its crystal structure.

COLLECTING LOCALITIES

Cavansite is a rare mineral that occurs in only four countries: India, the United States, Brazil, and New Zealand. The world's classic locality for cavansite is the Wagholi basalt quarry at Wagholi, Pune District, Maharashtra, India. Specimens are also collected at the adjacent Dhoot and Chavan quarries and at the Pashan Quarry in the nearby village of Pashan.

Very small cavansite crystals occur in the Morro Reuter municipal quarry in Rio Grande do Sul state, Brazil; and in the Aranga Quarry at Dargaville in Northland (North Island), New Zealand. In the United States, cavansite is found at the type locality in Lake Owyhee State Park, Malheur County, in east-central Oregon; and at the Chapman Quarry near Goble, Columbia County, in northwest Oregon.

JEWELRY & DECORATIVE USES

Because of its brittleness, small crystal size, and rarity, cavansite has limited use in jewelry. All jewelry forms of cavansite incorporate the matrix material, usually a zeolite mineral. The white or colorless zeolitic matrix with contrasting rosettes of radiating, bright blue, acicular cavansite crystals is cut into small "plugs" and mounted in earrings or made into pendants. Cavansite-on-matrix is also tumbled into "healing stones" for metaphysical purposes. These are worn as pendants and occasionally, despite their fragility, set into rings. Cavansite-on-matrix gemstones are usually mounted in silver.

Because of cavansite's rarity, brilliant-blue color, unusual crystal habit, and occurrence on a contrasting white matrix, specimens are in great demand by collectors for both display and study purposes.

HISTORY & LORE

Cavansite was unknown prior to 1960, when mineral collectors discovered a bright-blue mineral coating a rock surface in an andesite road cut near the Owyhee Dam in Lake Owyhee State Park, Malheur County, in east-central Oregon. The following spring these collectors sent a specimen, which they could not identify, to the American curator and author Dr. Paul Desautels (1920-1991), then the gem-and-mineral curator of the United States National Museum (Smithsonian Institution). Desautels reported that it was likely a new mineral and would require further study. In 1963, another mineral collector discovered a similar blue mineral in a basalt quarry near Goble, Columbia County, Oregon, 350 miles northwest of Owyhee. Also unable to identify these specimens, the collector sent them to geologists at the University of Oregon in Eugene. In comparative studies, researchers initially identified the Owyhee and Goble specimens as the

November 2012 Mineral of the Month: Cavansite

same mineral with an identical chemistry. But in 1967, X-ray diffraction studies of crystal structure confirmed that while specimens from both sites crystallized in the orthorhombic system, they differed significantly in their phyllosilicate layering. Furthermore, the Owyhee specimens exhibited a strong tendency toward twinning, while the Goble specimens did not.

Finally in 1973, mineralogists from the University of Oregon and the United States Geological Survey petitioned the International Mineralogical Association to recognize both minerals as new species. The association granted recognition that same year. Cavansite was named as a mnemonic word for three of its essential elemental components: **calcium**, **vanadium**, and **silicon**; pentagonite was named after the pseudo-pentagonal structure created by its frequent twinning. By then, mineralogists had also learned that cavansite and pentagonite occurred together at both the Owyhee and Goble sites.

Because of its rarity and small crystal size, cavansite was initially a mineralogical curiosity with no collector interest. But in late 1973, small, radiating, vivid-blue crystals were discovered in a dealer's stock of zeolite specimens in Pune, India. Indian mineral collector and dealer Dr. Rustam Kothavala (1934-) sent these specimens to Harvard University where they were identified as cavansite. Unfortunately, the precise source of the specimens had not been recorded. Finally in 1988, the source of the Indian crystals was confirmed as the Wagholi basalt quarry near Wagholi, Ahmadnagar, Pune District, Maharashtra, India (see "About Our Specimens"). Further investigation revealed quantities of larger crystals, some of which approached a half-inch in length. The attractive contrast between the deep, brilliant blue of the cavansite and the white or colorless stilbite-Ca matrix attracted great attention at the Tucson, Arizona, gem-and-mineral show in 1989. Dr. Kothavala described these specimens in a detailed 1991 article in *The Mineralogical Record*. Since then, subsequent recoveries in India have increased the supply and cavansite has become a very popular collectible mineral. The Wagholi Quarry is now recognized as the classic locality for cavansite specimens.

Metaphysical practitioners believe that cavansite stimulates intuition, heightens psychic awareness, enhances channeling ability, rids the mind of negative thoughts, and inspires new ideas. It is especially helpful in psychic healing as it protects participants during healing sessions. Physically, cavansite is thought to help alleviate the discomfort of throat ailments.

A VIEW OF VANADIUM

As explained in "Composition," vanadium (pronounced va-NAY-dee-um) is the element that gives cavansite its diagnostic, bright blue color. Although vanadium is a relatively abundant element, it is rarely seen in elemental form. Ranking 19th among the elements in crustal abundance, vanadium is about as common as copper, chromium, and nickel. It is found in about 70 minerals but, because of its great chemical affinity for oxygen, does not occur free in nature. In refined, elemental form, vanadium is a silver-white metal with an atomic weight of 50.94, about that of titanium and chromium. Although ductile (capable of being drawn into wire) and malleable (capable of being shaped), vanadium is among the hardest of all metals at Mohs 7.0 (as hard as quartz). It has high tensile strength and corrosion resistance, a high melting point of 3434° F. (1890° C.), and it takes an excellent polish.

November 2012 Mineral of the Month: Cavansite

Understanding vanadium required nearly 70 years of study. In 1801, Spanish mineralogist Andrés Manuel del R o (1764-1849) first proposed the existence of a new metal in “brown lead,” a mixture of lead minerals. In 1830, German chemist and mineralogist Friedrich Karl W hler (1800-1832) reexamined “brown lead” to confirm del R o’s claim of a new metal. But W hler died before he could publish his findings and was never credited for co-discovering the new element. The following year, Swedish chemist Nils Gabriel Sefstr m (1787-1845) experimented with ores from Sweden’s Taberg iron mine to obtain a colorful oxide of this mysterious metal. From its oxide, Sefstr m produced several other brightly colored red, yellow, and blue compounds. Despite failing to isolate the new element, he nevertheless named it “vanadium,” after Vanad s, the Norse goddess of beauty, alluding to its colorful compounds. Finally in 1867, British chemist Sir Henry Enfield Roscoe (1835-1915) isolated elemental vanadium by chemically reducing vanadium chloride.

When it was first isolated, vanadium was considered rare and obtainable only in small quantities from vanadinite [lead chlorovanadate, $Pb_5(VO_4)_3Cl$] or as a by-product of smelting certain iron ores. Although vanadium initially had no practical uses, French metallurgists in the 1890s learned that adding 0.1 to 5.0 percent vanadium to steel refined the grain of the steel to enhance tensile strength, toughness, ductility, and corrosion resistance. It also combined with the carbon present to form carbides that substantially increased the steel’s hardness. An initial industrial resistance to the unfamiliar vanadium steels faded quickly after 1910, when American automaker Henry Ford (1863-1947), seeking new materials for his early automobiles, inspected a European racing car that had crashed at the new Indianapolis Motor Speedway. The crash impact had bent or fractured virtually every chassis or power-train component—except for the crankshaft which, as Ford learned, consisted of a new vanadium-steel alloy. After testing vanadium-steels, Ford specified them for critical parts in his own automotive power trains. Vanadium-steels eventually went into 15 million Ford Model Ts, demonstrating to the world the value and superior qualities of vanadium-steel alloys.

Today, vanadium is recovered by processing vanadiferous iron and titanium ores, slags, and petroleum residues. Nearly 60,000 metric tons of vanadium are recovered worldwide each year, 85 percent of which is used in alloys. In oxide form, contained vanadium now sells for \$15 per pound. Vanadium steels are used in large-diameter pipeline sections, high-speed tool steels, and structural-steel girders. Vanadium-chrome steels are standard in automotive suspension springs, transmission gears, and high-stress engine components, while lightweight, heat-resistant, vanadium-aluminum-titanium alloys serve in high-performance jet and rocket engines. Vanadium dioxide, the metal’s most important compound, is a catalyst in the production of sulfuric acid and maleic anhydride, the latter a chemical feedstock for manufacturing polyester resins and fiberglass. Vanadium dioxide also goes into the huge “load-leveling” batteries that maximize commercial power-grid efficiencies and the smaller, but more familiar, rechargeable lithium batteries for clocks, watches, cameras, and computers.

TECHNOLOGICAL USES

November 2012 Mineral of the Month: Cavansite

Because of its great rarity, cavansite has no technological uses. It has, however, served as the model for its own laboratory synthesis.

ABOUT OUR SPECIMENS

Our cavansite specimens were collected at the Wagholi basalt quarry near the town of Wagholi, Pune District, state of Maharashtra, in the Republic of India. Maharashtra borders the Arabian Sea in west-central India. Its capital is the coastal city of Mumbai (formerly Bombay). With an area of 118,000 square miles, Maharashtra is nearly half the size of the state of Texas. Pune, one of Maharashtra's 34 administrative districts, is located in the southern part of the state. About the size of New Jersey, the Pune District has a population of 10.5 million. The city and district capital of Pune, population 6 million, is 40 air miles southeast of Mumbai. Wagholi, population 6,500 and 10 miles north of Pune city, is named after the historic Wagheshwar temple and in the local Maratha language means "tiger." At an elevation of 2,680 feet, Wagholi has a warm, semiarid climate and is an agricultural area known for its production of grapes, strawberries, sugar, tobacco, and cotton.

Within the state of Maharashtra, the districts of Ahmadnagar, Nashik, Nagar, Jalgaon, Mumbai, and Pune are the world's leading sources of zeolite-mineral specimens. These specimens occur in the basalt of the Deccan (DECK-kenn) Traps, one of the world's largest volcanic regions. This huge formation covers 200,000 square miles and includes most of Maharashtra and the entire Pune district. The Deccan Traps formed during a massive extrusion of magma during the late Cretaceous Period 65 million years ago. This magma rose through long, narrow, crustal fissures and faults, extruded onto the surface, and spread in horizontal sheets to form basalt formations thousands of feet thick. Although the Deccan Traps have no other commercial mineral deposits, the hard, durable, inert basalt is a fine construction material that is used as ballast, fill for roads and rail beds, and foundations for buildings and dams. When finely crushed, it is a gravel additive for cement. Basalt quarrying is a major industry throughout Maharashtra.

As an extrusive (volcanic) igneous rock, basalt forms when magma solidifies at or near the surface. It is a fine-grained rock with little quartz, but large amounts of iron and magnesium minerals that impart a characteristic, dark color. Its prominent structures are vesicles (cavities) and amygdules. Vesicles form from gas bubbles within the flowing magma, usually near the top of the flow where reduced pressure enables steam and gases to expand. Amygdules are vesicles that later become filled with such secondary minerals as quartz and zeolites. In the lava formations of the Deccan Traps, these hollow vesicles eventually filled with groundwater containing large amounts of dissolved silica minerals that precipitated a variety of zeolites along with such rare minerals as cavansite. The vanadium in cavansite was initially present in trace amounts in the basalt at a level of about 200 to 400 parts per million. Groundwater dissolved and concentrated the vanadium salts, transporting the vanadium ions into the basalt vesicles, then precipitating them as cavansite and, to a lesser extent, pentagonite.

In the 1820s, British surveyors and engineers working in the Deccan Traps began collecting finely developed crystals of quartz, calcite, and zeolite minerals. The abundance of the zeolites

November 2012 Mineral of the Month: Cavansite

was not realized until the 1830s, when the construction of railroad tunnels between Bombay and Pune exposed many large amygdules filled with beautiful crystals that initially had only scientific interest. In the 1960s, however, these zeolites gained sudden popularity on international mineral-specimen markets. After receiving attention in western mineralogical and mineral-collecting publications during the 1970s, the trade in Indian zeolite specimens boomed. Since then, collecting and marketing Deccan Traps zeolite specimens has become big business both in India and abroad. Today, zeolite specimens are recovered mainly from basalt quarries and also from canal, well, and building excavations. Quarrymen break the basalt by drilling and blasting, then crush and size the rock for specific uses. Because zeolite specimens are a valuable by-product of basalt quarrying, dealers and specimen miners contract with individual quarries for exclusive recovery rights. When zeolite- or cavansite-filled amygdules are encountered, supervisors often suspend operations to allow commercial collectors to utilize special techniques to extract intact zeolite specimens from the amygdules in the tough basalt.

At the Wagholi Quarry, the source of our cavansite specimens, the basalt layer is 30 feet thick and rests atop an andesite layer with no commercial value. During the 1970s, when workers encountered a section of fragmented basalt that hydrothermal solutions had naturally cemented together, they left it in place as a pillar. When quarry owners decided to remove the pillar in 1988, workmen discovered small, blue crystals in vesicles in the fragmented basalt. When larger, more numerous crystals appeared at the base of the pillar near the contact zone with the underlying andesite, geologists and mineral dealers were called in and identified the crystals as cavansite. These specimens were introduced to western mineral collectors at the 1989 Tucson, Arizona, gem-and-mineral show (see “History & Lore”) where they were acclaimed as the best cavansite specimens ever found.

Today, workmen at the Wagholi quarry occasionally encounter sections of fragmented basalt that contain amygdules filled with both zeolite crystals and vivid blue cavansite. Operations then shift to other sections of the quarry to enable commercial collectors, who pay a fee for the privilege, to gather specimens. Our specimens were collected in this manner in 2009.

The most striking visual feature of your specimen is the dramatic color contrast between the vivid blue cavansite and the colorless-to-white, crystalline matrix of stilbite-Ca. Few composite mineral specimens of any kind offer such a distinctive and eye-catching color contrast. Note how the blue cavansite is present as well-formed rosettes, which are spherical aggregates of radiating, acicular crystals. Under a magnifying glass or loupe with an intense light source, it is possible to see the individual, chisel-like terminations of these crystals. Your specimen is a composite of two minerals, both showing excellent crystal development. Note the flattened shape of the colorless, transparent or translucent, white stilbite-Ca crystals and their slanted terminations. Your specimen is also a record of sequential deposition in which the stilbite-Ca crystals formed first, followed by cavansite aggregates which crystallized atop the stilbite-CA. Your cavansite specimen is a reminder of the fascinating minerals that come from India’s Deccan Traps and an example of one of the Mineral Kingdom’s most striking color contrasts.

References: *Manual of Mineralogy*, Klein and Hurlbut, John Wiley & Sons; *Dana’s New Mineralogy*, Eighth Edition; *Encyclopedia of Minerals*, Second Edition, Roberts, et al, Van

November 2012 Mineral of the Month: Cavansite

Nostrand Reinhold Company; 2008 *Fleischer's Glossary of Mineralogical Species*, Joseph A. Mandarino and Malcolm E. Back, The Mineralogical Record, Inc.; *Mineralogy*, John Sinkankas, Van Nostrand Reinhold Company; "Cavansite and Pentagonite: New Dimorphous Calcium Vanadium Silicate Minerals from Oregon," L. W. Staples, H. T. Evans, Jr., and J.R. Lindsay, *American Mineralogist*, May-June 1973; "Crystal Structure of Cavansite Dehydrated at 220° C.," R. Rinaldi, J. J. Pluth, and J. V. Smith, *Structural Crystallography and Crystal Chemistry*, June 1975; "The Crystal Structure of Cavansite and Pentagonite," H. T. Evans, Jr., *American Mineralogist*, May-June 1973; "What's New in Minerals," Wendell Wilson, *The Mineralogical Record*, January-February 1977; "Cavansite from the Poona District, India," Bill Birch, *The Mineralogical Record*, January-February 1977; "Cavansite, near Wagholi, Poona District, Maharashtra, India," Robert B. Cook, *Rocks & Minerals*, May-June 1996; "The Wagholi Cavansite Locality near Poona, India," Rustam Z. Kothavala, *The Mineralogical Record*, November-December 1991; "Scientists Spot Rare Gem," *Deccan Herald* (New Delhi, India), December 19, 2005; "Let's Get it Right: Cavansite or Pentagonite?" John S. White, *Rocks & Minerals*, July-August 2002; "Collecting Cavansite in the Wagholi Quarry Complex, Pune, Maharashtra, India," M. F. Makki, *The Mineralogical Record*, November-December 2005; "Polymorphic Relation between Cavansite and Pentagonite: Genetic Implication of [Oxyvanadium] Ions in Cavansite," N. Ishida, M. Kimata, et al, *Journal of Mineralogical and Petrological Sciences*, Volume 104, 2009; "Vanadium," Désirée E. Polyak, *2010 Minerals Yearbook*, United States Geological Survey.

Mineral of the Month Club

37-14 61 Street
Woodside, N.Y 11377

November 2012 Mineral of the Month: Cavansite

800-941-5594

www.mineralofthemonthclub.org