

# Mineral of the Month Club August 2017

## CALCITE var. GREEN

For August we are featuring the green variety of massive calcite. Our write-up explains calcite's mineralogy and discusses the mining history and minerals of Mexico, one of the world's great sources of mineral specimens.

### OVERVIEW

### PHYSICAL PROPERTIES

Chemistry:  $\text{CaCO}_3$  Calcium Carbonate (The green variety of calcite contains traces of iron, chromium, and/or nickel.)

Class: Carbonates

Subclass: Anhydrous Carbonates

Group: Calcite

Crystal System: Hexagonal (Trigonal Subsystem)

Crystal Habits: Usually as rhombohedrons, scalenohedrons, prisms, and tabs; crystal habits are numerous and varied, with modified, pseudo-hexagonal shapes and twinning common. Also occurs in acicular, granular, compact, stalactitic, stalagmitic, oolitic, and earthy forms.

Color: The green variety of massive calcite varies in color from pale-green to brownish-green and apple-green; color intensities vary within the same specimen and color-zoning is prominent.

Luster: Vitreous to dull

Transparency: Usually translucent, occasionally transparent or opaque.

Streak: White

Cleavage: Crystals have perfect, three-directional cleavage to form rhombohedrons, but cleavage surfaces do not coincide with crystal faces; massive forms have no cleavage.

Fracture and Tenacity: Usually irregular, rarely conchoidal; brittle to tough.

Hardness: 3.0

Specific Gravity: 2.7-3.0; varies with the amount of iron present.

Luminescence: Often fluorescent; sometimes thermoluminescent, triboluminescent, or phosphorescent. In the green variety of massive calcite, fluorescence is most prominent in colorless or white sections of specimens.

Refractive Index: 1.486-1.658; crystals are birefringent or doubly refractive.

Distinctive Features and Tests: Best field indicators are rhombohedral crystal shapes, softness, and vigorous effervescence in acids. Calcite can be confused with the polymorphic, calcium-carbonate mineral aragonite, which lacks calcite's three-directional, rhombohedral cleavage. The green, massive variety lacks a crystal structure and typically exhibits prominently zoned, pale-green to brownish-green and apple-green colors.

Dana Classification Number: 14.1.1.1

## Mineral of the Month Club August 2017

**NAME:** The word “calcite,” pronounced KHAL-site, is derived from the Latin *calx*, meaning “lime” (calcium oxide) or any white, calcareous mineral. The variety name “green calcite” alludes to its pale-green to brownish-green and apple-green colors. Green calcite is also known as “emerald calcite,” “green Mexican onyx,” “Mexican jade,” “jade onyx,” “green onyx,” and “green alabaster.” In European mineralogical literature, green calcite appears as *grün Kalcit* and *calcita verde*.

**COMPOSITION:** The term “green calcite” refers not to an individual species, but to a variety of the mineral calcite. Calcite, by far the most abundant of the 192 members of the carbonate class of minerals, is a simple carbonate consisting of 40.04 percent calcium (Ca), 12.00 percent carbon (C), and 47.96 percent oxygen (O). As an allochromatic (other-colored) mineral, calcite’s colors are not caused by essential elements or the basic light-absorption characteristics of its crystal lattice, but by traces of accessory elements that create a wide range of colors. When pure or nearly pure, calcite is colorless or white. The pale-green, brownish-green, and apple-green colors of green, massive calcite are caused by traces of divalent chromium or nickel ions, divalent and/or trivalent iron ions, or included microparticles of actinolite [basic calcium magnesium iron silicate,  $\text{Ca}_2\text{Mg}_{4.5}\text{Fe}_{0.5}\text{Si}_8\text{O}_{22}(\text{OH})_2$ ]. Calcite occurs in many different types of rocks in sedimentary, metamorphic, and igneous environments. The green variety of massive calcite forms primarily in oxidized mineralogical environments that are rich in iron, chromium, or nickel.

**COLLECTING LOCALITIES:** Green, massive calcite is collected in Mexico, Honduras, Argentina, Peru, China, Australia, Canada, Japan, South Africa, Turkey, Belgium, Switzerland, Romania, Slovakia, Austria, Bulgaria, France, Germany, Spain, Italy, and England. In the United States, green, massive calcite is found in Montana, Colorado, Nevada, North Carolina, Idaho, and Wisconsin.

**HISTORY, USES & LORE:** Although calcite has been known since antiquity, its many confusing crystal habits precluded its recognition as a distinct mineral species until 1845. To modern metaphysical practitioners, green calcite is a stone of peace and tranquility that provides vitality and a renewed sense of purpose. It is helpful in achieving mental balance, eliminating unproductive energy patterns, coping with times of mental change or life transitions, retrieving comfortable life patterns that may have been lost, and assessing situations from new perspectives. It generally enhances health and well-being, and it helps gardeners to connect more closely with natural realms. Physically, it is thought to stimulate the immune system. Green, massive calcite has no technological uses; its use in jewelry is limited because of its softness, low index of refraction, and perfect, three-directional cleavage that makes cutting difficult. A popular decorative stone, it is fashioned into cups, bowls, ashtrays, spheres, paperweights, and figurines. Large specimens of green, massive calcite are often used in home and office décor.

**ABOUT OUR SPECIMENS:** Our specimens of green, massive calcite were collected in the Sierra San Juan de Minas (San Juan of the Mines Mountains) in the northern part of the Mexican state of Durango near the border with the Mexican state of Chihuahua. Located in northwestern

# Mineral of the Month Club August 2017

Mexico, the Sierra San Juan de Minas is a 150-mile-long sub-range of the eastern Sierra Madre Occidental. In this part of the arid Chihuahuan Desert, rugged, low mountain ranges separate broad plains. The plains, roughly 5,000 feet in elevation, are sparsely vegetated with cacti, thorny brush, and coarse grass; the higher elevations of the mountains host thin, scrub-oak forests. Our specimens formed as shallow veins from the circulation and crystallization of calcium-rich groundwater. After mining, commercial collectors ship green, massive calcite to Bermejillo, Durango, about 100 miles to the southeast. Bermejillo is a regional trading center for many Mexican mineral specimens, including those from the famed Ojuela Mine. All massive calcite, whether carved into decorative items or maintained in its natural shape, is immersed in acid baths to dissolve a thin, outer section and create a smooth, glassy surface that improves translucency, intensifies internal colors, and reveals internal color patterns.

## COMPREHENSIVE WRITE-UP

### *COMPOSITION & STRUCTURE*

“Calcite” is the mineralogical name for the trigonal form of calcium carbonate ( $\text{CaCO}_3$ ). The term “green calcite” does not refer to a distinct species, but to a color variety of the mineral calcite. As the most abundant of the 192 members of the carbonate class of minerals, calcite is a simple carbonate that consists of the elements calcium (Ca), carbon (C), and oxygen (O) in proportions of 40.04 percent calcium, 12.00 percent carbon, and 47.96 percent oxygen.

Carbonate minerals consist of metallic elements combined with the carbonate radical ( $\text{CO}_3$ )<sup>2-</sup>. Radicals are groups of atoms of different elements that act as entities in chemical reactions. The carbonate radical, the fundamental structural unit of all carbonate minerals, has a flat, triangular shape. Within this triangle, a central carbon ion  $\text{C}^{4+}$  is covalently bound by shared electrons to three equidistant oxygen ions ( $3\text{O}^{2-}$ ). The +4 charge of the carbon ion  $\text{C}^{4+}$  and the collective -6 charge of the three oxygen ions  $3\text{O}^{2-}$  provide the carbonate radical with a total -2 charge. Carbonate minerals form when these negatively charged carbonate radicals bond ionically to positively charged metal ions. As a simple carbonate mineral, calcite consists of a single metal ion bound to a single carbonate radical. Like all molecules, the calcite molecule consists of a positively charged cation and a negatively charged anion. The calcite cation is a single, divalent calcium ion  $\text{Ca}^{2+}$ ; its anion is a single carbonate radical ( $\text{CO}_3$ )<sup>2-</sup>. The +2 cationic charge balances the -2 anionic charge to provide the calcite molecule with electrical stability.

Most carbonate minerals exhibit a three-fold, crystalline symmetry that reflects the triangular shape of the carbonate radical. Calcite and other simple carbonates crystallize in the hexagonal system, where the six-sided, external shape is a multiple of three-fold symmetry. (Chemically complex carbonates have a distorted structure and crystallize in the orthorhombic or monoclinic systems.) Calcite and other simple carbonates crystallize in the trigonal (or rhombohedral) subsystem, which mineralogists now consider to be a division of the hexagonal system. The trigonal subsystem is characterized by three axes of equal length with angles between them of *other* than 90 degrees. The basic trigonal shape is the rhombohedron, a six-sided polygon with

## Mineral of the Month Club August 2017

parallelogram sides. Because of the large number of possible variations in this basic form, calcite has more than 300 habits and 800 distinct sub-habits and shapes, and exhibits four types of twinning.

Calcite crystals make an interesting comparison with those of halite [sodium chloride, NaCl]. Halite crystallizes in the cubic system and has a cubic habit with perfect, three-directional, right-angle cleavage. The carbonate radicals in the calcite lattice occupy exactly the same positions as the chlorine ions in the halite lattice. But the triangular shape of the carbonate radicals distorts the calcite lattice along one axis. Calcite therefore has perfect cleavage in three directions, but not at right angles. This explains why halite cleaves into perfect cubes, while calcite cleaves into perfect rhombohedrons.

Within the calcite lattice, six oxygen ions of the carbonate radicals completely surround each calcium ion to explain why calcite exhibits no metallic properties. The relatively weak ionic bonding between the calcium ions and the carbonate radicals accounts for calcite's minimal hardness of Mohs 3.0. Despite its close atomic packing, calcite has a low specific gravity of 2.7-3.0, only a bit higher than that of quartz [silicon dioxide, SiO<sub>2</sub>]. Its low density is due to the relatively low atomic weights of its essential components calcium (40.08), carbon (12.01), and oxygen (16.00). An important diagnostic feature of calcite is its vigorous effervescence in acids, a reaction that is due to its weak ionic bonding. Using hydrochloric acid (HCl) as an example, calcite effervesces when the acid's highly reactive chlorine ions Cl<sup>1-</sup> break calcite's weak ionic bonds and replace its carbonate radicals. This reaction proceeds according to the simple formula  $\text{CaCO}_3 + 2\text{HCl} = \text{CaCl}_2$  (calcium chloride) + H<sub>2</sub>O (water) + CO<sub>2</sub> (carbon dioxide). The resulting, rapid release of carbon-dioxide gas creates the diagnostic bubbles of effervescence.

Calcite forms in many mineralogical environments, most commonly in shallow conditions where carbonic acid (H<sub>2</sub>CO<sub>3</sub>) can react with various metal salts. Carbonic acid forms when atmospheric carbon dioxide (CO<sub>2</sub>) dissolves in water (H<sub>2</sub>O) according to the formula  $\text{H}_2\text{O} + \text{CO}_2 = \text{H}_2\text{CO}_3$ . Under proper conditions of temperature, pressure, and chemistry, free metal ions then bond ionically with carbonate ions from the carbonic acid to form carbonate minerals. This reaction is especially common in chemical-sedimentary environments and forms limestone, a marine sedimentary rock consisting primarily of calcite. Calcite also occurs in nepheline-syenite pegmatites, metamorphic rocks, basaltic volcanic rocks, high- and low-temperature hydrothermal veins, disseminated replacement deposits, and carbonatites (carbonate-rich igneous rocks). When calcite forms in oxidized mineralogical environments with an abundant supply of iron, chromium, or nickel and with an absence of space for crystal formation, it develops as the green, massive variety.

Calcite is a polymorphic mineral and one of three natural forms of calcium carbonate. The other polymorphic forms are aragonite and the rare mineral vaterite. Although these three minerals share identical chemistries, calcite crystallizes in the trigonal subsystem of the hexagonal system, while aragonite crystallizes in the orthorhombic system, and vaterite in the hexagonal system.

## Mineral of the Month Club August 2017

The Dana mineral-classification number 14.1.1.1 identifies calcite as a simple, anhydrous carbonate (14) with the general formula  $A^{2+}CO_3$ , in which “ $A^{2+}$ ” can be divalent ions of calcium, magnesium, iron, manganese, cobalt, zinc, nickel, chromium, or cadmium. The subclassification (1) defines calcite as crystallizing in the trigonal subsystem. Calcite is then assigned to the calcite group (1) as the first (1) of eight members. Other familiar members of the calcite group, which vary only in their cationic chemistries, include magnesite [magnesium carbonate,  $MgCO_3$ ], siderite [iron carbonate,  $FeCO_3$ ], rhodochrosite [manganese carbonate,  $MnCO_3$ ], and smithsonite [zinc carbonate,  $ZnCO_3$ ].

As an allochromatic (other-colored) mineral, calcite's colors are not caused by essential elements or the light-absorption properties of its crystal lattice, but by traces of accessory elements that create a wide range of colors. When pure or nearly pure, calcite is colorless or white. But the presence of manganese creates pink manganoan calcite, while cobalt creates purplish cobaltoan calcite. In these minerals, traces of manganese and cobalt distort the crystal lattice to alter its color-absorption and color-reflection characteristics. Calcite colors can also be caused by inclusions of accessory elements or minerals. Yellow calcite is sometimes created by inclusions of microscopic particles of elemental sulfur, while black colors are due to inclusions of microscopic particles of elemental carbon.

In our specimens of green, massive calcite, the color is due a number of factors or a combination of factors. These include the presence of divalent iron ions  $Fe^{2+}$  and trivalent iron ions  $Fe^{3+}$ ; trivalent chromium ions  $Cr^{3+}$  that replace trivalent iron ions; and divalent nickel ions  $Ni^{2+}$  that replace divalent iron ions. The color of some green calcite is due to inclusions of microparticles of actinolite [basic calcium magnesium iron silicate,  $Ca_2Mg_{4.5}Fe_{0.5}Si_8O_{22}(OH)_2$ ] or other related amphibole minerals.

### *COLLECTING LOCALITIES*

Although calcite is abundant, its green, massive variety is uncommon and has relatively few collecting localities. Our specimens are from the Sierra San Juan de Minas (San Juan of the Mines Mountains) in the northern part of the Mexican state of Durango near the border with the state of Chihuahua. Green, massive calcite also occurs in adjacent areas of southern Chihuahua, including the Gibraltar Mine at Naica and the Portillo, Potosí, and West Camp sections of the Santa Eulalia district at Aquiles Serdán.

Other Latin American localities include El Mochito Mine at El Mocho, Santa Barbara Department, Honduras; the Farallón Negro Mine at Farallón Negro, Belén Department, Catamarca, Argentina; and the Casapalca Mine at Casapalca in Huarochiri Province in Lima Department, and the Pachapaqui district mines at Pachapaqui in Bolognesi Province in Ancash Department, both in Peru.

Among China's sources are the Huanggang Mine in Hexigten Banner near Chifeng, Chifeng Prefecture, Autonomous Region of Inner Mongolia; the Manaoshan Mine in the Dongpo ore

## Mineral of the Month Club August 2017

field near Chenzhou, Chenzhou Prefecture, Hunan Province; and the Tuanshangou Mine, Huangpi District, Wuhan Prefecture, Hubai Province. Green, massive calcite also occurs at the Broken Hill mines in Yancowinna County, New South Wales, Australia; the Sulphurets district mines near the Iskut River, Skeena Mining Division, British Columbia, Canada; the Toyoguchi Mine at Yamagata, Iwate Prefecture, Tohoku Region, Honshu Island, Japan; the Wessel Mine at Hotazel in the Kalahari Manganese Field, Northern Cape Province, South Africa; and the Dokuztepe iron-manganese deposit at Ceyhan, Adana Province, Mediterranean Region, Turkey.

European sources include La Sambre Quarry, Landelies, Montigny-le-Tilleul, Heinaut Province, Belgium; the Gonzen Mine at Sargans, St. Gallen, Switzerland; the Cavnic and Boldut mines at Cavnic, Maramures County, Romania; the Banská Štiavnica district mines in Banská Bystrica Region, Slovakia; the Martis and Felixbau mines at Hüttenberg, Freisach-Hüttenberg area, Carinthia, Austria; the Stevanof Mine at Zlatograd, Smolyan Oblast', Bulgaria; the Rivet Quarry near Tarn, Midi-Pyrénées, France; the Sebnitz Mine in the Freiberg District, Erzgebirge, Saxony, Germany; Sierra de Aracina, Huelva, Andalusia, Spain; the Scrove Mine at Reppia in the Grange Valley, Genova Province, Liguria, Italy; and the Botallack Mine, Botallack, St. Just District, Cornwall, England.

In the United States, green, massive calcite is found at the Alice Mine at Walkerville, Butte district, Silver Bow County, Montana; the Rico Argentine Mine at Rico in Dolores County, and the Idarado Mine at Telluride in San Miguel County, both in Colorado; the North Aurora Mine at Treasure Hill in the White Pine district, White Pine County, Nevada; the Bald Knob deposit at Bald Knob near Sparta, Allegheny County, North Carolina; the Friday Mine in the Westview district, Boise County, Idaho; and the Montreal, Jupiter, Bourne, and Moore mines in the Gogebic Iron Range, Iron County, Wisconsin.

### *JEWELRY & DECORATIVE USES*

With its minimal hardness (Mohs 3.0), low index of refraction (1.486-1.658), and perfect, three-directional cleavage that makes cutting difficult, calcite has limited use in jewelry. Both the crystalline and massive forms of calcite, when displaying pleasing colors, are sometimes wire-wrapped for wear as pendants. Green, massive calcite is also fashioned into beads that are strung on necklaces.

Green, massive calcite is a popular decorative stone; large quantities with both solid and banded colors are sold under the such names as "green Mexican onyx," "green onyx," "green alabaster," "Mexican jade," "jade onyx," and "emerald calcite." Because of its relative softness, calcite is easily carved into ashtrays, chess pieces and chessboards, candleholders, jewelry boxes, spheres, bookends, figurines, small tabletops, paperweights, and other decorative objects.

Among calcite's diagnostic features is its rapid reaction with acids to create a vigorous effervescence (see "Composition & Structure"). This susceptibility to acid is employed to finish decorative objects fashioned from various forms of massive calcite. These objects are first



## Mineral of the Month Club August 2017

shaped with wheels and saws, then immersed briefly in a bath of dilute hydrochloric acid (HCl) to dissolve a thin, surface layer of calcite. The resulting irregular, but glassy-smooth and lustrous surface, greatly enhances translucency and intensifies color and colors patterns. This acid-immersion treatment is inexpensive and eliminates the need for costly, time-consuming, mechanical polishing. Most green, massive calcite from Mexico, whether used as specimens or made into decorative items, is acid-treated. Large, irregularly shaped blocks of green, massive calcite are popular as home- and office-décor objects. These colorful pieces, which can represent entire sections of green-calcite veins, often exhibit contrasting, brownish banding patterns caused by the presence of divalent iron  $\text{Fe}^{2+}$ .

### *HISTORY & LORE*

In its many forms that include limestone and marble, calcite has been known since antiquity. In his *Historia Naturalis*, written in 77 A.D., the Roman scholar Pliny the Elder (Gaius Plinius Secundus, A.D. 23-79) named calcite *calx*, meaning “lime” (calcium oxide) or any white, calcareous mineral. But because of its varied and confusing crystal habits, calcite was not recognized as a distinct mineral species until 1845, when it was formally named after the Latin *calx* by Austrian mineralogist Wilhelm Karl von Hardinger (1795-1871).

To modern metaphysical practitioners, green, massive calcite is a stone of peace and tranquility that provides vitality and renewed sense of purpose. It is helpful in achieving mental balance, eliminating unproductive energy patterns, coping with times of mental change or life transitions, retrieving comfortable life patterns that may have been lost, and assessing situations from new perspectives. It generally enhances health and well-being, and it helps gardeners connect more closely with natural realms. Physically, it is thought to stimulate the immune system.

### *TECHNOLOGICAL USES*

Although green, massive calcite has no specific technological uses, other forms of calcite, especially limestone and marble, are of great industrial importance. Limestone, a sedimentary rock consisting of at least 50 percent calcite, is quarried worldwide by the hundreds of millions of tons for use as dimension stone in building construction, and also as a source of calcium carbonate for conversion to calcium silicate, the basic feedstock material for the manufacture of cement. Marble, a metamorphosed form of limestone, is used extensively in architecture and in sculpting.

### *MEXICO: MINES, MINERALS, AND MINERAL COLLECTING*

Complex geology, extensive mineralization, a rich mining history, and a vibrant, modern mining industry make Mexico a superb source of mineral specimens. As a mountainous nation that lies on four major, tectonic fault systems, Mexico has literally hundreds of mineral deposits and a

## Mineral of the Month Club August 2017

mining history that can be traced back nearly 500 years. In world mineral production, Mexico ranks first in silver, second in bismuth and fluorite, third in celestine [strontium sulfate,  $\text{SrSO}_4$ ], fourth in lead, fifth in cadmium and molybdenum, seventh in zinc, and tenth in copper and gold. More than 330,000 Mexican citizens are directly employed in the mining industry, which has an annual mineral-production value of \$23 billion.

Along with Brazil, Pakistan, Peru, China, and India, Mexico is among the world's leading sources of mineral specimens. Mexico's importance as a supplier of specimens is reflected in our Mineral of the Month Club archives: Of the 255 Minerals of the Month that we have featured since 1996 when the Club was founded, 27 have come from Mexico.

Mexico's topography is dominated by three major mountain systems—the Sierra Madre Occidental in the northwest, the Sierra Madre Oriental in the northeast, and the Sierra Madre Sur in the south. Most of the nation's mines and specimen localities are found within a 900-mile-long, 150-mile-wide area along the northwest-southeast-trending Sierra Madre Occidental that extends from the border of the United States south to Mexico City.

Mexico's rich mineralization is attributable to its position near the common junction of the North American, Caribbean, Cocos, and Pacific tectonic plates. The collision and subduction of these four plates generated the stresses that weakened, faulted, uplifted, and folded the crust over much of Mexico, leaving it vulnerable to magmatic intrusions and volcanism. The original basement rock consisted largely of marine sediments laid down between 150 and 70 million years ago that eventually lithified into limestone and dolomite. The Sierra Madre Occidental, Mexico's largest mountain range, formed about 65 million years ago when tectonic stresses uplifted huge blocks of basement rock. Some 30 million years later, magma surged into the fractured crust of the Sierra Madre Occidental to form intrusive bodies of granitic rocks and extrusive formations of rhyolitic and dacitic volcanic rock. This volcanism created the Trans-Mexican Volcanic Belt, a volcanic sub-range southeast of central Sierra Madre Occidental, and was accompanied by surges of mineralized, hydrothermal solutions that emplaced many rich deposits of lead, zinc, copper, and silver in the present-day states of Sonora, Chihuahua, Durango, Guerrero, Zacatecas, San Luis Potosí, Guanajuato, Jalisco, and Querétaro.

Spanish prospectors made numerous silver discoveries during the 1500s in the southern Sierra Madre Occidental. The mines that were developed on these rich deposits enabled Spain's viceroyalty of Mexico to lead the world in silver production for the next three centuries. After Mexico won its independence in 1821, mine production declined, but later recovered with the influx of European and American development capital in the 1880s. By 1900, Mexico had regained its position as a major producer not only of silver, but also of lead, zinc, and copper. Mexico has yielded about one-third of all the silver ever mined throughout history.

Among Mexico's best-known mines are the Ojuela Mine at Mapimí, Durango; and the Naica Mine at Naica, Chihuahua. Spanish prospectors discovered the Ojuela deposit in 1598. By 1640, Ojuela had become a major source of silver. Over its long life, Ojuela produced more than seven million tons of ore that contained on average 15 troy ounces of silver, 0.1 troy ounce of gold, 15



## Mineral of the Month Club August 2017

percent lead, 12 percent zinc, and small amounts of copper. When regular ore production ended after World War II, the total production at Ojuela exceeded 100 million troy ounces of silver, 700,000 troy ounces of gold, and 200,000 tons of both lead and zinc. Although Ojuela has not produced ore in decades, it remains an important source of mineral specimens.

The Naica multi-metal deposit was first mined for silver in 1794. Naica has operated continually for more than 220 years and currently yields lead, zinc, and smaller amounts of silver, copper, and gold. Its historic production exceeds 40 million tons of ore. Today, Naica is Mexico's oldest active mine and its leading source of lead. Naica gained fame in the 1970s for its mineral specimens, initially fluorite [calcium fluoride,  $\text{CaF}_2$ ] and pyrite [iron disulfide,  $\text{FeS}_2$ ]. In 1981, Naica became a classic locality for anhydrite [anhydrous calcium sulfate,  $\text{CaSO}_4$ ]. In 2000, Naica miners discovered a natural geodic cave now known as *La Cueva de los Cristales Gigantes* (the Cave of the Giant Crystals). This horseshoe-shaped cave, 100 feet long and 35 feet wide, is filled with huge crystals of the selenite variety of gypsum. The most spectacular of these, 36 feet long, 4 feet thick, and weighing an estimated 55 tons, is the largest freestanding crystal ever found anywhere in the world.

American mineralogists did not appreciate the diversity of Mexico's minerals or the quality of its specimens until the 1940s. Specimens began reaching collectors' markets when specimen-savvy, retired Americans living in Mexico brought them to dealers in the United States. As demand increased among American collectors, Mexican miners started supplementing their incomes by collecting and selling specimens. By the 1970s, when mineral collecting was becoming big business in the United States and Europe, Mexico was already well-established as a major source of fine specimens. Today, most Mexican mineral specimens are collected in lead, silver, zinc, copper, and fluorite mines by miners who are skilled at extracting intact specimens. Other Mexican specimens are gathered by commercial collectors who contract for permission to collect on mining-company properties.

Mexico has more than 60 type localities where mineral species were first discovered, along with a dozen classic localities that provide superb specimens. Mexico is best-known for specimens of creedite [basic hydrous calcium aluminum fluorosulfate,  $\text{Ca}_3\text{Al}_2(\text{SO}_4)(\text{OH})_2\text{F}_8 \cdot 2\text{H}_2\text{O}$ ] from the Navidad Mine near El Rodeo, Durango; native silver [element, Ag] from Batopilas, Chihuahua; the amethyst variety of quartz [silicon dioxide,  $\text{SiO}_2$ ] from Las Vigas de Ramírez, Veracruz-Llave; calcite [calcium carbonate,  $\text{CaCO}_3$ ] and smithsonite [zinc carbonate,  $\text{ZnCO}_3$ ] from Santa Eulalia and anhydrite from the Naica Mine at Naica, both in Chihuahua. Specimens from the Ojuela Mine at Mapimí, Durango, include hemimorphite [basic hydrous zinc silicate,  $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$ ]; adamite [basic zinc arsenate,  $\text{Zn}_2(\text{AsO}_4)(\text{OH})$ ]; wulfenite [lead molybdate,  $\text{PbMoO}_4$ ]; legrandite [basic hydrous zinc arsenate,  $\text{Zn}_2(\text{AsO}_4)(\text{OH}) \cdot \text{H}_2\text{O}$ ]; mapimite [basic hydrous zinc iron arsenate,  $\text{Zn}_2\text{Fe}_3(\text{AsO}_4)_3(\text{OH})_4 \cdot 10\text{H}_2\text{O}$ ]; vanadinite [lead chlorovanadate,  $\text{Pb}_5(\text{VO}_4)_3\text{Cl}$ ]; malachite [basic copper carbonate,  $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$ ]; rosasite [basic copper zinc carbonate,  $(\text{Cu},\text{Zn})_2(\text{CO}_3)(\text{OH})_2$ ]; aurichalcite [basic zinc copper carbonate,  $(\text{Zn},\text{Cu})_5(\text{CO}_3)_2(\text{OH})_6$ ]; köttigite [hydrous zinc arsenate,  $\text{Zn}_3(\text{AsO}_4)_2 \cdot 8\text{H}_2\text{O}$ ]; and conichalcite [basic calcium copper carbonate,  $\text{CaCu}(\text{AsO}_4)(\text{OH})$ ]. Mexico also supplies fine specimens of

## Mineral of the Month Club August 2017

fluorite [calcium fluoride,  $\text{CaF}_2$ ]; danburite [calcium borosilicate,  $\text{CaB}_2(\text{SiO}_4)_2$ ]; and grossular [calcium aluminum silicate,  $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_3$ ].

As a supplier of mineral specimens, Mexico has a major geographic advantage because of its common border with the United States, which is the largest of all mineral-specimen market. Tucson, Arizona, which annually hosts the world's premier gem-and-mineral show, is only a short distance north of the Mexican border. That means that American mineral dealers, specimen miners, and mineralogists can easily reach Mexican specimen sources, while Mexican mineral dealers have ready access to American specimen markets.

### *ABOUT OUR SPECIMENS*

Our specimens of the green, massive calcite were collected in the Sierra San Juan de Minas (San Juan of the Mines Mountains) in the northern part of the Mexican state of Durango near the border with the Mexican state of Chihuahua. Located in northwestern Mexico, the Sierra San Juan de Minas is a 150-mile-long sub-range of the eastern Sierra Madre Occidental. In this part of the Chihuahuan Desert, rugged mountain ranges separate broad plains. The plains, about 5,000 feet in elevation, are sparsely vegetated with cacti, thorny brush, and coarse grass. Mountain summits reach elevations of just over 8,000 feet and host thin, scrub-oak forests.

The village of Villa Ocampo is 12 miles east of the locality where our specimens were collected. Located on Mexican Federal Route 45, Villa Ocampo has a population of 1,000, an elevation of 5,400 feet, and a ranching economy. The nearest city is Hidalgo de Parral, Chihuahua, 40 miles to the north. Hidalgo de Parral was founded following a major silver strike in 1631 and remained an important silver-mining center until the 1930s. After its mines closed, Hidalgo de Parral nearly became a ghost town. Beginning in the 1950s, however, its economy recovered as it developed into a regional trading center for a large outlying area of ranches and villages. Today, Hidalgo de Parral has a population of 100,000 and is best known as the site of the July 20<sup>th</sup>, 1923, assassination of the Mexican revolutionary Francisco "Pancho" Villa. The Francisco Villa Museum and an annual reenactment of Villa's assassination are major tourist attractions.

Our specimens of green, massive calcite were collected from outcropped veins that formed from the circulation and crystallization of calcium-rich groundwater. These veins are located at an elevation of about 7,000 feet in a section of the Sierra San Juan de Minas due east of Villa Ocampo. Commercial collectors mine the calcite, then ship it to Bermejillo, Durango, 100 miles to the southeast, which is a trading center for Mexican mineral specimens, notably those from the famed Ojuela Mine. In Bermejillo, the calcite is carved into cups, bowls, ashtrays, paperweights, figurines, and other decorative objects for export to markets in the United States and Europe. All this calcite, whether carved into decorative items or maintained in their natural form as specimens, is immersed in acid baths to dissolve a thin outer section and create a smooth, glassy surface that improves translucency, intensifies internal colors, and reveals color patterns (see "Jewelry & Decorative Uses").

## Mineral of the Month Club August 2017

While studying your specimen of green, massive calcite, note first the glassy luster and smooth, surface texture that have been created by acid immersion. The color of your specimen ranges from pale-green to apple-green and brownish-green. The prominent color-zoning indicates changes that occurred in the chemistry of the calcium-rich solutions during the crystallization process. The brownish or brownish-green sections contain increased amounts of divalent iron  $\text{Fe}^{2+}$ . Your specimen has a Mohs hardness of 3.0 and can be easily scratched with a needle or knifepoint. The moderate “heft” of the specimen in your hand indicates a specific gravity of about 2.9, meaning that its density is slightly greater than that of quartz (specific gravity 2.65).

References: *Dana's New Mineralogy*, Eighth Edition, Richard Gaines, Catherine Skinner, et al, Wiley-Interscience, 1997; *Encyclopedia of Minerals*, Second Edition, William Roberts, Thomas Campbell, Jr. and George Rapp, Van Nostrand Reinhold Company, 1990; *2014 Fleischer's Glossary of Mineral Species*, Malcolm E. Back, The Mineralogical Record, Inc.; *Mineralogy*, John Sinkankas, Springer-Verlag, 1993; *Gemstones of the World*, Fifth Edition, Walter Schumann, Sterling Publishing Company, 2013; *Gemstone and Mineral Data Book*, John Sinkankas, Geoscience Press, 1994; *The Complete Guide to Rocks & Minerals*, John Farndon, Hermes House, 2007; “The Origin of Color in Minerals,” Kurt Nassau, *American Mineralogist*, Volume 63, 1978; “High-Temperature, Carbonate-Hosted Lead-Zinc-Silver Massive Sulfide Deposits of Mexico,” Peter Megaw and Juan Ruíz, *Economic Geology*, Volume 83, 1988; “Tales from Mexico (Parts I and II),” B. Smith and C. Smith, editors, *Rocks & Minerals*, January-February and March-April 1999; “The Acid-Effervescence of Calcite,” Steve Voynick, *Rock & Gem*, November 2016; *2014 Mineral Commodity Summaries*, United States Geological Survey; “The Mineral Industry of Mexico,” Alberto Alexander Perez, *2014 Minerals Yearbook*, United States Geological Survey; *Geology of Mexico*, Susana Alaníz-Alvaréz and Ángel Nieto-Samaniego (editors), Geological Society of America Special Paper 422, 2007.