

Mineral of the Month Club February 2016

CALCITE (var. ORANGE)

This month's mineral is the orange variety of massive calcite from Mexico. Our write-up discusses calcite's mineralogy and unusually large number of forms and crystal habits; our special section looks back on the Mineral of the Month Club's 20-year history and breaks down our previously featured minerals by source and class.

OVERVIEW

PHYSICAL PROPERTIES

Chemistry: CaCO_3 Calcium Carbonate (Orange calcite contains particulate inclusions of the iron-oxide mineral hematite.)

Class: Carbonates

Subclass: Anhydrous Carbonates

Group: Calcite

Crystal System: Trigonal (subsystem of the Hexagonal System)

Crystal Habits: Usually as rhombohedrons, scalenohedrons, and prisms; also tabular, acicular, massive, granular, compact, stalactitic, stalagmitic, oolitic, and earthy; twinning common. Crystal habits are numerous and often exhibit trigonal and pseudo-hexagonal shapes.

Color: Orange calcite varies in color from amber and honey-yellow to orange and orange-red.

Luster: Vitreous to dull

Transparency: Translucent

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: Usually irregular; rarely conchoidal.

Hardness: 3.0

Specific Gravity: 2.7-3.0, increases with the amount of iron present.

Luminescence: Often fluorescent; sometimes thermoluminescent, triboluminescent, and phosphorescent. In massive, orange calcite, fluorescence appears in colorless or white sections of specimens.

Refractive Index: 1.486-1.658; crystals are 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. Massive, orange calcite is translucent with amber and honey-yellow to orange and orange-red colors with no visible crystal structure.

Dana Classification Number: 14.1.1.1

Mineral of the Month Club February 2016

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 “orange calcite” refers to its amber, honey-yellow, orange, and orange-red colors. Orange calcite is also known as “orange onyx,” “orange Mexican onyx,” “citrus calcite,” and “orange alabaster.” In European mineralogical literature, orange calcite appears as *orange Calcit*, *oranje calciet*, and *calcita naranja*.

COMPOSITION: The term “orange calcite” refers not to a distinct species, but to a variety of the mineral calcite. The most abundant of the 192 members of the carbonate class of minerals, calcite is a simple carbonate that consists of 40.04 percent calcium (Ca), 12.00 percent carbon (C), and 47.96 percent oxygen (O). Calcite is an allochromatic (other-colored) mineral in which colors are not caused by essential elements or by the light-absorption characteristics of its crystal lattice, but by traces of accessory elements that create a wide range of colors. Pure calcite is colorless or white, but traces of impurities create a wide range of colors. The distinctive amber, honey-yellow, orange, and orange-red colors of orange calcite are caused by light reflecting from included, microscopic particles of hematite [iron oxide, Fe_2O_3]. Calcite occurs in many different types of rocks in sedimentary, metamorphic and igneous environments. Massive, orange calcite forms only as a secondary mineral in oxidized, iron-rich environments where lack of space restricts crystal development.

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

HISTORY, USES & LORE: Although calcite has been known since antiquity, its many confusing crystal habits precluded its recognition as a mineral species until 1845. Various ancient cultures, notably the Olmec that flourished between 1500 and 600 B.C. in southern and central Mexico, carved ceremonial cups and figurines from both the orange and red varieties of massive calcite. Anthropologists suggest that massive, orange massive calcite was the Olmec symbol for the sun. Much later, European medieval physicians prescribed potions of powdered orange calcite as a remedy for ailments of the eyes. Modern metaphysical practitioners value orange calcite as an “enhancement stone” that restores mental and emotional equilibrium, relieves emotional fears, brings insight into the causes of apathy or lethargy, facilitates the release of past traumas, and increases memory and learning abilities. Massive, orange 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. However, its color and translucency makes it a popular ornamental stone that is fashioned into cups, bowls, ashtrays, spheres, paperweights, figurines, and especially candleholders that partially transmit the light of flames with a warm glow.

ABOUT OUR SPECIMENS: Our specimens of massive, orange calcite were collected at the Ojuela Mine at Mapimí in the Mapimí district, Durango, Mexico. One of the Western Hemisphere’s most historic and productive mines, Ojuela is located in north-central Mexico

Mineral of the Month Club February 2016

northwest of the city of Torreón. Ojuela has produced ore or mineral specimens continuously for more than four centuries. Since the late 1500s, Ojuela has yielded more than seven million tons of ore that provided great quantities of gold, silver, lead, and zinc. Ranking among the world's top-ten specimen-producing localities of all time, Ojuela has yielded more than 126 mineral species and is the type locality for 6 species. Ojuela is best known among mineral collectors for its fine specimens of the arsenate minerals austinite and adamite. Within the last decade, Ojuela has become an important source of both the orange and the red varieties of massive calcite. Both are obtained from the mine's upper levels, where they occur as fracture and fissure fillings. The orange color is caused by included, microscopic particles of hematite, or iron oxide. The orange calcite veins vary in thickness from about one inch to one foot and are mined by drilling and blasting. Miners then truck the calcite 16 miles to processing centers in the city of Bermejillo, where it is immersed briefly in dilute hydrochloric acid (HCl). The acid dissolves a thin surface layer of the calcite to create a smooth, glassy luster that greatly improves translucency and intensifies color.

COMPREHENSIVE WRITE-UP

COMPOSITION & STRUCTURE

Calcite is the mineralogical name for the trigonal form of calcium carbonate (CaCO_3). The term "orange calcite" refers not 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 containing 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 $(\text{CO}_3)^{2-}$. 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 in which three equidistant oxygen ions (3O^{2-}) surround and are covalently bound by shared electrons to a central carbon ion (C^{4+}) . The +4 charge of the carbon ion and the collective -6 charge of the three oxygen ions account for the carbonate radical's total -2 charge. Carbonate minerals form when negatively charged carbonate radicals bond ionically to positively charged metal ions. Like all molecules, those of calcite consist of positively charged cations and negatively charged anions. The calcite cation is the divalent calcium ion Ca^{2+} ; its anion is the carbonate radical $(\text{CO}_3)^{2-}$. The +2 cationic charge balances the -2 anionic charge to provide the calcite molecule with electrical stability.

Carbonate minerals usually exhibit a three-fold, crystalline symmetry that reflects the triangular shape of the carbonate radical. Calcite and other simple carbonates crystallize in the trigonal (or rhombohedral) subsystem of the hexagonal system, the basic six-sided, external, hexagonal shape of which is a multiple of three-fold symmetry. 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 parallelogram sides. Because of the many

Mineral of the Month Club February 2016

possible variations of this basic form, calcite has more than 300 habits and 800 sub-habits and shapes, and exhibits four types of twinning.

It is interesting to compare calcite crystals with those of halite [sodium chloride, NaCl]. Halite crystallizes in the cubic system and has a predominant cubic habit with perfect, three-directional, right-angle cleavage. The carbonate radicals in the calcite lattice occupy the same positions as do 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, three-directional cleavage, but not at right angles; while halite cleaves into perfect cubes, calcite cleaves into rhombohedrons.

Within the calcite crystal lattice, six oxygen ions of the carbonate radicals completely shield each calcium ion to explain why calcite has no metallic properties. The relatively weak ionic bonding between the calcium ions and the carbonate radicals accounts for calcite's minimal hardness of only Mohs 3.0. Despite its close atomic packing, calcite has a low specific gravity of 2.7-3.0, only minimally higher than that of quartz [silicon dioxide, SiO₂]. This low density is due to the relatively low atomic weights of its essential components calcium (40.08), carbon (12.01), and oxygen (16.00). A diagnostic feature of calcite is its vigorous effervescence in acids, a reaction that is due to weak ionic bonding. Using hydrochloric acid (HCl) as an example, calcite effervesces when the acid's highly reactive chlorine ions (Cl¹⁻) break the weak ionic bonds and replace calcite's carbonate radicals. This reaction is expressed by the formula $\text{CaCO}_3 + 2\text{HCl} = \text{CaCl}_2$ (calcium chloride) + H₂O (water) + CO₂ (carbon dioxide). The rapid release of carbon-dioxide gas creates the diagnostic bubbles of effervescence.

Calcite comprises an estimated four percent of the weight of the Earth's crust. It forms in many mineralogical environments, most often in shallow environments where carbonic acid (H₂CO₃) reacts with various metal salts. Carbonic acid forms when atmospheric carbon dioxide (CO₂) dissolves in water (H₂O) 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 the acid's carbonate ions to form carbonate minerals. This reaction commonly occurs in chemical-sedimentary environments to create 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). Massive, orange calcite develops in oxidized, iron-rich environments that lack the necessary space for crystal formation.

As a polymorphic mineral, calcite is 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, aragonite in the orthorhombic system, and vaterite in the hexagonal system.

The Dana mineral-classification number 14.1.1.1 identifies calcite as a simple, anhydrous carbonate (14) with the general formula A²⁺CO₃, in which "A²⁺" can be divalent ions of calcium, magnesium, iron, manganese, cobalt, zinc, nickel, or cadmium. The subclassification (1) defines

Mineral of the Month Club February 2016

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 calcite-group members vary only in their cationic chemistries and include magnesite [magnesium carbonate, MgCO_3], siderite [iron carbonate, FeCO_3], rhodochrosite [manganese carbonate, MnCO_3], and smithsonite [zinc carbonate, ZnCO_3].

Calcite is an allochromatic (other-colored) mineral in which colors are caused by traces of accessory elements. Pure calcite is colorless or white, but traces of manganese create pink manganoan calcite, while traces of cobalt create purplish cobaltoan calcite. In these minerals, manganese and cobalt distort the crystal lattice to alter its color-absorption and color-reflection characteristics. Some calcite colors are due to inclusions of particulate elements or minerals. Some forms of yellow calcite are caused by inclusions of microscopic particles of elemental sulfur, while black calcite is due to particles of elemental carbon. The color of orange calcite is due to included, nearly microscopic particles of hematite [iron oxide, Fe_2O_3]. Particulate hematite also creates the color of red calcite; however, the hematite particles in orange calcite are much more finely divided and produce a greater translucency.

COLLECTING LOCALITIES

Our specimens of massive, orange calcite are from the Ojuela Mine at Mapimí in the Mapimí district, Durango, Mexico. Orange calcite also occurs in other areas of northern Durango, as well as in the Santa Eulalia district at Aquiles Serdán and the Gibraltar Mine at Naica, both in southern Chihuahua. Other Latin American sources are the Farallón Negro Mine at Farallón Negro, Belén Department, Catamarca, Argentina; 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; and the El Mochito Mine at El Mocho, Santa Barbara Department, Honduras.

European localities include 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, Freischach-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 Freiburg District, Erzgebirge, Saxony, Germany; the Botallack Mine, Botallack, St. Just District, Cornwall, England; Sierra de Aracina, Huelva, Andalusia, Spain; and the Scrave Mine at Reppia, Grange Valley, Genova Province, Liguria, Italy.

In China, orange calcite occurs at the Manaoshan Mine in the Dongpo ore field near Chenzhou, Chenzhou Prefecture, Hunan Province. It is also found at Broken Hill, 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

Mineral of the Month Club February 2016

Field, Northern Cape Province, South Africa; and the Dokuztepe iron-manganese deposit at Ceyhan, Adana Province, Mediterranean Region, Turkey.

In the United States, orange calcite occurs at the Rico Argentine Mine at Rico in Dolores County, and the Idarado Mine at Telluride in San Miguel County, both in Colorado; the Alice Mine at Walkerville in the Butte district, Silver Bow County, Montana; 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 Montreal, Jupiter, Bourne, and Moore mines in the Gogebic Iron Range, Iron County, Wisconsin; and the Friday Mine in the Westview district, Boise County, Idaho.

JEWELRY & DECORATIVE USES

With its softness of Mohs 3.0, low index of refraction (1.486-1.658), and perfect, three-directional cleavage that complicates cutting, crystalline calcite has limited use in jewelry. Both crystalline and massive forms of calcite, when nicely colored, are sometimes wire-wrapped as pendants. Massive, orange calcite is also fashioned into beads for drilling and stringing into necklaces.

Massive, orange calcite has recently gained popularity as a decorative stone and is sold as “orange onyx,” “orange Mexican onyx,” “citrus calcite,” and “orange alabaster.” Because of its softness, it can be quickly and inexpensively carved by mechanical means into ashtrays, chess pieces, jewelry boxes, spheres, bookends, figurines, spheres, and paperweights. Among the most popular items fashioned from translucent, massive, orange calcite are “candle cups” which transmit light from internal candle flames with a warm orange glow.

A diagnostic feature of calcite is its rapid reaction with acids to create a vigorous effervescence (see “Composition & Structure”), a property that is now widely used to finish decorative objects and specimens of massive, orange calcite. Craftsmen shape these objects with wheels and saws, then immerse them briefly in dilute hydrochloric acid (HCl) to dissolve a thin, surface layer of the calcite. The resulting irregular, glassy-smooth, lustrous surface greatly enhances translucency and intensifies color. Inexpensive acid-immersion eliminates the need for costly, mechanical polishing. Most forms of massive, orange calcite from Mexico are now acid-treated.

HISTORY & LORE

The many forms of calcite, including limestone and marble, have been known since antiquity. Calcite was named *calx*, meaning “lime,” in 77 A.D. by the Roman scholar Pliny the Elder (Gaius Plinius Secundus, A.D. 23-79) in his *Historia Naturalis*. But because of its numerous varied and sometimes 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).

Mineral of the Month Club February 2016

The Olmec culture, which flourished between 1500 B.C. and 600 B.C. in what is now south-central Mexico, carved massive, orange calcite into ceremonial cups and figurines. Olmec cultural sites have yielded many calcite objects, and anthropologists suggest that orange calcite was the Olmec symbol for the sun. Medieval European physicians prescribed potions of powdered orange calcite to remedy ailments of the eyes. Modern metaphysical practitioners consider massive, orange calcite to be an “enhancement stone” that restores mental and emotional equilibrium, relieves emotional fears, brings insight into the causes of apathy or lethargy, facilitates the release of past traumas, and increases memory and learning abilities.

THE MINERAL OF THE MONTH CLUB: LOOKING BACK AT 20 YEARS

With this mailing of our featured mineral for February 2016, the Mineral of the Month Club has completed 20 years of service to its members. During that time, our Club has been featured three times in *Rock & Gem* magazine and our 240 consecutive, on-time monthly mailings have included 120 different mineral species, along with specimens of meteorites and a dozen mineraloids such as amber, tektites, obsidian, and opal.

For the benefit of our new members and also for those who may not have read the articles about the Mineral of the Month Club in *Rock & Gem*, the concept of mailing monthly mineral specimens to club members originated with California mineral collectors Russ and Alexandra Filer in the early 1970s, a time when the mineral-collecting hobby was growing rapidly. The big gem-and-mineral shows in Tucson, Arizona, and Denver, Colorado, were already established; magazines like *Rock & Gem* and *The Mineralogical Record* had just published their first issues; and dozens of new gem-and-mineral clubs were appearing across the country. In the Filer’s club, which was the forerunner of today’s Mineral of the Month Club, members received inexpensive, study-grade specimens. After the Filers retired in 1982, the club was inactive for more than a decade.

In the mid-1990s, Richard and Cheryl Sittinger, a couple from Cambria, California, who were then establishing themselves as mineral dealers, brought the Club back to life in its present form. The Sittingsers realized that while all collectors could buy mineral specimens, few had the time or the resources to research the specimens, and therefore could not fully benefit from the collecting experience. Accordingly, they upgraded specimen size and quality, and also researched and prepared a detailed, informational report, called a “write-up,” to accompany every specimen. The Sittingsers launched the modern Mineral of the Month Club in March 1996. Their first featured mineral was pyrite as perfectly formed, cubic crystals from the classic locality at Navajún, La Rioja, Spain. Interest in the club grew steadily and members soon numbered in the hundreds.

After operating the Club for 15 years, the Sittingsers began looking for a buyer. At the 2011 Tucson Gem-and-Mineral Show, they met Dimitri and Mary Spanos, businesspeople and avid mineral collectors from New York City. The Spanos’s had always loved minerals and were

Mineral of the Month Club February 2016

looking for a way to move beyond personal collecting and to share their interest in minerals with others. In the Mineral of the Month Club they found just that opportunity. The sale of the Club was finalized in spring, 2012. Over the next two months, the operation was moved from Cambria, California, to New York City. Richard and Cheryl remained connected with the Mineral of the Month Club as historians and advisors, positions they continue to fill today.

Dimitri and Mary Spanos set up offices and working space in the New York City borough of Queens at 37-14 61st St. in Woodside near LaGuardia Airport. They hired Christine Domino, an accomplished jewelry maker and long-time mineral-collector, to manage the Mineral of the Month Club. They also established a parent company—Celestial Earth Minerals—and used its www.celestialearthminerals.com website, to support the Mineral of the Month Club. To provide added service to Club members, they created the “Atlas of Minerals,” which provides on-line access to both brief and detailed descriptions of more than 100 minerals and mineral varieties. Club members received passwords to access to an on-line library of all previous, monthly write-ups from 1996 to the present. The Celestial Earth Minerals website also posted informational, magazine-type articles about various aspects of collecting written by noted gem-and-mineral writers. The Club continues to rely on the program of volume buying that was originated by Richard and Cheryl Sittinger, purchasing thousands of specimens each year to substantially reduce costs and to pass the saving onto members.

Some of our featured Minerals of the Month over the past 20 years have come from classic localities that have since closed. As an example, our rhodochrosite specimens that we featured in October 1997 are from Colorado’s Sweet Home Mine, the world’s premier rhodochrosite locality—and one that has been permanently closed since 1999. Other Mineral of the Month specimens that have similarly increased in value and are now rarely available on the market include calcite and fluorite from Tennessee’s Elmwood Mine, red beryl from Utah, apatite-(CaF) and vesuvianite from Canada, almandine (garnet group) from Alaska, and realgar and stibnite from China.

Over the past 20 years our 240 monthly mailings have included specimens of 117 different mineral species that range literally from “A” (actinolite) to “Z” (zircon). These specimens were collected in 32 different countries. Not surprisingly, the three nations that provided the most specimens—the United States, Mexico, and China—all have strong mining industries and numerous commercial specimen collectors. Ranking fourth is India, where the Deccan Traps basalt formations are the world’s leading source of such zeolite minerals as apophyllite-(KF), scolecite, and heulandite. Ranking fifth is Brazil, where granite pegmatites of Minas Gerais yield many fine mineral specimens. Following is the list of nations that have provided our Mineral of the Month specimens:

United States 64
Mexico 24
China 23
India 18
Brazil 16

D. R. Congo 4
Namibia 4
Spain 3
Afghanistan 2
Argentina 2

Lithuania 1
Malawi 1
Mali 1
Myanmar (Burma) 1
Nepal 1

Mineral of the Month Club February 2016

Russia 15	Bolivia 2	Pakistan 1
Peru 13	Czech Republic 2	Poland 1
Australia 10	England 2	Turkmenistan 1
Canada 7	South Africa 2	Uruguay 1
Madagascar 6	Chile 1	Western Sahara 1
Morocco 6	Greece 1	

The 64 minerals from the United States are from 16 individual states. California, with many mineral localities and several major evaporite-mineral deposits, provided the greatest number of specimens. The six states topping the list are all western states with active mining industries. Following is the list of American specimens arranged by state and number:

California 18	Utah 4	Alaska 1
Arkansas 8	Tennessee 3	Iowa 1
Arizona 7	Idaho 2	New York 1
Colorado 6	Michigan 2	Oregon 1
Nevada 6	Missouri 2	South Dakota 1
		Vermont 1

It is also interesting to arrange our previous Minerals of the Month by mineral class. Not surprisingly, the silicates, by far the largest mineral class which includes quartz, zeolite-group minerals, mica-group minerals, garnet-group minerals, and many others, tops the list:

Silicates 101	Phosphates 7	Borates 3
Carbonates 28	Mineraloids 7	Fossil Materials 3
Sulfides 22	Oxides 7	Chromates 2
Sulfates 20	Native Elements 5	Molybdates 2
Halides 13	Arsenates 5	Meteorites 1
		Tungstates 1

The number of specific minerals or mineral groups is headed by quartz, which is the Earth's most abundant mineral. Its macrocrystalline and microcrystalline forms include amethyst, citrine, rock crystal, agate, jasper, chrysoprase, and many other varieties. The zeolite-group minerals are second, followed by fluorite and the garnet-group minerals in a tie for third. The list by specific minerals or mineral groups is:

Quartz 17	Calcite 5
Zeolite Group 11	Barite 4
Fluorite 8	Gypsum 3
Garnet Group 8	Pyrite 3

Mineral of the Month Club February 2016

Looking back at 20 years of Mineral of the Month Club specimens, our featured minerals have reflected the diversity and great number of minerals and their varieties, their many nations and states of origin, and their widely varied colors and crystal structures.

TECHNOLOGICAL USES

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

ABOUT OUR SPECIMENS

Our specimens of massive, orange calcite were collected at the Ojuela (oh-HWAY-la) Mine at Mapimí (mah-pih-MEE) in the Mapimí district, Durango, Mexico. One of the most historic and productive mines in the Americas, Ojuela is located in north-central Mexico northwest of the city of Torreón. The village of Mapimí, is located at an elevation of 6,800 feet in the eastern foothills of the Sierra Madre Occidental, a region of the arid Chihuahuan Desert where rugged mountain ranges separate broad plains. The plains are 5,000 feet in elevation and are sparsely vegetated with cacti, thorny brush, and coarse grass; the highest mountains reach heights of 10,000 feet and host thin, scrub-oak forests at their higher elevations.

The Ojuela Mine exploits a major carbonate-replacement deposit in a 900-mile-long belt of folded carbonate rocks called the Mexican Fold Belt. The Fold Belt consists of marine sediments deposited between 150 million and 65 million years ago that later lithified into massive formations of limestone and dolomite. Limestone is a rock consisting primarily of calcite [calcium carbonate, CaCO_3]; dolomite rock consists mainly of the mineral dolomite [calcium magnesium carbonate, $\text{CaMg}(\text{CO}_3)_2$]. In the early Tertiary Period 65 million to 40 million years ago, tectonic stresses uplifted much of central Mexico and deformed these limestone and dolomite strata into folds and thrusts. Finally, between 40 million and 25 million years ago, regional volcanism and deep magmatic intrusions forced mineral-laden, hydrothermal solutions into the faults of the Fold Belt. The resulting mineral deposits were rich in silver, lead, and zinc, with lesser amounts of gold and copper. They were initially emplaced thousands of feet below the surface and were subsequently exposed by erosion.

Spanish prospectors discovered rich outcrops of chlorargyrite [silver chloride, AgCl] and argentiferous cerussite [silver-bearing lead carbonate, PbCO_3] at Ojuela in 1598. The Spaniards named the mine “*Hojuela*,” meaning “leaf-like,” and apparently alluding to sheet-like crystals of certain minerals that resembled leaves (*hojas*). The “H” was later dropped and the mine became known as “Ojuela.” By 1640, the Spaniards had developed Ojuela into a major underground

Mineral of the Month Club February 2016

silver mine. Over the centuries, wars and revolutions periodically slowed or halted production, and the mine was rebuilt and modernized several times. After World War II, the mine owner, Compañía Minera de Peñoles, relinquished direct operational control and leased mine sections to independent cooperatives of miners. Over its long life, Ojuela has produced more than seven million tons of extraordinarily rich ore, an average ton of which contained 15 troy ounces of silver, 15 percent lead, 12 percent zinc, 0.1 troy ounces of gold, and small amounts of copper. Total production exceeds 100 million troy ounces of silver, 700,000 troy ounces of gold, and 200,000 tons of lead and zinc. At today's metal prices, the gold and silver value alone exceeds three *billion* dollars.

Although Ojuela has not produced ore since the 1940s, it is still a source of mineral specimens. Its underground workings extend more than 250 miles. The lower levels are flooded, but miners lease the upper levels to recover specimens of austenite [basic calcium zinc arsenate, $\text{CaZn}(\text{AsO}_4)(\text{OH})$]; conichalcite [basic calcium copper arsenate, $\text{CaCu}(\text{AsO}_4)(\text{OH})$]; adamite [basic zinc arsenate, $\text{Zn}_2(\text{AsO}_4)(\text{OH})$]; and wulfenite [lead molybdate, PbMoO_4]. Ojuela is also known for specimens of calcite, fluorite [calcium fluoride, CaF_2], and malachite [basic copper carbonate, $\text{Cu}_2(\text{CO}_3)(\text{OH})_2$]. As one of the world's top-ten specimen-producing localities of all time, Ojuela has yielded 126 individual mineral species, is the type locality for 6 species, and is a classic arsenate-mineral locality.

Ojuela has recently become a noted source of massive, orange calcite, which occurs in the upper levels as fracture and fissure fillings. Because the Ojuela host rock is limestone, calcite is abundant; iron, as hematite [iron oxide, Fe_2O_3], is also present in large quantities in the oxidized, multimetal mineralization. Groundwater, which is slightly acidic from dissolved, atmospheric carbon dioxide, dissolved the calcite in the limestone. Rich in carbonate ions, and carrying quantities of particulate hematite, this groundwater filled fractures and fissures to solidify as orange calcite. Limited amounts of very finely divided, particulate hematite produce both the delicate translucency and the amber, honey-yellow, orange, and reddish-orange colors of orange calcite.

The veins of massive, orange calcite at Ojuela vary in thickness from a few inches to about one foot. Lease miners extract the calcite by drilling and blasting, then truck it to nearby Bermejillo for processing. Orange calcite is carved into cups, bowls, paperweights, candleholders, and other decorative objects. All the calcite, whether carved into decorative items or retained as specimens, is immersed in acid to dissolve a thin, surface layer to create a smooth, glassy surface that improves translucency and intensifies its internal colors.

As you examine your specimen of orange calcite, note first its glassy luster and smooth surface texture that has been created by brief immersion in acid. Its yellow-orange color is fairly uniform with only a few areas of white coloration. Your specimen's color and delicate translucency is caused by nearly microscopic particles of included hematite. Because of a Mohs hardness of only 3.0, it is easily scratched with a needle or knifepoint. The moderate "heft" of the specimen in your hand indicates a specific gravity of about 2.9, or a density slightly greater than that of quartz (specific gravity 2.65). Orange calcite is most attractive when backlighted

Mineral of the Month Club February 2016

with a strong light source. Your specimen is an unusual color variety of calcite, a popular decorative stone, and a keepsake from Mexico's most historic mine.

References: *Dana's New Mineralogy*, Eighth Edition; *Encyclopedia of Minerals*, Second Edition, Roberts, et al, Van Nostrand Reinhold Company; *2014 Fleischer's Glossary of Mineralogical Species*, Malcolm E. Back, The Mineralogical Record, Inc.; *Mineralogy*, John Sinkankas, Van Nostrand Reinhold Company; *Gemstone and Mineral Data Book*, John Sinkankas, Geoscience Press; *The Complete Guide to Rocks & Minerals*, John Farndon, Hermes House, 2007; *Mines and Minerals of Mexico, Volume Two: The Ojuela Mine*, Thomas P. Moore and Peter Megaw, The Mineralogical Record Company, September-October 2003 (Special Issue); "Famous Localities: The Ojuela Mine, Mapimí, Durango, Mexico," Thomas P. Moore and Peter Megaw, *The Mineralogical Record*, September-October 2003; "Mapimi: Mineral Collectors' Capital of Mexico," P. W. Johnson, *The Mineralogist*, May-June 1962; "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.

