

October 2008 Mineral of the Month: Smithsonite

“Because of its rather appealing, undulating form, coupled with its sometimes marvelously rich color, smithsonite is a much-admired collector mineral.”—Bob Jones, *Rock & Gem*

PHYSICAL PROPERTIES

Chemistry: Zinc Carbonate $ZnCO_3$, often containing iron, manganese, cadmium, and cobalt.

Class: Anhydrous Carbonates

Group: Calcite

Crystal System: Hexagonal (Rhombohedral)

Crystal Habits: Well-formed, scalenohedral crystals are rare; usually occurs in botryoidal, reniform, or banded stalactitic form; also incrusting, coarsely granular and compact. Botryoidal forms have radiating, internal fibrous structure.

Color: Pure or nearly pure smithsonite is white or colorless; when impure or as an intermediate member of a solid-solution series, smithsonite can appear green, blue, purple, yellow, pink, gray, or brown.

Luster: Vitreous, pearly

Transparency: Translucent

Streak: White

Cleavage: Perfect in three directions, forming a rhombohedron

Fracture: Uneven, brittle, splintery

Hardness: Mohs 4.0-4.5

Specific Gravity: 4.3-4.5

Refractive Index: 1.66-1.76

Luminescence: Usually none, occasionally fluoresces pale green or pale blue.

Distinctive Features and Tests: Best field marks are botryoidal form, rhombohedral cleavage, hardness, and high specific gravity. Smithsonite effervesces rapidly in warm hydrochloric acid and is harder and more dense than most carbonates. It can be visually confused with botryoidal forms of prehnite [$Ca_2Al_2Si_3O_{10}(OH)_2$], hemimorphite [$Zn_4Si_2O_7(OH)_2 \cdot H_2O$], and wavellite [$Al_3(PO_4)_2(OH,F)_3 \cdot 5H_2O$], but smithsonite is softer than prehnite, heavier than hemimorphite, and both heavier and harder than wavellite.

Dana Classification Number: 14.1.1.6

NAME

Smithsonite, which is named for British mineralogist, chemist, and benefactor of the Smithsonian Institution James Smithson (1765-1829), is pronounced just as it looks—SMITH-son-ite. Older names for smithsonite include “calamine” (also applied to hemimorphite), “zinc spar,” “carbonate of zinc,” “azurite of zinc,” “kapnit,” “herrerite,” “zinkspat,” “galmei,” and “kohlengalmei.” The pink, cobalt-rich variety is known as “cobaltoan smithsonite”; the yellow, cadmium-rich variety as “cadmian smithsonite” or “turkey-fat ore”; the blue, copper-rich variety as “cuprian smithsonite” or “azulite”; and the purplish, manganese-rich variety as “manganoan smithsonite.” A pale-blue variety is called “sacred turquoise,” a greenish variety “Aztec stone,” and a translucent, apple-green variety “bonamite.” “Dry-bone ore” is a porous, white variety. In current European mineralogical literature, smithsonite appears as *smithsonit* and *smithsonita*.

COMPOSITION

April 2001 was the first time we featured this marvelous mineral, sending Club members specimens of light green smithsonite on matrix from a new find on the eighth level of the San Antonio Mine, in the East Camp of the prolific Santa Eulalia District. Specimens from this find have been off the market for several years now, meaning your specimen has probably appreciated in value in the last few years!

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As shown by its chemical formula ZnCO_3 , smithsonite contains the elements zinc (Zn), carbon (C), and oxygen (O). Its molecular weight consists of 52.15 percent zinc, 9.57 percent carbon, and 38.28 percent oxygen. Smithsonite is a member of the carbonates, a class of nearly 100 minerals in which metallic elements combine with the carbonate radical $(\text{CO}_3)^{2-}$. This fundamental structural unit of all carbonates consists of a central carbon ion (C^{4+}) covalently bound to three equidistant oxygen ions (3O^{2-}). The +4 charge of the carbon ion and the -6 charge of the three oxygen ions give the carbonate ion its collective -2 charge. Carbonate anions $(\text{CO}_3)^{2-}$ are flat, triangular structures held together by shared electrons that form strong covalent bonds.

Simple carbonate minerals like smithsonite consist of a single carbonate ion bound to a single metal cation. In the smithsonite molecule, the cation (positively charged ion) is the zinc ion Zn^{2+} with its +2 charge. The anion (negatively charged ion) consists of the carbonate radical $(\text{CO}_3)^{2-}$ with its -2 charge. The balance of the cationic +2 charge and the anionic -2 charge provides the smithsonite molecule with electrical stability. Smithsonite is an anhydrous carbonate mineral, meaning it contains no water molecules (H_2O) or hydroxyl ions $(\text{OH})^{1-}$. Of the roughly 70 anhydrous carbonates, only calcite [calcium carbonate, CaCO_3] and dolomite [calcium magnesium carbonate, $\text{CaMg}(\text{CO}_3)_2$], are abundant.

Carbonate minerals are the inorganic salts of carbonic acid (H_2CO_3). Carbonic acid, which consists of hydrogen ions (H^{+1}) and bicarbonate ions $(\text{HCO}_3)^{-}$, forms in near-surface conditions when atmospheric carbon dioxide (CO_2) or carbonate ions $(\text{CO}_3)^{2-}$ from carbonate rocks dissolve in water 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, metal ions then bond ionically with bicarbonate ions to form carbonate minerals and free hydrogen ions. In the case of zinc, this formula is $\text{Zn}^{2+} + (\text{HCO}_3)^{1-} = \text{H}^{1+} + \text{ZnCO}_3$. This creates rows of alternating zinc and carbonate ions, with each zinc ion surrounded by six oxygen ions. This arrangement would normally form a cube, but the triangular structure of the carbonate ions negates cubic symmetry. The axes of the carbonate ions can align with only one of the three axes of a cube, while the wide spacing of these ions distorts the atomic planes into the shape of a rhombohedron and thus determines the crystal system for smithsonite (the rhombohedral system is a sub-system of the hexagonal system).

Within the smithsonite lattice, weak ionic bonding dominates three atomic planes to account for smithsonite's three directions of perfect cleavage, while its rhombohedral form explains why these cleavage planes never intersect at 90 degrees. Weak ionic bonding also accounts for smithsonite's only moderate hardness of 4.0-4.5. A diagnostic property of most carbonates, including smithsonite, is to effervesce in contact with hydrochloric acid (HCl). This occurs because the extremely high chemical reactivity of chlorine ions (Cl^{1-}) enables them to easily replace the carbonate radicals in carbonate minerals. The chemical formula $\text{ZnCO}_3 + 2\text{HCl} = \text{ZnCl}_2 + \text{H}_2\text{O} + \text{CO}_2$ shows how hydrochloric acid reacts with smithsonite to produce zinc chloride, water, and carbon dioxide, the latter forming the diagnostic bubbles of effervescence.

As a secondary mineral, smithsonite forms from the alteration of such primary zinc minerals as sphalerite [zinc sulfide, ZnS] in the oxidized zones of massive, zinc-bearing, hydrothermal replacement deposits. Associated minerals include hemimorphite [basic hydrous zinc silicate, $\text{Zn}_4\text{Si}_2\text{O}_7(\text{OH})_2 \cdot \text{H}_2\text{O}$], anglesite [lead sulfate, PbSO_4], cerussite [lead carbonate, PbCO_3], azurite and malachite (both basic copper carbonates), and aurichalcite [basic zinc copper carbonate, $(\text{Zn,Cu})_5(\text{CO}_3)_2(\text{OH})_6$]. Sphalerite often occurs with minerals of iron, lead, copper, silver, cadmium, cobalt and other metals. Because of the availability of these metal ions during the sphalerite oxidation process, smithsonite participates in a number of solid-solution series and often contains metal impurities that create a range of colors. Smithsonite also occasionally occurs in sedimentary deposits when zinc-rich solutions react with carbonate rocks.

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In the Dana mineral-classification system, the number 14.1.1.6 identifies smithsonite as an anhydrous carbonate (14) without hydroxyl ions or attached molecules of water. Smithsonite is then subclassified (1) by the general formula ACO_3 , in which "A" can be ions of calcium, magnesium, iron, manganese, cobalt, zinc, or cadmium. Finally, smithsonite is assigned to the calcite group (1) as the sixth (6) of seven members. These members all share a similar chemistry and structure and include calcite [calcium carbonate, $CaCO_3$], magnesite [magnesium carbonate, $MgCO_3$], siderite (iron carbonate, $FeCO_3$), rhodochrosite [manganese carbonate, $MnCO_3$], sphaerocobaltite [cobalt carbonate, $CoCO_3$], and otavite [cadmium carbonate, $CdCO_3$]. Smithsonite participates in partial solid-solution series with all the calcite-group members. Chemically related minerals can form solid-solution series through either cationic or anionic substitution. The smithsonite solid-solution series involve cationic substitution, with calcium, magnesium, iron, manganese, cobalt, and cadmium ions substituting for zinc cations and vice versa.

As an allochromatic mineral, smithsonite's colors are created not by its essential chemical components or the nature of its crystal structure, but by color-causing, metal impurities called chromophores. When pure or nearly pure, smithsonite is colorless, white, or gray. But smithsonite's broad range of colors is produced either by impurities or participation in partial solid-solution series, or by a combination of the two. Pink colors in smithsonite are caused by cobalt, purples by manganese, yellows by cadmium, and blues and greens by copper. A combination of chromophores produces intermediate colors.

COLLECTING LOCALITIES

Although uncommon, smithsonite is widely distributed in altered, hydrothermal veins of silver, copper, lead, and zinc minerals and thus has many collecting localities. Typically, the occurrence in one mine in a given mining district indicates a likely occurrence in other mines. Our specimens were collected at a classic smithsonite locality—the Refugio Mine near Choix in the state of Sinoloa, Mexico. Other Mexican smithsonite sources are the San Antonio and Potosí mines in the Santa Eulalia district at Aquilas Serdán in the state of Chihuahua; the Ojuela Mine at Mapimi in the state of Durango; the Mezequite Mine at Sahuaripa in the state of Sonora; the Amelia Mine in the Santa Rosalía (El Boleó) district at Mulegé in the state of Baja California Sur; and the San Francisco and Reyes mines at Zacatecas in the state of Zacatecas.

South American specimens are collected at the Malpaso Quarry at Dumesnil in Córdoba, Argentina; Cerro Rico at Potosí in Potosí Department, Bolivia; and the Vazante Mine at Vazante and the Mina Grande Quarry near Itacarambi, both in Minas Gerais, Brazil. Australian specimens come from the Broken Hill district mines in Yancowinna County, New South Wales; the Mt. Isa district mines at Mt. Isa in Queensland; and the Montana Mine at Zeehan in the Zeehan district of Tasmania. In Africa, superb specimens occur at the Tsumeb Mine at Tsumeb in the Otjikoto Region of Namibia. Other African sources are the mines at Kabwe in the Central Region of Zambia; and the Toussit mines in the Toussit district in Oujda-Angad Province, Morocco. Japanese specimens are collected at the Kamegi Mine at Kamegi in Toyama Prefecture on Honshu Island.

Notable European specimens come from the Agios Konstantinos and Kamareza mine groups in the Laurium district near Athens in Attika Prefecture, Greece; the Murnovis and Sa Duchessa mines at Dumusnovis, Carbonia-Iglesias Province on the island of Sardinia, Italy; the Pomorzony Mine at Olkusz near Kraków, Malopolskie, Poland; the Windisch-Bleiberg and Seealpe district mines in the Karawanken Mountains of Carinthia, Austria; the Montgros mines at Pinols in Haute-Loire, Auvergne, France; the Sel de Haya mines near Santander in the Picos de Europa Mountains in Cantabria, Spain; the Altenberg mines near Aachen in Nordrhein-Westfalen, Germany; and the Brownley Hill Mine in the Alston Moor district in Cumberland, England.

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The finest American smithsonite specimens are from the Kelly Mine at Magdalena in Socorro County, New Mexico. So exceptional are the smithsonite specimens from this locality that this mine was featured as one of the “American Mineral Treasures” at the Tucson Gem & Mineral Show earlier this year and in the accompanying book, which includes a history of the discovery and gorgeous photos of breathtaking beautiful smithsonite found there. Another New Mexico source is the Tyrone Mine at Tyrone in the Burro Mountains district of Grants County. Arizona specimens come from the 79 Mine near Hayden in the Banner district of Gila County; the Silver Hill mines in the Silver Hill district in the Waterman Mountains of Pima County; and the Mammoth-St. Anthony Mine at Tiger in the Mammoth district of Pinal County. Other sources include the Morning Star and Philadelphia mines in the Rush Creek district of Marion County, Arkansas; the Hidden Treasure Mine at Ophir Hill in the Oquirrh Mountains in Tooele County, Utah; the Union Shaft at Cerro Gordo near Lone Pine in Inyo County, California; and numerous mines in the Joplin lead-zinc district of Jasper County, Missouri.

JEWELRY AND DECORATIVE USES

Because of its softness (Mohs 4.0-4.5), predominant botryoidal habit, and susceptibility to mild acids, smithsonite has limited use as a gemstone. Nevertheless, rounded, botryoidal “free-form” shapes in rich blue, green, pink, or purple colors are sometimes wrapped in wire and made into pendants and earrings or cut as cabochons for mounting in brooches. Smithsonite cabochons are always unusually thick because of its tendency to cleave parallel to the fibers of its botryoidal structure. Hemimorphite, which is slightly harder but has a similar appearance, is occasionally misrepresented as smithsonite in jewelry. Thick, banded crusts and stalactites of smithsonite are carved into figurines and other small decorative objects. Larger, botryoidal pieces of smithsonite in attractive colors are used in paperweights and bookends.

By far the greatest demand for smithsonite is as collector specimens. Collectors value individual and composite specimens of smithsonite for study and display purposes because of their unusual forms, wide range of colors, and relative rarity.

HISTORY AND LORE

Because it occurs in accessible, shallow deposits, smithsonite has been known since antiquity. As early as 1500 B.C., metalworkers added smithsonite to copper-ore smelting mixes to produce a metal that was lighter in color and harder than copper, yet ductile enough to be hammered into thin sheets. This metal was the first form of brass, a copper-zinc alloy. Smithsonite’s alloying properties were doubtlessly discovered by accident, since early metalworkers had no knowledge of smithsonite’s chemical composition. Greek metalworkers routinely used large quantities of smithsonite from the great Laurium silver deposits in the mass production of brass. Until the 18th century A.D., adding smithsonite to copper-ore smelting mixes was the only way to make brass.

In the late 1600s, silver-lead miners in central Europe found a whitish mineral that they called “calamine.” By the 1730s, chemists had roasted calamine, then reduced it with charcoal to recover impure traces of a blue-white metal. In 1746, German chemist Andreas Sigismund Marggraff (1709-1782) reduced finely-ground calamine in a charcoal furnace to recover small, but nearly pure quantities of this metal. Marggraff recognized this metal as a new element and named it “*zink*,” after *zinkspat*, a German miners’ term for smithsonite. After Marggraff’s discovery, calamine was heavily mined throughout Europe as a source of metallic zinc for brass manufacturing.

At the time, chemists assumed that calamine was a single mineral—zinc oxide. The first suspicions that calamine might be two distinct minerals arose during early investigations of pyroelectricity. (Cont. page 6.)

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JAMES SMITHSON AND THE SMITHSONIAN INSTITUTION

James Smithson, for whom smithsonite is named, was born in France in 1765 as James Lewis Macie, the illegitimate and unacknowledged son of Hugh Smithson, an Englishman who later became the first Duke of Northumberland. His mother was Elizabeth Keate Hungerford Macie, a widow with royal bloodlines. Smithson used his mother's name until her death in 1800, then adopted his father's name. He became a naturalized British citizen and graduated from Pembroke College of the University of Oxford with a degree in chemistry in 1786. Deeply interested in chemistry and mineralogy, he quickly established a reputation as a serious researcher. He was elected to the Royal Society of London in 1787, where he established friendships with many leading scientists of the day. Smithson devoted his life to investigating the natural world and to obtaining crystals and minerals which he could then analyze to determine their elemental properties. Smithson wrote some 27 papers on various aspects of chemistry and mineralogy, the best known and arguably the most significant of which is *A Chemical Analysis of Some Calamines*, which identifies the mineral later named in his honor.



Figure 1. James Smithson. Image courtesy of Smithsonian Institution.

Smithson inherited a sizeable estate from his mother and, through shrewd investing, increased its value over the years. Smithson died in Italy after a long illness on June 27, 1829, and was buried in the English cemetery of San Benigno in Genoa. His will left the bulk of his estate to his nephew Henry James Hungerford. An unexplained contingency clause, however, directed that should his nephew die without children—legitimate or illegitimate—the estate would go to “the United States of America, to found at Washington, under the name of the Smithsonian Institution, an Establishment for the increase and diffusion of knowledge . . .”.

Henry James Hungerford died in 1835 without leaving any heirs and the United States Congress accepted Smithson's bequest the following year. After a lawsuit in London contesting the will was decided in favor of the United States in 1838, Smithson's bequest was delivered. Eleven sturdy wooden boxes containing 104,960 English gold sovereigns were shipped to the United States Mint at Philadelphia where they were melted down and reminted into dollar coinage worth \$508,318. Much controversy followed in the United States about just how to fulfill the intent of the bequest. Finally, in 1846, an Act of Congress founded the Smithsonian Institution as a “national museum” of the United States. In 1904, telephone inventor Alexander Graham Bell, then a regent for the Smithsonian Institution, brought Smithson's remains from Genoa to Washington, D. C., where they were re-interred in a tomb at the Smithsonian's “Castle” building.

The reasons behind Smithson's generous bequest to the United States, a nation that he had never visited, have never been satisfactorily explained. Historians cite three possible motivations. One was to found an institution that would outlast his titled father's dynasty. Another was disenchantment with an English social system that failed to acknowledge him as the son of duke. Finally, Smithson, who had spent time in Paris during the French Revolution, may have admired the revolutionary spirit of the United States and felt that his gift would have greater impact on a young nation which, unlike those of Europe, had few major research and educational institutions.

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Whatever Smithson's motivation was, his wish has certainly been fulfilled. His bequest founded what is now the world's largest museum complex. Today, the Smithsonian Institution in Washington, D.C., consists of 16 museums, the National Zoo, and a number of prominent research centers. Given his love of minerals, Smithson might be particularly proud of the National Museum of Natural History and its Janet Annenberg Hooker Hall of Geology, Gems and Minerals. This \$18-million-dollar, 9,000-square-foot hall opened in 1997 and now displays 2,450 mineral specimens representing 600 species. The displays include 548 gems, including the 45.5-carat Hope Diamond, the world's largest, deep-blue diamond. And, yes, the displays include two superb specimens of smithsonite, one from Tsumeb, Namibia, and the other from Magdalena, New Mexico.

Both French mineralogist René Just Haüy (1743-1822) and English chemist James Smithson (1765-1829) observed that not all "calamine" specimens exhibited strong pyroelectrical properties. In 1800, Smithson began concentrating his research on calamine. By 1802, he had learned that calamine did indeed consist of two minerals, one a carbonate of zinc. The following year, he published his findings in an article titled "A Chemical Analysis of Some Calamines" in the *Journal of the Royal Society of London*. Smithson's work with calamine was an important advancement in mineralogy that enabled chemists to distinguish mineral oxides from carbonates.

Because of lingering confusion with the other, as-yet-unidentified component of calamine, zinc carbonate, still known as *zinkspat* or "zinc spar," was not formally recognized as a distinct mineral species until 1832, when French mineralogist and geologist François Sulpice Beudant (1797-1850) named it smithsonite in honor of James Smithson. Calamine's other component was later identified as hemimorphite [basic hydrous zinc silicate, $Zn_4Si_2O_7(OH)_2 \cdot H_2O$]. The traditional name "calamine" continued to serve for both smithsonite and hemimorphite for another century until it was finally discredited by the International Mineralogical Association in 1962. Although the term "calamine" is no longer a valid mineral name, it survives today in calamine lotion—a skin lotion first made from powdered calamine in the mid-1700s.

According to modern metaphysical belief, smithsonite enhances tranquility, charm, and kindness. Other attributes of smithsonite are based specifically on color: green smithsonite is associated with renewal and rebirth, pink with the development of new ideas and concepts, blue with stabilizing emotions and expressing thoughts, purple with awakening abilities, and yellow with increasing mental energy.

TECHNOLOGICAL USES

Smithsonite was the world's only source of zinc until the 1870s, when it was replaced by sphalerite. It continues to serve as a minor ore of zinc. Powdered smithsonite is still used in some developing areas as a zinc-rich agricultural nutrient.

ABOUT OUR SPECIMENS

Our smithsonite specimens were collected at the Refugio Mine near Choix in the state of Sinaloa in northwestern Mexico. Sinaloa is bordered on the west by the Gulf of California and by the states of Sonora on the north, Chihuahua on the northeast, Durango on the east, and Nayarit on the south. Choix (pronounced "cho-EEZ"), is located in northern Sinaloa, about 200 miles south-southeast of the city of Hermosillo and 150 miles southwest of the city of Chihuahua. Choix, population 5,000, is located at an elevation of 800 feet in the western foothills of the Sierra Madre Occidental mountain range.

Geologically, Choix is located near the northern end of the Mexican Fold Belt, a 900-mile-long, north-south-trending belt of folded carbonate rocks. This belt's primary host rocks are marine sediments that

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scientists believe were laid down in late-Jurassic and Cretaceous time between 150 and 65 million years ago and that eventually lithified into limestone and dolomite. Limestone is a rock that consists primarily of calcite [calcium carbonate, CaCO_3]; dolomite, in its petrological context, is a rock made up mainly of the mineral dolomite [calcium magnesium carbonate, $\text{CaMg}(\text{CO}_3)_2$]. In early Tertiary time 60 million to 40 million years ago, crustal stresses generated by colliding tectonic plates deformed these limestone and dolomite formations into the folds and thrusts of the Mexican Fold Belt.

Finally, between 40 and 25 million years ago, regional volcanism and deep magmatic intrusions forced mineral-laden, hydrothermal solutions into the circulation systems within the folded sediments. Mineralization occurred when these saline, superheated, acidic solutions dissolved sections of the folded limestone and dolomite. The dissolving carbonate minerals neutralized the acidic solutions, while the precipitation of sulfide minerals replaced the carbonate rocks. These sulfide deposits, rich in silver, copper, lead, and zinc with lesser amounts of gold, were initially emplaced at considerable depth, but were later exposed by millions of years of surface erosion. Economic geologists now call this mineralized section of the Mexican Fold Belt the Sierra Madre Mineral Belt. The mineral belt, which extends from the city of Taxco north for 600 miles along the Sierra Madre Occidental range into the state of Sonora, hosts most of Mexico's economic metal deposits.

As erosion reduced the surface, lowered subterranean water tables exposed metal-sulfide minerals to free atmospheric oxygen and initiated the chemical process of oxidation. In the proper chemical environment and the presence of free atmospheric oxygen, sulfides oxidize or alter into such secondary, oxygen-bearing minerals as carbonates, oxides, phosphates, and arsenates which are often unusual and colorful. North and east of Choix, replacement deposits contain such ore minerals as sphalerite [zinc sulfide, ZnS], galena [lead sulfide, PbS], and chalcopyrite [copper iron sulfide, CuFeS_2], along with varying amounts of silver and gold. In the presence of acidic groundwater rich in carbonate ions picked up from the limestone-dolomite host rocks, the upper ore bodies oxidized into such secondary minerals as smithsonite, cerussite [lead carbonate, PbCO_3], and the basic copper carbonates azurite and malachite.

The Spaniards who explored the Choix area in the late 1500s discovered mineralized outcrops. But because the Choix deposits were remote and smaller than those discovered earlier at Taxco, Batopilas, Guanajuato, and Mapimi, mining did not begin until the late 1600s. With limited mine development and sporadic production, Choix never became a major colonial mining center. The best local ores graded about 12 troy ounces of silver and 1 troy ounce of gold per ton, along with significant values of lead and zinc. Spanish miners recovered only the silver and gold by amalgamation. The mines were horizontal, self-draining tunnels rarely longer than 800 feet.

Colonial mine production at Choix halted about 1800 and did not resume until well after Mexico had gained its independence in 1821. Miners returned to Choix in 1849 in the wave of prospecting inspired by the California gold discoveries. The Refugio, Santa Anita, and other Choix mines that exist today were opened during this time. But hampered by poor transportation, remoteness, mediocre ore grades, and lack of development capital, production lasted only about a decade.

The Choix mines again reopened in the late 1890s, with a small workforce of 20 miners using stoping methods to mine ore bodies ranging in width from 50 to 100 feet. The entire 1901 production amounted to only 1,062 tons. This ore was carefully hand-cobbed (manually graded), because only the highest grades could be shipped. Burros packed the ore 75 miles to the tiny port town of Topolobampo, where it was loaded aboard steamers bound for Guaymas, 200 miles to the north. From Guaymas, the ore was shipped north by rail 200 miles to Nogales, Arizona, where an American railroad then hauled it 250 miles east to El Paso, Texas. From there, another Mexican railroad hauled it 700 miles south to the Mexican city of Aguascalientes and the only smelter capable of handling the particular chemistry of the Choix ore.

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In 1903, Compañía Minera y Beneficiadora de Metales de Choix acquired the Choix mines. In 1906, Compañía Minera de Penoles, a large Mexican mining company backed by American and German capital and mining expertise, took over. By this time, a railroad had made mining much more efficient and Penoles began to modernize the district, but work was derailed by the start of the Mexican Revolution in 1910. Mining has been rather sporadic ever since. The documented Penoles production from 1906 until 1955 amounted to 5.4 million troy ounces of silver, 100,000 troy ounces of gold, and substantial amounts of zinc and lead.

Choix gained first attention for its smithsonite specimens in the early 1970s. Commercial collectors, encouraged by soaring specimen prices, reopened some old workings, among them the Refugio and the nearby Santa Anita mines, to recover quantities of smithsonite in large botryoidal masses and in colors ranging from grays and rich blues to pinks and violets. Few specimens of Choix smithsonite appeared during the 1980s and 1990s, but another significant recovery in 2002 again made specimens available to collectors. Choix smithsonite remains very much in demand today, with select, richly colored, 10-inch cabinet pieces selling for hundreds and even thousands of dollars.

The Choix mines may again become an important source of smithsonite specimens. With soaring prices for lead, zinc, silver, copper, and gold, mineral exploration is booming throughout the Sierra Madre Mineral Belt, and Choix is no exception. Six mining and exploration companies are now active at Choix, which has never before been explored by modern methods. One company plans to begin multi-metal mining ten miles north of Choix by late 2008. And drill cores collected during the past year indicate the existence of deep, economic deposits of zinc, lead, silver, and gold mineralization nearer to the town. Choix is already considered a classic locality for smithsonite, and it seems that its days as a source of fine specimens are not yet over. This is another specimen that will appreciate in value in years to come!

We did enjoy having an opportunity to examine some of the smithsonite specimens from this large, heavy (because of the zinc) lot. When choosing the specimens, we focused on pieces with the pretty pinkish-purple color we found especially attractive, but couldn't resist choosing some of the lovely light blues and greens, too. The bubbly, rounded botryoidal form smithsonite often assumes adds to the attraction. (Botryoidal means having the form of a bunch of grapes.) With our 10x loupe, we could see the tips of the crystals comprising the botryoidal form, and on the sides, the edges of the crystals. We didn't expect it to be affected by ultraviolet light, but under our lamp, some of the light purple smithsonite gave off a purple fluorescence. On a few pieces, the fluorescence was noted only around the edges, evidence of a previous layer of crystal growth now covered with a secondary growth. Some pieces of the pink and purple smithsonite gave off an eerie yellowish-green color under longwave ultraviolet light. Once again, we wish we had time to closely examine and write a report on each individual piece with its unique qualities! Perhaps we could persuade each one of our members to write a report on the fascinating features observed in their piece . . . We hope you enjoy examining and adding your specimen to your collection!

References: *Dana's New Mineralogy*, Eighth Edition; *Encyclopedia of Minerals*, Second Edition, Roberts, et al, Van Nostrand Reinhold Company; *1999 Glossary of Mineralogical Species*, J. A. Mandarino; *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; *The Copper Handbook*, H. J. Stevens and W. H. Reed, H. J. Stevens, publisher, New York, 1906; *Geology of Mexico*, Susana Alaniz-Alvaréz and Ángel Nieto-Samaniego (editors), Geological Society of America Special Paper 422, 2007; "The Smithsonian's Janet Annenberg Hooker Hall of Geology, Gems and Minerals," John S. White, *The Mineralogical Record*, May-June 2000; "The Frugal Collector: Smithsonite," Bob Jones, *Rock & Gem*, July 2004; "Connoisseur's Choice: Smithsonite, Tsumeb, Namibia," Robert B. Cook, *Rocks & Minerals*, May-June 2000; "What's New in Minerals: Tucson Show 1998," Thomas P. Moore, *The Mineralogical Record*, May-June 1998; "Famous Mineral Localities: The Magdalena District, Kelly, New Mexico," Ronald R. Gibbs, *The Mineralogical Record*, January-February 1989.