April 2010 Mineral of the Month: Topaz

"I pulled out a section of brush and there, stuck to the roots, were two rather large, perfectly flawless topaz crystals. Thus began the most exciting mineral collecting adventure of my life." Read on and you'll understand why a graduate student made this statement in 1973; and why commercial mineral collecting is such a risky business! And remember, store your topaz crystal away from sunlight to preserve its color!

OVERVIEW

PHYSICAL PROPERTIES

Chemistry: $Al_2SiO_4(F,OH)_2$ Basic Aluminum Fluorosilicate
Class: Silicates
Subclass: Nesosilicates
Group: Topaz
Crystal System: Orthorhombic
Crystal Habits: Usually as stubby to medium-long prismatic crystals with pseudohexagonal cross sections, sometimes with lengthwise striations; also granular and massive; terminations often multi-faced; twinning rare.
Color: White, colorless, sherry, yellow, orange, pink, red, greenish, beige, and brownish; occasionally orange to dark orange-red; rarely violet and blue.
Luster: Vitreous
Transparency: Transparent to translucent
Streak: Colorless
Refractive Index: 1.606-1.638
Cleavage: Perfect in one direction
Fracture: Subconchoidal to uneven; brittle.
Hardness: 8.0
Specific Gravity: 3.4-3.6
Luminescence: Often fluoresces yellow under short-wave ultraviolet light and pale, creamy-yellow under long-wave ultraviolet light. Our specimens do not fluoresce.
Distinctive Features and Tests: Best field marks are hardness, density, and occurrence with rhyolite or granite pegmatites. Topaz is harder than quartz [SiO_2] and beryl [$Be_3Al_2Si_6O_{18}$]. Quartz and beryl lack the perfect, one-directional cleavage of topaz.
Dana Classification Number: 52.3.1.1.1

NAME The word "topaz," pronounced TOW-pazz, stems from the Greek *topazos*, a reference to the Red Sea island of Topasos (now Zebirget). Originally, "topaz" was used for any yellowish gemstone, but since the 1740s it has referred specifically to basic aluminum fluorosilicate. Topaz has also been known as "chrysolithos," "chrysolite," "physalite," and "pyrophysalite." "Hyacinth" is an orange-red gem variety, "imperial topaz" is a pink gem variety, and "precious topaz" refers to any true topaz gem. In European mineralogical literature, topaz appears as *topas*, *topacio*, and *topasio*.

COMPOSITION: The chemical formula $Al_2SiO_4(F,OH)_2$ shows that topaz contains aluminum (Al), silicon (Si), oxygen (O), fluorine (F), and hydrogen (H). The molecular weight of topaz is made up of 29.61 percent aluminum, 15.40 percent silicon, and 43.02 percent oxygen, 11.47 percent fluorine, and 0.50 percent hydrogen. Topaz is a member of the silicates, a mineral class that consists of silicon and oxygen combined with one or more metals. The basic silicate structural unit is the silica tetrahedron $(SiO_4)^{4-}$, in which four equally spaced oxygen ions surround a silicon ion at the four corners of a tetrahedron. Topaz occurs mainly in two mineralogical environments: granite pegmatites and cavities within volcanic rhyolite. As an allochromatic mineral, pure topaz is colorless or white, but trace amounts of chromium deform the topaz crystal lattice to create pink, red, orange, and violet colors. The yellow, beige, sherry, blue, and brownish topaz colors are due to color centers, which are lattice defects resulting from abnormal crystal growth or exposure to natural geophysical radiation. The combination of chromium chromophores and color centers creates the wide range of topaz colors.

COLLECTING LOCALITIES: Topaz is a widely distributed mineral, but few occurrences provide fine specimens. Important topaz localities in the United States are found in Utah, California, Colorado, Wyoming, Texas, Connecticut and Maine. Most of the world's supply of gem-quality topaz comes from Brazil's pegmatite mines. Other sources are found in Russia, Finland, Japan, Pakistan, Sri Lanka, and Myanmar.

HISTORY, LORE, & USES: Topaz has been known since antiquity, but was long confused with other minerals and gemstones. About 1740, German chemist and mineralogist Johann Friedrich von Henckel (1678-1744) assigned the name "topaz" to basic aluminum fluorosilicate after studying samples collected in Saxony, Germany. Because of its relative abundance, transparency, hardness, moderately high index of refraction, and range of attractive colors, topaz is a popular gemstone. The "classic" topaz gem colors are yellow-brown or yellow-orange. The most valuable and rarest colors are pink and pinkish-red. Its perfect one-directional cleavage makes topaz difficult to cut. Cleavage and brittleness also make topaz susceptible to chipping and gems must be handled carefully. Finely ground topaz serves as a specialty abrasive in whetstone compounds that require a specific degree of hardness. In medieval times, topaz and other yellowish gemstones were believed to endow wearers with intelligence, long life, and attractive appearance, and to protect them from disease, poisons, and sorcery. According to modern metaphysical practitioners, topaz enhances one's spiritual potential, increases intelligence and creativity, aids in meditation, and imparts wisdom and wealth.

ABOUT OUR SPECIMENS: Our specimens were collected at the Maynard topaz claims at Topaz Mountain in the Thomas Range of Juab County, Utah. Topaz Mountain is one of the premier mineral-collecting areas in the United States and a classic topaz locality. The Thomas Range, a minor volcanic range 35 air miles northwest of Delta, Utah, was created by eruptions of fluorine-rich, rhyolitic magma between six and eight million years ago. The resulting gray, fine-grained rhyolite became permeated by fluorine-rich gases that condensed and crystallized as well-developed topaz crystals lining the walls of cavities and conduits. Topaz Mountain, a source of topaz specimens since 1858, has a long collecting history and has yielded many fine topaz specimens. Our specimens were collected in late 2009 by The Collector's Edge of Golden, Colorado, a commercial-collecting organization. The sherry, yellow-brown, and brown colors of Topaz Mountain topaz are due to the formation of lattice defects called color centers. In our specimens, color centers were created by exposure to natural geophysical radiation emitted by uranium minerals. **This color is unstable and can fade with prolonged exposure to bright sunlight, so we recommend that you avoid storing or displaying your specimen in direct sunlight.**

10 YEARS AGO IN OUR CLUB: Variscite, Lucin, Box County, Utah. We love when we have a coincidental connection between two featured minerals ten years apart–both April 2000 and April 2010 are from Utah! The variscite write-up began with quotes by June Culp Zeitner and Bob Jones, respectively: "One of the most elegant of American cabochon gemstones is variscite," and "With all the uproar over blue turquoise these days, it seems inevitable that the equally beautiful green gem variscite will gain rapidly in favor." The write-up described the variscite collecting experience at Lucin, but focused more on the fascinating history of the famous classic variscite locality at Fairfield, Utah County, Utah, and the now legendary collecting team of Edwin Over and Arthur Montgomery, who were instrumental in developing the site. Over the year, we have been privileged to handle some of the gorgeous green variscite and associated rare minerals from this unique, long-closed locality.

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COMPREHENSIVE WRITE-UP

COMPOSITION

It was March 2001 when we first shone the spotlight on this amazing mineral, sending Club members small but excellent crystals of orange-yellow Imperial topaz crystals from Ouro Preto, Minas Gerais, Brazil. We've put a copy of that 2001 write-up on our web site so you can enjoy checking it out.

The chemical formula $Al_2SiO_4(F,OH)_2$ shows that topaz contains aluminum (Al), silicon (Si), oxygen (O), fluorine (F), and hydrogen (H). The molecular weight of topaz is made up of 29.61 percent aluminum, 15.40 percent silicon, and 43.02 percent oxygen, 11.47 percent fluorine, and 0.50 percent hydrogen. Like all molecules, the topaz molecule is made up of positively charged ions called cations and negatively charged ions called anions. The topaz cation consists of two aluminum ions ($2Al^{3+}$) with a cumulative +6 charge. The topaz anion has two types of radicals (groups of ions of different elements that act as entities in chemical reactions): one silica radical $(SiO_4)^{4-}$ and two fluorhydroxyl radicals $2(F,OH)^{1-}$. Within the silica radical $(SiO_4)^{4-}$, one silicon ion Si^{4+} is bonded to four oxygen ions $4O^{2-}$ to provide a -4 charge. In the fluorhydroxyl radical, both the fluorine ion F^{1-} and the hydroxyl radical $(OH)^{1-}$ have a -1 charge. The comma within this radical indicates variable proportions of fluorine ions and hydroxyl ions. The net charge of the radical, however, is always -1. The -2 charge of the two fluorhydroxyl radicals $2(F,OH)^{1-}$ together with the -4 charge of the silica radical $(SiO_4)^{4-}$ provide a total -6 anionic charge, which balances the +6 cationic charge to provide the topaz molecule with electrical stability.

As a silicate, topaz is a member of the largest and most abundant class of minerals. Silicates consist of silicon and oxygen combined with one or more metals. The basic silicate structural unit is the silica tetrahedron $(SiO_4)^{4-}$, in which four equally spaced oxygen ions surround a silicon ion at the four corners of a tetrahedron. The oxygen ions are bonded to the silicon ion by strong covalent bonding. In silicate minerals, silica anions and metal cations are linked together like polymers (repeating chains) to form seven types of structures: independent tetrahedral silicates (nesosilicates); double tetrahedral silicates (sorosilicates); framework silicates (tectosilicates); single- and double-chain silicates (inosilicates); ring silicates (cyclosilicates); and sheet silicates (phyllosilicates).

Topaz is a nesosilicate, in which metal cations are packed tightly between silica tetrahedra. These tetrahedra are isolated with no direct silica-silica bonding. In the rigid nesosilicate crystal lattices, silica anions bond only to metal cations. In the topaz lattice configuration, each aluminum ion is surrounded by six silica tetrahedra (six coordination). Each silica tetrahedra is bound—covalently and ionically to aluminum ions, and ionically to fluorhydroxyl ions—in a repeating hexagonal structure, with the fluorhydroxyl ions nestled into spaces between the silica tetrahedra. This close atomic packing strengthens the ionic bonding. In turn, the ionic bonding reinforces the inherently strong covalent bonding to account for topaz's hardness of Mohs 8 (much harder than quartz). Although topaz's elemental components have light atomic weights (aluminum 26.98, silicon 28.09, oxygen 16.00, fluorine 19.00, and hydrogen 1.01), close atomic packing explains topaz's relatively high specific gravity of 3.4-3.6.

Topaz crystallizes in the orthorhombic system, which is characterized by three mutually perpendicular axes of different lengths. Minerals with complex chemistries or bonding arrangements, such as topaz, often crystallize in the orthorhombic system. Orthorhombic crystals are usually blocky in appearance, but growth conditions or chemistry can sometimes elongate one axis. In topaz, the varying proportions of fluorine and hydroxyl ions within the fluorhydroxyl radical create crystal shapes from nearly equant to medium-long prismatic. Although topaz's atomic bonding is generally omnidirectional, relatively weak ionic bonding dominates one plane to create its perfect, one-directional cleavage.

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As an allochromatic mineral, pure topaz is colorless or white. The wide range of topaz colors is due to traces of nonessential coloring agents called chromophores and/or to the presence of color centers. Trace amounts of trivalent chromium ions (Cr^{3+}) deform the topaz crystal lattice in a manner that causes it to reflect pink, red, orange, and violet hues. The yellow, beige, sherry, blue, and brown topaz colors are caused by lattice defects called color centers, which result from abnormal crystal growth or exposure to natural geophysical radiation. In topaz, color centers form when fluorine ions are displaced from their normal lattice positions to create voids which trap electrons. Light then boosts these trapped electrons to higher energy levels; to return to their normal levels, they release excess energy as yellow, green, or blue light. When color centers are stable, topaz will retain its yellow-brown colors indefinitely. But stones with unstable color centers can fade from exposure to sunlight–do not store your topaz specimen in sunlight! The combination of chromium chromophores and color centers create the wide range of topaz colors.

Topaz occurs primarily in granite pegmatites and rhyolitic cavities. Pegmatites are bodies of coarse-grained granite that formed when residual magma, often enriched with rare elements, cooled very slowly. Rather than quickly “freezing” into fine-grained granite, residual magma crystallizes on a fractional or mineral-by-mineral basis to form pods, lenses, pockets and irregular dikes. As residual magma slowly solidifies, gases can create vugs or mariolitic cavities that provide space for the growth of unusually large, well-developed crystals. In granite pegmatites, topaz is associated with beryl [beryllium aluminum silicate, $Be_3Al_2Si_6O_{18}$], quartz [silicon dioxide, SiO_2], tourmaline-group minerals (complex sodium aluminum borosilicates), microcline [potassium aluminum silicate, $KAlSi_3O_8$], muscovite [basic potassium aluminum silicate, $KAl_3Si_3O_{10}(OH)_2$], and albite [sodium aluminum silicate, $NaAlSi_3O_8$]. In the volcanic rock rhyolite, topaz is found in mariolitic vugs that formed from trapped gas bubbles within the rapidly solidifying magma. Fluorine-bearing gases given off during the later stages of the solidification of rhyolite can condense and crystallize as topaz to line cavity walls. Rhyolitic topaz is associated with the garnet-group mineral spessartine [manganese aluminum silicate, $Mn_3Al_2(SiO_4)_3$], bixbyite [manganese iron oxide, $(Mn,Fe)_2O_3$], and quartz. Topaz also occurs in massive form in granite, in high temperature hydrothermal veins, and in granular form in metamorphic gneiss. Because of its hardness and relatively high specific gravity, topaz can weather free from its host rock and concentrate in unconsolidated alluvial (placer) deposits, which are sometimes of commercial value.

The Dana mineral classification number 52.3.1.1 first identifies topaz as a nesosilicate containing insular (unbound) $(SiO_4)^{4-}$ silica groups along with oxygen, hydroxyl and/or fluorine ions and/or water molecules. Topaz is subclassified (3) as having silica anions present in lattice coordinations of six. Topaz is then assigned to the topaz group (1) as the first (1) of two members. The other member is krieselite, a rare, basic aluminum gallium germinate mineral [$(Al,Ga)_2(Ge,C)_4(OH)_2$]. Although not a silicate, krieselite is grouped with topaz because of its hydroxyl radical and anionic six-coordination.

COLLECTING LOCALITIES

Although topaz is widely distributed, few localities yield fine specimens. Our specimens were collected at the Maynard topaz claims at Topaz Mountain in the Thomas Range of Juab County, Utah. Nearby sources include The Cove, Garnet Basin, Solarwind Claim, Holfertite Pit, Mile High Claim, Starvation Canyon, and Lookout Prospect. Other notable localities in the western United States are the Mineral Hills pegmatites in Crook County, Wyoming; the Ash Creek rhyolite outcrops at Hayden, Pinal County, Arizona; the Sawtooth granite batholith in the Sawtooth Mountains, Custer County, Idaho; and the Zapot Pegmatite in the Fitting district, Mineral County, Nevada. California sources, all in San Diego County, are the Blue Tourmaline Mine in Chihuahua Valley in the Warm Springs district; the Maple Lode Mine in the Aguanga Mountain district; and the Little Three, A.B.C., Cable, and Surprise mines in the Ramona district. Texas localities include the Streeter, Katemcy, Grit, and Fredonia areas of Mason County; and the El Paso tin deposit in the Franklin Mountains of El Paso County. Colorado’s localities include the pegmatites at St. Peters Dome and Crystal Park in El Paso County; Tarryrall Park and Spruce Run in Park County; White Mountain and Mt. Antero in the La Plata district, Chaffee County; and the Devil's Head district in Douglas County.

In the eastern United States, topaz is found at Graves Mountain in Lincoln County, Georgia. Among Maine's localities are the Pulsifer Quarry at Auburn, Androscoggin County; and the Bennett Quarry at Buckfield, the Lord Hill Quarry at Stoneham, and the Tamminen and Waishanen quarries at Greenwood, all in Oxford County. Connecticut sources include the Walden Gem Mine at Portland and the Hewitt Gem Mine at Long Hill in Middlesex County; and the State Route 111 road cuts and the Hubbard tungsten mine at Trumbull in Fairfield County. Among New Hampshire's localities are the Ruggles Mine at Grafton, Grafton County; the Diamond Ledges site at Berlin, Coos County; and the Government Pit at Albany and Charles Ravine at Chatham, both in Carroll County. Virginia specimens come from the Rutherford pegmatite mines at Amelia County Courthouse, Amelia County; and the Herbb No. 2 Mine at Flat Rock, Powhatan County.

In Europe, topaz comes from the Viitaniemi Pegmatite at Orivesi in the Eräjärvi area of Etelä-Suomen, Lääni, Finland; the Trevaunance Mine in the St. Agnes district, Cornwall, England; the San Nicolás Mine at Badajoz in Valle de la Serena, Extremadura, Spain; and the Suelo Mine on Mount Carmoscio near Baveno, Verbano-Cusio-Ossola Province, Piemonte, Italy. Russian topaz comes from the Murzinka Mine at Ekaterinburg, Urals Region; and the Spokoininskoye Mine at Orlovskoya, Eastern-Siberian Region. In Asia, specimens are collected in Tajikistan at the Mika Pegmatite in the Pamir Mountains, Viloyati-Mukhtori Gorno-Badakhshan; in Sri Lanka in the Balangoda gem gravels at Ratnappura, Sabaragumura; in Myanmar at Sakangyi and Pandaw near Mogok, Sagaing district, Mandalay Division; in Japan at the Takatori Mine at Nishi-ibaraki-gun in Ibariki Prefecture, Kanto Region, Honshu Island; and in Pakistan at Bulochi, Astore District, Northern Areas, and at the Sassi pegmatites in the Hunza Valley, Gilgit District, Baltistan.

Brazil's Minas Gerais state in the Southeast Region supplies most of the world's gem topaz, from the Barra de Salina district near Coronel Muerta, the Xanda Mine at Virgem da Lapa, the Vermelhão Mine at Saraminha, and the Dom Bosco Mine at Ouro Preto. Topaz is collected at the La Verde Mine at La Bella, Ñuflo de Chavez Province, Santa Cruz Department, Bolivia; El Chaltén, Santa Cruz Province, Argentina; and the Pasto Bueno District mines in Pallasca Province, Ancash Department, Peru. Mexican specimens come from the Tepate and Lourdes Mines at Villa de Arriaga, San Luis Potosí.

JEWELRY & DECORATIVE USES

Its relative abundance, excellent transparency, hardness, moderate index of refraction, and pleasing colors make topaz an attractive and popular gemstone. Although softer than the corundum gemstones ruby and sapphire, topaz is considerably harder than those of quartz and beryl (emerald, aquamarine). Its hardness enables topaz to take a superb polish. Topaz's index of refraction is a moderate 1.606-1.638. Index of refraction measures a crystal's ability to refract light and thus produce brilliance and sparkle in cut gems. While less than that of ruby and sapphire (1.766-1.774), topaz's refractive index is much higher than that of the quartz gemstones (1.544-1.553). The "classic" topaz colors are yellow-brown or yellow-orange. Natural, pale-blue and intense pink and pinkish-red hues are quite rare and valuable. Pink-red topaz, discovered in Russia's Ural Mountains in the 1800s and initially available only to the Russian royal family, is known as "imperial topaz."

Topaz's perfect, one-directional cleavage makes cutting difficult. Because of its cleavage and brittleness, topaz gems are easily chipped and must be handled carefully. Topaz gems are always faceted, usually in rectangular, baguette, octagon, oval, or other elongated shapes to maximize cutting retention of its prismatic crystals. The finest topaz gems are highly transparent and virtually free of inclusions. Topaz prices range from less than $100 per carat for small, yellowish stones to several hundred dollars per carat for intensely colored, yellow-orange stones. Topaz gems of three or more carats are the most popular. Four-carat, "imperial orange" (reddish-orange) gems cost about $1,000. The rare, intensely colored pink or reddish-orange stones can cost $1,000 per carat.

With their broad color range, topaz gems and their look-alikes have acquired many misleading names. "Smoky topaz" is really smoky quartz, while "citrine topaz," "Bohemian topaz," "golden topaz," "Madeira topaz," and "occidental topaz" are all citrine (yellow quartz). Topaz gems are easily confused with the aquamarine, heliodor, morganite, and goshenite color varieties of beryl [beryllium aluminum silicate, $Be_3Al_2Si_6O_{18}$]; the kunzite variety of spodumene [lithium aluminum silicate, $LiAlSi_2O_6$]; varicolored sapphires [corundum, aluminum oxide, Al_2O_3]; spinel [magnesium aluminum oxide, $MgAl_2O_4$]; and zircon [zirconium silicate, $ZrSiO_4$]. To avoid confusion, true topaz gems are often referred to as "precious topaz."

Topaz crystals and collector gems can be surprisingly large. In 1965, a blue topaz crystal weighing 220 pounds was found in the Ukraine! The National Museum of Natural History (Smithsonian Institution) in Washington D.C. displays several cut topaz gems of more than 1,000 carats each. Arguably the most valuable topaz gem is the 70.4-carat, cherry-red stone displayed at New York's American Museum of Natural History. The largest pink-red, imperial topaz gem weighs more than 80 carats.

Blue topaz is extremely popular in jewelry. Because natural blue topaz is rare, virtually all blue topaz gems have been altered. The bombardment of inexpensive colorless or very pale topaz rough by high-energy electrons in cyclotrons or by neutrons in nuclear-fission reactors alters the topaz color centers (see "Composition") to create beautiful, intense blue colors, which are then stabilized by secondary heat treatment. Because it is mass-produced, irradiated blue topaz is generally inexpensive. Irradiated, blue-topaz gems of five carats sell for only about $80. Heat treatment is also used to produce attractive light-red and purplish-red colors in pale sherry or yellowish-brown topaz.

HISTORY & LORE

Topaz has been known since antiquity, but the name originally referred to any yellowish gemstone. The name "topaz" stems from the Red Sea island of Topasos (now Zebirget). Interestingly, Zebirget was never a source of topaz, but of peridot, the greenish-yellow gem form of forsterite [magnesium silicate, Mg_2SiO_4], our December 2003 featured mineral, from the San Carlos Apache Reservation, Arizona. According to the Bible, the "Breastpiece of Judgement" worn by high priest Aaron of ancient Israel contained a topaz set as the middle stone in the first row of gems. The apostle John describes topaz as the ninth foundation stone of "the holy city, new Jerusalem, coming down out of heaven from God," in Revelation chapter 21.

The word "topaz" was first used in its modern context about 1740, when German chemist and mineralogist Johann Friedrich von Henckel (1678-1744) assigned that name to a specific mineral from the Schneckenstein deposits at Voigtland, Saxony, Germany. The Schneckenstein deposits, known since the 1500s, were the most important source of gem topaz before the discovery of Brazil's topaz pegmatites in the mid-1700s. In 1776, Andreas Sigismund Marggraf (1709-1782), a pioneer in analytical chemistry and a former student of von Henckel's, confirmed that Schneckenstein topaz was, in fact, a new mineral species. In a paper titled "Findings on the Topaz of Saxony," Marggraf wrote: *The interior structure is compact but with thin leaf-like layers, which this gem has in common with diamond. It has a prismatic structure at four unequal angles; it is hard with a bright sparkle.* Marggraf's "leaf-like layers" referred to topaz's perfect, one-directional cleavage. In the early 1800s, advanced analytical methods proved that the Schneckenstein specimens were basic aluminum fluorosilicate. In 1928, American chemist and physicist Linus Carl Pauling (1901-1994) used X-ray diffraction to define the atomic structure of topaz.

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In medieval times, topaz and other yellowish gemstones were believed to endow their wearers with intelligence, long life, and an attractive appearance, and to protect them from disease, poisons, and sorcery. According to modern metaphysical practitioners, topaz enhances one's spiritual potential, increases intelligence and creativity, imparts wisdom and wealth, and is considered to be a strong healing and rejuvenating crystal. Blue topaz is believed to enhance communicative abilities and self-expression.

Topaz is the birthstone for November and the symbolic gemstone for the 16th wedding anniversary. In 1969, the Utah legislature designated topaz from the Thomas Range of Juab County as the official Utah state gemstone. Both as cut gems and natural crystals, topaz has appeared on the Brazilian 1.30-cruzeiro stamp of 1977, the Soviet Union's 2-kopeck stamp of 1963, and the 20-pfennige stamp of the German Democratic Republic (East Germany) of 1974. Topaz was featured on the cover of the January-February 1995 issue of the prestigious *Mineralogical Record*, which was devoted entirely to our featured mineral and contains an article on Topaz Mountain, source of our wonderful specimens.

TECHNOLOGICAL USES

Finely ground topaz (Mohs 8) is used as a specialty abrasive in whetstone compounds that require a specific abrasive hardness midway between that of quartz (Mohs 7.0) and corundum (Mohs 9.0).

COMMERCIAL MINERAL COLLECTING: A RISKY BUSINESS

Our topaz specimens were collected by one of the world's foremost commercial mineral-collecting organizations—The Collector's Edge of Golden, Colorado, who have conducted many previous field projects. This one, at Utah's Topaz Mountain, seemed to have everything going for it: a proven, classic locality; beautiful and marketable specimens; and a top-notch group of professional collectors. But even though this project yielded many excellent specimens, it was considered a commercial failure because the costs of the venture exceeded the income from the sale of specimens—a risk that commercial mineral collectors always face.

To mineral collectors, commercial mineral collecting, which combines travel, adventure, and the excitement of discovery, might seem like a dream job. And based on today's high prices for mineral specimens, it might also appear to be a sure source of income. But commercial mineral collecting is actually a very risky business. To appreciate the degree of financial risk that commercial collectors face, consider the business's five basic aspects: Feasibility Studies and Research, Planning and Outfitting, Field Operations, Specimen Preparation, and Marketing.

***Feasibility Studies and Research**: The first step in a collecting project is assessing its economically feasibility or the probability of realizing a profit. This means determining whether or not the proceeds from the sale of the specimens will exceed the recovery and associated costs. Making this assessment requires extensive field experience and familiarity with the specimen market. Considerations include the marketability of the target mineral, the projected quantity and quality of the recovered specimens, the estimated market prices of the specimens, and the projected recovery costs. The element of financial risk becomes immediately apparent in the key word "projected," because the quantity and quality of the specimens, and the full costs of recovering them, will be known only when the project is completed. Once a project is judged to be economically feasible, or "worth taking a chance on," commercial collectors must conduct detailed studies of the geology, mineralogy, and mining or collecting history of the site. They must also acquire or negotiate the necessary leases or permits. At this point, costs have already accrued, because knowledgeable individuals have invested a considerable amount of time in time and travel.*

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***Planning and Outfitting**: Once leases or permits have been obtained, commercial collectors must schedule the project; select the individuals to be involved; plan logistics that include everything from supplying food and water to maintaining on-site living quarters; lease or rent equipment such as excavators, compressors, pumps, drills, explosives, etc.; arrange for transportation and shipping; and address a host of many small but important details.*

***Field Operations**: In the field, operating expenses add up quickly. Equipment requires fuel, lubricants, maintenance, and often repair or replacement; personnel require salaries; and unexpected problems from adverse weather to equipment failure must be anticipated. Experience is critical in field operations, since supervisors must be able to provide accurate, on-the-spot interpretations of geological and mineralogical trends and adjust operations accordingly. Excavating or mining operations must often proceed very slowly to avoid destroying or damaging specimens. Recovered specimens are fragile and must be protected and specially packed for transport. And one very important factor that can neither be planned for nor purchased is luck. A few feet or even a few inches can make the difference between opening—or missing—a crystal-filled pocket that can make or break the project!*

***Specimen Preparation**: After field operations have been completed, considerable time, work, and expense must now be invested in sorting, cleaning, and trimming specimens before they can be marketed. Removing surface coatings through various means or artfully trimming the matrix so that a crystal sits more centrally on it can greatly increase a specimen's value.*

***Marketing**: Specimens must be marketed in a manner that maximizes income, and that means contacting dealers, advertising, and exhibiting at gem-and-mineral shows, all of which incur additional expense. Pricing is critical and must be neither so high that it restricts sales, nor so low that it minimizes or even negates profits. When many specimens are involved, marketing can take years, thus precluding any hope of a quick return on the project investment.*

The Collector's Edge collected our topaz specimens at Utah's Topaz Mountain over a 10-week period of field operations in late 2009. Because of this project, many collectors are acquiring Thomas Range topaz for their mineral collections. Based on the quantity of the recovered specimens, however, The Collector's Edge will not recoup its investment. Fortunately, The Collector's Edge has many successful previous projects to fall back on, most notably the reopening of the Sweet Home Mine at Alma, Colorado, in the 1990s. That project, which lasted nearly a decade, yielded many extraordinary specimens of rhodochrosite [$MnCO_3$] worth several million dollars. (In 1997, owner Brian Lees kindly allowed us to tour this famous mine and gave us a tremendous discount on specimens so that we could feature Sweet Home rhodochrosite in our Club!) When it comes to commercial mineral collecting, the bottom line is that considerable financial risk is an inherent part of the endeavor.

ABOUT OUR SPECIMENS

As noted, our topaz specimens are from the Maynard topaz claims at Topaz Mountain in the Thomas Range of Juab County, Utah. Topaz Mountain is one of the premier mineral-collecting areas in the United States and a classic topaz locality. Located in west-central Utah, Juab County covers 3,400 square miles (twice the area of Delaware). Most of its population of 9,000 resides in or near Nephi, the county seat, at the eastern end of the county. The north-south-trending Thomas Range, 20 miles long and 10 miles wide, is located in central Juab County. Topaz Mountain, elevation 7,046 feet, marks the southern end of the range. Topaz Mountain's precise location is 39.72˚ north latitude and 113.13˚ west longitude; it is 43 miles east of the Nevada line and 90 air miles southwest of Salt Lake City. The nearest sizeable town, Delta, population 5,000, is 35 air miles to the southeast. The regional climate is arid, with cold winters and hot summers. The elevation at the base of Topaz Mountain is 5,500 feet. Vegetation is limited to sagebrush on the valley floors and groves of juniper in the higher elevations.

As a part of the basin-and-range geological province that covers western Utah and adjacent Nevada, Juab County is geologically characterized by a north-south-trending network of crustal faults. Tectonic stresses have buckled many of these faults upward to form thrust-type ranges; other faults have served as conduits for erupting magma that formed volcanic ranges. The topography is dominated by minor, north-south trending ranges separated by arid, barren valleys. The Thomas Range is a relatively young volcanic range formed between six and eight million years ago by five dome-like flows of rhyolitic lava. Rhyolite, a high-silica, volcanic rock, is the extrusive counterpart of the intrusive rock granite. The light-gray, fine-grained Thomas Range rhyolite formed from a viscous, high-silica, fluorine-rich magma. As this magma cooled, late-stage volcanic gases altered the hardness of the resulting rhyolite and created mariolitic cavities and conduits. Later, these cavities filled with superheated steam and fluorine- and silica-rich vapors which cooled, condensed, and crystallized as well-developed topaz crystals that lined the cavity walls. Subsequent weathering and surface erosion freed many of these topaz crystals and scattered them about the adjacent ground.

While conducting a wagon-route survey across west-central Utah in 1858, U. S. Army Captain J. H. Simpson (1813-1883) made the first documented visit to Topaz Mountain. Simpson named the Thomas Range for then-Assistant Adjutant General of the Army Lt. Colonel Lorenzo Thomas (1804-1875). Accompanying Simpson's expedition was geologist Henry Engelmann (1831-1899), who discovered the topaz crystals at Topaz Mountain. In 1884, Salt Lake City mining engineer Joshua E. Clayton collected at the site and sent topaz specimens to George Frederick Kunz (1856-1932), America's first true gemologist, who described them as gem quality. The prominent American mineral collector Maynard Bixby (1853-1935) visited Topaz Mountain in the 1890s. Bixby staked several topaz claims which are still known today as the "Maynard claims" (the source of our specimens) and identified several new minerals, including bixbyite, which was named in his honor. He also found beautiful red hexagonal crystals, thinking he had discovered another new mineral. The crystals were named "bixbite," but the name was later discredited when they were shown to be a variety of beryl. Horace Bushnell Patton (1858-1929), a Colorado School of Mines professor, surveyed the site in 1906 and published a report titled "Topaz of the Thomas Range, Utah" in the 1908 *Bulletin of the Geological Society of America*. In the 1930s, the noted Colorado collectors Arthur Montgomery (1909-1999) and Edwin J. Over (1903-1963) spent two seasons at Topaz Mountain collecting topaz, red beryl, and bixbyite.

The full specimen potential of Topaz Mountain was finally realized in 1973, when University of Utah graduate student John Holfert (1949-) conducted field work for his master's thesis in geology on Thomas Range minerals. While taking a break from collecting samples, Holfert reclined under the shade of some brush that had taken root in the otherwise barren hillside. To help sit up, he pressed down on a screwdriver—which penetrated the supposedly "solid" rhyolite up to its handle. Holfert later wrote: *"I pulled out a section of brush and there, stuck to the roots, were two rather large, perfectly flawless topaz crystals. Thus began the most exciting mineral collecting adventure of my life. It turned out that the brush had grown into a large gas vent that had managed to break through the rhyolite to the surface. Over the next ten years, we mined this area and found spectacular specimens of topaz, bixbyite, and garnet pseudomorphs . . . magnificent clusters of topaz, some of the finest topaz specimens from the Thomas Range or the world."* Holfert is now a University of Utah professor and an authority on Topaz Mountain minerals. The rare mineral holfertite [$U_{1.75}TiCa_{0.25}O_{7.5}\cdot 3H_2O$], which he discovered at Topaz Mountain in 2003, is named in his honor. Topaz Mountain is the type locality for holfertite and another very rare mineral, weeksite [(K,Na)$_2$(UO$_2$)$_2$(Si$_5$O$_{13}$)·3H$_2$0]. Other notable and collectible Thomas Range minerals include bixbyite [(Mn,Fe)$_2$O$_3$], specular hematite or specularite, [Fe$_2$O$_3$], the garnet-group mineral andradite [Ca$_3$Fe$_2$(SiO$_4$)$_3$], pseudobrookite [(Fe^{3+},Fe^{2+})$_2$(Ti,Fe^{3+})O$_5$], and the aforementioned rare, red variety of beryl sometimes called "bixbite." Red beryl is better known from the Wah Wah Mountains in Beaver County, Utah, where our specimens were dug when we featured this extraordinary beryl variety in March 1999. The 2008 book "American Mineral Treasures" includes a chapter on "Red Beryl and Topaz" from Beaver and Juab counties, Utah, cementing their places among the United States' greatest mineral localities.

As explained in "Commercial Mineral Collecting: A Risky Business," The Collector's Edge collected our topaz specimens in late 2009 on the Maynard claims at Topaz Mountain. As you might imagine, these specimens were exhibited and widely acclaimed at the Tucson Gem & Mineral Show in February 2010.

The sherry, yellow-brown, and brown colors of Thomas Range topaz are caused by color centers (see "Composition") that formed from exposure to natural geophysical radiation emitted by uranium minerals. This color is unstable and can fade with prolonged exposure to bright sunlight—the reason that the loose crystals on the surface at Topaz Mountain are mostly colorless. Only crystals removed from intact cavities, such as our specimens, exhibit intense sherry, yellow-brown, and brown colors. Most crystals are a quarter-inch or less in size, but beautiful crystals more than two inches in length have also been found. Three types of topaz crystals occur here: transparent, gem-quality crystals; crude, "rough," opaque crystals; and better developed "smooth," opaque crystals. The opaque crystals, which contain as much as 20 percent silica as fine sand particles, are not gem quality, though they do make interesting specimens.

In studying your specimen, first note the prismatic crystal shape, which is typical of rhyolitic topaz. The prism faces may or may not show faint, lengthwise striations. The prism cross sections exhibit a four-sided diamond-shaped cross-section typical of crystals of the orthorhombic system. Also note the complex, multi-faced terminations, in which the number of terminal faces often exceeds that of the prism faces. Your crystal has excellent transparency and may be of gem quality, meaning that it could be faceted into a gem. The color, a warm sherry with hints of red, is typical of Thomas Range topaz. The depth of this color indicates that these specimens have been recovered from intact cavities that have never been exposed to sunlight. Because their color centers are not stable, this color can fade with prolonged exposure to direct sunlight. **To preserve its color, do not expose your specimen to prolonged periods of direct sunlight.** The light gray, crystalline material on your topaz crystal is the host rhyolite. If you upgraded to a matrix specimen, note how the topaz has formed atop the rhyolite, meaning that a barren rhyolitic cavity was later coated with topaz by vapor deposition. This matrix has extremely fine grain with a glittery, sugary appearance, indicating that it formed from magma that had cooled very quickly. This rhyolite may even show the wavy flow patterns of the magma before it solidified. Think of your topaz-rhyolite specimen as a microcosm of Utah's Topaz Mountain—one of the premier mineral-specimen localities in the United States!

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