# April 2014 Mineral of the Month

QUARTZ (var. AMETHYST)

This month our featured mineral is the amethyst variety of quartz from the basalt formations of Namibia. Our write-up discusses the mineralogy, gemology, and distinctive color of amethyst, and describes some of Namibia's most interesting mining operations.

**PHYSICAL PROPERTIES**

Chemistry: $SiO_2$ Silicon Dioxide (The amethyst variety always contains traces of iron and sometimes manganese.)
Class: Silicates
Subclass: Tectosilicates
Group: Quartz
Crystal System: Hexagonal
Crystal Habits: Usually as long, prismatic, hexagonal crystals striated crosswise and terminated by hexagonal pyramids (double rhombohedrons) or dihexagonal (12-sided) pyramids; less often as short or nearly bipyramidal prisms; also granular, disseminated, stalactitic, and massive (microcrystalline); sometimes distorted, skeletal, and drusy. Twinning common.
Color: The amethyst variety of quartz is light-to-dark purple, lavender, violet, or lilac, sometimes with pink, red, or blue tints and highlights. Color intensity varies greatly and color zoning is prominent.
Luster: Vitreous to greasy
Transparency: Transparent to translucent
Streak: White
Refractive Index: 1.544-1.553
Cleavage: None
Fracture: Conchoidal; brittle to tough.
Hardness: Mohs 7.0
Specific Gravity: 2.65
Luminescence: Impurities sometimes produce a greenish-white fluorescence.
Distinctive Features and Tests: Best field marks are vitreous-to-greasy luster, distinct conchoidal fracture, hexagonal cross sections of crystals, crosswise striations, and hardness. The amethyst variety of quartz has diagnostic, light-to-dark purple, lavender, violet, or lilac colors.
Dana Classification Number: 75.1.3.1

**NAME:** Amethyst, pronounced AM-eh-thist, stems from the Greek *amethystos*, literally meaning "remedy against drunkenness" and alluding to the ancient belief that amethyst prevented inebriation. In European mineralogical literature, amethyst appears as *amatista*, *ametist*, and *ametista*. Other names include "bishops' stone," "lavendine," and "amethystine quartz." The word "quartz," pronounced KWORTZ, comes from the German *Quarz*, which comes from the Slavic word *kwardy*, meaning "hard." In Europe, quartz appears as *Quarz*, *kwartz*, and *cuarzo*.

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**COMPOSITION**: Quartz consists of 46.74 percent silicon (Si) and 53.26 percent oxygen (O). Silicon and oxygen, the most abundant elements in the Earth's crust, combine to form more than 2,000 silicate minerals that account for 75 percent of the total crustal weight. The basic building block of all silicates is the silica tetrahedron $(SiO_4)^{4-}$, in which a silicon ion is surrounded by four equally spaced oxygen ions positioned at the corners of a tetrahedron (a four-faced polyhedron). Quartz is a framework silicate or tectosilicate that occurs in both macrocrystalline and microcrystalline forms. As an allochromatic (other-colored) mineral, the colors of quartz are caused by traces of nonessential, color-producing elements called chromophores. Pure quartz, or rock crystal, is colorless, but traces of impurities coupled with the effects of natural geophysical radiation can impart a wide range of colors. The purple-to-lilac color of the amethyst variety is due to traces of iron and sometimes of manganese that disrupt the crystal lattice to create "color centers" that alter light absorption. Quartz, a component of most igneous, metamorphic, and sedimentary rocks, forms as a component of solidified magma in intrusive and extrusive (volcanic) rocks and by the crystallization of silica-rich, hydrothermal fluids and groundwater.

**COLLECTING LOCALITIES**: The amethyst variety of quartz is collected in Namibia, Russia, Brazil, Uruguay, Bolivia, Mexico, and Canada. In the United States, amethyst occurs in Maine, Rhode Island, Connecticut, North Carolina, Pennsylvania, Arizona, Montana, Colorado, Arkansas, Massachusetts, Missouri, New Hampshire, and New Mexico.

**HISTORY, LORE & GEMSTONE/TECHNOLOGICAL USES**: The ancient Greeks associated purple amethyst with the color of wine and believed that it protected against drunkeness. Amethyst was one of the 12 stones in the jeweled breastplate of Aaron, the first high priest of the Hebrews. Medieval physicians believed that amethyst helped to remove toxins from the body, ease arthritic pain, and alleviate disorders of the digestive and circulatory systems. Amethyst has served as a gemstone since antiquity and is the most valuable of all quartz gemstones. Because amethyst symbolized piety and was thought to encourage celibacy, it was worn by Catholic clergymen during the Middle Ages and is still worn by bishops today. Transparent amethyst is usually faceted into square, emerald, or rectangular cuts in sizes ranging from two to six carats. Sub-transparent and translucent amethyst is cut into cabochons. Modern metaphysical practitioners believe that amethyst promotes serenity and calmness, enhances the assimilation of new ideas, provides mental strength and stability, and balances physical, intellectual, and emotional states.

**ABOUT OUR SPECIMENS**: Our amethyst specimens were collected at Tafelkop in the Goboboseb Mountains in the Brandberg area of the Erongo Region of Namibia. The Goboboseb Mountains are a group of low, volcanic mountains located 160 miles northwest of the Namibian capital of Windhoek, and about 50 miles east of the Atlantic coast. The nearest town is the settlement of Uis, population 3,000. Tafelkop is a small volcanic mountain with a summit elevation of 3,300 feet. It rises from a flat plain that is covered only by sparse, brushy, "thornveld"-type vegetation. Tafelkop is the remnant of a massive volcanic flow called the Entendeka Volcanic Field that once covered the region to a depth of several thousand feet. In parts of the original magma, gas bubbles created voids in the solidifying basalt. With further cooling, contraction created broad networks of cracks and channels throughout the basalt which conveyed silica-rich solutions. Vugs in the basalt sometimes filled with these solutions which then precipitated well-developed quartz crystals in the form of rock crystal, smoky quartz, and amethyst that lined the vugs. Tafelkop amethyst attracted attention on the international specimen markets in the late 1990s, and the locality is now recognized as an important source of fine amethyst. The small-scale mining of amethyst has become a local industry for the villagers of Uis.

## COMPREHENSIVE WRITE-UP

### *COMPOSITION*

Amethyst is the most popular and valuable of all the gem varieties of quartz. Although it is abundant and widespread, relatively few localities yield top-quality, gem amethyst or fine specimens. Amethyst from different localities varies widely in crystal habit, color, color intensity, color zoning, and mineralogical associations. As an example, in April 2013, our Mineral of the Month was the "cactus" subvariety of amethyst from South Africa, which differs radically in crystal structure, origin, and mineralogical association from the Namibian specimens we are now featuring.

Quartz is a member of the silicates, the largest of all mineral groups. Silicon and oxygen, which are essential elements in all silicate minerals, are the most abundant elements in the Earth's crust and are present in more than 2,000 silicate minerals that make up 75 percent of the total crustal weight. The chemical formula $SiO_2$ shows that quartz contains oxygen (O) and the semimetal silicon (Si). Its molecular weight consists of 46.74 percent silicon and 53.26 percent oxygen. All molecules are made up of positively charged cations and negatively charged anions. In quartz, the cation is the silicon ion ($Si^{4+}$) with its +4 charge. The quartz anion consists of two oxygen ions ($2O^{2-}$) with a collective -4 charge. The balance of +4 cationic and -4 anionic charges provides the quartz molecule with electrical stability.

All silicates are built around the silica tetrahedron $(SiO_4)^{4-}$, which consists of a silicon ion surrounded by four equally spaced oxygen ions positioned at the corners of a tetrahedron (a four-faced polyhedron). In the quartz-crystal lattice, all four oxygen ions in each silica tetrahedron bond covalently with the silicon ions of adjacent tetrahedra, leaving each silicon ion surrounded by four oxygen ions and each oxygen ion surrounded by two silicon ions. Because this "four-oxygen-coordination" arrangement satisfies the -4 charge of each individual tetrahedron, no other ions are needed for electrical stability. This coordination creates the infinite, three-dimensional structure of quartz, in which each electrically balanced, molecular unit within the lattice is described by the formula $SiO_2$.

In all silicates (except for quartz itself), silica anions bond with metal cations in repeating chains to form seven types of structures: independent tetrahedral silicates (nesosilicates); double tetrahedral silicates (sorosilicates); single- and double-chain silicates (inosilicates); ring silicates (cyclosilicates); sheet silicates (phyllosilicates); and framework silicates (tectosilicates). Quartz is a framework silicate or tectosilicate that occurs in two distinct forms: macrocrystalline and microcrystalline. Macrocrystalline quartz forms large, individual, transparent-to-translucent crystals or groups of crystals. Microcrystalline quartz or chalcedony is a compact or massive form that consists of interlocked grains of microscopic silica and includes such varieties as chert, jasper, and agate.

Present in virtually all igneous, metamorphic, and sedimentary rocks, quartz forms as a component of solidified magma in both intrusive and extrusive (volcanic) rocks; by the crystallization of silica-rich, hydrothermal fluids; and by the downward percolation and crystallization of silica-rich groundwater. Macrocrystalline quartz most often occurs in granite pegmatites and hydrothermal-emplacement veins. Microcrystalline quartz usually forms through the crystallization of silica-rich groundwater in shallow environments under conditions of low temperature and low pressure.

Quartz crystallizes in the hexagonal system, which is characterized by four axes, three of equal length and lying in a common plane. The fourth axis, which is unique to the hexagonal system, is of variable length and perpendicular to the plane of the other three. The dominant quartz habit is the hexagonal prism in which the six prismatic faces are parallel to the unique axis. Quartz crystals are usually terminated by hexagonal pyramids or dihexagonal (12-sided) pyramids. All atomic bonding within the quartz lattice is covalent. Because covalent bonding exerts omnidirectional strength, quartz crystals have no cleavage planes. This lack of cleavage and the high bonding strength derived from close atomic packing account for quartz's substantial durability and Mohs hardness of 7.0. Despite close atomic packing, the light atomic weights of its essential elements silicon (28.09) and oxygen (16.00) give quartz a relatively low specific gravity of 2.65.

The Dana mineral classification number 75.1.3.1 first identifies quartz as a tectosilicate or framework silicate (75). The subclassification (1) defines it by the chemical formula $SiO_2$ and by its four-oxygen coordination in which four oxygen ions are bound to each silicon ion. Quartz is then assigned to the quartz group (3) as the first (1) and only member.

Quartz is an allochromatic (other-colored) mineral, meaning that its colors are caused by traces of nonessential, color-producing elements called chromophores. Pure quartz, or rock crystal, is colorless. But traces of chromophoric impurities and the effects of natural geophysical radiation can disrupt the symmetry of the crystal lattice to impart a wide range of colors. The primary chromophore that creates the purple color of amethyst is ferric iron ($Fe^{+3}$). Traces of ferric iron as small as 40 parts per million are distributed in layers parallel to the tetrahedral interfaces. These form "color centers," which are imperfections in the crystal lattice that alter its light-absorption characteristics. The ferric iron ions substitute for silicon ions and, under certain conditions, can give up another electron, thus producing $Fe^{4+}$ ions. The free electrons then migrate to vacant sites in the lattice called "electron traps," where they impart a local, negative charge that alters the manner in which visible light is absorbed. In amethyst, these electron traps absorb the yellow and green portions of the visible spectrum, thus transmitting and reflecting the combined red and blue wavelengths to create purple, violet, or lilac colors. Manganese ions ($Mn^{2+}$) can also contribute to amethyst color by introducing reddish hues and highlights.

Color zoning is prominent in amethyst, with the purple color concentrated in certain sections of the crystal. Color zoning is produced by changes in the chemical composition of the silica solutions during crystallization. Intensely colored sections of amethyst crystals result from growth solutions that were relatively rich in ferric iron, while paler or nearly colorless sections developed from solutions that were deficient in ferric iron. Many amethyst crystals have repetitive color banding, which indicates a sequential enrichment and depletion of the ferric iron content in the silica solutions during the growth process.

*COLLECTING LOCALITIES*

Our amethyst specimens were collected at Tafelkop in the Goboboseb Mountains in the Brandberg area of the Erongo Region of Namibia. Amethyst also occurs at the nearby Messum Crater and in the Spitzkopje area at Erongo Mountain in the nearby Karibib District. Other African localities include Boekenhoutshoek, Mkobola District, Mpumalanga Province, South Africa; and the Baobob Mine at Embu in the Kitui District, Eastern Province, Kenya.

Other sources include the Parian amethyst locality in the Panjsher Valley, Panjsher Province, Afghanistan; the Great Australian Amethyst Mine at Wyloo Station, Ashburton Shire, Western Australia, Australia; the Huanchaca Mine at Huanchaca, Antonio Quijara Province, Potosí Department, Bolivia; the Dorian Amethyst and Diamond Willow mines at Pearl Station, Ontario, Canada; the Ambatofotsikely pegmatite at Fidorana Commune, Vakinankaratra Region, Antananarivo Province, Madagascar; Piedra Parada near Las Vigas de Ramírez, Veracruz-Llave, Mexico; the gem gravels at Ratnapura, Ratnapura District, Sri Lanka; the Tormiq Valley in the Haramosh Mountains, Skardu District, Baltistan, Northern Areas, Pakistan; the Santa Ana Quarry at Artigas, Artigas Department, Uruguay; the pegmatites of Minas Gerais, Brazil; and the Dodo Mine at Saranpaul, Tyumenskaya Oblast', Western-Siberian Region, Russia.

In the United States, amethyst is collected at the Four Peak Amethyst Mine in the Mazatal Mountains, Maricopa County, Arizona; the East Wilson Pit, Wilson Springs, Garland County, Arkansas; the Roncali Quarry, East Granby, Hartford County, Connecticut; the Deer Hill locality at Stow, Oxford County, Maine; the Notch Quarry at Amherst, Hampshire County, Massachusetts; the Pohndorf Mine in Jefferson County, Montana; numerous quarries in Phelps, Osage, and Franklin counties, Missouri; Hurricane Mountain at Conway, Carroll County, New Hampshire; the Black Hawk Mine in the Big Burro Mountains, Grant County, New Mexico; the Rist Mine at Hiddenite, Alexander County, North Carolina; the Bristol Ferry and Mt. Hope localities at Bristol, Bristol County, Rhode Island; and the Red Feather Lakes district, Larimer County, Colorado.

*JEWELRY & DECORATIVE USES*

As the most valuable gem variety of quartz, amethyst has always been a popular gemstone. Stones with deep, even coloration, called "royal purple," are the most valuable, although the paler, "rose de France," lilac shades that were popular in Victorian-era jewelry continue to appear in jewelry today. With a Mohs hardness of 7.0, amethyst gems are suited for use in all types of jewelry, including rings. Amethyst is usually faceted into square, emerald, or rectangular cuts. Most amethyst gems weigh between 2 and 6 carats, although gems larger than 10 carats are not unusual. Amethyst's pronounced color zoning tends to limit gem size, since stones must be cut in a manner that conceals uneven coloration. Sub-transparent and translucent amethyst is fashioned into beads and cabochons. Most amethyst gems are heat-treated to intensify their color and reduce color zoning.

The British Museum in London displays a superb, 343-carat gem, while the National Museum of Natural History (Smithsonian Institution) in Washington, D.C., displays a 1,362-carat gem from Brazil and a 202.5-carat gem from North Carolina. Amethyst is often cut into collectors' gems. Because large amethyst crystals are readily available, large collectors' gems are quite affordable, with 100-to-200-carat gems selling for less than $1,000.

Massive amethyst is carved into various decorative objects, especially miniature wine goblets that reflect the stone's significance in Greek mythology (see "History & Lore"). Amethyst crystal clusters, usually large sections of geode walls, are valuable as both specimens and display pieces for interior decoration.

*HISTORY & LORE*

The ancient Greeks connected amethyst with wine and its intoxicating effects. The word "amethyst" stems from the Greek *amethystos*, literally meaning "remedy against drunkenness," a reference to the belief that amethyst prevented inebriation. Ancient Greeks and Romans alike often wore amethyst jewelry or amulets while drinking wine to protect them from intoxication. Some also drank wine from amethyst goblets, believing that because goblets retained their purple color after the wine had been consumed, the intoxicating effects remained within the goblet. A Greek myth about the origin of amethyst involves Dionysus, the Greek god of wine and joviality (the Roman equivalent is Bacchus), and Artemis, the Greek goddess of the moon and the hunt (Diana is the Roman equivalent). Insulted by a mortal, Dionysus swore revenge on the next mortal he met and created fierce tigers to carry out his intent. The unlucky mortal who crossed his path was a young maiden named Amethyst, who was on her way to pay homage to the goddess Artemis. Attacked by Dionysus' tigers, Amethyst cried out to Artemis for help. To protect the maiden, Artemis turned her into a statue of pure, colorless quartz. Dionysus, awed by the statue's beauty and shamed by his own ruthlessness, remorsefully wept tears of wine that colored the quartz purple.

Amethyst was one of the 12 gems in the jeweled breastplate of Aaron, the first high priest of the Hebrews. In the first century A.D., the Roman scholar Pliny the Elder (Gaius Plinius Secundus, A.D. 23-79) recounted the legend of amethyst being named for its wine-like color. By then, amethyst was also thought to aid in hunting, to protect soldiers from harm in battle, and to protect wearers from the intoxication of love. Medieval physicians believed that amethyst removed bodily toxins, eased arthritic pain, and alleviated digestive and circulatory disorders. Because amethyst symbolized piety and was thought to encourage celibacy, it was worn by Catholic clergymen during the Middle Ages, a tradition that survives today in the amethyst rings worn by Catholic bishops.

Amethyst crystals and gems have been featured on Austria's seven-schilling stamp of 1990; the 20-manat stamp of Azerbaijan in 1994; Brazil's 1.5-cruzado stamp of 1989; Bulgaria's sevenleva stamp of 1995; the one-franc stamp of the French Southern and Antarctic Territories in 1997; the German 25-pfennige stamps of 1972 and 1974; Kenya's one-shilling stamp of 1977; the 20-chon stamp of the Democratic People's Republic of Korea (North Korea) in 1995; New Zealand's four-cent stamp of 1982; Russia's 6-kopeck stamp of 1963; the Swiss 30-centimes stamp of 1979; Uruguay's 5-peso stamp of 1997; the 10-cent stamp of the United States in 1974; and Zimbabwe's 17-cent stamp of 1974.

Amethyst is the birthstone for February, the symbolic gift for the 17$^{th}$ wedding anniversary, and the official gemstone of both North Carolina and the Canadian province of Ontario. Metaphysical practitioners believe that amethyst promotes serenity and calmness, enhances the ability to assimilate new ideas, provides mental strength and stability, and balances physical, intellectual, and emotional states.

*MINING IN NAMIBIA*

This month's amethyst specimens are from Namibia (see "About Our Specimens"). But amethyst represents only one of the interesting mineral deposits that are being mined in that African nation. Namibia's legacy of gemstone and metal mining goes back more than a century to the days when it was a German colony. Today, Namibia, a major producer of diamonds, uranium, lead, and zinc, is just reaching its full potential as a source of minerals.

Namibia owes its mineral richness to its geology—specifically to the crustal distortion that accompanied the breakup of the ancient Gondwana supercontinent, during which South America broke away from Africa. Most Namibian country rock consists of sedimentary and volcanic formations that were laid down or emplaced about 240 million years ago. About 135 million years ago during the mid-Cretaceous Period, the breakup of Gondwana fractured the crust, enabling magma and associated, mineral-rich fluids to surge upward and create deposits of such metals as lead, zinc, and uranium. A subsequent uplift of much of southern Africa greatly accelerated surface erosion, exposing many deposits. The combination of accelerated surface erosion and increased flow in the Orange River in what is now southern Namibia created the world's richest diamond placer deposits.

Diamonds were discovered in Namibia in 1908 near the coastal town of Luderitz when the nation was still the German colony of South-West Africa. This was an extraordinary discovery because diamonds could literally be picked by hand from the sandy floors of the desert valleys. By the start of World War I, German colonists had already gathered more than seven million carats of diamonds. Another diamond discovery in the 1930s near Oranjemund at the mouth of Orange River was even larger. This region has now been mined continuously for 80 years, with total production surpassing 65 million carats. Namibia currently ranks sixth in world annual diamond production.

All Namibian diamonds occur in placer deposits, which are concentrations of loose diamonds in alluvial gravels and sands. These diamonds were transported by the Orange River into the Atlantic Ocean and distributed northward by the littoral currents. Diamond placers occur in bedrock gullies and eluvial deposits in desert wind corridors, and in both raised and "drowned" ancient beaches,. Namibia now recovers about 1.6 million carats of diamonds per year from three basic types of mining: open pit, onshore, and offshore.

Open-pit mining is conducted near the mouth of the Orange River, while onshore miners work the gravel terraces and beach pockets along the coastline from Oranjemund north to Luderitz. Offshore mining, which includes shallow-water and deep-water operations, now accounts for 60 percent of Namibia's diamond production. Shallow-water mining from the surf to depths of 60 feet is conducted by divers who guide suction hoses that are connected to pumps on the beach. Sea-bottom gravels are then pumped ashore to be screened for diamonds. Offshore diamonds are recovered by deep-water mining at depths greater than 300 feet, with robotic sea-bottom "crawlers" dredging gravels onto ships for sorting. Geologists estimate that more than two billion carats of diamonds—95 percent of which are gem quality—are potentially recoverable from the Namibian sea-bottom.

Most mineral collectors are familiar with Namibia not because of diamonds, however, but because of the legendary Tsumeb Mine. Located at Tsumeb in northern Namibia, the Tsumeb multimetal deposit was first commercially mined by German colonists in 1905. The name Tsumeb comes from a native word meaning "place of the moss," referring to a prominent hill of green, oxidized copper minerals. The Tsumeb deposit is a huge, highly mineralized, nearly vertical geological pipe, the origin of which is still debated. More than 30 million tons of Tsumeb ore have yielded 1.7 million tons of copper, 900,000 tons of zinc, 2.8 million tons of lead, 90 tons of the rare element germanium, and substantial amounts of silver and gold. On average, Tsumeb ore is exceedingly rich, containing 10 percent lead, 4.3 percent copper, and 3.5 percent zinc. The mine was closed in 1996, but has recently reopened. The lower levels of this 3,000-foot-deep mine are flooded, but enough shallow, oxidized ore remains for many more years of mining.

Most leading collectors and museum curators consider Tsumeb to be the world's greatest source of mineral specimens. More than 282 minerals have been identified at Tsumeb, which is the type locality for 70 mineral species, some of which have never been found elsewhere. Tsumeb doesn't only have a remarkably wide variety of minerals, but many of its specimens are also exceptional in size, intensity of color, and degree of crystal development. Tsumeb specimens can be found in virtually all the world's leading mineral collections.

Namibia also has a rapidly growing, small-scale mining sector that produces gemstones and decorative stones and is centered in the Erongo-Brandberg region of granite pegmatites and basaltic vugs. After quantities of gem-quality aquamarine and amethyst were discovered there in the late 1990s and sold to Tsumeb mineral dealers, hordes of native diggers descended upon the region. Today, several thousand small-scale miners earn their living recovering gemstones, decorative stones, and mineral specimens.

Accurate production figures for independent miners are virtually impossible to compile, first because of incomplete reporting and second because Namibia imposes a tax on mineral production as high as 55 percent. Not surprisingly, many gemstones and decorative stones are smuggled out of the country to avoid paying the tax. Government estimates of gemstone and decorative-stone production, that is, the material actually taxed, are believed to be very low. For example in 2012, these figures include agate, 100 pounds; amethyst, 6,000 pounds; blue chalcedony, 20 pounds; "picture stone," 100 pounds; rose quartz, 8,000 pounds; sodalite, 800 pounds; and the elbaite and schorl members of the tourmaline group, 50 pounds.

To increase its own tax revenues and also to further the lot of the independent miners, the Namibian government is taking steps to structure the small-scale mining sector. It is setting up channels to help small-scale miners export directly to European buyers, and is even considering establishing domestic cutting and polishing facilities so that "value-added" gemstone products can be exported at far higher prices. The government is also helping to set up regional organizations and associations, such as the Erongo Small-Scale Gemstone Miners Association of Namibia, to introduce advanced mining techniques and geological information, increase safety, and assist in marketing and business planning.

With the reopening of the Tsumeb Mine and the increasing production of diamonds and other gemstones and decorative stones, mining is playing an increasingly important role in the Namibian economy. And for collectors, that means greater availability of Namibian minerals and gemstone specimens.

*TECHNOLOGICAL USES*

Amethyst has no technological uses.

*ABOUT OUR SPECIMENS*

Our amethyst specimens were collected at Tafelkop in the Goboboseb Mountains in the Brandberg area of the Erongo Region of Namibia. Located in southern Africa, Namibia is bounded by the Atlantic Ocean to the west, Angola to the north, Botswana to the east, and South Africa to the south. Covering 318,259 square miles, Namibia's area roughly equals that of the combined American states of Texas and Oklahoma. Because much of Namibia is arid desert, its population is only 2.2 million, making it the second least-densely populated nation in the world behind Mongolia. The national capital, located in central Namibia, is Windhoek.

In 1884, Britain annexed the coastal areas adjacent to its Cape Colony (now South Africa), while Germany claimed nearby coastal sections and parts of the interior as its Südwestafrika (South-West Africa) colony. During World War I, British troops from South Africa occupied South-West Africa. South Africa assumed the regional administration of the former German colony in 1920, then annexed it in 1946. In the 1960s, guerrilla forces of the South-West Africa People's Organization (SWAPO) began fighting against South African troops. In 1968, the United Nations renamed the region Namibia after the ancient, indigenous, Nama-speaking people, and appointed an international council to supervise its affairs and plan for its independence. Fighting between South African troops and SWAPO rebels continued through the 1980s. In 1992, Namibia adopted a SWAPO-controlled, Western-style, constitutional government and was granted its full independence. Today, Namibia's economy relies on farming, ranching, and mining, the latter for diamonds, gold, copper, lead, zinc, uranium, and gemstones.

# April 2014 Mineral of the Month

The Goboboseb Mountains are a group of low, volcanic hills located 160 miles northwest of Windhoek and about 50 miles east of the Atlantic coast. The nearest major landmark is Brandberg Mountain, a huge granite massif with a summit elevation of 8,550 feet. The mountain, which is the site of has thousands of ancient pictographs, is of great spiritual significance to the regional San (Bushman) tribes. Brandberg Mountain is part of Namibia's Brandberg National Monument. In 2002, the United Nations, citing Brandberg Mountain's cultural and natural significance, designated it a UNESCO World Heritage Site. The Goboboseb Mountains are located southeast of Brandberg Mountain near the settlement of Uis, population 3,000. Uis was established in 1958 as a mining town when a South African tin-mining company began operating nearby. Since the mine closed in the 1990s, the population of Uis and the strength of the local economy have declined sharply. Many residents now work as independent miners and mineral collectors who search for amethyst at Tafelkop in the nearby Goboboseb Mountains. Tafelkop is a small volcanic mountain with a summit elevation of 3,300 feet. It stands alone on a flat plain covered only by sparse, brushy, "thornveld"-type vegetation. The entire region is an arid desert that receives less than eight inches of annual precipitation.

Tafelkop is a remnant of the Entendeka Volcanic Field, a massive volcanic flow that once covered the region. In the mid-Cretaceous Period some 135 million years ago, crustal disruption associated with the breakup of the Gondwana supercontinent (see "Mining in Namibia") triggered widespread volcanic activity that created thick basalt formations. In some of the original magma, gas bubbles created vugs in the solidifying basalt. With further cooling, contraction created broad networks of cracks and channels which conveyed silica-rich solutions. Voids in the basalt sometimes filled with these solutions, which precipitated quartz crystals in the form of rock crystal, smoky quartz, and amethyst within the vugs. Erosion eventually reduced the massive basalt formation, leaving only the low Goboboseb Mountains and their exposed vugs filled with rock crystal, smoky quartz, and amethyst.

The first geological surveys of the Goboboseb Mountains were conducted in the early 1900s, when the region was under German control. In the 1920s, British prospectors discovered small, but rich, outcrops of ferberite [iron tungstate, $FeWO_4$] and cassiterite [tin oxide, $SnO_2$]. Several tin-tungsten mines began operating in the 1930s, but are no longer active. The early German and British surveyors and prospectors doubtlessly were aware of the Tafelkop amethyst crystals and gathered them for their personal collections.

Commercial interest in Tafelkop amethyst began in the late 1990s, after the aquamarine variety of beryl [beryllium aluminum silicate, $Be_3Al_2Si_6O_{18}$] was discovered at Erongo Mountain 40 miles to the southeast. When this aquamarine attracted considerable attention on international specimen markets, native diggers flocked to Erongo Mountain. Many also searched adjacent areas, including the Goboboseb Mountains, where they discovered gem-quality amethyst crystals at Tafelkop. By 2006, after Tafelkop amethyst had been publicized in *Rocks & Minerals* magazine, Namibia was recognized as an important source of quality amethyst.

Mining and collecting at Tafelkop is difficult because of the hardness and durability of the basalt. Mining at Tafelkop employs two basic approaches. One method, which requires only picks, shovels, and screens, involves digging through the talus material at the base of the slopes in search of loose amethyst crystals. Loose crystals, which are usually abraded, broken, and of poor specimen quality, are sold mainly to regional tourists and visitors. In the second approach, small-scale, commercial, specimen-and-gemstone miners stake claims and hire teams of laborers to methodically break the basalt with hammers, chisels, and bars to search for intact, crystal-filled pockets. Small compressors and air hammers are occasionally employed. Commercial miners supply most of the amethyst specimens that are exported from Namibia. The Namibian government is currently taking steps to organize small-scale miners and improve marketing efforts (see "Mining in Namibia").

Along with the rock crystal, smoky quartz, and amethyst at Tafelkop, other interesting minerals include the agate variety of quartz, calcite [calcium carbonate, $CaCO_3$], prehnite [basic calcium aluminum silicate, $Ca_2Al_2Si_3O_{10}(OH)_2$], and the zeolite mineral analcime [hydrous sodium aluminum silicate, $NaAlSi_2O_6 \cdot H_2O$], all of which sometimes occur in association with amethyst in interesting composite specimens.

As you examine your amethyst specimen, note first its delicate, purple-to-lilac color. The intensity of this color varies widely among Tafelkop specimens. Tafelkop amethyst often has a very delicate, pale, lilac color that is known in gem circles as "rose de France." Some specimens can appear as nearly colorless rock crystal capped by a secondary growth of amethyst. All these crystals are very well-developed and show such diagnostic quartz features as hexagonal prisms, pyramidal terminations, crosswise striations, and a bright, vitreous luster. Color zoning, a diagnostic characteristic of amethyst, is prominent in most specimens, with the most intense colors concentrated near the crystal terminations. At the base of the crystals, many specimens will have bits of massive quartz and weathered basalt, which are part of the vug wall in which they developed.

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