"FLOWERS" OF AMETHYST

Radiating Crystal Clusters from Brazil

Unlike many gemstones, amethyst comes in a single color—purple. Only a few other transparent gemstones, notably tanzanite and the kunzite variety of spodumene, intrude upon amethyst's color domain. But while amethyst occurs only in purple, it's range extends from soft, delicate lilacs all the way to intense, saturated "royal" hues. This remarkable array of pleasing, purple colors explains why amethyst is the most valuable and desirable of all the quartz gemstones.

For many collectors, the appeal of amethyst extends beyond color to a variety of crystal forms. Amethyst prisms from Maine are typically short and blocky, while those from Mexico are long and slender. South Africa's amethyst cactus quartz consists of complex arrangements of secondary-growth crystals, while amethyst from Namibia often takes the form of scepter crystals. Amethyst also occurs as drusy coatings, geode linings, agate, and a number of massive forms that are carved into cabochons and decorative objects.

One of the most unusual amethyst forms are "flowers"—clusters of radially oriented prisms that resemble open flower petals. Amethyst "flowers" combine beautiful amethystine colors and well-developed prisms with the intriguing complexity of radiating, crystalline aggregates.

The finest amethyst "flowers" come from Brazil, where they precipitate from silica solutions in two divergent mineralogical environments: granite pegmatites and basaltic vugs. Despite the different geological origin, the appearance of both pegmatitic and basaltic amethyst "flowers" is quite similar.

As a color variety of quartz, amethyst is silicon dioxide (SiO_2) that consists of 46.74 percent silicon (Si) and 53.26 percent oxygen (O). Quartz crystallizes in the hexagonal system with 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 is perpendicular to the plane of the other three.

The diagnostic habit of quartz is the hexagonal prism, in which six prismatic faces are arranged parallel to the unique axis. Terminations are usually well-developed, hexagonal or dihexagonal (12-sided) pyramids. Quartz has a specific gravity of 2.65, a Mohs hardness of 7.0, a vitreous luster, and a conchoidal fracture.

Quartz is an allochromatic or "other-colored" mineral, meaning that its colors are caused by factors other than its essential elemental components or the nature of its crystal lattice. When pure or nearly pure, quartz is colorless or white. Its colors are created by traces of nonessential, color-producing elements called chromophores; the effects of geophysical radiation; lattice defects called "color centers"; or inclusions of foreign minerals. These factors, alone or in combination, produce a wide range of colors and other visual effects. The main quartz color varieties are colorless rock crystal, gray-brown smoky quartz, white milky quartz, yellow citrine, rose quartz, pink quartz, and purple amethyst.

Amethystine colors in quartz are relatively rare because their origin is complex and requires specific chemical and environmental conditions. The trace presence of ferric iron Fe^{+3} creates amethyst's basic purple color. These ferric ions—present in amounts of only about 40

parts per million—must then substitute for silicon ions within the quartz lattice and, under proper conditions, give up another electron to produce Fe^{4+} ions. These freed electrons then become trapped in vacant lattice sites called "color centers." Because of their negative charges, color centers alter the light-absorption properties of the crystal lattice, causing it to absorb the yellow and green wavelengths of the visible spectrum, while transmitting and reflecting only the red and blue wavelengths, which the human eye perceives as purple.

In the most desirable amethyst colors, the basic purple is highlighted by flashes of red and pink. These are created by the presence of divalent manganese ions Mn^{2+} which substitute for iron in the crystal lattice and function as a chromophore that reflects red light from point sources.

Adding to the complexity of amethyst color is color zoning, which is prominent in most amethyst specimens. Color zoning develops when the iron content of the silica solutions change during crystallization. Intensely colored sections of amethyst crystals form from iron-rich solutions, while pale or nearly colorless sections form from iron-deficient solutions. Many amethyst crystals exhibit repetitive color banding that reflects a sequential enrichment and depletion of the iron content in the silica solutions.

The most intense amethyst colors are often—but not always—concentrated in the crystal terminations. Within single amethyst crystals, color zoning can sometimes be quite extreme, with certain sections appearing colorless, while others exhibit intense color. In mineral specimens, such extreme color zoning can be visually appealing. But for gem cutters, it complicates the process of faceting of uniformly colored gems.

Amethyst crystals tend to have water-clear transparency. Their refractive index of 1.544-1.553 approximates that of the emerald and aquamarine varieties of beryl. While this not a particularly high refractive index, neither is it problem, because the appeal of amethyst gems is vested, rather than brilliance.

Because of its color, amethyst has long been associated with wine. The word "amethyst" actually comes from the Greek *amethystos*, meaning "remedy against drunkenness." Both the ancient Greeks and Romans wore amethyst jewelry while drinking wine to ward off drunkenness. Wine aficionados often drank from goblets carved of massive amethyst in the belief that, since the goblets retained their color after the wine had been consumed, they also retained the wine's intoxicating effects.

Medieval alchemists theorized that amethyst was actually "unripe" ruby and sought ways to speed the "ripening" process. Physicians of that era prescribed potions of powdered amethyst to remove bodily toxins, cure digestive and circulatory ailments, and alleviate arthritic pain. Amethyst also acquired unusual religious significance. Medieval clergymen wore it to encourage celibacy and to symbolize piety, traditions that survive today in the amethyst rings worn by Catholic bishops.

With its distinctive purple color, amethyst is the most recognizable of all quartz gemstones. Its substantial hardness suits it for use in all types of jewelry, including rings. Deeply colored, "royal purple" amethyst has traditionally commanded the highest prices. But soft, lilac shades are also quite beautiful; called "rose de France," pale amethyst stones were especially popular in jewelry of the Victorian era.

To intensify color and reduce color zoning, amethyst is often heat-treated before faceting. Heating almost to the melting point of quartz allows the ferric ions to diffuse more evenly throughout the stone. Excessive heat-treating, however, can transform the purple into a golden-yellow color that is very similar to the citrine variety of quartz. In fact, most citrine gems sold today are actually heat-treated amethyst.

Faceted amethyst gems are usually cut in square, emerald, or rectangular styles. Such gems generally weigh between 2 and 6 carats, but sizes of 10 or even 20 carats are not unusual. Amethyst's color zoning can sometimes limit gem size, however, since stones must be carefully cut to minimize any uneven coloration.

Despite its color zoning, amethyst makes wonderful collectors' gems. Because large amethyst crystals are readily available from sources in Russia and Brazil, collectors' gems as large as 200 carats are surprisingly affordable, sometimes costing less than $1,000. The largest faceted amethyst is a spectacular, 1,362-carat gem from Brazil that is part of the collection of the National Museum of Natural History (Smithsonian Institution) in Washington, D.C. The British crown jewels also include several stunning amethyst gems that are just as impressive as other royal gems of much greater rarity and value.

Amethyst specimens are widely collected for their colors, crystal forms, and mineralogical associations. Many private amethyst collections focus specifically on colors or crystal forms. One of the most unusual forms are amethyst "flowers."

Amethyst "flowers" form only within pegmatite or basaltic vugs that have irregular inner surfaces. While smooth vug walls produce only uniform crystal linings, uneven walls provide the raised points that are necessary for crystals to develop in wide, radiating sprays.

According to metaphysical lore, amethyst promotes serenity and calmness; provides mental strength and stability; balances physical, intellectual, and emotional states; and encourages the assimilation of new ideas. But in amethyst "flowers," the radiating crystal clusters impart added significance. Amethyst "flowers" symbolize community, while specifically providing harmony and balance in group and familial relationships, and generally removing negative energy from social environments.

Amethyst occurs in granite pegmatites; iron-rich, basaltic rocks; and hydrothermal-emplacement veins. Important sources of amethyst include Brazil, Uruguay, Madagascar, Mexico, Russia, Bolivia, Canada, Zambia, and Namibia. In the United States, amethyst specimens are collected in Maine, North Carolina, Colorado, and Arizona. Amethyst "flowers," however, are found only in Brazil.

Brazil has dominated world amethyst production since the early 1800s, providing superb specimens from both pegmatitic and basaltic environments. Today, Brazil's amethyst exports are estimated at between 2,000 to 4,000 tons per year. Amethyst "flowers," which are relatively rare, make up only a small part of this production. And some of the best amethyst "flowers" are recovered from pegmatites near the small city of Itambacuri in the Doce Valley of Brazil's Minas Gerais state.

Minas Gerais has a population of 18 million and is about the size of the state of Texas. It borders the Atlantic Ocean on the east and the states of Bahia on the north, Tocantins on the west, and São Paulo on the south. In the 1700s, the mines of Minas Gerais (Portuguese for "General Mines") made the Portuguese colony of Brazil the world's leader in gold production. Today, Minas Gerais has a much more balanced economy based on the mining of gold, gemstones, iron, manganese, zinc, and aluminum; the agricultural production of coffee, sugarcane, cotton, and oranges; and a growing manufacturing industry.

Minas Gerais is famed for its mineral specimens and gemstones, most of which are mined from granite pegmatites. The Minas Gerais Pegmatite Belt, a geological zone of gemstone-rich, granite pegmatites, extends 170 miles east-west and 360 miles north-south in the northeast part of the state.

Granite pegmatites are bodies of very coarse-grained granite that originate as pockets of residual magma, which is the last of a magmatic intrusion to cool and solidify. Residual magma cools so slowly that it crystallizes on a fractional, or mineral-by-mineral, basis in the form of irregular pods, lenses, veins, and dikes.

Residual magma is often enriched with accessory or rare elements that form unusual minerals. Gases within residual magma can sometimes create mariolitic cavities that provide space for the growth of large, well-developed crystals. Minas Gerais has produced many extraordinary specimens of elbaite, topaz, spinel, brazilianite, chrysoberyl, various color varieties of beryl, the hiddenite and kunzite varieties of spodumene, and the amethyst variety of quartz

The Minas Gerais pegmatites formed about 490 million years ago during the early Paleozoic Era when the present-day surface was deeply buried. Subterranean basement rock consisted, at that time, of highly metamorphosed gneiss, quartzite, and schist. Following tectonic fracturing, granitic magma surged upward through fissures and was initially capped by the basement rock. Before cooling and solidifying, columns of residual magma then surged upward into fissures to cool very slowly and form pegmatites. Erosion eventually exposed these pegmatites that are now the basis of the gemstone-mining industry in Minas Gerais.

Itambacuri, population 25,000, is located 50 miles southeast of the city of Governador Valadares in the Doce Valley and about 50 miles from the Atlantic coast. This region is 400 miles northeast of the coastal city of Rio de Janeiro and at the eastern limit of the Minas Gerais Pegmatite Belt. With its warm tropical climate, Itambacuri has an economy based on cattle ranching and the production of coconuts, coffee, sugarcane, manioc, and corn.

Several major pegmatites exist near Itambacuri, where miners blast and remove large quantities of surrounding rock to expose the pegmatite veins. The Itambacuri pegmatites yield fine specimens of amethyst “flowers,” along with those of the tourmaline mineral elbaite. After blasting has exposed the pegmatite vugs, miners then extract the crystals manually using hammers and chisels, taking great care not to damage the fragile specimens.

Buyers from Governador Valadares then purchase the amethyst “flowers” and deliver them to international markets, where collectors around the world have the opportunity to acquire specimens of one of the most beautiful and distinctive forms of amethyst.