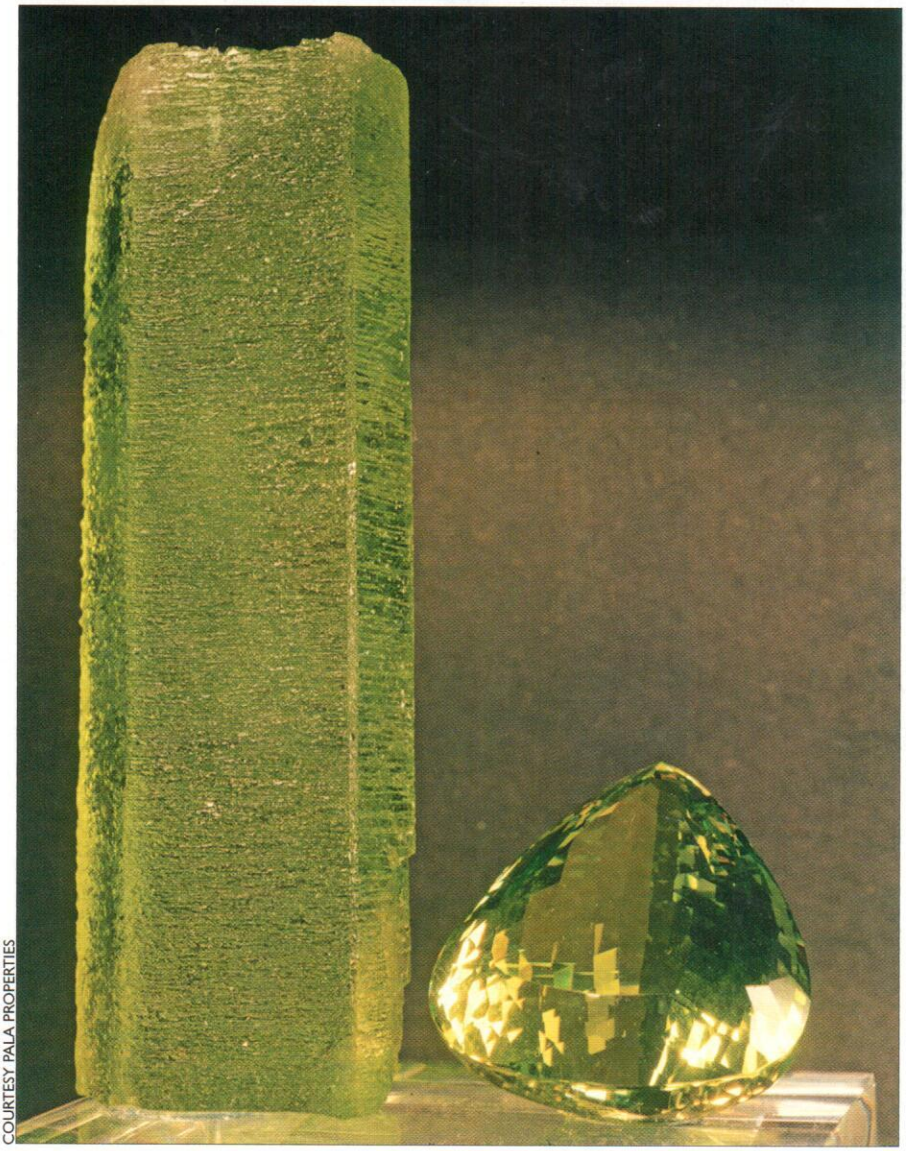
The BERYL MINERAL GROUP

Story and Photos by Bob Jones

The element beryllium has the atomic number 5 on the periodic table of elements, but to many jewelers and lovers of gems, some beryllium minerals rank as No. 1 on the must-have table.



COURTESY PALA PROPERTIES

This 6-inch light-green beryl crystal with a 180-carat faceted companion is from Brazil.

Colorful Crystallized and Massive Gem Materials

Like garnet, feldspar, and some other minerals, beryl is actually the name of a mineral group that includes aquamarine, morganite, goshenite, emerald, heliodor, and pale-green and red varieties with no special names. Most of these varieties are gemmy, or at least very attractive, hexagonal display crystals, but the metal beryllium, extracted from large masses of opaque beryl, is hard, light, and very useful in the aircraft and rocket industries. Beryl in pegmatite deposits form from the final-stage fluids of a huge, slowly solidifying igneous mass, while beryls in metamorphic rocks like schist and igneous rocks like rhyolite originate from impurities in the rocks that are extracted by hot vapors.

We are not sure when beryl gems were first discovered, but some historians suggest the green gem in the Breastplate of Aaron, the High Priest of Israel, described in Exodus 28:17-20 (circa 1400 BCE) was an emerald. We do know the green gem emerald was highly prized by the native peoples of South America, particularly Colombia, who mined it for centuries before the arrival of the Spanish Conquistadors.

Many mineralogists and collectors would dispute the existence of "colorless" beryl. Pure beryl would be colorless, but since few natural minerals are completely pure, even "colorless" beryl is slightly tinted. Any beryl that is colorless or nearly so is called "goshenite", after its type locality of Goshen, Massachusetts. It is found in minor amounts in some pegmatite deposits and is prized only as a collector mineral. Far more important are the colored varieties of beryl; a hardness of Mohs 8, well above that of quartz, makes them desirable for gem use. Beryl's appeal lies in its variety of colors, so the fact that radiation and other treatments can improve poorly colored stones delights both miners and faceters!

The most common colored variety of beryl is aquamarine, so named for its pale to very dark blue color, depending upon the chromophore involved. Morganite is a lovely pink to peach color. Heliodor (the Greek word *helios* means "sun") is so named

This cluster of fine green emeralds from Muzo, Colombia, is in the collection of the Smithsonian Institution.

because of its sunny yellow color. Red beryl is found in limited amounts of quite small crystals, so gems over 5 carats are rare, while gems weighing thousands of carats have been cut from aquamarine and heliodor.

The variety of beryl that has most excited the world is emerald. Once considered a symbol of royalty, it is cherished above all other beryls. Its rich green color, caused mainly by chromium and, less often, by vanadium chromophores, is rivaled only by that of rare green garnets.

Significant deposits of gem emerald are found only in two historically important deposits and three more recently developed sources. The jungles of Colombia, South America, and Russia's Ural Mountains have long histories of emerald production. Mines in Bahia, Brazil, and the Kafubu area of Zambia have recently produced fine emeralds. Large hexagonal crystals have begun to emerge from China, though I have yet to see any large emerald gems cut from them. The crystals I've seen are embedded in metamorphic rock, are prismatic and slender, and have a modest green color and dull luster. Those I've seen do not compare with crystals from other sources.

Russian emeralds occur locked in a gray schist. The thick, stubby crystals often have biotite mica inclusions, with the mica often jutting out of the green hexagons. The vast majority of Russian emeralds are cloudy to opaque and are useless as gems, but make fascinating display specimens. Such crystals are seldom more than a few inches long and a couple inches across. Crystals with gemmy sections are cut and produce fine, rich green gems. Russian empress Catherine the Great loved emeralds and had a stunning horse bridle made that was encrusted with Uralian gem emeralds.

The original Russian deposit is located in the Ekaterinburg district (Sverdlovsk region) of the Ural Mountains, and yielded the lovely chrysoberyl variety alexandrite, as well. The district was named for Catherine the Great (Yekaterina II Velikaya). The discovery was accidental: A woodcutter saw green bolts embedded in the roots of a fallen tree and took them to the Ekaterinberg lapidary works, where the manager identified them. A rush ensued, and thousands of crystals were extracted, most of which had their enclosing biotite mica removed.

I was fortunate to visit several of the emerald mines at Muzo and Coscuez, Colombia, which prompted me to study up on their history. The indigenous Indians diligently mined the stones from the black shale and gave them as tribute to their royalty, who were considered representatives of the gods, or sacrificed them directly by casting them into a deep spring or lake. When the Spanish explorers arrived, the natives refuse to reveal their source, no matter how much torture was applied. A war ensued to no avail. As fate would have it, a soldier's horse came up lame from an emerald crystal embedded in his hoof as it crossed the mine dumps, and the jig was up.

We are fortunate that emeralds of superb quality have been found in pegmatites in western North Carolina. Finds were sporadic for decades, but in the late 1990s, a young fellow named Jamie Hill began mining seriously and discovered amazing, green gem crystals in the Hiddenite area. This remarkable find gave collectors hope that more emeralds might someday be found.

When discussing beryl found in pegmatite deposits, keep in mind that these deposits contain the final-stage fluids of a huge, slowly solidifying igneous mass that cooled miles down in the earth's crust. These final solutions are made up of rare or uncommon elements like fluorine, lithium and cesium, which become part of the slowly forming beryls, elbaites, and a variety of rarer late-forming species. As the temperature of the solution gradually drops over thousands of years, large crystals can develop, some of which weigh hundreds of pounds! All sorts of odd and rare elements can also develop from the remaining rich solution.

Aquamarine is the more common variety of beryl being mined. Large aquamarines—some of them very dark blue, others pale blue—have been repeatedly found in the pegmatites of Brazil. After centuries of mining, this source has diminished somewhat. Most of the finest Brazilian aquamarine crystals ever found were cut and faceted into stunning jewelry stones, some of them weighing thousands of carats.

Aquamarine's light- and dark-blue shades result from two different causes. In light-blue stones, an iron chromophore substitutes for some beryl atoms. In dark-blue aquamarine, iron works in concert with oxygen. As the electrons in iron atoms absorb light energy, some of them jump back and forth between the iron and oxygen atoms. This is called "charge transfer".

Heliodor is another charge transfer beryl. As its iron electrons absorb some

This striated aquamarine with black tourmaline on feldspar is from the Erongo Mountains in Namibia.

light energy in the yellow-green range, they move to nearby oxygen atoms. The difference is that this is a one-way transfer; these electrons do not move on to other iron atoms. This results in the lovely yellow and sometimes yellow-green color of these gem beryls.

Heliodor crystals are readily available today thanks to several amazing finds that began in the 1950s. Wonderful beryl crystals ranging from pale green to fine yellow, discovered in a mine at Volodarsk-Volynski (Zhitomir Oblast), Ukraine, flooded the market. The most stunning find in this mine was a pegmatite pocket that yielded 2.2 *tons* of crystals! Crystals 6 and 8 inches long were found here. I saw an interesting example of a Volodarsk crystal a few years ago. The yellow crystal had been split lengthwise and one half was irradiated, which turned it blue.

In the last few decades, Pakistan and Afghanistan have been prolific sources of fine, pale-blue aquamarine crystals occurring in subparallel clusters on matrix. The larger crystals reach 6 inches long. The quantity of specimens from this source has been great, and collectors see a good selection of these aquamarines at shows today.

The mines of China have started to yield fine, mostly light-blue aquamarine specimens consisting of groups of simple hexagonal prisms. The crystals almost always show beryl's typical flat, pinacoidal termination. Minor modifications of the flat terminations are typical in these crystals.

Bright-pink morganites, named in honor of banker and mineral collector J.P. Morgan, are also very popular. They range from pale pink to a rich pink that shades into peach. The bulk of the morganites we see have come from a number of pegmatite localities in Brazil, where morganites tend to be tabular rather than long and prismatic. Their large, flat terminations are always slightly modified. Some of the larger crystals can be 4 or 5 inches across the larger faces.

Pale pink morganites have also been found sparingly in several of Southern California's pegmatite mines. The most exciting

This superb morganite and fine kunzite, on matrix is from the Laghman Province of Afghanistan.

of these formed on and with finely colored pink to red elbaite crystals in a wonderful display combination.

The morganites from Pakistan are exceptionally lustrous, though not as large as many from Brazil. Their colors tend to be quite a strong pink, which suggests a slightly different chemistry from those found in Brazil. The trace chromophore manganese colors the crystals fair to pale pink, while the darker pink morganites have carbon dioxide as a chromophore.

Beryl that is mined for beryllium metal is called "common beryl", as it has no gem use. It ranges from dull, pale yellow to equally dull pale green. Some crystals were huge. I recall visiting a quarry in Connecticut in which common beryl was being mined for ore back in the 1950s. Some of the crystals I saw weighed several hundred pounds. They were ugly, dull, slightly rounded hexagons, but valuable nonetheless.

Red beryl has no varietal name. It is the least common beryl and forms the smallest crystals; crystals that exceed an inch in length or are thicker than a pencil are exciting. In most cases, red beryls have a gemmy area near the termination, while the base is cloudy with included clay or rock.

I was lucky enough to collect red beryl from quarries in the Wah Wah Mountains of Utah. The host rock is very tough white rhyolite. The beryls formed in very small openings created by the accumulation of volatile gasses and in clay seams in the rhyolite. Tiny topaz crystals and microcrystals of fluorite may be found in or near these openings. This is evidence that the rare red beryls converted directly from a gas to a solid by sublimation, and failed to pass into a liquid phase.

The fine color of red beryl is due to manganese, which can also act as a chromophore in pink morganite. To get one or two crystals of red beryl, a miner usually has to move several tons of rhyolite.

Beryl crystals are nice additions to any mineral collection. You'll find them at shows in a full range of quality and prices. With pegmatite, schist and rhyolite environments all over the world, there is no reason to think the supply will diminish anytime soon.