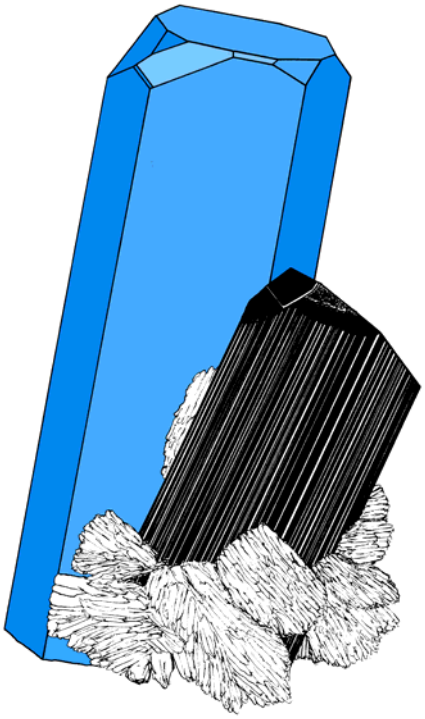
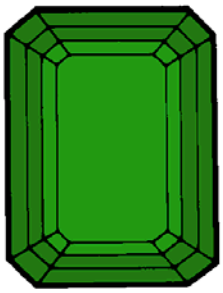
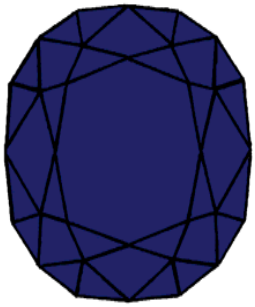
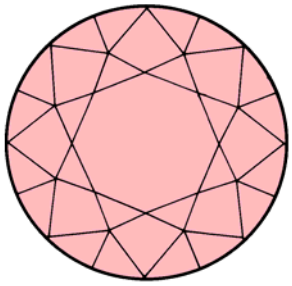
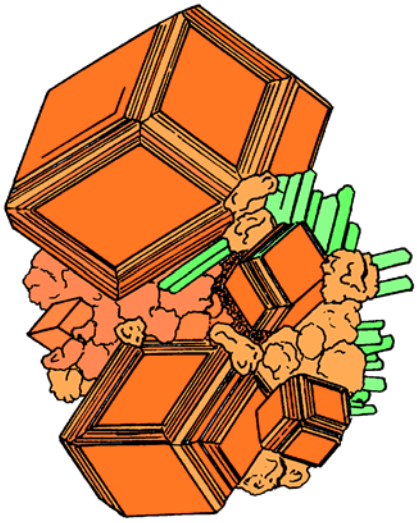


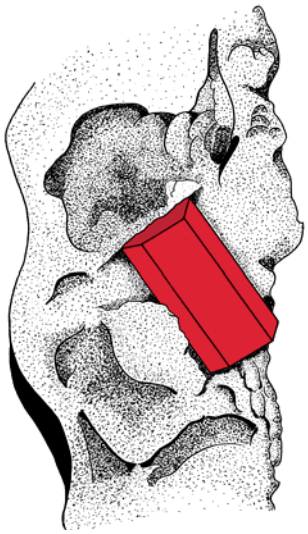
GEMS & GEM MINERALS

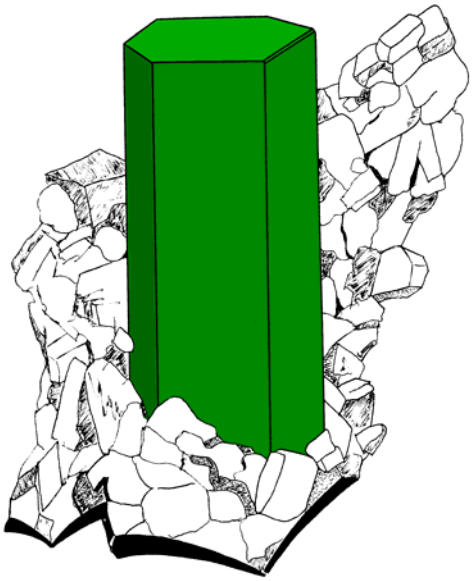


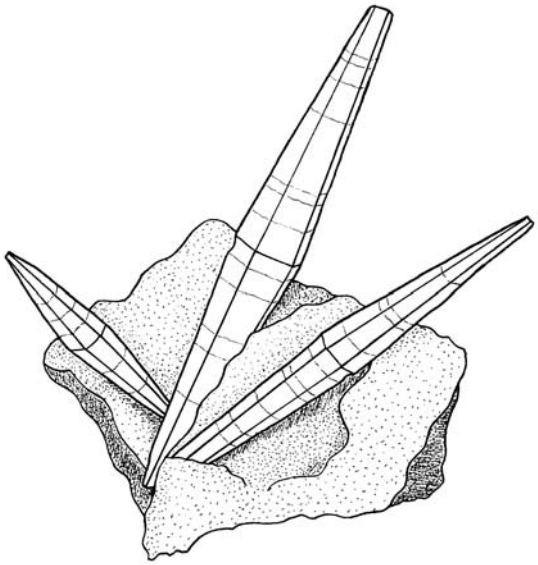












This book was created by Darryl Powell at
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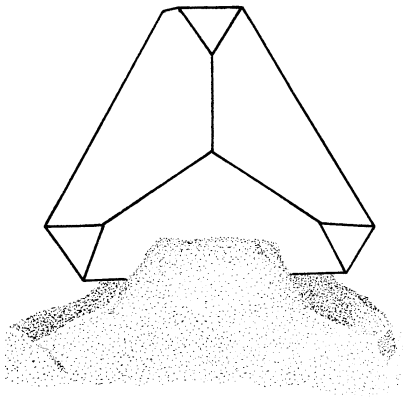
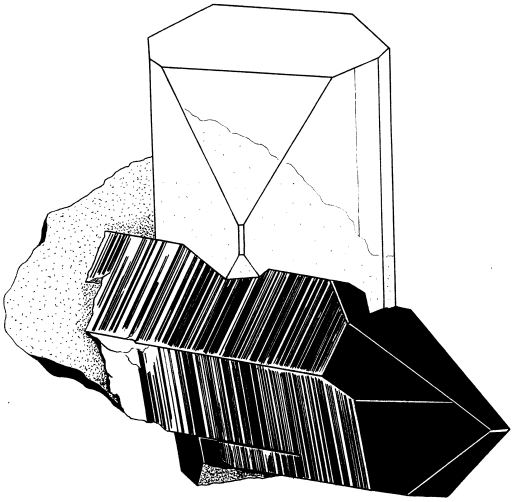
WHAT IS A GEM?

There is a difference between a "gem" and a "gemstone." A gem is the final cut and polished object. A gemstone is usually a mineral, but sometimes another natural material, in its untouched, natural form.

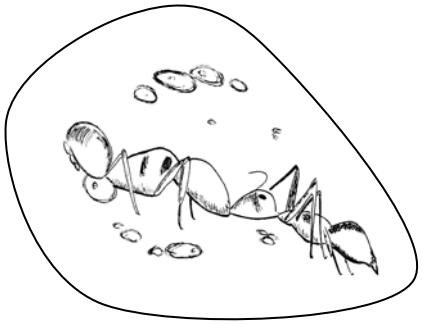


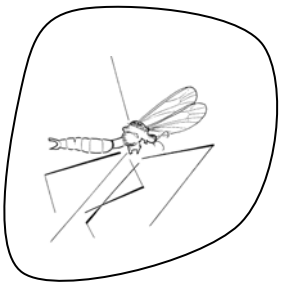
For a mineral to be considered a gemstone, it has to have three basic properties. First, it has to be colorful and beautiful to look at. Second, it has to be hard enough to be able to be shaped, cut or polished. Its hardness is also important because gems are worn in jewelry, so a gemstone has to be hard enough to be worn in jewelry without being easily scratched, chipped or damaged.

Most gemstones are minerals. A mineral is a naturally occurring substance that was not created by a living organism and that has a known chemical formula and a regular internal crystal structure. Diamonds, rubies and emeralds are minerals.



There are also some gemstones that are naturally occurring, but were created by living organisms. Well-known examples of this category are amber and pearls.





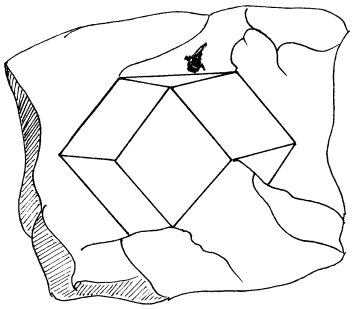
Ants and a Crane fly in Amber.

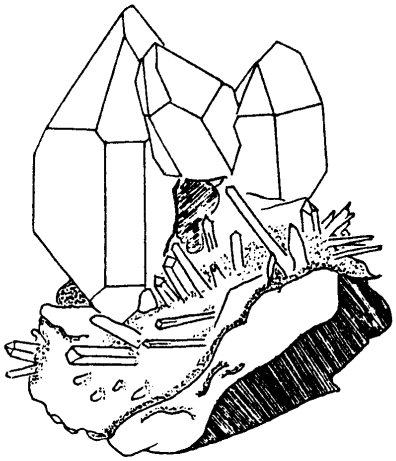
BIRTHSTONES

What is your birthstone? Birthstones are gemstones that represent each month of the year. On the next two pages you will see the birthstones and a crystal drawing of each. This is one popular list of birthstones.

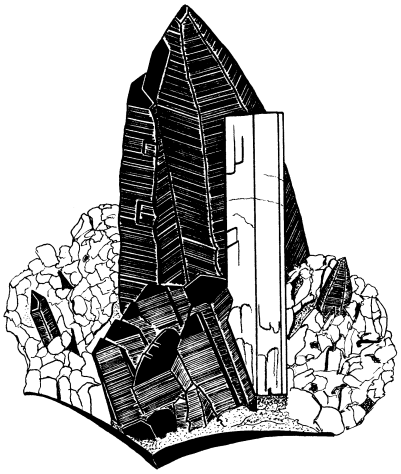
Garnet ~ Red crystal from Connecticut
Amethyst ~ Purple crystals from Mexico.
Aquamarine ~ Light blue from Colorado.
Diamond ~ Colorless from South Africa.
Emerald ~ Deep green from Russia.
Alexandrite ~ Yellow from Russia.

January ~ Garnet

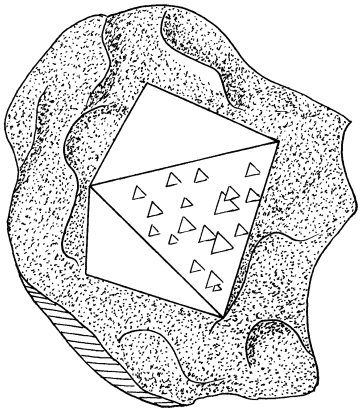




February ~ Amethyst

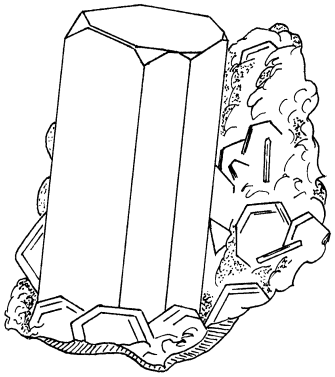


March ~ Aquamarine

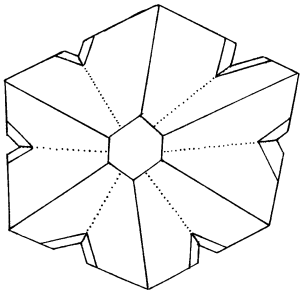


April ~ Diamond

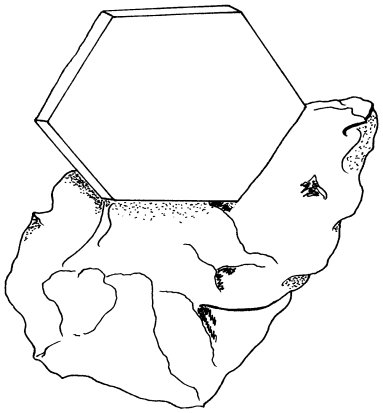
May ~ Emerald



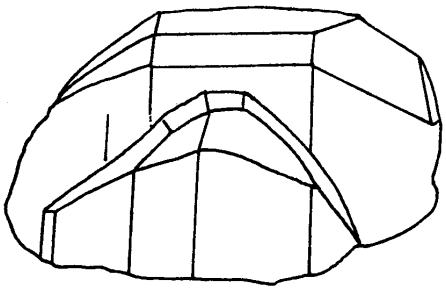
June ~ Alexandrite



July ~ Ruby

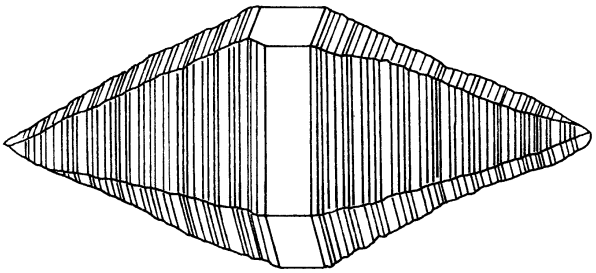


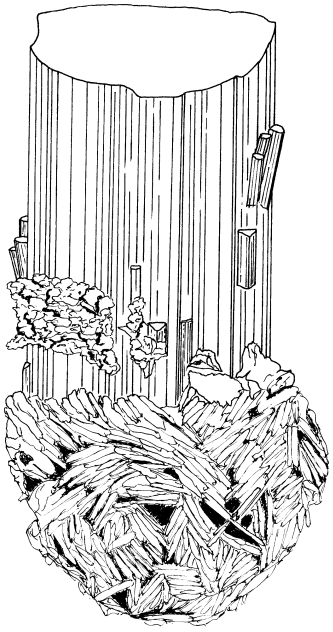
Ruby ~ Deep red corundum from Australia.
Peridot ~ Light green from Egypt.
Sapphire ~ Dark Blue corundum from India.
Tourmaline ~ Pink with blue top from California.
Citrine ~ Yellow quartz from Arkansas.
Turquoise ~ Green-blue turquoise from Nevada.



August ~ Peridot

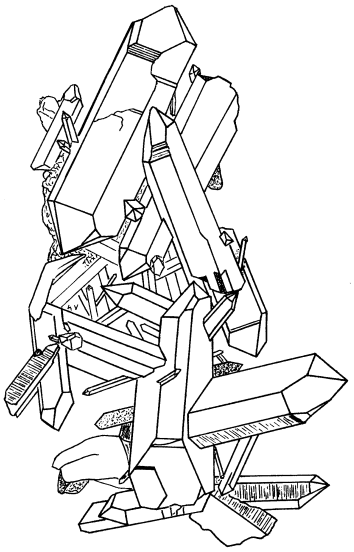
September ~ Sapphire

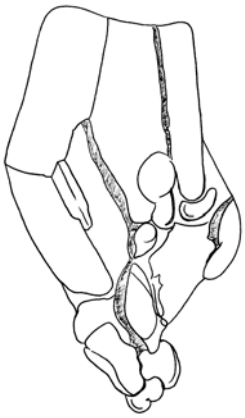




October ~ Pink Tourmaline

November ~ Citrine





December ~ Turquoise

My Birthstone is

_____

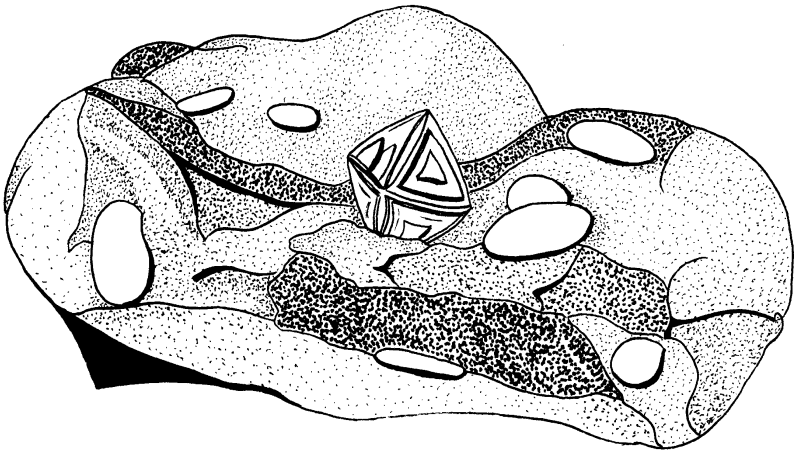
DIAMOND

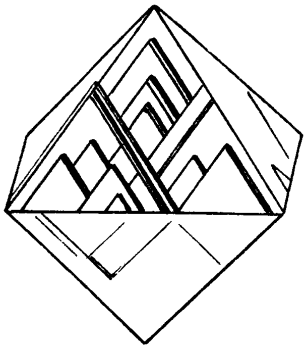
One of the most famous, popular and valuable of all gems is the diamond. Diamond is number 10 on Mohs' Hardness Scale, making it the hardest substance on Earth. It is so hard that it is actually 4 times harder than corundum (number 9 on the hardness scale) and 8 times harder than topaz (number 8 on the hardness scale).

Most diamonds contain black carbon. These black diamonds are not useful as gems, but they are useful to make diamond blades for cutting and polishing rock. Pure diamonds are colorless. When light shines through them, especially when the diamonds are cut into gems, they break the light into its different colors. You will see flashes of different colors when light hits a gem quality diamond. This is a special optical property of gems called *refraction*. Refraction is a measurement of how much a material breaks light into its individual colors.

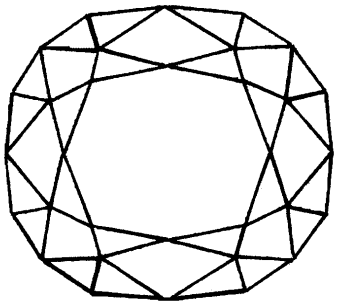
Natural diamonds are usually "diamond-shaped," that is, they are octahedral crystals, like the pictures above. They can also form as cubes, and rarely in more complicated crystal forms.

In very rare situations, diamonds can have deep colors, like blue, yellow, red, orange or pink.

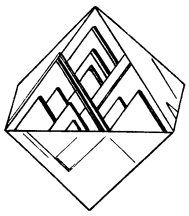




Above left: A diamond crystal in matrix, known as "blue ground" because it is a dark, grayish-blue color. This specimen is from South Africa.
Above right: A single, octahedral diamond crystal. Note that the faces are composed of smaller octahedra.



Diamonds that are naturally colored are called "fancy diamonds" and can be extremely valuable. The Hope Diamond is one of the most famous fancy diamonds in history. Today it belongs to the Smithsonian Institution in Washington, D.C. and is on display in the Gem Gallery. If you go to the Smithsonian, you will see that the Hope Diamond is set in a necklace and is surrounded by diamonds. Here is a simple drawing of the Hope Diamond by itself.



The name *diamond* literally means "invincible." As a result, people have believed that diamonds have the power to do all sorts of wonderful things for those fortunate enough to wear one. Legend says that diamonds protect people from fire, poisoning, snakes, a variety of sicknesses, floods and even evil spirits. Soldiers who wore diamond would be extremely courageous and, therefore, would be victorious in battle. Diamond rings are given before a couple gets married. This tradition goes back to the days when people believed that diamonds were a sign of purity and would make people love each other even more than they could without the diamond!

THE FOUR C'S OF DIAMONDS

Diamonds are graded based on "the four C's," which are color, clarity, cut and carat weight. A higher quality gem, which means a more valuable gem, has high scores in each of these categories.

COLOR is a description of how colorless to yellow a diamond is. The highest quality white diamonds are the ones with absolutely no yellow color at all and are described as *colorless*. The scale is colorless, near colorless, faint yellow and yellow.

CLARITY is a description of the number of the flaws inside a cut diamond as well as where they are in the diamond. "Flaws" include inclusions and fractures.

CUT You might think that "cut" refers to the shape of a gem and the facets cut into that gem. However, cut is really a description of the dimensions of the gem. In other words, is it the right width and height so that light goes into the gem from the top and bounces back off of the faces on the bottom of the gem.

CARAT WEIGHT is a measure of the weight (and therefore, the size) of a cut diamond. Heavier, larger diamonds are a rarity and are, therefore, more valuable.

The value of a diamond is determined by the combination of its color, clarity, cut and carat weight. Based on what you have learned, describe a diamond of very high value:

_____

_____

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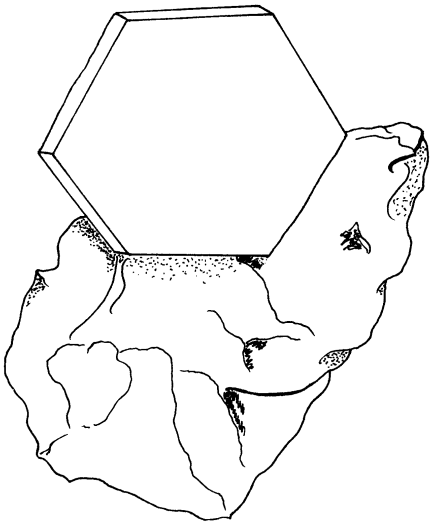
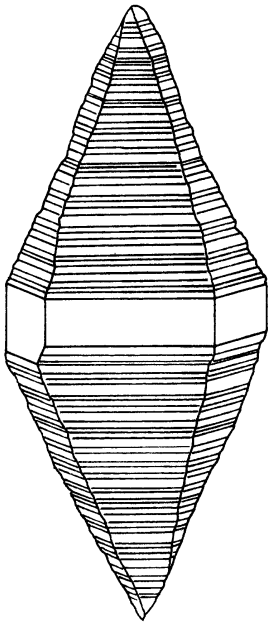
CORUNDUM

RUBIES & SAPPHIRES



Sapphire is the blue, yellow and colorless variety of the mineral *corundum*. It is number 9 on the Mohs' Hardness Scale. Because it is so hard, corundum is used to make grinding wheels and papers for grinding and polishing softer materials like porcelain, metals and wood, for example. Pure corundum is aluminum oxide, Al_2O_3, and is colorless. But, if it has small amounts of the element *chromium* it becomes red. Red corundum is called *ruby*. The presence of the elements *iron* and *titanium* in corundum gives a blue color. Blue corundum is called *sapphire*. When gem-quality corundum is another color like yellow, for example, it is called *yellow sapphire* or very simply *fancy corundum*.

In ancient times people believed sapphire had special powers or properties. Some believed that a king who wore sapphire jewelry would be protected from harm. In Europe, people believed sapphire could protect its owner from ever being poor. Others believed wearing a sapphire would bring intelligence and wisdom, especially to someone who is "stupid." There were also legends about the powers of ruby. Some thought rubies would keep a person healthy. Others believed they would take away evil thoughts. One legend tells us that the first wife of England's King Henry VIII (Catherine of Aragon) predicted there would be many troubles in her life because her ruby was getting darker and darker!

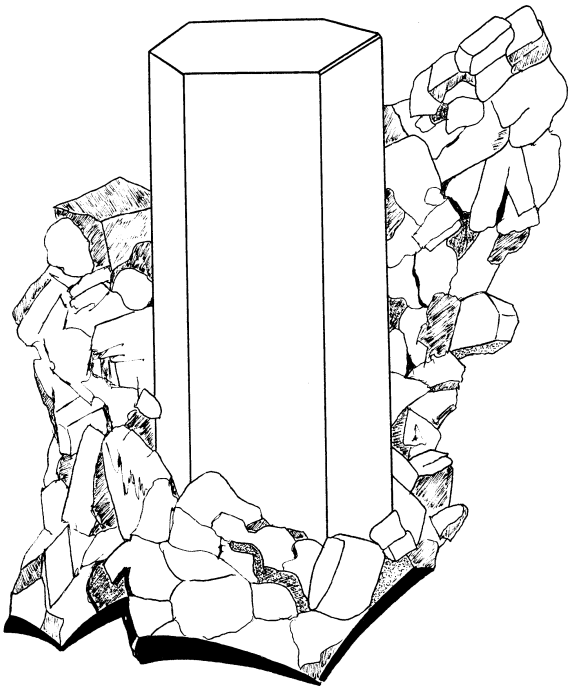


Gemologists discovered that lighter blue sapphires can be made dark blue by heating them. A natural, dark blue sapphire is a very valuable gem. Many of the dark blue sapphires sold in jewelry stores have been heat-treated to make them darker.

Above left: A bright red ruby crystal in matrix from Australia.
Above right: a single, doubly terminated sapphire crystal from Sri Lanka.

BERYL

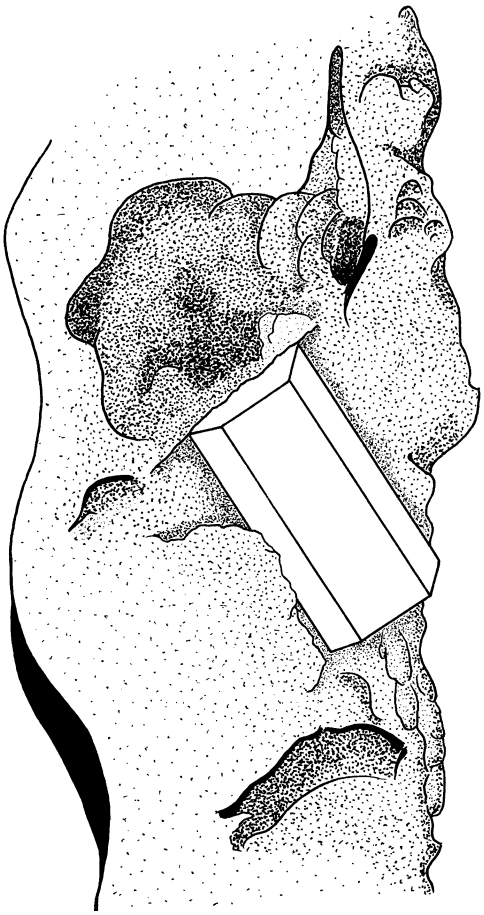
EMERALD, AQUAMARINE, HELIODOR & MORE



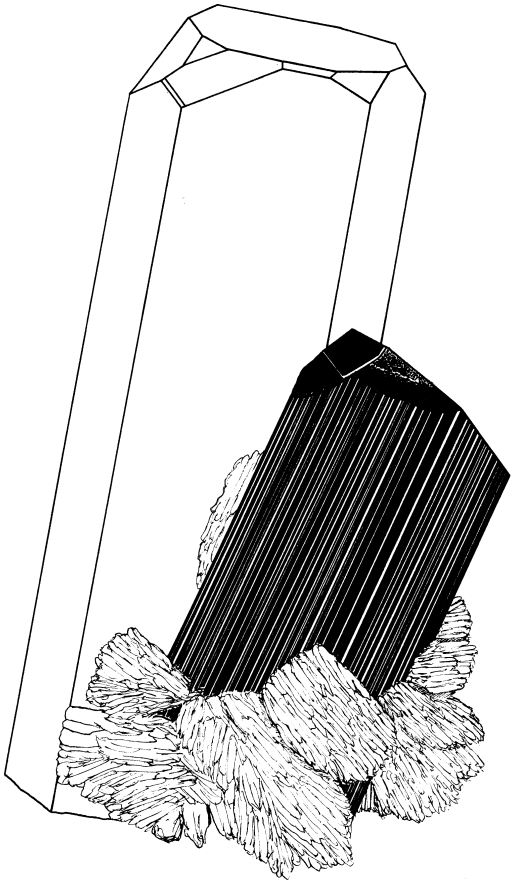
Beryl is the name of a group of minerals that are different only in color. All their other physical properties are the same. They all crystallize in the hexagonal system, have a chemical formula of $Be_3Al_2Si_6O_{18}$, and have a hardness of 7 1/2 to 8.

Each color variety has its own name. Green beryl is called *emerald*; blue is called *aquamarine*; yellow is called *heliodor*; pink is called *morganite*. Red beryl is also known as *bixbite*.

Emerald is the green variety of *beryl*. People have believed emerald to have many different "powers" through the ages. The Romans thought it was a symbol of the power of nature to reproduce. The ancient Greek philosopher/scientist, Theophrastus, claimed emeralds could bring rest to the eyes and relieve eye problems. In the 1600's emerald was thought to have the "power" to stop bleeding and take away fevers. Others believed an emerald could help a person predict the future.



Above: Emerald from Colombia.
Right: Red Beryl from the Wah Wah Mountains, Beaver County, Utah.



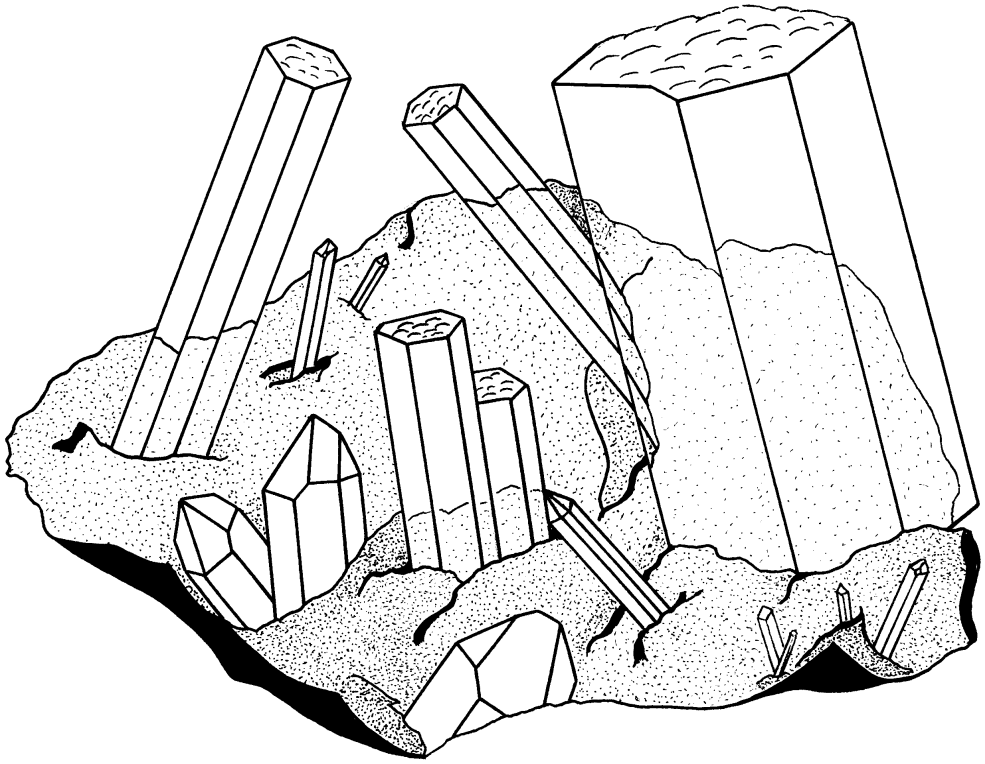
Aquamarine is the blue variety of beryl. The name *aquamarine* comes from two Latin words, *aqua marina*, which mean *water of the sea* or *ocean*. Deep blue aquamarines are popular gemstones, both as gems and as specimens.

Beryl was once the most important source of the element *beryllium*. Beryllium is mixed with light metals, like aluminum. The mixture of two or more metals is called an *alloy*. Mixing small amounts of beryllium with aluminum creates an alloy that is very light weight, but also very strong. Strong, lightweight alloys are used to make aircraft and spacecraft.

In ancient times, sailors wore aquamarine because they believed it would give them courage and protection from the dangers at sea. The yellow variety of beryl, called *heliodor*, was believed to be a cure for laziness!

Above: Aquamarine with schorl (tourmaline) and albite from Pakistan .

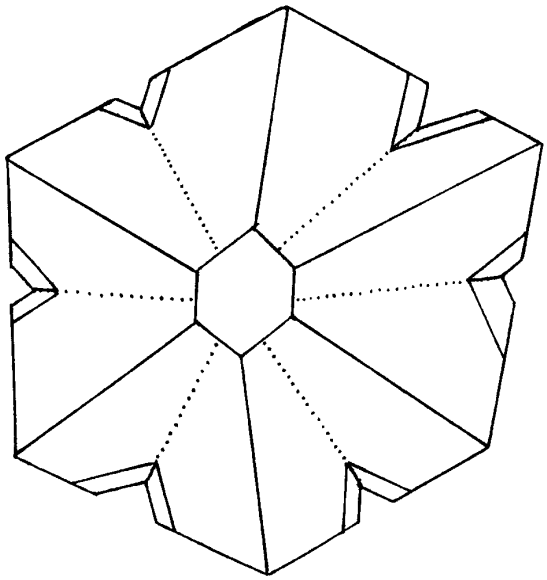
Below: Yellow heliodor crystals with quartz from the Ural Mountains, Russia.



CHRYSOBERYL

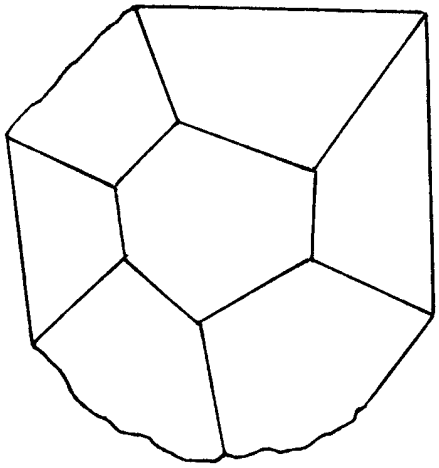
CAT'S EYE & ALEXANDRITE

There are two varieties of chrysoberyl that are polished into gems. One is called *cat's eye*. When this yellowish variety of chrysoberyl is polished as a rounded stone (called *en cabochon* by gemologists) light bounces off of the gem making it look like a cat's eye. This effect is described by mineralogists and gemologists as *chatoyant*. The formal name for "cat's eye" is *cymophane*.



The green gem variety of chrysoberyl is called *alexandrite*. Alexandrite is an interesting gemstone because it changes color! Alexandrite from the Ural Mountains in Russia is green when viewed in daylight. But when the same gem is viewed in light from a light bulb (incandescent light) it is reddish-purple. This is called *The Alexandrite Effect*.

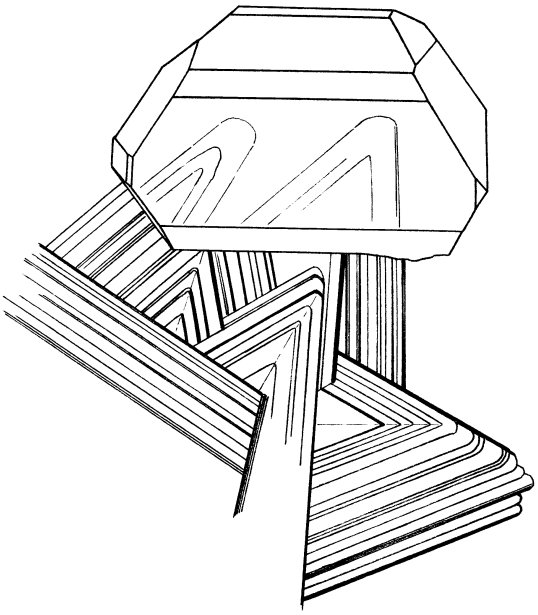
Even though *chrysoberyl* and *beryl* have similar names, they are very different from each other and are two separate gemstones. They both contain the elements beryllium (Be) and aluminum (Al). Beryl contains silicon and is a silicate mineral. Chrysoberyl contains oxygen (and no silicon) and is an oxide. Beryl crystallizes in the hexagonal system; chrysoberyl crystallizes in the orthorhombic system.



There are some interesting legends associated with cat's eye and alexandrite. In China it was believed that holding a cat's eye between the eyes would give a person the ability to see into the future. In Russia, it was at one time believed that alexandrite would bring good fortune to anyone who wears it.

Look for the "Hope Chrysoberyl" from the Natural History Museum of Great Britain here at the show.

BRAZILIANITE

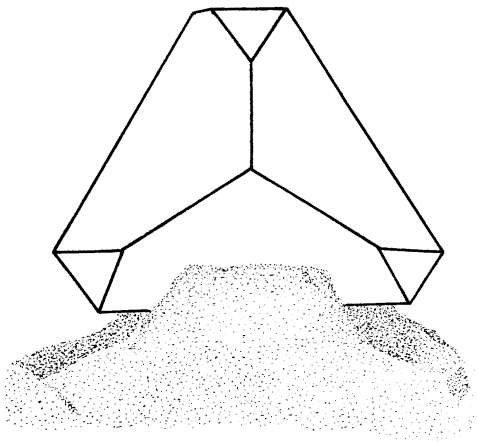


Brazilianite was named after the country in which it was first discovered, Brazil. It is yellow to yellow-green, rarely occurring as dark, olive green specimens. It was discovered in 1945 making it a fairly new gemstone. Brazilianite is often found growing on and with silvery muscovite crystals. These muscovite crystals form a shape that looks like a star, as seen in this drawing of a Brazilianite crystal on mica from Minas Gerais, Brazil. As with the gemstone *zoisite*, Brazilianite is a newer gemstone and does not have old legends of healing or powers associated with it. However, some people today believe that Brazilianite helps a person meditate.

Above: Greenish-yellow Brazilianite on silvery "star mica" from Minas Gerais, Brazil.

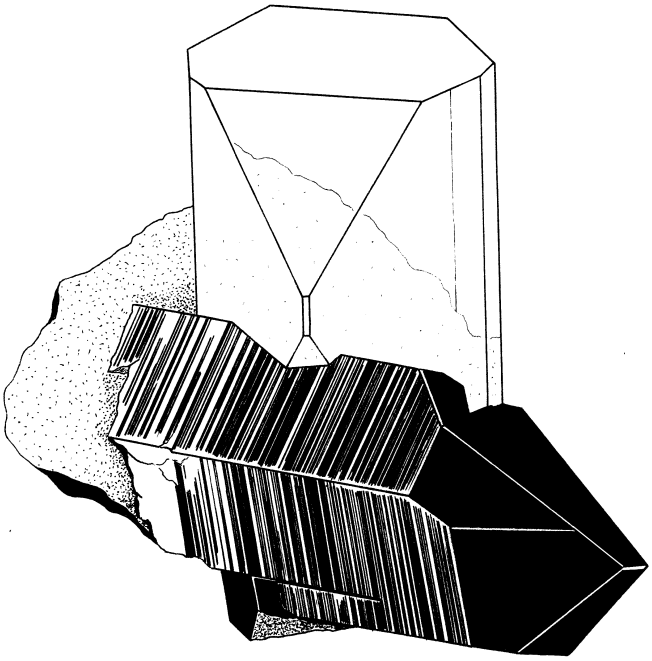
BENITOITE

Benitoite is yet another new gemstone. It was first discovered in 1906 in San Benito County, California (can you see how it got its name?!) by James M. Couch who was camping in the hills. The story goes that he woke up to find the sunshine bouncing off of the faces of benitoite crystals that were on the ground around his campsite. Not only is benitoite a rare mineral but gem-quality crystals are even rarer. It is only found at this locality in California - it has never been found anywhere else in the world. Because of this fact, California adopted benitoite as its official state gem on October 1, 1985.



Right: A single benitoite crystal from San Benito County, California.

TOPAZ

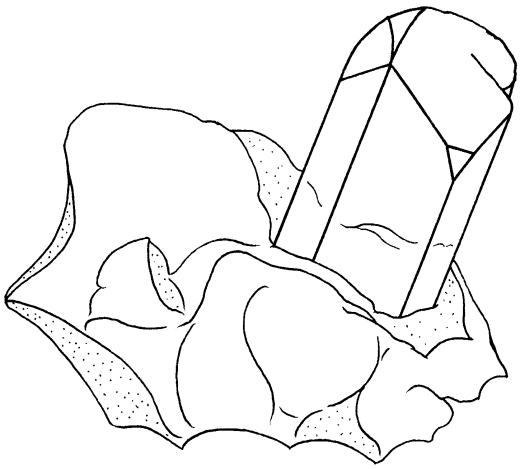


Like quartz, tourmaline and garnet, topaz is a silicate mineral. Its chemical formula is $Al_2[(F,OH)_2SiO_4]$. Silicate minerals are hard (from 6 to 8 on the mineral hardness scale) and therefore have a vitreous or glassy luster and are hard enough to be cut, polished and worn as gems. Topaz is number 8 on the hardness scale. It can be colorless, red, blue, pink, yellow, golden brown, sherry red, and even orange. Orange topaz is also referred to as *Imperial Topaz*. Colored topaz gems are beautiful and very popular.

Gemologists have discovered that heat treatment and irradiation can change the color of topaz from light blue or gray to dark blue. Almost all topaz gems are treated to improve their color.

Topaz crystals can be less than an inch long and can be as large as a boulder. The world's largest topaz crystal is from Minas Gerais, Brazil and weighs almost 600 pounds! It is at the American Museum of Natural History in New York City.

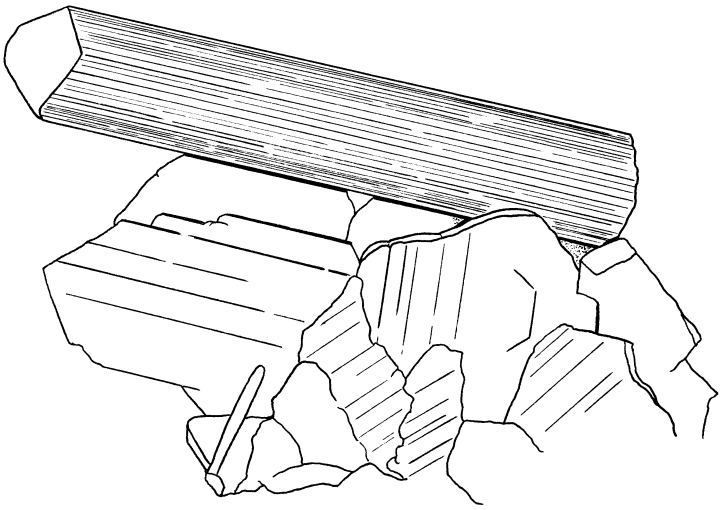
Topaz, like the other gemstones highlighted in this book, has had many legends attached to it through the centuries. Hundreds of years ago it was believed that wearing topaz could heal mental illness and make a person wise. Others used it to make a person's eyesight better by placing topaz crystals over the eyelids. The book, "Gems & Crystals from the American Museum of Natural History" tells this story (page 85) about using topaz to improving the eyesight: "*The prescription called for immersing the gem in wine for three days and three nights, followed by application of the topaz to the afflicted eye.*" The ancient Greeks believed that wearing topaz would make a person exceptionally strong, especially in an emergency.



Above: Orange topaz on smoky quartz from the Skardu District, Pakistan
Right: Sherry-brown topaz from the White Mountains, New Hampshire.

Look for this year's Show Poster which features Imperial Topaz!

TOURMALINE



Like quartz and topaz, tourmaline is a silicate mineral. It can be red, green, black, blue, pink, brown, yellow and colorless. The different colors have different names:

Colorless, Red, Pink, and Green tourmaline is called *Elbaite*.

"Watermelon Tourmaline" is an informal name given to specimens that are green on the outside and red or pink on the inside.

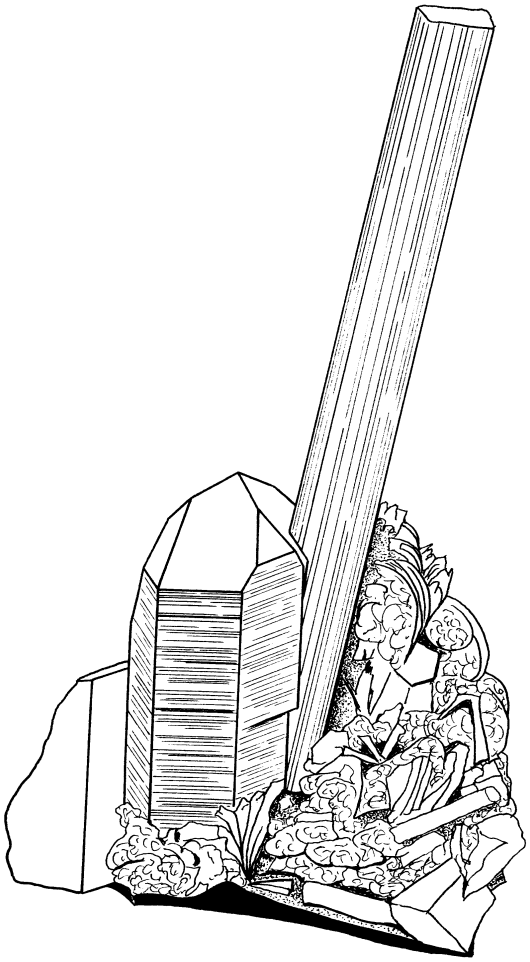
Black tourmaline is called *Schorl.*

Brown tourmaline is called *Dravite.*

Tourmaline and quartz both have special physical properties that have made them useful in electronic equipment. These properties are called *piezoelectricity* and *pyroelectricity*.

"Piezoelectricity" means that when pressure is applied to one end of a tourmaline crystal, an electric charge is created where one end of the crystal is electrically positive and the other is electrically negative. "Pyroelectricity" is the formation of electrical charges on the ends of a tourmaline crystal when the crystal is heated. The same can be created when the crystal is rubbed with a soft cloth.

Tourmaline is a newer gem in America. It was first seriously used here as a gem in the early part of the 1900's by the famous jewelry company called Tiffany & Company in New York City. However, it was discovered and used as a gem in Pakistan hundreds of years ago.

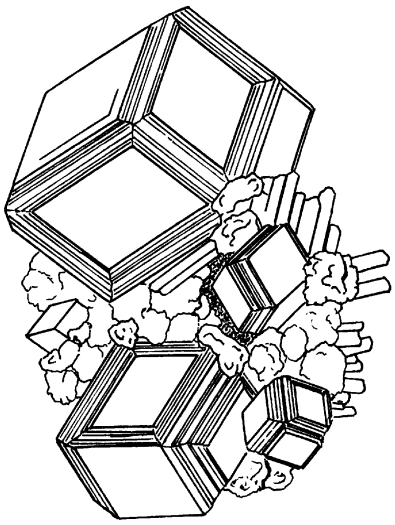


Above: Cranberry-red tourmaline from Itatiaia, Brazil.

Right: Green tourmaline with gray quartz and pink lepidolite mica from Brazil.

GARNET

PYROPE, ALMANDINE, GROSSULAR, UVAROVITE

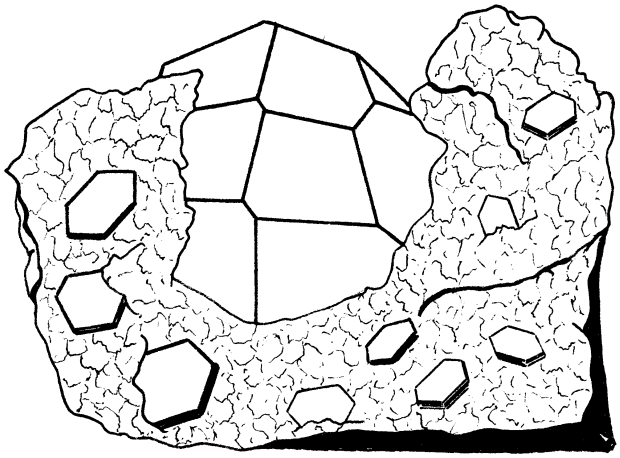


There are a number of different types of garnet. Mineralogists put garnets into two different groups. One group is called the *pyralspite garnets* which includes *pyrope, almandine, and spessartine* garnets. The second group is called the *ugrandite garnets* which includes *uvarovite, grossular and andradite* garnets. When any of these varieties has a deep color and has other gem qualities (like clarity and luster) they are cut into gems.

Garnets are silicate minerals. As a result they have vitreous luster (also called *glassy*) and are hard enough to be worn as gems. Their hardness ranges from 6 1/2 to 7 1/2.

In earlier times, red garnets were the ones most commonly polished, carved and used in jewelry. Today, green uvarovites are also cut into gems. Another very popular gem garnet is called *Tsavorite*. Tsavorite is a beautiful green variety of grossular garnet.

Through the ages, people have worn garnet jewelry not just for the beauty of these gems, but also because they believed the garnet had special properties. For example, in the Middle Ages, people believed garnet would help strengthen a person's faith in God. In the 17th century (the 1600's) it was thought that wearing a garnet would take away depression and bring joy and happiness to the wearer. Perhaps because it is dark red, it was believed that garnet had the power to stop bleeding.

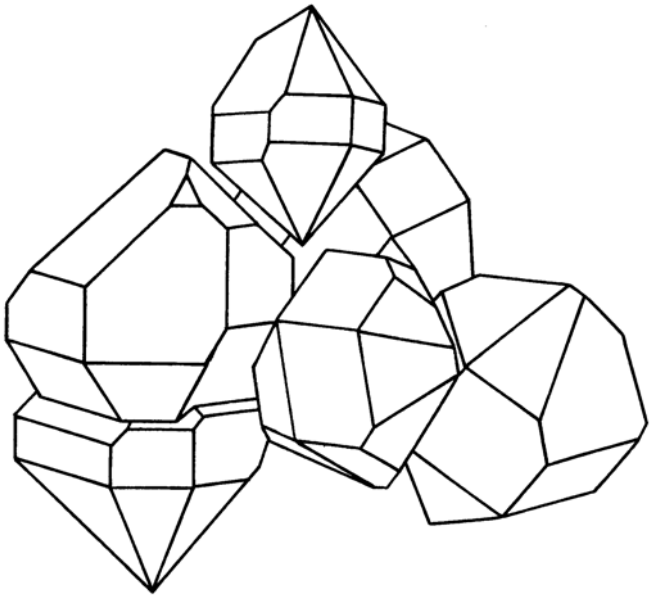


Above: Orange garnet (called Hessonite*) from the Jeffrey mine, Asbestos, Quebec, Canada.*

Below right: A deep red almandine garnet from Maine. This crystal sits in massive white to gray quartz with small, tan muscovite crystals scattered about the quartz matrix.

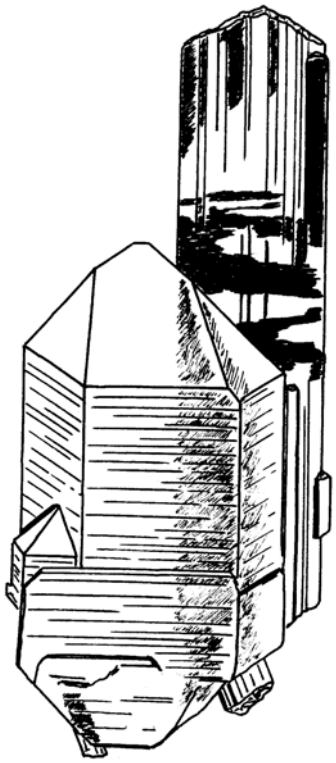
QUARTZ

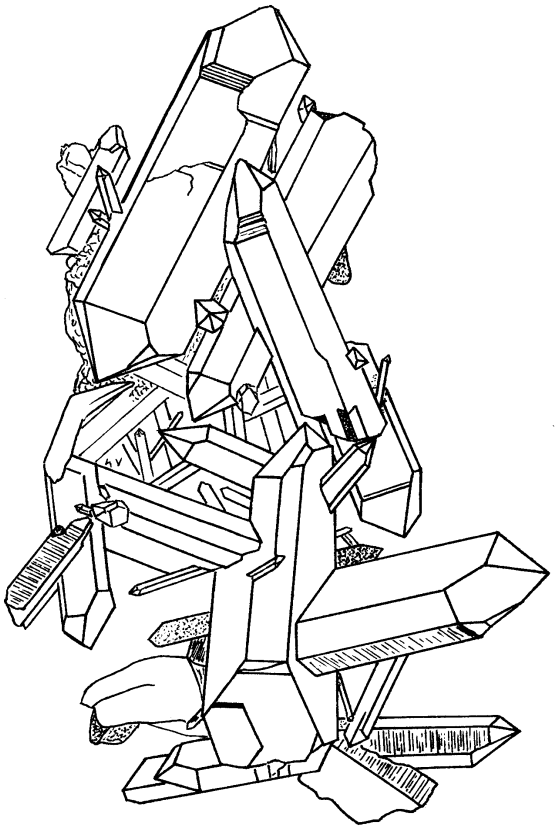
ROCK CRYSTAL, AMETHYST, CITRINE, SMOKY QUARTZ



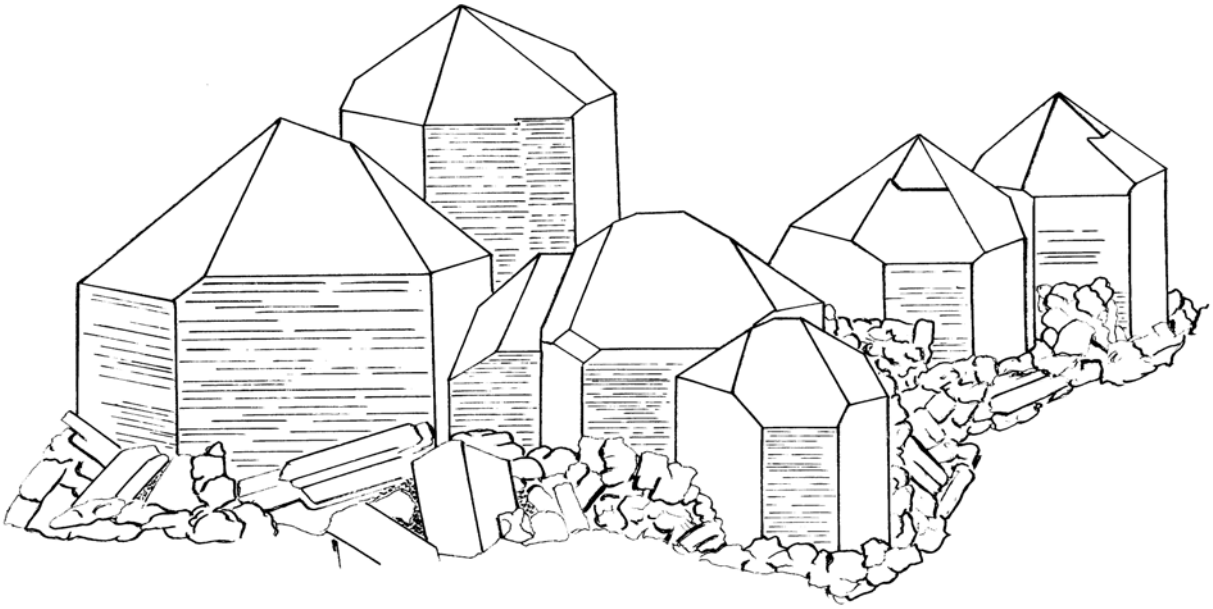
Pure quartz, silicon dioxide (SiO_2), is colorless. Colorless quartz is also called *rock crystal*. Rock crystal is cut into gems for use in jewelry. It looks a lot like diamond, however, it doesn't refract light as well as diamond, so quartz gems don't have flashes of color like diamonds do. (Do you remember what *refraction* means from the diamond page in this book?)

Colored varieties of quartz are considered gemstones and are often cut and polished to make gems. The purple variety of quartz is called *amethyst*. The color can range from very light purple to deep purple that almost looks black. Dark purple is most desired for gems. Yellow quartz is called *citrine*. Light pink quartz is called *rose quartz*. Occasionally black quartz (also called *smoky quartz*) is cut into gems.





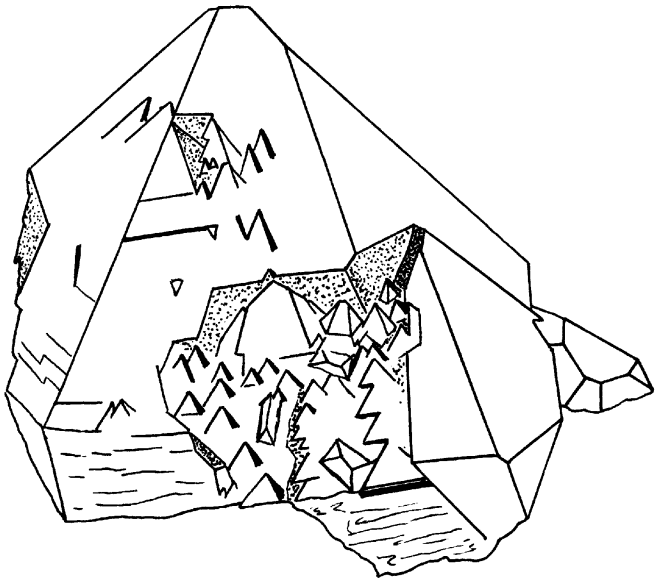
Above left: Colorless Quartz, "Herkimer Diamonds," from Middleville, New York.
Right: A group of yellow-brown citrine quartz crystals.
Left: Quartz with black tourmaline.

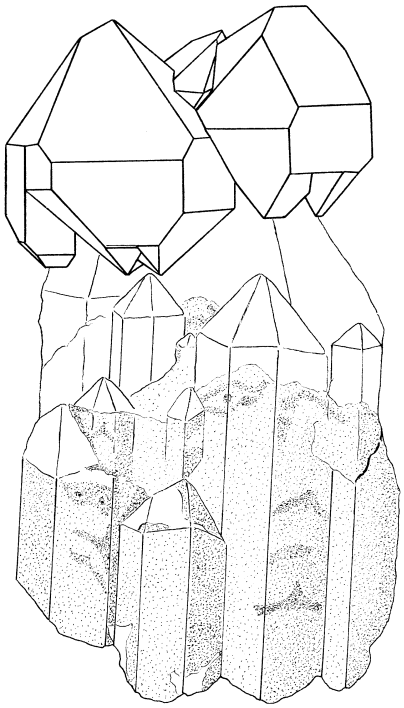


As with all other gemstones, people have believed that quartz minerals also have special powers. It is said that the Japanese people called pure quartz crystal "the perfect jewel." You will quickly discover that perfectly clear quartz really is beautiful to see and to hold. It looks like perfectly clear, crystallized water. As a matter of fact, the ancient Romans believed that quartz crystal was water that had frozen so hard that it would never thaw and melt. In other words, they thought of quartz as petrified water! Hold a piece of quartz and feel how cool it is. Quartz feels cool, even on a very hot day, because it has the ability to move heat away from your skin and into the crystal very quickly.

Native American peoples also use quartz and believe in its special properties. For example, at one time the Cherokee Indians believed quartz would bring a successful hunt. They would even rub a quartz crystal with deer's blood to make it more powerful.

Purple quartz, known as *amethyst,* was believed to have special powers since ancient times. The name "amethyst" comes from the Greek word "amethustos" which means "not drunken." The ancient Romans believed that if a person wore an amethyst gem, or if they drank wine from an amethyst goblet, he or she would not become drunk.

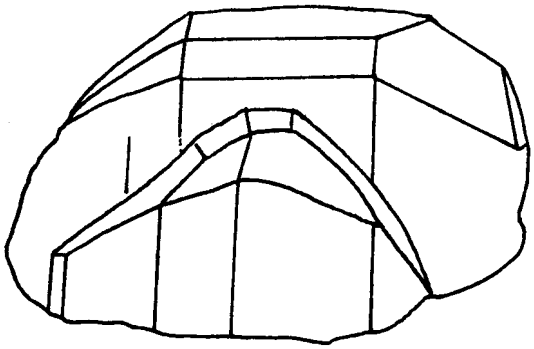




Above: Black smoky quartz crystals in feldspar from New Hampshire.
Left: Deep purple amethyst crystals from Thunder Bay, Canada.
Right: Deep purple amethyst on white quartz. from North Carolina.

PERIDOT

OLIVINE



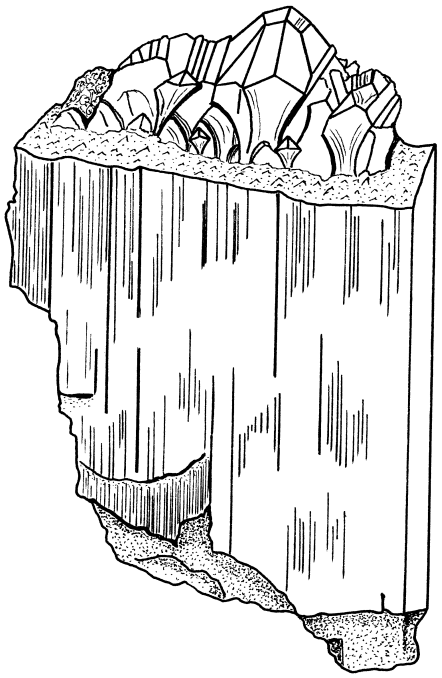
Olivine is a silicate mineral that contains iron and magnesium. It is one of the most common minerals on Earth and is even found on the moon and in meteorites. It forms in dark igneous rock like basalt.

Gem quality olivine is called *peridot*. Even though olivine is very common, gem quality olivine is rarer. It is grass green. The more desired peridot gems are darker green. Peridot is the birthstone for the month of August. Peridot is found in a type of meteorite known as *Pallasite meteorites*. It is, in fact, the only gemstone found in meteorites!

There are different legends about peridot. People in the Middle Ages believed wearing peridot would protect a person from evil spirits. Others thought it could make a person wealthy.

TANZANITE

ZOISITE



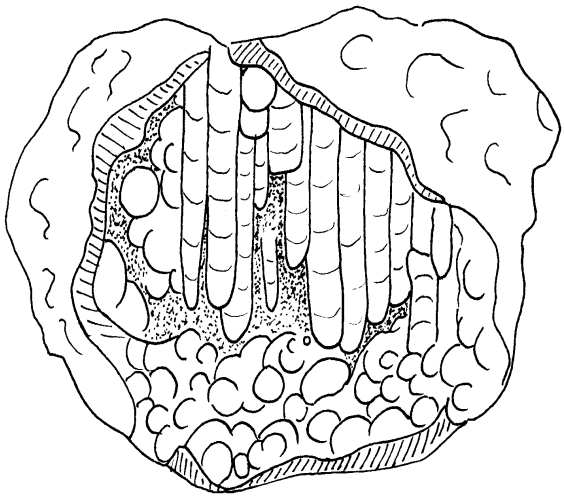
Tanzanite is a deep blue to purple variety of the mineral *zoisite*. This gemstone is one of the most recent gemstone discoveries. It was first discovered in 1967 in the country of Tanzania, from which it gets its name. Tanzanite has quickly become a very popular gemstone.

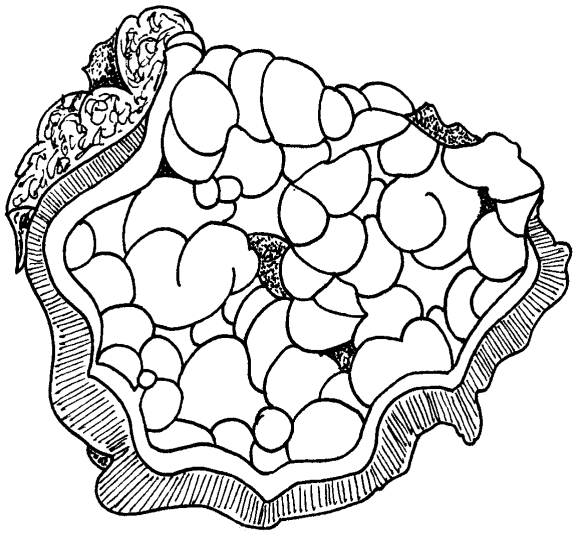
Some gems change color depending on how they are held in the light. This is a property called *pleochroism*. Most gems display two colors. Zoisite, however, displays *three* different colors depending on how it is held in the light. The color changes from blue, light purple and deep red. Because it shows three colors, it is described as being *trichroic*.

CHALCEDONY

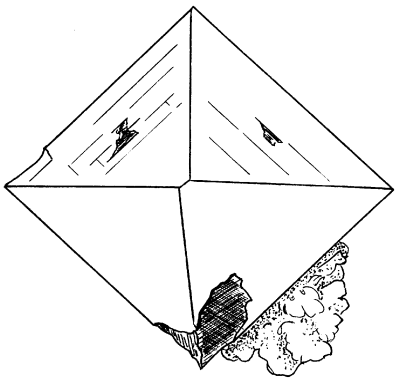
Gemstone varieties of quartz like rock crystal, amethyst, citrine, smoky, and rose quartz grow as large, visible crystals. There is another type of quartz that mineralogists call *cryptocrystalline*. This means that the crystals are so small that they can only be seen by very powerful microscopes. As a group, they are referred to as *chalcedony*. There are a number of different varieties of this type of quartz. They are carved into decorative items and polished to make jewelry. Different types of chalcedony include apple-green chrysoprase, heliotrope (which is dark green with blood-red spots), carnelian, tiger's eye, multi-colored banded agate and red and yellow jasper.

To the left is a translucent, yellow to tan chalcedony specimen.
To the right is a deep red chalcedony.





ZIRCON



Zircon crystals can be colorless, yellow, red, brown, blue, purple and green. Colorless zircon crystals, when they are gem quality, are sometimes used as a less expensive substitute for diamonds. Zircon crystals that are not gem quality are an important source of the metal *zirconium* and for the *Rare Earth Elements* including scandium, yttrium, cerium and many more.

Above Left: A single, dark brown zircon crystal from Mont Saint-Hilaire, Quebec, Canada.

FELDSPAR

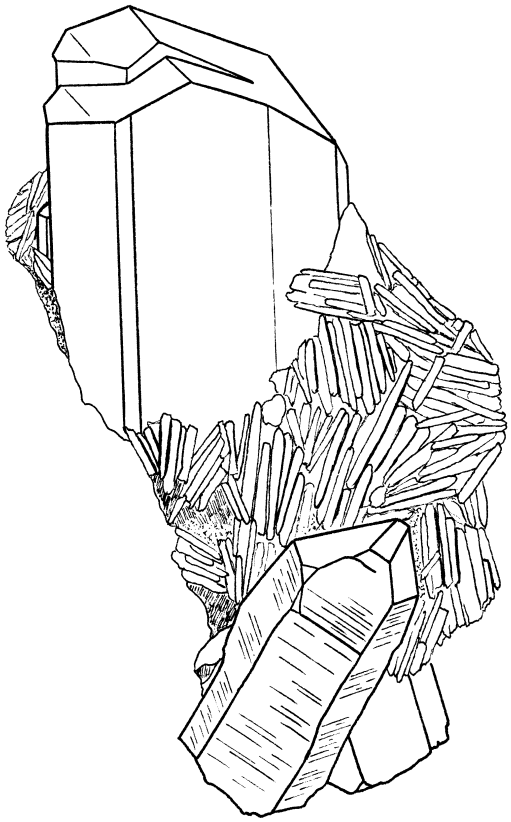
AMAZONITE & LABRADORITE

Amazonite is also called Amazon stone. It is opaque (this means light does not pass through it) so it is not faceted like diamonds or emeralds. It is carved into small figurines and polished to make semi-precious gems for rings, necklaces and ear rings.

Amazonite is a variety of the group of minerals called *feldspars*. Specifically, it is the turquoise-colored variety of microcline feldspar.

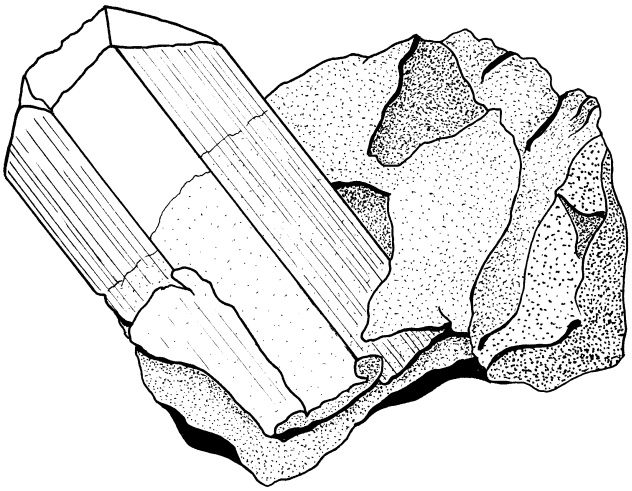
The ancient Egyptians believed amazonite would protect its owner from trouble. The Roman historian named Pliny reported that the ancient Assyrian people used amazonite in their religious rituals to their god named Belus.

Labradorite is also a feldspar mineral and it belongs to the *plagioclase* group of feldspars. When light bounces off of a polished piece of labradorite, blue, green, and red colors flash off the surface.



Right: Amazonite crystal with smoky quartz and white albite from Colorado.

KUNZITE

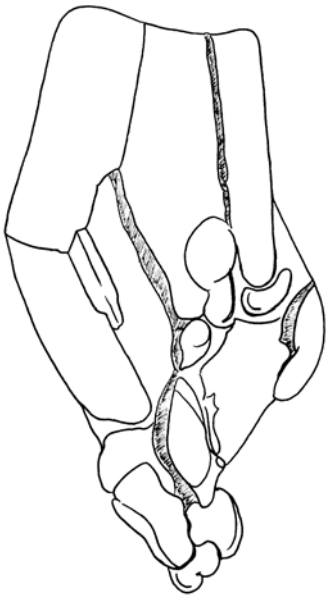


Kunzite is the light purple variety of the mineral *spodumene*. It is a source of the element *lithium* (Li). It was named after the famous gemologist, George F. Kunz, who was chief gemologist for Tiffany & Company in New York City. The light green gem variety of spodumene is called *Hiddenite*.

Afghanistan has produced gem-quality kunzite crystals up to 2 feet long!

Above: Pink kunzite crystal on matrix from the Anita mine, Pala District, San Diego County, California.

TURQUOISE



Turquoise has been valued by peoples all over the world as a gem and an ornamental stone for many centuries. It is blue to blue-green. It is used by Native Americans in beautiful silver jewelry. In Arizona gem-quality turquoise comes from Kingman and Bisbee.

Turquoise is almost always found as masses. It rarely occurs as crystals. In the United States turquoise crystals are found in the Bishop mine, near Lynch Station, Virginia. Turquoise crystals have also been found in Nevada, New Mexico and Pennsylvania. They are always microscopic.

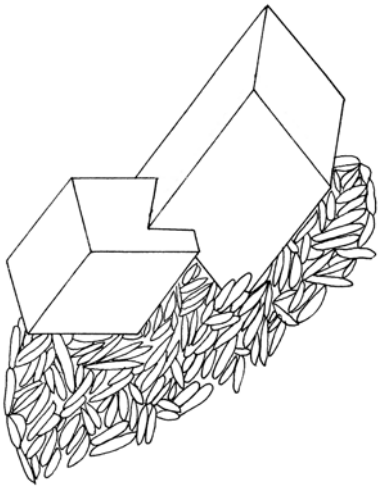
The name *turquoise* comes from the French word for "Turkish" because it was believed turquoise was mined in the country of Turkey. History has shown that turquoise was not mined in Turkey, but it was traded in Turkish markets.

Turquoise pseudomorph after apatite from the Dusty Tim #1 mine, Mina, Mineral County, Nevada.

MINERALS THAT CAN BE CUT BUT ARE NOT GEMSTONES

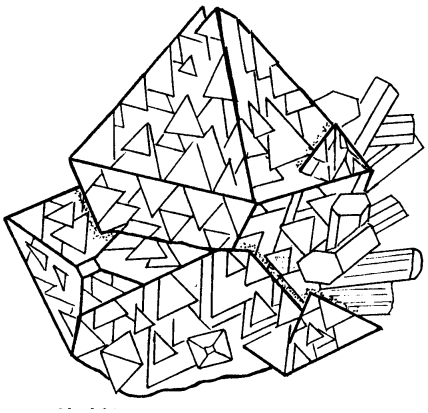
There are a number of minerals that can be cut into beautiful gems by highly skilled gemologists. However, because these gemstones are so soft or fragile, the gems can never be worn as jewelry, or they will chip, break, crack and therefore be easily destroyed. Cut gems of soft and fragile minerals are always on display and are never worn in jewelry.

Minerals that have been cut into gems, but are usually not thought of as gemstones include the following:



CALCITE

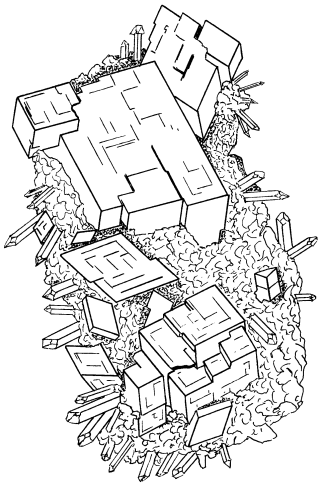
Clear, colorful, glassy calcite crystals can be cut and polished to make beautiful cut gems. But calcite is only 3 on the hardness scale and is easily scratched. It also has distinct, rhombohedral cleavage and breaks, easily, along its cleavage planes. When cut calcite produces brilliant flashes of light. Gemologists describe this by saying it has a very high *refractive index*.



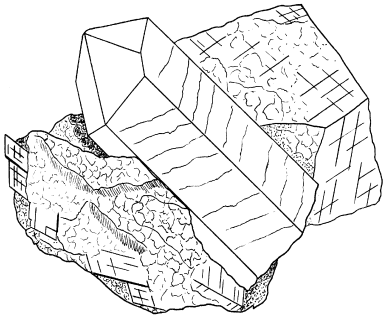
FLUORITE

Like calcite, fluorite is found as very colorful, often clear, and glassy crystals that can be cut into gems. But fluorite is also fairly soft, only 4 on the hardness scale. Like calcite, it also easily cleaves. Too much pressure or a sudden increase in temperature during polishing can cause a fluorite gem to easily break into many pieces.

RHODOCHROSITE



Rhodochrosite is found both as pink to red crystals and as pink to red banded masses. Clear, glassy crystals have been faceted into gemstones. Banded masses of rhodochrosite are usually cut and polished to make semi-precious stones for jewelry and to make decorative figurines and boxes. Banded masses are often worn in jewelry because they do not scratch easily. Faceted rhodochrosite, however, is not worn in jewelry because it is too soft.

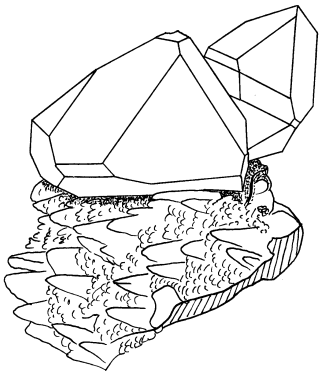


APATITE

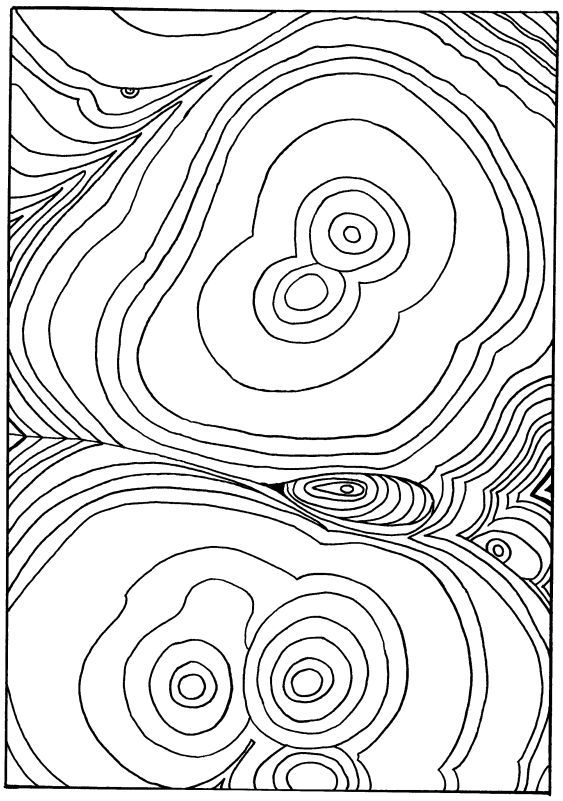
is also a soft mineral, too soft to be worn in jewelry. Clear, flawless, glassy apatite crystals, however, have been cut into gems for display in collections and museums. Apatite gems have been used in ear rings.

MALACHITE

Malachite is a copper mineral that often occurs as extremely large masses. These masses often show banding. The bands are different shades of green. Malachite is a *monochromatic* mineral. This means that it occurs <u>only</u> in one color. You will never find blue or red or yellow malachite. It is always green. Massive malachite is cut an polished to make jewelry and ornamental items such as bowls, boxes, statues, animals figurines and more.



Huge masses of banded malachite (right) have been found in the Urals region of Russia and Zaire (now called Democratic Republic of Congo).



Left: Malachite after cuprite on tan calcite.