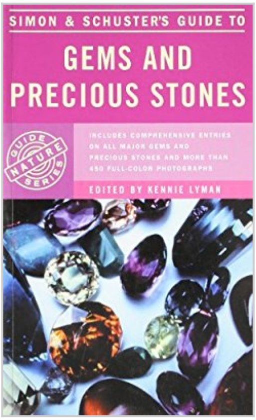

Simon & Schuster's Guide to Gems and Precious Stones

By Simon & Schuster

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Chapter 1

1 DIAMOND

C

Native carbon. The same element also occurs naturally in the form of graphite, another mineral with completely different characteristics and appearance.

Its name comes from the Greek *adámas,* meaning "invincible," in recognition of its exceptional hardness, which makes it resist any form of abrasion by other minerals.

Crystal system Cubic.

Appearance Diamonds most commonly occur as isolated crystals, which may be in the form of a more or less perfect octahedron, an octahedron with curved faces, or sometimes an icositetrahedron or hexoctahedron, which are more complex forms somewhat similar to an octahedron. The crystal can also be in the form of a rhombic dodecahedron or a tetrahexahedron with rounded corners and slightly curved faces, to the point of being almost spherical. Certain flattened, basically triangular twinned forms are also frequent. More or less cubic forms are rare. Rough-looking surfaces characteristically display superficial irregularities either in the form of fairly large cavities or hundreds of smaller irregularities, only recognizable under a lens, the extreme hardness of diamond generally ruling out the signs of abrasion seen on rough surfaces of other minerals that are found in secondary deposits. Pieces of diamond are often found that are clearly cleavages of other larger stones. Less typical, but quite frequent, are forms consisting of agglomerations of crystals, with concentric zoning and numerous impurities. Generally of irregular or globular appearance, with a rough or almost smooth surface, they are called *bort (or boart).* Another microcrystalline form occurring as irregular aggregates of roughly octahedral, cubic or rhombic dodecahedral appearance, is called *carbonado,* on account of its blackish color. Bort and carbonado are used for industrial purposes only. Diamond's microcrystalline structure compensates for its brittleness due to easy cleavage. Crystals with flat faces can be transparent, with strong luster, but blackish carbon inclusions, cloudy patches or fractures are often visible on the inside.

When the faces are curved or fairly rough, the crystals are generally merely translucent, even though it may be evident from cleavage surfaces that these imperfections are in an outer "skin," and that the crystals are transparent on the inside. Transparent stones are usually more or less colorless, but can be various shades of yellow-to-dull-yellow or more rarely, yellow with a brownish tinge. But bright yellow and clear brown are possible; and, as an extreme rarity, there are diamonds that are blue, pale green, pink, violet, and even reddish. The translucent stones with a skin often look grayish white (like ground glass); or dull yellow, yellow-brown, pale green, or pink. But they are often different on the inside: fairly clear, tinged with yellow or, more rarely, brown. The strongest colors are usually confined to the less transparent, outer layer. The bolt varieties can often be yellowish, yellow-brown or grayish, while carbonado is blackish.

Physical properties Diamond is rated 10 on Mohs' scale of hardness. It is the only mineral with this degree of hardness, although such a property is difficult to quantify. Depending on the methods of measurement, it is estimated to be from 10 to 150 times harder than corundum, the only mineral with a hardness of 9. Because all the remaining minerals have a hardness of less than 9, clearly there is a vast difference between them and diamond. But diamond has fairly easy cleavage parallel to the octahedral faces, which can make it brittle. The density is 3.52 g/cm3. The refractive index of *n* 2.417 is well in excess of the measuring capabilities of the average refractometer. Singly refractive, diamond crystals can display areas of anomalous birefringence. It has fairly high dispersion, equal to 0.044, which is the highest for colorless minerals (the effect of dispersion is not appreciated in colored stones, so it is not considered).

Genesis There is still considerable uncertainty as to the origin of diamond. The most widely accepted theory is that it was formed at great depths in the earth's crust, at very high pressures and temperatures. Explosive types of volcanic phenomena would then have been responsible for driving it to the surface, with such a rapid drop in temperature that it was impossible for the diamond to be transformed into graphite, which is the carbon phase stable at Iow pressures. It would presumably have been carried to the surface in breccia of the peridotitic type known as kimberlite, which constitutes the infill of diamond-bearing pipes (structures with the appearance of explosive volcanic vents).

Its outstanding resistance to physical and chemical erosive agents means that crystals are found in a variety of environments, in secondary deposits where they have arrived unchanged after two or more cycles of erosion and sedimentation, making it impossible to establish a relationship between present deposits and places of origin.

Occurrence For many centuries, the only place where diamonds were found was India, where, however, very small quantities were mined. Early in the eighteenth century, diamonds also began to be mined in Brazil, which shortly afterwards became the principal world supplier. In the second half of the nineteenth century, they began to be mined from deposits in South Africa, which in turn, soon became the chief world source. Since the beginning of the twentieth century, diamonds have also been found in Angola and Zaire (responsible for up to 60 percent of annual world production, mainly for industrial uses), Ghana, Guinea, Ivory Coast, Tanzania (which has one of the largest primary deposits in the world), and the Soviet Union (which is currently the second largest producer in the world). Diamonds are also found in Guyana, Venezuela, and, in very limited quantities, Borneo. They have recently begun to be mined in China (in the province of Hunan), and considerable quantities have been discovered in Australia, where extraction has already begun. Bear in mind, however, that diamonds are only said to be worth exploiting where they occur in average concentrations of one part in twenty million, or in other words, where twenty tons of rock have to be worked for each gram of diamonds.

1.1 Diamond

Ancient civilizations were fascinated by the exceptional hardness of diamond, although colored gems were regarded as more aesthetically pleasing. Diamond was extremely rare up to the eighteenth century and was only fully appreciated after the modern type of brilliant cut, which shows it in all its glory, was developed at the beginning of the twentieth century. It is the most important gemstone today. Statistics a few years ago showed that diamonds accounted for eighty percent of the movement of money generated by gemstones. About two million carats of cut diamonds are issued on the market each year (it is the only gemstone for which reliable statistics are available), equal to a volume of little more than 110 liters.

Appearance In most cases it is almost colorless or, to be more precise, ranges from perfectly colorless (infrequent) to yellow-tinged or, sometimes, brownish. Diamonds with a definite color are extremely rare. This can be yellow, yellow-brown, or predominantly brown or, very occasionally pink to reddish, blue, blue-gray, pale green, or violet. Its luster, depending on reflection from both the inner and outer surfaces of the light incident on the table and crown, is greater than that of other gemstones, due both to its high refractive index, which facilitates total internal reflection and its exceptional hardness, enabling it to acquire a similar degree of polish.

By far the most widely used cut is the round, brilliant type, which best displays the gem's unique characteristics. But oval, marquise, pear and, more rarely, heart-shaped fancy cuts are also used. Most of these have a girdle consisting of a series of small, polished facets, while in brilliants, a girdle cut this way is uncommon and is reserved for stones treated with particular care. The special, rather elongated forms often show a dull area along the minor axis. Obviously, the better the cut, the less this band will show. The so-called emerald cut is also quite common. This has a rectangular table, stepped and chamfered. Unfortunately, this cut, which is used to reduce wastage when the stone is fashioned, is more often than not given the wrong proportions. The crown is usually too shallow (even less than 10 percent of the smaller side of the girdle) and the pavilion too deep (50-55 percent of the smaller side). The result is a stone with a lot less fire than one with a brilliant cut, or even than the rare examples of gems with correctly proportioned emerald cuts.

Diamonds are also found on the market with unusual, antique or specially designed cuts. Old mine cuts are not normally circular, but squarish, with rounded corners, or almost rectangular with rounded corners (some people call these polygonal shapes with slightly curved sides and smoothed corners "cushion" shape). The proportions of the height of the crown, the pavilion and the diameter vary a great deal in these cases, depending on the creativity of the cutter. It is still possible to find what are known as "rose" cuts, with a flat base, both in stones of some size, which are usually old or antique, and in small, shallow stones one or two millimeters in diameter, generally used in old-fashioned jewelry.

Distinctive features Hardness can be an important factor in distinguishing diamond from other stones. It is in fact the only gemstone capable of scratching corundum. The best modern imitation, cubic zirconia, is less hard than corundum, so the two can easily be distinguished by comparing them with corundum, although the results of the tests must be observed under a binocular microscope or at least a lens. Diamond's exceptional hardness is also displayed by the facet edges, which are sharper than in imitations. This is best appreciated in relation to zircon, which has brittle, easily damaged edges, and the less hard imitations such as synthetic ruffle and strontium titanate. If the stones are turned between the thumb and forefinger, the two softer substitutes feel more slippery, almost oily, compared with diamond, because of this difference in the edges.

Another characteristic can be seen in the girdle, but only when it is not faceted. Due to the procedure used in turning brilliant cuts, the girdle of a diamond will have a satiny finish, similar to that of finely ground glass (in recent years a similar effect has been achieved with cubic zirconia, but no other imitation displays this). Also, when there are numerous flaws like minute cracks extending from either side of the girdle (these are known as "bearding" and are due to inexpert turning of the rough stone), it is bound to be diamond. A brilliant cut can display small facets on the girdle or extending from the girdle toward the pavilion (or more rarely, toward the crown). These are the remains of the outer surface of the uncut octahedron (nearly always with minute, crystallographically oriented shallow triangular cavities), or of the faces of octahedral cleavage. In the latter case, small steps can be observed between contiguous, specular plane surfaces. However, these details are only readily visible if magnified at least 10-20 times. Sometimes small triangular facets alone are seen extending from the girdle. Called extra facets or supplementary facets, these are produced by polishing of the facets just described or by the elimination of some small, almost superficial flaw. Although very similar to the foregoing and not usually found on imitations, these facets are less distinctive in that they could be produced on any other stone.

Other distinctive features are related to the fact that the most frequently used, brilliant and emerald cuts, are designed to make the most of the high refractive index of diamond and obtain the maximum possible total internal reflection of the light coming from the table facet. Therefore if a diamond is placed with the table facet against tiny written characters, nothing will be visible through it, unless the pavilion is extremely flat. With imitation diamonds of a much lower refractive Index, such as YAG (Yttrium Aluminum Garnet), something will be visible through the stone and still more will be seen through synthetic spinel and colorless sapphire. The difference is more obvious with emerald cuts than with brilliants. A similar effect, but confined to brilliant-cut stones, can be seen through the table facet. By steadily tilting a stone of lower refractive index than diamond, and looking through the table, a nonreflecting transparent triangle can be seen to appear in the pavilion, with its apex at the center and its base toward the edge of the table opposite the observer. The lower the refractive index of the stone, the smaller the angle at which this will appear. In diamonds, this effect is very difficult to see, except in poorly cut stones with very shallow pavilions.

Single refraction is another characteristic that distinguishes diamond from zircon, which is strongly birefringent and from an infrequent imitation of diamond: synthetic rutile, which is even more strongly birefringent. The famous dispersion in diamond, although considerable, is much less than that of synthetic ruffle and strontium titanate; but these now uncommon imitations look positively iridescent when viewed through a lens and even to some extent with the naked eye.

Given the constancy of shape and proportions, at least within certain limits, of stones with a round brilliant cut, a given weight can be said to correspond to a given diameter. If the diameter of a stone presumed to be a diamond can be measured with some precision, one can check to see whether it has a suitable weight (in which case it will either be diamond or a stone of comparable specific gravity), or whether the weight immediately rules out the possibility of its being diamond. Generally simulants are too heavy, as in the case of cubic zirconia, GGG (Gadolinium Gallium Garnet) or, to a much less obvious extent, zircon or YAG (Fig. A.). This method could not be used to distinguish diamond either from synthetic spinel, colorless topaz, or colorless sapphire, as their relative densities are too similar, although all of them have other characteristics unlikely to deceive any but the most casual observer.

It was mentioned in discussing physical properties, that the very high refractive index of diamond is outside the range of normal refractometers and the same can be said of many of its imitations. In compensation, however, diamond has other characteristics, such as reflectivity and thermal conductivity, which are quite different (because much higher) than those of its present substitutes. Small instruments the size of a pocket calculator have been produced to measure these characteristics, making a rapid distinction possible.

Occurrence Gem quality diamonds are found in about twenty different countries, a dozen of which are in Africa, three in Asia, one in Oceania, and three in South America. By far the largest producer is South Africa, including the neighboring Lesotho, Botswana, and Namibia. Next come the Soviet Union, Angola, Zaire, and Sierra Leone. Other important areas are the Central African Republic, Tanzania, Ghana, and Venezuela, with Australia and Brazil further behind, and India now one of the last.

Value Diamond is one of the most valuable stones, together with ruby and emerald. The market value of diamonds is determined by complex grading systems that divide them into a wide range of different categories. The basic characteristics considered are weight, color, and purity. Less crucial factors are the proportions of the cut and surface finish.

The influence of weight Although a diamond weighing over 3000 carats has been found, rough diamonds of considerable weight are extremely rare. Still rarer are heavy cut diamonds, given that the average loss of weight in the cutting process is more than 60 percent. All else being equal, a diamond twice the weight of another is much rarer and therefore much more precious and will have a higher price per carat. Weight also has psychological as well as scarcity value: a diamond of I carat or slightly more is worth more weight for weight than one of 0.9 carats because it exceeds the conventional limit of the complete carat. The same applies at the dividing line for 2 carats, 3 carats, and so on (Fig. B). In short, the price per carat increases by stages with each complete carat number, up at least to a weight of about 10 carats, after which the effect is negligible, although such large diamonds are extremely uncommon.

The influence of color The vast majority of diamonds are colorless, or yellowish, ranging from a barely perceptible tinge to straw-yellow. Perfectly clear stones, however, are comparatively rare, but the effect of dispersion in diamonds is more pleasing on a clear ground than on a yellowish one. For these, plus psychological reasons, the more or less perfectly colorless stones are in greater demand; and value diminishes with an increase in yellow (or more rarely, brown) coloration.

In an effort to quantify this, scales of colors of different intensities were established, with names of the color categories relating to the principal localities in which diamonds of that color were found, or to other factors. Thus the main diamond trading centers evolved roughly similar color codes matched by approximate sets of values. A very precise scale has more recently been introduced in the United States, with grades distinguished by letters of the alphabet (beginning with D, not A) and referring to data supplied by special measuring instruments rather than the naked eye. Over the last few years, European scales have been adapted to that of the United States, a series of sample diamonds being used for purposes of comparison. The four scales most widely used today and in the recent past are shown in Fig. C (4b is the same as 4a, but with the old nomenclature of 1). The correspondence between scales 1 and 2 is approximate, as is their relationship to the others, whereas 4a and 4b were designed to be cross-referenced. As a general guide, color H (white) is very good and few diamonds 'can boast such quality. Color I (the old "commercial white") is much better than this name would imply, with a barely perceptible yellow tinge; and many stones on the market, particularly medium- or large-sized ones, come under categories J, K, L, or M. By contrast, "rare white" stones are much less frequent. A very rough idea of the visibility of coloration in diamonds of different grades (seen from above only, in conditions of "use," rather than the ideal conditions according to which they are classified) can be obtained from Fig. D, which uses the classifications of the CIBJO scale. Naturally, the larger the area over which any coloration is viewed, the easier it is to see. All else being equal, the price of diamonds varies quite sharply with color. Again, as a rough guide and obviously depending on the state of the market, if a diamond with certain characteristics and weight of color H were worth 100, another with the same characteristics of color F could be worth 130, while one of color J would be worth 80, and one of color M, 40.

The influence of purity Many diamonds contain crystalline inclusions or discontinuities (even just fractures) which reduce their transparency, by interrupting the paths of the light rays. Stones free of inclusions or visible discontinuities are described as pure, and value diminishes as visible imperfections increase.

Classification is based on visual criteria and detailed diagrams are available to establish a basis of comparison. Stones are conventionally examined under a 10x lens. The grades of the scale of purity are shown in Fig. E and are referred to by internationally accepted sets of initials, according to the English terminology. Pure stones of IF grade are uncommon; VVS and VS grades are of a good level of purity, SI and PI grades are not so pure and P2 and P3 are the lowest categories. Naturally, stones combining perfect purity with excellent color are rare, especially those weighing several carats. If one is prepared to compromise over a single characteristic such as color, it will be easier to find stones of good purity and weight. Similarly, it will be easier to find a stone of good color and weight but mediocre purity; and those of middling color, medium purity, and small size are obviously the most common.

The above should give some idea of the complexity and also the degree of organization of criteria used for the valuation of diamonds. In addition to these fundamental criteria there are others based on the proportions of the cut (when not ideal, they reduce the stone's powers of light reflection and refraction) and surface finish, which are taken into account in establishing value. Proportion and finish are judged as "very good," "good," "medium," or "poor." Sometimes these judgments are based on measurement, but usually they are established by the visual evaluation of experts.

Simulants and synthetics Diamond has been imitated by glass and special glass with a mirror backing to increase reflection, called "strass." It has been imitated by colorless, synthetic spinel and corundum ever since these began to be produced. Over the last few decades, moreover, it has been imitated by a whole range of synthetic and artificial products:

* strontium titanate or fabulite, which has much higher dispersion than diamond, with striking iridescence, low hardness, considerable brittleness and density;

* synthetic ruffle or titania, which has very high dispersion with striking iridescence, marked birefringence, high density, and low hardness;

* YAG (Yttrium Aluminium Garnet), which has a slightly lower refractive index than diamond, a hardness of less than 9, and greater density;

* GGG (Gadolinium Gallium Garnet), which has a fairly low hardness and double the density of diamond;

* cubic zirconia (cubic zirconium oxide), djevelite or phianite, the most recent and hardest to distinguish from diamond. Its density, however, is much greater, and its hardness is less than 9.

Many other artificial substances are similar to diamond, but are not used as imitations because their cost is generally much higher and their characteristics no better than those simulants already mentioned. Diamond has been and still is manufactured synthetically, in minute crystals, only suitable for industrial purposes. It has also been produced experimentally for use as a gemstone and a few gems of about 0.25-0.45 carats have been cut. But it is so hard to make the crystals grow that the cost would be much higher than that of natural diamonds obtained from known deposits.

2 CORUNDUM

Al2O3

Aluminium oxide. The name is probably derived from an old Indian word, *corund,* which referred to an unknown mineral or gem.

Crystal system Trigonal.

Appearance It occurs in semiopaque masses similar to whitish or grayish vein quartz, but also in distinct, prismatic or tapered crystals, with close transverse striations, some of which resemble elongated bipyramids. Often opaque or translucent, corundum can be partially or perfectly transparent. All the colors of the spectrum are possible, from red to yellow, green, blue, and violet; in addition, the stones may be pink, gray, black, or colorless and all the shades between. Brightly colored, transparent, translucent, or semiopaque varieties make highly aesthetic and valuable gems. Because of its hardness and resistance to chemical attack, corundum is often found in alluvial deposits in the form of pebbles that retain clear indications of their original crystal shapes.

Physical properties Corundum has a hardness of 9, the highest in the mineral world after diamond. The density is approximately 4.0 g/cm3. The refractive indices are about n??? 1.760, n??? 1.769. Parting parallel to the basal plane is sometimes visible, with an appearance of cleavage.

Genesis It is formed by contact metamorphism between alumina-rich magmas (and related pegmatites) and limestone, or by regional metamorphism of alumina-rich, silica-poor rocks.

Occurrence The least attractive variety of corundum, known as emery (usually a corundum-magnetite mixture) and used as an abrasive, is mainly found in Greece, the United States, and Australia. The gem varieties come chiefly from Sri Lanka, Thailand, Cambodia, Burma, and Australia, with smaller deposits in India, Tanzania, and the United States.

2.1 Ruby

The most valuable variety of corundum is ruby. The name comes from the Latin *rubrum,* "red." Like other red stones, it has also been called *carbunculus,* or carbuncle, meaning a small coal or ember.

Appearance The color varies from fiery vermilion to violet red, but because rubies are pleochroic, different colors are also found in the same stone; bright or sometimes brick -ed in one direction, tending to carmine in the other. The color is also accompanied by marked fluorescence which ,s stimulated by ordinary, artificial light and above all, by the ultraviolet rays of direct sunlight. Thus rubies turn brighter red under such light and the purplish ones look "redder." If the color is too pale, they are no longer called rubies, but pink sapphires; if it is more violet than red, they are known as violet sapphires. But it is hard to establish precise limits, as all the intermediate shades are possible. The brightest red and thus the most valuable rubies (usually from Burma often have areas full of inclusions in the form of minute ruffle needles (or straws), which interfere with the light, producing a distinctive silky sheen known, in fact, as silk. When the silk is not heavy, the stones are clearer, more attractive, and even more valuable. Other, mainly crystalline inclusions are normally found as well. Rubies of this type are not usually more than a few carats in weight. The rare exceptions generally contain copious inclusions. Violet red, sometimes quite dark, rubies come principally from Thailand. The type most often found on the market nowadays, they can be several carats in weight. They are normally clearer, without patches of silk. While good-sized clear stones are found, specimens with many inclusions are commonly sold as well. Rubies are usually given a mixed cut, which is generally oval, but can be round or, more rarely, other shapes. In the past, they were given a cabochon cut, like all stones outstanding for their color. Today, however, this cut is reserved for less transparent stones with numerous inclusions.

Distinctive features Rubies can often be distinguished by their immediately visible characteristics: a fairly obvious pleochroism, a distinct brightening of color in strong light, the silk effect (where present), and a considerable luster. While spinel can be a similar color and has a similar luster, it is not pleochroic, turns much less bright in strong light, and never displays the silk effect. Red garnet is not pleochroic and the color does not brighten in strong light; it has a similar luster, but when given a faceted cut often displays dark, blackish areas within the stone. Red tourmaline is usually a completely different shade, but can be very similar, with a pleochroism comparable to that of ruby. It does not, however, brighten in strong light, and this can be sufficient indication to warrant testing its physical properties, which are quite different. The other red gemstones mentioned also differ physically from ruby. Some caution is needed with garnets, which show wide variations in both density, which in some cases coincides with that of corundum, and refractive index, which can coincide with one of the figures for corundum. Garnet; however, is singly refractive, and examples with an index in the region of 1.76 have a lower density than that of ruby.

Occurrence The rubies with the finest color come from the Mogok region in Burma. These are most truly vermilion, though they still have a touch of carmine. Thailand, however, is today the main source of rubies. Thai rubies are usually slightly less attractive, a bit darker with a violet tinge, but they often have fewer inclusions. Rubies are also found in Sri Lanka, but in very small quantities. Often pale, almost pink, they can be attractive, with an appearance that is both brilliant and lively. Small quantities of very fine rubies also come from the area of Cambodia on the border with Thailand, while rather opaque specimens, mainly of inferior quality, are found in India and Pakistan. Tanzania and neighboring countries have also been mining rubies for a few years. Some of the rubies found in these countries are almost as finely colored as those from Burma, with inclusions similar to rubies from Thailand, while others are semiopaque and of very limited value.

Value The highest quality, best colored and most transparent stones (usually from Burma), weighing, for example, 3 to 5 carats, can be as valuable as diamonds, or even more so. Very good quality rubies of even greater weight are extremely rare and fetch exceptionally high prices. Good quality stones of at least 2 carats (a bit more violet in color and usually from Thailand) are still quite valuable (particularly the more transparent ones). The price falls considerably for stones of less than a carat, which are too dark in color, and have inclusions clearly visible to the naked eye.

Simulants and synthetics Ruby has very occasionally been imitated by glass, which has a rather different, less lively color and an inferior luster. It has sometimes been imitated by doublets, with the top part consisting of garnet, to provide luster, hardness, and natural-looking inclusions and the bottom part of red glass, fused rather than cemented to the garnet layer. But such imitations are uncommon. Synthetic ruby has been produced from the beginning of the twentieth century and was the first synthetic gemstone to be manufactured on an industrial scale. To make these synthetic stones harder to distinguish from some natural rubies with numerous inclusions, they have sometimes been fractured internally by heating and rapid cooling. More recently, doublets imitating rubies have also been produced in the Orient. The top part of these doublets consists of poorly colored (usually pale green or yellow) natural corundum with obvious, typical inclusions; and the lower part is synthetic ruby, held to the corundum by transparent cement. The effect is highly deceptive: the reassuring presence of natural inclusions and characteristic luster combined with a color which is not perfect, but is normal for the majority of rubies, can be much more convincing than a synthetic ruby.

2.2 Sapphire

This is the blue variety of corundum. The name is probably derived, through the Latin *sapphirus* and Greek *sápheiros*, from a Sanskrit word. As with other gem names, however, the Latin *sapphirus* did not originally denote the gem it is associated with today. Judging by the description of Pliny the Elder, it almost certainly referred to what is now known as lapis lazuli, rather than corundum.

Appearance Sapphires can be a very dark blue, to the point of seeming dense and blackish from a distance, sometimes accompanied by a blue to dull green pleochroism, which is only visible from the side in cut stones. They may also be a strong, but not too bright blue, easily recognizable from a distance, this being the ideal color. Other possibilities are light, usually bright, blue, with the color unevenly distributed; palish blue or, finally, blue with a violet tinge, at least in bright light. Like all corundum, sapphire always has good luster.

Some sapphires display clearly defined streaks of paler color, in contrast to a dark ground. Others have areas with a slightly silky sheen, which are not clearly delineated. Still other, uncommon varieties assume a distinct, milky appearance in strong light, with a marked increase in color intensity. Inclusions are, as a rule, less obvious in very dark stones, due to their general lack of transparency, whereas medium to large, pale stones often show distinct "veils" or "feathers" caused by very fine inclusions and foreign crystals, which are sometimes transparent, sometimes dark, submetallic, and opaque, and, very occasionally, bright red. Sapphires are usually given oval or less frequently, round, mixed cuts, but rectangular or square, step cuts, with or without trimmed corners, are also possible. The cabochon cut is used as well, although less frequently than in the past. Nowadays it is generally reserved for stones full of inclusions or those in which the color is concentrated in a few streaks on a light ground. In the latter case, in fact, the cabochon cut gives the color a more uniform appearance. Stones weighing several carats or even 10 to 20 carats in the case of light-colored specimens, are not uncommon.

Distinctive features Like other types of corundum, sapphires have a striking luster. The color is also quite distinctive, whether or not clear blue-green pleochroism is visible. The overall appearance is very important. For example, a deep blue color with distinct blue-green pleochroism and internal streaks straight across or at an angle of 120°, combined with the powerful luster of corundum, indicates a sapphire of Australian origin. A slightly patchy, blue color with imperceptible pleochroism and strong transparency showing veillike inclusions and a slight silk effect, still with excellent luster, denotes a sapphire from Sri Lanka. Cornflower to deep blue in a stone without obvious inclusions but of slightly milky appearance, acquiring a distinct fullness of color in bright light, is characteristic of the rare sapphires from Kashmir. Of the other blue stones, tanzanite always shows a hint of violet, fairly obvious pleochroism, and less luster than sapphire. Cordierite, apart from being less lustrous and violet or gray blue, has striking pleochroism from blue to an unmistakable drab yellow. Strongly colored specimens of indicolite tourmaline are often an attractive greenish blue, with a pleochroism ranging from blue to green, but the green is very different from that of sapphire which, when it is present, is always dull or yellowish. Still on the subject of pleochroism in tourmaline, the direction corresponding to the blue color shows a characteristic lack of transparency. While blue zircon has a luster similar to that of sapphire, it is an electric blue or blue-green unlike that of any other gemstone. Furthermore, its strong birefringence, seen in a clear duplication of the facet edges when viewed through the stone with a lens, would remove all trace of doubt; sapphire is doubly refractive as well, but to a much lesser degree. In the rare cases when blue Spinel is not cloudy blue or violet gray, but a vivid mid-blue, it can look very much like sapphire, partly on account of its strong luster. In this case, it can only be distinguished by its physical characteristics; establishment of single refractivity, or measurement of the density or refractive index should suffice.

Occurrence The best sapphires were discovered in a small deposit in Kashmir in 1880, in a remote mountain area which has now probably been exhausted. Very fine sapphires are also found in Burma, but in limited quantities.

Appreciable quantities of light- and bright-blue sapphire are found in alluvial deposits on the island of Sri Lanka. These are always attractively (if sometimes patchily) colored, the richest versions being very similar to the Burmese sapphires and equally valuable. The sapphires of Sri Lanka are also famous for the variety of inclusions they display: long, thin rutile needles, like very fine silk; soft, liquid inclusions arranged in the form of veils, lace, and feathers; striking inclusions with a moving bubble, like a spirit level; zircon crystals with small stress cracks radiating from them, and various other types of transparent crystals.

Sapphires are also mined in Thailand and neighboring Cambodia. These are generally pleasing to the eye, though often rather deeply colored. But most sapphires come from Australia, which has numerous deposits of deeply colored stones, sometimes too dark, in most cases with blue-green pleochroism. These are the least valuable, but most widely available on the market. Less important sources are the United States (Montana), Tanzania, and Malawi.

Value The finest stones, weighing at least several carats, are almost as valuable as diamonds and rubies and are hence very highly priced. This is particularly true of most sapphires from Kashmir, many from Burma, and some from Sri Lanka, Cambodia, and Thailand. But when the color is too dark, blackish or greenish blue or a bit too pale, the value falls sharply, to that normal for secondary gems. Inclusions obvious to the naked eye also lower the price. Small stones (of a fraction of a carat) are modestly priced and readily available. Large ones (from more than ten to several tens of carats), although not common, are much less rare than rubies of this size.

Simulants and synthetics Sapphire has been imitated by dark to cobalt blue glass, but particularly by doublets with a top part consisting of red almandine garnet, which is very hard and lustrous, with natural inclusions, and a bottom part of dark-to-cobalt blue glass, welded together, not glued. It has also been imitated in the past by synthetic blue spinel, which is brightly colored but emits strange red gleams in bright light. Synthetic sapphire has likewise been produced for many years now, mainly by the Verneuil flame fusion method. Recently, doublets have been produced consisting of a top portion of light green or yellow-green natural corundum with visible inclusions and a lower portion of synthetic sapphire, held together by transparent cement. The visible inclusions and typical corundum of the top part, along with the color, make these doublets very convincing at first sight.

Since the end of the 1970s, greater knowledge of the nature and causes of color in gemstones has enabled the modification of this feature by various procedures. The most recent and important techniques, in fact, relate to the blue coloration of sapphire. One method is to subject very pale blue, almost colorless stones with numerous silklike ruffle inclusions to prolonged heating at temperatures in the region of 1500-1600°C. in a reducing environment. This "reactivates" the titanium in the ruffle, which reacts with the traces of iron in the sapphire. In this way, the silk is absorbed, while the trivalent titanium and iron thus formed, which are responsible for the blue coloration of sapphire, greatly intensify the color of the stone. This treatment is now very widespread and more or less reproduces the sequence of events that occurred when many sapphire crystals were formed. As a result, it is not always possible to distinguish a completely natural sapphire from one whose color has been intensified in this way, and they are treated as one on the market. According to another procedure, however, colorless, pale yellow or pale green stones are covered in a paste consisting of iron and -- mainly -- titanium compounds. The specimens are then heated to a temperature of about 1700°C. for perhaps several days. The iron and titanium oxides slowly infiltrate the stones to a depth of about one millimeter, producing a deep blue coloration. The stone then has to be repolished (the surface having been damaged by heating to near melting point). Hence part of the colored layer is removed, leaving a very small thickness. This procedure is surprisingly common and involves the introduction of additives as colorants. It is universally regarded as fraudulent if the treated stones are then offered for sale as natural stones, as is often the case.

2.3 Pink sapphire

This is the name given to the pink variety of corundum, red corundum generally being known in English-speaking countries as ruby, blue corundum as sapphire, and any other shades as sapphire combined with the appropriate color: pink sapphire, yellow sapphire, green sapphire, etc. Pink sapphire and ruby are regarded as two different varieties, despite the fact that the only difference is their depth of color. The same does not apply to tourmaline, both the pink and red forms of which are known as rubellite, or to sapphire and emerald, which keep their names even for paler specimens.

Appearance Pink sapphire may range from a very delicate, pleasing, lively pink, without any overtones, to pink with a slight violet tinge; but all gradations of color are possible, from those tending toward ruby to those tending to???ard violet sapphire. Like all forms of corundum, it has very good luster. It is normally given a mixed, oval cut and sometimes has fine inclusions and liquid veils in lacelike formations, characteristic of the corundum of Sri Lanka, from where most pink sapphire comes. Stones of several carats are normal, but specimens of 10 carats or more are rare.

Distinctive features Pink sapphire's most striking characteristic is its luster, common to all corundum and most noticeable in light-colored specimens. It is usually, though not always, a livelier, more attractive color than tourmaline; and as is often the case with paler stones, the physical characteristics generally have to be measured to tell them apart. In the case of pink stones, measurement of the density by means of heavy liquids may be sufficient.

Occurence Pink sapphire comes almost exclusively from Sri Lanka; much more rarely from Burma.

Value Although the "minor" varieties of corundum are always a lot less valuable than rubies and sapphires, pink sapphire is more highly prized than the yellow, green, and violet varieties, as it is so attractive. It is one of the most valuable secondary gems.

Simulants and synthetics Pink sapphire has not really been imitated, but it has been produced synthetically by the Verneuil flame fusion method. The synthetic form, like that of yellow sapphire, is extremely well disguised and it is very hard to distinguish it from the natural varieties.

2.4 Violet sapphire

This is the name now given to the violet variety of corundum. It was formerly known as "oriental amethyst," on account of its color; but this name has now been abandoned in favor of the debatable, but mineralogically more precise, term used for all minor forms of corundum.

Appearance The typical color is a definite violet, like amethyst, which is very attractive and tends to turn reddish violet in the sun or bright light. But all gradations of color are possible from the violet blue of some sapphires to the violet red of some rubies and the violet pink of some pink sapphires. Whatever the exact shade, it is always a very pleasing color, and has perhaps been less appreciated than it deserves because of the association of violet with mourning and sorrow in the West. As always with corundum, it has very good luster, most evident in lighter gemstones. It is usually given a mixed, oval cut. Stones weighing a few carats are often found, but those of 10 carats and more are rare.

Distinctive features When the color of the sapphire tends to be blue-violet, red-violet or pink-violet (the first turning more violet, the others, redder, in sunshine or bright light), it is fairly distinctive, but not so when it is a true violet or violet with a slight hint of red. Some very fine amethysts look very similar to such sapphires, even to the reddish tinge. The characteristic luster of corundum is another distinctive feature, but here too, care is needed, as amethyst can bear a close resemblance.

Violet sapphires are easily distinguished, however, by their physical characteristics. If the density is measured with a heavy liquid such as methylene iodide, corundum rapidly sinks, while amethystine quartz floats.

Occurrence Many violet sapphires, particularly the paler, pinker ones, come from Sri Lanka. Much smaller quantities are also found in Thailand and Burma.

Value Despite its considerable aesthetic qualities, violet sapphire is not widely appreciated. It is accorded much the same value as other, secondary gemstones, being somewhat more valuable than yellow sapphire (which is more plentiful).

Simulants and synthetics Violet sapphire does not appear to have been imitated; but from the time synthetic corundum was first produced, various shades of violet have been manufactured, along with the other varieties. Large quantities of violet synthetic corundum are still produced, faceted into every imaginable shape, from oval or round mixed cuts to true brilliants and square and rectangular step cuts. The curious thing is that these stones, which are often of considerable size and weight (even 10 to 20 carats) are sold throughout the world under the name of alexandrite, an extremely rare form of green chrysoberyl that changes color to red, and is therefore not even vaguely like synthetic corundum.

2.5 Yellow sapphire

This is the name given to the more-or-less yellow variety of corundum, in accordance with modern terminology for colors other than blue and red. It was also formerly known as "oriental topaz."

Appearance Yellow sapphire may occur in quite a wide range of colors, from pale to canary yellow, gold, honey, and brownish yellow. The lighter, brighter colors are the most common. Medium-sized or large stones are often seen, generally with a mixed oval cut having a rather large pavilion (to increase the depth of color). Because of their transparency, veillike or lacelike liquid inclusions and even foreign crystals are often visible inside these stones. Like all corundum, they have considerable luster. Honey-colored stones, which are less common and often smaller, are equally lustrous and are given both oval and rectangular step cuts. The color can be quite similar to that of certain topazes.

Distinctive features Like all corundum, the yellow type can often be distinguished from other gems by its luster, but not from yellow chrysoberyl, which is very similar in this respect. The canary yellow color is not often found in other stones, except citrine, which is, however, a bit less lustrous. Yellow zircon has luster similar to that of yellow sapphire but is usually distinguishable through a lens by its much stronger birefringence, the facet edges appearing much more clearly duplicated and both facets and edges giving an impression of less hardness and greater brittleness. The inclusions in yellow sapphires are also fairly characteristic, at least when viewed through a lens. All in all, however, many yellow gems show some resemblance to yellow sapphire and must, therefore, be distinguished by their physical properties.

Occurrence Most light or canary yellow sapphire comes from Sri Lanka, and only a small proportion from Australia, which, however, supplies most of the less common honey, golden yellow or yellow-brown stones. Limited quantities are obtained from Burma.

Value Somewhat surprisingly, even very attractive yellow sapphires with fine luster are of relatively Iow value compared with other secondary gems; they are, for example, worth a lot less than the pink variety.

Simulants and synthetics Yellow sapphire was never really imitated by other substances until synthetic corundum was first produced. Since then canary and honey-yellow varieties have been widely manufactured. Like pink and colorless synthetic corundum, the yellow variety produced by the Verneuil flame fusion method is highly convincing and harder to distinguish from its natural counterparts than are rubies and sapphires produced in this way.

2.6 Green sapphire

This is the name given to the relatively uncommon, green variety of corundum. In the nineteenth century it was also known as "oriental emerald," just as violet and yellow corundum were called "oriental amethyst" and "oriental topaz." These names stemmed from a scant knowledge of mineralogy among gem merchants and have now been abandoned.

Appearance Due to its iron content, green sapphire is generally quite a strong, bright green color, sometimes with green to bluish green or yellowish green pleochroism. Individual stones are sometimes cut at different angles from the rough crystal, to bring out the best color. The luster is very good, as with all corundum. The mixed, oval cut is the most common, but square or rectangular step cuts are also used. These gems are usually small to medium-sized and rarely exceed a few carats.

Distinctive features The color is quite distinctive, especially combined with the particular luster of corundum. While green tourmaline can, at first glance, look fairly similar in color, it has more pronounced pleochroism, the direction corresponding to the bluer green often seeming rather opaque, and it is always, or nearly always, given a rectangular, step cut strictly aligned to the elongated shape of the prism. Green zircon can be quite similar to green sapphire in both color and luster, but it has far less obvious pleochroism and sometimes much stronger birefringence, easily detectable with a lens. Many green zircons, however, have weak or virtually nonexistent birefringence. In such cases, their density is also very similar to that of corundum, so the physical characteristics will need careful checking to establish a distinction.

Occurrence Green sapphire comes mainly from Australia, but it is also found in the United States (Montana) and Thailand.

Value As for all forms of corundum except ruby and sapphire, its value is quite low. It is perhaps worth a bit more than yellow sapphire, due to its greater rarity and the difficulty of finding stones of any size.

Simulants and synthetics Not being widely known or appreciated, this stone is not often imitated. But green synthetic corundum has occasionally been produced; it is of a brighter color than the natural mineral. Bluish green synthetic spinel has also been produced, whether to imitate green sapphire or zircon it is hard to say, as it bears little resemblance to either.

2.7 Colorless sapphire

When the crystal structure of corundum does not contain trace elements that act as colorants, it is completely clear, although this form is the least known and appreciated on the gem market. The name of leucosapphire, coined fairly recently, is derived from the Greek *leykòs,* meaning "white."

Appearance It is perfectly colorless or occasionally has a slight yellow tinge and has the typical luster of corundum. It can have fine veillike and lacelike liquid inclusions and even areas that look cloudy in bright light, due to the presence of fine, crossed needles or minute straws of rutile; it may also have small crystalline inclusions with minute cracks radiating from them, like much corundum from Sri Lanka. It is given a round (or almost round) mixed cut, or a slightly modified brilliant cut, having mainly been used as a substitute for diamond.

Distinctive features Despite its luster, it is very easily distinguished from diamond, which it was once meant to simulate. It has less dispersion and fire, plus weak birefringence, where visible. Diamond, of course, is singly refractive. The faint yellow coloration of some colorless sapphires can, however, make them more plausible as imitations. Colorless corundum is distinguished from colorless zircon by the pronounced birefringence of the latter.

Occurrence Colorless sapphire comes mainly from Sri Lanka, where quantities of light-colored corundum are found, but is apparently also found in Burma and elsewhere. It is of little interest as a gemstone and is chiefly used for industrial purposes as an abrasive.

Value Very Iow, but hard to quantify, as it now has scarcity value for collectors and amateurs.

Stimulants and synthetics Colorless corundum has not been imitated, but was formerly used to imitate diamond. It has been produced synthetically and as with the other pale varieties, the internal features characteristic of Verneuil synthetic corundum are very well disguised. Synthetic leucosapphire is used mainly as a diamond simulant, particularly for small stones, in which the differences are less apparent.

2.8 Star rubies and sapphires. Different-colored asteriae

Corundum often contains very fine needles of ruffle (TiO_2) arranged in intersecting lines in accordance with the symmetry of the crystal. These apparently develop when the stone is formed: as the temperature fails, the TiO_2 is no longer soluble in the Al_2O_3 and forms separate crystals. When the needles inside the corundum are particularly numerous, and the stone is cut *en cabochon*, with its base (or widest diameter) parallel to the base of the prism, a silk-type reflection is visible in bright light; it is fairly mobile and has the appearance of a six-rayed star, the closer and thicker the rutile needles inside, the more clearly this stands out. When reasonably pronounced, this effect is considered attractive, contributing in the past to the aura of mystery surrounding some gemstones.

Appearance The most striking phenomenon of rubies and sapphires is the development of the six-ray star, arranged in perfect symmetry, which shifts its center as the stone is moved. It is clearly visible under a single light source such as the sun or a lamp; much less so in diffuse light. If two or more powerful light sources are set close together, as many stars (their centers not far apart) can be seen in the stone. Each light produces its own star, which is basically a reflection. The effect is usually less pronounced in more transparent stones. The ground color can be ruby red (or an almost grayish, dull red), in which case it is known as a star ruby, or sapphire blue, in which case it is known as a star sapphire, but it can also be blue-gray, smoke gray, or blackish, all of which come under the name of asteria, a generic term also applied to ruby and sapphire. Such stones are invariably given a round or oval cabochon cut. The most highly prized are the ruby-colored (provided they are not the opaque, grayish red of some Indian rubies) and sapphire blue varieties. The others are less valuable, but still sought after, provided the star is clearly visible and they are not too small (3 or 4 carats, at least). Some star stones may weigh 10 carats or more.

Distinctive features The star with its distinctive mobility is characteristic, having six rays, unlike star diopside, for example, which has four. But to be certain of distinguishing star corundum from the widely divergent (but very few) other gems which can display the phenomenon of asterism, one normally has to measure the physical properties.

Occurrence Rare but magnificent star rubies and sapphires are found in Burma, although most star corundums come from Sri Lanka, usually being light blue or gray. Dark asteriae are found in Australia, and dull red, opaque specimens are found in India. Despite being rubies and displaying the phenomenon of asterism, these stones are not very attractive.

Value Star rubies and sapphires of good or even above-average color are distinctly valuable, as much so as faceted stones of similar color. The value of the grayish or dark asteriae is lower, though not much, for unusually fine specimens. On the other hand, comparatively small stones of insipid color or with a poorly defined star are worth a great deal less, and the same applies to dull-colored rubies, which often have a broad, smudgy star.

Simulants and synthetics Because of their undoubted attraction, star stones have been imitated in various ways. Efforts have been made to produce a star by engraving it on the base of a cabochon, or lining the base with a sheet of metal engraved with a six-rayed star. Milky quartz, which exhibits a weak form of the same type of asterism, has also been used, the base of the cabochon being covered with blue lacquer to give color to the stone and increase the contrast with the star; but the effect is somewhat different from that of natural star stones. In the last few decades, however, some manufacturers of synthetic corundum (using the Verneuil method) have found a way of producing both red and blue star stones with very pronounced stars (more pronounced than the natural versions), which are not as a rule too transparent and have an attractive, lively color; and these have been a great success in the United States.

3 CHRYSOBERYL

BeAl2O4

Crystal system Orthorhombic.

Appearance Single crystals are rare. Chrysoberyl is usually found as V-shaped twins or sometimes repeated twinning of flattened crystals, giving an appearance of hexagonal symmetry. It is normally cloudy, but when transparent, has considerable luster. The most common color is yellow, but it can also be grayish, greenish yellow, or even more or less green.

Physical properties It is quite hard: 8.5 on Mohs' scale, with a density of around 3.7 g/cm3. The refractive indices are roughly n[???] 1.74, and n[???] 1.75. It has weak prismatic cleavage.

Genesis Chrysoberyl occurs in granite-pegmatites and is an uncommon mineral.

Occurrence It is found in some pegmatites in the United States, in the Ural mountains in the Soviet Union, and in Sri Lanka, Rhodesia, Brazil, Madagascar, and Italy.

3.1 Alexandrite

This extremely rare gemstone of fairly recent history owes its name to the fact that it was first discovered in the Urals in 1830, on the day of Prince Alexander of Russia's coming of age.

Appearance Green: it can be almost emerald-colored, but is more often yellowish or brownish green. Its main characteristic is the ability to change color if exposed to a light source rich in red rays; by candlelight or tungsten light, it turns red or reddish. This unusual phenomenon is what distinguishes it from other green chrysoberyl. This pronounced color change from green to red is highly prized and, as always, the exact tone of the color, or colors, is important, the ideal being brilliant green turning to fiery red, although dull green turning reddish or slightly turbid blood red is more common, and given alexandrite's extreme rarity, even stones with a number of inclusions are cut. It is given an oval or round, mixed cut, or a rectangular, step cut. Alexandrite is so rare that few people have ever seen one; and perhaps for this reason, the name is applied to other, mainly synthetic stones, not remotely like it (usually violet-colored synthetic corundums).

Distinctive features The changing color is an unmistakable characteristic. However, in the last few years, small quantities of green or bluish-colored grossular garnet that turn red like alexandrite have been found in East Africa. To distinguish between the two, it is useful to look for signs of birefringence, as garnet, unlike alexandrite, is singly refractive. The refractive indices of the two stones, on the other hand, are very similar, as are their densities.

Occurrence Found in limited quantities in the Soviet Union, Brazil, Sri Lanka, and some East African countries (Zimbabwe and Tanzania).

Value Fine stones are extremely, valuable and on a par with emeralds, rubies, and sapphires. When the colors are dullish, the value falls appreciably, but because of its rarity, all alexandrite is expensive. It is a collector's item.

Simulants and synthetics Attempts have been made in the past to imitate alexandrite's change in color using synthetic spinel and corundum, but the results have been modest. More recently, a violet-colored synthetic corundum has been widely marketed under the name of alexandrite, despite its lack of any real similarity to the natural stone. However, many who have never seen true alexandrite apply the name to this synthetic corundum and possibly for this reason, some manufacturers of synthetic corundum call their violet stones "alexandrite type." Synthetic alexandrite has also recently been produced, but mainly for industrial purposes. For the time being, therefore, synthetic alexandrite is even rarer than the natural variety.

3.2 Chrysoberyl

This is the true chrysoberyl, also known as golden chrysoberyl, a synonym, the prefix "chryso" being Greek for "golden." It is the most common variety of chrysoberyl.

Appearance The color varies from yellow to greenish yellow or green, brownish yellow, or pale yellow. It has basically the same color range as cat's eye (cymophane) with a bit more green or brown.

Mixed oval or round cuts or even triangular, marquise, or pear-shaped cuts are all used -- any cut, in fact, which can set off the excellent luster of the stone, and allow it to be used even in jewelry of complex design.

Distinctive features The color can frequently be fairly similar to that of certain beryls, or to some particularly yellow olivines; but it has greater luster than these two stones. It also has quite different refractive indices and a different density from that of beryl. When the color is pale yellow, it can closely resemble what is known as yellow sapphire, but the density is different.

Occurrence Chrysoberyl is mainly found in Brazil, Sri Lanka, and Madagascar.

Value Although of some importance in the past, it is comparatively little known and appreciated today, probably on account of its rather weak color, Its value is accordingly quite Iow, about the same as that of beryls, tourmalines, and spinels of unexceptional color.

Simulants and synthetics Very occasionally, a few greenish yellow synthetic spinels, which could be regarded as imitations of chrysoberyl, appear on the gem market. Synthetic yellow chrysoberyl, on the other hand, does not appear to exist on the market, which is hardly surprising, given the modest value of the genuine article and the complexity and high cost of synthesis.

3.3 Cat's-eye or Cymophane

This is the name given to the yellow, yellow-green or gray-green variety of chrysoberyl, which displays the phenomenon of chatoyancy because of the inclusion of numerous fine, parallel crystal needles.

Appearance The color is greenish yellow or yellowish, sometimes with a rather cold, almost grayish tone. Some fine stones are a honey brown. In the proper light, the near side will appear yellowish white while the brown of the far side will be intensified, creating a milk-and-honey effect. Cat's-eye is always cut *en cabochon,* round or oval, to emphasize the cat's eye effect, and can be fairly transparent. Due to its hardness, it takes and maintains good luster, and the more pronounced and pleasing the cat's-eye effect, the greater is its value.

Distinctive features The most common cat's-eye stones are the quartzes, which, however, usually have a rather different color from chrysoberyl and are less transparent with brighter, but more superficial, chatoyancy. If there is any doubt, they can immediately be distinguished by their different density, because refractive indices are always hard to establish for curved stones.

Occurrence Cymophanes are mainly found in Sri Lanka and Brazil, although they are not common.

Value Cat's-eye is highly prized by collectors and connoisseurs. Its value is accordingly quite high. Very fine examples are less valuable than the principal gemstones, including alexandrite, but more so, for example, than a fine topaz or spinel. Due to its value and hardness, it is also known as "noble cat's-eye."

Simulants and synthetics Various natural stones have been used as substitutes, including fluorite, which, however, is much softer, and kornerupine, a gem still rarer than cymophane, with lower hardness and density. Quartz has also been used, although its color rarely resembles that of cymophane and its density is also much lower. To our knowledge, no attempts have been made to produce this gem synthetically.

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