Gems and Gemology

Diamonds mounted in Platinum

Modern design for the gift of sentiment and value

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IN THIS ISSUE

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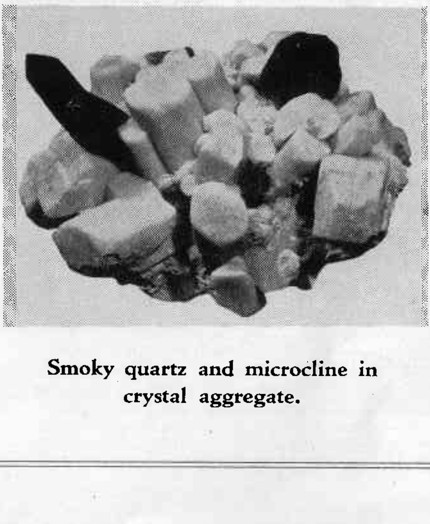
Harvard Gem Collection

by

CHARLES PALACHE, Ph. D.

Prof. Mineralogy Emeritus, Harvard University

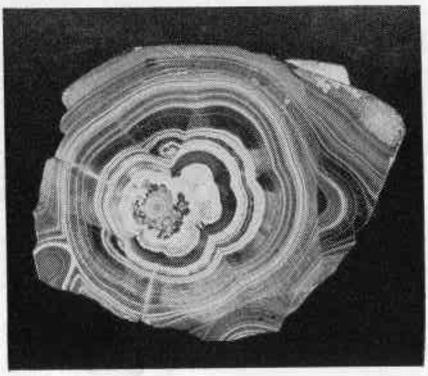
THE Harvard University Mineral Collection has been in existence since 1784, but it is improbable that during its first hundred years there was contained in it any specimens worthy of the name of gems. The beginning of the gem collection was the Acquisition of the Hamlin Collection of tourmalines from Mt. Mica, near Paris Hill in Maine, in 1892. The negotiations for the purchase of these specimens were carried through by George F. Kunz, gem expert for Tiffany & Company of New York, on behalf of James A. Garland of New York City. There were a large number of specimens, among them several of the gem-worthy crystals described and figured in Hamlin's book on Mount Mica published in 1895, and a few cut tourmalines of fine quality. At about the same time with the Hamlin tourmalines, Mr. Garland presented the University with a number of uncut gem minerals and a few cut stones. These included a magnificent 82-carat octahedron of yellow diamond from Kimberly, a blue topaz and several aquamarines and golden beryl from Russia, a large mass of Australian opal, and a fire opal from Mexico. The cut stones were blue topazes. These minerals were first exhibited in 1895 in two cases in the gallery of the Mineralogical Museum and remained the only important gems in the Harvard Collection until the acquisition in 1913 of the mineral collection of A. F. Holden. In this collection there were no cut stones, but the tourmalines from Pala, California were among the finest ever obtained there. There were cross sections and a large crystal of tourmaline from Madagascar, then just coming onto the market, and two superb kunzite crystals from California.



Smoky quartz and microcline in crystal aggregate.

The receipt by the University of Mr. Holden's large endowment fund for the Department of Mineralogy, which took place in 1922, marked the beginning of any attempt at Harvard to really form a gem collection. It was my endeavor, as curator of the collection, to gradually acquire worthy representative specimens of all the important gem minerals from various localities in their natural condition and various colors and to place alongside of these cut gems of a size and quality as good as our funds would permit. New window cases on the main floor of the Museum gave opportunity to exhibit the new acquisitions in a worthy manner. While few large cut stones are to be found there, many of the gem crystals are noteworthy.

The main portion of the floor of the exhibition room is given over to the display of mineral specimens arranged systematically according to the chemical classification of minerals. Some representatives of the gem minerals are to be



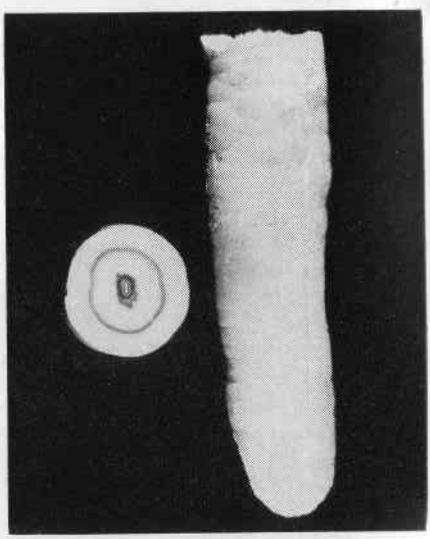
Finely banded malachite from Harvard Collection.

found in their proper places in this exhibit, but the finest of them are displayed in the window cases on both sides of the room. Let us consider some of the gems one would see if one were to enter the main room and turn left to examine the specimens in the window cases.

In the first case (No. 106) are two rubies, still in the white calcite matrix in which they formed. Although not spectacular, they are unusual for most rubies are broken from the matrix when they are found. These are from Burma. There are also two isolated Burma ruby crystals, the larger of which weighs 635 carats. There are 15 cut sapphires that the gemologist on close examination would not find to be of the highest quality, but they show well the range in color from deep blue to colorless. Others are pink, green, blue, and yellow ranging in size from 3 to 100 carats. This same case contains several cut chrysoberyls, many variously colored zircons, andalusite, and peridot. The largest cut peridot of a deep green color weighs 23 carats.

The second case (No. 107) is devoted to topaz and exhibits mostly uncut crystals. The largest specimen is a Brazilian crystal which weighs 43 pounds and is composed of colorless topaz of gem quality. Another crystal also from Brazil is 8½ inches long and 1¼ inches wide and while containing many flaws has the amber color usually associated with gem topaz. The cut stones are mostly colorless but there are pink, green, yellow, and blue representatives. The largest weighs 105 carats.

In the third case (No. 109) are cut



Harvard Collection's Smithsonite stalactite.

and uncut varieties of quartz. Of the cut stones, amethyst predominates with 20 stones, the outstanding one a rich purple 183 carat brilliant from Siberia. Various depths of color of citrine are shown in 10 cut stones, the largest — 135 carats — is from Brazil. Smoky quartz crystals and cut stones are also shown. One of the most striking specimens in this case is a rutilated quartz crystal about four inches high and three inches across.

In the fourth case (No. 110) there is only one specimen. This is from Brazil where it formed a portion of the lining of a large cavity. It is three feet long, 1½ feet wide, and covered with amethyst crystals.

In the next case (No. 111) is mostly uncut rose quartz and opal. The most interesting of these specimens is a rose quartz ball about two inches in diameter which shows a striking asterism. Here also are the Australian opal and Mexican fire opal that were among the first gems to come to the Harvard Collection.

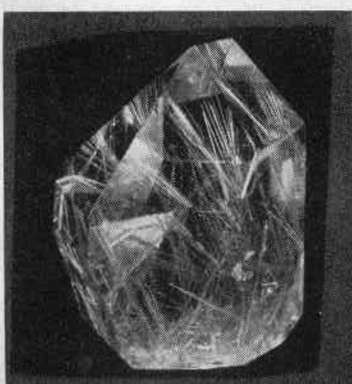
Case No. 113 displays two types of gems. Here are shown 17 boules of synthetic corundum and spinel, and stones that have been cut from other boules of the same color. Some of the cryptocrystalline varieties of quartz such as chrysoprase, carnelian, heliotrope, chalcedony, and agate are also shown together with cut and carved pieces of these minerals.

In the seventh and last case along the east windows (No. 112) are several of the gem minerals of lesser value such as turquoise, varisite, prehnite, malachite, lapis lazuli, crocidolite (tiger eye) smithsonite, and chrysocola.

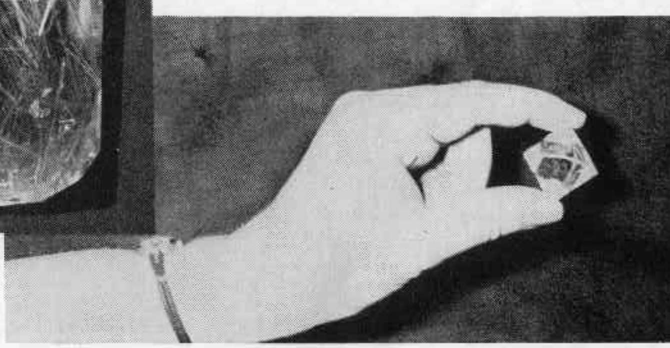
Directly across the room in the first case under the west windows (No. 114) is an exhibit of tourmaline. Gem crystals and cut stones of many colors from Ceylon, Southwest Africa, Brazil, Russia, and Madagascar are displayed. Most striking are six transparent slices cut from a large crystal from Madagascar which show triangular markings outlined in different colors.

The next case (No. 115) under the west windows contains more tourmaline crystals and cut stones. Among them are specimens from the Hamlin Collection from Mt. Mica, Maine and the famous Hamlin necklace. This necklace, set with

(Continued on page 23)



At the left, rutilated quartz crystal, four inches high, and below, an unusually large, well-formed diamond octahedron.



Gem Deposits of Southern California

by

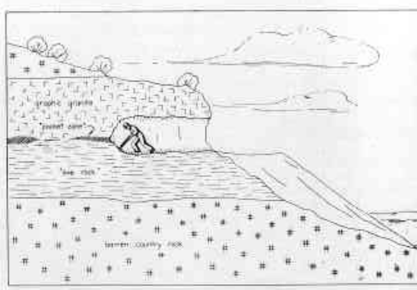
RICHARD H. JAHNS, Ph.D.

ON a warm June day nearly 76 years ago, Henry Hamilton was picking his way along the brushy southeastern slope of Thomas Mountain in the Coahuila district of southern California's Riverside County. As he crossed a small gullied area, he noticed several rough mineral fragments of attractive pink and green color. Carefully tracing the occurrence of this loose "float" material to its source higher on the hill, he encountered a ledge of light gray rock in which a few irregular cavities were lined with crystals of quartz and other minerals. Among these others were beautifully transparent pencil-like crystals of red, pink, green, and blue color. These constituted the first California discovery of gem tourmaline, a material that already had been mined in eastern parts of the United States.

A little mining was done at the new locality, and some excellent gems were obtained. As the interest of other men was quickened by Hamilton's success, additional deposits were soon discovered in the same general area, but it was not until nearly 20 years later that any important find was announced. This, in an area 24 miles to the southwest, was an occurrence of tourmaline with large quantities of the lithium-bearing mica, lepidolite. The deposit was exposed on a hill slope immediately north of the little mission town of Pala, on the San Luis Rey River. In addition to large quantities of lithium minerals, it yielded numerous specimens of lilac-colored lepidolite with coarse sprays of deep pink tourmaline. These found favor in museums and collections the world over.

The greatest discovery of all was made still later, in 1898, when several blue, green, and red crystals of tourmaline were shown to cowboys by Indians living near Mesa Grande. The source of this material was found to lie on a high wooded slope south of the San Luis Rey River and about 11 miles south of Palomar Mountain. This ledge became the site of the world-famous Himalaya Mine, the greatest producer of gem tourmaline in North America.

Tourmaline was not the only mineral involved in a series of spectacular discoveries made during the period 1902-1905. Frederick M. Sickler, while work-



Diagrammatic cross section showing distribution of the gem-bearing "pocket zone" and the other rock types characteristic of many Southern California pegmatite dikes.

"Pay streak" in Pala Chief mine northeast of Pala. Crystals of spodumene (white) are embedded in a matrix of clay and quartz (dark gray). Some of the spodumene crystals contain material of gem quality.

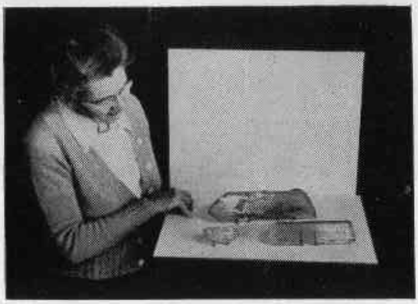
ing a lepidolite deposit a short distance northeast of Pala, encountered numerous transparent masses of a mineral colored in delicate tints of pink, lavender, lilac, and blue-green. These were subsequently identified as a rare, remarkably clear variety of the lithium-bearing mineral spodumene. The pinkish to lilac-colored types were given the name kunzite, in honor of Dr. G. F. Kunz, who first identified them in his capacity as mineralogist for Tiffany and Company of New York. Kunzite thus is one of California's own minerals.

Additional spodumene deposits soon were discovered in the Pala area, and mining for this mineral, tourmaline, and lepidolite led to recognition and recovery of fine transparent quartz crystals and a beautiful pink to deep peach-colored variety of beryl. The aquamarine and emerald varieties of beryl were well known at the time, but this type was new, and was named morganite in honor of the noted financier. Such beryl also was encountered during mining in the Mesa Grande and Rincon districts.

Tourmaline was found on the slopes of Aguanga Mountain, near Palomar Mountain; at several places in the Mesa Grande area; near the town of Ramona; and at numerous other localities during subsequent years. Colorless to blue topaz, some of it in large, perfect crystals, was discovered at several Aguanga Mountain and Ramona localities, and subsequent mining yielded stones of quality equal to that of the best material obtained from Brazil. In addition the essonite, or hyacinth variety of garnet was found in the Ramona deposits, chiefly as honey-colored to orange-red transparent crystals. It also occurs in the Mesa Grande area; in the vicinity of Jacumba, far to the south near the Mexican boundary; and at several intervening localities.

The locations of the principal gem-producing areas of southern California are all in the province of the so-called Peninsular Ranges, a series of ridges and mountains that extends southward from the edge of the Los Angeles Basin. This great highland mass separates the Salton-Imperial depression on the east from the coastal areas on the west, and also forms the "backbone" of much of Baja California. It is characterized by medium-to coarse-grained igneous rocks that range widely in composition.

All the gem materials and minerals occur in pegmatite, a granitic rock characterized by extreme coarseness of grain. The pegmatite ordinarily forms dikes, and these tabular masses range in thickness from less than an inch to 100 feet or more. In most places the pegmatite is surrounded by other, less coarse-grained igneous rocks of more basic composition. In most areas the dikes trend north to north-northeast and dip



Leonora S. Reno, secretary of the Division of the Geological Sciences, admires three giant crystal fragments of gem spodumene. The largest ones are two very remarkable specimens from the collection of T. W. Warner, Pasadena.

westerly at gentle to moderate angles. Although they consist chiefly of graphic granite, a peculiarly regular intergrowth of quartz in microcline feldspar, careful examination discloses numerous variations in their composition and internal structure.

Many of the pegmatite masses are very regular in thickness and attitude, and most of them contain little or no gem material. Others are "two-ply" features, with upper parts of graphic granite and lower parts of a strikingly layered, much finer-grained rock that consists mainly of sugary albite feldspar with garnet, black tourmaline, or both minerals. The latter has been termed "line rock," owing to the appearance of its many thin, subparallel garnet—or tourmaline—rich layers on most outcrop surfaces. A little of this material has been used as an ornamental stone, but none of it has yielded gems.

In the central part of some dikes, commonly along or near contacts between "line rock" and overlying graphic granite, is the so-called "pocket zone," "pay streak," "clay layer," or " gem strip." Ordinarily this is an irregular series of tabular or pod-like masses that are rich in quartz. Associated with the quartz are albite, microline, and orthoclase feldspars, muscovite, and lepidolite micas, tourmaline of various colors, beryl, and rarer minerals. These masses generally are surrounded by pegmatite rich in muscovite and coarse prisms of black tourmaline.

Some well formed quartz crystals weighing 100 pounds or more have been encountered during mining, although few gem crystals of quartz or other minerals exceed six inches in maximum dimension. The gem material of best quality is found embedded in a pink to pinkish brown clay, which is thus regarded by miners and prospectors as a very favorable indication of "pay stones." Some of the gem crystals are loose in the clay, some are attached to other minerals that line the clay-filled "pockets," and a few are wholly or almost wholly embedded in solid pegmatite.

Most of the pegmatites that contain gem tourmaline, topaz, garnet, or beryl are 5 to 20 feet thick, although there is little systematic relation between thickness and gem content. Indeed, the famous Himalaya pegmatite, in the Mesa Grande district, was only one to five feet thick where richest in gem minerals. There is a definite relation, on the other hand, between the occurrence of kunzite and the local thickness of spodumene-bearing pegmatite dikes. Such dikes characteristically thicken and thin, or "pinch" and "swell," as traced along their outcrops. The central part of each bulge or "swelling" is commonly marked by a pod-like mass of quartz or of quartz with long, thin, lath-like crystals of spodumene.

The spodumene is opaque and white to pinkish in color, and much has been thoroughly decomposed to a clay-like substance. Inside some of the crystals, however, are fragments of clear kunzite, which appear to represent those parts of the crystals that escaped alteration. The proportion of clear material is rather high in the crystals nearest the centers of the largest pegmatite bulges, and a very few laths are entirely unaltered. Gem crystals of this type are known to reach thicknesses of two inches and lengths of nearly a foot, but unfortunately are exceedingly rare.

The mining of pegmatite gems in Southern California reached its peak during the decade 1902-1912, when material valued at more than $1,500,000 was marketed. Tourmaline, which represented most of the output, was graded on the basis of size, color, transparency, and freedom from bubbles, inclusions, and other imperfections. Nearly all the gem crystals are shaped like a short lead pencil, with diameters of most ranging from one-eighth inch to four inches or more. They are characteristically hexagonal, with flat or nearly flat terminations. A wide variety of colors has been found but red, pink, salmon, green, dark blue, and black are most widespread. Many crystals are bi-colored or multi-colored with sharp or gradual changes from one end to the other or from the interior outward. Some crystals with pink interiors and green rims are known as "watermelon" tourmaline.

Most transparent crystals of high quality were cut into gems, which commanded prices of $2 to $10 per carat. Current prices are somewhat higher than this. Much pink material of slightly inferior grade was sold to Chinese markets, where it was highly prized as carving material. Thousands of crystals, representing a wide range of quality and size, also were marketed as specimens in all parts of the world. So much tourmaline was sold during the "golden decade" of mining, however, that the market collapsed shortly before World War I, and only during recent years has it shown signs of recovery.

During World War II a little tourmaline of deep green and blue color was sold from the Pala district. This represented material left over from previous production, and was used because of its piezoelectric properties. The current demand for such material, as well as for gem stock of highest quality, far exceeds the present available domestic supply.

The rough crystals of kunzite are blade—or lath-shaped, and nearly all are deeply striated and grooved. Most are small, with lengths of two inches or less, but some nearly a foot long and weighing 24 ounces or more have been recovered during mining. The limiting factor for size of top-quality cut stones is the thickness of the source crystal, as the deepest colors are obtained only when the stones are viewed parallel to the long axis of the crystal. The mineral is a very difficult one to prepare as a gem, owing to its two directions of perfect cleavage and hence its tendency to break near the edges during cutting. However, it yields stones of exceptional beauty.

Current prices for facet-cut stones of this high quality range from $2 to more than $25 per carat, depending chiefly upon the nature and depth of their color. Kunzite is so rare that it also has considerable value as a specimen material. It has been mined sporadically during recent years in the Pala district, and three mines are being reopened for systematic operation at the present time.

Colorless to blue topaz has been mined chiefly from deposits near Ramona and on Aguanga Mountain. It has found a ready market, commanding prices of $5 to $15 per carat in the form of facet-cut stones. Much specimen material has been sold as well.

Quartz, garnet, and both aquamarine and pink to salmon-colored varieties of beryl represent only a small proportion

(Continued on page 28)

Formation of Gemstones

by **CORNELIUS S. HURLBUT, JR., Ph.D.**

A talk given at A. G. S. Conclave in Washington, D.C.

THE subject, "The Formation of Gemstones," is a large one, almost as large as "The Formation of Minerals," for if we were to group the minerals according to the manner in which they were formed we would find some gem minerals in each group. In this respect gems are like gold, they are where you find them. There are certain places, however, where there is a concentration of gems and if one were to prospect for them he could be guided by the geology to search in certain places.

GEMS IN IGNEOUS ROCKS

Much of the rock that makes up the crust of the earth is known as igneous rock; that is, it has crystallized from a hot molten magma, and the minerals that make it up are the common ones such as quartz, feldspar, and mica. In some of these rocks, however, other minerals have formed in perfect enough crystals to be of gem quality. They, like feldspar and mica, are considered as rock-forming minerals. For example, the diamond in the diamond pipes of Africa is scattered uniformly through the rock and in this case must be considered a rock-forming mineral, although the percentage of diamond is small, about one volume of diamond to forty million volumes of rock. In other places, zircon and garnet have crystallized from a molten magma in large enough and clear enough crystals to be used as gems. One of the most interesting examples of a gem being found as a rock-forming mineral is sapphire at Yogo Gulch, Montana. Here sapphires are uniformly scattered through a dike of igneous rock. The material from which this rock crystallized was forced into a crack in the earth's crust several miles long, from 10 to 20 feet wide and of undetermined depth. Sapphires have been extracted from the rock all along the surface and at one place mining had extended to a depth of 200 feet when operations were abandoned in 1929.

Igneous Rock—slowly cooling —showing the granular aggregate structure.

One of the most interesting types of igneous rock is found in pegmatite dikes. These dikes and the gem minerals associated with them are considered later.

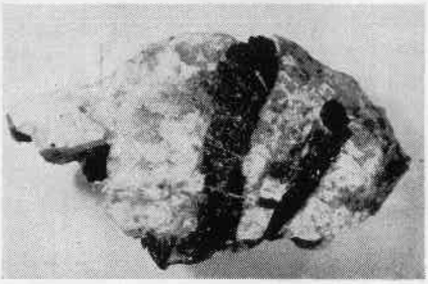
GEMS IN METAMORPHIC ROCKS

When a rock is once formed, it does not always remain in its initial condition but changes take place due to deep burial within the earth's crust and to the high temperatures that obtain there. Such changes give rise to metamorphic rocks. In these rocks the percentages of the various chemical elements are not greatly different from those in the original rocks, but a rearrangement has taken place destroying some of the old minerals and giving rise to new ones. Thus in some metamorphic rocks garnets, andalusite, and staurolite are found abundantly. In a schist (a type of metamorphic rock) in the Ural Mountains, much of the finest beryl (emerald) and chrysoberyl (alexandrite) have been found. From a marble in Burma, have come many superb rubies and gem spinels. A highly prized specimen in any mineral collection is a Burma ruby still partly embedded in the white marble in which it grew.

GEMS IN VEINS IN GEODES

In addition to occurring as rock-forming minerals, gems are found in veins where well-formed crystals have grown into open spaces. Water-rich solutions carrying some dissolved mineral matter may move through cracks in the rocks and, due to changes in temperature and pressure, will deposit some of the dissolved mineral matter. Since crystals formed in this way are attached to the walls and grow outward into open spaces, they are not interfered with by others. As a result they frequently are beautifully formed specimens showing many crystal faces. Most of the gem quartz, whether it is rock crystal, amethyst, or smoky quartz, is found in veins which formed in this way.

If a more or less spherical cavity exists in a rock, solutions passing slowly through it may deposit crystals of minerals which grow inward from the wall. If growth continues for a long time, these crystals will eventually meet at the center and interfere with one another. Such cavities not completely filled are called geodes. One of the commonest occurrences of amethyst is in beautiful crystals lining the walls of geodes. If for some reason the solutions do not deposit well-formed crystals of quartz (amethyst) but lay down concentric colored layers of the same mineral in fine-grained aggregates, agate results.



Pegmatite—showing characteristically large crystals.

SECONDARY GEM DEPOSITS

After a gem mineral has been formed, it may be weathered from the rock in which it grew and moved from its place of origin. All rocks including those in which the gems occur are broken up by weathering processes and their constituent minerals are either dissolved and carried away in solution or washed down the slopes into the neighboring streams. If a mineral is soft, it will be completely disintegrated in this process but, if it is hard, as most gems are, it will not be broken up but merely rounded by the abrasive action of other minerals in the stream bed.

To form a concentration in a stream bed the minerals must have in addition to a high hardness a high specific gravity, that is, higher than the average, which is about 2.65. These heavier minerals will work their way down through the sand and the gravel to the bottom of the stream bed, where they may accumulate.

Another property necessary for such accumulation is chemical stability. Some minerals react with water and with the oxygen and carbon dioxide of the air to form powdery, soft materials. A mineral would not be considered a gem unless it has chemical stability. Thus, most gem minerals by virtue of the properties that make them gems tend to accumulate in this way. This type of accumulation is known as placer. Many of the best gems reaching the markets of the United States have been found in such placers in the stream beds of Burma, India, and Brazil. A few of the gems found in placers are diamond, tourmaline, chrysoberyl, beryl, ruby, sapphire, and topaz. It is probably safe to say that since man first used minerals for gem purposes, only a small percentage has not come from placer deposits.

OF WHAT ARE GEMS MADE?

If we were to analyze the rocks of the earth's crust to a depth of several miles, we would find about eight chemical elements were present in abundance and the remaining 84, out of a total of 92, were present in only small amounts. Among these the most common are oxygen and aluminum, the two elements which combine to give rubies and sapphires. Also we would find the chemical ingredients of garnet, andalusite, staurolite, peridot, jadeite, nephrite, spinel, and others.

It is not a scarcity, then, of the chemical constituents that brings about a scarcity of these gems, but a scarcity of the conditions necessary for their formation. One of the best examples is quartz, made up of silicon and oxygen. Quartz is an abundant mineral, but quartz of gem quality is comparatively rare. Perhaps a more striking example is that of diamond. There are millions of tons of nearly pure carbon in the many coal beds throughout the world, millions of tons more of carbon in the limestones that underlie so much of the United States, and yet in only a very few places has this carbon encountered the right conditions so that diamond will crystallize.

PEGMATITES AND GEMS

As we have just seen, the proper conditions as well as the necessary chemical elements must exist for the formation of a gem mineral. In certain places and under certain conditions rare elements are found under the proper conditions to form unusual minerals. An example of this is the pegmatites. Here a concentration of rare elements exists that gives rise to minerals such as beryl, topaz, chrysoberyl, spodumene, and tourmaline.

To understand what a pegmatite is and the manner of concentration of these elements requires a knowledge of the formation of the igneous rocks. Let us assume there is a large volume of hot molten rock deep within the earth's crust. It is made up of those chemical elements from which quartz, feldspar, and mica (common minerals of a granite) will eventually crystallize. In addition to these common elements, there are traces of rarer ones and some volatile constituents, particularly water. As the magma begins to cool and crystallize the chemical elements will be extracted from it that go to make up the common minerals, leaving behind in the still molten part the rare elements and the volatiles. As crystallization proceeds,this concentration of the rarer elements gets greater and greater so that when the rock is almost solidified there remains a highly fluid liquid portion containing most of the rare elements that originally existed throughout the whole mass. Perhaps due to the pressure of the solutions themselves or because of a cracking in the earth's crust, these fluid solutions will be forced upward into cooler surroundings. Crystallization will take place but here, and because of the fluid nature of the material, large crystals will form. These crystals will be made up for the most part of the common minerals, and large crystals of quartz, feldspar, and mica will form.

In addition, if there has been a con-

(Continued on page 24)

Something of Collections and Collectors

By **ELSIE RUFF, F.G.A.**

WHEN a very small child produces three or four bus tickets, with the injunction "Don't tear these up, I'm collecting" the interested parent begins to question the source of this new trait. Every child, apparently, falls prey to the collecting habit at some period or the other and may carry it on into adult years. Observation leads one to suspect that collecting, like other characteristics, though often emulative, is almost as often original. To find two of a kind, with slight distinctions, suggests three, and four, and so on.

The use of jade makes an interesting point. Far removed (in those days) from all possible contact with each other, neolithic man discovered jade in various parts of the world and proceeded to fashion it for his own use as implements. The tendency of the researcher is to start retracing a tribe's migration from one country to the other, thereby hoping to account for the strange similarities of conduct and then, confronted by disturbing gaps of time, to attribute that which cannot be deduced to some sort of race memory.

Experience of such research usually weakens, if not weans, the common ancestor theme and forces one to conclude that the human mind works in much the same grooves, regardless of race or geographical position. For even if one traces something back to a common ancestor, it still had to be thought up by this ancestor, and he was probably no more original than anybody else.

Perhaps only one brought up in an outrageously lonely outpost of civilization could today claim originality in the matter of gemstone collecting. But the fact that children do, apparently, think up the idea of collecting (anything) for themselves, in itself tells us that it is a very, very ancient trait, something that has been called "the collecting instinct of the community." Primitive man undoubtedly collected, maybe with different motives. Perhaps the small accumulations of gemstones that have come down to us from time to time were more collections than gemstones for their own sake.

Writing of collecting a little while back, an English commentator deplores

From a collection at the *Cleveland Museum of Art* is this chiselled gold frame set with a miniature of Napoleon I, surrounded by diamonds, and signed "Isabey, 1810."

the philatelist. He considers the object of his excitement " unworthy of human dignity." Further, he writes: "I know another man who collected jade. Few things are more satisfactory than a fine jade figure here and there; but to see three hundred pieces of jade arranged in glass cases seemed to suggest, not that the man liked or understood jade, but that he did not really know what jade figures were meant to be or mean."

With gemstone collecting there is some confusion. A gemstone collector is just that, pure and simple. He may, on occasion, use part of his collection for ornamental purposes, but his main interest does not deviate. He does not collect jewelry. If, in order to obtain a particular stone, he finds it necessary to buy a piece of jewelry, then he promptly disposes of the setting; unless the bare setting has some significance where the stone is concerned. Again, a woman who owns, and wears, a great amount of jewelry, is not necessarily a jewelry collector. In fact, she seldom is. Her jewelry is for her ornamentation from which she derives pleasure on that account. Yet it is no great step for the owner of fine jewels to turn connoisseur and the connoisseur to turn collector.

So in any study of gemstone collecting the bejeweled monarchs and dandies of early days must be outruled. When Henry VIII made his memorable ride to the Tower of London, he attached to his person a variety and quantity of gemstones wide enough in range for a practical gemology demonstration, but it was essentially ornamentation and riches and, from a modern point of view, propaganda. Edward I was an earlier monarch reputed to have had a great collection of gemstones, including diamonds, sapphires, topazes, amethysts, carbuncles, garnets, and chalcedonies. Whether he can be classed as a collector is difficult to say. Certainly his period coincided with a new race of collectors then embryonic.

We must also outrule many a famous woman who, for love of gemstones or for ornamentation, has sustained that spectacular streak we find throughout history. There was Agnes Sorel, in the semiofficial capacity of mistress to a king, who did so much for diamonds that the Diamond Corporation should put her among their hierarchy. There was the Roman Lollia Paulina, according to Pliny, covered in emeralds of fabulous worth. Actually her emeralds were part of a collection handed down from her grandfather. In emerald display she must have challenged Cleopatra, despite the fact that the Egyptian queen had a business interest in the emerald mines of her own country. Indeed, the Egyptians of that day were almost fanatical in their appreciation of the emerald, though not apparently with any magico-religious intent. More modern emerald admirers — and wearers — were Josephine, wife of the first Napoleon, and the Empress Eugenie, wife of the third. One would like to think of the Queen of Sheba as a collector, but her journey to Jerusalem, carrying gold and gemstones, was a diplomatic tribute in the manner of her day.

Gemstone collectors too would seem to be sharply divisible, according to the social conditions of their time. There was the primitive collection, a likely free-for-all, though with any great development of the tribe it would almost certainly become the prerogative of chiefs or the socially favored. And there is the gemstone collector who is partly the product of a nation at its peak, when wealth, and luxury, and education, and leisure, and foreign travel or influence unite. The first civilized collectors, as opposed to the primitive, would seem to be the jade collectors of China. Old jade has always been important enough for charlatans to counterfeit. But hundreds of years ago the jade of earlier periods was being simulated for the benefit of collectors. As a result, the symbolism is so confused that present connoisseurs hardly dare hope to understand it. Extant is a catalog of a magnificent collection once belonging to an emperor of the Sung dynasty. It was published in the 12th Century, a period when China was already sensitively aware that her great days of jade culture were over.

Perhaps contemporary with these jade collections were the gemstone collections of India. Gemstones have for long been the insurance policy of that country, but the hoards were so fabulous and so rare that in no sense could they be disregarded as collections. One of the oldest of which there is record is attributed to the first Century B.C. and contained pearls, corals, beads of sapphire, agate, and crystal.

Ever since the Renaissance, when the modern museum originated, collectors have usually left their gemstones to these institutions, where all might see and enjoy and study. Before the day of the museum, however, there was the temple, performing in some sense a similar function, for collectors bequeathed or presented just such collections to the public via what was to them a sacred building. The word *museum* actually means *a temple of the Muses.* Aristotle is said to have owned a natural history collection, some of which he acquired through the good graces and the travels of Alexander the Great. Possibly it was later housed in one of the Greek temples, where collections of paintings and statuary were common.

Sandwiched between the period of the temple and that of the museum was what we call the Dark Ages, an interval of time the antithesis of conditions stimulative to gemstone collecting. It was during the 15th Century that the wealthy were once more publicly interested, turning their attention to statuary, gemstones, manuscripts, and such like. One to collect objects of natural history was the "father of mineralogy," Georg Agricola (1490-1555).

It is significant that a collection of gemstones in classical days had a name to itself. Pliny tells us it was called by the "foreign" name of *dactyliotheca,* a Greek word meaning collection of finger rings. In naming the Roman gemstone collectors, Pliny speaks of the consecration of a gemstone collection that had once belonged to Mithridates, King of Parthia (died 64 B.C.) and which seems to have been superior to any of the Roman collections. The first Roman to possess himself of a *dactyliotheca,* according to Pliny, was Scaurus (died 88 B.C.), the stepson of Sylla. For some time he alone enjoyed this distinction. Later, Julius Caesar, who has been called a "discriminating collector," and who added Scottish river pearls after his conquest of Britain, consecrated no less than six *dactyliothecae* in the Temple of Venus Genetrix; and Marcellus, son of Octavia, presented one to the Temple of the Palatine Apollo.

Gemstone collecting in ancient Rome has been described as a passionate pursuit, the wealthy (men in this instance) vying with each other for fine specimens and paying enormous prices for them. The Romans, on the top of the world of their day, were in the favorable position of being able to import the luxuries they wanted. Moreover, educated men were expected to have some knowledge of gemology. Among the collections, therefore, was a great variety, particularly in engraved gemstones. Emeralds, topazes, beryls, amethysts, sapphires, carnelians, sardonyx, sards, chalcedonies, garnets, hyacinths, peridots, onyx, jaspers, were the most favored. And the shape of these gems was nearly always that of the ring

(Continued on page 22)

The Tetragonal System

by

MARK C. BANDY, Ph.D.

Director of Research, Gemological Institute of America

THERE are seven classes of symmetry in the tetragonal system. All forms are referred to two horizontal axes (a_1, a_2) of equal length and a vertical axis (c) of variable length. The principal forms are the unit prism, pyramid, and base. Although all natural tetragonal crystals may show a base, they are usually terminated by pyramids. The crystals may show first and second order pyramids and prisms and third forms known as ditetragonal pyramids and prisms. When the ratio of length of the horizontal and vertical axes approaches unity, the crystals may resemble isometric cubes of octahedra. The prismatic forms that may resemble cubes are distinguished by physical properties such as cleavage, striations, etc., which are consistent for the two basal directions or the four prisms but not for all faces as in the isometric system. The pyramidal faces are isosceles triangles in the tetragonal system and not equilateral triangles as in the isometric.

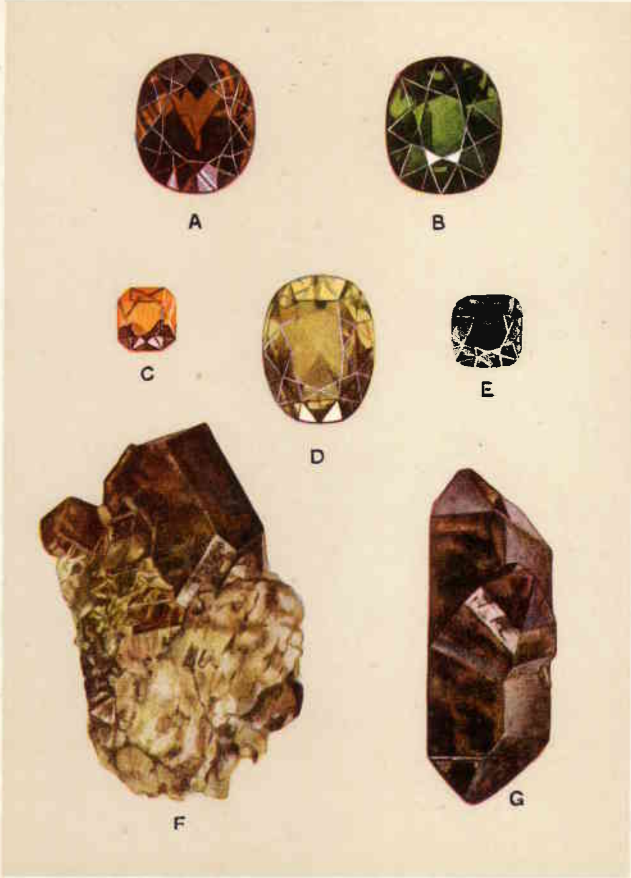
Of the seven classes of possible symmetry, natural crystals are known to occur in only five and gemstones are limited to two of these, the normal and pyramidal.

The tetragonal system is relatively unimportant from the gemologist's point of view. Only two gemstones of importance crystallize in this system, zircon and idocrase, and only one gemstone of minor importance, scapolite. Scheelite, apophyllite, cassiterite, anatase or octahedrite and xenotime may be regarded as collectors' items. Rutile, the latest mineral to join the field of synthetics, crystallizes in this system; the natural gemstones being collectors' items.

Unlike the gem minerals crystallizing in some of the other systems, valid generalizations of physical properties cannot be made. All have cleavages of greater or less perfection and, with the exception of apophyllite and scapolite, have refractive indices higher than 1.70 and with these two exceptions, all have specific gravities higher than 3.4.

Only two gem minerals are shown on the accompanying plate. The apophyllite crystal shown at A is a rare blue color. This mineral occurs in many mines and areas of basic igneous rocks that have been poured out on the surface of the earth or intruded in thick sheets or dikes into the rocks near the surface. It is less common in acid igneous rocks. Crystals are sometimes cut as a collector's gem and may be found in light tones of pink, blue, green, yellow, and colorless. Here the crystal shows the unit first order pyramid, a base of small area and a prominent second order prism. The association of a first order pyramid and second order prism is characteristic of apophyllite, just as the association of the first order pyramid and first order prism is characteristic of zircon. Apophyllite has the peculiar optical property of being both positive and negative—an unique feature of idocrase as well.

Scheelite, C, has appeared in faceted stones in recent years in the U. S. and



ZIRCON

Several of the colors common to zircon are shown on this plate. Although they can be correctly referred to as orange zircon, green zircon, etc., some of the colors have variety names. The stones shown at (A) and (C) are Jacinths, both from Ceylon. (B) is a green zircon. A Jargoon is shown at (D) and a blue zircon at (E). The zircon crystal in syenite (F) from Russia and the twinned crystal (G) from a Canadian deposit are characteristic in appearance to rough stones before heat-treating. Specimens from the collection of British Museum (Natural History), London.

A

B

C

D

CRYSTALS: TETRAGONAL SYSTEM

The light blue crystal (A) is apophyllite. Because of its softness and lack of transparency it seldom is found in the jewelry trade. It is interesting to note that the optic sign of this mineral may be either positive or negative. The crystal aggregate at (B) is wulfenite from Arizona. Another mineral commonly found in Arizona is scheelite (C). The torberite (D) is from Gunnislake Mine, Cornwall and is orthorhombic, not tetragonal. Specimens from the collection of British Museum (Natural History), London.

these colorless gems, if cut with the proper proportions, have an adamantine lustre and brilliancy comparable to zircon and sphene. Unfortunately, the softness (4.5-5) and lack of dispersion will always limit them to collectors' items. The crystal in the accompanying plate shows only the unit first order pyramid, a characteristic habit of the mineral. Wulfenite, B, is closely related mineralogically to scheelite. Transparent material suitable for faceting is unknown and, if found, its hardness of 2.5 to 3 would limit the gem to advanced collectors in spite of its adamantine luster and brilliancy. Wulfenite crystals are characteristically tabular, often in very thin crystals less than 1/16" thick. Here the crystals show a large base and small pyramid and prismatic forms.

The mineral torbernite, D, is a hydrous phosphate of copper and uranium. This is an example of a mineral which is pseudo-tetragonal. This was originally identified as a tetragonal mineral and it was only in recent years that it has been correctly classified as orthorhombic following exhaustive X-ray studies. Torbernite crystals are usually tabular and occur in foliated mica-like aggregates as shown here.

The Zircon

ZIRCON can be considered a newcomer among the gemstones of the western world. The mineral has been known, probably since before the time of Theophrastus but the gem is essentially oriental. Tracing its history back through the ages is particularly fascinating since the mineral has been known by many names and its modern name was only introduced by Werner in 1783, when he described crystals from Ceylon. It is believed by some that the ancient name "lyncurium" (amber) may have embraced brown zircon but this is doubtful. It is more probable that hyacinth and jacinth, which at first referred primarily to the amethyst and garnet, was given to the zircon and then later to the sapphire, spinel, etc. Zircon was also known as jargon or jargoon and this name has been preserved in the literature of today for the colorless variety. A number of names are found in the literature but these have been discarded, fortunately. The name zircon is of uncertain origin, but it is probably derived from the Persian "zargun," meaning gold-colored.

This plethora of names is not surprising when it is realized that zircon is actually a group of minerals which, even today, is poorly understood. The group occurs naturally in a wide variety of colors which are readily altered and usually improved by heating. In spite of this wide variety of beautiful colors, zircon is not widely known and in view of its remarkable properties, it is probably the least appreciated of all gems. Curiously enough, it is most widely known today in an unnatural hue of blue, which is a result of heating. The gem is actually a victim of rapacious exploitation.

The zircon has been separated into three varieties known as low, intermediate, and high. The low variety is uncommon in nature, rarely seen in cut stones and is so designated because of its comparatively low refractive index and specific gravity. It consists of amorphous silica (SiO_2) and clouds of crys-

(Continued on page 27)

Diamonds . . .

NINETEEN hundred years ago Pliny, that erudite old Roman, correctly stated that the diamond is the hardest of all substances. But he is scarcely correct in stating that if placed on an anvil and hit with a hammer, the hammer is shattered and the stone buries itself in the anvil. Nor is he correct where he states that before the stone can be broken it must be steeped in the blood of a freshly killed he-goat. The diamond, nevertheless, is more than four times as hard as the ruby and more than twice as hard as boron carbide, the hardest of all artificial substances.

The first diamond, we infer, was found about 800 to 600 B.C., by some Hindoo wading a stream and being attracted by the fire of a colorless crystal. A Hindoo book, written early in the third century B.C., describes six varieties of diamonds from as many Indian mines. Diamonds reached Rome shortly before the time of Christ, and Pliny states that they were so unusual in his day that they were possessed "only by kings, and by but few of these."

Tavernier

Diamonds were rare in Europe until 300 years ago and were distinctly a masculine ornament until the time of Agnes Sorel (1422-50 A.D.). In her day glamour girls did not go to Hollywood but to the courts of kings. Her boy friend, Charles VII of France, gave her a diamond necklace, probably crudely cut which, she tells us, while uncomfortable, she wore out of love of her king. Many women since then have been willing to undergo similar tortures.

Thanks to the mines of India and Borneo, diamonds became more common in Europe in the 17th century; still less rare in the 18th century—due to the Brazilian mines—and, today, we have an adequate supply from Africa. Were it not, however, for the extraordinary increase in the income of the world's citizens, and the attainment of perfection in diamond cutting, the diamond would still be known only to kings.

The river alluvials of South Africa were found in 1867; the pipe mines in 1870. Then followed a sequence of discoveries of important alluvial deposits; the Belgian Congo in 1907; South West Africa in 1908; Angola in 1913; the Gold Coast in 1919; and Sierra Leone in 1930.

But while the diamond rarely occurs in commercial deposits its occurrences as a mineral curiosity, even in our country, are many. It has been found in numerous places in the southeastern states, in California, and sparsely in other western states. In Arkansas is a true pipe of the South Africa type, but apparently too poor to work. In the Middle West a number of fine stones have been found in the terminal glacial moraine. Therefore, somewhere east of Hudson

We print here the first part of a talk given by Dr. Ball at the 13th Conclave of the American Gem Society, held in Washington, D.C. The balance, covering industrial diamonds, will appear in the next issue of GEMS & GEMOLOGY.

The King of Gems

By **SYDNEY H. BALL, Ph.D.**

Bay is a diamond-bearing lode containing fine gemstones. Is it commercial? *Quien sabe,* as the Mexicans say.

The papers during the past year have been full of sensational tales of the Williamson Mine in Tanganyika Territory. That British mandated African area has been producing a few stones for 33 years. Five years ago, after a long decline, production began to mount but Tanganyika is not today an important factor in the industry. Whether it is to become such, time will tell.

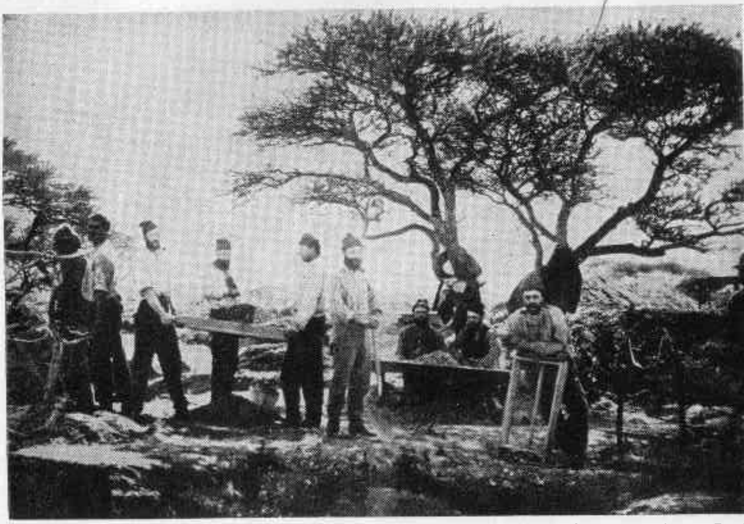
A word or two about certain of these fields. Spirits are said to own the Bornean diamond deposits and without their cooperation diamonds will not reward the miners. Medicine men are at hand to guarantee that cooperation. Their batting average is at least as good as that of the economists of today. When, a century ago, James Brooke, that astounding Englishman who became the first white Sultan of Sarawek, was about to start up a diamond mine, his guide left at the pit a card with the following Chinese characters: "Rajah Muda Hassim, James Brooke, and Hajji Ibrahim present their compliments to the spirit and request his permission to work at the mine."

South Africa for centuries had been a flop financially when in 1867 the bright eyes of a little boy, Erasmus Jacobs (he died only a year or two ago); the intelligent curiosity of a Boer farmer, Van Niekirk; of a wandering Irish trader, O'Reilly; and the mineralogic knowledge of a modest man of science, Atherstone, made it—by the discovery of alluvial diamonds—into a prosperous dominion, our valued ally in both World Wars. For a time new discoveries were few, but in 1860 the "Star of Africa" turned up, a stone which, when cut, weighed 45.5 carats. Many larger stones exist, but it is the most important diamond of all time for it turned a hopelessly poor country into a rich nation—for Kimberly fortunes transformed Rand prospects into the Witwatersrand gold mines of today.

Van Niekirk

When diamonds were said to have been found in South Africa, important London financial houses sent a leading engineer, Gregory, out to investigate. He rightly found conditions different from the Indian and Brazilian occurrences and therefore concluded that the diamonds were planted by real estate speculators who desired to sell their holdings. When a mining engineer errs, the public is without charity, and today, as you sip your "sun-downer" at the Kimberly Club, if you tell a tall story, you are "Gregorizing."

In 1870 the stolid Boer farmer, Dutoit, sitting idly before his cabin late one afternoon, saw a diamond sparkling in its adobe walls. Soon he spotted 16 more, and the South African pipes, the world's diamond El Dorado, were a reality—the



DeBeers Consolidated Mines, Ltd.

THE DISCOVERERS: JULY, 1870

instrument which made Cecil Rhodes and, through him, Rhodesia.

There is an unimportant diamond field in Shan-Tung, China. The Chinese peasant and his habits are always interesting. Rains, he believes, produce diamonds, and after rains, the native, shod in straw sandals, walks over the fields. Naturally, the sharp-pointed diamonds stick in the sandals. These are then burned and the diamonds recovered from the ashes. (If there are any metallurgists present, I can assure you that the patent has expired on this process and you can use it as you see fit.)

Up to the discovering of the South African pipes—old volcanoes filled with a dark-colored igneous rock—all diamonds had been recovered from stream gravels; that is, all mines were placers. Twenty-five years ago, however, the South African pipes were dominant in the industry. They since have lost their pride of place as to production to the alluvials farther north, but may regain it in 1949.

Most gem diamonds are small, but there is an exclusive club of producers of large stones. The old members were India, South Africa and the small Bagagem district in Brazil. Sierra Leone was admitted two or three years ago. The club's admission committee is considering the application of Venezuela and Tanganyika Territory.

Remember that diamond mining is 2,500 years old and that it employs some 125,000 men. The all-time production has been a little over 78 tons, the chief contributors being the Union of South Africa and the Belgian Congo. Without interstices, this would form a cube nine feet on a side, but cut gemstones of one carat or more of good quality would form a cube but 2.5 feet on a side. Therefore, the woman who wears a one carat or larger solitaire is a stand-out, whether or not she belongs to the Daughters of the American Revolution, or the Colonial Dames. She owns an integral and an appreciable part of one of the world's most precious commodities.

Today, I estimate that the world's production ranges from 9,000,000 to 14,000,000 carats a year of which about 2,500,000 carats—say 1209 pounds—is of gem grade.

Broadly, mining and milling methods are similar to those of metal mining, except that the gravel or rock treated is very low grade. To get a unit of diamonds we mine from 20,000,000 to 60,000,000 rock units. The average hard-working diamond miner, with luck, may produce a grain a day. And Job was supposed to be patient!

Stones available for use as gems must, of course, be cut. To cut a diamond to give it its maximum brilliancy, the cutter must know not only the crystallographic characters of his piece of rough, but also optics. Before World War II, Belgium and Holland were the great cutting centers. In 1940 these were blacked out and the cutting industries, formerly unimportant, expanded in our own country, Porto Rico, and Brazil. They also sprang up in Palestine and Cuba. In the past year and a half the Belgian and Dutch industries have revived.

Jean Baptiste Tavernier, the greatest gem merchant of all time, who lived in the 17th century, is our chief authority on the mines of India (Gibbon of Roman Empire fame refers to him as "that jeweler who had read nothing, but had seen so much and so well.").

As was to be expected, Tavernier had Gallic wit: "All the Orientals are very much of our taste in matters of whiteness and I have always remarked that they prefer the whitest of pearls, the whitest of diamonds, the whitest of breads, and the whitest of women." He describes the selling methods of the Hindoo gem merchants, a technique used today in the Chinese jade market: "The buyer and seller sit facing one another like two tailors and one of the two opening his waistband, the seller takes the right hand of the buyer and covers

DeBeers Consolidated Mines, Ltd.

1871: THE EARLIEST DIGGINGS

Diamonds . . .

his own with his waistband under which, in the presence of many other merchants who occupy themselves sometimes in the same manner, the sale is completed secretly without anyone having cognizance of it." The silent code depends on whether the whole hand, a finger, or a mere joint is covered, each having its numerical value.

A century later, when the Brazilian mines were discovered, European diamond merchants had adequate stocks of Indian diamonds. They, therefore, stated that the Brazilion stones were not diamonds, or if so, of an inferior quality. The Portugese, however, had an Indian colony at Goa. The stones were shipped there, transshipped to Europe, and brought top prices as Indian stones.

The magical powers ascribed to gems are intriguing. Regarding the diamond, let us quote that worthy, Camillus Leonardus, doctor of medicine and protege of Caesar Borgia, who wrote in 1502: "The Virtue of all these Species (of Diamonds, SHB) is to repel Poison though ever so deadly: is a defense against the Arts of Sorcery; disperses vain Fears; enables to quell all Quarrels and Contentions; is a Help to Lunaticks and such as are possessed with the Devil; being bound to the left Arm it gives Victory over Enemies; it tames wild Beasts; it helps those who are troubled with Phantasies, and the Night-Mare; and makes him that wears it bold and daring in his Transactions."

Notwithstanding the gem's rumored power against poison, diamond powder administered internally has long been supposed in certain quarters to be a deadly poison. One of Cellini's most amusing tales is of an attempt upon his life by this method by his rivals. His miraculous escape was due to the cupidity of the lapidary to whom the task of grinding the diamond was assigned. He, being in financial straits, pocketed the diamond and substituted a softer and cheaper stone.

Collections . . .

(Continued from page 15)

stone. Flute players liked to flaunt their gemstones in rings, which showed to advantage on these instruments, and there was rivalry about these rings among the flutists themselves. The story of the Senator Nonius, exiled from Rome because of his refusal to part with a particular gemstone to Mark Antony, is well known. The Emperor Commodus (161-192 A.D.), a son of Marcus Aurelius, was also a collector of some note and owned a beautiful aquamarine engraved with a figure of Hercules. (A statue of Commodus, unearthed in Rome during 1874, represents him as Hercules.)

In the early days of the Renaissance one or two collectors emerge. The French Valois, for instance, were quite famous collectors. In those times the court moved around with an *entourage* that included jewelers and gemstone engravers. So presumably these collections took on a professional character. A famous collector also was Pope Julius II (1443-1513), who laid the foundation stone of St. Peter's. As a patron of the arts and literature he founded the Vatican Museum. His gemstone collection included the very pale yellow Florentine brilliant; an aquamarine, 2 1/16 inches in length, which he wore in his tiara; and a beautiful emerald engraved with his name.

The Spanish Cortez can hardly go down as a collector, despite five cases of emeralds he shipped to Spain, and reputedly lost at sea, or the further consignment sent his fiancee, some of which later turned up in Paris for sale. But it does establish magnificent collections of emeralds, many delicately carved, among the Aztecs themselves; emeralds that Cortez likely acquired as ransoms or for less virtuous reasons.

A noteworthy British collector was Sir Hans Sloane, a physician. Included in the index of his collection were over a thousand *christolls,* hundreds of beautiful agate cups and agate handles, 290 cameos, and 232 engraved gemstones. Among single items was a pebble of Egyptian jasper with a portrait of Chaucer engraved upon it. An earlier English collector was Thomas Howard (Earl of Arundel, 1586-1646). What has been called the Marlborough gems from his collection have been scattered among other collections. John Ruskin (1819-1900) presented his own collection to the British Museum in 1884 and later the yellow Colenso diamond and the Edwardes' Ruby.

Though this article has dealt only summarily with collections and collectors generally, it is perhaps sufficient to establish a certain consistency for this pursuit throughout history. Yet a change is apparent. Apart from the fabulous gemstone collections of India, those in private hands have largely dispersed, due to rapidly changing social conditions. But gemology—scientific gemology—is a new stimulant, and a new race of collectors is on the way. The gemology student's collection will hardly be pretentious or valuable, but it will contain rare and little known specimens and the range will be great. Moreover, the collection itself will ring a different note, for each stone will be scientifically tested by its owner. For this reason alone it will be more intimate. In Oscar Wilde's *Picture of Dorian Gray* the author makes his hero take up the study of jewels. Certainly Wilde must have had access to one of the fine collections of his time (was it Ruskin's?), but only an appreciative writer could have given us such a description. It represents a phase of exquisiteness in gemstone collecting that the gemologist should not miss.

". . . He would even spend a whole day settling and resettling in their cases the various stones that he had collected, such as the olive-green chrysoberyl that turns red by lamplight, the cymophane with its wire-like line of silver. The pistachio-colored peridot, rose-pink and wine-yellow topazes, carbuncles of fiery scarlet with tremulous four-rayed stars, flame-red cinnamon stones, orange and violet spinels, and amethysts with their alternate layers of ruby and sapphire. He loved the red gold of the sunstone, and the moonstone's pearly whiteness, and the broken rainbow of the milky opal. He procured from Amsterdam three emeralds of extraordinary size and richness of color, and had a *turquoise de la vieille roche* that was the envy of all the connoisseurs."

Harvard . . .

(Continued from page 5)

18 large, variously colored tourmalines and many smaller stones, came to the Harvard Collection in 1923 long after the original gift. This rather ornate piece of jewelry was made by Mr. Hamlin with what he considered the finest gems to come from Mt. Mica.

The third case (No. 116) contains California tourmaline. To the mineralogist the superb specimens of crystal groups from the famous localities of Pala and Mesa Grande are of most interest. Among the cut tourmalines is a 201 carat brilliant cut rubellite as well as an interesting carving in rubellite.

The next case (No. 117), containing an exhibit of beryl, is considered by many to be Harvard's outstanding single exhibit of gem minerals. A crystal of aquamarine from Brazil 13 inches long and

Harvard . . .

2½ inches in diameter is the largest specimen in the case. Other uncut crystals arranged beside stones cut from similar material are shown. The largest cut stone is an aquamarine weighing 243 carats. Gems from California, New Hampshire, Massachusetts, and Maine are shown. Most beautiful of all are the cut stones from Brazil. These show a variety of shades of blue and green as well as the rich yellow of golden beryl. In the same case are emeralds. A beautifully formed isolated crystal from Brazil weighs 60 carats and a large one from Colombia, still in the matrix, weighs approximately 80 carats.

In the next case (No. 118) are several crystals of pink beryl, morganite, and a cut stone of this material from Madagascar weighing 32 carats. Here, too, are the gem varieties of spodumene — a deep green hiddenite crystal from North Carolina is the one figured in color in Kunz' *GEMS OF NORTH AMERICA* and is the second largest found at the type locality. A paler hiddenite is shown with a 56 carat cut stone from Brazil. The two large kunzite crystals which came to Harvard with the Holden Collection are not on exhibit, but another is displayed that measures 9x4x2 inches and weighs 72 ounces. This is of interest to jewelers in that it was in G. F. Kunz' private collection. In this same case are cut garnets from North Carolina, New York, California, Brazil, Mexico, Russia, and Greenland.

In case No. 120 are shown some less common gem minerals such as the datolite from Lake Superior colored a delicate shade of pink by inclusions of native copper, hematite, and andalusite (chiastolite) and sphalerite. Fluorite in crystals, carvings, and cut stones and cut and uncut scapolite are also here. An unusual stone exhibited is a cat's eye scapolite from Burma. A cut scapolite from Brazil weighs 106 carats. Here also are specimens of nephrite and jadeite with some small carvings from similar material.

In the last case (No. 121) are a number of other comparatively rare cut stones. Among these are sphene, apatite, willemite, benitoite, diopside, scheelite, and cassiterite. The various varieties of feldspar are also displayed. There is the deep green microcline (amazon stone); peristerite from Madagascar and Hybla, Ontario; monnstone from Ceylon; labradorite from Labrador; and sunstone from Norway. Most striking of the cut feldspars is a deep yellow orthoclase from Madagascar weighing 35 carats.

The most recent acquisition to the Harvard Mineralogical Museum is the Burrage collection of minerals and gems. Time has not yet permitted a cataloging of these specimens but when this is done and they can be put on display the gem collection will be greatly enhanced. Among the gems there are many fine cut stones of ruby, sapphire, chrysoberyl, spinel, and tourmaline.

Formations . . .

(Continued from page 12)

centration of the rare element boron, tourmaline may be found. Tourmaline is a common and abundant mineral in pegmatites, usually black and not of gem quality. If, however, there is not only a concentration of boron but also one of lithium, tourmaline may crystallize that is red, green, blue, or colorless. In the same pegmatite may be found topaz resulting from a concentration of the rare element fluorine. One of the most characteristic minerals in a gem pegmatite is beryl, made up of the three common elements aluminum, oxygen, and

(Continued on page 30)

Gemological Digests

Method for Producing Synthetic Emerald

During World War II, Professor R. Nacken of the Mineralogical Institute, Frankfurt University, Frankfurt, Germany, perfected a method for growing synthetic quartz crystals, and several other minerals including emerald. Professor Nacken had been working on the growth of crystals since 1912, and the following is an account of the method he developed for growing synthetic quartz crystals. It is of special interest to gemologists because exactly the same method was used successfully to grow synthetic emerald crystals.

As a starting point for the production of quartz crystals, seeds in the form of thin lamellae were cut from natural quartz crystals. The apparatus used consisted of an autoclave (high pressure "bomb") having an inner and outer chamber. The inner chamber was made of steel, cylindrical in shape and lined with silver. It had a capacity of about 30 ml. The inner chamber was contained in an outer vessel with thick steel walls, closed by a screw plug. The seed crystal was suspended in the inner chamber by a silver wire. Raw material in the form of chemically pure silica glass was placed in the outer chamber. Solvent was added which consisted of a very dilute (N/1000) solution of sodium bicarbonate. The solvent occupied about 20 per cent of the total volume of the autoclave at room temperature. The autoclave was sealed and the temperature raised to 370-400 degrees C. and maintained at this value for several days. The apparatus was so designed that the temperature of the inner chamber would be slightly lower than that of the outer chamber, and the solvent circulated, carrying silica in solution from the silica glass and depositing it as quartz on the seed crystal. A quartz crystal about 1.5 cm. by 0.3 cm. could be grown from a thin "seed" plate in a few days time.

Professor Nacken used with success a similar method for the synthesis of other minerals, including feldspars, micas, and beryl. He made large numbers of synthetic emeralds, using a trace of chromium to produce the color. Hexagonal prisms weighing 0.2 grams (1 carat) were grown in a few days.

Abstracted from: *SYNTHETIC QUARTZ CRYSTALS,* by G. Van Praagh. (Geological Magazine, vol. 84, No. 2, pp. 98-100, 1947).

—George Switzer, Ph.D.

Recent Information On Emerald Production

The emerald zone of Muzo is situated in the valley of Rio Itaco, tributary of the Rio Minero. The mines are about 100 km. north of Bogota, at an elevation of about 600 meters above sea level. The mines are about eight miles from the village of Muzo by mule trail.

When the Muzo mines, together with the Coscuez mines, a short distance to the north, are in operation, they produce the highest quality emerald in Colombia at a rate of about 13,000 carats annually. The only other important emerald mine in Colombia is the Chivor mine, 90 km.

northeast of Bogota, in the valley of the Rio Guavio. This mine is owned by an American concern.

None of the Muzo mines, government or privately owned, have been in exploitation since 1939. Now, however, the government has leased the National mines to the Bank of the Republic, which plans to reopen the Muzo and Coscuez mines shortly.

When in operation the Muzo mines are worked rather primitively. The mountain face is first cleared, then terraces are cut on the slope, forming a broad ampitheatre. The workmen work on the terraces following the course of the emerald-bearing veins. No dynamite is used for fear of shattering the emeralds. The mining is carried out almost entirely by means of long bars of 1½ inch round iron, pointed at one end and flattened at the other. The parts of the vein containing emerald are picked out by hand and deposited at a sorting office where they are cautiously broken up to smaller fragments and the emeralds are picked out and sorted. The emeralds are finally classified by color, transparency, absence of fractures, and size. The emeralds of very low quality are usually destroyed. This method of exploitation of the Muzo emerald mines has been used unchanged for centuries.

Abstracted from: *THE MUZO EMERALD ZONE,* COLOMBIA, S.A., by Victor Oppenheim. (Economic Geology, vol. 43, No. 1, pp 31-38, 1948). (Manuscript dated October 23, 1947).

—George Switzer, Ph.D.

Dr. Ball Awarded Third Belgian Congo Decoration

Dr. Sydney H. Ball, New York City mining engineer, and member of the Gems & Gemology Editorial Board, recently received his third decoration from the Colonial Government of the Belgian Congo.

For furthering the development of mining in that district during the past 40 or more years, Dr. Ball has been awarded titles of *Chevalier de l' Ordre Royal du Lion, Officier de l'Ordre Royal du Lion,* and in January, this year, *Commandeur de l'Ordre de Leopold II.*

Reprint of a portion of Dr. Ball's A.G.S. Conclave talk on "Diamonds" will be found on page 18 of this issue of Gems & Gemology.

Woyie River Diamond Displayed To Public

For the first time since its discovery in January, 1945, the 770 carat diamond recovered in the gravels of the Woyie River, Sierra Leone, will be displayed to the public at the British Industries Fair opening in London, England this month.

Not only is the Woyie River Diamond the largest ever recovered from an alluvial source, it is the third largest rough diamond ever found, and the largest uncut diamond in the world.

Forty-four carats heavier than the Jonker, it has been surpassed in size only by the 3,106 carat Cullinan, and the Excelsior of 995.7 carats.

Hope Diamond Held In Trust

With the passing of Evalyn Walsh McLean early this year, the famous Hope Diamond, appraised at $176,920, has been placed in trust. Under the terms of her will the diamond, along with other jewelry, will ultimately go to her grandchildren.

Pyrandine . . . A New Name For An Old Garnet

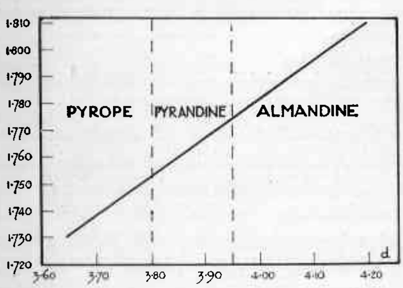
By B. W. ANDERSON

(Abstract from Article in *Journal of Gemmology,* April, 1947.)

Fully appreciating the undesirability of loading the literature of gemology and mineralogy with new names, Anderson proposes that the name pyrandine be used for the common calcium-iron garnet. He points out that pure pyrope and pure almandite are almost unknown in nature and indicates the advantages of using this term to eliminate confusion and often incorrect usage of the other two terms. He would limit the name to red garnets which have refractive indices between 1.75 and 1.78 and with densities between 3.80 and 3.95.

It would appear that this new name could be used with advantage and this is probably the only instance in the garnet group where such a hybrid name is indicated.

If one will recalculate the numerous analyses of garnets in the literature, it



is soon evident that so-called pyrope garnets contain from 40 to 74% of the pyrope molecule and from 15 to 43% of the almandine. Analyses of the so-called almandite garnets show compositional variations from approximately 50 to 83% almandine and from 3 to 27% pyrope molecule. In recalculating these two species of garnets, it is immediately apparent that the pyrope garnet has a definite composition variation toward the almandite garnet while the almandite garnet varies toward both the spessartite and andradite species, as well as pyrope.

There will no doubt be a certain reluctance to accept this new name with the arbitrary limits placed by Anderson but to prevent a mix-up of this name, the limits indicated should be accepted. The only limits placed upon the application of this new name are those indicated above and variations in color, chemical composition, etc., are not considered.

Zircon . . .

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tallites of zirconium oxide. Stott and Hilliard found that the normal zircon structure breaks down into these two constituents when heated to 1580 degrees centigrade. The breakdown is accompanied by a lowering of both index and density. This variety is known only in some hue or tone of green.

The intermediate variety is somewhat more common in nature but is comparatively rare among faceted gems. It has the typical zircon structure with physical and optical properties intermediate between the low and high varieties. It grades imperceptively into the high variety that is usually seen in jewelry. The latter occurs in a wide range of natural colors and, through heating, some of these colors may be changed to the characteristic blue or colorless stones which are the most widely known of all zircons. These latter hues are rarely, if ever, found in nature in large crystals. The optical and physical properties of this variety are distinctive in the upper range but grade into the intermediate variety, which is characteristically some hue or tone of green. There is a sharp

Zircon . . .

break between the intermediate and low varieties. When the intermediate variety is heated to 1450 degrees centigrade, it converts to the high type and since almost all cut zircons have been heat-treated, this explains the prevalence of this type in jewelry.

Zircon (high) has an unusually high refractive index (1.925-1.984) which gives it an adamantine luster approaching that of the diamond. Its dispersion (.038) also closely approaches that of the diamond (.044). With optical properties so near those of the diamond, it was inevitable that unscrupulous merchants would substitute it for the latter gem. To obtain colorless stones, it is necessary to heat-treat the natural gems. Zircon, unfortunately, is relatively brittle and only slightly harder than quartz. Since heating reduces the hardness and increases the brittleness, the close resemblance to the diamond has served as a detriment to this beautiful gem. Many brown and yellow stones can be changed to an attractive blue when heated and when these latter were introduced to the western world about 1923, they enjoyed an immediate and unprecedented popularity. They were purchased without knowledge of their brittle character and without knowing that they had been heat-treated and might possibly revert to their natural color in time. When many of them became yellowish and most of them developed surface pits, the gem was blamed. Because of the criticism, it soon became almost as unpopular as the opal. Fortunately, the name zircon did not suffer quite the same fate, since these colorless and blue stones were usually sold under an ingenious variety of incorrect names.

Anyone who purchases a zircon with the full knowledge of its lack of extreme hardness, its brittleness and its potential change of color but with an appreciation of its beauty of color, luster and high dispersion will possess a gem that will always be a source of pleasure and pride.

Since the gem was not identified as a separate species prior to the latter half of the 18th century, it does not enjoy the fascinating myths associated with the more common gemstones. The zircons of the Middle Ages and possibly the ancient world, came from Ceylon. In recent years, most of them have come from Siam and Indo-China, where the gem cutters and dealers have developed heat-treating to such an art that all stones are said to be so treated. Color banding is common in the natural stone and heat will reduce or eliminate this defect.

In the accompanying plate, a characteristic crystal from a Canadian locality is shown at G and a similar crystal on matrix from Russia is shown at F. Five faceted gems of various colors are also shown but no illustration could do justice to the brilliancy, dispersion, and scintillating beauty of the actual gem.

—Mark C. Bandy

Deposits . . .

(Continued from page 9)

of the gem production of Southern California, in terms of both bulk and value, but they are widespread in their occurrence and in their distribution in gem and mineral collections. A large pocket of peach-colored beryl crystals was encountered during recent wartime mining for quartz crystals of radio grade in the Pala district, and other crystals of similar form and color have been encountered from time to time in the search for kunzite. Still other occurrences have been reported during recent years from deposits in Riverside County.

The moribund gem mining industry of

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Contributors In This Issue

CHARLES PALACHE, Assistant, Instructor, Professor of Mineralogy, Harvard, and Curator of the Harvard Mineralogical Museum, 1895 until his retirement in 1940, has given long and distinguished service to this field of science. In 1941 he was awarded an honorary LL.D. degree. Describer of twelve new mineral species; author of one hundred and forty-two scientific papers; senior author of the new *System of Mineralogy* founded on Dana; the first Roebling Medalist of the Mineralogical Society of America; Dr. Palache is a member of most of the important mineralogical and geological societies in this country and abroad.

CORNELIUS S. HURLBUT, JR., has been Associate Professor of Mineralogy at Harvard University since 1940. In 1941 he revised Dana's *Manual of Mineralogy,* and his revision of Dana's *Minerals and How To Study Them* will be published this year. Secretary of the Mineralogical Society of America since 1944, Dr. Hurlbut is a Fellow of the Geological Society of America, a member of the American Academy of Arts and Sciences, American Association for the Advancement of Science, British Mineralogical Society, and Sigma Xi.

ELSIE RUFF, F.G.A., Surrey, England, studied the science of gemology back in its early pioneering days. She has spent many years in research and writing on the subject, living part of the time in her native England, and part of the time abroad. If heredity plays any part in interest in the subject, Miss Ruff (Mrs. Gordon Glennie in private life) has been well qualified, having three generations of jewelers behind her.

Shortly after his graduation from California Institute of Technology in 1935, RICHARD H. JAHNS joined the staff of the U. S. Geological Survey. Although he returned to the Institute as Assistant Professor of Geology in 1946, he still works with the U.S.G.S. and is currently engaged in mapping mines in California under the cooperative program of state and federal departments. Dr. Jahns has made an extended study of pegmatites in Southern California and northern Mexico as well as other western, most eastern, and Rocky Mountain states.

Formations . . .

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silicon, but with the addition of the rare element beryllium. Chrysoberyl also is found in pegmatites and it, like beryl, is found only where there is a concentration of beryllium.

Beryl crystals in some pegmatites reach gigantic sizes. At Albany, Maine, crystals 18 feet long and three feet across have been found. Unfortunately, they are not of gem quality but of use only as a source of beryllium. In the heart of some of the large crystals there may be a core of clear unflawed aquamarine. It is intriguing to speculate on the possibility that at one time the whole crystal was of gem quality and, if it had not been subjected to earth movements, it might all be of gem quality today.

Spodumene, of which the pink kunzite and the green hiddenite are the varieties of most interest to gemologists, is found in pegmatites. This mineral, like the colored varieties of tourmaline, requires not only the proper conditions but also a concentration of lithium. It is thus very common to find spodumene and colored tourmalines not only in the same pegmatites but also in the same pocket, the name given by the miner to the cavities in which gems are found in pegmatites.

Although pegmatites are noted mostly for the gem minerals containing the rarer elements, they occasionally present the proper conditions for the common minerals quartz and feldspar to crystallize in an uncommon manner. In some pegmatites well-formed rock crystal and smoky quartz is found, but much rarer are beautiful yellow crystals of orthoclase feldspar.

Although pegmatites are a rather common geologic phenomenon, gem-bearing pegmatites are comparatively rare. Some of the most world-famous localities are in Madagascar and Brazil. In the United States Maine, North Carolina, and California are the most noted states.

The minerals of pegmatites are deposited from solutions in which many elements are carried. As time passes, these solutions may change in their chemical composition and a mineral may find itself, as the geologist says, out of equilibrium with the solutions. Thus, after a mineral has been deposited, the succeeding solutions may attack it and dissolve away part of the already-formed mineral. In this way many beryl and topaz crystals become deeply etched and destroyed as far as the gem value is concerned. In such cases, the miner has arrived a million or more years too late!

Only a few of the minerals that are used as gems have been mentioned, but most of them as well as many of the others are not rare but occur abundantly at some localities. Diamond is the outstanding exception. For example, beryl, spodumene, corundum, tourmaline, quartz, and garnet have been found by the ton but not of gem quality. Thus in the formation of a gem, it is necessary that the correct chemical elements be brought together under the ideal geologic conditions.

Deposits . . .

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Southern California, with a total recorded production valued at more than $2,000,000, is currently showing signs of revival. Although "bonanza type" operations probably are gone forever, it will be interesting to see whether a gradually rising market and a modern approach to pegmatite geology and mining will sustain activities at somewhat less spectacular levels.

Book Review

The Gemmologists' Compendium, by Robert Webster, F.G.A., 2nd Edition, 241 pages, 20 plates (10 in color), 1947. N.A.G. Press Limited, London. (Henry Paulson and Co., Chicago.) Price $4.00.

This new book is a revision of the Gemmologists' Pocket Compendium, published by the same author in 1937. The word pocket has been dropped from the title of the new edition because of its increased size (4½ x 7 inches).

The book is divided into two parts. Part One is a glossary of names and terms used in gemology, and consists of concise definitions of approximately 1300 entries. Part One makes up about one half of the book (116 pages).

Part Two is a collection of tables and other data pertaining to gem materials. The subjects covered are numerous and varied, as is shown by the following partial list: the crystal systems, gemstones listed in order of hardness, tables of specific gravities, methods of determining refractive index, tables of optical properties of gems, absorption spectra of gems, gems listed according to color, transparency of gems to X-rays, fluorescent color of gems, data on synthetic and manufactured gems, artificial coloring of gemstones, plastics, types of gem cutting, list showing principal sources of gemstones, tables for blowpipe analysis, and microchemical tests, table of atomic weights, periodic table of the elements, acid tests for precious metals, price calculation of gemstones and pearls, temperature conversion table, tables of density of water and toluene, table of logarithms, and the Greek alphabet.

Although Webster's "Gemmologists' Compendium" is no longer a pocket size book, it is interesting to compare it with the 2nd edition of Shipley's "Jewelers Pocket Reference Book" (Gemological Institute of America, Los Angeles, California, 1947). There is much material common to the two books, especially many of the tables on properties of gemstones, and much of the material in their respective glossaries. They differ widely in other respects, however. Shipley has included material of value to a retail jeweler, such as silverware patterns, emblems for fraternal and civic groups, styles of clocks, etc. Webster has designed his book to be of maximum value to the advanced gemologist who needs information to enable him to learn about, or be able to identify, every conceivable type of gem material.

The "Gemmologists' Compendium" is printed on good quality paper and attractively bound. The illustrations, especially the color plates, are excellent. Mr. Webster has done a fine job in producing a reference book that should be on the book shelf of every gemologist, especially those advanced students who want a source of information about the unusual and little known gem materials.

—George Switzer, Ph.D.

Correction . . .

In the last issue of this magazine the price of the new Gems and Gem Minerals was erroneously reported as $5.50. Price of this fifth edition by Edward H. Kraus and Chester B. Slawson, published by McGraw-Hill, sells for $4.00.