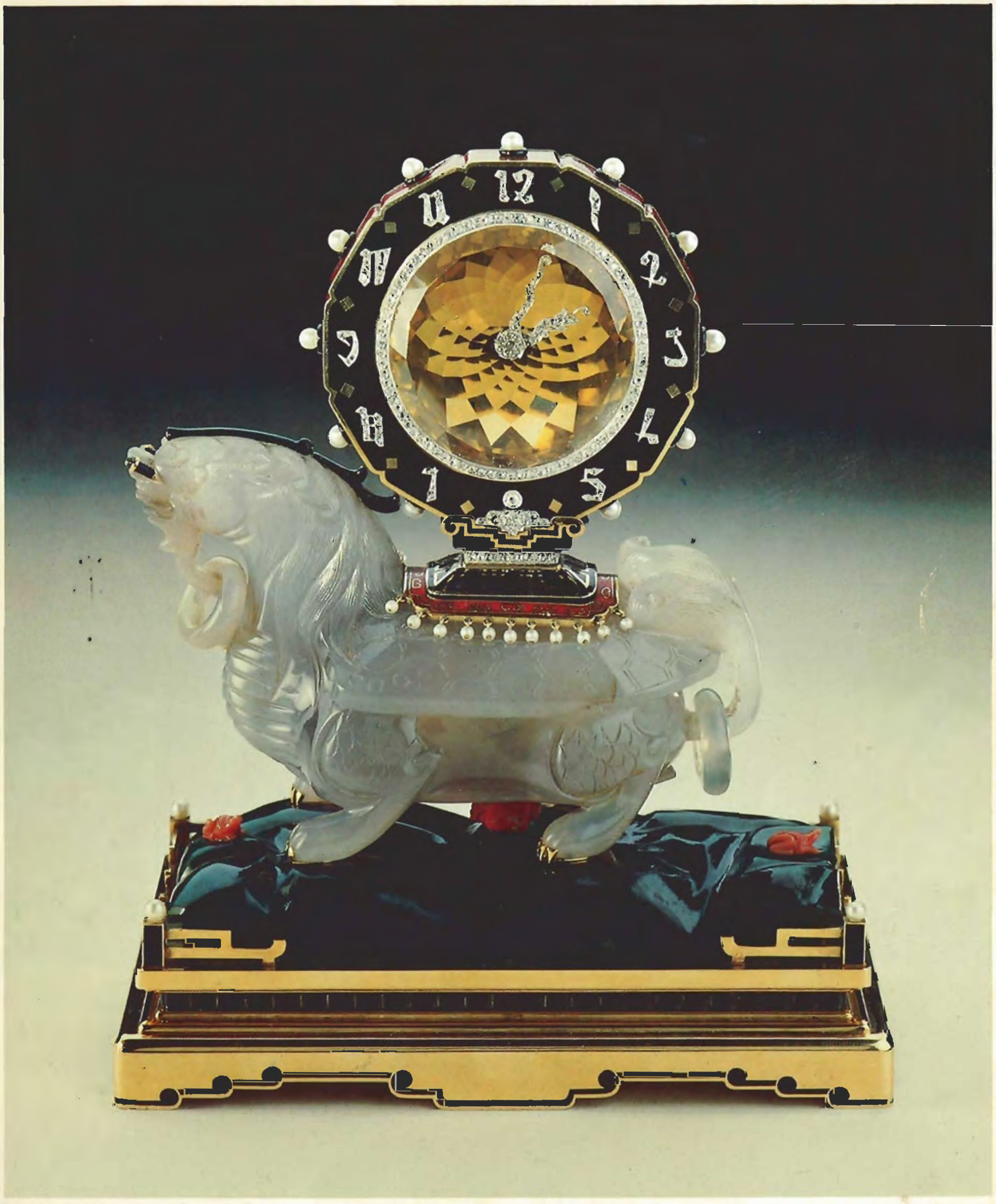
Gems & Gemology

VOLUME XXI SUMMER 1985



The quarterly journal of the Gemological Institute of America

SUMMER 1985
Volume 21 Number 2

Gems & Gemology

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ABOUT THE COVER: For thousands of years, mankind has been fascinated by pearls. Virtually every civilization has revered their natural beauty, and considered them to be among the most precious of gems. This issue features a review of the history of pearl fashion, ancient to modern, in the Mediterranean, Western Europe, and the United States. The signed Cartier Art Deco mystery clock pictured here demonstrates one of the many ingenious ways that pearls have been incorporated into jewelry and objets d'art *throughout the ages. It is fabricated of gold and platinum with a citrine face. The hands are set with diamonds, and pearl studs mark the hours. The clock rests on a pearl-fringed saddle that sits on a chalcedony chimera set with cabochon emerald eyes. Two coral frogs observe from a nephrite base. The entire piece measures 13.7 × 7.2 × 17.3 cm (5¾ × 2⅞ × 6¾ in.). Photo courtesy of Cartier, Inc.*

Typesetting for Gems & Gemology is by Scientific Composition, Los Angeles, CA. Color separations are by Effective Graphics, Compton, CA. Printing is by Waverly Press, Easton, MD.

 ISSN 0016-626X

Gems & Gemology

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Subscriptions in the U.S.A. are priced as follows: $29.50 for one year (4 issues), $82.50 for three years (12 issues). Subscriptions sent elsewhere are $40.00 for one year, $115.00 for three years.

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Gems & Gemology is published quarterly by the Gemological Institute of America, a nonprofit educational organization for the jewelry industry, 1660 Stewart St., Santa Monica, CA 90404.

Application to mail at second class postage rates is pending in Santa Monica, CA 90404 and at additional mailing offices.

Postmaster: Return undeliverable copies of *Gems & Gemology* to 1660 Stewart St., Santa Monica, CA 90404.

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PEARL FASHION THROUGH THE AGES

By Dona M. Dirlam, Elise B. Misiorowski, and Sally A. Thomas

This article traces the use of pearls from antiquity to the initial appearance of cultured pearls in the 1920s. The first section touches on the early fascination with pearls as revealed through historical literature, including Cleopatra's pearls, Roman pearl jewelry, and medicinal pearl recipes of the Middle Ages. During the Renaissance, Spain's exploration of the New World resulted in the discovery of vast quantities of valuable pearls that were eventually spread throughout Europe. Queen Elizabeth I's magnificent collection of pearls and the intriguing baroque pearl figurines of the later Renaissance are also discussed. The article concludes with a review of pearl fashion from 1800 to 1930, including delicate Victorian seed-pearl jewelry, Queen Alexandra's dog-collar chokers, and Art Deco pearl-inlaid jewelry.

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Acknowledgments: The authors would like to thank the following people for their help in securing the photographs for this article: C. Kinion, Walters Art Gallery; N. Letson, Richter's; J. Ogden, London; P. Sanford, Cartier, Inc.; A. Haruni, Christie's; E. Perese, Sotheby's; and Harold & Erica Van Pelt, Photographers.

Pearls are the oldest gems known to man, perhaps because no shaping or cutting is needed to reveal their beauty. Scrolls and papyri from ancient civilizations describe wondrous legends of pearls long turned to dust. Time and again throughout Western history, the passion for pearls was reborn whenever culture and civilization thrived. Faceless ancients, Roman statesmen, Renaissance kings and queens, Victorian ladies, and sleek flappers were all fascinated by the natural beauty—and intrigue—of pearls. In recent years, pearls and pearl jewelry have once again assumed a major role in the public eye; no longer the sole province of royalty and the wealthy, cultured pearls are now one of the most popular of gems worldwide.

The origins of this fascination with pearls are as captivating as the pearl itself, more so than many other gems, perhaps, because its very fragility has made a historical record that much more difficult to maintain. This article delves into that history with a survey of pearl fashion from ancient to modern times, encompassing trends in the Mediterranean, Western Europe, and the United States. We will examine how pearls were used in jewelry, art, and even medicine through the ages, and the cyclical nature of pearl fashion throughout history.

EARLY HISTORY

In one of the earliest references to the use of pearls for adornment, the Greek poet Homer described the Roman goddess Juno's pearl earrings in his epic poem, the *Iliad:* "In three bright drops her glittering gem suspends from her ears." And in the masterful *Odyssey,* also composed several centuries before Christ, he again refers to "Earrings bright with triple drops that / cast a trembling light . . . the liquid drops of tears that you have shed / shall come again transformed in Orient pearls / advantaging their loan with interest / of ten times double gain of happiness" (Fitzgerald, 1961).

Figure 1. This gold-covered bronze Paphos pin consists of a large (14 mm) saltwater pearl topped with a small (4 mm) freshwater pearl. This unusual pin was found in the temple of Aphrodite at Paphos (on Cyprus) and dates from the third century B.C. Photo by permission of the Trustees of the British Museum.

The earliest archaeological evidence of pearls in jewelry was found at Susa, the ancient capital of Elam, in the Khuzistan region of Iran. In 1901, a magnificent necklace of 216 pearls divided into three equal rows was recovered from the bronze sarcophagus of an Achaemenid princess at Susa. The necklace, which is currently in the Louvre museum in Paris, dates from not later than the fourth century B.C.

The Paphos pin, currently in the British Museum in London, illustrates a very different form of pearl jewelry that was known in Greece in the third century B.C. (figure 1). It came from the temple of Aphrodite at Paphos, on the island of Cyprus. According to Kunz and Stevenson in their outstanding *Book of the Pearl* (1908), the 14-mm saltwater pearl in this pin is the largest ancient pearl ever found, weighing about 70 grains. Interestingly, the small (4 mm) pearl is freshwater in origin, and weighs only about 2 grains.

Not until the Mithridatic Wars (88–63 B.C.), and the resultant annexation of Syria by Pompey the Great, did pearls become abundant and popular in Rome. The great treasures of the Near East enriched the victorious army as well as the aristocracy. According to Roman chronicler Pliny (23–79 A.D.) in his *Natural History*, the displays at Pompey's third triumphal procession included 33 crowns of pearls and a shrine covered with pearls, as well as numerous other pearl ornaments. Pearls also have been cited as one of the reasons for the first Roman invasion of Britain in 55 B.C. (Ogden, 1982). Kunz and Stevenson (1908) refer to a number of Roman writers, such as Tacitus, who described British pearls as golden brown and second only to Indian pearls in value.

Pliny also described the two large and very valuable pearls that Cleopatra wore in her ears, recounting how she dissolved one and subsequently swallowed it to win a wager she had made with Roman statesman Mark Antony. Following her death (in 30 B.C.), the other pearl was cut in two "in order that this, the other half of the entertainment, might serve as pendants for the ears of Venus, in the Pantheon at Rome" (Pliny, Book 11, Chap. 36, from Bostock and Riley, 1893–98).

Pearls quickly gained great favor in the eyes of the Romans. Some Roman ladies in Nero's day (the first century A.D.) slept on pearl-inlaid beds (Kunz and Stevenson, 1908). The basic Roman earring during these years when the Roman Empire was at its height was composed of a disk-shaped earwire with pendant (Garside, 1979), for which pearls were frequently used (figure 2). Another popular style was an S-shaped wire threaded with pearls. Pliny said that even an oyster's ability to close itself could not protect it from a woman's ears (Book 11, Chap. 55, from Bostock and Riley, 1893–98).

MIDDLE AGES

Byzantium and the Early Middle Ages. As the division of the Roman empire into East and West was finalized with the fall of the Western empire in the fifth century A.D., Constantinople, on the site of the ancient city of Byzantium, became the center of culture and civilization in Europe and the Near East. Like their counterparts in Rome, the Byzantine jewelers preferred to use fine gold leaf on most large decorative objects, often with discreet quantities of gems as well. Pearls from the Indian Ocean, lapis lazuli from Asia Minor, as well as agates, rose quartz, emeralds, and amethyst were popular materials. In a Byzantine mosaic at San Vitale in Ravenna, Italy, the Emperor Justinian (527–565 A.D.) is shown bedecked with pearls and wearing a sacred pearl cap that marks him as the spiritual and temporal leader of his people.

The earrings from this period often hung down to the shoulder, and included enamel, pearls, and other gems. Sickle-shaped earrings of filigree with triangles of filigree and pearls were popular (Garside, 1979), as were necklaces with both pearls and unevenly cut emeralds.

While Constantinople thrived as a cultural center in what is present-day Turkey, much of Western Europe suffered from the attacks of barbarians and a general breakdown in political institutions during the centuries immediately following the dissolution of the Roman empire. Although interest in jewelry for personal adornment was almost nonexistent compared to that of the earlier (more affluent and more secure) Roman gentry, the introduction and spread of Christianity gave a fresh impetus to the arts in Western Europe. With churches to be built and decorated, iconography was brought into the decorative tradition of the jeweler. The change was confirmed in the works of sainted goldsmiths of the seventh century, who often banded together in monasteries to create great jeweled shrines.

With the widespread adoption of Christianity in Western Europe came a change in burial rites. Unlike the earlier polytheistic Romans and Egyptians, the Christians of Western Europe were not buried with all their jewelry (Rogers and Beard, 1947). Therefore, for the most part jewelry recovered from the eighth century on is limited to those items preserved in cathedral treasures or royal collections (Gregorietti, 1969). Consequently, relatively few examples of pearls used for personal adornment have survived from this period. Even so, the sociopolitical climate of this period was not conducive to the wearing of many jewels. The main items were rings for use as talismans and seals, and brooches to hold garments together.

Figure 2. Three pearls hang from rings attached to a thick wire hoop with gold balls and garnets on these Roman (second century B.C.) earrings. Granulation beads decorate the front surfaces only. Photo courtesy of the Walters Art Gallery.

During this period of transition from pagan to Christian beliefs in Western Europe, from the intellectual and cultural disruption of the Dark Ages to the enlightenment of the Renaissance, pearls were perhaps most frequently used in a capacity far removed from personal adornment or religious decoration: for their mystical and medicinal attributes.

Mystical and Medicinal Uses of Pearls. From the earliest time, pearls have been credited with mystical properties and healing virtues. Both the Hindus and Taoists believed that pearls had the power to perpetuate youth. The Archbishop of Mainz, Rabanus Maurus, wrote in 850 that "mystically, the pearl signifies the hope of the Kingdom of Heaven, or charity and the sweetness of celestial life." Pearl signified purity, innocence, humility, and a retiring spirit (Evans, 1970).

Pearl is described as a remedy in the oldest Sanskrit medical work, *Charaka-Samhita.* Much later, in 1240, Narahari, a physician of Kashmir, wrote that pearl cures eye diseases, is an antidote for poisons, cures consumption and morbid disturbances, and increases strength and general health. The *Lapidaries of Alfonso X of Castile* (1221–1284) report that pearl is excellent in medicinal art for treating palpitations of the heart, for those who are sad or timid, and in every sickness caused by melancholia. It also removes impurities from the blood.

While interest in the mystical and medicinal properties of pearls may have flourished during the Middle Ages, it did not end there by any means. One of the great authorities of the 17th century, Anselmus Boetius de Boodt (1550–1634), physician to Holy Roman Emperor Rudolph II, gave directions for *aqua perlata,* which he recommended to restore strength. Dissolve the pearls in strong vinegar or, better, in lemon juice. Add fresh juice and then decant. Add enough sugar to sweeten the milky and turbid solution. Take care to cover the glass while the pearls are dissolving, lest the essence should escape. Drink as needed.

The practice of ingesting pearls to cure ailments is also well documented in the 19th century. Arabian doctors in 1825 believed powdered pearls were helpful to alleviate weak eyes, nervousness, heart palpitations, and hemorrhaging. In 1881, the Raja S. M. of Tagore listed a page of the curative powers then attributed to pearl powder in his treatise on gems (*Mani-Mala,* Vol. II, pp. 871–873). Essentially, the list agrees with that of the Arabian doctors. The accepted dosage was ¼ to ½ grain of powdered pearl, depending on the ailment.

Late Middle Ages. During the 11th to 13th centuries, the returning crusaders brought back both pearls and a taste for adornment (Kunz and Stevenson, 1908). During this period, too, we begin to see fine jewels reemerge as a symbol of rank. In the 11th century, the monastic workshops declined and were gradually replaced by secular workshops that served the courts and noble families. In the 12th century, the first goldsmith guilds were formed.

By the end of the 13th century, not only had the wearing of jewels become a definite mark of rank, but efforts were taken to legally restrict this practice to the nobility. The French ordinances of 1283 forbid the bourgeois and their ladies from wearing precious stones, belts of gold set with pearls, or coronals of gold or silver.

As the 13th century progressed, the amount of jewelry worn increased slowly. Because the Italian trading cities were strengthening their contacts with Eastern markets in the 14th century, pearls gradually became more abundant. With the increased supply and demand for gemstones came more laws regulating their use. In 1331 an edict was passed in Paris that prohibited the use of paste gems, and in 1355 jewelers were forbidden to use "oriental" (saltwater) and "river" (freshwater) pearls in the same piece. In the 1300s, luxury played a greater and greater role in the French court, with jewelry as well as clothes and furnishings more richly and intricately fashioned.

The French influences as well as Edward II's (1284–1327) taste for luxury brought similar standards of magnificence into English fashion. The inventory of Alice Perrers, the mistress of Edward III (1312–1377), stated that she owned nearly 22,000 pearls (Evans, 1970).

This was a time of transition in the history of jewels. Not only were gems available in great quantities, but cutters were also developing new techniques and better skills. This shifted the emphasis from the design of jewels in gold and the techniques of filigree and enameling, to the beauty and glow of the gems themselves. Pearls were used to outline gems and to provide a contrast that drew attention to the colors of these gemstones.

An interesting tangent to this is the fashion seen in the 15th century of illustrating gems in the margins of illuminated manuscripts. One of the best examples is the *Grimani Breviary,* in which the jewels are lozenge-cut and *en cabochon* in simple gold rims surrounded by pearls (Evans, 1970). Drilled pearls were frequently sewn into the covers of manuscripts during this period or depicted on the elaborate illustrations included inside (figure 3).

From 1380 on, women's hair styles grew more and more elaborate. The hair was puffed and pad-

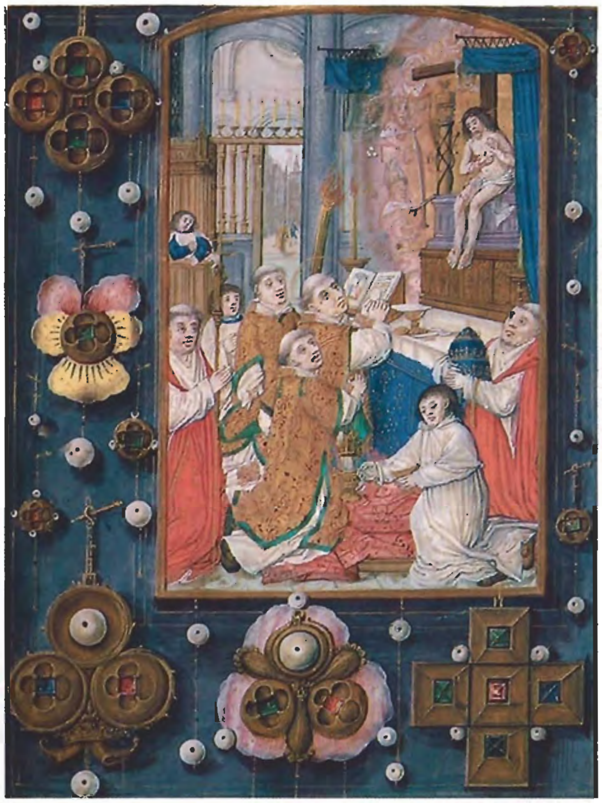

Figure 3. The border of this page from an early 16th-century German Book of the Hours *is illustrated with pearls hanging from fine gold chains. Pearls also are used to accentuate the quarterfoil, trefoil, and cross pendants. Photo courtesy of the Walters Art Gallery.*

ded around the ears with a golden net to keep the shape. In her 1970 book, Evans includes a picture of a portrait by Van der Goes of Margaret of Denmark (1353–1412) that shows her hair held in place by a gold network with a toque-like coronal draped with pearls. She is also wearing a necklace composed of two rows of pearls divided by clusters of gemstones with a large pearl hanging from a triangular pendant.

As low-necked dresses became fashionable in the middle of the 14th century, a necklace or chain and pendant became a decorative necessity. When Margaret, the wife of John Paston, wrote to her husband in 1455, she asked him for "sommethyng for my nekke" since, when Queen Margaret of Anjou came to Norwich, Margaret had to borrow a cousin's "devys" (pendants) "for I durst not for shame go with my beads among so many fresch jauntylwomen" (Evans, 1970).

Purely ornamental pendants grew more popular. Many were so unique that they had names. Ludovico il Moro, Duke of Milan, had a diamond pendant with three pearls, valued at 12,000 ducats, called "Il Lupo." Pendants were frequently worn on the hat, as were other jewels designed specifically as hat ornaments.

RENAISSANCE

No one day or even year marks the end of the Middle Ages and the beginning of the Renaissance in Europe. Rather, it was a gradual revival of artistic and intellectual life. The Renaissance (literally, *rebirth*) marked the transition in Europe from medieval to modern times. It began in 15th-century Italy, rose to magnificent heights in the 16th century in England and France, and gradually declined during the 17th century. This period was marked by a humanistic revival of classical influence, expressed in a flowering of art, literature, and science. The nobility of Europe were hungry for power and wealth and for any opportunity to display it, surrounding themselves with extravagant jewelry and ornaments. It was during this opulent era that pearls and pearl jewelry became extremely popular throughout Europe, especially with the influx of enormous amounts of saltwater pearls from the newly discovered Americas.

The Dawn of the Pearl Age. When Columbus braved the flat, monster-ridden sea of his era to land in the Americas in 1492, he opened the door to a New World rich with precious stones, pearls, and gold. On his third voyage, in 1498, he discovered that the natives on the islands off the Venezuelan coast had accumulated large amounts of valuable pearls. Columbus traveled from island to island, trading scissors, broken pottery, needles, and buttons for the Indians' treasure. Upon his return to Spain, he presented his sponsors, King Ferdinand and Queen Isabella, with almost 50 ounces of pearls collected on that voyage.

The great pearl rush was on as Ferdinand and Isabella financed a series of expeditions to the New World. A 1499 inventory of the Spanish monarchs revealed ropes that contained up to 700 pearls each; 122 assorted pearls were sewn onto one gorget (an ornamental collar) alone (Muller, 1972).

In 1515, the Spanish explorer Balboa discovered a breath-taking 200-grain pear-shaped pearl in the Gulf of Panama. Known as *La Peregrina,* after the fierce, swift peregrine falcon,

Figure 4. This portrait of King Henry VIII by Hans Holbein the Younger shows Henry's flamboyant taste in finery. Each knot on his collar ornament contains 16 large round pearls, and large pearls are also sewn onto his hat.

this pearl was to grace the Spanish crown jewels for several centuries. Ironically, although this pearl still exists today, its luster and value were severely damaged when it was chewed by the dog of its current owner, Elizabeth Taylor (Sitwell, 1985).

Yet another Spanish explorer, Hernando De Soto, was sent to explore the Savannah River area in North America. One report for this expedition mentioned fabulous amounts of pearls owned by the natives: "The quantity of pearls there was so great that 300 horses and 900 men would not have sufficed for its transportation" (Kunz and Stevenson, 1908). Pearls poured into Spain: in one year, over 320 kg (700 lbs.) of pearls arrived in the port of Seville alone. Spain was at the height of its grandeur, and the nation's pride was reflected in its *nef pendants:* miniature sailing ships made from gold and encrusted with gems and pearls. These pendants were also popular in the Mediterranean countries, which were enjoying much wealth and power due to their strong shipping industries.

In England, an imperious Henry VIII assumed the throne in 1509. His legendary love of personal splendor was financed at first by the money he inherited from his father, and then in part by the treasures he wrested from monasteries and cathedrals when he disbanded the Catholic church in England. Henry craved jewelry, and ordered massive amounts of pearls to be sewn onto his robes, coats, hats, and even his shoes (figure 4). Following Henry's example, men of his court sported gold-and-pearl earrings. Henry also lavished pearls on his court favorites and his many wives. Examples of the ladies' lovely ropes of pearls can be seen in portraits by court painter Hans Holbein the Younger.

It was during the reign of Henry's daughter, Queen Elizabeth I (1558–1603), that pearls were prized more than any other jewel. Elizabeth realized that as an unmarried ruler she would appear weak or vulnerable in the eyes of her contemporary male monarchs. She used her passion for pearls—and all they represented—to silently demonstrate her power, opulence, and regal dignity (figure 5). Horace Walpole, an 18th-century author, described the Renaissance queen vividly: "A pale

Roman nose, a head of hair loaded with crowns and powdered with diamonds, a vast ruff, a vaster farthingale, and a bushel of pearls, are features by which everybody knows at once the pictures of Queen Elizabeth" (Kunz and Stevenson, 1908). Literally thousands of pearls were sewn onto her gowns in a crisscross fashion, and all had to be carefully removed each time the gowns were cleaned. She also wore magnificent pearl earrings, and owned several large pendant pearls. In addition to all this, she customarily wore seven or more ropes of large, fine pearls, the longest of which extended to her knees.

Elizabeth also acquired the famous Hanoverian pearls, which had originally been given to Catherine de Medici upon her marriage to King Henry II of France in 1533. Catherine passed the pearls to her daughter-in-law Mary Stuart, Queen of Scots. A contemporary described the Hanoverian pearls thus: "There are six strings in which they are strung like rosary beads, and besides these, there are 25 separate pearls even more beautiful and bigger than those which are strung, the greater part like nutmegs" (Twining, 1960). Queen Elizabeth saw Mary as a threat to her sovereignty, and in 1567 the fierce English Queen had Mary beheaded. Afterwards, Elizabeth bought the Hanoverian pearls (at her own price) and incorporated them into her crown jewels.

Even in death, Elizabeth was dressed in all her finery. Her funeral procession was designed to imprint the image of her regal strength on her contemporaries, and indeed left the world with an image of the Queen that would endure through the coming centuries. A wax effigy of the dead queen lay on top of the royal coffin, arrayed with Elizabeth's pearls: a coronet of large round pearls, her famous pearl ropes, a splendid pearl stomacher, and large pearl earrings. There were even broad pearl medallions attached to her shoes.

Figurine Pendants. As mentioned earlier, Renaissance artists turned to the beauty and grace of the classics for much of their inspiration. During this period, a philosophy known as Humanism was widely espoused. Humanism emphasized human values as opposed to dogma and ritual and was instrumental in reviving interest in Greek and Hebrew studies. Thus, Greek mythology and stories from the Old Testament became the subjects of many interesting jewels and ornaments.

Some of the best known examples of this type of work are the highly imaginative figurine pendants that became popular during the middle of the Renaissance. Pearls of different shapes, sizes, and colors were used to create miniature figures constructed from precious metal and enamel work and encrusted with other precious stones. The pearls were strategically positioned to represent portions of the anatomy, such as a person's stomach, a horse's body, or a woman's bosom. The oddly shaped pearls stimulated the artists to create magnificent mermaids, sirens, sea monsters, and wonderful Greek gods and goddesses. One of the most famous pearl figurines is the Canning Jewel (figure 6): a large baroque pearl forms the torso of Triton, son of the Greek god Neptune. In addition to these fanciful creatures, animals such as rabbits, swans, pelicans, dolphins, monkeys, and lions

Figure 5. This portrait reveals how Queen Elizabeth I used her passion for jewels and especially pearls to reinforce her image of regal strength.

Figure 6. The famous Canning Jewel (circa 1560) uses a large baroque pearl to form the body of this richly jeweled Triton. Photo courtesy of the Victoria and Albert Museum.

were also popular subjects for figurine pendants (figure 7). According to Heiniger and Heiniger (1974), "this imaginative marriage of natural phenomena with the technical perfection of the goldsmith's art was characteristic of this age of exploration and discovery."

During the late 16th century, an art style called Mannerism appeared in Europe. It employed the classicism of the early Renaissance, but incorporated a feeling of tenseness, subjectivity, and artificiality. Manneristic art is characterized by jarring color combinations, elongated or otherwise disproportioned figures, an illogical mixture of classical motifs, and highly imaginative or grotesque fantasies. The pearl pendant figurines of this period reflect this preoccupation with the bizarre. Jewelers and goldsmiths such as Gerardet, Ferbecq, Dinglinger, and Mignot were "obsessed" by the grotesque, creating miniature pearl figurines of one-eyed beggers, David with the severed head of Goliath, and other twisted characters, all painstakingly crafted with the finest materials (Hughes, 1972; Mezhausen, 1968).

MODERN

Early Modern: The Age of Pearls Declines. Gradually, the opulence of the Renaissance began to fade. The 17th century saw most of Western Europe involved with religious and political up-

Figure 7. This jeweled, enameled, gold, and baroque pearl lion (4¾ in. tall) is typical of the fanciful pearl figurine pendants that were popular throughout England, Western Europe, and the Mediterranean during the Renaissance. Photo reproduced courtesy of Sotheby's.

heaval. The Thirty Years' War ravaged the continent, and England was torn apart by a Civil War from 1642–1646. In the New World, natives had grown hostile to the explorers' exploitation, the traditional fisheries were exhausted, and there was no money to spare for new expeditions.

Many European governments tried to invoke sumptuary laws to help curb the excesses of the nobility. These laws regulated how much and what type of jewelry could be worn by certain people. The sumptuaries were especially restrictive to the rising middle class and, as witnessed by paintings and other historical documents from this period, the European nobility tried to disregard these restrictions whenever possible.

In Spain, the sumptuary laws, or *pragmáticas,* attempted to forbid jewelry manufacturing and enamel and relief work. The wearing of certain jewels was restricted. Women were only allowed to wear necklaces of uniformly shaped stones, beads, or pearls, or a simple pearl pendant (Muller, 1972). In response, bodices were cut lower to display the strands and pendant pearls to their full advantage. Despite these restrictions, the Spanish nobility continued to deck themselves with as much jewelry as they dared, making full use of the pearls that were allowed them. Bracelets, or *muelles,* of strung pearls held together by a single clasp, and single-pronged hair pins *(punsónes)* made of gold and pearls were very popular. Gold filigree and pearl earrings were common, and pearls were also incorporated into gold hair filets called *apretadores.* Pearl-studded hat ornaments were popular with Spanish noblemen of this period.

But even this semirestricted display of wealth could not be sustained for long under severe economic stress. One by one, European governments—and the nobility that had controlled them—were forced, often through violence, to acknowledge the needs and rights of the lower classes. Thus, it was not until the early 19th century that pearls and pearl jewelry came back into vogue.

Neoclassic (1800–1820). At the beginning of the 19th century, jewelry styles and dress were more tailored and simple in reaction to the exaggerated and flamboyant dress of the late 18th century. This simplicity was further influenced by early archaeological explorations, particularly those at Pompeii, which brought to light the lifestyle of the ancient Greeks and Romans. Women's dresses imitated the flowing robes, their hair was styled à la Grecque, and jewelry was patterned as close to the original designs as possible. There was an absolute passion for cameo jewelry during the Neoclassic period. Antique cameos were preferred, but many fine imitations were made by talented gem carvers in Italy and Germany. Pearls were often used as accents in the borders around cameos (figure 8), intaglios, and mosaics, as well as around lapis lazuli, agate, malachite, and jasper cabochons (Hinks, 1975). Even Napoleon I gave his wife Josephine a parure (matching set of jewelry usually comprised of a necklace, brooch, bracelet, and earrings) of 82 cameos set in gold and surrounded by pearls (O'Day, 1974).

Figure 8. This 19th-century cameo brooch made of coral has been surrounded by gold set with pearls in the classical revival style.

During the Regency period in England (1811–1820), jewelry often took the shape of garlands of fruit or flowers. Pearls and seed pearls were used to represent clusters of currants or bunches of grapes in necklaces, earrings, bracelets, and tiaras. These pieces were executed with delicacy and realism.

Early Victorian (1837–1860). The coronation of Queen Victoria in 1837 began a new era that was to continue throughout the century. England was

Figure 9. An engraving done by John Sartain in 1858 of Princess Victoria (Queen Victoria's daughter) and her husband Prince Frederick William III of Prussia. Note how the low-cut dresses of this time promoted the use of elaborate jeweled head ornaments as well as ropes of pearls worn draped across the shoulders and bosom rather than around the neck.

prosperous and readily embraced the virtues that their diminutive but indomitable Queen represented: thrift, industriousness, respectability, and domesticity. France was too busy with politics to set fashions for the Western world, as it had done before and during Napoleon's reign, so the people of England turned to Queen Victoria and slavishly copied her mode of dress and ornamentation. Only 18 when she was crowned, the young queen had a taste for color and splendor. Jewelry fashions, set by her, had a light, airy quality with an intensely romantic flavor that offset the grinding rigidity of the industrialization of that time. Ladies still wore cameos, often accompanied by strings of pearls. In the evening, *ferronières* (strings of pearls worn on the head with one large pearl or jewel suspended on the brow) were worn. Since evening dresses were quite décolleté, large, elaborate jeweled collars (figure 9) were worn more on the shoulders than around the neck (Hinks, 1975). Often Medieval in style, these collars were made of enameled gold set with gems and baroque pearls.

Medieval costume balls were in vogue, and fabulous jewels were concocted for these revels as well as for regular wear. Castellani and Giuliano, Italian jewelers during this time, catered to this passion and produced reproductions of Byzantine and Medieval jewelry. As a consequence of the ongoing archaeological excavation of classical sites by the British, copies of Etruscan, Greek, and Roman styles were fabricated as well. Castellani's Etruscan and Greco-Roman pieces were primarily of gold with only an occasional bezel-set pearl or cabochon-cut stone. A rare example exists in a paper knife fashioned after a Roman dagger, with a beautiful four-lobed baroque pearl mounted with a smaller baroque pearl in the hilt (Munn, 1983). Giuliano, however, often used many pearls in his Medieval revivalist jewelry. The pearls were incorporated in a variety of ways: as the final drop from the point of an enameled pendant set with gems, strung on gold wire as links in a chain, bezel set or fixed on pins to outline a pendant or brooch, and as tasseled ends to some of his more elaborate collars (Munn, 1983).

Seed-pearl jewelry also was popular during this period. The tiny pearls, coming primarily from India or China, were drilled and threaded on white horsehair to a mother-of-pearl backing (Becker, 1980). These delicate necklaces and earrings took the shape of flowers and vines following the romantic style of the times (figure 10).

According to the *World of Fashion* in 1838, "Pearls are much in request with muslin robes, and it matters little whether they are mock or real" (Flower, 1951). A variety of imitations were used to

Figure 10. Intricate jewelry made of seed pearls on mother-of-pearl backings was very popular during the early 19th century. Photo ©Harold & Erica Van Pelt.

fill the occasional void in supplies of natural pearl. French pearl imitations were made by filling thin glass spheres with "oriental essence," an iridescent paste made with fish scales. Diamonds and natural pearls were sometimes incorporated into the same piece. This was the case with an elaborate diamond and pearl necklace constructed for Empress Eugénie, the wife of Napoleon III. The 73 pendaloque pearls in the large, collar-shaped *berthe* necklace, comprised of gems from the French crown jewels, were false because the jewelers were unable to find enough good-quality matching pearls within the budget allowed to complete the piece (Gere, 1972).

Because pearls continued to signify purity and sweetness, they were thought to be an appropriate wedding gift, especially for European royal weddings, although it was considered unlucky for the bride to wear them on her wedding day. Empress Eugénie ignored this superstition and wore several strings of pearls on the day of her wedding to then-president of France, Louis Napoleon Bonaparte. According to Kunz and Stevenson (1908), her later life was "one long tragedy."

High Victorian (1860–1890). Queen Victoria went into deep mourning after Prince Albert's death in 1861. As a result, mourning jewelry became quite fashionable. Hair jewelry was one of the forms this fashion took. Here, the hair of a loved one was woven or braided into a variety of patterns and worn as a sentimental remembrance. When set under glass in a brooch or locket, the hair was often ringed with pearls, signifying tears for the departed (Becker, 1980). Portraits of the deceased were also painted on mother-of-pearl. These lockets and por-

Figure 11. Machine-stamped jewelry, such as this gold and black enamel parure set with half-pearls, emeralds, and diamonds, became common during the industrial revolution. Lightweight and moderately priced, this type of jewelry was popularized by the emerging middle class. Photo courtesy of the Walters Art Gallery.

traits were often worn as pendants suspended from pearl necklaces or chains with pearl links.

Gemstones such as topaz and amethyst mounted in filigreed gold and offset with freshwater pearls were also fashionable during the early 1860s. The popularity of these jewels, and the continued interest in Renaissance revival jewelry, caused a sudden demand for freshwater pearls.

At the time, freshwater pearls came from either the Mississippi River in the United States, or from the Tay and Spey Rivers in Scotland (Bradford, 1959). For many years, the Scottish rivers had been fished for pearls in a modest way by one fisherman year-round and by children during the height of summer. Prices paid varied from threepence to a shilling per pearl, depending on size and quality. In 1863 Moritz Unger, a gem dealer in Edinburgh, advertised that he would buy unlimited quantities of freshwater pearls for a fixed price. This announcement instigated a "pearl fever," whereby men and women of all ages fished avidly for pearls. Ultimately, the "fever" caused a pearl glut and the bottom fell out of the market (Hinks, 1975).

As the new middle class acquired more disposable income, they began to wear more jewelry (figure 11). Where before, a single strand of pearls was considered by many families to be the only suitable ornament for an unmarried daughter (Bradford, 1959), jewelry was now worn by women of all ages. Pearls were incorporated into many items of jewelry for everyday wear. Serpents, birds, crosses, hearts, stars, and flowers were popular motifs that were often pavéed with pearls and worn as brooches, necklaces, rings, bracelets, earrings, and hair ornaments. For evening, pearls were woven in the hair, and the *aigrette,* a feathered hair ornament, richly set with pearls, came into vogue. The *sautoir,* a long rope of pearls often with tasseled ends (figure 12), first appeared at this time (Flower, 1951).

Men wore pearls as well, set in gold with mother-of-pearl or onyx as shirt studs and cuff links. They also sported pearls mounted in novelty

Figure 12. Seed-pearl sautoirs *like the one shown here first became popular in the mid to late 19th century. The tassels also have yellow and blue sapphires as well as diamonds set in white gold.*

settings (e.g., griffins, horseshoes, insects, and animals) as stick pins in their ties or lapels (Becker, 1980).

Turn of the Century. Toward the end of the 19th century and into the beginning of the 20th, several types of jewelry were in fashion. Even though they differ from one another in terms of style, components, and craftsmanship, they overlap somewhat in terms of the periods during which they were popular, and there is no question that they influenced one another. The names we associate with these various styles are the Arts and Crafts Movement (1850–1890), Art Nouveau (1870–1910), and Edwardian (1890–1920).

The Arts and Crafts Movement, which had its roots in England in the 1850s, was a reaction against the standardization of the industrial revolution. The ideals espoused by the followers of this movement were based on the Renaissance concept of individual craftsmanship preserved within a professional community or guild. The jewelry created under the influence of this movement is symmetrical and has a simplified serenity showing Pre-Raphaelite and Celtic influences (O'Day, 1974). Jewelers borrowed the flowing lines and rhythms found in nature. Their materials were primarily silver with colored enameling, accented by pearls and cabochon-cut gems. Moonstones, turquoise, garnets, opals, and mother-of-pearl were most frequently employed. The look of this jewelry was handcrafted and deliberately unfinished.

Out of this fertile ground grew the more polished and sophisticated movement known as Art Nouveau. L'Art Nouveau was the name of a fashionable shop in Paris, owned by Samuel Bing, that sold Arts and Crafts wares and Oriental imports (O'Day, 1974); the latter were in great demand after Japan lifted its trade embargo in the 1860s. Art Nouveau jewelry, symbolizing a break from normal constraints, appealed to liberal, rising middle-class women, actresses, and other women in the arts who enjoyed dramatic modes of expression.

British jewelers were fairly restrained in their designs, and there is a cool detachment in their Art Nouveau pieces. Baroque pearls, set in a manner similar to Renaissance jewelry, formed the bodies of insects or flowers, as well as drops dangling from brooches, pendants, and necklaces (figure 13). The

Figure 13. This Art Nouveau brooch is made out of gold and enamel and is set with pearls, cabochon sapphires, and diamonds.

Figure 14. Her Grace, the Duchess of Marlborough, is shown here in ceremonial dress wearing a pearl dog collar of the kind made fashionable by Queen Alexandra. Note also the Edwardian crescent pendant.

French jewelers, however, took up the naturalistic trend and carried it to daringly erotic and grotesque extremes. Lalique, Fouquet, Falize, Vever, and Louis Tiffany created Art Nouveau jewelry.

The upper class and the nobility generally disdained Art Nouveau jewelry as being too decadent. This was a prosperous time for them, and they ostentatiously displayed their wealth in their jewelry. Although pearls were considered rarer and were more expensive than diamonds, women wore them in profusion (Kunz and Stevenson, 1908). In the last years of the 19th century, Queen Victoria, although in strict control of the government, was largely in seclusion socially. Her eldest son Edward, Prince of Wales, and his wife Alexandra were the visible trend-setters of the wealthy upper class and nobility of Europe. They inspired a style of jewelry, subsequently called Edwardian, that was characterized by pearls and diamonds set in delicate platinum or white gold mountings. The fabrication techniques were intended to make the mountings nearly invisible, and the pieces were light and feminine in contrast to the heavy gold of the late Victorian period. Stars and crescents were popular symbols and these, studded with pearls, were incorporated into dainty necklaces, pins, bracelets, and earrings (Becker, 1980).

One pearl fashion that is particularly attributed to Alexandra was the dog collar: a choker of eight or more strands of pearls with gold spacers at intervals. She wore these chokers to hide a scar on her neck, and the style soon became popular with her contemporaries (figure 14; O'Day, 1974). For formal and state occasions, the dog collar was further augmented by *rivières* (three or more strands of pearls graduated in length) and *sautoirs*, along with bracelets, earrings, and tiaras (Becker, 1980).

For her coronation in 1901, Queen Alexandra wore seven strands of pearls, some of which were undoubtedly the Hanoverian pearls mentioned earlier. These were inherited by Queen Victoria after a bitter lawsuit with her uncle, the Duke of Cumberland. As the last of the House of Hanover, he claimed all of the jewels that had come to England with George I and any jewels added during the Hanoverian reign. Fortunately, there was sufficient evidence that the pearls had been in the crown jewels since the 16th century, when Elizabeth I acquired them from the estate of Mary Stuart. The House of Lords ruled that the pearls should pass to Queen Victoria and be "vested as heirlooms forever in the British Crown" (Abbott, 1933). Because of the lawsuit, Queen Victoria never felt comfortable wearing the Hanoverian pearls, but Queen Alexandra wore them frequently. On one occasion, they broke as she was getting into her coach, scattering into the street and under the hooves of the horses. Miraculously, the pearls were all recovered without undue harm and are part of the crown jewels of England today (Abbott, 1933).

Art Deco (1920–1930). The start of World War I in 1914, and the subsequent onset of the Russian Revolution in 1917, ushered in a period of radical change throughout Europe and the Western world. Speed and modernity were the dominating concepts of the 1920s. Cars and especially airplanes were new symbols of the times. Again, there was a reaction against the preceding period. Where Ed-

Figure 15. This woven Art Deco seed-pearl handbag is attached to a white enameled gold frame studded with carved emeralds, rubies, sapphires, and diamonds. Photo courtesy of Cartier, Inc.

wardian jewelry was ultra-feminine and essentially colorless, the new styles utilized geometric shapes, bold colors, and stylized symmetry. Arabic, Egyptian, and Oriental patterns and motifs were imitated in platinum and brightly colored gems. The artwork of the time was cubist and abstract, and the music was jazz. Women were more independent than ever before. They wore their hair bobbed, their clothes tailored, and their skirts short. The sleek, slim look was accentuated by long earrings and long ropes of pearls (Becker, 1980).

In 1916, one of the chief architects of the Art Deco movement, Louis Cartier, traded a two-strand oriental pearl necklace for a Neo-Renaissance mansion on Fifth Avenue, which remains New York's House of Cartier to this day. Both the necklace and the mansion were valued at $1.2 million, a fair exchange at the time (Cartier, 1982).

The style came to be known as Art Deco after an exhibition in Paris called "Exposition des Arts Décoratifs et Industriels," in 1925. Pearls were utilized in Art Deco jewelry as a contrast to the emeralds, rubies, and sapphires that were commonly used together. The pearls added a textural richness and softness to the stiff geometric shapes. Mother-of-pearl was used in cigarette cases that women now carried as well as men. Some of these were combined vanity and cigarette cases and had rings or clips incorporated into the design so that they could be fastened onto a belt. Because of the heightened fascination with ancient Egypt that followed the discovery of King Tutankhamen's tomb, these cases were frequently of Egyptian design, intricately worked in contrasting colors and materials to look like miniature sarcophagi. Chinese motifs were also popular, with inlaid mother-of-pearl carved and stained to depict Oriental scenes. Seed pearls were woven into beaded evening bags, richly finished with gold clasps that were set with gems (figure 15). Mother-of-pearl and pearls were also used in the Deco clocks that Cartier in particular popularized during the 1920s, to embellish the pedestals and sometimes the faces of these unique timepieces, and on the posts to mark the hours (see cover).

CONCLUSION

Several factors contributed to the decline in popularity of natural pearl jewelry beginning in the 1920s. Cultured pearls, which had been in an experimental stage since 1893, appeared on the market in the 1920s, causing the devaluation of the natural pearl and creating confusion with pearl consumers. The great Depression of the 1930s curtailed spending on jewelry and other luxuries for many years. World War II saw the exhaustion and pollution of Oriental pearl fisheries. Following this war, Japan, eager to regain financial stability, concentrated on enlarging their cultured pearl industry. Today, fine-quality natural pearls are rare and very highly valued.

Within the past decade, pearls have made a spectacular reentry into the fashion scene. Large quantities of lower-priced cultured pearls are now available to a new generation of young, eager consumers. High-fashion jewelry designers feature an astounding variety of pearl jewelry, including rings, pendants, and brooches. Necklaces, bracelets, and chokers of pearls, often set with lavishly jeweled clasps, have surged to the forefront of fashion. Innovative pearl jewelry for men is also gaining popularity.

Thus, although their popularity has fluctuated over the centuries, pearls continue to be one of mankind's most precious gems. Their luminous sheen and rich luster are as attractive to modern men and women as they were to their earliest ancestors. Whenever culture flourished, pearls were fashioned into beautiful, imaginative jewels. Despite their fragility, some of these precious pearl treasures have withstood the rigors of time, testimony to the creativity and skill of craftsmen throughout the ages.

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RUSSIAN FLUX-GROWN SYNTHETIC EMERALDS

By John I. Koivula and Peter C. Keller

A relative newcomer to the international gem market is an attractive flux-grown synthetic emerald of Russian manufacture. This article provides a general discussion of the technique used to grow these stones and describes their gemological properties and chemistry. The Russian flux-grown synthetic emeralds were found to be similar to other flux-grown emeralds in refractive index and specific gravity, and therefore to be readily distinguished from natural emeralds on the basis of these two properties.

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Acknowledgments: The authors wish to thank Carol Stockton of the GIA Research Department for providing the chemical analyses of the study samples, and C. W. Fryer for checking the gemological properties reported in this article.

During the 1982 meeting of the International Mineralogical Association at Varna, Bulgaria, a Russian scientist gave one of the authors a spectacular sample of synthetic emerald that had reportedly been manufactured in the Soviet Union. This sample consists of a cluster of self-nucleated hexagonal prisms with pinacoidal terminations radiating from a crust of polycrystalline material (figure 1), not unlike the typical material currently produced by the Chatham Research Laboratory. The individual crystals in the cluster range up to 3 cm in length and 4.2 cm in diameter. The transparent to translucent crystals exhibit excellent bluish green to green emerald color and are only moderately included. The emerald specimen was accompanied by a relatively recent article from a Soviet publication that describes the flux-fusion and hydrothermal methods the Russians have been using to grow emeralds (Bukin et al., 1980); thus far, this article has not appeared in the Western gemological literature.

Recently, significant amounts (at least several hundred carats) of faceted Russian-made flux-grown synthetic emerald have appeared in the world gem markets, particularly in Hong Kong and New York. In March of this year, the GIA Research Department obtained 18 gem-quality faceted stones for study purposes. This article reviews the general history of the flux growth of emeralds and presents what details are known of the Russian technique for growing commercial-size synthetic emeralds by the flux-fusion method. In addition, this article describes the gemological properties of the Russian flux-grown synthetic emerald and identifies the key characteristics by which it can be distinguished from natural emeralds using routine gemological tests.

THE FLUX GROWTH OF SYNTHETIC EMERALDS

A Historical Review. The knowledge that synthetic emerald can be grown from a flux melt has been available since Ebelman (1848) heated powdered natural emerald in a molten boric acid flux and produced minute hexagonal

Figure 1. A cluster of flux-grown synthetic emerald crystals manufactured in the USSR. The largest crystal is 3 cm long × 4.2 cm in diameter. Photo by Susan Gipson.

emerald prisms as the mixture cooled. Hautefeuille and Perrey (1888) did extensive work with lithium oxide and molybdenum oxide fluxes and purified reagent chemicals of beryl to grow emerald crystals up to 1 mm across in 14 days. In 1911, the IG-Farben Company began a study that investigated the use of a lithium molybdate flux with additional molybdenum oxide and reagent-grade chemicals to grow crystals up to 2 cm in length in just 12 months. The IG-Farben study lasted 31 years; the results of this research were not published until 1960, when Espig's report appeared. Simultaneous and almost identical with the IG-Farben work was that of Richard Nacken (Nassau, 1980). As far as we know, however, neither the IG-Farben nor the Nacken work ever resulted in the wide-scale commercial growth of synthetic emeralds, and by the 1940s neither investigation was active. However, the work of IG-Farben and Nacken laid the foundation for the commercially successful flux-grown synthetic emeralds that eventually appeared in the marketplace. The most successful commercial growth of flux-fusion emeralds, probably using a lithium molybdate–vanadate flux technique, was accomplished in 1935 by Carroll F. Chatham of San Francisco, California, and again almost 30 years later, in 1964, by Pierre Gilson of France. It appears that the Russians have now entered the market with a new commercially viable product.

The Russian Method. The flux growth of emerald in the USSR is being carried out by a group under Gennadi Bukin at the Geological Institute of Akademgorod, Novosibirsk. The technique being used by the Russians (K. Nassau, pers. comm., 1985) is accelerated crucible-rotation flux growth (H. J. Scheel and E. O. Schulz-Du Bois, 1971), a variation of the flux-fusion method described by Linares (1967). Rather than using the lithium molybdate–vanadate flux attributed to the Chatham and Gilson products, the Russians have been using a lead vanadate (PbO-V_2O_5) flux similar to that used by Linares, with a nutrient of natural beryl or reagent-grade BeO, $BeCO_3$, Al_2O_3, and SiO_2, together with Cr_2O_3 or $LiCrO_4$ plus Fe_2O_3 as coloring agents.

The basic process for synthesizing flux-fusion emeralds has not changed significantly since the IG-Farben work (Espig's 1960 report is well summarized in Sinkankas, 1981). Espig's report, augmented by published papers of the Linares process and the brief information supplied by the Soviets (Bukin et al., 1980), results in the following generalized description of the Russian process:

The appropriate mixture of PbO-V_2O_5 flux, nutrients, and coloring agents is heated to 1250°C in a platinum crucible. The nutrients sink to the bottom of the crucible since they have a higher density than the PbO-V_2O_5 flux. The necessary silica is supplied in the form of quartz (SiO_2), which floats to the surface of the molten mixture because it has a lower density than the flux. As the quartz slowly dissolves at the top of the flux, the nutrients dissolve from the bottom of the crucible and react with the molten flux to form complex oxides. Convective currents in the crucible carry these complex beryllium oxides to the top of the crucible to react with the dissolved silica and eventually crystallize out as emerald. When the emeralds have reached appropriate size, the mixture is cooled at a rate of 3°C to 10°C per hour to a temperature of 700°C. The crucible is then removed from the furnace and the remaining solution is poured off. As the final step, the crucible is allowed to cool to room temperature and any remaining flux adhering to the emerald crystals is cleaned off using hot nitric acid.

Figure 2. Some of the faceted Russian flux-grown synthetic emeralds used in this study. The largest stone weighs 3.82 ct. Photo ©Tino Hammid.

Linares (1967) never reported the growth of flux crystals larger than 5mm^3, much too small for commercial purposes. The Russian crystal growers, however, have reported success in using a technique similar to that of Linares to grow crystals up to 10 cm long and 6 cm in diameter. The 10-cm-long crystals reportedly require three to four months to grow (K. Nassau, pers. comm., 1985).

MATERIALS AND METHODS

The collection of Russian flux-grown synthetic emeralds available for testing consisted of the large crystal cluster shown in figure 1 and 18 faceted stones: 10 emerald cuts, six pear-shaped brilliants, and two round brilliant cuts, some of which are shown in figure 2. The largest of the faceted stones is a 3.82-ct emerald cut and the smallest is a 0.48-ct emerald cut. The faceted stones are all transparent and range from bluish green to green. All are moderately included; some of the inclusions are visible to the unaided eye and others are easily observed at 10× magnification.

The large crystal cluster and the 18 faceted stones were all subjected to standard gemological testing procedures. Although we found that the Russian flux-grown synthetic emeralds, like other flux-grown emeralds, can easily be distinguished from natural emeralds on the basis of refractive index and specific gravity (see table 1), the test stones were also examined (1) for their reaction to ultraviolet radiation, (2) with a spectroscope,

TABLE 1. Comparison of the key gemological properties of the Russian flux-grown synthetic emeralds with those of natural and other flux-grown synthetic emeralds.

Material	Refractive index		Birefringence	Specific gravity
	o	ϵ		
Russian flux-grown synthetic emerald	1.563	1.559	0.004	2.65±0.01
Other flux-grown synthetic emeralds[a]	1.563	1.560	0.003	2.65–2.69
Natural emerald[a]	1.571–1.593	1.566–1.586	0.005–0.008	2.68–2.77

[a] *As reported in Webster (1983).*

and (3) internally to identify the nature of the inclusions. The results of this examination are reported below.

GEMOLOGICAL PROPERTIES

Refractive Index. The faceted stones and two of the flat faces on the large crystal cluster were tested for refractive index using a Duplex II refractometer, a polaroid filter for birefringence, and a sodium vapor monochromatic light source. In all cases, the reading obtained was $\epsilon = 1.559$, $o = 1.563$. The optic character was determined to be uniaxial negative (−), and the birefringence was 0.004.

Specific Gravity. The faceted stones and a small fragment from the synthetic emerald crystal cluster were tested for specific gravity in a standard 2.67 heavy liquid. All subjects floated in this liquid, with the bulk (approximately 98%) of their volume below the liquid's surface. Next, a heavy liquid of 2.65 specific gravity was used. All of the stones and the crystal fragment sank very slowly in the liquid at about the same rate as a rock crystal quartz indicator. Thus, the specific gravity of these Russian flux-grown synthetic emeralds was determined to be very near 2.65.

Ultraviolet Fluorescence. All of the samples were exposed to long-wave and short-wave ultraviolet radiation. Contrast control glasses were worn during testing. The faceted stones were all inert to short-wave radiation; to long-wave radiation they showed an expected orangy red glow of moderate to weak intensity.

The large crystal cluster also gave an orangy red glow of moderate to weak intensity when the long-wave lamp was used. With short-wave radiation, we observed small patches of bright chalky yellow fluorescence on the faces of some of the emerald crystals, while the crystals themselves were inert. The patches were superficial only and would be cut away during faceting. The exact nature of the fluorescent patches and their cause was not determined. They were not visible with the microscope.

Spectroscopic Examination. The crystal cluster and each of the faceted stones were next examined using a GIA GEM Instruments spectroscope unit. When the emeralds were placed on the opening of the iris diaphragm, we observed that they transmitted red. When looking down the optic axis direction, we saw in all stones a vague general absorption from 440.0 nm down, a sharp line at 477.0 nm, a broad band of absorption between 560.0 and 620.0 nm, and lines in the red situated at 637.0, 646.0, 662.0, 680.5, and 683.5 nm. The bands and lines were visibly weaker in the smallest faceted synthetic stones.

Microscopy. The synthetic emeralds were next studied under magnification and photographed using a gemological stereo microscope. The crystal cluster was studied for both internal and external features, while the faceted stones were examined primarily for their inclusions.

Close scrutiny of the surface of the crystal cluster revealed the presence of three separate and distinct crystalline-appearing solid phases in addition to the synthetic emerald. The most obvious of these phases was a near-colorless transparent, to white translucent, brittle material adhering to the back of the crystal cluster. A small flat-faced fragment of this material was removed, and testing determined that its specific gravity and refractive index matched that of phenakite. The synthetic phenakite contained flux inclusions, and because of its near-colorless and transparent nature the

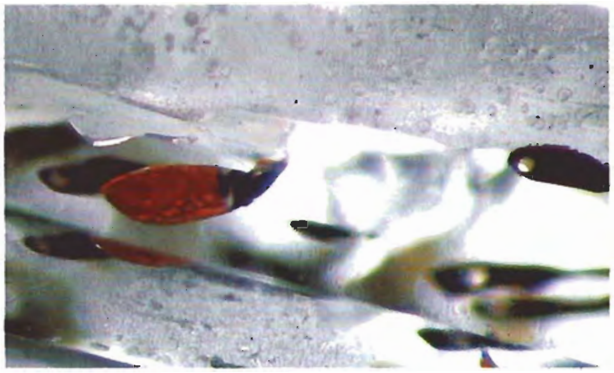

Figure 3. Primary flux inclusions in synthetic phenakite which was found on the back of the flux-grown synthetic emerald crystal cluster. Transmitted and oblique illumination, magnified 50×.

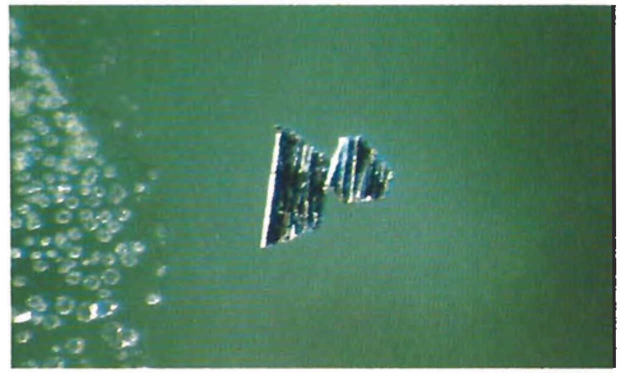

Figure 4. Two tiny platelets of metal (probably platinum) found on one of the prism faces of a Russian flux-grown synthetic emerald crystal. Oblique illumination, magnified 50×.

true color of the dark brown to orange flux used to grow the crystal cluster was easily observed (figure 3).

Also present on the surface of the synthetic emerald crystal cluster were several small singles and groupings of euhedral orthorhombic four-sided prisms, with blunt-ended pyramidal terminations, that showed a distinct color change from brownish red in incandescent light to grayish green in fluorescent light. A small, 2-mm-long crystal was removed from the specimen and tested for refractive index, approximate specific gravity (using 3.32 heavy liquid), and hardness. Because the properties obtained from this small euhedron matched those of chrysoberyl, and a color change had been noted, this associate was identified as synthetic alexandrite. The presence of both phenakite and chrysoberyl are not surprising considering their close chemical relationship to beryl.

The third solid associate, shown in figure 4, was opaque, grayish silver, metallic, malleable and had a hardness of approximately 4–4½ on the Mohs scale. Since it is common practice to use platinum-group metal crucibles or crucible liners for the flux growth of synthetic emeralds, these

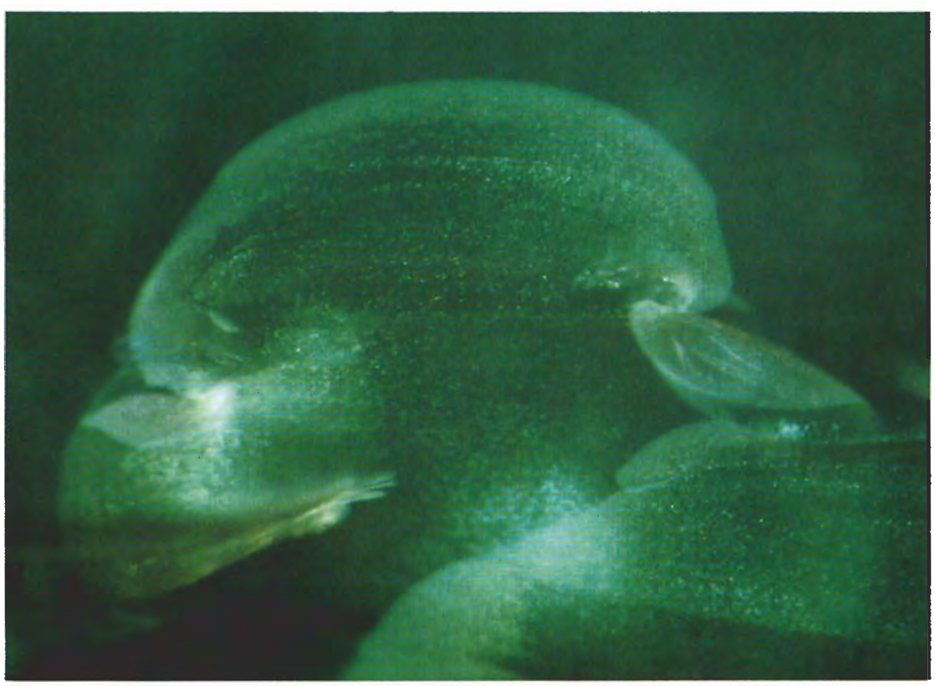

Figure 5. Secondary healed fracture ("fingerprint") in the Russian flux-grown synthetic emerald crystal cluster. Oblique illumination, magnified 35×.

Figure 6. Secondary "fingerprints" of various textures in the Russian flux-grown synthetic emerald crystal. Oblique illumination, magnified 20×.

Figure 7. Primary two-phase inclusions in a faceted Russian flux-grown synthetic emerald. Dark-field and oblique illumination, magnified 35×.

metallic platelets are probably a member of the platinum group, most likely platinum.

Aside from minor growth features and color zoning, the only inclusions observed in the crystal cluster and the 18 faceted stones were flux inclusions. Easily visible at 10× magnification, the flux inclusions were present in two forms: as secondary healed fractures and as primary void fillings. The large crystal cluster contained numerous healed fractures ("fingerprints"). Most of these, as in figures 5 and 6, were extremely delicate, and only in thicker areas was the true, dark, yellow-brown to orangy brown color of the flux visible. Primary flux inclusions were also plentiful. The faceted stones yielded the best view of primary flux inclusions (figure 7). Note in figure 7 the two-phase nature of some of the inclusions, consisting of a contraction (vacuum) gas bubble and glassy flux, and also the color of the glassy flux. Like the crystal cluster, the faceted stones also displayed numerous secondary flux inclusions ("fingerprints"); one of these is shown in figure 8.

Figure 8. Typical secondary "fingerprint" in one of the faceted Russian flux-grown synthetic emeralds. Partial polarized light, magnified 45×.

Takubo et al. (1979) reported on the internal characteristics and surface texture of flux-grown emeralds from the Soviet Union. They also found flux-filled wispy veils ("fingerprints"), as well as silk-like inclusions of unknown composition oriented nearly perpendicular to the c-axis of the crystals. No such silk-like inclusions were observed in the stones examined for the present study.

CHEMISTRY

Microprobe analysis of two of the cut stones from the study collection shows consistency with previous data on other flux-grown synthetic emeralds, except with respect to MgO content (see table 2). The chemical data from Bukin et al. (1980) are also provided in this table. Unfortunately, we have no information regarding the size of the Bukin et al. sample or the method of analysis. This is particularly unfortunate because their data show some significant departures from the analyses obtained for the present study as well as from the limits set forth by Stockton (1984) for the distinction between natural and synthetic emeralds. This may be due either to the techniques of chemical analysis employed by the Russians or to changes in the "recipe" that have been made since Bukin's report was issued in 1980. It is not unusual for such changes to be made by manufacturers of synthetics during the early (and often experimental) years of production. In any case, the recent material analyzed for this study shows no significant differ-

TABLE 2. Chemical data (in wt.%) for synthetic emeralds grown by flux fusion.

Oxide	Present study[a]	Bukin et al. (1980)	Other flux[b]	Natural[b]
Na_2O	nd[c]	0.22– 0.29	≤ 0.04	0.04– 2.3
MgO	0.1	nd	nd	tr– 3.1
FeO	0.2[d]	nd	≤ 0.52[d]	0.06– 2.0[d]
Al_2O_3	19.2	17.86–18.27	18.1–20.1	11.7 –18.2
V_2O_3	<0.1	nr	≤ 0.19	tr– 2.0
Cr_2O_3	0.3	0.31– 0.48	0.2– 2.19	tr– 2.06
SiO_2	66.4	64.4 –65.3	65.7–67.4	63.3 –66.5
BeO	na	13.2 –13.9	na	na
Fe_2O_3	nr[d]	0.14– 0.16	nr[d]	nr[d]

[a] *These data represent an average of the results obtained from four microprobe analyses of two specimens from the study collection.*
[b] *From Stockton (1984) and Schrader (1983) as reported in the former article.*
[c] *nd = not detected; nr = not reported; na = not analyzed.*
[d] *Total iron reported as FeO.*

ences in chemical composition—other than MgO content—from flux-grown synthetic emeralds from other sources.

DISCUSSION AND CONCLUSION

After closely examining the sample crystal cluster and stones from a gemological viewpoint, we determined that these Russian flux-grown synthetic emeralds have properties similar to those of other known flux-grown synthetic emeralds and therefore can be separated from natural stones on the basis of their low refractive index and low specific gravity (see table 1). The presence of flux inclusions only makes identification that much easier.

It is interesting to note that all but one of the faceted stones used in this study were purchased as Russian hydrothermal synthetic emeralds. Russian hydrothermal synthetic emeralds were available at the most recent Tucson Show (February, 1985) and have been seen at the GIA Gem Trade Laboratory (Koivula, 1984). It now appears that Russian flux-grown synthetic emeralds are being sold in the trade as well. T. Chatham (pers. comm.) reported seeing 400 carats of this material at one source in Hong Kong in May 1985.

Even though our test sample consisted of 18 faceted stones and a crystal cluster providing this study with a good data base, it must be remembered that the growth process may be altered in the future; if this were to happen, the overt gemological properties would probably change as well.

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GEM PEGMATITES OF MINAS GERAIS, BRAZIL: THE TOURMALINES OF THE GOVERNADOR VALADARES DISTRICT

By Keith Proctor

The previous article in this series focused on tourmaline production around the city of Araçuaí, in northeastern Minas Gerais, and discussed 20 important mines in that area. The present article turns to the major tourmaline mines in southeastern Minas Gerais, in the broad area surrounding the gemstone capital, Governador Valadares. Specifically, the Cruzeiro, Golconda, Santa Rosa, and Jonas mines–all of which count among the most famous tourmaline mines in the world–are described.

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Acknowledgments: The author thanks the following people for their assistance: L. Nercessian, J. Lowell, A. Lucio, Dr. C. Barbosa, J. Sauer, H. Stern, Dr. H. Bank, E. Swoboda, P. Bancroft, A. Sabbagh, K. Elawar, and O. J. de Moura. Thanks also go to Harold and Erica Van Pelt for their many photographs, to Wendell Wilson for art work, and L. Moffett for typing, and to Drs. P. Bariand, R. Gaines, P. Keller, P. Moore, R. Nash, F. Pough, J. Shigley, and J. Sinkankas for reviewing and critiquing the original manuscript. Special appreciation goes to Mauna Proctor for her help in translating, typing, and editing, and for her constant support. The many miners and mine owners who were so instrumental in providing information for this series are acknowledged at the end of this article.

Unless otherwise noted in the figure legends, the location photos are by the author. Also, the mineral specimens and cut stones shown in figures 1, 3, 7, 8, 11, and 13 are the property of the author.

Although hundreds of mines in the broad region north, east, and southeast of Governador Valadares have produced tourmaline, four major deposits account for most of the production in this area: Cruzeiro, Golconda, Santa Rosa, and Jonas. Not only have these mines been the source of millions of carats of fine blue, green, red, and multicolored tourmaline, but the very human stories that surround their major discoveries have achieved the status of legends in only a few short years. A single pocket in the Jonas mine, for example, found after months of back-breaking work by a few determined miners—and only days before mining was to cease for lack of funds—yielded hundreds of kilograms of fine gem- and specimen-quality "cranberry"-red tourmaline; a second pocket yielded only one superb crystal (figure 1).

This third article in a series on the gem pegmatites of Minas Gerais (see Proctor, 1984, for part 1—on the overall history, geology, and mining of the region as well as the major aquamarine deposits; and Proctor, 1985, for part 2—on the tourmaline deposits of the Araçuaí districts) describes these four major pegmatite areas of the Governador Valadares region and the great variety of fine gem tourmalines found there. The history of these mines and the major finds associated with each are discussed, as are the occurrence of the gem material, the gem deposits themselves, and past and potential production. Other mines in this area are also identified; the reader is referred to the map in figure 2 for the localities of the most notable deposits.

CRUZEIRO

The Cruzeiro pegmatite deposit is one of the largest and most consistent producers of tourmaline in the world. It is particularly noted for the fine green tourmalines found there (figure 3). The mining region is reached via BR-116, a paved road that connects Governador Valadares with

Figure 1. The Rose of Itatiaia, a 35 × 12-cm rubellite crystal with cleavelandite, was the only specimen taken from the second pocket of the legendary Jonas mine, one of the principal deposits of the Governador Valadares district. Photo © Harold & Erica Van Pelt.

Teófilo Otoni to the north (again, see figure 2). After proceeding 43 km (27 mi.) north from Governador Valadares, turn at the village of Frei Inocêncio onto a dirt road that leads northwest for 53 km to the village of São José da Safira. From there, a narrow, steep, barely passable road takes you up the mountain for 12 km to the main mine offices. The pegmatites are on the east slope near the top of a long north-south–trending range called the Serra Safira (after the "sapphire" blue tourmalines that were found here by early explorers). The range divides the watersheds of the Rio Sauçuí Grande and its tributary the Rio Urupuca (Cassedanne and Sauer, 1980).

History. The mountains in the Serra Safira range are undoubtedly the "Emerald Mountains" discovered by Paes Leme during his 1674 expedition (Proctor, 1984). In 1914, deposits of green and blue tourmalines were rediscovered and primitive mining was begun; a few magnificent crystals were produced and cut as gemstones (Bank, 1979; Lucio, 1980). However, full-scale commercial mining at Cruzeiro began not with tourmaline but with mica.

Because of their richness in electronic-grade mica, pegmatites in this region were mined as early as World War I, with the first formal mining concession granted in 1916. In 1933, the German export firm of Werner, Frank & Cia. hired Dilermando Rodrigues de Melo to secure mica properties and commence mining in the district around Figueira do Rio Doce, a small (approximately 1,000 inhabitants) village that grew into the present city

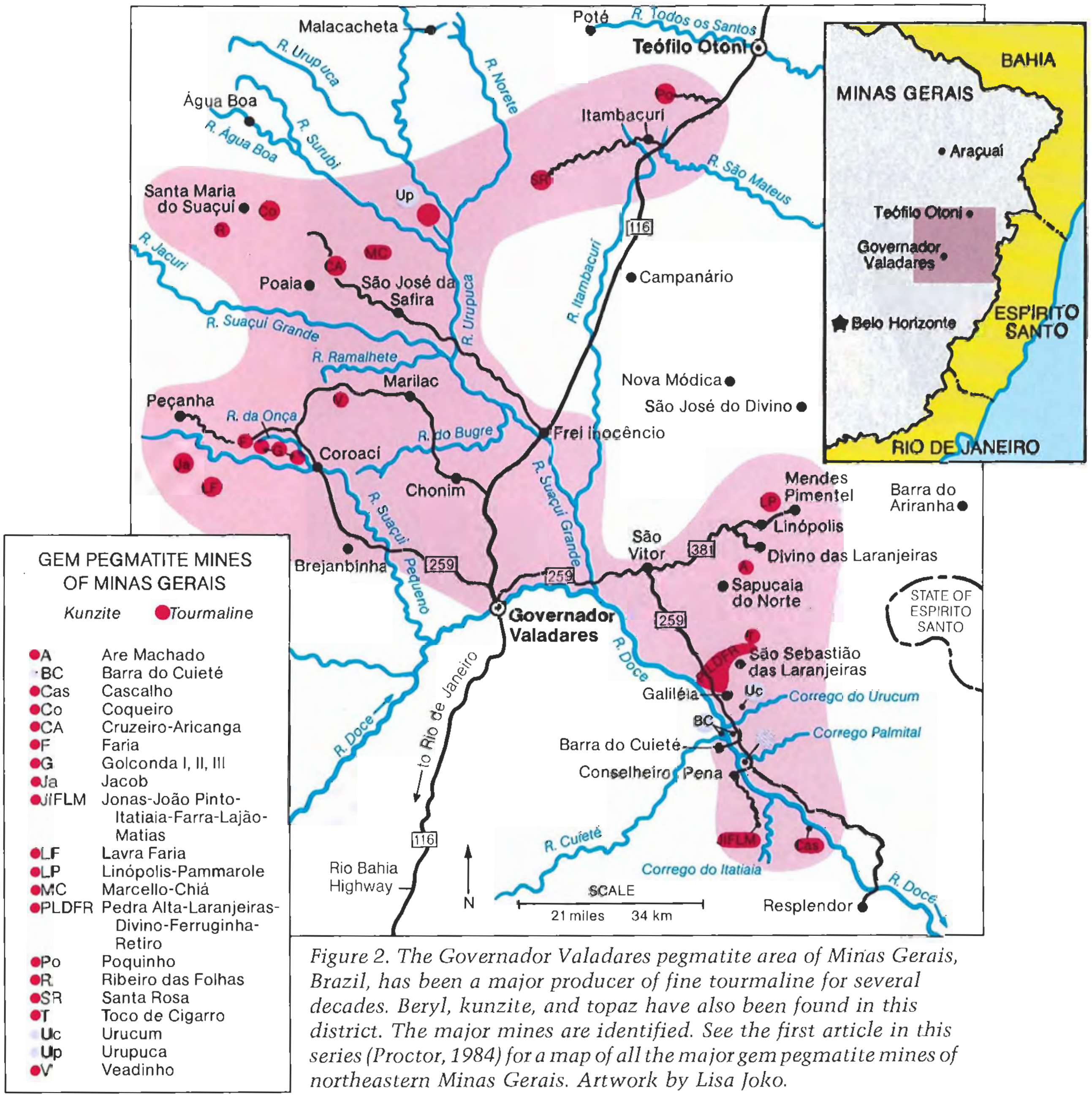


Figure 2. The Governador Valadares pegmatite area of Minas Gerais, Brazil, has been a major producer of fine tourmaline for several decades. Beryl, kunzite, and topaz have also been found in this district. The major mines are identified. See the first article in this series (Proctor, 1984) for a map of all the major gem pegmatite mines of northeastern Minas Gerais. Artwork by Lisa Joko.

of Governador Valadares. During World War II, control of Cruzeiro passed to Rodrigues de Melo, and the government of Brazil invited technical experts from the United States to help increase production of this extremely valuable wartime mineral commodity. During the war, when the mica was at peak production, 600–800 *garimpeiros* worked more than 40 locations in the pegmatites (Sauer, 1975). Ultimately, the Cruzeiro region provided 12% of Brazil's entire wartime production of mica (Ottoni and Noronha, 1942; Barbosa, 1944; Murdock and Hunter, 1944). Details on the Cruzeiro pegmatites and over 200 other potential gem mines in this area are provided by Gonsalves (1949) and Pecora et al. (1950a). Even today, when the Cruzeiro deposits are more famous for their gemstones than their mica, it is the mica that pays for the entire mining costs and for the most part supports the inhabitants of the small village of Cruzeiro, which lies just above the main mine, high on a ridge of the Serra Safira (figure 4). Ironically, while the Americans were exploiting the mica during the 1940s, the German gem dealers came down from Teófilo Otoni and purchased tons and tons of gem tourmaline crystals that were produced incidentally (L. Nercessian, pers. comm., 1984).

Although mining at Cruzeiro decreased sharply after the war, the "rediscovery" of large, fine tourmaline crystals in the 1950s led to renewed mining activity and signaled the beginning of the "modern" period of Cruzeiro's development. At present, the major portion of the Cruzeiro property is owned by José Neves, but one end of the 1300-m-long pegmatite area, located on the brow of the mountain ridge, is owned and aggressively mined by the Aricanga Company.

Occurrence. The Cruzeiro "mine" actually consists of several individual mines that exploit three more or less parallel, largely unweathered granitic pegmatite bodies that are simply called the No. 1, 2, and 3 bodies. All three bodies have been mined for gemstones, although No. 1 has been the most productive.

These three vein-like pegmatite bodies strike approximately N 20° W, and dip steeply SW. Along with several minor side veins, they intrude a layer, several hundred meters thick, of quartzite (a rarity in this region) and mica schist. In places the veins are only a few meters thick, but elsewhere they widen to as much as 55 m (180 ft.). The

Figure 3. This ring (11.83 ct) and pendant (16.5 ct), together with the 12.5-cm (5-in.) crystal also shown here, represent some of the fine green tourmaline found at the Cruzeiro mine. Jewelry created by Bud Stafford, Stafford-Kay Jewelers, Colorado Springs, CO.

Figure 4. The entire village of Cruzeiro (note the cross in the foreground, from which the village and mine get their name) is pictured here, isolated along this ridge of the Serra Safira. Photo by Peter Keller.

Cruzeiro pegmatites are classic examples of internally zoned complex pegmatite bodies. The zoning is similar to that shown diagrammatically by Shigley and Kampf (1984, pp. 70 and 71; see also Cassedanne and Sauer, 1980): a muscovite, quartz, and feldspar wall zone, with a quartz-microcline-albite intermediate zone. The gem crystals are usually found in the intermediate zone and occasionally in the peripheral part of the core zone. This pocket region on the margin of the core contains lepidolite, milky quartz, large microcline feldspars, and albite. Pockets in this region frequently contain superb gem tourmaline crystals and occasionally 1-m-long altered spodumene crystals.

Many opaque to transparent green, blue-green, and pink tourmaline crystals, some of them 10–25 cm (4–10 in.) long, have been found. The tourmalines occur both in groups and as freestanding single crystals attached to the pocket wall. Although the latter are much less common, they are frequently the most gemmy. As an indication that gem pockets are close by, miners watch for the presence of bladed albite (cleavelandite), lepidolite associated with black tourmaline, and dark coatings of iron-manganese oxides or phosphates on quartz and other minerals. It is interesting to note that gem-quality tourmaline is usually found

Figure 5. Open-pit mining is commonly used in some of the wider sections of the Cruzeiro vein. Note the two tunnels that follow the vein into the quartzite wall of this open pit. Photo by Peter Keller.

associated with albite but not with microcline, which indicates that the first two formed together.

Massive nongem garnet occurs in the Cruzeiro pegmatite, as do large nongem beryl crystals and such rarer minerals as amblygonite, torbernite, phosphuranylite, coeruleolactite, columbite-

Figure 6. A garimpeiro stands in the doorway of his mud-and-stick hut, near the entrance of one of the many tunnels driven throughout the Cruzeiro region.

Figure 7. Elongate green tourmaline crystals on quartz from the Cruzeiro mine. The specimen is 16 cm wide × 12 cm high (6.5 × 4¾ in.). Photo © Nelly Bariand.

tantalite, and cassiterite. These minerals indicate that the solutions that formed the Cruzeiro pegmatite were especially rich in lithium, boron, beryllium, manganese, tin, niobium, tantalum, phosphorus, uranium, and even copper.

Although most mining throughout this pegmatite region is via tunnels, open-pit mining is used in some of the wider sections of the veins (figure 5). Several major tunnels enter the hillside through quartzite or schist near the top of the mountain at an altitude of 1100–1200 m (Sauer, 1975). Presently, though, most of the mica tunnels driven during wartime and many of the gemstone tunnels have caved in or are filled with waste. The few tunnels that are still open traverse the body in random fashion and generally are small, narrow exploratory openings (figure 6). Parts of the Aricanga Company mine have been weathered to a soft, altered kaolin that the miners can dig with their bare hands or using only primitive tools (Baker, 1975).

The Cruzeiro Gems. Cruzeiro is famous for its gem-quality and specimen-grade tourmaline crystals, including fine blue-greens and pinks, near-"emerald" greens called chromolites, and fine blues (indicolites). The gems cut from the blue and green material are usually eye clean. At times, superb red tourmalines (rubellites) have been found in crystals 5 cm (2 in.) or more in length: some are among the best ever produced in Brazil. Especially notable are the popular green-and-pink bicolored gems called "watermelons," although these are commonly heavily included.

Diversity in crystal habit and coloration is characteristic of the tourmaline crystals from the Cruzeiro deposits. Some crystals are long and thin (figure 7), and others are thick, short, flatly terminated prisms (as shown in Keller and Kampf, 1977, figure 7). Still others have a black, almost velvety termination. Some of the finest crystals of stubby habit and flat termination exhibit the dark rose to red tint characteristic of Cruzeiro rubellite and may weigh several kilograms each (Cassdanne and Sauer, 1980).

Production. Cruzeiro is probably the most consistent gem-producing region in Brazil. For 15 years, from 1955 to 1970, the Cruzeiro mine produced an average of 200 kg (440 lbs.) of crystals per week, although usually only 1 or 2 kg of the weekly total was gem-quality tourmaline. The overall production of tourmaline at the Aricanga mine has been somewhat less, but a much greater proportion of the tourmalines found there have been gem quality.

Major pocket finds at Cruzeiro are almost too numerous to mention. In 1966, for example, a superb rubellite crystal was taken from a hard-rock pocket that contained no other gem-quality crystals. This 14-kg deep red crystal cut 10,000–12,000 ct of very clean stones. In 1968, over 2,000 kilos of largely opaque crystals of fine green color were removed from a single pocket. These crystals were used worldwide for carving and as mineral specimens. In mid-1971, in one of Brazil's largest rubellite finds, 400 crystals were taken from several pockets. This was the find that established Cruzeiro as one of Brazil's premier rubellite mines.

The most impressive find at the Aricanga mine occurred in 1982, when a big pocket yielded over 700 kg of mostly clean tourmaline "pencils," 90% of which were a nice green with the rest blue-greens and reds (L. Nercessian, pers. comm., 1984). Many kilos of fine rubellite and specimen-quality green tourmaline were found at the Cruzeiro as recently as 1983 and 1984, respectively. Because of its size, Cruzeiro (including the Aricanga mine) will probably continue to produce consistently for several more decades.

GOLCONDA

Among the best known and most productive pegmatite mines in Minas Gerais are the three Golcondas, which are located within 5 km of one another northwest of Governador Valadares (see figure 2). The two newer Golconda mines (II and III), in particular, are noted for having produced some of the finest green tourmalines and blue tourmalines to emerge from Brazil, as well as some unique bicolored crystals (figure 8). The Golconda mines are reached by taking highway BR-116 north from Governador Valadares approximately 3 km, turning off to the northwest at the road to Coroaci, (#259) and proceeding 33 km to the Golconda II, which is located on the headwaters of Onça Creek. Golconda I lies 4 km east, and Golconda III 1 km northwest, of Golconda II.

History. *Golcondas I and II.* The original Golconda, named after the famous diamond city of ancient India, has been operated as a mica mine since its discovery in 1908; it is one of the oldest pegmatite mines in Brazil (Pecora et al., 1950b). It is such a large pegmatite that at times over the years it has produced significant quantities of gem rough.

Golconda II was opened in 1935, when foreign interests first exploited it for mica. Since World War II, notable deposits of gem crystals, including green, blue, and rose tourmaline and small quantities of morganite, have been produced by Golconda II, which, like Golconda I, is an immense pegmatite body. Fifty kilograms of "sapphire"-blue "pencils" were found here in 1968. Most of the stones produced were of the finest pure blue color, which established Golconda II as one of the premier sources for fine indicolite.

However, the Golconda mine so fabled in the tourmaline mining lore of Minas Gerais is a small hillside deposit, Golconda III. In 1961, a single immense "pocket" found at Golconda III yielded 900 kg (about one ton) of the choicest "emerald"-green gem tourmaline crystals ever discovered in Brazil. This harvest of crystals yielded gems of a quality so high that they set standards of color and clarity by which dealers in Brazilian gems still measure all other green tourmaline.

Golconda III. The history of Golconda III began in 1961 on a small farm owned by José Menezes Zequinha. A small hill was the dividing line between his farm and that of his neighbor, Pedro Espirito. One day, Zequinha began digging a few small tunnels in a pegmatite outcrop on his side of the hill and almost immediately ran into white kaolin. Whenever they had free time, he and his family kept digging in the kaolin vein, which became wider and wider as they progressed toward the center of the hill. Within a month they discovered a great profusion of beautiful gem tourmaline crystals buried in a large body of soft, solid kaolin deep inside the hill. In a bonanza never before experienced in Brazil and experienced only once since, the entire Zequinha family harvested an average of 35 kg (80 lbs.) of virtually flawless crystals each day for the first 10 days. As they feverishly continued digging, their kaolin "room" kept getting bigger and bigger.

On the 11th day, when word of the discovery had finally gotten out to all of the local gem dealers, Zequinha's neighbor Espirito found out what was going on. He realized that part of the deposit was probably on his land, and he and his family immediately started digging from their side of the hill. Within a few days they hit the other side of the same "pocket," and the two families feverishly worked toward each other. When both families eventually broke through into the same area, great fights erupted over crystals, with each family claiming that the other was in their private territory. Garimpeiros were brought in by both sides so that each could claim as many crystals as possible, and within two months the pocket (which eventually measured 12 m long × 4 m wide) was totally cleaned out.

The crystals were the perfect shape for cutting stones in the 6–15 ct range; for the most part they were flawless and, incredibly, of virtually identical color throughout the pocket. Bracelets and necklaces of matched stones could be assembled easily. Most importantly, the color of the cut stones more closely approached "emerald" green than any other large deposit of tourmaline crystals ever found. The total pocket probably yielded over two million carats of finished gemstones (2.5–3.0 ct per gram of rough).

In 1963, after two years of intensive digging, another major find occurred in hard-rock pegmatite 150 m from the original "pocket" and 20 m deeper into the hill. This deposit yielded another 450 kg of totally clean "pencils" similar in size to the first crystals but with some yellow. It took almost two years to completely clean out this deposit; 80% of the rough was exported to Idar-Oberstein (K. Elawar, pers. comm., 1985).

Another deposit that encompassed a number of small pockets was found at Golconda III in 1967 in hard-rock pegmatite in the lower part of the hill. The harvest was a considerable number of distinctive collector specimens: beautiful rose tourmaline crystals tipped in green on a matrix of cookeite (again, see figure 8). After the 1967 strike, Levon Nercessian bought the Espirito farm and rented the Zequinha farm, but all of his tunneling since then has produced no major finds.

Figure 8. These bicolored tourmalines, rose shafts tipped with green on a cookeite matrix, are characteristic of the Golconda mine. The longest crystal is 8 cm. Photo © Harold & Erica Van Pelt.

Occurrence. Little is known about the Golconda III body. Although the original 1961 deposit at Golconda III was found in a large kaolinized body, the subsequent discovery of two hard-rock pocket groups deeper within the same hill suggests that the original kaolin mass was probably a secondary, eluvial deposit.

The dike-like Golconda II pegmatite body forms a series of ridges of considerable height, with deep valleys where mining and subsequent erosion have exposed large areas of the pegmatite body. Where exposed, the body appears to be about 60 m (200 ft.) wide and has been traced along the outcrop to a distance of 400 m but may be as much as 700 m long. The strike is N 20° E. The pegmatite appears to be a single sheet, but Ailton Barbosa (one of the current owners of the Golconda II) claims that there are actually two bodies (pers. comm., 1983).

The pegmatite body is intruded into schist and forms the foundation of a large hillside (figure 9). Most of the pegmatite is hard feldspar, but softer areas, rich in albite, have been the source of many gem pockets (figure 10).

Figure 9. The white pegmatite body (massive feldspar) at Golconda is sharply exposed against the enclosing gray schist in the center of the hill. Note also the many galleries that have been drilled and blasted into the pegmatite body.

Currently, the mining operation at Golconda II is heavily mechanized: the garimpeiros drill and blast tunnels throughout the pegmatite, while heavy tractors move the overburden and waste (see Proctor, 1984, figure 5). In the course of all of this activity, a huge cavern over 30 m wide and 8 m high has been carved out at the main entrance. Dozens of galleries and tunnels have been created throughout the pegmatite body (see figure 9).

Production. As mentioned above, while relatively small amounts of gem crystals have been found at Golconda I over the years, literally millions of carats of fine blue-green, green, and rose-colored tourmalines were taken from Golconda III between 1961 and 1967.

Compared to the Golconda III deposits, no great bonanzas have been discovered at Golconda II, but the mine has repeatedly produced small amounts of fine green, blue-green, and rose gems for which it has become well known. Its greatest fame, however, is derived from the occasional pockets that have yielded some of the finest "sapphire"-blue tourmalines ever found in Brazil.

In late 1982, the Golconda II was purchased by Ailton Barbosa, Celso Cravinhoff, and Frank Davis. Although mining for gem tourmaline at

Figure 10. Many gem pockets have been found in the soft kaolin of Golconda II. The black tourmaline lining the walls is an indication that gem crystals may be nearby.

Golconda II has been sporadic, the renovation of this mine by its current owners suggests great promise for the future. Small quantities of fine blue (150 ct) and low-quality green (50 kg) crystals have been found in the last two years.

SANTA ROSA

Noted in gemological circles for the fine bicolored (pink and green) tourmaline found there (figure 11), the Santa Rosa—like the Cruzeiro and Golconda mines—was first worked for mica. Located in a primitive area 36 km southwest of Itambacurí (see figure 2), it can be reached only by traveling an extremely rough dirt road that is totally impassable during the rainy season.

History. The mica mine, which opened in 1938, was abandoned after World War II. However, on October 12, 1967, garimpeiro Tiao Matias noticed chips of colored tourmaline in a series of ant holes and armadillo burrows while prospecting the Santa Rosa hillside. In a race against the ants, he first dug out druses of tourmaline and then, going deeper, found a mass of quartz crystals encrusted with gemmy pink and green bicolored crystals. This strike remains the most important in the mine's history. In less than one year, literally tons of gem- and specimen-quality tourmalines were recovered.

Because much of the pegmatite was totally altered, with the hard "pocket" crystals of tourmaline and quartz buried within soft kaolin, virtually no investment in equipment was needed. Matias found it easy to gather together a group of fellow miners to work, under his "control," what he believed to be the choicest area. Matias allowed no guns, knives, or hard liquor, and promised imprisonment to thieves. But he was far too optimistic about his ability to control when such riches were at stake. Within weeks, as word of the strike spread, the entire kilometer-long hillside was overrun by more than 4,000 garimpeiros (Pough, 1968a and b). Itambacuri became the center of furtive bargaining between these independent miners and the buyers that came from all over the world (Bancroft, 1984).

Dr. Fred Pough, who visited the mine only nine months after the initial discovery (1968a and b), provides a vivid account of the completely disorganized and wasteful mining that quickly riddled this kaolinized pegmatite and probably left as much gem material behind as was extracted:

Figure 11. This Santa Rosa mine "watermelon" tourmaline crystal on quartz illustrates the rose center sheathed in green that is characteristic of this locality. This crystal measures 10 cm × 1.25 cm (4 × ½ in.). Photo © Harold & Erica Van Pelt.

> Since the pegmatite rises through the hill, the tunnels have been started in from the sides, and . . . run in horizontally a few meters or tens of meters until they intersect the wall of the pegmatite. As is almost universal in this part of Brazil, weathering has so decomposed the rocks near the surface that most of the digging is through earth, and the tunnels, often unshored, are not very secure. The advent of a real rainy season will probably cause havoc and might well be the end of the mine. Timbering is held to a minimum, for suitable wood is scarce and Brazil's garimpeiros are not really [professional] miners. . . . On the day of our visit we saw one badly lacerated man [who had been] hurt in a cave-in. . . .
>
> What do they do when they get to the pegmatite? Well, what can they do, with another tunnel right alongside, probably one above and another just below—or about to be? Nothing! They can scratch out any quartz and tourmaline they happen to encounter in the face of their drift and they can go on into the pegmatite until it becomes barren (presumably the core) and they can cheat a little by bulging their tunnel as much as they dare,

and then they quit, perhaps to go and start another tunnel somewhere else. . . . No attempt seems to have been made to sink shafts or pits from the summit. In any case, the outcrop is now blanketed with a town. Once they hit the pegmatite, the group working the tunnel is not necessarily instantly rich. Many workers have already moved on to greener fields, for of all the 452 tunnels, only six were producing at the time of our visit, and the 4,000 miners have diminished to 1,000.

Eventually the miners moved into the hard-rock pegmatite that encompasses much of the Santa Rosa hill. Interestingly, the hard-rock tunnels yielded fewer tourmalines, of which a much smaller proportion (1% to 2%) were gem-quality, than the original colluvial deposits (L. Nercessian, pers. comm., 1985) The greatest activity at Santa Rosa lasted only five months; within three years the mine was virtually abandoned.

Occurrence. As you approach the Santa Rosa area from Itambacurí, the first indication of the frenetic mining that went on there are the red and white piles of dirt and clay—hauled from a myriad of tunnels—that completely dot the hillside (see figure 12). The hill has been honeycombed by tunnels driven in from both sides to intersect what must be a sheet-like pegmatite rising fairly vertically through the hill. Relatively short tunnels were required to mine the "front side" (as you approach from Itambacurí) because the weathered (colluvial) deposit is so near the surface (again, see figure 12). However, the "backside" of the hill, with its strike parallel to the elongation of the hill, contains several tunnels 200 to 300 m long, which penetrated the hard-rock primary pegmatite. The geologic environment of the initial find, which was on the "backside," is similar to that of the Frade aquamarine deposit (Proctor, 1984, see figure 4). Again, all of the stages of pegmatite decomposition, erosion, and dispersal are represented in this one Santa Rosa hillside.

The Santa Rosa Gems. Although this mine produced attractive, rose-colored stones of the same fine quality as the Golconda mine previously discussed, it is noted particularly for the superb "watermelon" tourmaline found there (again, see figure 10). Spectacular crystals, 10–25 cm long (4–10 in.), with cores of rose-colored or red gem tourmaline surrounded by a sheath of superb green gem tourmaline were found in abundance at Santa Rosa. It is probably due to these crystals that the term *watermelon* became associated with the Santa Rosa mine. Some of the multicolored tourmalines from this deposit also exhibit a gemmy purple termination, while others include areas of blue as well as pink and green.

Most of the gem-quality crystals were used for cutting or carving, while many extremely large (some as long as 45 cm and weighing more than 20 kg), spectacular, though nongem-quality crystals

Figure 12. At the time Dr. Fred Pough visited Santa Rosa in June 1968, 452 tunnels had been driven into the hillside. Photo by Fred Pough.

were sold as specimens. Some of these immense crystals can be seen in the Smithsonian Institution in Washington, DC, the American Museum of Natural History in New York, the Sorbonne exhibit in Paris, and the Folch Museum in Barcelona.

Many of the tourmaline crystals (usually about 2.5 cm in diameter) found in the colluvium at Santa Rosa had begun to decompose, leaving at least partially visible a flawless, rounded, gemmy, dark green central core. In some of these crystals, nugget-like cores called "balinhas," or "bullets," had been freed completely. In others, considerable skill with a hammer was required to tap the weathered prisms, or "canudos," just right in order to free the highly prized "balinhas" inside. Many of these nugget-like cores of dark green tourmaline represent some of the best rough found at Santa Rosa (Pough, 1968b).

Production. Despite the hit-and-miss mining, the yield of clean and near-clean multicolored crystals from this mine was tremendous. Levon Nercessian, a frequent visitor to the Santa Rosa mine, estimates that at least 500 kg of clean, multicolored tourmaline and 200 kg of "balinhas" were found at Santa Rosa within a year after Matias's initial find, plus an additional 1600 kg of specimen-quality material.

After only the first five months, mining activity dropped off dramatically. Within three years, the mine was essentially abandoned. Although it is likely, given the disorganized fashion in which the pegmatite was attacked, that many areas of the pegmatite remain untouched, the honeycomb of unstable tunnels makes mining at Santa Rosa both difficult and dangerous. It is interesting to speculate how many more gems would have been removed if the deposit had been worked lengthwise with a bulldozer from the top down, in the same manner as the Salinas mine (Proctor, 1985).

Since fall 1980, however, there has been some renewed activity at Santa Rosa and at four or five nearby hills. Everything found, even in the nearby deposits, is simply labeled Santa Rosa. A limited quantity of mostly fine green crystals (some as long as 15 cm) have been produced, reportedly from the hard-rock, unaltered part of the pegmatite. A large pocket with superb collector crystals was discovered in the late fall of 1984. One dealer recently purchased 625 g of superb "emerald"-green tourmaline produced at Santa Rosa in 1985 (K. Elawar, pers. comm., 1985). Approximately 50 garimpeiros are working the area now, some by enlarging a number of the old hard-rock tunnels and others by opening new tunnels into the less-worked backside of the mountain. Considering its size and recent yields, Santa Rosa is one of the most promising mines in Brazil for future gem production.

Figure 13. This 7.5-cm (3-in.) doubly terminated rubellite crystal with lepidolite matrix and the accompanying faceted stones (4 and 7 ct, respectively) represent some of the fine red tourmalines taken from the main pocket at the famous Jonas mine. Photo © Harold & Erica Van Pelt.

JONAS

The Jonas mine, which represents the single most important rubellite discovery in the history of Brazil (figure 13), provides a fitting climax to our discussion of gem tourmalines in Minas Gerais. Not only is it the most recently discovered major gem deposit (1978), but its fascinating story is well documented, involving incredible hardships, tremendous good luck, natural hazards that had to be overcome, and unproductive mining that almost brought a halt to what eventually led to a rubellite bonanza greater than any known before or since.

The mine itself is not far from Governador Valadares and is only a few kilometers from the town of Conselheiro Pena (see figure 2). To reach the Jonas mine, take Highway 259, a good dirt road, from Governador Valadares 85 km (53 mi.) east-southeast to Conselheiro Pena. From there, a passable dirt road leads 4.8 km (3 mi.) southeast to the mine, which lies on the Itatiaia hillside overlooking the valley and stream of the same name.

History. The Itatiaia hillside encompasses one of the largest and most important pegmatite regions in Minas Gerais. For almost 50 years, the Itatiaia mine produced hundreds of kilos of multicolored "parrot" tourmalines; nearby alluvial deposits have yielded literally tons of green gem tourmaline over the years. The Jonas mine is within 1 km of the Itatiaia mine (now largely inactive), where garimpeiro Barbosa first found the famous "parrot" tourmalines in the early 1930s. The present story, fittingly enough, involves as one of its principal characters garimpeiro Ailton Barbosa, his son. Most of the following account was told to the author by Ailton Barbosa.

The hard-rock pegmatite body now known as the Jonas mine was first tunneled by a local farmer, João Pinto, in the early 1940s. For several years it produced superb four- and five-colored pristine crystals up to 12 cm (4.75 in.) long (E. Swoboda, pers. comm.; Bancroft, 1984).

The Jonas pocket. The modern history of the Jonas mine (previously called the João Pinto mine) began to unfold in 1977, when Ailton Barbosa told well-to-do gem dealer Jonas Lima of Governador Valadares of his determination to one day mine Itatiaia as his father had done and find many fabulous gems. Ailton, also a gem dealer, invited Jonas along on one of his buying trips to Itatiaia and introduced him to the rancher-owner of the Itatiaia hillside that Ailton had coveted for so many years. The land owner knew Ailton and agreed to lease the mine to Jonas, who was to put up all the operating capital, on condition that Ailton would supervise the mining. The lease payment was only 1,000 cruzeiros (roughly US$70) per month; the land owner did not insist on a percentage of royalties on any gems found.

With his crew of only four garimpeiros, Ailton started mining in October 1977 by extending an existing short tunnel horizontally into the enclosing schist and pegmatite. They worked four months with little success, finding only some matchstick-sized green tourmalines attractively arranged on 5-cm white albite crystals (Lallemant, 1978). In early February 1978, they finally penetrated several large pockets, but all they removed were three tons of worthless black tourmaline crystals mixed with albite.

Ailton and Jonas stopped working together for awhile after this disappointing start, but later Jonas went to Ailton and asked that they try again.

On the first of April, after six months of fruitless and expensive blasting and digging, and only a week before the big discovery, a discouraged Jonas told Ailton he wanted to call it quits; he would not go on without some financial support (Huber and Huber, 1980). Ailton, who has more faith than any other garimpeiro the author has ever known, had found occasional patches of lepidolite—the best overall indicator of gem tourmaline—in the pegmatite wall. Ailton told Jonas three times that they must go on, and promised Jonas what appeared to be a wild fantasy: "a huge gem pocket and rubellites as thick as his forearm." Ailton later confided that he didn't know that much about rubellites at the time and had never seen one that big, but he had a very strong premonition that he would find such crystals. Jonas was to find Barbosa's description of the crystals incredibly accurate.

After drilling and blasting through 30 m of schist and only a few meters of pegmatite, Ailton, only a few days away from the big discovery, finally blasted into a second big pocket—again containing large, worthless crystals of opaque black tourmaline with opaque pink tops and albite mixed with mud, water, and much quartz and mica. Ailton was near financial exhaustion himself, but the 25-cm (10 in.) black and pink crystals encouraged him to go on. Ailton even surrendered the title to his Volkswagen to raise the money for food and mining for just one more week; he promised Jonas that when the food and the dynamite ran out, he would finally abandon the mine.

As Ailton laboriously cleaned out this worthless chamber, he felt certain that the water entering from above indicated the existence of another pocket. So Ailton directed the excavation upward and, using hand digging and only partial sticks of dynamite, he carefully engineered an opening big enough to thrust his arm through into the area from which the water was draining. This was on Good Friday, 1978, and as he first reached his arm into the hole and groped above in the darkness, his and Jonas's lives were forever changed. For when he brought his hand out it contained a large, almost flawless, gem rubellite crystal. He then flashed his brightest mining light into the hole and revealed an immense cavern, its walls sparkling with the red of gem rubellites (figure 14).

Ailton and his four fellow garimpeiros immediately closed the small hole. Ailton rushed to Conselheiro Pena and telephoned Jonas in Governador Valadares. Matter-of-factly, he told him: "I found the gems, COME ON DOWN."

After Jonas arrived, they began digging another route into the pocket, since they had first entered it through the bottom. They dug all night and most of the next day; with great anticipation they finally reached the pocket again. They were flabbergasted to find that the pocket was so big that they could walk right into it—with rubellites and albites crunching underfoot.

Imagine the gem pocket—an oval 3 m (10 ft.) high, 3 m long, and 2.5 m (8 ft.) wide—uniformly lined with rubellite crystals interspersed with just three other minerals: snow-white albite, transparent quartz, and pink lithium-bearing lepidolite mica (see figure 14). These three finely crystallized minerals provided the matrix into which the gem rubellites were nestled on the walls. Some of the rubellites had fallen, but most were intact. Many were doubly terminated—another rarity. Among the multitude of great surprises was the fact that the pocket was almost totally clean; virtually no chemical alteration had occurred. There was only a little sand mixed with the albites and rubellites on the floor, and the specimens were so clean that they did not even need to be washed. The elation and awe these men felt is beyond description. Lying before their eyes was the richest, most valuable, and certainly most stunning pegmatite gem pocket ever seen by man. Only Jonas knows how many millions of dollars lay there within his grasp. This pocket became known worldwide as the *bamburrio* (jackpot) pocket, and quickly claimed its place in gemstone lore.

Standing out among this richness was a fabulous matrix gem crystal specimen that hung precariously from the ceiling. This specimen, later named Joninha ("small Jonas," after Jonas's young son) consists of two gigantic rubellite crystals 50 × 25 cm and 25 × 30 cm (20 × 10 in. and 10 × 12 in.) growing on two quartz crystals 20 cm and 45 cm long. The specimen is partially coated with albite; a 20-cm (8 in.) doubly terminated pale citrine crystal hangs on the side of the largest rubellite.

The Joninha specimen, which with its massive matrix weighs 352 kg (775 lbs.), had been partially dislodged from the wall—probably by the small dynamite charges. The miners could fit their hands behind part of the specimen. This masterpiece of the gem kingdom was about to fall.

Lying broken on the floor were three pieces of a gigantic rubellite crystal that, when glued back together, soared 107 cm (more than 3½ ft.) from a matrix of doubly terminated 35-cm-long quartz crystals. This specimen, the largest known rubellite crystal, was named the Rocket. It weighs 135 kg (300 lbs.) and is mostly opaque (not suitable for cutting). The broken edges of the three pieces had been rehealed by minute tourmaline growth yet still fit together perfectly; even though a few pieces were missing when the specimen was repaired, it is stunning (see figure 15).

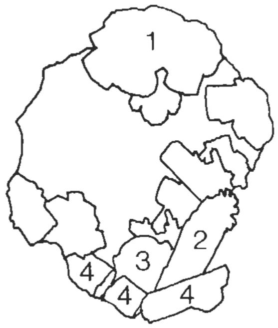
Also lying on the floor was the opaque rubellite crystal named Tarugo ("a short, fat, ugly man") that is approximately 85 cm long, 30 cm wide, and weighs 82 kg (180 lbs.).

The fourth great specimen they noted was the Fleur de Lis, a 35-cm tourmaline attached to a 60-cm quartz crystal and, unfortunately, 65% covered with albite. Many of the smaller gem crystals on the walls and ceilings were surrounded by intricate clusters of small, gemmy, pink lepidolite crystals (again, see figure 13).

Understandably, Jonas required a large dose of Valium to calm down. After their whoops and hollers had subsided, the miners decided their first order of business was to save the Joninha. Ailton came up with the idea of piling old tires up from the floor to just below the specimen and covering the topmost tires with a burlap pad. With miners pushing upwards on all sides, a final pry with the crowbar released the Joninha gently onto the tires. Miraculously, it left the mine and reached Governador Valadares that night without damage, even though Ailton fell asleep at the wheel, missed a curve, and drove the Jeep down a 20-m embankment.

What happened next as they started to clean out this incredible pocket has become legendary in the gem and mineral community around the world. Jonas's first concern was the security for his valuable cache. The history of Brazil's "wild West" closely parallels that of our own, except that the land wars, lawlessness, and gunfights in Governador Valadares climaxed only in the mid-1950s when a very valiant man, a Colonel Pedro, brought


Wendell E. Wilson 1985©



1. Joninha
2. Tarugo
3. Fleur de Lis
4. The Rocket

Figure 14. Artist's conception of how the Jonas mine pocket may have looked when first discovered. The reconstruction is based on photos and measurements of some of the major pieces, and on interviews with the original miners regarding the location of specimens within the pocket. The pocket measured 2.5 × 3 × 3 m (8 × 10 × 10 ft.); the specimens are drawn approximately to scale. Rendering courtesy of Wendell E. Wilson.

the army into the region and exterminated the outlaws (A. Lucio, pers. comm.; Caplan and Wilson, 1980). Jonas is Pedro's son-in-law, so it wasn't hard for him to find old-time gunfighters who were willing to help with security while loving the drama and importance of the event, which rekindled the excitement of that earlier era.

In only eight days this first pocket was completely cleaned out and the crystals, under a guard befitting the crown jewels, were transported 90 km to Governador Valadares. Eventually both the mine entrance and the warehouse in Governador Valadares where the gems were stored were declared off-limits to photographers and most other people. These two regions became armed camps. It even became difficult for gem dealers and crystal collectors to view the material and, when viewing was allowed or sales were made, armed guards were visible everywhere. Even Brazilian Internal Revenue agents were unsuccessful in their attempts to examine the discovery (Lallemant, 1978). According to Wilson and Barreto (1978), the Rocket and other specimens under guard at the warehouse sat on tables supposedly wired to dynamite stacked underneath. Jonas threatened that if robbers or revenuers came around he would blow the whole thing up—evidently he would have been satisfied with melee. When Jonas gave the author the honor of viewing the four major specimens in the summer of 1980, he quoted the total value of all four at US$9,000,000. Jonas eventually started charging $8.00 per person just to see the four major pieces (Huber and Huber, 1980).

For the remainder of the specimens,. Jonas chose as his agent one of the best salesmen and most colorful characters in the region, João das Moças (John of the girls), who is notorious for having seven wives—all at the same time. John eventually made enough money to buy a house for each of them.

The Second Pocket. Within three months of the first discovery, Jonas had a disagreement with the land owner over the lease of the mine, and by late July 1978 he had abandoned the operation. He also dynamited the tunnel shut about 30 m inside the entrance and left a wheelbarrow full of unstable, decomposing dynamite nearby (Keller, 1979).

Figure 15. The Jonas mine specimen known as the Rocket is believed to be, at 107 cm (more than 3½ ft.), the largest rubellite crystal ever found.

However, a large adit intersected the pegmatite about 50 m above the closed tunnel, allowing an alternate entrance into the workings.

A new lessee, Dilermando de Melo ("Dilo") began mining immediately. In the ensuing two years, he opened a tunnel 130 m long. A few insignificant pockets with small dark green tourmalines on white albite were opened, and occasional rubellite specimens were found, but nothing truly exceptional was recovered during the first several months (Huber and Huber, 1980; Lucio, 1980). Surprisingly, Dilo found quite a few excellent gem blue tourmaline crystals in this region of the pegmatite. Then, in early April, a year after the first pocket discovery, Dilo and his miners encountered all the signs of another great find.

Working down through the pegmatite, they struck the outer wall of what appeared to be a large pocket, right beneath their feet on the floor of the tunnel. Quickly they set off the dynamite charge to open the pocket, and Dilermando, in his excitement, neglected to allow the necessary time for the gasses to disperse. He went directly to the blast site and, leaning over to look into what he hoped was another Jonas pocket, was immediately overcome with the fumes from the explosion. His foreman took him to the hospital, and Dilermando lay there impatiently waiting to be well enough to return and find out what his last charge of dynamite had revealed. When Dilo was released from the hospital, he and his partner went immediately to the mine. Coincidentally, Good Friday, 1979, again brought a choice discovery. The pocket was not yet open completely. Still remaining to be penetrated was a thin, 7.5-cm (3 in.) layer of albite from the inner pocket wall. With picks and crowbars, they pried and finally broke loose a 45-cm almost-square piece of this inner wall. With one person on each side, they carefully removed the section, fortunately by lifting straight up. When they turned it over, there on the other side of the piece was the beautiful Rose of Itatiaia, shown in figure 1.

This gem pocket, completely filled with moist sand, was a 2- to 2.5-m (6 to 8 ft.) oval inside; like the Joninha, the Rose was hanging upside down, suspended from the ceiling of the geode-like pocket. Surprisingly, this was the only rubellite specimen in this second huge gem pocket. So ends the saga of the Jonas rubellite mine. To this day, no other major rubellites have been found. Although considerable pegmatite remains, there is little activity in the area as of this writing because of the expense of mining this deposit.

The Rose of Itatiaia specimen is somewhat brighter in color than those of the first pocket (Huber and Huber, 1980). This 35 cm (14 in.) long by 12 cm (5 in.) wide gem rubellite crystal is nestled in a bed of gemmy albite crystals. The author acquired the Rose of Itatiaia in the summer of 1980, and several articles have been written about the harrowing odyssey this specimen went through before it finally arrived safely in Colorado (Zeitner, 1981 and 1983; Jones, 1982).

The survival undamaged of the Joninha and the Rose of Itatiaia as well as other major gem crystals from this and other great gem mines is truly remarkable. Not only did they withstand the violent conditions of changing heat, pressure, and earth movements under which they were created, but they also survived the trauma of dynamite and removal at the hands of the miners.

The Joninha was eventually sold to a private party in the United States for US$1,300,000; the Rocket was subsequently acquired for the same mineral collection.

Occurrence. According to Ailton Barbosa, the pegmatite that housed these tremendous finds is 12 m wide and 200 m long as it snakes its way nearly horizontally through the hillside in a N 30° E direction. Therefore, it is only one-fourth as long as the three Cruzeiro pegmatites and only a small fraction of their overall width. Jonas worked only 30 m of the pegmatite.

Sharp crystals of cassiterite, pink apatite, and the rare mineral microlite were found in the pegmatite. Unusually sharp microcrystals of monazite were also frequently found. It is significant to note that no muscovite mica or microcline was found in either of the two great Jonas mine pockets. Also, as might be expected from all the rubellite present, spessartine garnets were found on the dumps by the author; these were wafer-thin and were squashed between large muscovite mica sheets from the pegmatite body and not the Jonas pocket.

There are many other gemstone mines in this rich Itatiaia pegmatite district, including alluvial tourmaline deposits and mines that were producing highly etched but attractive beryl crystals at the same time as the Jonas mine discovery (Keller, 1979). However no aquamarine, topaz, or spodumene was found in the Jonas mine.

Production. The original Jonas pocket yielded, at best estimates, at least 200 kg (450 lbs.) of fine-quality cuttable crystals of an exceptional "cranberry," or deep magenta-red, color. One crystal alone cut a million dollars (retail) worth of gems. Additionally, approximately 3,600 kg (8,000 lbs.) of specimens (rubellite with matrix) were removed (Keller, 1979). Both foreign and local experts agreed that this was the single most important find of tourmaline in history.

Because so many of the crystals were fat, even large gemstones could be cut perpendicular to the c-axis. The finished gems were dazzling in color, brightness, and fire (Lallemant 1978). Keller (1979) said they were among the finest rubellites known. In this author's opinion, however, even the best red tourmalines from the Jonas mine are not as good as the very finest "cherry"- and "ruby"-red stones to come from the Ouro Fino or Cruzeiro mines.

As is the case with other rubellites, flawless stones from Jonas material are rare, but their extraordinary cranberry color far outweighs their ever-present inclusions. As is usually the case with fine rubellite, gemstones cut from the Jonas material were absorbed into the market quickly. In less than two years, they were already in short supply.

OTHER MINES IN THIS REGION

In the general region between the Araçuaí and Governador Valadares districts, deposits of fine tourmaline have been found in varying frequency in areas surrounding the cities of Turmalina, Minas Novas, Capelinha, Poté, and Itambacuri, with the best gems having come from Novo Cruzeiro (see map, figure 2, in Proctor, 1984). It is safe to say that the Cruzeiro-Aricanga, the Jonas-Itatiaia, the three Golcondas, and the Santa Rosa have produced a higher dollar value of fine gems than all the rest of the mines in the Governador Valadares district combined. However, many other smaller but important deposits in this district have been mined and deserve mention.

Near the Cruzeiro, the Marcello mine has produced some of the finest blue stones ever found in Brazil. The nearby Chiá and Urupuca mines, also produced fine blue stones. The mines around the town of Galiléia, such as Pedra Alta, Laranjeiras, Divino, Ferruginha, and Retiro, have produced fine green, blue-green, and rose material. In the Golconda region, yellow-green, fine blue, and gold tourmalines have been recovered from the Faria, Jacob, and Lavra Faria mines, respectively. The Pammarole and Linopolis mines near the city of Linopolis are known for their fine red material (Bank, 1970). Other notable tourmaline deposits are indicated on the map in figure 2.

SUMMARY AND CONCLUSION

Minas Gerais, Brazil, is the largest producer of gem tourmalines in the world. The pegmatites in the northeastern area of this state have yielded literally millions of carats of tourmalines of virtually every color variety. Twenty important mines were discussed in the preceding article in this series, on the Araçuai districts (Proctor, 1985). Although the present article focused on only four localities, these four include some of the oldest and most productive mines in Minas Gerais.

Cruzeiro (including the Aricanga Company-owned mine) and Golconda (I, II, and III mines) represent two of the largest known pegmatite deposits in Brazil. They have consistently produced gem- and specimen-quality tourmalines for more than 30 years. While Cruzeiro has yielded large quantities of fine blue-green, green, blue, pink and "watermelon" tourmalines, the rubellite found there is considered among the best in Brazil. All three Golconda mines have produced tourmaline over the years, but the most important find (900 kg of "emerald"-green gem tourmaline, as well as significant deposits of green "pencils" and distinctive bicolored crystals) was made at Golconda III. Golconda II is now the most active of the three mines and is noted as a sporadic producer of green, blue-green, and rose tourmalines as well as small amounts of spectacular blue gems. Now undergoing renovation, it promises to be the most productive of the three Golconda mines in the future.

In the space of a year, the Santa Rosa mine yielded an estimated 2300 kg of gem- and specimen-quality tourmaline, primarily multicolored crystals. But as quickly as the Santa Rosa hill was entered, it was virtually abandoned. For more than 10 years after the initial 1967 find, there was almost no activity at Santa Rosa. The renewal of mining since 1980 has produced small quantities of gem material, but nothing on the scale of the original bonanza.

The Jonas mine produced the largest and most valuable deposit of fine gem rubellite ever found in one pocket and possibly in one mine. Not only was this the cleanest and least altered chemically of the large gem pockets with which the author is familiar, but it was also possibly the largest open gem pocket on record. Five of the largest and finest gem rubellite crystals ever found were produced in this one mine. In addition, hundreds of thousands of carats of gems were cut. After the original discoveries, however, there were no additional major finds. Because of the expense of mining the hard-rock pegmatite, the legendary Jonas mine is now essentially abandoned.

Of the 30 best-known tourmaline mines in this district, only four are sporadically producing, and two others—the Cruzeiro and the Aricanga—are responsible for 90% of the present production.

Author's Note: *I wish to especially thank the following people for allowing me to visit their mines (indicated here in parentheses) and take the many photos needed for this series of articles: Dr. Rex Nash (Marambaia Valley); Inacio Moura Murta (Frade mine); José de Estrada (Jenipapo and Piauí deposits); Servio Getulio Ursine (Virgem da Lapa); Halley Freire Batista (Salinas); Francisco Freire Murta and Wilson Freire Murta (Ouro Fino mine); José Neves (Cruzeiro mine); Frank Davis and Celso Cravinhoff (Golconda mine); José Gomez da Rocha (Santa Rosa mine); Ailton Barbosa, Jonas Lima and Dilermando Rodrigues de Melo (Jonas mine); Agenor Tavares and Henry F. Kennedy (Corrego do Gil and Barro Preto); and Neylson Barros (Corrego do Urucum).*

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NOTES
· AND ·
NEW TECHNIQUES

THE EYEPIECE POINTER: A USEFUL MICROSCOPE ACCESSORY

By C. W. Fryer and John I. Koivula

The eyepiece pointer is a very useful microscope accessory for the gemologist. It is always in focus and points to the center of the microscope's field of view regardless of the magnification or plane of focus within the stone. The eyepiece pointer simplifies the task of pointing out microscopic features on or in any gemstone, whether mounted or unmounted. It can be fashioned easily for use on virtually any microscope.

Almost every jeweler–gemologist who has occasion to use a microscope has run into the problem of trying to point out something in the field of vision to a client, co-worker, student, or friend. If the microscope subject is subtle and/or the person being shown the subject is not a gemologist or microscopist, that person may have difficulty seeing what you see. Although the external needle-type pointer offers some help, it has limitations that the eyepiece pointer overcomes.

The eyepiece pointer is basically a thin, strong, acicular fiber that is affixed to the inner diaphragm of the microscope eyepiece (figure 1). Because it is actually part of the eyepiece unit, it is always in the same plane of focus as the subject and is always the same size no matter what magnification is used. Even at 50× magnification, when the subject is in focus, it can be lined up precisely with the tip of the eyepiece pointer, just as if the pointer were inside the host gemstone with the subject.

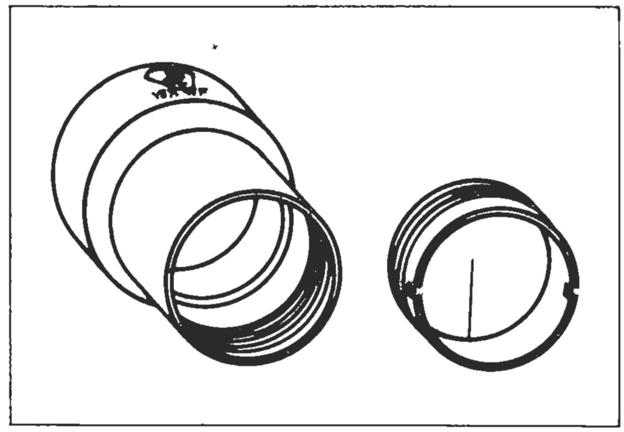

Figure 1. The eyepiece pointer is simply a strong, thin, acicular fiber that can be attached to the inner diaphragm of the eyepiece on virtually any microscope.

By contrast, an external needle-type pointer is never in the same plane of focus as the subject unless the subject is on the surface of the stone or only a low magnification is used; even at 10× difficulties begin to arise. The tip of a needle-type pointer is large in comparison to many inclusions

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A

B

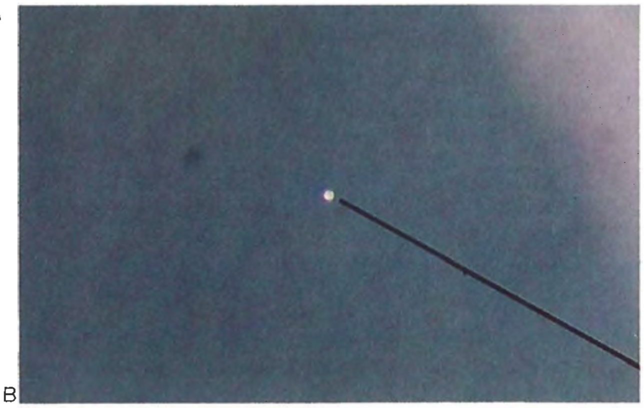

Figure 2. (A) A tiny gas bubble in a man-made glass being "pointed out" at 10× magnification by the eyepiece pointer. Notice how both the pointer and the bubble are in focus. (B) The same gas bubble in glass at 50× magnification. Notice that both the pointer and the bubble are still in focus and that the pointer is still the same size while the bubble has been highly magnified.

and, unlike the eyepiece pointer, its apparent size increases as the magnification is increased. With needle-type pointers you can focus on either the pointer or the inclusion, but rarely on both at the same time. This can be a serious drawback if, for example, you are trying to point out a tiny gas bubble in a glass imitation or a flame-fusion synthetic ruby at 50×. Pinpoint inclusions in diamonds are extremely difficult to see at 10× except to a skilled diamond grader. Pointing these out in a client's supposedly "flawless" diamond is almost impossible with a standard needle-type pointer, but is easy with the eyepiece pointer.

A COMPARISON

For comparison purposes, a faceted man-made glass was selected that contains a gas bubble that is just visible at 10×. First, the subject was photographed at 10×, then at 50×, with the eyepiece pointer in place. The results are shown in figure 2. Notice that both the pointer and the gas bubble are clear and sharply in focus. Even at 10× magnification, the subject is obvious. However, figure 3 tells another story. The same gas bubble in glass was again photographed, this time using the external needle-type pointer. Again, starting at 10× (figure 3A), both pointer and inclusion are visible, although the pointer is slightly out of focus. In figure 3B, also at 10×, the pointer is now in focus but the gas bubble is blurred and almost invisible. As magnification is increased, this problem with the needle pointer becomes more obvious. If we increase the magnification to 50× and focus on the needle pointer, as in figure 3C, the bubble cannot be seen at all. If we then refocus on the bubble, as in figure 3D, the needle pointer is now nothing more than a vague blur. This simple example makes the usefulness of the eyepiece pointer readily apparent.

In addition to its value as an inclusion pointer, the eyepiece pointer has a number of other applications. For example:

1. To point out manufacturing details of a jewelry item such as the gold stamp or a manufacturer's hallmark.
2. To make clients aware of existing damage to their jewelry before the items are taken in for repair and/or appraisal.
3. To make clients aware of damage to a watch such as a broken balance staff.
4. As an educational aid for training employees in the proper use of the microscope.

CONSTRUCTION

The eyepiece pointer is easy to make and can be adapted to virtually any microscope. All that is required is a straight, hair-line fiber of fiberglass (e.g., from a fiberglass eraser), camel hair (e.g., from a painter's brush), or some similar thin, acicular, strong material, plus a small drop of glue or cement. Basically, the eyepiece pointer is fashioned by cementing this thin, straight material in the appropriate place inside the microscope eyepiece.

The fiber used for the pointer must be placed in the eyepiece in a position where it is sharply in focus at all times. This is accomplished in the following manner. Remove the eyepiece from the microscope, turn the eyepiece over and look in the bottom. You will see a black ring that protrudes approximately ⅛ of an inch all around from the inner wall of the tube. The location of this diaphragm will vary slightly with each different make

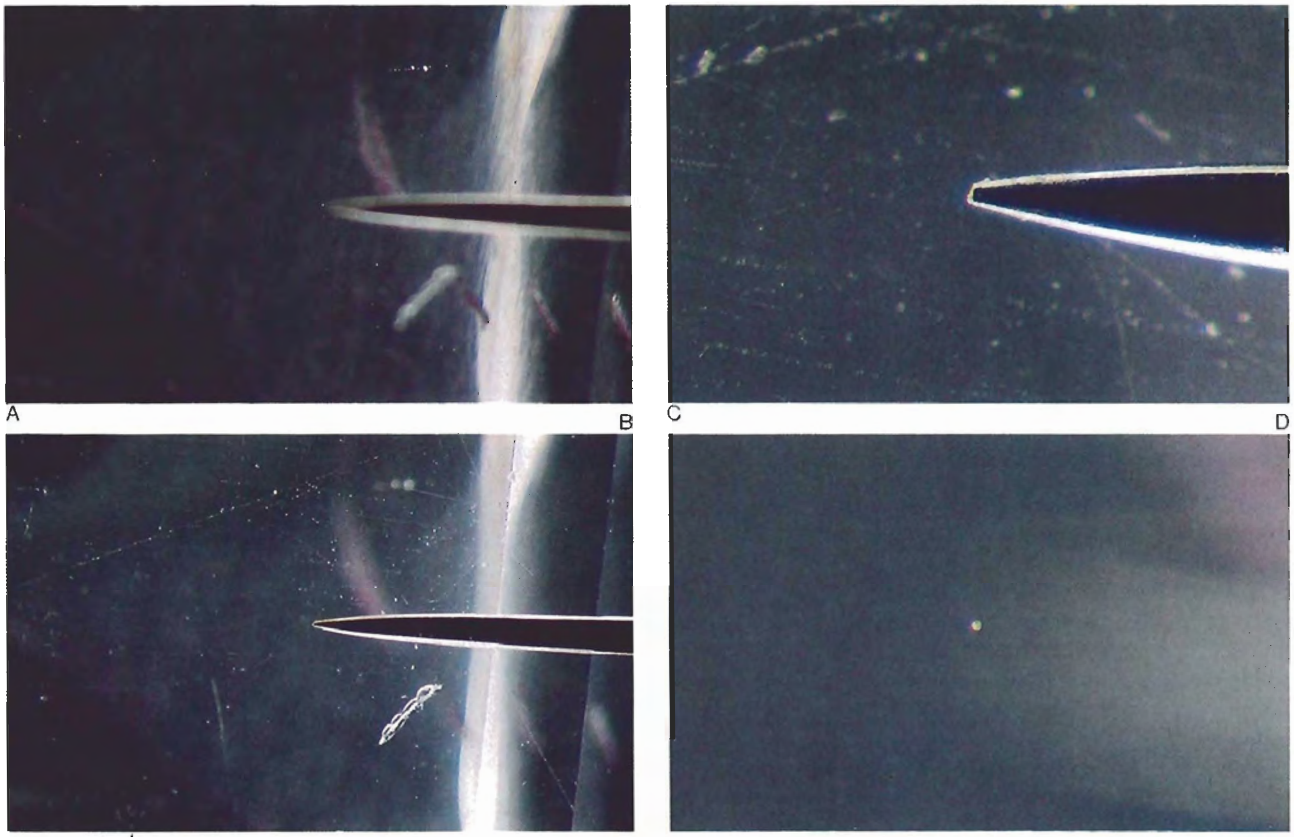

Figure 3. (A) The gas bubble in glass is again shown at 10× magnification, but the eyepiece pointer has now been replaced by the needle-type pointer; notice that the needle pointer is slightly out of focus. (B) Again at 10×, the needle pointer is now in focus but the gas bubble is only a blur. (C) Increasing the magnification to 50× and focusing on the pointer we completely lose the image of the gas bubble we were trying to point out. (D) If we maintain the 50× magnification and refocus on the gas bubble, the image of the needle pointer is almost completely lost.

of microscope, but it is present in all makes. The fiber must be cemented to the *top* surface of this ring (the surface closest to the lens) so that it protrudes from the edge into the center of the field of view.

Bausch & Lomb eyepieces have a removable diaphragm ring that can simply be unscrewed from inside the bottom of the eyepiece tube. Place a small drop of cement on the top surface of this diaphragm ring and then put one end of the fiber pointer in the cement. Position the fiber so that it is perpendicular to the edge and points toward the center of the diaphragm. Adjust the length of the fiber so that it reaches halfway across the opening. This will place the end of the pointer in the center of the field of view. When the cement has dried, simply screw the diaphragm back into the eyepiece until it is sharply in focus when looking through the lens.

American Optical eyepieces have a fixed diaphragm, and the lens must be removed from the top to gain access to the top surface of the diaphragm. Cement the fiber to the top surface as previously instructed and reassemble the lens, taking care that the lens surfaces are clean and do not have any fingerprints or dust on them.

Other microscope eyepieces will have either a fixed diaphragm or a removable one. To make your own eyepiece pointer, simply follow the appropriate instructions from the preceding paragraphs.

CONCLUSION

While the needle-type pointer is useful for pointing out surface characteristics and internal features requiring low magnification, the eyepiece pointer offers added range and flexibility. Anyone who has ever experienced the frustration of trying to show another person something through the microscope will greatly appreciate this handy little device.

Gem Trade LAB NOTES

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AMBER, with Unusual Inclusions

Figure 1 illustrates a metallic inclusion in a fashioned piece of Dominican amber that the New York lab examined recently. The inclusion appears to be massive pyrite or marcasite, although the fact that iron and nickel are mined locally suggests that it may be bravoite $(Fe,Ni)S_2$, another member of the pyrite group. The reddish coloration around the inclusion indicates a chemical reaction with the amber. Such inclusions are encountered occasionally by amber workers and may present a problem in polishing. *RC*

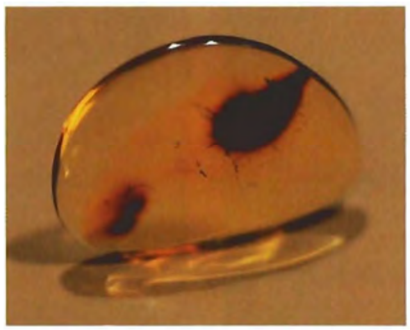


Figure 1. Metallic inclusion in Dominican amber.

AMETHYST, with Confusing Inclusions

With amethyst rising in popularity, as reported in recent trade publications, more stones are being examined. However, the separation of natural from synthetic stones continues to baffle the trade. A stone with no inclusions cannot at present be identified by routine tests. At one time, the presence of "bread crumb" inclusions was accepted as an indication of synthetic origin. Conversely, certain included crystals, "fingerprint" inclusions, and "zebra stripe" healed fractures were accepted as evidence of natural origin. Lately, however, there has been some indication that cutters of synthetic amethyst are aware of these distinctions, and have been including "fingerprints" or other irregularities that they formerly had eliminated in their efforts to produce clean stones.

Recently, an amethyst was submitted to the New York laboratory that had a low-relief crystal with a flattened gas bubble at the interface between the inclusion and the host (figure 2). This crystal indicated a natural stone. However, at the opposite end of the stone, equally convincing "bread crumbs" (figure 3) indicated a synthetic stone. We still do not know if this stone is synthetic or natural. *RC*

Figure 2. Included low-relief crystal with flattened gas bubble in amethyst. Magnified 30×.

Figure 3. "Bread crumb" inclusion in amethyst. Magnified 30×.

DIAMOND

Damaged in Cutting

When a diamond cutter has a blocked stone break on the wheel for no apparent reason (figure 4), he is usually philosophical and dismisses it as all in a day's work. However, when five out of a lot of 16 rough stones end up breaking, he begins to search for the reason. The possibility exists that rough material from certain mines has undergone serious deformation resulting in weak directions and internal strain. Unfortunately, the source of the approximately 2.5-ct diamond illustrated in figure 4 is not known. It is one of the five that broke on the wheel. *RC*

Fancy Blue Diamond

Frequently when the laboratory staff is testing a blue diamond for conductivity, it becomes necessary to

Editor's note: The initials at the end of each item identify the contributing editor who provided that item.

Figure 4. Blocked out 2.5-ct diamond that broke on the wheel. Magnified 10×.

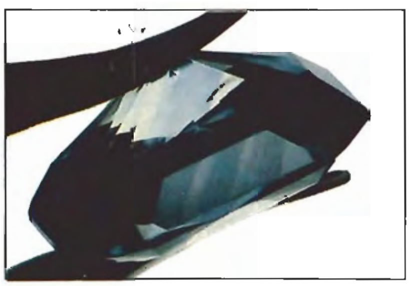


Figure 5. Color zoning in a 2-ct fancy blue diamond. Magnified 10×.

probe very carefully until certain "sensitive" areas are touched. The color zoning shown in figure 5, taken in the New York lab, suggests the reason for the difficulty: current is conducted most readily along the blue bands. In addition to causing problems when testing, such color zoning makes it difficult for the planner of the rough to orient the stone for best color. *RC*

FLUORITE Carving, Damaged by Sulfuric Acid

The carving illustrated in figure 6 was sent to the Los Angeles laboratory for examination. Our client explained that after soldering a 14K gold bail on the carving, which he thought was amethyst, he had placed the piece in a sulfuric acid and water solution (nine parts water to one part acid) for one hour to remove soldering flux and tarnish from the gold. When he removed the carving from the "acid bath," our client realized that the smooth, shiny, delicately carved surface had become frosted and heavily etched (see figure 7). The client asked the laboratory to determine whether or not the stone had been "rough cut to a frosted condition and then coated with something to give it a finish rather than being polished in the appropriate manner." Interestingly, when we viewed the carving there was no bail on it.

The surface of the carving was too heavily etched to provide a refractive index reading. When tested with a polariscope, the material was determined to be singly refractive, thus ruling out amethyst. Using hardness points in an inconspicuous place, we estimated the material to be approximately 4 on the Mohs hardness scale. A very weak bluish purple fluorescence was observed when the carving was exposed to long-wave ultraviolet radiation, and an extremely weak greenish white fluorescence was noted on exposure

Figure 6. This fluorite carving, which measures approximately 45.75 × 29.70 × 11.90 mm, was originally thought by the owner to be amethyst.

Figure 7. Extensive etching caused by immersion of the fluorite carving shown in figure 6 in a sulfuric acid solution. Magnified 30×.

to short-wave ultraviolet radiation. Using the hydrostatic method, we found the specific gravity to be approximately 3.20. The carving was therefore determined to be fluorite, which is very susceptible to attack by sulfuric acid. *RK*

HEXAGONITE, Cat's-eye

The Los Angeles laboratory recently had the opportunity to examine two rare pink cat's-eye hexagonites. The name *hexagonite* was applied to this purple-to-pink variety of tremolite many years ago, in reference to its apparently hexagonal structure. The material was later shown to be actually monoclinic. The two hexagonites that we examined weighed 1.86 ct and 2.72 ct; figure 8 shows the smaller stone. These two rare cabochons were cut from material found at Fowler, St. Lawrence County, New York. Hexagonite also occurs at Edwards and Balmat, New York.

Figure 8. Cat's-eye hexagonite, 1.86 ct.

It has been reported in the past that many hexagonites are heavily fractured and therefore difficult to cut. Both of the cabochons that we examined were indeed heavily included, with parallel cleavage planes, fractures, parallel needles, opaque dark brown euhedral crystals, and irregularly shaped cavities filled with an opaque dark brown material. The properties of tremolite are compared with those of the cat's-eye hexagonites we examined in table 1. *RK*

OPAL

Unusual Gilson Synthetic

One of the GIA students showed us a quite unusual synthetic opal that we had not yet encountered in our laboratory. The almost rectangular piece of material, which measured approximately 8.7 × 6.8 × 4.9 mm, was translucent brownish orange with a very pronounced play of color; it resembled top-quality Mexican fire opal. However, a side view of the piece revealed a very peculiar structure that became even more obvious under magnification (figure 9). The piece appeared to have been assembled, with rather thin, colorless top and bottom layers that showed no play of color. The center area, however, was a brownish orange and showed a rather unusual play of color; the different hues were confined to certain areas, as if they had been arranged in distinct columns. When the stone was viewed through the colorless layers, the snakeskin pattern characteristic of synthetic opal became visible in the cross sections of the color columns.

We also noticed other differences within the same piece. The refractive index of the colorless material was 1.495, but that of the center area was slightly lower, at 1.47. Although neither area fluoresced to short-wave ultraviolet radiation, the near-colorless area showed a chalky white fluorescence to long-wave ultraviolet rays, while the center area remained inert. The different areas varied in hardness as well. The colorless surface area was easily indented by a pin and started to flow readily as soon as the hot needle of the thermal reaction tester was held just above it. The center area was definitely much harder; the pin left no mark on the surface. Although there was no flowing when the hot needle was applied to the center area, the needle did discolor the translucent brownish orange material and leave a white opaque spot. We have no idea why the synthetic opal was covered on the top and bottom surface with this transparent colorless plastic. *KH*

Yellow-Green Opal

The New York lab recently examined a 2.30-ct semitransparent,

TABLE 1. Gemological properties of cat's-eye hexagonite and tremolite.

	Refractive index	Birefringence	Pleochroism	Specific gravity	Cleavage
Cat's-eye hexagonite	1.60–1.62 (spot)	Approx. 0.02	Weak orangy pink, purplish pink, and purple	Approx. 3.00 (heavy liquids)	One direction with parallel cleavages
Tremolite[a]	1.600–1.625	0.025	Weak orangy pink, purplish pink, and purple	2.98–3.03	Good two directions

[a] *As reported in W. R. Phillips and D. T. Griffin (1981)* Optical Mineralogy, the Nonopaque Minerals. *William Freeman & Co., San Francisco, CA*

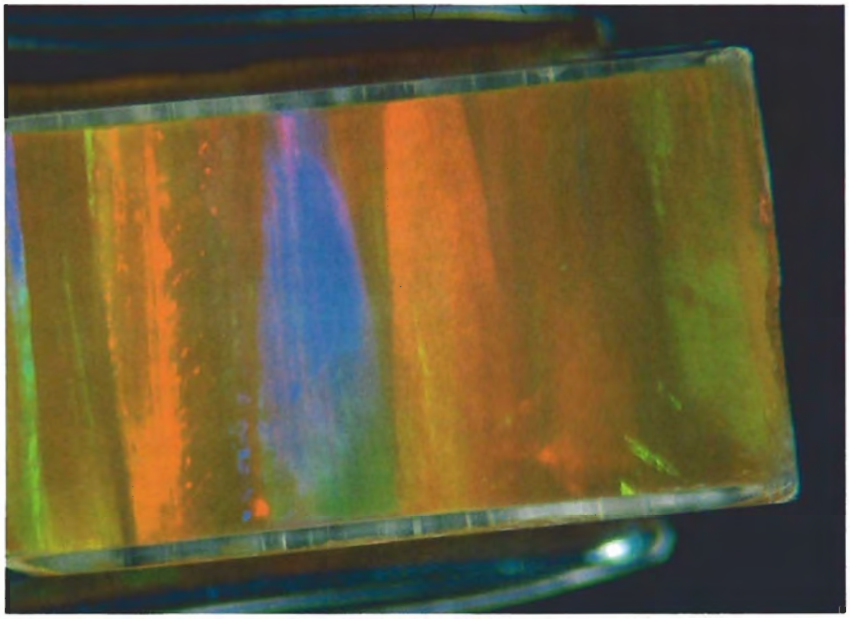


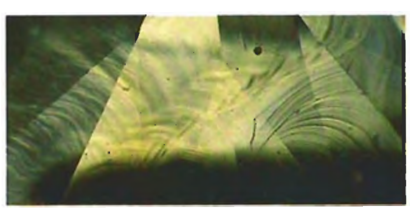
Figure 9. Colorless outer layers are clearly evident on the top and bottom of this synthetic opal. Magnified 10×.

faceted, yellowish green opal (figure 10) that reportedly came from Mexico. Our first impression based on the oily appearance was that the stone might be highly fluorescent, particularly when it was examined in daylight at the window. Sure enough, the stone fluoresced an extremely strong, bright, yellowish green when exposed to either long- or short-wave ultraviolet radiation. The intense fluorescence seemed to follow the pattern of the internal botryoidal flow structure (figure 11). There was no phosphorescence.

Figure 10. A 2.30-ct faceted yellowish green opal.

When we checked the stone with a Geiger counter, it was found to be slightly radioactive (0.1 to 0.4 mR/hr), only a little above the background count. When the stone was left on unexposed X-ray film for approximately five days, the radiation of the stone exposed the film, so that it took its own radiograph. That the radioactive property might be due to the presence of a trace of uranium is suggested by the absorption pattern as observed on a spectrophotometer chart. The vague bands at 4950 Å (495 nm) and 4600 Å (460 nm) plus the cutoff at about 4300 Å (430 nm) in the violet (seen with difficulty in the hand spectroscope), closely resemble the pattern for a uranium glass recorded in Webster's monumental book, *Gems.* The refractive index of 1.455 and the specific gravity of 2.18 are in the normal range for opal. *RC*

Figure 11. Flow structure in the faceted yellowish green opal shown in figure 10. Magnified 15×.



PEARLS

Freshwater Cultured Pearls from China

A large lot of undrilled fancy-colored pearls reported to be of natural origin were brought to our Los Angeles laboratory for identification. We were told that these pearls had been purchased in China. The pearls were all symmetrical in shape, primarily slightly off-rounds and ovals, and they ranged in size from approximately 4 to 5.5 mm in diameter. As shown in figure 12, the colors varied from different shadings of rose to purple, lavender, and bronze. They all showed a very high, almost metallic, luster. All of the pearls also showed a more or less strong fluorescence (depending on the intensity of their body color) when exposed to X-radiation, which indicates freshwater origin. The X-radiograph revealed the characteristic irregular voids that prove that these were mantle tissue–nucleated cultured pearls. These pearls had the most intense color and highest luster of any of the symmetrical freshwater cultured pearls that we have encountered to date in the Los Angeles laboratory. *KH*

Imitation Pearls

One fact the manufacturers of imitation pearls must consider is that of comparative weight or "heft." Most use an opalescent glass bead center that approximates the specific gravity of pearls or cultured pearls. Shell bead centers are also essentially the same as pearls in this respect. Plastic bead centers have been used, but their low specific gravity is a detriment. Recently, the New York lab examined one half of a bead that indicated an advance in several ways. A

Figure 12. Some of the colors observed in the Chinese freshwater mantle tissue-nucleated cultured pearls examined in the Los Angeles lab (4–5.5 mm in diameter).

Figure 13. An 8-mm imitation pearl showing a metallic core and iridescent ring. Magnified 15×.

central core consisting of several small metallic spheres provided weight for the essentially plastic bead. Iridescence was provided by finely divided particles of unknown composition reminiscent of those seen in the Slocum imitation opal; these particles lay in a ring halfway between the metallic core and the surface (figure 13). The plastic above the iridescent layer is quite transparent and thick enough to allow repolishing if the bead were damaged. The usual coated imitation pearl cannot be repaired because the coating is so thin.

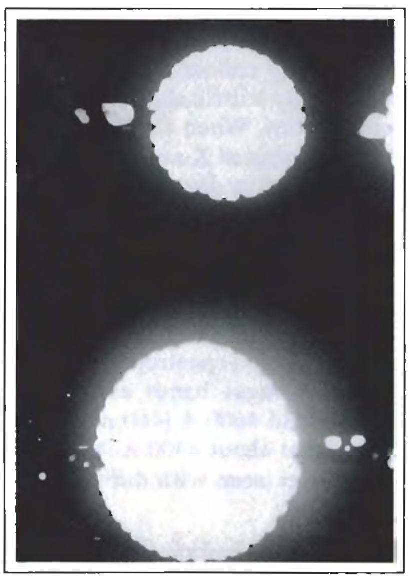


Figure 14. The metallic cores of imitation pearls similar to the one shown in figure 13 are clearly evident in this X-radiograph.

Figure 14 is an X-radiograph of a section of a necklace that was made with these new imitations. The metallic spheres are embedded in a white plastic matrix. One sphere was tested with a hot point. It behaved very much as a lead solder would, indicating a low melting point. *RC*

QUARTZ, Very Dark Reddish Gray Cat's-eye

The 6.97-ct cat's-eye quartz shown in figure 15 was submitted to the Los Angeles laboratory for identification. Refractive indices of 1.540–1.550 were obtained on the flat base of the cabochon. The specific gravity was determined to be approximately 2.67. No distinct bands or lines were observed in the absorption spectrum when the stone was examined with a hand-held spectroscope. The stone was inert to both long-wave (366 nm) and short-wave (254 nm) ultraviolet radiation. Examination with the microscope revealed numerous parallel long, thin, red needles throughout the stone, which caused the chatoyancy. Small, circular, orange disks were also observed throughout the stone. This is the first time that the Los Angeles lab has seen a cat's-eye quartz of this particular color. *RK*

Star SAPPHIRE, Diffusion-treated

The New York lab was recently asked to examine a star sapphire weighing approximately 10 ct that the client had started to recut only to discover that he had ground off one leg of the star (figure 16). Examination under magnification revealed that the star existed only on the surface, a result of diffusion treatment whereby an excess of titanium oxide is allowed to form oriented needles in the surface lattice structure of the corundum. Further proof that the stone had been subjected to the heat required for the diffusion treatment process is provided by the melted appearance of the base of the cabochon (figure 17). *RC*

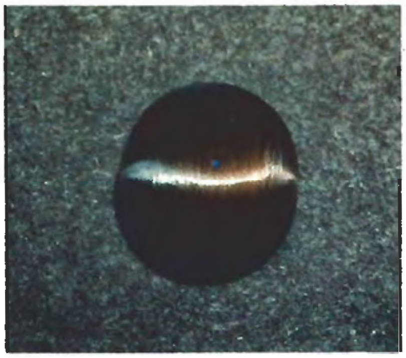


Figure 15. A 6.97-ct cat's-eye quartz.

SCAPOLITE, Dark Cat's-eye

The Los Angeles laboratory recently received for identification the 52.92-ct nearly opaque, extremely dark yellowish green-brown chatoyant round double cabochon shown in figure 18. Testing with a refractometer revealed a weakly birefringent spot reading at approximately 1.56. The cabochon was inert to long-wave ultraviolet radiation, but a barely perceptible red fluorescence was observed when the stone was exposed to short-wave ultraviolet radiation. The specific gravity was determined by the hydrostatic method to be approximately 2.70. Microscopic examination revealed minute, parallel needles throughout, as well as several large and small fractures. Using a hardness test on the base of the cabochon, we estimated the stone to be around 6 on the Mohs hardness scale.

A minute amount of powder was then scraped from the girdle of the stone for X-ray diffraction analysis. We obtained an X-ray powder diffraction pattern that came very close to matching ASTM file pattern 29-1036 for mizzonite. Mizzonite is a member of the scapolite (wernerite) group, which also includes marialite, dipyre, and meionite.

This is the first cat's-eye scapolite of this color that we have encountered. *RK*

Figure 16. The star in this approximately 12-ct sapphire was found to be produced by diffusion treatment when one leg was ground off in the course of recutting. Magnified 10×.

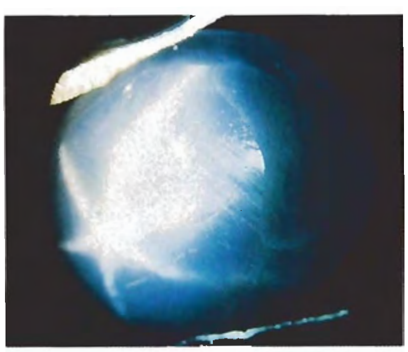
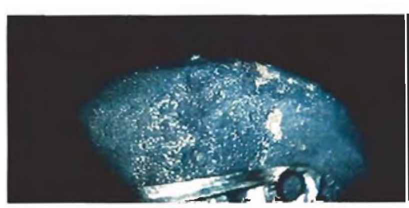


Figure 18. A dark green-brown cat's-eye scapolite, 52.92 ct.

TOPAZ Imitation

A beautiful pink cushion antique mixed-cut stone weighing more than 100 ct was submitted to the New York lab for identification. The refractive index of 1.63 and the general appearance suggested a fine pink topaz. A cursory glance under low magnification disclosed what appeared to be "fingerprint" inclusions (figure 19). However, the stone proved to be singly refractive and the "fingerprints" to be nothing more than veils of gas bubbles—in glass. *RC*

Figure 17. The melted base of the star sapphire shown in figure 16 provided further evidence that it had been diffusion treated. Magnified 10×.



ZIRCON, Cat's-eye

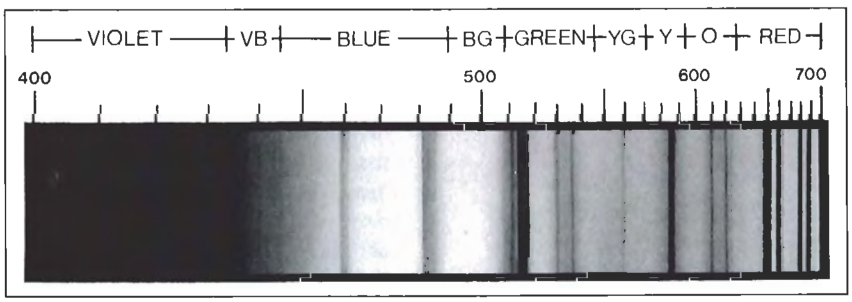
The Los Angeles laboratory recently identified three cat's-eye zircons ranging from 1.60 to 2.97 ct (see figure 20). These chatoyant zircons were different in both color and diaphaneity from two cat's-eye zircons recently reported in *Gems & Gemology:* a 3.43-ct translucent, heavily included grayish green oval cabochon (Winter 1983), and an 8.63-ct translucent brownish yellow oval cabochon (Summer 1984).

The three stones we examined were all translucent and were light gray, light orangy brown, and medium gray, respectively, in color. They were reportedly from Sri Lanka. These three chatoyant cabochons were readily identifiable as zircon by the presence of characteristic absorption spectra. Numerous bands and lines were observed throughout the visible-light spectrum of each stone. Figure 21 shows a

Figure 19. Gas bubbles appear in a "fingerprint" pattern in this glass imitation of topaz. Magnified 10×.

Figure 20. Three very translucent cat's-eye zircons that weigh 1.60, 2.28, and 2.97 ct, respectively.

Figure 21. Absorption pattern of cat's-eye zircon.



drawing of this image as observed through a hand-held spectroscope.

It should also be noted that two of the stones fluoresced a very weak dull orange to long-wave ultraviolet radiation while the third was inert (all were inert to short-wave ultraviolet radiation). With magnification, dense concentrations of parallel bands of small mineral flakes were evident throughout all three stones, with strong doubling visible. Cavities and fractures were observed on the base of all three stones; on one they were stained an intense orange, on another a large fracture was stained dark brown, and no stains were observed on the base of the third stone. *RK*

PHOTO CREDITS

Steve Hofer took the photos used in figures 1, 3–5, 10, and 13. Ricardo Cardenas supplied figures 2, 11, and 19. Shane McClure is responsible for figures 6, 7, 9, 12, 15, and 18. Figure 8 came from Tino Hammid. The X-radiograph in figure 14 was furnished by Bob Crowningshield, and Dave Hargett photographed the stone seen in figures 16 and 17. Figure 20 came from John Koivula, and the absorption pattern used for figure 21 is reprinted from the 11th edition of the Handbook of Gem Identification, *by R. T. Liddicoat, Jr.*

Editorial Forum

FOIL BACKING STILL A POPULAR TREATMENT

The Gem Trade Lab Notes section (Winter 1984, p. 228) reported on emerald imitations constructed from colorless rock crystal quartz and backed with green foil. This practice is common today, even in enamelled jewelry. Colorless beryl or corundum is often backed with red or green foil to imitate emerald or corundum. Silver foil is sometimes used with colorless synthetic or natural sapphire to enhance brilliance.

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Gem Identification Laboratory
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MINERALS OF THE TAAFFEITE GROUP

The recent paper by M. Gunawardene dealing with inclusions in taaffeites from Sri Lanka (*Gems & Gemology*, Vol. 20, 1984, pp. 159–163) included a minor, but nonetheless important, error in mineralogical nomenclature.

The original description of taaffeite from Sri Lanka (*Mineralogical Magazine*, Vol. 29, 1951, pp. 765–772) incorrectly reported its chemical composition to be $BeMgAl_4O_8$. However, more recent study of "taaffeites" from a number of localities by myself and several colleagues (see *Journal of Gemmology*, Vol. 18, 1983, pp. 623–634, for a summary of these investigations) has identified two distinct but chemically related mineral species—taaffeite ($BeMg_3Al_8O_{16}$) and musgravite ($BeMg_2Al_6O_{12}$)—in this group. Both minerals have a hexagonal unit cell and have similar structural and physical properties. To date, it is only with taaffeite that crystals of suitable size and quality for faceting are known. The crystals from different localities cited by Mr. Gunawardene in the introduction to his article are not all taaffeites; for example, all the material from Casey Bay, Antarctica, was determined to be musgravite. At present, no mineral or synthetic phase with the formula $BeMgAl_4O_8$ is known to exist.

Furthermore, the locality for the samples described by Kozhevnikov is incorrectly given as Ladoga Lake, whereas the correct locality is Eastern Siberia, USSR (*Doklady Akademii Nauk SSSR*, Earth Science Sections, Vol. 224, 1977, pp. 120–121).

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Institute of Mineralogy and Petrography
University of Heidelberg
West Germany

NATURAL FADING OF AMETHYST

In the Gem Trade Lab Notes section of the Spring 1985 issue, Bob Kane reported on the instability of some amethyst to sunlight as well as heat. Figure 1 shows the result of an informal experiment I recently conducted on a piece of amethyst I had purchased in Rio Grande do Sul, Brazil. In January 1982, I broke this piece in two and placed the left side in a dark closet and the right side outdoors. Almost three years later, in October 1984, I glued the two pieces back together again. As is evident from the photo, the exposed piece had faded dramatically. There was no change, however, in the clarity or luster of the exposed amethyst.

In my several years of experience as a dealer in amethyst from this locality, the greater part of this material will fade on prolonged and continuous exposure to sunlight. It should also be noted, however, that the change did require an unusual amount of time and degree of continuous exposure; when the two pieces were checked after six months, it was difficult to see any difference. Consequently, such fading would not be expected in amethyst jewelry under normal wearing conditions.

Rock H. Currier, G.G.
Jewel Tunnel Imports
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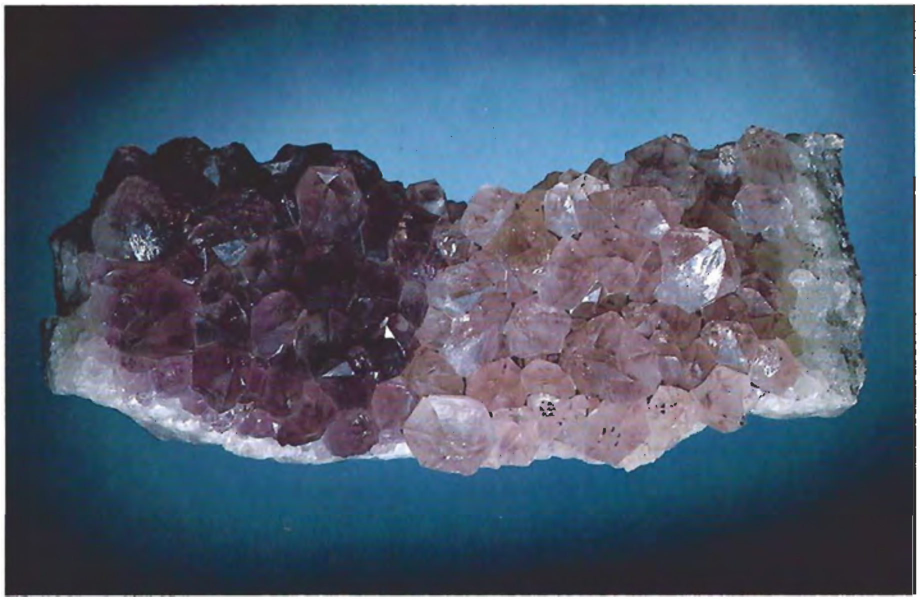

Figure 1. The left side of this 20-cm × 8-cm amethyst specimen from Rio Grande do Sul, Brazil was placed in a closet for almost three years, while the right side was left outdoors, exposed to daily sunlight. Photo © Harold & Erica Van Pelt.

UNUSUAL COLOR-CHANGE GARNET

At the recent Tucson Gem and Mineral Show, we encountered an unusual color-change garnet (figure 2). This particular color change, from yellow-green in fluorescent light to red-brown in incandescent light, is unlike any we have observed before.

The stone's refractive index (1.769) and spectrum (430-nm cutoff, and bands at 460, 480, and 500 nm) indicate that it is a member of the pyrope-spessartine garnets. This is consistent with the fact that all color-change gem garnets so far examined by us belong to this same compositional range. Chemical analysis, however, indicates that this stone is somewhat out of the ordinary, with negligible chromium, considerable vanadium, and more manganese (spessartine component) than is present in any pyrope-spessartine we had previously encountered. Also, the calcium (grossular) content

Figure 2. An unusual color-change pyrope-spessartine garnet (4.58 ct.; GIA catalogue no. 1/338) as seen in fluorescent (left) and incandescent (right) illumination. Our thanks go to Bill Marcue for the loan of this intriguing garnet. Photos © Tino Hammid.

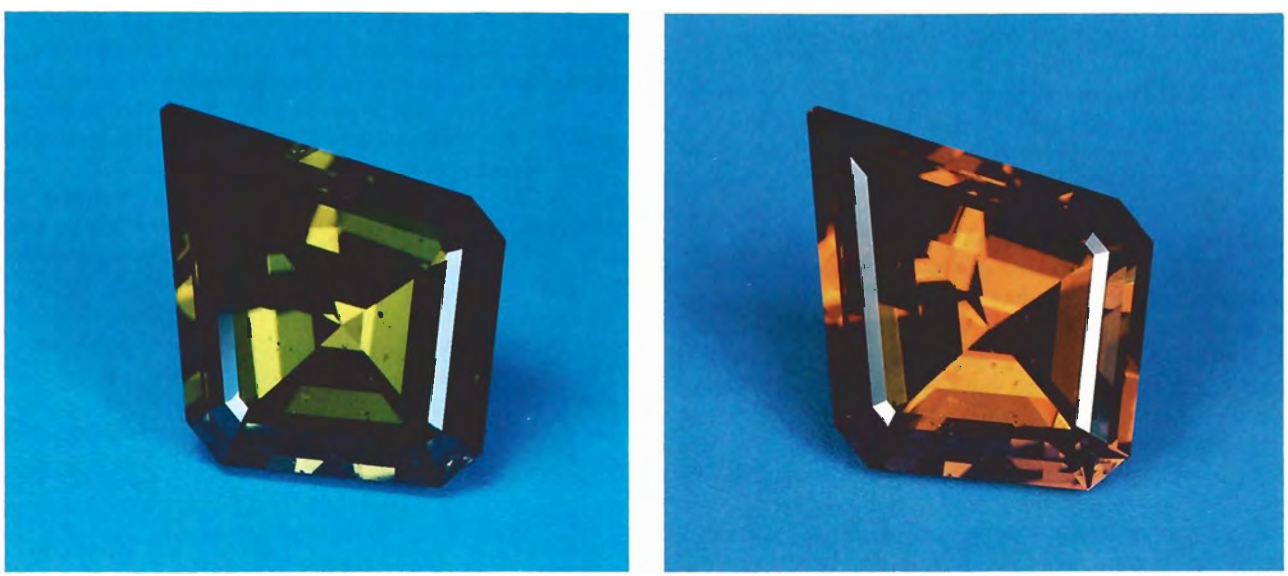

TABLE 1. Microprobe chemical analysis of an unusual color-change garnet.

Oxide	Weight %[a]	Principal end member	Weight %
SiO_2	39.5	Pyrope	24.2
TiO_2	0.3	Almandine	2.9
Al_2O_3	21.7	Spessartine	52.3
V_2O_3	0.3	Grossular	17.1
Cr_2O_3	—[b]	Andradite	0.6
MgO	7.3	Total	97.1
CaO	6.9		
MnO	22.9		
FeO	1.8		
Total	100.7		

[a]*These figures are averaged from two point analyses. Details of the analytical procedures are available upon request to the authors.*
[b]*Less than 0.1 wt.% present.*

is the second highest we have measured for any pyrope-spessartine garnet. Table 1 provides the results of the microprobe analyses and the conversion of oxides to end-member components.

While this garnet is undoubtedly a pyrope-spessartine, its high Mn content extends the chemical range of these relatively newly described garnets. In addition, the low level of chromium, the element that generally has been associated with the change-of-color phenomenon, indicates that vanadium can play a similar role in generating color change, particularly in association with a high manganese content in garnets.

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D. Vincent Manson, Ph.D.
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Errata

In the article "An Extraordinary Calcite Gemstone," in the Winter 1984 issue of *Gems & Gemology*, two corrections should be made on page 225: (1) the dispersion of diamond should, of course, be 0.044; (2) in the fifth line under "Concluding Thoughts," "almost" should read "most" (i.e., "Calcite is *most* commonly twinned on [01$\bar{1}$2]").

In the article "Sapphire from the Mercaderes-Rio Mayo Area, Cauca, Colombia," in the Spring 1985 issue, the authors wish to add *Smithsonian* magazine and the Los Angeles County Museum of Natural History to their acknowledgments for their partial support of the travel that contributed to this study.

GEM NEWS

John I. Koivula, *Editor*
Elise Misiorowski, *Contributing Editor*

DIAMONDS

Africa

Diamond find in Guinea. An exciting new diamond find has been made by Australia's Bridge Oil, one of the partners in the Aredor Diamond Project. The new deposit, which lies outside the main project area, contains six pipes and potentially rich alluvial diggings. Bridge Oil believes at this time that the kimberlite pipes and alluvials contain at least 2.5 million carats of diamonds.

The discovery site covers approximately 300 km^2. The only major investment in the exploitation of the area will be to build a road from the deposit to the ore-processing compound.

Ninety-five percent of the diamond output is expected to be gem quality, with the rough averaging 1–1.2 ct. Diamonds of 3 ct or more are expected to form one-third of the output. Production was scheduled to begin by April of this year. (*Diamant,* January 1985)

Kimberley diamonds dated. According to geochemist Stephen Richardson and his co-workers, the diamonds in Kimberley, South Africa, may be more than 3 billion years old. This is the first time that researchers have been able to scientifically date diamonds.

Hundreds of Kimberley diamonds were crushed to free small garnet inclusions trapped inside. The garnets, which formed at essentially the same time as their diamond hosts, contain trace quantities of radioactive samarium and rubidium and their decay products neodymium and strontium. Using the ratios of these radioisotopes and their corresponding half-lives, the scientists were able to calculate that the diamonds formed 3.1–3.5 billion years ago and were subsequently carried to the earth's surface by igneous eruptions that occurred millions of years later. (*De Belgische Diamantnijverheid,* December 1984)

Australia

Production at Argyle Mines declines. As anticipated, the carat yield of diamonds at Argyle Diamond Mines in Western Australia declined from 6.2 million carats in 1983 to 5.69 million carats in 1984. This is due to a depletion of the higher-grade alluvial material. The average yield for 1984 was 3.86 ct per ton, down from 5.81 ct per ton in 1983. (*Mining Journal,* April 1985)

Canada

Exploration scheduled in British Columbia. Diamond exploration of an area in British Columbia known to have two kimberlite pipes is planned by Dia Met Minerals. A core sample taken in 1982 of the larger pipe revealed a total of 60 diamond indicator minerals such as pyrope, ilmenite, and chromite. A 0.43-mm gem-quality diamond was also found on the site. (*Mining Journal,* March 1, 1985)

China

Diamonds discovered in China. A group of Australian gemologists who were allowed to explore mainland China have reported recent discoveries of "exceptionally beautiful" diamonds in that country. As a result, the government at Peking has decided to accelerate diamond-mining development. In view of these recent discoveries, and a few notable ones in the past, it is possible that significant diamond finds may be made in China. (*Gem and Jewellery Business Intelligence,* March 13, 1985)

United States

Diamond found in Alaska. A 1-mm octahedral crystal found in 1982 in a gold sluice box in the Circle District near Fairbanks, Alaska, was recently examined by a De Beers subsidiary and found to be diamond.

A team of geologists has since explored the area where the crystal was discovered and found chrome diopside, garnet, and magnetite, which are all associated with kimberlites. However, no other diamonds were found. The geologists believe that the diamond was transported a long distance from its geologic point of origin. (*National Jeweler,* February 16, 1985)

PRECIOUS METALS

Alluvial gold in India. Eight million cubic meters of gold-bearing alluvium estimated to contain approximately 3,000 kg of gold have been located by the Geological Survey of India in the Nilambur area of Kerala. The Kerala state government, with the assistance of United Nations experts, intends to set up a pilot mining operation to study the feasibility of mining this and other alluvial deposits. (*Mining Journal,* April 19, 1985)

Bacterial gold mining. Albert Bruynesteyn, of Burnaby, British Columbia, a research pioneer in the development of accelerated bacterial leaching of ore, has proposed a plan to rework abandoned gold mines by using bacteria to eat away the unwanted waste material and leave the gold behind.

Precious Metals Bioleaching reported at a recent Canadian Institute of Mining conference that they have found a way to accelerate the leaching process so that it proceeds thousands of times faster than it occurs in nature. The technique should be viable for commercial application within the next few years. (*The Daily Breeze,* November 18, 1984)

Bolivian placer gold. Cofadena, the armed forces development corporation of Bolivia, has recently announced that it will develop its placer gold deposits in the Kaka and Mapiri rivers, located approximately 150 km (93 mi.) north of La Paz. Cofadena plans to work the high terraces by using a washing plant first and then follow up by dredging the alluvial deposits. The Upper and Lower Mapiri will be worked first; the Upper Mapiri area is said to average over 0.2 g of gold per cubic yard. (*Mining Journal,* April 5, 1985)

Gold and silver exploration in Guatemala. The Guatemalan Ministry of Mines began a 32-hole exploratory drilling program in February 1985. The target area measures 1.3 km^2 and is situated near El Pato and Poxte in the Chiquimula area. Some surface trenching and tunneling is also planned. Early geologic samples taken from the area have graded between 8 and 25 g of gold, and 5 to 15 g of silver, per ton. (*Mining Journal,* March 15, 1985)

Saudi Arabian gold mining. Two more contracts, for water and electrical works, for the development of the Mahd Al-Dhahab Gold Mine have been awarded by Petromin of Jeddah. When operational in mid-1987, the gold mine, located 275 km (171 mi.) northeast of Jeddah, is expected to produce two to three tons of gold. (*Gem and Jewellery Business Intelligence,* February 20, 1985)

SYNTHETICS AND SIMULANTS

Method for coating with synthetic diamond. When microwaves irradiate a mixture of methane and hydrogen gases, tiny microscopic synthetic diamonds are produced. This treatment decomposes the gases to create a plasma of charged particles. Over a period of hours, the carbon from the methane combines to form tiny synthetic diamonds not more than 30 μm in diameter. The synthetic diamonds form on the surface of a support placed inside the microwave chamber. Researchers at the Hitachi Research Laboratory in Japan, who discovered the technique, see possible future applications for placing synthetic diamond coatings on silicon wafers for the integrated-circuit industry. Such coatings could be deposited on other surfaces as well. According to the scientists, the method is far from ready for industrial application. The ideal conditions in the microwave chamber for producing synthetic diamonds have yet to be discovered. Under some circumstances, graphite or some other form of elemental carbon may be formed and deposited instead of diamond. (*Science News,* January 26, 1985)

New man-made materials developed. Two materials originally developed for the laser industry are now being faceted and set in jewelry: Alexandrium and Laserblue. They are not classified as synthetics because they do not duplicate natural minerals. Alexandrium, so named because it exhibits a color change from lavender to light blue, is a lithium aluminum silicate. Its color change is due to the added rare earth metal, neodymium. It has an R.I. of 1.58 and a hardness of 6.5. Laserblue is a borosilicate with a large percentage of copper that gives it a vivid blue color. It has an R.I. of 1.52 and a hardness of 6.75. Both materials are amorphous, singly refractive, and sensitive to heat, which causes them to lose color and crack; they are also attacked by acids. (*Jewellery World,* April 1985)

Plastic scrimshaw. Opaque white polymer plastics formed in the shapes of whale teeth and bones are being used as substitutes for the true whale bones and teeth traditionally used for the American art form known as scrimshaw. The carving on some of these imitations is excellent, and many are weighted with lead to give them a more realistic heft. If you intend to purchase scrimshaw, be sure to check the item closely under magnification for the typical structures associated with the natural materials (*Connoisseur,* March 1985)

ANNOUNCEMENTS

Hong Kong Jewelry & Watch Fair. The 1985 fair has been scheduled for September 10–13, 1985. Three venues—the Regent Hotel, the New World Hotel, and the Golden Mile Holiday Inn—will highlight every major line of the jewelry, watch and clock, and gemstone industry. For details, please contact the organizer: Headway Trade Fairs Ltd., 628 Star House, 3 Salisbury Road, Kowloon, Hong Kong.

A European conference on precious stones has been scheduled for October 18–21, 1985, in Antwerp, Belgium. Organized by the Coloured Gemstones Federation and the Diamond High Council in agreement with the Antwerp Chamber of Commerce, the conference will offer lectures and seminars under two headings: "Geology and Gemmology of Precious Stones" and "Economy of Precious Stones." Experts in these fields interested in speaking are encouraged to apply to the Diamond High Council, Public Relations, Miss M. Moll, de Kayserlei 58-60, B-2018 Antwerp, Belgium.

At the request of the gem trade, the date of **Munich's INHORGENTA 86**—the 13th International Trade Fair for Watches, Clocks, Jewellery, Precious Stones and Silverware, and their Manufacturing Equipment, has been postponed and definitely fixed for February 7–11, 1986.

Diamond bourse in Singapore. As of January 1, 1985, the Diamond Importers Association of Singapore (D.I.A.S.) became the Diamond Exchange of Singapore (D.E.S.), the first diamond-trading center in Asia. D.E.S. is a member of the World Federation of Diamond Bourses and is determined to act as a self-regulating authority to maintain high standards in the diamond trade. All existing members of D.I.A.S. are automatically members of D.E.S. The exchange is located at 545 Orchard Road #05-06, Far East Shopping Center, Singapore 0923. Telephone: 2354326.

Schuetz design winners announced. GIA's Jewelry Manufacturing Arts Department, which each year administers the George A. Schuetz Memorial Fund Jewelry Design Contest, has announced the winners of the 1985 competition. First prize has been awarded to Judy Evans of Minneapolis, Minnesota, whose

Figure 1. Judy Evans won first place in the 1985 Schuetz Jewelry Design Contest for this rendering of a platinum-and-gold man's ring.

rendering of a platinum and 18K gold man's ring earned her a $500 scholarship award. The ring, as designed, is set with two sapphire cabochons and one round-brilliant diamond.

Second place went to Victoria Jirikow of Playa del Rey, California. She was awarded a $300 scholarship for her design of a platinum man's ring with black onyx insets. Silvia Pompeo of Rome, Italy, garnered third place (a $200 scholarship) for her design of a platinum pocket watch (with chain), inset with burnished iron and diamonds.

The Schuetz contest, established in the memory of George A. Schuetz, Sr., longtime president of Larter and Sons, an East Coast jewelry manufacturing company, is for the design of men's jewelry only. The scholarships may be applied to jewelry-related training at any institution of the winners' choosing. The deadline for next year's Schuetz Contest is late February, 1986. Detailed information on contest rules will be available this fall from GIA's Jewelry Manufacturing Arts Department.

L. A. County Museum of Natural History unveils a new gemstone gallery. May 3 marked the opening of the Deutsch Gallery at the Los Angeles County Museum of Natural History.

The new permanent gallery, titled "Gemstones and Their Origins," explains how gem materials are formed, mined, and shaped into sparkling jewels. The graphically exciting exhibit contains colorful maps, rough-and-cut gems, a 400-lb. amethyst geode, and touchable turquoise and jade specimens. Visitors also have the opportunity to view the miniature world of gemstone inclusions as seen with a microscope video system. For more information about the gallery, call (213) 744-3411.

GEMOLOGICAL ABSTRACTS

Dona M. Dirlam, Editor

COLORED STONES AND ORGANIC MATERIALS

Alexandrite-chrysoberyl from Zimbabwe. G. Brown and S. M. B. Kelly, *Australian Gemmologist*, Vol. 15, No. 8, 1984, pp. 275–278.

The results of the examination of one crystal cluster and one poorly faceted specimen of alexandrite chrysoberyl from the Fort Victoria district of Zimbabwe are summarized in this Australian Gemmology Study Club report. The authors speculate that the material could have come from the Novello alexandrite deposit, located 18 km northwest of the town of Fort Victoria, and provide a summary description of the deposit. Gemological properties of the faceted specimen were determined to be as follows: color—dark green (daylight), dark red (incandescent light); Mohs hardness—8 to 9; cleavage—none detected; fracture—conchoidal; S.G.—3.8; R.I.—α = 1.749, β = 1.752, γ = 1.758; birefringence—0.009; optic character—B+; luster—vitreous; diaphaneity—transparent to translucent; pleochroism—apricot, yellowish green and blue-green; Chelsea filter reaction—bright red; UV fluorescence—LW red, SW inert; absorption spectrum—Cr lines at 680, 665, 655, 650 nm; phenomenon—alexandrite effect of moderate intensity. Magnification revealed strong, straight-line color zoning (banding?) in blue, yellow, and red hues. Some of the inclusions observed are randomly oriented syngenetic two-phase inclusions in feather- or veil-like patterns, two-phase dagger-like inclusions and two-phase tubular inclusions oriented parallel to the c-axis, and irregular masses of iridescent flakes (possibly phlogopite mica).

The six illustrations that accompany this report include five photomicrographs. *RCK*

This section is designed to provide as complete a record as possible of the recent literature on gems and gemology. Articles are selected for abstracting solely at the discretion of the section editor and her reviewers, and space limitations may require that we include only those articles that will be of greatest interest to our readership.

Inquiries for reprints of articles abstracted must be addressed to the author or publisher of the original material.

The reviewer of each article is identified by his or her initials at the end of each abstract. Guest reviewers are identified by their full names.

Australia's first emeralds. G. Brown, *Journal of Gemmology*, Vol. 19, No. 4, 1984, pp. 320–335.

Finally, a gemological study has been produced on the historically important Emerald Mine of Australia. In 1890, an amateur mineralogist discovered beryls of sufficient color to be called emeralds. This emerald-bearing lode in northern New South Wales is reportedly a quartz-topaz-feldspar-mica "pegmatite" in which the emeralds occur as "bunches" firmly embedded in flattened cavities. On the basis of spectrographic analyses performed in 1971 on an unreported number of samples, Brown attributes the color of this material to the 1,000 ppm of vanadium, and possibly also to the 450 ppm of copper, present. A chromium content of 350 ppm is, at one point in the article, denied a role in the color of these emeralds while, in the conclusion, is acknowledged as a "possible chromophore." No iron was detected. No explanation is provided for these conclusions about the causes of color in these emeralds, which is especially surprising in light of the unusually significant role attributed here to copper.

Average gemological properties are reported for these emeralds, which do not depart in any way from the usual properties for emeralds, unless the absence of chromium lines is considered significant. Nonetheless, Brown concludes that "to classify this beryl as an emerald would seem correct; in spite of its 350 ppm chromium content." This is considered low for emerald and, in fact, for proponents of the chromium-based definition of emerald, would disqualify it as an emerald altogether. Brown, however, provides no comment on his potentially controversial conclusion.

The summary of the history of this emerald locality and the descriptions of inclusions are interesting and informative. The discussion of color and chemistry, however, is somewhat confusing. While the author promises "ultimate confirmation by subsequent analytical results," it is unfortunate that more precise spectral and chemical data were not included at this time. On the other hand, the article is exceptionally well illustrated, with photomicrographs of inclusions and photos of the locality itself. *Philip G. Yurkiewicz/CMS*

Chromdravite—a new mineral from Karelia. Y. V. Rumyantseva, *International Geology Review,* Vol. 25, No. 8, 1983, pp. 989–992.

A tourmaline recently found in the Onezhskiy Depression, Central Karelia, USSR, represents a new species in the tourmaline group and has been named chromdravite. It occurs in micaceous, metasomatic clay-carbonate rocks in association with quartz, dolomite, and several micas. Here it forms small needles or pyramidal crystals up to 0.1 mm that are dark green to nearly black. These crystals are uniaxial negative, pleochroic, and have measured refractive indices of $\epsilon=1.722$ (5) (yellow green) and $\omega=1.778$ (5) (dark green). The measured density is 3.40 (1) g/cm^3. The absorption spectrum is characterized by a band centered at 600 nm. Computer refinement of the X-ray diffraction data yielded the following unit-cell dimensions: a=16.11, c =7.27 Å. The crystals contain the highest known chromium content of any tourmaline: up to 31.6 wt % Cr_2O_3, or 78 mole % of the theoretical chromdravite end member whose ideal chemical formula is $NaMg_3Cr_6(BO_3)_3Si_6O_{18}(OH)_4$ (with 40.79 wt.% Cr_2O_3). Tourmalines with even greater chromium content would have higher refractive indices and densities. The article gives no indication that any of this material has yet been encountered in jewelry or has been found in crystals large enough for faceting. *JES*

Chromium-bearing kyanite from Mozambique. A. M. R. Neiva, *Mineralogical Magazine,* Vol. 48, 1984, pp. 563–564.

A chromium-bearing kyanite occurs as blue crystals in a pegmatite at Serra do Menucué in Mozambique. These crystals can reach 30 × 5 × 3 mm in size, and are found associated with muscovite, biotite, and andesine. The mineral has refractive indices of $\alpha=1.720$, $\beta=1.730$, $\gamma=1.753$ (±0.002). Its specific gravity is 3.70. In microscope thin section, it is pleochroic from light blue to colorless and is observed to contain numerous inclusions of rutile. Unit-cell dimensions of the kyanite are also given. The physical properties and unit-cell dimensions of the crystals from Menucué differ slightly from those of other kyanites due to their unusual chemical composition. Chemical analysis shows the blue kyanite to contain Cr, Ti, and Fe as important minor constituents, and also trace amounts of V, Ba, Pb, Ge, Ga, Zr, Zn, and Sc. There is some uncertainty as to the cause of the blue color in kyanite, but in this instance the color is attributed to the presence of Ti. No indication is given of the amount of this blue kyanite available or whether it is of faceting quality. *JES*

Coesite and pure pyrope in high-grade blueschists of the Western Alps: a first record and some consequences. C. Chopin, *Contributions to Mineralogy and Petrology,* Vol. 86, No. 1, 1984, pp. 107–118.

In the Western Alps of northern Italy, an unusual geologic assemblage has yielded a mineral previously known only in synthetic form: virtually pure pyrope garnet. The colorless material occurs in crystals up to 25 mm in diameter that are largely fragmentary and are composed of 90%–98% of the pyrope end member ($Mg_3Al_2Si_3O_{12}$), the remainder being almandine and some grossular. The larger crystals contain lesser amounts of pyrope. Previous to this discovery, pyropes barely exceeded 80% of the Mg end member and invariably included significant amounts of chromium, which acted as a coloring agent. The nearly pure pyropes reported in this article contain no detectable chromium and, in the absence of any other chromogens, are colorless.

The article describes in depth the geologic occurrence of these new garnets, as well as their inclusions, which consist mainly of kyanite, rutile, and coesite that has partially altered to quartz. Chemical analyses of the garnets and the components of their matrix are reported, and phase relations are discussed in order to deduce the petrogenesis of this unusual mineral assemblage.

Other than information on inclusions and chemical composition, no data of use to the gemologist for identification of this new type of garnet are included in the article. As yet, this material has not been found in sizes that would cut as gems, and the locality is extremely difficult to reach. However, gem crystals may yet be located, so the gemologist should be aware that such material exists. Samples of this pyrope have been distributed to scientists worldwide, so more data will undoubtedly appear soon in the mineralogic and gemological literature. *CMS*

Ein neuer Edelstein aus der Feldspat-Familie (A new gemstone from the feldspar group). C. R. Bridges, G. Graziani, and E. Gübelin, *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* Vol. 33, No. 3/4, 1984, pp. 104–113.

East Africa, particularly Kenya and Tanzania, is a leading source for many fine and rare gemstones today. The authors describe a new gem feldspar, of light green to light blue color, from Kioo Hill in Kenya. The chemical analysis of the new feldspar shows it to be a low temperature albite with peristerite structure. The physical data include refractive indices of α=1.535 ±0.002; γ=1.539 ± 0.004, with a birefringence of 0.008; 2V=90°. These data confirm that the new find is of the albite end of the mixed crystal series. The pegmatite also contains blue disthene (kyanite), quartz, tourmaline (schorl), and vermiculite (a dark mica) in addition to the gem feldspar. *MG*

Estudio colorimétrico de las variedades verdes del berilo—esmeralda (Colorimetric study of the green varieties of beryl—emerald). R. Möller Durán, *Gemología,* Vol. 17, No. 55–56, 1982, pp. 3–56; Vol. 18, No. 57–58, 1983, pp. 3–53; Vol. 19, No. 59–60, 1983, pp. 5–38.

The author addresses emerald far more comprehensively than the title would suggest. He surveys the lore, etymology, geology, and lapidary of the stone, as well as its gemology. There are detailed discussions of light and color theory, color perception, and optical physiology.

To establish criteria for the color-quality grading of emeralds, Mr. Durán examined 342 available crystal specimens from sources around the world. He selected 43 to become models for master stones. These were cut—wherever possible, parallel to the c-axis—into 1-mm-thick laminae of parallel faces. Physical and optical properties were recorded, and inclusions were studied and reported in detail. The color coordinates were determined by spectral analysis, and chemical analysis was done by electron microprobe.

Conclusions are drawn with respect to color as a function of chemical composition and color as a function of thickness. For applied gemology (the certification of stones), Mr. Durán considers it important to place the hue into one of five quality levels, and to state the tone, hue, and saturation for the entire range of "greens" that beryl offers.

The article is replete with tables, diagrams, and drawings that relate the various properties under study to countries and mines of origin. *SLD*

Harts Range sunstone. G. Brown and H. Bracewell, *Australian Gemmologist,* Vol. 15, No. 8, 1984, pp. 263–274, 278.

This article reports on an investigation of "sunstone" feldspar from the Harts Range of the Northern Territory, Australia. Examination of this material yielded the following description of its macroscopic appearance: whitish to pale pink to deep reddish brown color, often modified by pearly subsurface lusters; no striations on major cleavage faces; aventurescent interference colors often observed being reflected from included metallic platelets. Examination of this feldspar with a microscope revealed inclusions of thin, reddish brown, translucent platelets, predominantly hexagonal and oriented in two planes at right angles to one another; cleavages, both incipient and healed, at approximately 90° to one another; partly healed internal fractures; two-phase negative crystals; and opaque, greenish brown crystals. Gemological properties include: hardness—6 to 6½; uneven fracture; S.G.—2.57; diaphaneity—translucent; luster—vitreous to pearly; R.I.—α=1.520, β=1.525, γ=1.527, spot reading = 1.52; birefringence—.007; optic character—B−; pleochroism—indistinct; no UV fluorescence or diagnostic absorption spectrum. Additional chemical and optical tests were performed in order to conclusively identify the type of feldspar involved. The authors conclude that this material is an untwinned aventurine microcline-microperthite feldspar.

The authors also address the often contradictory terminology used in characterizing sunstone and/or aventurine feldspars. Numerous excerpts from the gemological literature illustrate this point. Out of this discussion emerges the conclusion that the Harts Range material should be called aventurine feldspar, not sunstone. This is an important, well-illustrated article on the subject of phenomenal feldspars. *RCK*

In the land of the cultured pearl. E. Blauer, *Modern Jeweler,* Vol. 83, No. 9, 1984, pp. 43–50.

The author bases her article on her trip to Japan, the heart of the cultured pearl industry, where she visited numerous pearl farmers, processors, exporters, and jewelry designers. Blauer expands on some of her observations, most of which cover the culturing and processing of the round, or mother-of-pearl induced, cultured pearls which are all saltwater products. The correct water temperature and food supply support the cultivation of the Akoya mollusk, which is gathered for the nucleation process at the age of three years. Both before and after the mollusks are nucleated, their mortality rate is a constant concern; many die from such health hazards as parasites, seaweed entanglement, red tide, or even an abrupt change in water temperature. The pearls are rarely left in the mollusk through a third year because every year brings the risk of something killing the mollusk. Many of them are harvested within their first year of cultivation. Once the pearls are removed from the mollusk they are sorted, drilled, matched, processed, and strung. The processing generally consists of chemically treating the pearl to bleach, change, enhance, or stabilize the color.

There was an estimated 15%–20% price increase on pearl exports from Japan in 1984. Reportedly, however, not all of the exported pearls, specifically the freshwaters, were Japanese products. Many freshwater pearls are cultivated in China, pass through Japan where they are inspected, and leave bearing a tag stating that they are a "product of Japan." The Chinese product seems to be getting increasingly finer, since they are no longer easily distinguishable from the Japanese Biwas. Culturing activities in Japan, however, remain stronger than ever.

The author wound up her trip with visits to several jewelry showrooms where she viewed the Japanese concept of combining their pearls with metals to create some exquisite and sometimes prize-winning pieces of jewelry. *Mary Hanns*

Schleifwürdige blaue und grüne Berylle (Aquamarine und Smaragde) aus Nigeria (Gem-quality blue and green beryls (aquamarine and emerald) from Nigeria). Th. Lind, K. Schmetzer, and H. Bank, *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* Vol. 33, No. 3/4, 1984, pp. 128–138.

Since early 1984, the authors have examined a number of blue and green beryls that are reported to be from a new occurrence. Inquiry into their origin led the authors to study in detail the occurrence, chemistry, physical properties, and microscopy of these beryls. The samples used ranged from intense blue or green to near colorless. The material is said to be of Nigerian origin, from the mining area near Jos. The colors are attributed to the varying concentrations of V, Cr, and Fe. The intense blue beryls contain significant Fe, while the green samples contain higher percentages of Cr and V. The refractive indices were determined as ω=1.570–1.574 and ϵ=1.564–1.568; specific gravity was found to be 2.66–2.68 g/cm^3. Spectroscopy revealed absorption curves typical of aquamarine (colored by Fe) and emerald (colored by Cr and V). Microscopic study of the new beryls from Nigeria revealed color zoning in many samples. Two types of two-phase inclusions were recognized: irregular "feathers" that occur mostly in the central portions of the crystals, and zig-zag cavities parallel to the prism faces of the crystal. *MG*

DIAMONDS

Genesis of diamond: a mantle saga. H. O. A. Meyer, *American Mineralogist,* Vol. 70, No. 3/4, 1985, pp. 344–355.

This article presents a model for the genesis of natural diamond based on the physical, chemical, and mineralogical properties of diamond. Optical studies suggest that individual diamond crystals have had a complex growth history in which growth may not always have been continuous. Evidence for the environment of diamond formation comes from chemical data on both trace elements and isotopes in diamonds as well as from examination of mineral inclusions. These data suggest that diamonds form at depths of approximately 180 km at temperatures from 900°–1300°C and pressures of 45–65 kbar. The data also reveal that the carbon present in diamond came from sources of differing isotopic composition. This variation in isotope content may have been produced by the inhomogeneity of carbon in the mantle, by the presence of recycled carbon brought in by subducted crystal rocks, or both. Diamond crystallization took place in any mantle material in which chemical interactions produced elemental carbon. Genetically related host rocks of diamond in the mantle can be broadly grouped into eclogitic and ultramafic (peridotitic) categories. It is likely that most diamonds formed in the Archean or Proterozoic Eras. Although diamond is commonly found in kimberlite and in lamproite at the earth's surface, these two rock types are not genetically related to diamond formation. Rather, they are the transport vehicles that brought diamond rapidly from mantle depths to the crust.

This is an article that all gemologists interested in diamond formation will want to read. *JES*

Indian kimberlites and the genesis of kimberlites. E. A. K. Middlemost and D. K. Paul, *Chemical Geology,* Vol. 47, 1984/85, pp. 249–260.

Kimberlites of Late Proterozoic age occur in both southern and central India. Those in the central region, near the town of Majhgawan, are the only ones being mined for diamonds at the present time. This article presents new chemical and mineralogic data on the constituent minerals in the kimberlites from both regions. These data and other studies indicate that there are many similarities in petrography and geochemistry between the Indian kimberlites and those of both southern Africa and Yakutia, USSR. Details of the mineralogy of the Indian kimberlites are described. The authors propose that a typical Indian kimberlite is the product of the mechanical mixing of a number of batches of kimberlitic magma.

Such magmas are thought to have originated from depths of 110 to 260 km. During their movement to the surface, they reacted and equilibrated with mineral phases in the upper mantle to produce their distinct mineralogic and geochemical features. Ideas on the petrogenesis of the kimberlite pipes in India are summarized. *JES*

The razzle-dazzle diamond market. G. Y. Dryansky. *Town & Country,* Vol. 139, No. 5059, 1985, pp. 127–128.

As a segment of a larger article entitled "Europe's Colorful Crossroads: the Special Delights and Discoveries of Belgium and Holland," this serves as a general overview of the diamond industry in Antwerp and Amsterdam. It reads like the script for a tour guide, with a bit of history, a bit of business, and a few insiders' insights into the diamond trade to pique the interest of the general public. The author may be excused the few inaccuracies that exist in this segment (example: GIA hasn't had a Diamond Grading Laboratory in Santa Monica since 1982) as, overall, the piece is meant simply to titillate the reader by giving him basic insight into the workings of a complex and highly specialized industry. *EBM*

Solid grounds for higher output. J. Roux, *Jewellery News Asia,* No. 9, 1985, pp. 30–31, 34–35.

As the retired manager of technical information for De Beers Central Selling Organization, author Johnny Roux uses his expertise and insight to interpret annual diamond production figures. Roux discusses, outlines, and then summarizes the world production of diamonds, bringing to light particular aspects that help give more meaning to the mass of figures put out by the U.S. Bureau of Mines and the *British Mining Annual Review.* He points out that while overall figures show an increase of 10 million ct in 1983 over 1982 figures, many prominent mines had a decrease in production. The four Kimberley mines alone (De Beers, Dutoitspan, Bultfontein, and Wesselton) decreased by approximately 118,000 ct in 1983. On the other hand, changes in the crushing circuits at the Premier mine have increased its production by some 184,400 ct. Roux points out that De Beers's careful production regulation is "part of a plan to maintain the smooth flow of rough diamonds from which the clients of the CSO can produce saleable polished."

Roux also examines diamond production in other African republics, and then moves on to Australia, with the "expected" increase from 557,000 ct in 1982 to 6.2 million ct in 1983 mainly due to Argyle production. He also reviews the production in South America and Asia, as well as in the Communist Bloc (as with the USSR estimated by the U.S. Bureau of Mines to be producing approximately 11 million ct a year).

Danusia Niklewicz

Working of diamond with metal. A. P. Grigoriev and V. V. Kovalsky, *Indiaqua,* Vol. 39, No. 3, 1984, pp. 47–54.

Ten years ago the authors discovered a method by which diamond can be worked using metal foil heated in a hydrogen atmosphere at atmospheric pressures. They describe the process as rather simple: a piece of iron or nickel foil dissolves the diamond carbon at the point of contact. The carbon atoms diffuse through the foil, react with the adjacent hydrogen, and are removed as methane. Thus, the foil sinks uniformly into the diamond to form a smooth-walled hollow that corresponds to the shape of the foil. The temperatures required are 600° to 1200°C (well below the temperature at which graphitization begins).

Using this "thermo-chemical" technique, diamonds can be worked without regard to hardness directions at speeds that closely approximate those of mechanical methods in the softer directions. Many interesting applications, both gemological and industrial, are suggested. Macles (twin crystals) that previously would have been left for industrial uses can easily be shaped thermo-chemically into gems. For industry, unusual products such as diamond gears and diamonds with precise figure-shaped holes, previously unobtainable, are now possible. The renowned "Russian operation" for eye surgery is now performed using a thermo-chemically sharpened diamond knife.

Although the article contains ample illustrations of the technique's capabilities, too little is said of the thermo-chemical technique's current impact on the diamond industry. *Dave Thomas*

GEM LOCALITIES

The mystique of place: the battle over gemstone origin. D. Federman, *Modern Jeweler,* Vol. 84, No. 3,1985, pp. 22–28.

Taking a comprehensive approach, David Federman reviews today's attitudes toward the ongoing controversy about gemstone origin. In the past, naming the origin of a gemstone was relatively simple because there were so few major gemstone localities and their color differences were very distinct. Today, treatment to change or enhance color has made this task much more difficult. Concentrating on emerald, ruby, and sapphire, noted members of the trade discuss both sides of the issue by examining the real value of a locality designation, and whether or not it is too specialized a service for most dealers to perform. Most of the panel believed that these questions are very important to the trade. In fact, so few people have the experience necessary to accurately pinpoint a gemstone's origin that it might be recommended that jewelers "abandon selling on the basis of origin and sell geared to color pure and simple." But this has its drawbacks as well. To deny a ruby its justified "Burma" designation could ruin its romance and mystery, thus reducing sales appeal. Then again, to call a Sri Lanka sapphire "Kashmir" because heat treatment has produced the "Kashmir" appearance would also be wrong.

While the article gives no answers to the controversy, it does bring to light the dilemma faced by dealers and appraisers. Awareness of the various approaches taken by prominent people in the trade may make future decisions on this matter easier. *Danusia Niklewicz*

The rare-earth element abundance in the sedimentary gem deposits of Sri Lanka. M. S. Rupasinghe and C. B. Dissanayake, *Lithos*, Vol. 17, 1984, pp. 329–342.

The gem deposits of Sri Lanka are a well-known source for a wide variety of gemstones, including corundum and spinel. These gemstones are found with various heavy minerals in placer deposits in sedimentary gravels derived from the erosion of underlying crystalline metamorphic and igneous rocks. Until recently, however, there has been limited geologic study of the origin of the gem-bearing sediments in this part of the world.

The study described in this article represents one of the first geochemical investigations of the rare-earth elements in the gem-bearing sediments in Sri Lanka. The rare-earth elements—those lying between lanthanum (La) and lutetium (Lu) in the periodic table—are found as widespread minor or trace constituents in the rocks of the earth's crust and can occur in greater amounts in such minerals as monazite and zircon. Because of their distinct geochemical behavior, careful investigation of the relative distribution of these elements has led to a better understanding of many igneous and metamorphic geologic processes. The present study was undertaken to learn more about the origins of the gem minerals in the placer deposits of Sri Lanka.

Analysis of sediment samples from the Ratnapura and Elahera gem fields showed that the sediments are highly enriched in rare-earth elements relative to known rock standards. There is also a marked similarity in the distribution patterns of the rare-earth elements for the sediments and for charnockites (pyroxene-bearing granitic rocks) that are found in the same area. From these results and a knowledge of the general geology of the gem fields, it appears that the rare-earth elements in the sediments were derived from a magmatic charnockite-granite source that is prevalent in the areas of Sri Lanka where gemstones are found. This result lends support to the hypothesis that formation of the charnockites may have been related to the formation of some of the gem minerals in this region. *JES*

INSTRUMENTS AND TECHNIQUES

The Alpha-test gemstone identifier—a test report. P. Read, *Journal of Gemmology*, Vol. 19, No. 3, 1984, pp. 261–265.

The Alpha-test uses thermal conductivity not only to separate diamond from its simulants, but also to distinguish between other gemstones. When a heated probe tip is applied to the surface of a stone, a reading is seen on the instrument's digital display. The reading represents the amount of time taken for the probe tip to fall from one predetermined temperature to another. The faster the temperature falls, the smaller the reading, and the more rapidly the stone conducts heat away from the probe tip.

Numerous comparisons are made between the Alpha-test unit and the Gemtek Gemmologist (reviewed by Read in a previous article, "The Gemtek Gemmologist—a test report," *Journal of Gemmology*, Vol. 18, No. 7, 1983, pp. 643–650). A number of environmental restrictions and conditions are given for both units.

The test results indicated that, with care, positive separations could be made between diamond and its simulants; between ruby and garnet; among aquamarine, spinel, and topaz; between sapphire and tourmaline; and between natural and some flux-grown synthetic emeralds.

A photograph of the unit and a table showing the test results accompany the article.

Douglas E. Kennedy

Color grading systems revisited. C. Kremkow, *Goldsmith*, Vol. 165, No. 8, 1984, pp. 28, 30, 66–67.

In September 1983, the Accredited Gemologists Association (AGA) sponsored a Color Grading Test among four color-grading systems on the market: GIA's Colored Stone Grading System, Cap Beesley's Color/Scan, California Gemological Laboratories' Gem Color Guide, and Howard Rubin's Gem Dialogue. The purpose of the test was to compare the four systems and rate their effectiveness in accurately and consistently describing color.

As reported in other publications, AGA ultimately chose GIA's Color Grading System and Cap Beesley's Color/Scan as the two most "practical" systems because they presented what the judging team called "total visual communication." The outcome of the test has been highly criticized, mostly because of the way the gathered data were analyzed and interpreted. The test information was ultimately passed on to a color scientist from the Appearances Committee of the American Society for Testing and Materials who will translate the data into a three-dimensional international visual color communication language (CIELAB).

General trade feelings on choosing a single system and language are variable. Some feel that all of the systems have their merits; others disregard the concept of grading colored stones altogether. Apparently the AGA test made many gemologists wary of choosing any system, and some think that many people will wait until one system gains industry acceptance before using any of them. *Mary Hanns*

LED there be light. P. Read, *Canadian Jeweller*, Vol. 105, No. 7, 1984, p. 16.

After reporting on the history and use of yellow light-emitting diodes (LEDs) as a refractometer light source, Read briefly describes two units presently available.

The author found that in comparison to a sodium light source, an LED unit is less expensive and produces a cooler light that does not require as much warm-up time to reach full intensity. Unfortunately, the non-monochromatic LED source does not produce as sharp and clearly defined a refractometer reading as the monochromatic sodium light does.

In comparison to an interference-type filter with a high-intensity white light source, the LED unit produces a cooler light. Although neither source is truly monochromatic, the LED's refractometer reading is still not as sharply defined. Because very sharp refractometer readings are frequently needed, it is surprising that the author did not explore the limitations of the less-sharp LED readings.

The article ends with brief descriptions of the Eickhorst GemLED Refractometer and the Rayner LED Refractometer, accompanied by a photograph of the latter and a circuit diagram of its light source.

Douglas E. Kennedy

JEWELRY ARTS

Jade carving in two cities. S. Markbreiter, *Arts of Asia*, Vol. 15, No. 1, 1985, pp. 63–73.

During the past 10 years, modernization of carving techniques and new sources of jade have altered the jade carving industry in China. In 1984, the author visited two jade carving factories in Taipei and Canton; he reports here on his observations.

The Con Da Enterprise factory in Lu Chou, Taipei, is very small and employs only eight people. These carvers primarily use white Korean nephrite and some Canadian green nephrite to produce their solid carvings. Their highly mechanized cutting and carving processes are revealed in detail, along with some interesting information on how they obtain rough jade for carvings.

In contrast, Southern Jade Craft factory in Canton employs 700 workers, 500 of whom are carvers. Although a portion of the factory (that was not open to the author) does produce "largely unoriginal and highly commercial" cut jade for jewelry, the craftsmen demonstrate their skill and originality through carvings made from serpentine. The factory produces intricate openwork; several concentric pierced balls that rotate within one another can be carved from a single block of stone. Such work demonstrates a precision of craft that is somewhat unexpected from such mass production.

The article is accompanied by many photographs of jade carvings in an attempt to help the reader distinguish new commercial copies from old, traditionally crafted pieces. The author does warn, however, that these photos and descriptions are to serve as guides only, and that prolonged personal exposure to Oriental carvings is necessary in order "to arrive at sensible conclusions." *SAT*

Up to snuff. I. McNicholl, *Arts & Antiques*, November, 1984, pp. 70–73.

Along with the extensive art collection he inherited from his father in 1947, Baron Hans Heinrich Thyssen-Bornemisza also inherited a passion for collecting that has spurred him to amass one of the greatest private art collections in the world. Among his many treasures are a variety of 18th-century jeweled snuffboxes, seven of which are described and illustrated in this article. Beautifully fashioned of gold with inlaid gems and enameling, the boxes are, in the baron's words, "masterpieces of the craftsman's art." *EBM*

RETAILING

Smash, grab and runs: the 3-minute burglaries. L. Martin, *Modern Jeweler*, Vol. 84, No. 2, 1985, pp. 60–63.

Thousands of dollars of jewelry can be stolen in just 60 seconds. Smash-grab-and-run burglars beat even sophisticated alarms and vibration detection devices, and flee the scene before police can arrive. Jewelers Mutual Insurance Company reports a drastic reduction in such claims since 1980, when they first required their jewelers to install devices to prevent break-ins. "Those committing smash-grab-and-runs are not skilled burglars. They are often young punks. If you put up a barrier against them, you can stop them," explains Jed Block, communications director for Jewelers Mutual.

Iron gratings installed *inside* the windows and doors are highly recommended because the barrier allows the police more time to respond to the window alarm while the thieves try to break in. The gratings can be decorative and are relatively inexpensive compared to the cost of stolen merchandise. Also recommended are burglar-resistant glazing, bullet-proof glass, sliding security grills, and simply locking *all* valuable merchandise in a vault every night. Names and addresses of some companies that manufacture and install these protection devices are included in the article.

Daytime grab-and-runs can be prevented by installing a door chime, dispersing valuable pieces throughout the store, using a closed-circuit television with a backroom monitor, and designing the store to slow a thief's exit. Most importantly, never turn your back on a customer, and refuse to be diverted by other people. *SAT*

SYNTHETICS AND SIMULANTS

Einige Erkennungsmöglichkeiten für Kashan-Rubinsynthesen (Some of the identification characteristics of Kashan synthetic rubies). U. Henn and H. W. Schrader, *Goldschmiede Zeitung*, Vol. 82, No. 12, 1984, pp. 40–42.

The inclusions in synthetic Kashan rubies can be classified into four types: (a) feathers, (b) "fingerprints," (c) "string of pearls," and (d) "comets" or hair-fine needles. The authors also analyzed Kashan rubies by electron microprobe and neutron activation (NAA), which revealed the presence of more Na than is typical of natural rubies. The authors propose that this is due to the use of cryolite (Na_3AlF_6) in the manufacturing process. The article is accompanied by seven inclusion photographs and tables giving the NAA and microprobe data. *MG*

Zwei neue Kunstprodukte auf dem Edelsteinmarkt. Synthetischer "Ramaura"-Rubin und Yttrium-aluminimgalliat (Two new artificial products in the gem market. Synthetic Ramaura ruby and yttrium aluminum gallate). E. Gübelin, *Goldschmiede Zeitung,* Vol. 82, No. 11, 1984, pp. 55–61.

Dr. Gübelin presents a lengthy article covering the Ramaura synthetic ruby and an artificial product known as yttrium aluminum gallium garnet, both of which are now available in the trade.

The author describes his visit to the U.S. manufacturer of the new synthetic ruby and the method of synthesis. The main component, aluminum oxide, is mixed with chromium oxide (which acts as a coloring agent) and fluxes such as lead fluoride, bismuth oxide, or lanthanum oxide. A platinum crucible is used to melt the solution in a melt-diffusion atmosphere at a temperature of about 1250°C. The addition of lanthanum oxide results in the formation of rhombohedra rather than the platy crystals that would otherwise grow. Crystallization is spontaneous, but the growth directions can be controlled by using seed crystals.

Since the physical data for both natural and the Ramaura synthetic rubies are nearly the same, the author presents 24 color photographs of distinctive inclusions. He also reports that ultraviolet spectrophotometric analysis fails to distinguish Ramaura from natural or other synthetic rubies with any certainty.

A new imitation for tsavorite garnet is yttrium aluminum gallium garnet. It can be easily separated from tsavorite garnet because the physical data of the two materials differ greatly. The reported refractive index is about 1.90, and the specific gravity is 5.06 to 5.08. It is known in the trade as "YAGG" (the second G stands for garnet). While it is not a silicate, like the natural gem, its structure is similar to that of garnet. Apart from the main chemical components of yttrium, aluminum, and gallium, the new product contains traces of PbO, PbF_2, and Bi_2O_3. The characteristic inclusions noted are remains of flux in various forms, and are mostly yellow in color. Forty-two photographs and illustrations accompany the article. *MG*

MISCELLANEOUS

Why does George Holmes keep winning awards? D. Reese, *Folio,* March, 1985, pp. 61–63, 66, 71.

Under Editor George Holmes's careful guidance, *Jewelers' Circular-Keystone* has captured 12 Neal Awards (trade publishing's "Pulitzers"). Last year, Holmes won the Crain Award for an outstanding career in business journalism. His success stems from a basic commitment to sharp business reporting, tempered by the queries: "Is it accurate, is it relevant, is it fair?" JC-K has been called the "bible" of the jewelry industry, and Holmes sees its role as that of a community watchdog that services its 40,000 retail jeweler subscribers. " 'Each year, we try to isolate what we see as the most crucial issues for our readers,' Holmes says. Once a story is isolated, 'whatever we find, we report. There's no suggestion that you have to put on the brakes for any reason.' "

Holmes believes in first-hand reporting from across the nation or, if need be, around the world, and he backs that policy with an ample budget. In the same vein, he regularly mails out questionnaires and uses the resulting feedback to keep JC-K attuned to its readers' concerns. In addition, Holmes does not shrink from covering controversial issues, but delves into them with intensive primary research to reveal every possible angle. Taking his editorial responsibility an extra step, once a problem is revealed, Holmes presents possible ways for jewelers and the industry to deal with it.

George Holmes has managed not only to tap the life-line of the industry, but has also kept a healthy distance from its entanglements, an accomplishment that has maintained JC-K's reputation for both incisive business reporting and credibility within the industry. *SAT*