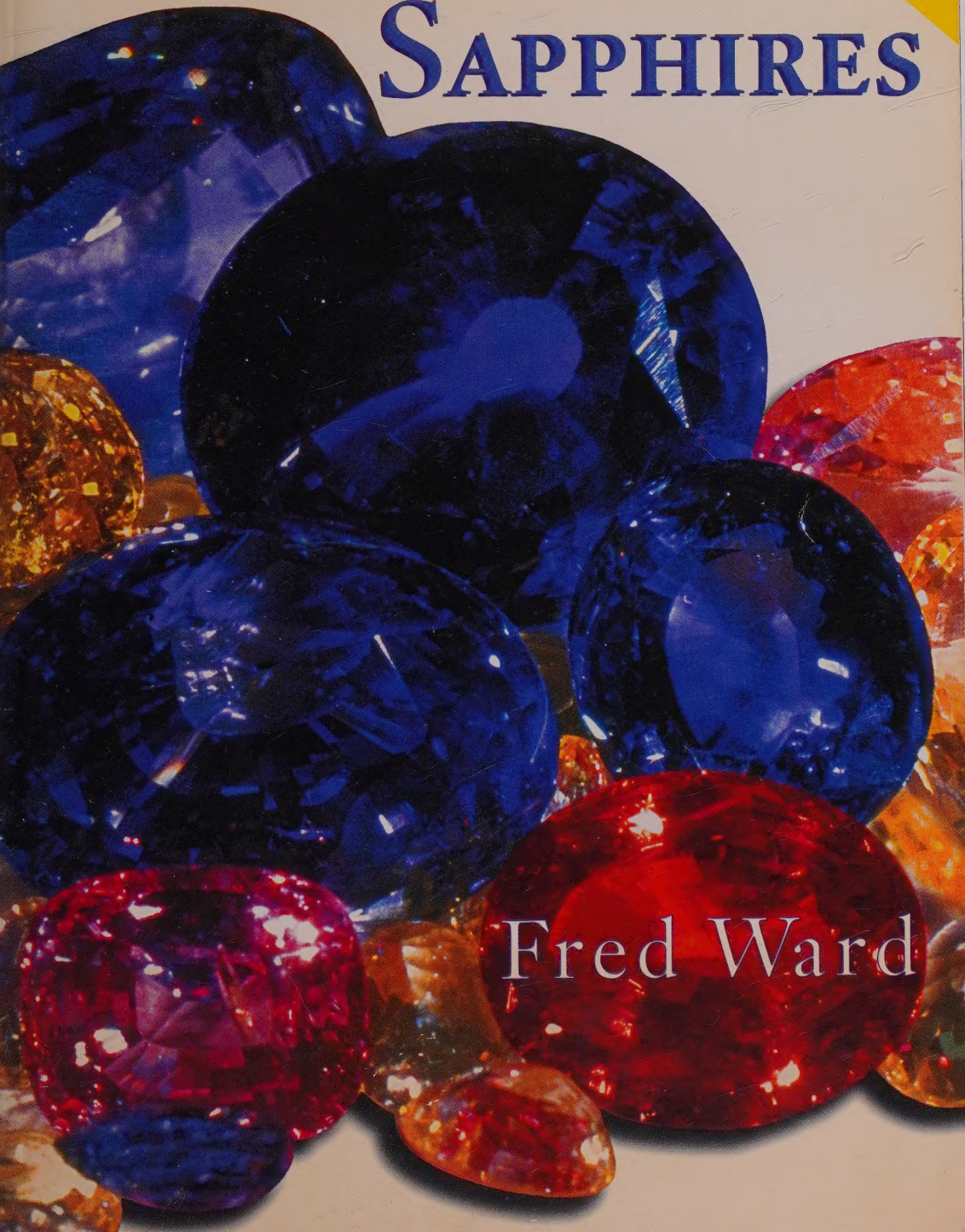
FRED WARD GEM SERIES

Revised Edition

RUBIES & SAPPHIRES



Fred Ward

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Acknowledgments:

A project such as this revised edition always incorporates the efforts of and information from many people. My friends, gem writers Richard Hughes, David Federman, and Robert Weldon, shared their insights freely. Marc Bielenberg, Shirley Beck, and Dale Siegford kept me regularly updated about the always active movements in Montana sapphires. Roland Naftule helped with global market information. Tom Banker and Jeffrey Bergman provided Bangkok details. Tom Chatham, Judith Osmer, and Frank Reed kept me abreast of synthetic corundum developments. Jeff Post and Chip Clark at the Smithsonian Institution assisted with pictures of the National Gem Collection. As usual, smooth text flow was assured by the editing insights of Charlotte Ward. And Michele Zabel combed a decade of corundum literature so this revision would be timely. To all these and many others I again extend my heartfelt thanks and appreciation

F.W.

Published by Gem Book Publishers
7106 Saunders Court
Bethesda, MD 20817 USA
Telephone 301-983-1990
FAX 301-983-3980

http://www.erols.com/fward/
fward@erols.com

First edition, 1992
Revised edition, 1995
Revised edition, 1998

ISBN 1-887651-01-2

Rubies & Sapphires

Text and Photographs
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Charlotte Ward

The "Panther Brooch," made for the Duchess of Windsor, features a 152 carat Sri Lanka blue sapphire.

Magnificent! Exceptional! Incredible!

All these adjectives and more have been used over the years to describe this gem classic, a Kashmir sapphire and diamond bracelet made and signed by Cartier in New York.

Its uniqueness derives from the size and quality of its 65.15-carat Kashmir sapphire, one of the largest ever faceted. Diamonds, 63 matched sapphires, and a platinum setting complete the Art Deco look.

Kashmir sapphires enjoy an almost mystical appeal, perhaps because they were mined so briefly, between the 1880s and 1920s. Collectors love them for both their rarity and their beauty. As a result, per-carat prices for Kashmir sapphires typically top all lists.

We may never know a contemporary value for this bracelet because it was stolen during a 1996 auction exhibit in Milan. It is thought never to have been sold again after it was delivered to its original owners, a prominent American family, in 1923.

History and Lore

Rubies—the color of passion and love's own hue, gems that glow red as no others. Whatever primeval chord they strike deep within us rings almost universally. Their charisma seduces a world of willing subjects. Potentates, emperors, and maharajahs have risked all to possess their beauty. And the beautiful have risked all to call rubies their own.

Many people express great surprise to learn that rubies have a fraternal twin, one with little visible family resemblance and a separate illustrious romantic history. Rubies' true natural sisters are sapphires. As different as they usually look, rubies and sapphires are composed of the same material, aluminum oxide (corundum), a relatively common mineral in the earth's crust. But as gem crystals, corundum is rare.

All corundum gem crystals except one—every color of the rainbow—are sapphires. When gem corundum is red, it alone is ruby. In a pure state, corundum, and thus sapphire, is colorless. Tiny trace amounts of other materials determine the fabulous hues that make rubies and sapphires the treasures we love. A minute amount of chromium makes rubies red. The blue in sapphires comes from the simultaneous presence of titanium and iron. Iron causes yellow. Various other elements and concentrations color sapphires pink, lavender, orange, green, purple, and peach-apricot.

Remarkably, until the mastery of chemistry in the 1700s, much of the world did not even recognize rubies and sapphires as family members. Once people knew that rubies and sapphires were different colors of the same material, and that sapphires came in every color, then they realized that corundum accounts for half of the four major gemstones (with diamonds and emeralds). In some places and at some times, they occur together, as in Burma (now called Myanmar) and Sri Lanka (formerly British-ruled Ceylon), where they are found in the same mines or a few miles apart. Kenya, Thailand, and Tanzania have both gems, but in separate locations. Montana, China, Australia, and several African countries produce only sapphires.

For most people in the West, the first references to rubies they hear are four from the Bible. All relate to the value of the stones; two compare rubies to wisdom and two compare them to women. Three of the references appear in Proverbs:

> *She is more precious than rubies.*
> *For wisdom is above rubies.*
> *Who can find a virtuous woman? For her price is above rubies.*

The fourth is in Job:

> *For the price of wisdom is above rubies.*

Jews believe rubies are the most precious of the 12 gems God created when making all things. Ruby is revered as the sacred gem of the tribe of Judah, the fourth stone set in Aaron's breastplate.

Most red Biblical jewels were probably not rubies. Before scientists classified gems and minerals by their atomic structure, the Greek scholar Theophrastus practiced a far more obvious system. Writing one of the earliest gem books about 315 B.C., he grouped stones by color. He categorized rubies, garnets, spinels, and other red gems as *carbuncles*, a name that actually referred to the color of glowing embers. Cutters knew there were differences because some were so difficult to work with primitive tools and grit. The harder rubies and sapphires took much longer to shape.

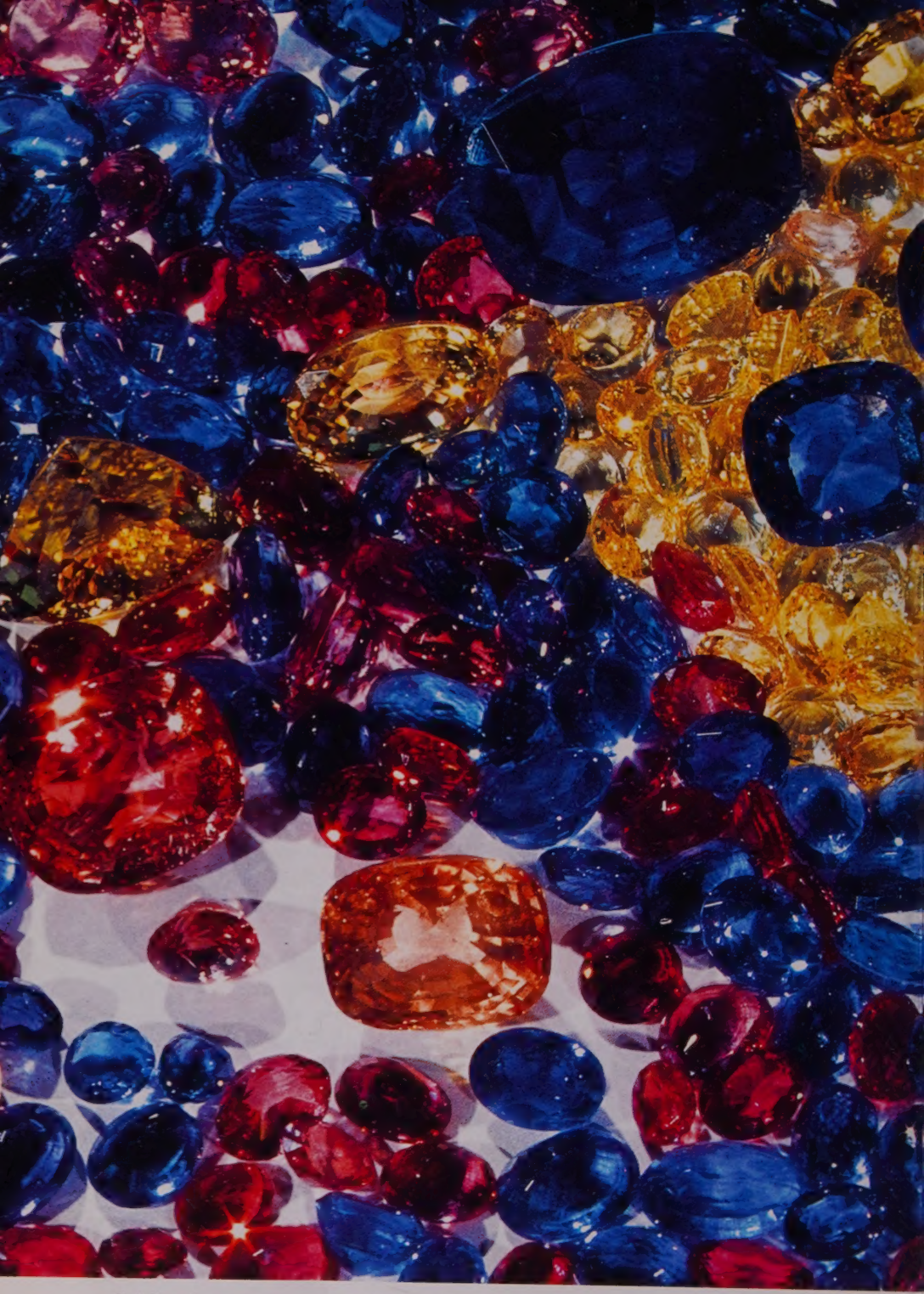
Large gem-quality rubies are among the rarest crystals on earth. A faceted gem ruby over 50 carats is virtually unknown. Recently this remarkable 500-carat specimen (left), found in Burma, was named* The Mogok *to honor the legendary gem center.

A great fist-sized crystal (right) from Sri Lanka may be the world's finest uncut sapphire. Priced over $1 million, this 3965-carat treasure will likely yield a number of gems between 50 and 100 carats.

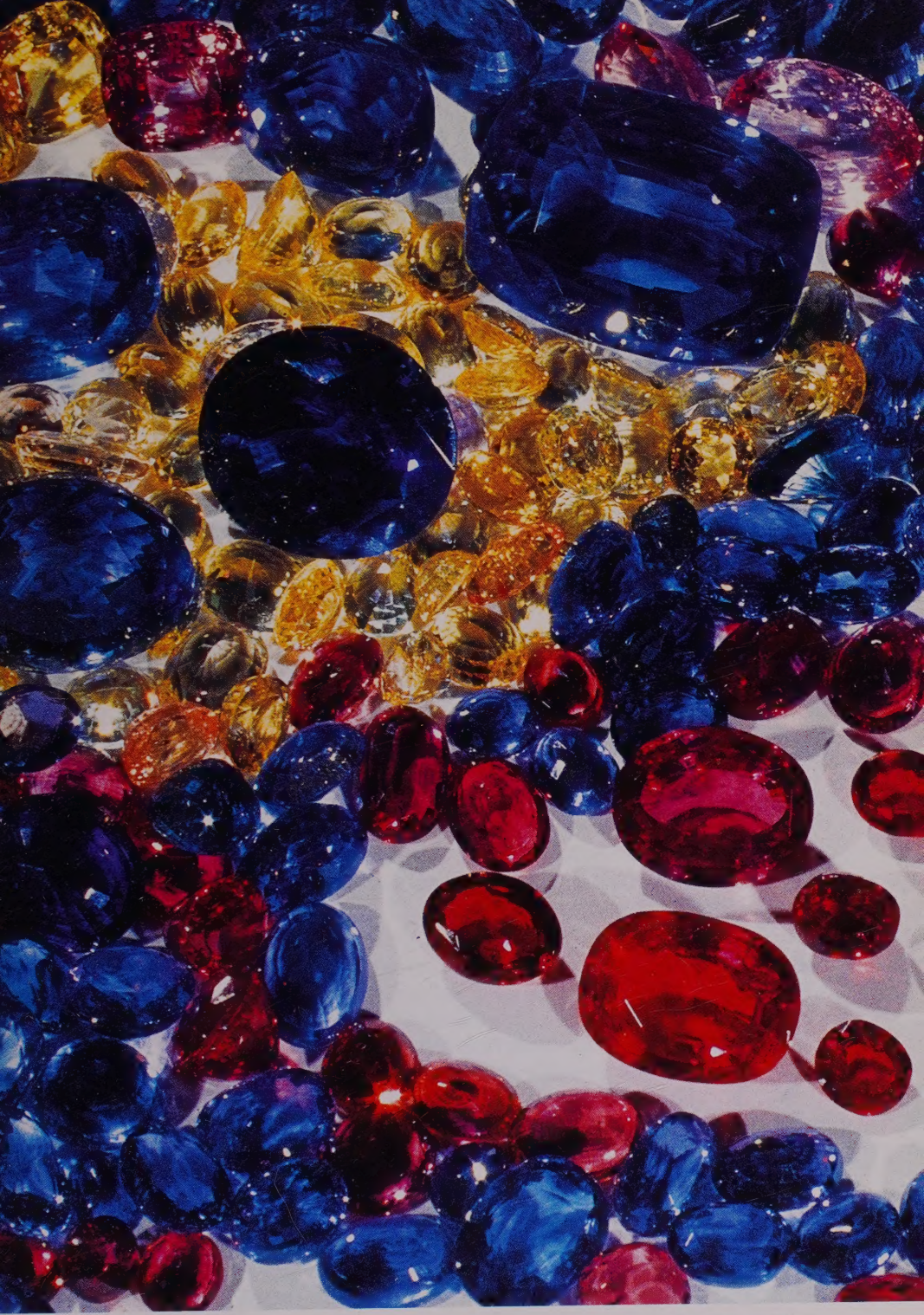
Pliny might be called the world's first gemologist. In first-century Rome, he already knew a number of details that gemologists had to relearn in this century. For instance, he noted that dealers deliberately simulated rubies to fool buyers, that a ruby's weight (specific gravity) was an identifier that separated it from other red stones, and that even with an unaided eye rubies could be verified by their natural inclusions (which the public calls flaws). Before his death in 79 A.D., Pliny wrote on every known topic. In his magnum opus, *Natural History*, he noted that "carbunculi are imitated by glass and such imitations at first sight are excellent. False carbunculi are detected by lack of hardness of their powder and by their weight...further, one sees in false carbunculi certain small inclusions, that is blisters and vesicules, which look like silver."

While tenth-century European rulers stuffed their coffers with red spinels labeled balas-rubies, Arab scientist Al-Biruni listed nearly exact specific gravities for spinels, rubies, and sapphires, and separated them by name—*balkhash* for red spinel and *yaqut* for corundum. It would take another seven to eight hundred years for scientists to confirm chemical differences.

Sapphires did not escape historical confusion. Just as the word *ruby* derives from the Latin *ruber* for red, our word *sapphire* is from the Latin form of the Greek word for blue. Similar Hebrew and Persian words also equate blue with sapphires. However, as with rubies, blue gemstones were first categorized by color, not chemistry. Both buyer and seller of any attractive blue gem probably called it sapphire. The most likely candidate for blue "sapphire" in the Old Testament is lapis lazuli from Afghanistan.



Sri Lanka once was named Serendip. Surely finding such incredible treasures on "Gem Island" parallels the tales of happy, unexpected discoveries that gave us the word, serendipity.



With a profusion of colors, Sri Lanka, famed for magnificent blue sapphires, also has huge pinks, resplendent yellows, and most expensive of all sapphire colors, the luminous orange-pink "Padparadscha."

The Green Vaults, Dresden (2)

Researchers generally believe true rubies and sapphires reached the Mediterranean area and Europe after the Old Testament, during Greco-Roman times. India has the greatest love for and longest history with colored stones. Ancient records describe the "Gem Island" of Serendip, near India, where jewels washed down from the central mountains after every heavy rain. Such serendipity continues to this day on Sri Lanka, as Serendip is now called. One gem dealer recently joked, "We must be the most pious people on earth because we always walk with our heads bowed," referring to the local habit of constantly looking for gemstones in fields and along the roads.

With their unprecedented history in rubies and sapphires, Asians have mined the largest stones and told the grandest tales. An old Hindu belief held that the god Krishna rewards supplicants who offer rubies; a good ruby assures rebirth as an emperor, lesser stones only make a king. A relatively common bit of folklore still repeated by peasants says all rubies start colorless and ripen with age. Sometimes this tale broadens to say that pink sapphires should be replanted until they become rubies, and that gems with many inclusions are overripe.

The most famous early Western traveler through Asia, Marco Polo, wrote that the king of Serendip had a ruby over four inches long and as big as his finger. Such legends whetted the appetite of Europeans for exotic gems. And no wonder. The Asian penchant for ascribing magical powers to gems spread to the Continent, where rubies were said to cure circulation disorders

Throughout history, royalty reserved precious stones for themselves. In the 1700s Europe's wealthy duke, August the Strong of Saxony, assembled a fabulous gem collection, now in Dresden's Green Vaults (left).

Early Romans and Greeks learned to carve sapphires with images like the woman with eagle (right).

India's Mogul rulers wore jade archery thumb rings decorated with rubies (below).

Fitzwilliam Museum at Cambridge University

The British Museum, London

and melancholia. Wearers of the red beauties could expect wisdom, health, happiness, and good luck in gambling and with the opposite sex. Who could resist that combination?

Once rubies and sapphires arrived in Europe, lore associated with colored gemstones took a turn to the dark side. Perhaps a colder climate put a chill on the hot tropical gems. Or maybe it was mixing jewels with Western religions. Whatever the reason, in medieval Europe, some owners believed that rubies possessed magical powers to turn dull and dark as warnings to their owners. Legend has it that the downfall of Catherine of Aragon, first wife of Henry VIII, was presaged by the darkening of her ruby. A similar tale grimly reveals that Elizabeth, wife of Franz Joseph of Austria, always wore a ruby as a talisman...with the exception of ONE particular morning. Apparently she forgot to put it on...and was assassinated.

Most ruby lore extols the good luck and fortune the stone brings owners. It is no surprise that anyone would relate possession of such a rare and beautiful jewel with happiness and success. U Thein Lwin, the Myanmar Gems Enterprise advisor, says his countrymen call rubies *Ma Naw Ma Ya*, "Desire Fulfilling Stones," because they make dreams come true. Burmese often consider rubies the King of Gems and call all other stones, including sapphires, attendants. Well-known international sapphire dealer Roland Naftule takes a different view saying, "Rubies are gorgeous gems and certainly deserve their reputation, but there is nothing as beautiful as a richly colored sapphire."

Even great collections contain questionable gems. Queen Therese's "Ruby Jewelry" in Munich's Residenz (right) includes an array of rubies, spinels, and simulants. The tip-off—rubies seldom scratch. These off-color, deeply abraded center stones look like glass.

Some famous artifacts may not be what they seem. In the authentic tenth-century Talisman of Charlemagne (left), glass and quartz stones, widely publicized as sapphires, sandwich what are said to be splinters of the True Cross.

"I love them both," says Jack S.D. Abraham, one of the most personable dealers in fine gems. "There are very solid reasons for owning both rubies and sapphires. But rubies have a special place in my heart. Among many people in the world with high and medium incomes, gems are the traditional means of transferring savings without oppressive taxes. Gems are a timeless hard currency. They are also durable. Crystals that sparkled 2000 years ago will continue to sparkle long after whole civilizations turn to dust."

In fact, the intertwining stories of people and gemstones weaves one of the oldest threads through time. Every culture that has come into contact with gem crystals has loved and coveted them. Whether the prevailing allure relates to magic, power, wealth, beauty, durability, or rarity, the historical reality remains. Early humans formed an integral bond with gemstones that remains unbroken. Geology, gemology, and chemistry now tell us the molecular structure of gems, their age, where they come from, and how we can duplicate the process of creating them. But the ultimate appeal defies description. We know innately that gems possess a fundamental beauty and that they are valuable beyond almost every other object on earth. As a European collector once told me, "Spend $50,000 on your wife or girlfriend for a fur coat or a car. In ten years she has a rag or a wreck. Use the same money to buy her a fine gem, and she has a treasure worth even more over time, which she can pass along to her children."

Gems are concentrated, portable wealth. What was true historically remains relevant today. We comfortable Westerners may forget the cyclical nature of the rise and fall of countries, institutions, and personal wealth. During periods of turmoil, paper may become worthless. Money, stocks,

Treasure of the Munich Residenz

bonds, and homes often lose their value. Markets fluctuate, and governments never last forever. People who live in troubled times and places know to put something aside in case of crisis. Most often they collect gems because of their almost universal acceptance and unprecedented price/weight concentration. Think about transporting a million dollars. That million in dollar bills, almost a ton of money, occupies 42 cubic feet of space. A million-dollar gold brick (with $400-an-ounce gold) would be difficult to lift at 156 pounds. But the 15.97 carat *Mogok Ruby* (page 46), at about an eighth of an ounce, weighs only slightly more than a copper penny. Before being set in a ring, the unmounted stone sold for $3,600,000, more than $225,000 a carat!

People ask me continually if there are any differences between "old" and "new" gems. Every gemstone that has been mined or will be mined in our lifetime is already millions of years old. For a gem to be so near the surface that people can uncover it means it has been pushed to or through the earth's crust by the effects of mountain-building, upthrusting of the land, or volcanic explosions. It is intriguing to think that new gemstones are forming this very minute, miles beneath our feet. However, it may take tens of millions of years until they surface for the planet's inhabitants. Thus, there is no real difference between old and new gems insofar as quality, value, durability, and beauty are concerned. The only difference is whether the gems have already been mined, or are yet to be discovered and mined.

The Hunt for Treasure

International dealers joke that gems always seem to occur in remote sections of Third World countries. Most do, but there are some remarkable and surprising exceptions. Rubies and sapphires, often associated with the Orient, have a long history in Asia. Although we do not know a precise date and place, most likely natives of India and Sri Lanka first appreciated rubies and sapphires more than 2000 years ago. Even corundum, the mineral name for rubies and sapphires, probably came from the Hindi word *kauruntaka*. For more than a millennium, the great gemstones that now fill royal vaults and public museums were mainly bought and sold in India.

Because of their beauty, color, and hardness, crystals fascinated and mystified early humans. Over the centuries Sri Lanka consistently produced stunning varieties of pink, blue, and yellow sapphires, in addition to red, pink, and blue star corundum. Scholars have dated Middle Eastern jewelry studded with gems as early as 3000 B.C. Even then, India was well known for large quantities of medium quality, moderate-sized rubies and for enhancing other gemstones. King Tut's Egyptian tomb, dug for the boy king about 1300 B.C., contained red agate and carnelian, which had been treated and assembled in India 700 years earlier.

India's importance in the gem trade developed over generations of relative political stability with dozens of maharajahs and thousands of court members as potential buyers. Potentates, ruling a subcontinent blessed with a wide variety of gemstones, coveted jewels and gathered craftsmen who learned to fashion them. A huge domestic and foreign market burgeoned into the world gem-trading center for diamonds, rubies, sapphires, pearls, lapis lazuli, agate, and garnets.

Today India no longer produces diamonds and pearls. It does maintain a thriving business in small, relatively inexpensive rubies, the translucent to opaque red or purple crystals that most often decorate lower-

From the legendary ruby and sapphire mines at Mogok, Burma, the 196-carat* Hixon Ruby *is one of the finest crystals ever found.

Natural History Museum of Los Angeles County

Dug by hand, Kenya's Aqua Mine, north of the Tanzanian border, has produced a steady supply of rubies for years. Most of the output goes to Thailand for marketing.

In an attempt to control animal poaching, the Kenya government closed the area to everyone, including miners, for two years. Ruby theft is now a larger threat.

priced necklaces and earrings. In addition to mining several different, usually inexpensive, gemstones today, India is a major world cutting center. Specializing in faceting smaller, less costly gems, Indians cut and polish diamonds, emeralds, rubies, cubic zirconia, and other stones worth hundreds of millions of dollars a year.

Sri Lanka is a wonderland for gem and crystal enthusiasts. Properly nicknamed the "Gem Island," its southern two-thirds are almost literally awash with jewels. A central mountain range holds the original treasure, which millions of years of rains and erosion have generously spread throughout the island. Traditional mines are unheard of. As gem dealer Tom Ellawala and I walked through Paradise Estate, a large plain already mined five times, he explained, "Mechanization is prohibited here as a safety valve. At current mining rates, our supplies will last for decades. This way we stretch our resources while employing as many people as possible."

All farmers are potential miners because they routinely plow up gems. Since most gem sites are alluvial, landowners lease low-lying rice paddies for repeated digging. Heavier than rocks and other gems, rubies and sapphires tend to accumulate at the bottom of gravel layers. So, when miners hit gravel, they almost always find gems. The largest sapphire crystal I ever

Sri Lanka, formerly named Ceylon, abounds in gems. Any citizen may mine with an easy-to-obtain permit, and at some time during his life, almost everyone does. Although individuals and small groups organized by investors have worked Paradise Estates (left) at least five times, it still yields enough sapphires to turn a profit for new leaseholders.

With the 1992 discovery at Mong Hsu, Burma produced enough rubies to actually lower prices. Mong Hsu now mines even more rubies than Mogok. Although typically small, Mong Hsu crystals often exhibit blue cores (upper right), which disappear with heating. Recent controversy about "glass-filling" is hindering sales. Burma and other Third World countries frustrate the gem trade with inferior faceting because they use primitive cutting equipment (right) and unskilled labor on some of the world's great gemstones.

© Tony Laughter, RW Hughes Collection (2)

saw, weighing more than 10 kilograms, was recently uncovered by a homeowner excavating a new basement.

The magic word for rubies and sapphires is Burma. Nothing like Burma's appeal exists with any other source for gems, except possibly Colombia's for emeralds. No woman brags, "Oh, look at my Siberian diamond," or suggests that her engagement ring is better because it came from Namibia. In fact, it is unlikely that she or her jeweler knows or could find out the origin of her diamond. But the same buyer might lean across the counter to stipulate, "I want a pigeon-blood ruby from Burma." Fine rubies are typically sold as being either from Burma or not from Burma. And many an owner extends a hand and proudly asserts, "It's from Burma."

At the epicenter of the world market in two important areas, color and price, Burma rubies hold an unprecedented allure for buyers, despite (or perhaps because of) limited production and a near-total reliance on smuggling in order for gems to reach the outside world. The world trade reveres "Burma red," or "pigeon blood" as an almost mystical standard. And this special appeal determines price. When two rubies of comparable quality are offered for sale, the one from Burma often fetches twice as much. This is one time that buyers should ask where a gem under consideration originated.

Mogok, regarded by gem traders and historians alike as the mineral Mecca, is an almost inaccessible wonderland filled with treasures and secrets. The ruby and sapphire mining region in Upper Burma had been off-limits to foreigners for three decades after a military government took control in 1962. That government's descendant, still a military regime, recently renamed the country Myanmar and loosened travel restrictions. Although some maps reflect the new name, no one in the gem trade calls the country's most famous products "Myanmar Rubies."

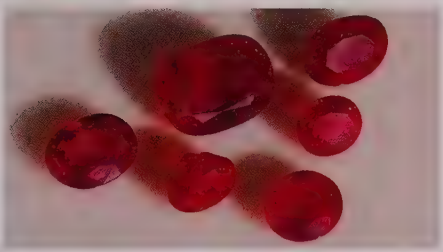
In 1991, I was the first journalist allowed to visit Mogok in the almost 30 years since 1962. In Rangoon, at the annual Gems, Jade, and Pearl Emporium, I watched $1.3 million of gems (along with more than $10 million of jade and pearls) auctioned to invited international dealers. Then I flew to Mandalay for a six-hour pot-hole-pounding drive north under the watchful eyes of two armed soldiers.

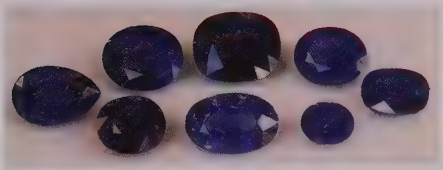
For over 800 years the Mogok Stone Tract, as the British called it, has produced what most dealers and the buying public accept as the world's finest rubies and sapphires. Nestled in a mountainous bowl 4,000 feet high, Mogok is the only city of consequence in a mining area that extends about 20 by 20 miles. Europeans arriving in Burma in the fifteenth century described a thriving local trade in rubies. The first European to reach Mogok was probably Portuguese priest Pere Guiseppe d'Amato in 1833. His description of "square-set" mining, where workers dig a square hole vertically to a gravel layer, precisely matched the procedures I observed still being used. The adventurous father reported that Chinese merchants traversed the mountains annually to barter nutmeg, cloves, carpets, and cloth for gems.

Times changed for Mogok and Burma in 1885 when England annexed the area as part of its India holdings. The Burma kings who had ruled from Mandalay had maintained a rigid policy of possessing all gems above a certain size and quality. Noncompliance could have meant being burned alive. A major British target during their takeover, along with the king, was the royal gem collection, which the army expected to snare when it captured the palace in December, 1886. However, chivalry, or naiveté, cost England a king's ransom. No one thought to search the parade of female servants who shuttled in and out of the palace throughout the night, spiriting away the treasure under their *longyis*.

Today's Mogok is a vastly different place from how gem dealers remember it before 1962. No longer a sleepy rural village, Mogok bustles with more than 100,000 people, a building boom that even includes two new hotels, and unusually visible prosperity. New Japanese motorbikes and automobiles crowd the still dusty streets. Government officials estimate that 90 percent of the people earn their living from the gem trade. For years moonlight mining and massive smuggling made this an illicit but powerful economy. Everyone—miners, smugglers, managers, Thai dealers, and buyers—agreed that many more gems left the country illegally than ended up with the government. After all, gem smuggling is commonly known as the world's second oldest profession.

To stem the hemorrhage of ruby smuggling, the Burma government





Long hidden from view, the world's most famous ruby and sapphire mines surround Mogok in upper Burma. Once the perquisite of kings, later chartered to a British mining company, the area is now mined by the socialist government of Myanmar (Burma).

The recently finished central wash plant in Mogok handles all the state's ruby and sapphire mines. High pressure hoses blast away the dirt, leaving gravel and gems to pass over vibrating screens. Heavier, the gems drop to the bottom, making them easier to retrieve once the screens are flipped upside-down.

© RW Hughes Collection

Mining rubies and sapphires in most of the world is a labor-intensive, low-tech task. In one of Vietnam's new ruby mining areas near Quy Chau (left), workers pick into a hill, dropping dirt and gravel into buckets for washing. Vietnam's first rubies were confused with Burma's, and its fine electric-bright pink sapphires stunned the market. Supplies seem unreliable, and once again Burma's output overshadows Vietnam's.

Hand digging a new ruby find in the foothills below Mehenge (right), independent Tanzanian miners bag their dirt and gravel before trudging downhill to a nearby stream to screen for gems. Early production suggests a medium-quality mine.

implemented a novel plan to allow private mining partnerships. Citizens obtained two-year leases with the government claiming first choice of everything found. Not satisfied, the military regime next moved in to become everyone's unwelcome partner, skimming a large percentage of each mine's income. This has had two conflicting effects—it is now legal to own and sell gems (which limits smuggling somewhat), but no one wants to pay the military up to 60 percent of his profits (which encourages smuggling).

Fetching prices sometimes exceeding Burma rubies, sapphires from Kashmir, in what is now northern Pakistan, are favorites among connoisseurs (see page 2). Unfortunately, the high frozen remote controversial area was mined only for a few years, more than half a century ago.

Thailand, which frenetic expansion recently transformed into the world's largest gem-marketing center, was for several years an important mining source for both rubies and sapphires. In 1990 near Kanchanaburi, three hours west of Bangkok, the 1600-acre S.A.P. facility was the world's largest single sapphire mine. Inside the fence hundreds of miners worked around the clock to wash 8000 tons of gravel daily, yielding more than 100,000 carats of sapphires a week. Relentless strip mining reduced the area to a barren moonscape gravel pit in less than a decade.

Thailand's ruby mines used to lie southeast of Bangkok, near the Cambodian border. For years ruby deposits were heavily mined around Chanthaburi, Trat, and Borai. Now ruby mining in Thailand is unproductive. Thai cutting factories currently depend on rubies from Cambodia,

Umba Valley mine

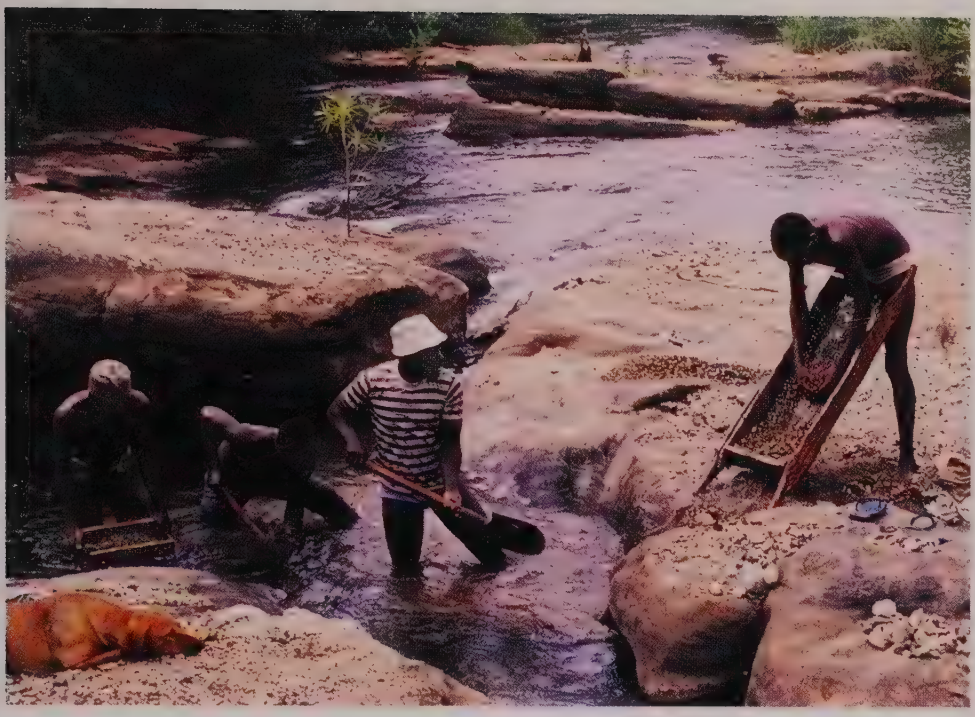
Sapphires in a profusion of colors are a hallmark of Tanzania's amazing Umba mine (above). Although Australia's sapphire fame rests mainly with inexpensive, dark blue stones, it does produce a large variety of other colors (below).

Burma, and elsewhere to remain open. In Chanthaburi powerful Thai gem families controlled the corundum markets in much of the world and employed tens of thousands of workers. The bubble burst in 1996-1997, when financial markets reacted to the unwarranted expansion into gems and real estate without underlying value. Thailand's economy stumbled and may be slow to recover.

In Africa only De Beers manages consistent and efficient gem mining. Elsewhere miners, dealers, and bureaucrats struggle with a legacy of endemic corruption. Sapphires occur across the continent, with serious mining in Tanzania, Madagascar and Kenya. But only Tanzania and Kenya

Outside the main Thai-operated mine at Umba, Tanzania, natives try their luck daily in the Umba River (right). Usually a few minutes of searching through the stream's gravel produces a dozen or more garnets and sapphires.

Nunan Sapphire International (PVT) Ltd.



provide commercial sources of the elusive ruby. Several factors affect mining as well as marketing. When the vast majority of rubies and sapphires were heated, cut, and sold in Thailand during the 1990s, such activity gave Thai dealers enormous marketing power and control over the corundum trade. Thai firms could actually cause one country's fortunes to decrease by concentrating on gems from another. Such power brought abuse and resentment. With their current financial crisis, it is unclear how much influence Thailand will have in the future.

"Penny Lane" is what local wags call Kenya's string of ruby mines running mainly east to west near the Tanzanian border. With the volume and quality of their output, they might have been successful had they not fallen prey to the usual greed and corruption that has crippled many other African governments. Unusually promising, rubies from Kenya's John Saul Mine compared favorably with Burma's, but few are mined there today.

Cornucopia of color, the fabulous Umba Valley gem deposit sparkles with world-class colored gemstones, which Tanzania has had difficulty controlling. Its current foreign leaseholder insists there are few gems to be found at what was the most prolific producer of the world's fanciest colored sapphires. In fact, sapphires still abound. Every time I stopped my vehicle along the unpaved track through the bush, natives appeared with handfuls of multicolored sapphires, garnets, zircons, and chrome tourmalines. One of the most amazing sapphires I own, a two-and-a-half-carat deep raspberry beauty, I bought in a parcel along the road at Umba for five dollars.

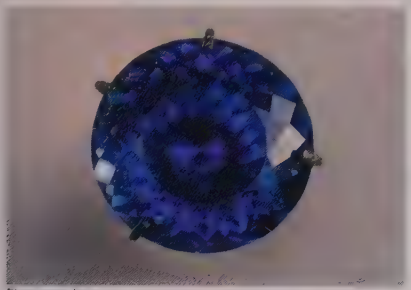
Dark blue to opaque midnight blue Australian sapphires used to be

the world's largest sellers. From the 1960s to the late 1980s, Aussie miners flooded the market with inexpensive sapphires that wholesaled for $8 to $80 a carat. Simultaneously, while buying almost all of Australia's output, Thai dealers and miners busily tied up production from several African countries and China. Then the Thais hit midnight blue pay dirt at Kanchanaburi. With a plentiful supply of dark sapphires from several sources, Thailand no longer needed Australia.

Two unfortunate consequences followed. First, the buying public came to consider sapphires a cheap gem. Retailers filled display cases with inky bluish black sapphires that looked like onyx and told customers the darker the better. The residual impact of that episode is that sellers continue to find it difficult to persuade buyers that beautiful, transparent blue and multicolored sapphires are gems of value.

My personal gauge for choosing sapphires is this: if a blue sapphire appears black in room light at night, where you wear most gems, then I reject it. In better jewelry there is no excuse for buying opaque or dark sapphires, unless you are collecting black star sapphires, which are beautiful. Why not treat yourself to a brilliant blue, fuchsia, lavender, teal, or hot pink sapphire? Australian stones (and the darker material from Africa, Thailand, and China) do solve one of the most nagging problems of jewelry making with colored gems. It is expensive and time consuming to match color, cut, and size for pairs and sets. But bracelets, earrings, and necklaces are no problem with overly dark sapphires, because blue-black is easy to match. Even Australia's substantial sapphire reserves have now been seriously depleted by industrial-strength mining. And the marketing tide seems to be turning from dark-blue-to-black sapphires toward more colorful gems.

Although Montana is a large producer of fine sapphires, it is often overshadowed by overseas sources. Colorful pink sapphires from Rock Creek (right) are the equal of any in the world. The 1880s find at Yogo Gulch started the first U.S. sapphire rush. Yogo still produces beautiful cornflower blue gems such as the 2.75-carat prize below. Vortex (opposite), the only U.S. underground sapphire mine, is one of two firms at Yogo .



Roncor, Inc.

Sapphire Gallery, Philipsburg, MT

Montana, one of the world's best-kept mining secrets, astounded me. After a global search for sapphire sources and too many "me-too" blues, the rich color diversity, bicolors, color-change, and uniquely hued sapphires right in our own backyard came as a total surprise. The U.S. has a treasure chest that buyers are just beginning to discover.

The 1880s gold rushers stumbled on sapphires. After tossing out the annoying hard heavy pebbles that clogged their sluices, finally someone recognized the "riffle clutter" as gemstones and sent a package of them to America's first gemologist, Frederick Kunz. He identified the sapphires and sent a check for a handsome amount, asking for more. Tiffany's displayed the gems, and Montana was in the sapphire business.

The best-known deposit is at Yogo Gulch, near the center of the state. Although Yogo sapphires are typically small and flat, their unheated color, dubbed "cornflower blue," is superb. That name, which is often misused when applied to other sapphires, is a rich, lighter blue that holds its hue at night. Yogo's owners justify high wholesale prices (two to three times other Montana sapphires) because of the mine's reputation for quality and its relatively low output. Unlike most other sapphires from Montana or elsewhere, its finely colored gems do not require heating.

Most of Montana's volume comes from the state's southwest, around Gem Mountain and Dry Cottonwood, west of Philipsburg. Brighter, more colorful sapphires, including deep to intense blues, still lure prospectors and corporate scam artists who continue to plague the state. A robust local cottage industry of cutters and setters is making Americans aware of Montana's mines and of our domestic source of world class gems.

ROMANCING THE STONE

Most crystals look nothing like gems. Perfect crystals in their original state, such as diamonds and spinels, occasionally surface attractive enough to meet our human criteria for beauty, but rarely do specimens look finished enough to collect on their own merits. We want to enhance them. We cut and shape them. We facet them. We polish them. Truth be told, we romance them.

Gem crystals are among the hardest and most durable objects on earth. It may come as a surprise that the delicate-appearing jewels gracing slim fingers are usually harder than stainless steel or the front bumper of their owners' fine motorcars. At 9 on the Mohs scale of 1 to 10, rubies and sapphires are second only to diamonds as the world's hardest natural materials, a tremendous benefit when you consider purchasing a gemstone.

To attain gem status, a crystal or other material needs two additional characteristics: beauty and rarity. Rubies and sapphires score high on all three counts. Relatively soft, beautiful, and rare collectibles from living organisms, pearls, amber, coral, and ivory (which the gem trade calls "organics"), must be handled with care. Diamonds, rubies, and sapphires are substantially harder than the precious metals that hold them and harder than practically everything else they contact. Of course, diamonds carelessly stored in a box or drawer with other jewelry, will scratch even rubies and sapphires.

Thousands of years ago, when primitive tribes found crystals, they wore the stones as they came from the ground or water. Because these treasures were harder than any other object in their cultures, early people revered them, believing they possessed magic powers. However, tribesmen lacked today's lapidary techniques to cut and grind crystals or to polish the resistant stones. The concept of putting tiny flat surfaces, or facets, on the gems to catch and reflect light might have occurred to them, but not until Renaissance Europe did jewelers seriously alter or reshape diamonds, rubies, or sapphires.

Glittering bright as a galaxy, Sri Lanka rubies and sapphires display classic six-sided stars as light reflects from tiny internal rutile crystals.

Heat treatments vary widely around the world. Little has changed with heating procedures still practiced in rural Sri Lanka (left). By puffing a blowpipe twice a second, a worker can raise the temperature of a 12-carat ruby inside coconut husk charcoal to above 1400° C.

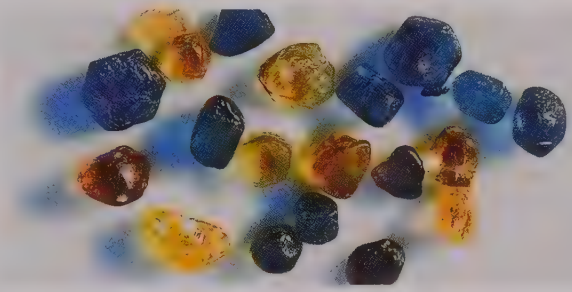
Newer Sri Lankan facilities (bottom, opposite page) use bottled gas for fuel.

In Thailand (below) treaters for years considered their methods a national secret, though they sometimes heated in open, outside fires. U.S. treaters, who typically use electric furnaces, generally lead the way with sophisticated controls and research in their attempt to increase the percentage of clear, colorful gems.

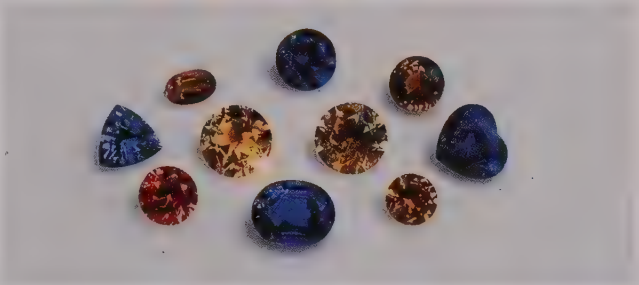
Birthplace of stars... deep within a Burma ruby (above) shimmer thousands of microscopic rutile needles, here magnified 50 times. Perfectly mimicking the ruby's hexagonal habit, the tiny crystals align at 60° angles, reflecting light in a rare, natural display—a star.

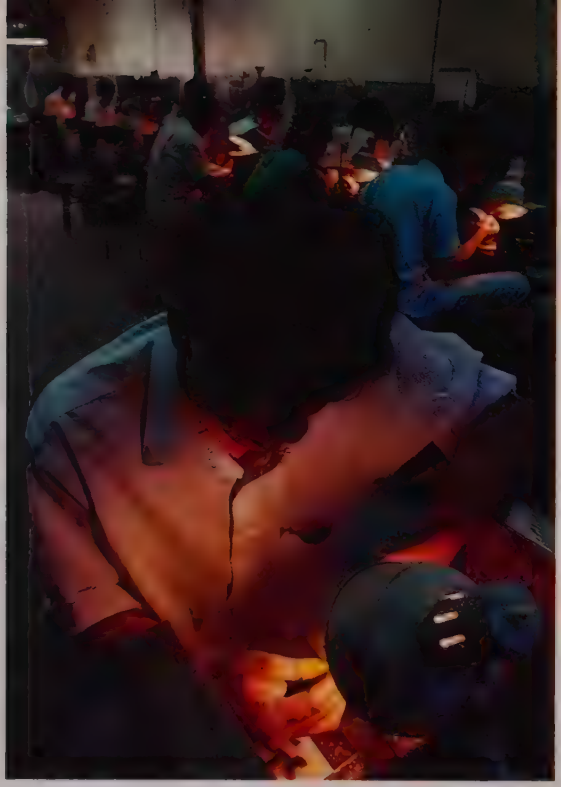
Untreated sapphires from Montana's El Dorado Bar deposit (top right) resemble aquarium gravel more than gemstones.

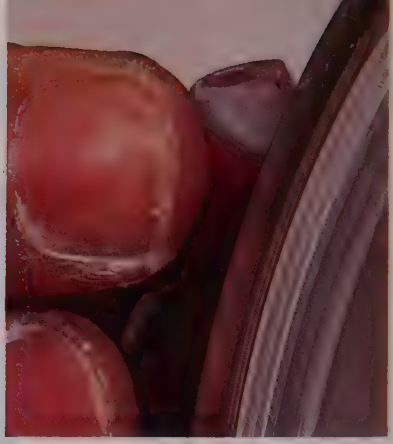
But look what happens when sapphires are taken to high temperatures in controlled atmospheres. After heat treating alters the internal chemistry (center), some stones intensify to brilliant blues and yellows.



Today, heating is used to improve permanently the color and sometimes the clarity of most faceted rubies and sapphires (right).







A large trained labor force in Thailand (left and above) facets most of the world's rubies and sapphires at unbeatable prices.

In Sri Lanka (below) hundreds of morning street dealers sell gems. The country encourages new cutting factories (right) as a means of keeping some profits at home.

Ancient jewelry shows that craftsmen did attempt to fashion stones into more convenient or attractive shapes. They usually ground gems into crude ovals, circles, squares, and rectangles without much control over symmetry. Because ancients did not know the art and mathematics of faceting, they rounded the tops of crystals into cabochons. Most efforts were toward polishing only, to open up the gem's surface and reveal more color. Workers used sand to polish anything with a Mohs hardness up to 7, which includes most gemstones except topaz, spinel, rubies, sapphires, and diamonds. Once the Roman Empire provided trade routes to Asia, caravans returned to Europe with granulated corundum, emery. Emery made it possible to cut and polish all gems except diamonds.

East Indian craftsmen made some of the first efforts to enhance the effects of light in gems. They even chose the hardest of all gems, diamonds, for their work. Using other diamonds and diamond powder as cutting tools, Indian lapidaries as early as 800 B.C. put large, flat tables on some of the huge crystals unearthed around Golconda. Even at that time buyers wanted beauty, and the people who worked with gems struggled to augment a stone's inherent allure by cutting and reshaping.

Color is the most important feature of rubies and sapphires. Seldom are crystals sold with the same colors that came from the ground. Luck, art, and science combine to achieve marketable hues. Heating, used at least as early as 2000 B.C. and still the most prevalent of all gem enhancements,

Whether rubies are found in southern Kenya (below), or along the Thai-Cambodian border (right), almost all will be cut and polished somewhere in Thailand and marketed in Bangkok. This young Thai woman does "bush cutting" at home in Chanthaburi. Holding dopsticks tipped with inexpensive quarter-carat rubies, she rounds cabochons to be used in earrings and other popular jewelry.

Collection-quality gems (opposite) usually pass through Thai hands at least once on their way to the world's jewelry markets.

improves the color and clarity of more than ninety percent of all rubies and sapphires today. At its most elemental, heating is simply men puffing through blowpipes to raise the temperature of a coconut charcoal fire to a white-orange glow. Heating becomes high-tech art in the laboratories of U.S. treaters John Emmett and Dale Siegford. With sophisticated computer-controlled electric furnaces, they hold temperatures to five-degree tolerances in precisely cycled heating-cooling sequences. Happily, such treatment is inexpensive and permanent.

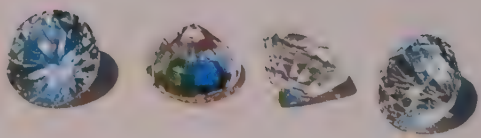
"We finish what nature forgot," that's the heat-treater's motto. Sapphire crystals, for instance, must have titanium and iron with proper valence states in adjacent lattice sites to produce royal blue. Heaters maximize a stone's color potential by realigning elements and altering valence states. To accomplish the two heating goals, rich color and clarity, they raise temperatures near corundum's melting point, 2050° C., and control the gaseous atmosphere around the glowing crystals.

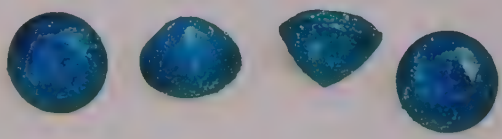
Most consumers have everything to gain from buying heat-treated stones. Without heating, rich blue sapphires and the few natural rubies with clean interiors could cost hundreds of times more. The price of a simple $1000 engagement ring might soar to more than $100,000. It is virtually impossible to find quality faceted unheated corundum. Since the vast majority of rough rubies and sapphires are heated soon after they are found, dealers assume, unless there is substantial proof to the contrary, that all rubies and sapphires they sell have been heated. Most customers today accept heating as a reality.

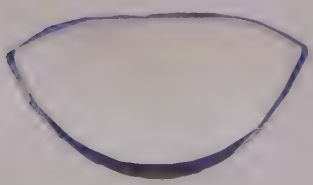
Stars, a soft appearance, and collector preference are three valid

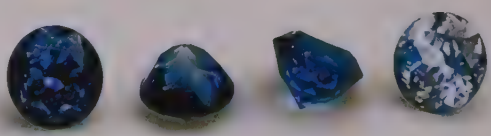
The British Museum (Natural History), London

Diffusion, the latest enhancement, pleases the public though it alarms dealers. Companies like Gem Source in Bangkok buy inexpensive Sri Lanka pale or colorless sapphires (right, top), facet, and diffusion treat them in a U.S. lab. During 600 hours of intense 2000° C. heat, iron and titanium atoms from surrounding powders penetrate about 0.4mm into the surface to form a thin blue layer (cross-section below). Mottled by heat (right, center), the stones are lightly repolished for sale (right, bottom). Although often sold as diffusion-treated, all too many are passed as naturally colored.









reasons to keep stones natural. Microscopic rutile needles inside rubies and sapphires create a number of effects that overjoy and frustrate owners and heat treaters. When these crystals within crystals line up perfectly at 60° angles, they reflect light as a six-pointed star. A small amount of rutile elegantly softens some rare deep blue sapphires from Kashmir, interplaying a subtle light just beneath the surface. Too many needles cloud corundum, making stones "sleepy." Although heating will not remove inclusions, it will dissolve rutile needles. Obviously, no one wants to remove a star or ruin a Kashmir, so owners leave stars alone and heat only to brighten cloudy stones. After heating, cutters round any remaining cloudy stones into cabochons and facet the rest into sparkling, eye-catching gems.

Corundum cutting has changed all too little over the centuries. Though progress has come to many related industries, gem cutting remains tradition bound. The business continues to be mainly Asian because of favorable government policies, experience, and low labor costs. Cabbing operations I saw in northern Burma are right out of the 1500s. India, Thailand, and Sri Lanka cut most of the world's rubies and sapphires. Sri Lankans and Thais have added electric motors in their factories, but Indian children still spin laps with their feet or hand-power bow strings.

Cutters occasionally saw or cleave, but despite use of the word "cutting," mostly they shape, facet, and polish crystals by grinding them away with diamond grit or paste. A major change in the last decade was to standardize (or calibrate) and even automate gem cutting. Israeli companies market robotic computer-controlled machines to pick the best shape for each piece of rough, to preform gems, and to cut and polish diamonds and emeralds. Manufacturers are demanding uniform gem sizes so they can mass-produce precast jewelry. More and more cutting centers are being forced to deliver gems measuring exact millimeter sizes, precision never before required in colored stones.

Market demands challenge tradition in a classic conflict between human and machine, manufacturers and cutters, First and Third World. It is virtually impossible for anyone else to compete with Asians. Sri Lanka cuts many of its own larger gems, Burma does primitive cutting of gems destined to leave the country both legally and illegally. Hong Kong, Korea, and mainland China are all increasing their abilities in the trade, and India continues to employ a child labor force to cut a great many small, inexpensive rubies. In Bangkok, Sri Lanka, and Hong Kong, the price can drop to under a dollar per stone for soft material and synthetics, $1 to $2 for uncalibrated gems, and $2 to $5 for calibrated stones. In the U.S. and in Europe, cutters charge $15 to $50 per gem for faceting small stones.

Workers hand-cut almost all rubies and sapphires. Because gems sell by weight, trade practice has been to maximize weight and let sizes fall where they may, producing what the trade calls "native cuts," a euphemism for asymmetry. But to compete globally, price-conscious jewelry makers must place precisely-sized gems into precast settings. Thus the dilemma—how to maintain low Asian labor costs, and, at the same time, cut gems to within a tenth of a millimeter.

Jewels and Artifacts

Try imagining history without jewels. Impossible? Yes, these beautiful and fascinating baubles have lit our march through time. There must be reasons why we love them so, reasons buyers perhaps only dimly understand when they step up to the counter to purchase an engagement ring, a birthday bracelet, or an anniversary necklace. These gorgeous crystals are more than a manifestation of our affection. They are a perfect piece of time preserved.

Jewels played different roles in other centuries. Just one startling realization helps explain the current state of the gem market, as well as gem prices. I call it the "democratization of jewelry." In fact, it parallels the democratization of half the world. Before the 1800s gems and jewelry were the playthings of royalty. They also symbolized the "state" and formed part of the state's treasury. Today almost anyone can buy several pieces of jewelry a year. Ponder the prospects of a barmaid or farmer's wife in Elizabethan England receiving a sapphire engagement ring. Preposterous!

So, what has happened? How did we move from a time when kings wore the jewelry and fought for more, to a culture that gives 16-year-olds gemstone earrings? Democracy and the Industrial Revolution have done it. As soon as wealth was distributed instead of being centered in the castle, workers earned wages instead of meals and began aspiring to own upscale possessions previously reserved for royalty. Gems were high on their list. This century, for the first time in history, anyone with a little money can buy a genuine jewel. Jewelers have structured their businesses to service this democratization, to advertise, price, and market to society in general.

While researching, writing, and photographing the gem series for *National Geographic* Magazine for 14 years, I enjoyed an unprecedented opportunity to view firsthand almost all the world's great jewel collections.

The 98.57-carat* Bismarck Sapphire, *donated in 1967 by Countess Mona von Bismarck, is one of the treasures in Smithsonian's newly renovated Janet Annenberg Hooker Hall of Geology, Gems, and Minerals.

National Museum of Natural History (Smithsonian Institution), by Chip Clark

Bank Markazi Jomhouri Islami Iran

One of the most famous jewel creations of all time (above) was, in fact, a form of inventory control. Fearing theft, an early Persian ruler ordered hundreds of his loose rubies set into a geographic fantasy.

Standing about a meter high and part of the famous Crown Jewels of Iran, this glittering globe has emerald oceans and ruby continents. Even so, thousands more gems remain in a Tehran vault, waiting to be set.

In addition to the wealth and power the gems represent, one other aspect impressed me. All the great old treasuries (the Crown Jewels of Iran, the Topkapi gems, the British Crown Jewels) started as loose stone collections. Master goldsmiths then fashioned jewelry, decorative pieces, and crown regalia for state occasions. In some cases, a single gem might have been reused dozens of ways over the centuries. After all, gems do not age, only their owners do. Various British monarchs have transferred some of their impressive South African diamonds from crown to crown.

One of the most famous gems in the Tower of London has an illustrious history. The *Black Prince Ruby*, not a ruby at all, is actually a spectacular two-inch long 170-carat spinel. It first appeared in Spain in the 1300s; later, in 1336 the Black Prince in Bordeaux received it for services rendered. Then, in 1367 the jewel surfaced in England on the person of the Prince of Wales. The gem's next appearance was its most noteworthy. Henry V donned it as decoration on his battle helmet. In 1415 he was victorious at Agincourt, an event frozen in time by the king's speech as written in Shakespeare's play. The "ruby's" history did not end there. King James liked it so much he had it set in the State Crown, after which it joined the *Cullinan Diamond* as part of the Imperial State Crown.

Another spinel confused with a ruby illustrates the difficulty in tracking gems. London's Victoria & Albert Museum once displayed a collection on loan from the descendants of Plato Zoubov, who had the dubious distinction of being "Catherine the Great's last lover." Among his rewards was a great jewel, which came to be known as the *Zoubov Ruby*. Using information from the family, the V & A's label said it was actually a spinel, not

Bracelet courtesy of Sapphire Gallery, Philipsburg, MT Natural History Museum of Los Angeles County (righ

Some new gem creations are destined to become collection pieces. Years of patience, 49 pink Ceylon sapphires, and a masterly color, size, and shape match combine in this stunning contemporary bracelet. The Hixon Collection in Los Angeles (right) illustrates sapphire's great color variety.

R. Esmerian, Inc.

an uncommon confusion in the 1700s. But on closer examination, I identified it as a flame-fusion synthetic ruby, manufactured in this century. Zoubov received a spinel, which somebody probably exchanged in the last few decades. Such switching no doubt accounts for a number of historical jewels being less than their labeled names.

Rubies and sapphires dominate the colored gemstone trade. Out of 30 to 40 colored gems, these two alone account for over half the total sales. But their importance pales in comparison to diamonds. No company has promoted any colored stone worldwide the way De Beers has publicized diamonds. The cartel controls about 80 percent of rough diamond sales and spends more than $90 million dollars annually promoting diamond purchases in the U.S. alone. Its slogan, "Diamonds are forever," is one of the most recognized in all advertising.

In the colored stone trade, there has never been an organization like De Beers. The American Gem Trade Association (AGTA) and the International Colored Gemstone Association (ICA) have begun their first gem promotions and plan more. In 1997 ICA spent more than $400,000 for the first international promotion of a colored gemstone—rubies. No single dealer or company could afford such mass-market advertising and promotion for colored gemstones, and no gem trade organization, such as ICA, can match the consumer-awareness display ads and commercials that De Beers does so brilliantly for diamonds. Thailand and Sri Lanka occasionally mount small promotions for their own national gem trades, but they do not concentrate on single colored stones or advertise globally.

Government of Myanmar

Burma rubies as fine as any ever found were retained by the government for these extraordinary and priceless rings (above). The color and clarity in the 5.56- and 5.25-carat gems illustrate ideal Burma quality.

New York dealer Ralph Esmerian says he envisioned a woman coming out of the ocean wearing only this belt when he designed this piece (opposite). Gem-quality ruby beads form most of the belt, which also includes a 113-carat cabochon emerald and a number of emerald beads.

Sri Lanka is famous for producing large, clear yellow sapphires (below). These superb untreated gems, 91 and 75 carats, were found in the 1960s.

Sri Bhadra Marapana

The padparadscha, *namesake of delicate pinkish orange lotus blossoms, is the rarest and often most expensive sapphire color. This unsurpassed gem (above), perhaps the largest ever found, was cut from a Sri Lanka crystal. "Pads" are prized by collectors, particularly in Japan, where they bring huge prices.*

True pads are usually said to occur only in Sri Lanka, but dealers often include brownish orange sapphires from Africa in the rare category, selling them as pads.

Gerhard Becker, Idar-Oberstein

Rubies are usually considered the most expensive of gems. Sold by the carat, which is an ancient weight now standardized as 1/5 gram or 142 to an ounce, some non-gem rubies are so large they are marketed by the kilogram. The Longido mine in Tanzania produces huge opaque ruby crystals surrounded by green zoisite, which creates a "watermelon" effect. At the mine (left) workers inspect ruby boulders before exporting. Thai dealers sometimes buy the material, hoping to find edges clear enough to facet.

But the bulk of Longido's output ends in Idar-Oberstein, in Germany, where carvers create incredible shapes like the elephant with gold tusks and an American Indian that capitalizes on the two-toned ruby-zoisite interface. One buyer even had a 16-inch long Mercedes carved for $240,000.

Matching colorless diamonds is easy compared to matching colored gemstones. Hue, brightness, and shape variations among rubies and sapphires increase the combinations toward infinity. For you it means the time spent accumulating matched sets costs money. I occasionally stop by Van Cleef & Arpels on Fifth Avenue to see a longtime friend, Véronique Ma'Arop. She says her single most difficult task is assembling rubies or sapphires for a major million dollar necklace, the firm's specialty. "I know before I start," she laments, "that I have a one- to two-year task before me. I can match sizes. Or I can locate similar shapes. But to get a size, shape, and color match is almost impossible."

Such difficulty in matching blue sapphires explains Australia's success over the past two decades. Its sapphires were so near black that they were easily matched. Sapphires from one huge Thai mining area were popular for the same reason. Often too inky to be truly blue, Kanchanaburi sapphires readily color-matched into jewelry. Because gems are most often worn in low-level incandescent lights at night, such inky blue-black stones look more like onyx than sapphires. Fortunately, such sapphires are no longer in favor as both Australia and Kanchanaburi produce very little today.

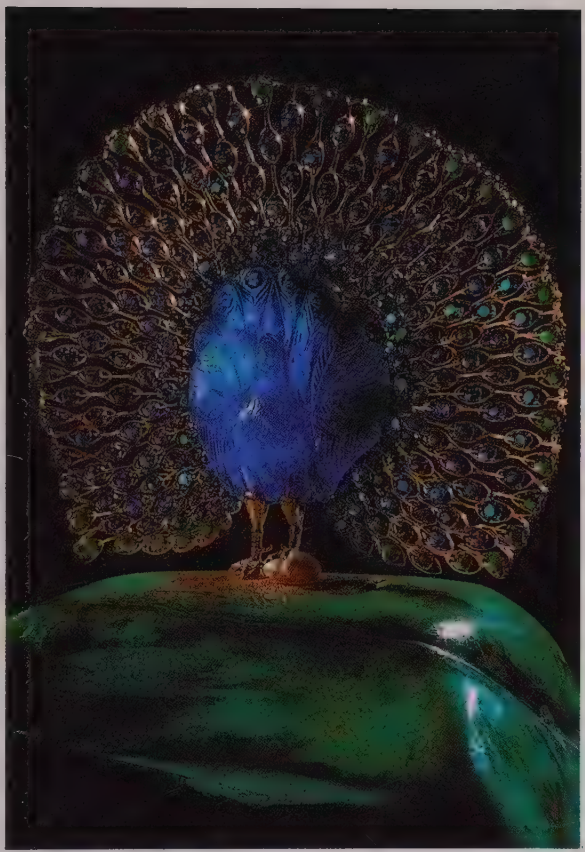
Sapphires are the bargain of the gem world. They are plentiful, which always affects price. Compared to other gems, little history is associated with them, which results in a lack of recognition. (Chances are the only named sapphires you can think of are stars—the *Star of India*, *Star of Lanka*, *Star of Asia*, *Star of Bombay*, *Midnight Star*. The famous named diamonds, the *Hope*, *Cullinan*, *Koh-i-noor*, *Eugenie*, *Tiffany*, are synonymous with history as well as beauty.) And the easy availability of inexpensive Australian sapphires over the past two decades led a generation of buyers to believe that sapphires were dull and dark, thus forgetting that fine, richly-colored sapphires are as rare and valuable as other gems—but priced lower.

Good rubies are so rare that few jewelers or buyers ever see them. No matter the source, a ruby, to be really valuable, has to be red! Purple and pink are not red. Despite what you will hear repeatedly, there is no such color as "pigeon blood." In fact, I know a frustrated ruby mine owner in Africa who flew to Burma, bought eleven pigeons, and took them and a Buddhist priest down to the ocean at midday. With chanting in the background, he chopped off each bird's head, dripped the blood onto his fingers, and waited the prescribed two minutes before looking. According to the samurai miner, instead of the desired prime Burma color, they were all "hot pink." Not one pigeon bled deep red.

Fellow gem writer Richard Hughes, who studied corundum from his former Bangkok home-base, and I agree that a major contributor to the allure of Burma ruby color is fluorescence. As we will learn in the next chapter, trace amounts of chromium (sometimes less than 1%) are responsible for the red color in rubies. This impurity also causes rubies to fluoresce under ultraviolet light or even in sunlight, giving Burmese rubies, which contain more chromium than most others, their appealing red glow. Some Thai rubies may actually be redder than Burma rubies, but they lack the same fluorescence. Burma's red is prized but no longer unique. Rubies from the new Vietnam

A large carved Burma sapphire is the peacock's body in this remarkable new creation (right), owned by the government of Myanmar. Blue sapphires highlight the feathers of this elegant bird, perched atop a small boulder of Burmese jadeite.

Ensconced in a drab, utilitarian safety deposit box in New York for the past 20 years, the 15.97-carat Mogok (opposite) created an auction sensation when its sale total soared to $3,600,000. That made its quarter million dollars a carat the highest price per carat yet paid for a ruby. Set as a ring in England, the jewel's location is now a secret.



mines look remarkably similar. In fact, the first few Vietnam rubies sent to gemological labs around the world for identification were erroneously classified as "Burma rubies." This is not surprising because the crystals are actually from the same geological area.

Vietnam's rubies and neon-bright sapphires, marketed as "hot pink," Tanzania's sapphires from Tunduru and Songea, and Burma's rubies from Mong Hsu are the world's most exciting recent corundum discoveries.

Some consumers wonder about their gems fading. "My ring looks great now, but will the color last?" a buyer asks. With rubies and sapphires the answer is yes. The color you love will still be bright and lively fifty million years from now. Some kunzite, topaz, morganite, and others may fade over time and exposure to light. But the colors in most gems are the result of impurities altering the structure of crystals. The crystal itself acts as a color filter. With a moderate amount of care, as discussed in the last chapter, your rubies and sapphires will be colorful and beautiful forever.

The Mogok Ruby/Graff, London

Synthetic Corundum and Simulants

The man in the front row grew more and more animated during one of my frequent gem talks. I sensed his excitement as he realized his choices between natural and synthetic rubies and sapphires. I continued projecting a selection of slides illustrating synthetics in jewelry, watches, lasers, microchips, and other industrial applications.

"Are you telling me those rubies were grown to be exactly the same chemically as natural rubies?" he questioned.

"Yes, that's right," I assured him.

"And they're flawless for just a few dollars a carat?"

"Right," I repeated. "And you can get them in almost any shape, size, and color."

"Then," he wondered aloud, "why would anyone spend thousands for a natural ruby when you can get one of those perfect synthetics for a few dollars? Which should I buy?"

"It depends on what you want, " I replied, and here is what I told him.

There are legitimate reasons for rubies' wide price variations. Understanding pricing will make you a smarter buyer. Four types of rubies are marketed—naturals and at least three different synthetics. Begin by applying the three traditional criteria for gems—beauty (which with colored stones means great color), durability, and rarity. I propose the gem trade adds a fourth criterion—naturalness. Humans place a premium on nature and things natural. Manufactured materials may be hard and beautiful, but they lack rarity and that special aspect of being formed in the earth. Thus, this natural factor, perceived value, supply, and demand all determine price.

"Natural" means just what it says. The trade defines it specifically as a gem formed by nature. In the strictest sense, natural also carries a second, more refined definition at an even higher price; a stone that has not been heated, irradiated, or enhanced. (Rubies, like emeralds, are sometimes oiled

John Chatham at Chatham Created Gems recently grew the world's largest gem-quality synthetic ruby crystal, 2134 carats.

H. Djevahirdjian S.A., Monthey, Switzerland

The world's biggest synthetic producer, H. Djévahirdjian S.A. in Monthey, Switzerland (above), makes flame- fusion rubies and sapphires by the ton in a process largely unchanged since the 1800s. Two thousand furnaces burn around the clock to grow corundum for watch crystals, bearings, and inexpensive jewelry.

Transparent sapphire crystals and ruby bearings in high-ticket watches use more than 40 tons of synthetic corundum a year. Century Time calls its unique all-sapphire timepiece "the watch that is a jewel" (below left). Saphikon makes unbelievable sapphire items, like this coiled condenser, which is used for cooling blood samples (below).

Century Time, Biel, Switzerland

Saphikon, Milford, New Hampshire

Flame-fusion crystals form fast. A single crystal of synthetic corundum (above) grows in 5 to 16 hours. The process is deceptively simple. Fine aluminum oxide powder (with metallic oxides for color) falls through flames, melts, and drops onto pedestals, where it crystallizes into a boule. Depending on additives, any color is possible.

Tiny doughnuts of red corundum (below) reduce friction and wear in Swiss watches. Synthetic ruby bearings are harder than spinning steel shafts they hold in place. Machinists once hand-drilled holes. Now, powerful lasers burn precision circles through microscopic discs for compasses, electric meters, and new-age electronic products.

Chatham Created Gems

The world's two principal synthetic gem ruby crystal growers melt metallic powders to create "flux," a molten simulation of the earth's magma. They add the ingredients of rubies, aluminum oxide and chromium, to crystallize. John Chatham (left) extracts ruby crystals from hardened flux at Chatham Created Gems.

After a multi-month crystallization cycle, Judith Osmer (right) empties still-glowing molten flux to harvest rubies like the one below which grow inside the platinum cups.

J.O. Crystal Co. (2)

or even "glass-filled" to mask inclusions.) Gemstones formed by nature can have everything—beauty, rarity, and durability—therefore, they have always been in high demand, which translates to high prices. Prices for natural rubies soar from more than $2000 a carat for commercial grades, to $25,000 a carat for fine jewels, up to a breathtaking $225,000 a carat for the gem on page 46.

Synthetics" are laboratory-grown replicas that have the same chemistry and characteristics as natural crystals. Gemology borrowed "synthetic" from science, where a synthetic material is a human-made duplicate. Three types of corundum synthetics are sold. Flame-fusion rubies and sapphires, the least expensive synthetics at under a dollar a carat, enjoy wide use in both jewelry and industry. Flux-grown rubies, sold only as gems, cost several hundred dollars a carat. And the final synthetic, Czochralski-melt or -pulled rubies and sapphires, are indispensable in high-tech applications.

"Simulants" are not synthetics but are inexpensive look-alikes. Cubic zirconia, when used to imitate diamonds or corundum, are simulants.

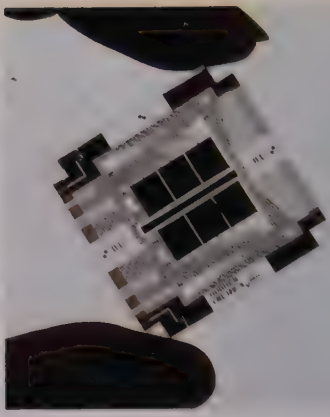
Only once did synthetic gems disrupt the market for naturals. Almost as long as people have worn adornments, they have dreamed of creating gems. Until the end of the nineteenth century, their fantasy had met with about the same success as transforming lead or straw into gold. Then, in 1891-92 in sealed letters to the Paris Academy of Science, Auguste Verneuil, a modern-day Rumpelstiltskin, described a new crystal-growing process. When Verneuil introduced his new rubies in 1902, they caused a sensation. He became the first synthesizer of precious gems, which he said were "equal

to nature's finest." Since jewelers and customers had no way of differentiating naturals from synthetics, prices for naturals plummeted. By 1907 production exploded to five million carats of rubies a year. That sudden influx relegated synthetics to low-priced commodities, and it took years for naturals to return to prices that accurately reflected their rarity.

The availability of inexpensive, uniform material resulted in a Swiss relationship that remains at the heart of synthetic ruby production today. The idea for jewel watch bearings to reduce wear and friction began in England in 1704. In 1830 the Swiss opened a natural ruby bearing factory, and by 1850 most Swiss watch movements pivoted on tiny ruby doughnuts. Verneuil changed the industry with less expensive and more homogeneous synthetics. Verneuil originally envisioned his material as gems, but industrial applications became a larger market. Today a single factory in Monthey, Switzerland, H. Djévahirdjian S.A., grows 80 tons of synthetic rubies and sapphires annually. From that, 40 tons go into a single product, watch crystals. The crystals of most watches that sell for $400 or more are slices of colorless synthetic sapphire. Transparent, strong, and impervious to chemicals and scratching (except by diamonds), sapphire is perfect for the task.

Flame-fusion synthetics, at the bottom of the market, now cost about a dollar a carat. These colored stones in birthstone and costume jewelry, graduation and club rings compete directly with colored cubic zirconia, rhinestones, the least expensive colored crystals from overseas, and glass or plastic imitations.

A big step up in price and rarity occurs with synthetic rubies and



Synthetic ruby rods for medical lasers (left) pass stringent final inspection at Union Carbide.

Engineers specify sapphire substrates, which naturally resist errant radiation, for microchips in satellites and military gear (above).

Sapphire plates (right) protect laser readers from scratches at grocery checkout counters.

sapphires made by an entirely different method. Flux-grown synthetics are the top man-made gems in cost and appearance. Two U.S. firms, operated by the Chatham brothers in San Francisco and by Judith Osmer in Los Angeles, make virtually all the flux-grown rubies in the world. It is not worthwhile to synthesize similar gem sapphires because their price is too close to diffused sapphires, and rubies are more profitable. The Chathams' father, Carroll, grew the world's first flux-grown gems—emeralds—in the 1930s, and John Chatham's research led to successful ruby production in 1978.

Gems grown in flux are a costly and time-consuming venture. As the first outsider ever to see inside the Chatham facility, I can verify that gem growing is an expensive and dangerous business. First John Chatham melts metallic powders in pure platinum crucibles at temperatures up to 1200° C. This flux duplicates the earth's molten magma, where natural gems form. Into this brew he adds small ruby seed crystals and the constituents of rubies, aluminum oxide and chromium. If everything works right, in nine to twelve months he cools the furnace and hammers apart the hardened flux ball. The new ruby crystals fall onto a table.

Of all the synthetics, flux-grown gems look the most like naturals. They even have inclusions, which Tom Chatham says "seem to be part of the

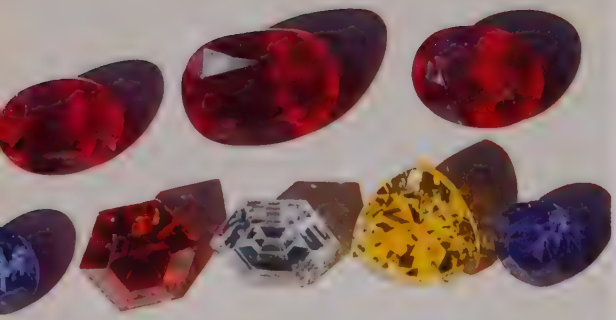
growth process. If we knew how to make our gems flawless, we would. We lose a lot of material in manufacturing and more in cutting because of inclusions. Our crystals are subject to the same stresses and growth processes as naturals." That is true except for an absence of pressure and movement.

Synthetic crystals grown by a totally different process are more at home in a research laboratory than a jewelry box. Invaluable to industry, rubies and sapphires from the Czochralski melt, or pull, process are stretching the limits of technology. When creating the first laser, Union Carbide considered a wide variety of materials. Chromium, the element that makes rubies red, also causes them to fluoresce, which is the vital feature that makes a laser work. A flawless, chromium-doped synthetic ruby rod was the heart of the world's original laser.

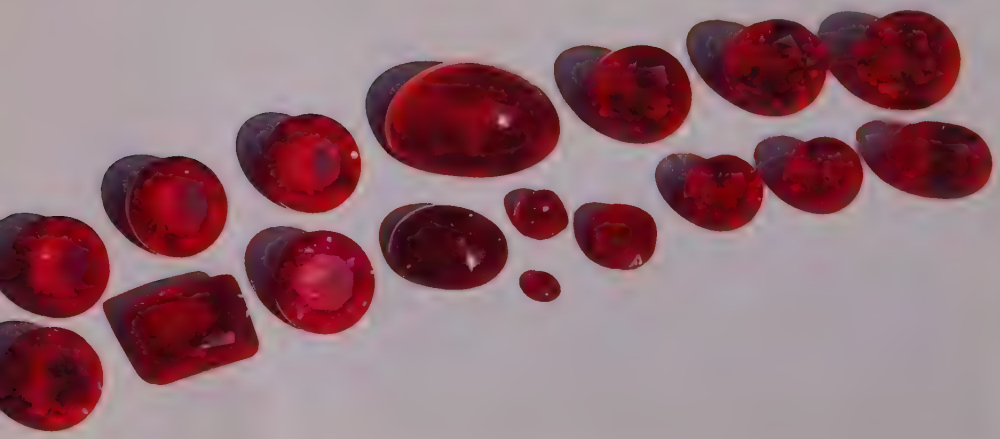
Synthetic sapphires also provide a solution necessary for communications satellites and nuclear defense systems. Radiation, either from the sun or from atomic blasts, sometimes causes errors in microchips. When stray charged particles penetrate circuits, they travel through traditional silicon substrates, upsetting normal readings. Sapphire, an almost perfect insulator, naturally "radiation hardens" circuits. Over the past few years, manufacturers

Separating natural gems from synthetics, simulants, and fakes is a job for experts. And sometimes even they get fooled. The cushion cut gem (far left) is a natural; its look-alike, a U.S.-made synthetic.

In the center picture, the rear three "rubies" are doublets, off-color sapphire crowns glued on top of synthetic ruby pavilions. In the bottom row, the first four imitations are cubic zirconia; the right imitation is synthetic rutile.



(Below) The left six rubies are flawless, so clean they are clearly man-made flame-fusion synthetics, worth just a few dollars a carat. The large Chatham cabochon flux-grown synthetic (near the center) sells for several hundred dollars a carat. The four middle stones are all naturals, from Tanzania and Burma. All six stones to the right are Czochralski-pull synthetics, which sell for about a seventh the cost of flux material.



have replaced traditional silicon on silicon chips with Silicon on Sapphire (SOS) in military and communication satellites and in microcircuits for missiles, fighter planes, tanks, and battlefield installations.

You come into weekly contact with a piece of sapphire larger than a queen's tiara, although it is never identified. Supermarket checkout counters need hard, clear windows for sweeping lasers to "read" product bar codes. After a few days of dragging cans across early glass windows, store managers found that scratches interfered with accurate laser readings. The top 1/32 inch of the new windows made by Saphikon in New Hampshire is pure sapphire. Although their less hard stainless steel frames need replacing, sapphire units in use eight years show no signs of wear.

Just like the supermarket laser windows, to work effectively, a missile's sensors must remain transparent. Saphikon's most innovative creation, a pulled single-crystal sapphire dome, protects the sensors in the nose of a heat-seeking missile. During months of training flights, airborne sand and other debris abrade traditional crystal missile windows. It is strategically unsound to defend a $30-million airplane or a billion-dollar aircraft carrier with a million-dollar missile blinded by scratches on its nose cone. The U.S. Navy is testing the sapphire domes, which cost a few thousand dollars each. Saphikon's esoteric product line also includes hair-thin sapphire reinforcing fibers for the supersonic aerospace plane, tiny sapphire tubes incorporated into automatic blood sampling machines (because blood won't coagulate on single crystal sapphire), and surgical tips for medical lasers.

Simulants are a persistent threat to gem buyers, and today's variety of fakes is staggering. Were these imitations represented honestly and sold at honest prices, they might be just another alternative for inexpensive jewelry. But all too often unscrupulous vendors dupe the unwary. From its pre-Roman origin, glass continues as the most common imitation gemstone. A whole new chemical stew of competitive materials makes differentiating fakes difficult for the casual buyer.

Another prevalent fake is a sandwich of two or three materials, which when set, you may find almost impossible to detect. The stone's top is often genuine but off-color ruby or sapphire. The bottom may be glass, synthetic ruby or sapphire, or blue or red synthetic spinel. A $10 price would be fine; offered for $1000 a carat, it is robbery. A new imitation I got in Bangkok was made to simulate a natural ruby's inclusions. Someone had heated faceted colorless quartz, then tossed it into cold water, causing the quartz to "quench-crackle" with hundreds of microscopic cracks. Soaked in red dye, the "ruby" fools the unsuspecting.

The best advice continues to be, buy from dealers you know and trust to stand behind their products. Be wary when you shop outside recognized stores. A tourist without gem training is fair game in Third World street markets. My tip for you is to carry a magnifier. Look for inclusions. Glass is typically clean inside, except for tiny gas bubbles, while natural gems usually have characteristic identifying inclusions. If the deal seems too good to be true, it probably is.

Buying and Caring

Buyers of fine jewelry usually ask the same two questions—where should I shop, and what is the best way to take care of my purchase? These are important issues. By choosing wisely you can avoid disappointment and save money. When I speak to groups or talk with clients, I give them as much information as possible. The more I share with buyers, the more they treasure their purchases. The result is to satisfy the customer so that he or she owns an object of lasting beauty, finds the perfect gift, or creates a piece of wearable art.

Buying is our first topic. Customers feel confident when they know what they are buying has inherent value. But one illusion I want to dispel immediately is that you can get it wholesale. It is no more likely that you will buy gems wholesale than that you will get your next car at true dealer's cost. Stores cannot sell at wholesale to retail customers, unless your brother owns a jewelry store, and even then it is unlikely. Everybody has to make a profit. What you really seek is to pay the least amount for the quality you want. That is smart buying, and it is possible if you follow a few sensible practices.

A jewelry store is a business like any other. The owner pays rent or mortgage, taxes, salaries, inventory, advertising, office expenses, and training, plus some extraordinary expenses, such as insurance and security. Managers have to make a profit. The store will not sell at a loss. As a smart shopper, it is your job to know what you want and what you are willing to pay. Be leery of discounters with continuous sales. Such "sale prices" are actually their retail.

World gem prices fluctuate depending on supply and demand. With a little study and research you can gather information for shopping. Newspaper ads for regular jewelry stores and discounters will give you a comparison. Window shop. Allocate several days to compare prices and quality at several retailers. Remember, with gems an almost imperceptible yellow tint greatly reduces the cost of a diamond, and a more intense hue raises the cost

A sumptuous array of glittering Montana sapphires lures color-conscious buyers to America's own high-quality gemstone.

Sapphire Gallery, Philipsburg, MT

racelets and ring, Sapphire Gallery, Philipsburg, MT; watch, private collection, Bangkok, Thailand

Mined and designed in the U.S.A., the multihued Montana sapphires in the above bracelets and ring are durable and beautiful. The elegant jewelry watch features matched diamonds and Thai sapphires. To keep a bright new look, wash sapphires in warm water with mild soap or detergent, or have them cleaned ultrasonically.

of a colored gem enormously. Be fair. Compare apples with apples. An unfair sales technique is to show you a heavily included ruby with mediocre color and insist that it is very clean with great color. By comparing stones you will recognize the difference.

Having lived half my life overseas, I know bargaining to be an honorable business practice in many countries. Generally, quality stores in the U.S. do not bargain. A store will inform you if it sells only at marked prices. A considerable benefit from a reputable jewelry store is its high-quality ongoing service. You will have a place to go for questions, cleaning, repairs, and additional matching pieces. Discounters and mail order firms advertise lower prices partly because they provide little or no service. A favorite practice among such retailers is to raise prices 5 times, hold a half-price sale, and still net more than most jewelry stores.

You have other buying options. Designers and goldsmiths will work with you to make custom jewelry. Personal shoppers can make your buying trips. The important consideration is to find what fits you.

With an expensive gem, I recommend obtaining a laboratory report verifying color, clarity, size, finish, etc. The Gemological Institute of America, EGL-USA, and other reputable U.S. and European labs provide this expert service. Ask your jeweler which labs issue reports that the trade respects.

Some aspects of caring for gemstones are best left to experts. This 10-carat ruby (right) recently sold at auction for one million dollars with a visible chip on its edge. Although an owner might choose to hide the imperfection with a prong, the responsible dealer opted to have the ruby recut, losing part of a gem valued at $100,000 a carat. Recutting is an option with old gems too. Many antique stones lack the brilliance achievable with modern cuts. Sacrificing weight when recutting may actually increase the value of your heirloom.

Finally, there is the question of value. I wrote earlier of gems as concentrated, portable wealth. Historically, fine gems maintain value better than many other luxuries. Dealer Jack Abraham estimates rubies are 50 times rarer than diamonds, but cost only a few times more for similar size and quality. That would appear to make rubies somewhat of a bargain. A bigger bargain is sapphires, which still sell for hundreds to thousands of dollars a carat instead of the tens of thousands a carat that top quality emeralds, diamonds, and rubies command.

My advice is to buy the best ruby or sapphire you can afford. Such gems are usually stronger and can easily withstand daily wear. Some of my clients consider durability, rarity, and uniqueness as important as beauty. Realize that almost all rubies and sapphires are heated to enhance their colors and improve clarity. Assume your gem is heated unless specifically told it is not. Increasingly common is the presence of "glass-like" fillers, such as borax, in rubies. These mask inclusions and improve a gem's appearance. Whether a by-product of heating or deliberately placed in a ruby, such enhancement should be disclosed.

Rubies and sapphires are almost perfect gems. At Mohs 9, they are harder than all other gems except diamonds. And they are durable. They will scratch anything they come into contact with except diamonds, and only diamonds will scratch them. So keep your rubies and sapphires separated

from softer gems, from each other, and from diamond jewelry. Store your jewelry separately, preferably in soft bags. Almost any of your gemstones are harder then gold, platinum, or silver and so will scratch the metal holding your gems. So avoid letting gemstones touch other gems or jewelry mounts.

Almost any cleaning technique works. You can normally use ultrasonic cleaners, steamers, warm soapy water, and brushes. Regular washing and cleaning are good for your gems and makes them sparkle. You should avoid cleaning heavily fractured gems or oiled rubies with mechanical cleaners. Steam or ultrasonic cleaning might remove the oil. Rubies and sapphires are among the most durable and colorful of all gemstones. At least once a year have your fine jewelry examined by a professional jeweler. Simple regular care will help keep your treasures beautiful for a lifetime.

For gift-giving and planning, remember that ruby is the birthstone for July. Also remember that rubies must be red. Corundum in any other color is a sapphire, not a ruby. Sapphires, the birthstones for September, come in every conceivable color. Do not feel limited to blue. Although blue is certainly the most recognized and purchased sapphire color, dazzling jewelry is available in yellow, pink, orange, green, gold, teal, and colorless sapphires. Put a little color in your life with other sapphire colors.

Whatever your preference, wise gem buying promises excitement and reward. In the end, jewelry is better than a bouquet of flowers or a box of candy; visually stimulating and satisfying, rubies and sapphires are much longer lasting.

ntana sapphires from Fred Ward

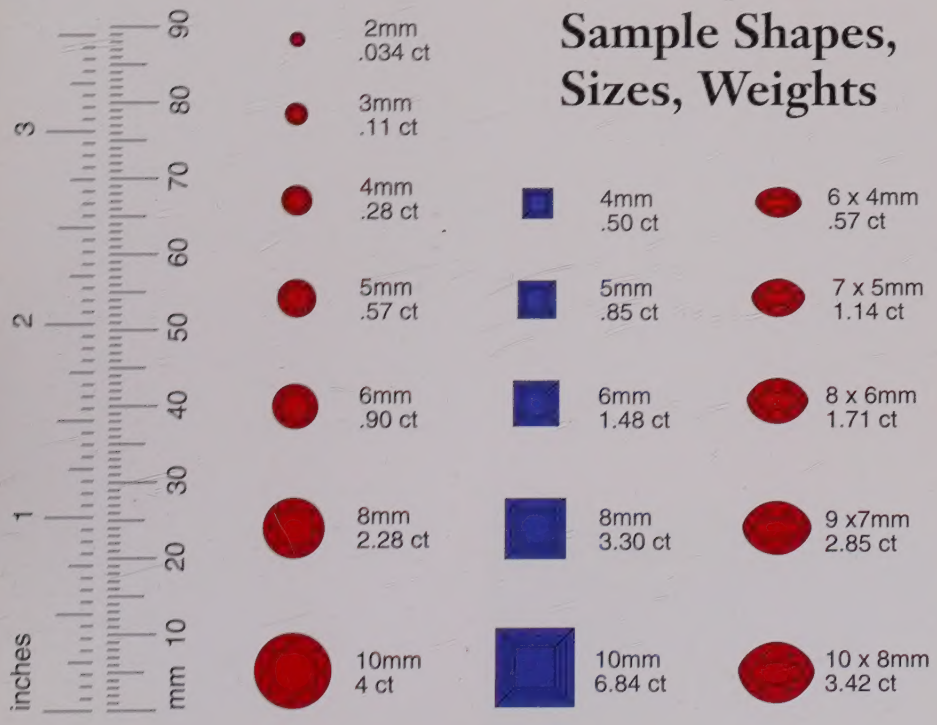
Nature's finest, most perfect creations capture time in wearable form, forever new, eternal. When you buy rubies and sapphires, you own the rainbow.

Gemstones are sold by weight, not by size or volume. This significant difference makes them more like gold and silver than other luxury products such as furs, yachts, automobiles, or watches. Since gems are comprised of different chemical elements, they do not all weigh the same. Therefore, gemologists use weight as one means of identification.

Weight, or density, is expressed as specific gravity (SG). Diamond has an SG of 3.52, which means a diamond weighs 3.52 times as much as the same volume of water. Rubies and sapphires are heavier, with an SG of 4, quite high for gems. In practical terms they are dense, with a solid, hefty feel. They also vary in size from other gems of the same weight. This is important when choosing settings.

Gems are weighed in carats (not to be confused with *karat*, which refers to the purity of gold). A carat, from the ancient Indian use of carob seeds for small consistent weights, equals 1/5 gram, or 1/142 ounce. Sizes are measured in millimeters (see below). A round one carat diamond, a standard in the trade, is typically 6.5mm in diameter. A round one carat ruby or sapphire, being denser, measures 6.1mm across. So, rubies and sapphires of the same weight as a similarly cut diamond are physically smaller.

Cutting proportions vary far more in colored stones than diamonds, especially from Third World cutters. When buying, the main considerations after color and clarity are the quality of the cutting and the final proportions. Beauty is a major component in the "make" of a colored gem.



Approximate weights of round, square, and oval rubies and sapphires in a variety of sizes.

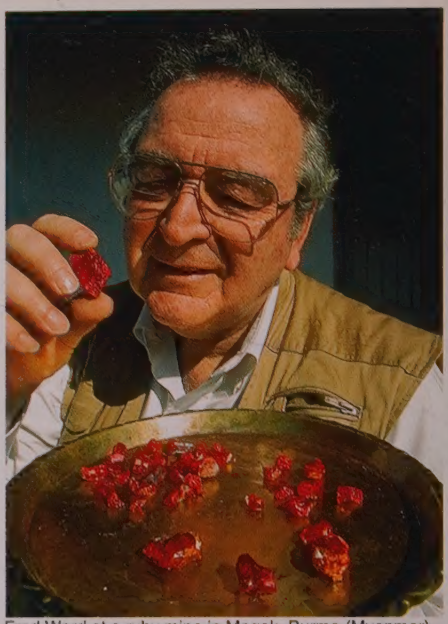
About Fred Ward and his Gem Book Series

Glamour, intrigue, romance, the quest for treasure... these are all vital aspects of mankind's eternal love for gemstones. For as long as people have roamed the world they have placed extraordinary value on these incredible crystals.

Rubies & Sapphires was the first in a series of eight gem books written and photographed by Fred Ward. Each book, *Diamonds* (in English and in Russian), *Opals*, *Pearls*, *Emeralds*, *Jade*, *Rubies & Sapphires*, and *Gem Care* is the culmination of a year-long global search into the gem's history, geology, lore, and sources. Fred Ward personally visited all sites and examined each artifact to provide the most authentic and timely information available in the field. His original articles on these topics first appeared over 14 years in *National Geographic* Magazine. Mr. Ward is a Graduate Gemologist (GIA), the gem trade's highest academic achievement.

Endlessly surprising, *Rubies & Sapphires* are actually the same material, corundum. They are formed in every color of the rainbow. All are sapphires except when they are red. Red corundum stands alone, in price and rarity, because red corundum is ruby.

Fred Ward at a sapphire mine in Sri Lanka



Fred Ward at a ruby mine in Mogok, Burma (Myanmar)

Mr. Ward, a respected authority on gems and gemology, is in great demand as a speaker to professional and private groups. After years viewing the gem trade from the inside, he formed a custom-jewelry firm that specializes in fine custom-designed jewelry and private gem searches for discriminating clients.

When he is not exploring gem mines overseas, Mr. Ward lives in a secluded woods near Washington, D.C. with his wife Charlotte, who edits the gem series texts .

This book was printed by Haff-Daugherty Graphics in Hialeah, Florida, using Janson Text Roman type. The book is part of the computer revolution with all-digital layouts and typesetting in PageMaker, color scans, separations, and color-correction in Photoshop, and all assembly on a Power Computing Power Tower Pro 225.

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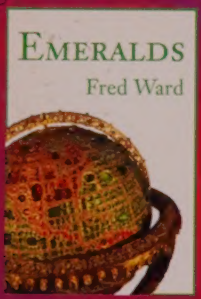

"The color work is superb and the text is so interesting that lay person and jeweler alike will eat it up. It is so handsomely presented that it can't help but be a great value in enhancing gem knowledge."

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