From Satan's Crown to the Holy Grail

Emeralds in Myth, Magic, and History

DIANE MORGAN

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Introduction

Rocks are among the commonest things on earth, and the strongest. The very word pulses with power: the Rock of Gibraltar, the Rock of Ages, bedrock, "like a rock." Throughout the ages, which themselves take their names from rocks (Paleolithic, Neolithic, the Old and New Stone Ages), humankind has been enthralled with the simple power of stone: the strength of granite, the cool serenity of marble, the firepower and surgical sharpness of flint.

Above all, the glitter of gems has enchanted us and held us hostage. Despite their secret birth underground, they live a rather public life among us, admired, bought, sold, and hoarded. They have become ours in a way a hunk of raw granite never can. Gems have studded ears, adorned fingers, encircled arms, and emblazoned belly buttons. Bits of compressed carbon no larger than a match head have transmogrified themselves into emblems of undying love. Nothing could be more civilized.

Or more brutal. Men have bled for rubies and drowned for emeralds. They have killed for beauty as they have killed for love. And this has been the case forever. Popes and kings, emperors and magicians, commoners and criminals, all have looked to these glowing fruits of the earth as a means to wealth, status, power, or spiritual achievement. Countless legends tell how gems have cursed, blessed, persecuted, or utterly changed their wearers. According to ancient lore, gems can confer chastity, enhance virility, calm storms, and provide insight into the future. Hidden just beneath their shining depths are a thousand strange tales and curious adventures.

The tiny jewels winking suggestively at us from store windows, the faded rubies, flawed diamonds, cloudy emeralds, and dull sapphires, seem a far cry from the storied stones of yore: the Hope Diamond, Star of India, and the

fabled Koh-i-noor. But they fascinate us still. We spend months of income for a flash of fire on our finger, a piece of sky at our throat. Even the poorest among us spend their first or last nickel for a little bit of bling.

It seems very odd, but then a gem is an odd thing: part nature and part artifice, a nexus between the natural earth and the civilized world. The strange alchemy that turns soot into diamond has worked an even more remarkable transformation on the human spirit. It has taught us to prize beauty over usefulness and symbol over fact. This impractical preference may be the final barrier that separates us from our animal cousins, who, by and large, are sensible enough to know that diamonds are not good to eat, and therefore have no practical importance. (Their marginal value in industry in no way accounts for the esteem in which they are held.) Gems cannot satisfy hunger, quench thirst, or return affection. Their worth is primarily reflective, more a mirror of our own desires than a portal to some unknown and magical world. Or perhaps they are both.

All gems have two births. The average gemstone is born in fire and baptized in rivers, living hidden underground, trapped in its matrix, until discovered and resurrected into a new and perfect body in a lapidary's shop. It is oiled, polished, drilled, ground, etched, inscribed, and faceted. It sounds painful. But the lapidary knows the gem's secret, knows that brooding within the hidden, earthy heart of every gem smolder the raw lights of the cosmos: sky, moonlight, and stars.

For truly there is *something* about gems, something below the earth and above the world, something magic. It's the elemental magic that makes the gem as hard as stone, as clear as air, shining as water, as alive as fire. I use the word "magic" deliberately. These are not simple baubles; they are fearful stones of awesome power. Somehow we know that to wear a gem is to ally oneself with the crystallized force of the universe, and with its immeasurable beauty. We're hoping just a little will rub off.

That's magic. To deny the magical power of stone is to throw away our history and our hopes. To hold a rough, unpolished rock is to touch our past. To gaze into a polished stone is to hold a magical mirror to ourselves. Gems contain our longings, our passions, our aspirations, our virtues, and our fears. They enter our consciousness at every level: material, intellectual, moral, and spiritual.

Every gem has a story. Part of that story is the earth's secret, and part is a matter of public record. Another part lives in the imagination and myth.

Yes, every gem has a story. This is the story of the emerald. It's a tale of fire, water, and serendipity. From the beginning of history, the emerald has had ties with both the sacred and the profane. Legend says that an emerald belonging to Satan himself was found by the Queen of Sheba, who gave it to King

Solomon. Later, the Holy Grail was carved out of it. It sounds impossible, but it's all part of the extraordinary business of being an emerald.

This is also a tale of robbers, miners, explorers, fanatics, nabobs, conquistadors, gods, and kings. Some worshipped emeralds, some destroyed them. Some found them, some lost them. Some lived for them, some died for them, and some killed for them. This is their story too.

The Green Legend

The very first emerald in the universe belonged to Lucifer. According to legend, it was the chief jewel of his heavenly crown, glowing brilliantly in the light of the Lord. But then the Troubles came, and Lucifer the Shining became Satan the Adversary, the prideful Fallen Angel, disgraced in the eyes of God, and cast into Hell. But the emerald did not follow its first master. As Satan was hurled into the burning pit, the stone slipped out of his now-tattered crown, and tumbled to Earth—from which it was born anew.

Wise emerald. For this great stone knows it belongs neither to Heaven nor to Hell. It is an earthly creation, sister to the verdant land and green-shining sea. It's here on Earth that it began its history, a history of grails, goddesses, and conquistadors, a history that is both true and mythical, sometimes both at once. It has the longest history of any major gemstone. From the very beginning it was clear that the emerald, above all other gems, had a significance that surpassed even its surpassing loveliness. It is of course the symbol of spring, love, youth, and rebirth. But it is so much more.

SAY THE SECRET WORD

The mystery of the stone begins with its name, whose origins lie as deep as the stone itself. The word "emerald" comes to us ultimately from the Sanskrit word *marakata*, which simply means "green stone." It's a stretch, but there it is. The ancient Egyptian term *mafek-en-ma* likewise refers simply to a green stone, and was used to describe peridot, malachite, and turquoise as well as emerald. This may seem odd to us, but of course, the Egyptians had no way of scientifically determining the composition of a rock. Besides, for

the Egyptians, the most important thing about gemstones was their color, which had a high symbolic value in their culture. And green, of course, is the defining characteristic of emerald, just as hardness (not sparkle) is the defining characteristic of diamond.

The "emerald" word traveled along through the Persian *zamarrad* and Arabic *zumurrud* through the Greek *smaragdos* (again meaning simply "green"). The connection between the Sanskrit *marakata* and the Greek *smaragdos* can be seen if you look carefully.

From *smaragdos*, it's a pretty straight shot to the Latin *smaragdus* to the Middle English *esmeralde*. Stop along the way for the Spanish *esmeralda* and the French *emeraude*, also the name of that lovely evening perfume. The Germans tried very hard to transform *smaragdos* into their own language, and for a while were stuck with *schmaragt*, a word which eventually back-evolved into *Smaragd*. It may be difficult to pronounce, but it harks back nicely to its Greek roots.

The Myth and the Magic

If the history of the name is misty, the mystery of the stone itself is downright foggy. Like the name, emerald myths have traveled the globe. These travels can be symbolized, perhaps, in the Emerald Scepter of Prester John. Prester John (or Presbyter John or Priestly John or Priesty John) is one of the most mysterious figures in Western myth. His ancestry is uncertain, but some claim he was a descendant of one or all of the Wise Men. He is variously portrayed as a king, pilgrim, explorer, caliph, lama, pope, or saint. Various sources have him traveling to Asia, Ethiopia, and India at differing times between the tenth and sixteenth centuries. He was supposed to have left behind a bunch of letters detailing his exploits with elephants and pygmies, as well as his trips to the Fountain of Youth and the Garden of Eden.

The only constant element in the various stories told about him is his Emerald Scepter, which he carried wherever he went, and which symbolized his fabulous wealth. To the ancients, who didn't know how to unlock the fire of the diamond, and to whom the ruby symbolized blood and war, the emerald always remained the supremely good and peaceful stone of earthly power and heavenly riches. Not coincidentally, Prester John was often considered a protector of the Holy Grail, which in many accounts is made of emerald. Could his scepter itself have been the Holy Grail? Did he hide it by keeping in plain sight?

The emerald has adorned as many legends as it has bodies. No other gem has had so many magical and supernormal powers attributed to it. Long tradition declares that the emerald used in magical rites should be worn alone, for other stones can diminish its power.

Physicians in Greece and Rome believed that merely placing an emerald upon the eyelids would cure inflammations and infections. The emerald was said to facilitate childbirth, and if women wished to hasten the event, they could do so by wearing an emerald bound to their thigh. Doctors of the Middle Ages averred that dangling an emerald over the abdomen would cure dysentery. (In some Hindu systems, on the other hand, the emerald was used as a laxative, just what you don't need if you have dysentery.)

Even today many people believe this stone to possess special virtues for physical health, mental acuity, and spiritual or psychic development, although it is not clear whether or not the stone reveals future events in its own depths like a crystal or ball or merely enables the wearer to see them in her mind. It is said to protect chastity and assure a happy marriage. Emerald is supposed to aid meditation, strengthen memory, and provide keener insight into dreams. Dreaming of an emerald means the renewing of friendship and a bright future. It imparts the gift of eloquence. On a psychological level, emeralds are said to impart psychological balance, tranquility, and patience. In the symbolism of the early Christian church, the emerald represented purity, faith, and immortality. Emerald green is worn during "ordinary" time throughout the church year—that is, at times other than Advent, Christmas, Easter, or Pentecost.

Contemporary "crystal medicine" healers attribute to emeralds the same powers as did the most ancient writers. It is considered a "body stone," representing structure, strength, renewal, creativity, stability, and prosperity.

In olden days emeralds were reckoned to cure leprosy; today their powers have been updated to counteract the evil effects of radiation toxicity. While they once fought demons, they now cure mental illness, depression, and neurological disorders. Emeralds can enhance the immune system, banish insomnia, detoxify blood, free prisoners, cure infertility, raise libido, bring sweet dreams, and treat ailments of the heart, eyes, pancreas, backbone, lymph nodes, intestines, kidneys, and thymus. They alleviate complications from diabetes. Set in copper or silver, they cure arthritis of the hands, elbows, and shoulders. Touch an emerald against the throat to renew energy. To top it off, they provide access to universal truth.

How does this magic happen? Crystal therapists declare that the "emerald rays" focus on the weakest area of the body, the place where the "vibratory rate" is lowest. When an emerald is worn, it neutralizes negative energies. When you're really sick, however, you may need to wear as many as 75 or more carats of emerald to counteract the evil energy. Not only that, emerald energy must be "continually replenished" since there is such a "massive war" going on between the emeralds and the disease. Emeralds should also be worn after healing to allow it to resolve the "corresponding inner-body disharmony." They can also, we are assured, undo magic spells. And there is something even more mysterious.

The Unownable Stone

Emeralds are the unownable stones. It is they that possess their wearers, not the other way around. Emeralds can be bought, filched, and borrowed, but never truly possessed. They may lend themselves to us from time to time, but eventually, they are lost, cracked, pawned, or re-stolen. Sometimes, as with Lucifer's emerald, they seem to steal away by themselves. Lucifer is not the only one to lose an emerald from his crown, after all. The same thing happened to King George III of England, from whose crown, it is reported, a large emerald fell during his coronation. Believers in the stone's predictive powers claimed (after the fact) that the loss of the stone presaged the American Revolution and consequent loss of the colonies. More cynical observers noted that it was more likely the loss of George III's reason than of the emerald which precipitated the revolt.

The ancient Greeks were equally adept at losing emeralds, sometimes on purpose, often with disastrous results. One such story concerns Polycrates, a savage political adventurer who seized the tiny, beautiful isle of Samos around 530 BCE. His two brothers helped him, but after taking over the island, Polycrates killed one and banished the other, so he had the place all to himself. Under Polycrates's leadership, Samos became even more beautiful; he built a fabulous temple to Hera, a breakwater to protect the harbor, and aqueducts. He also attempted to expand his power, and created a strong navy to that end. But alas, things never work out as one plans. Herodotus, the father equally of history and tall tales, tells us that Polycrates's good friend, Amasis, king of Egypt, was disturbed by Polycrates's extraordinary good luck. He warned him that the gods tended to be jealous of the fortunate and suggested a remedy: "Reflect on what you most love, something whose loss would cause you the acutest pain, and toss it away so that it will never appear again." For some odd reason, this seemed like a good idea to Polycrates. He never considered the fact that perhaps the gods had brought him the good luck in the first place and might be irritated at his throwing it away, or that Amasis was a little on the jealous side himself. At any rate, Polycrates decided to listen to Amasis and toss his emerald and gold signet ring into the sea.

He set out in one of his fifty-oared boats, and rowed out a long, long way. In full sight of the rowers, he removed the treasured ring from his finger and tossed it gamely overboard. He didn't feel very good about it, though, and mourned its loss for days afterward. But, as luck would have it (and what is this tale about, after all, but luck?), a few days later, a fisherman caught an unusually large and tasty-looking fish. He thought it so impressive he presented it to the king as a gift. Polycrates was pretty amazed too and asked the fisherman to stay for dinner. When the cook cut open the fish, guess what

was inside? Yes, the very signet ring itself. Unnerved, Polycrates wrote to his friend in Egypt, recounting the whole tale, which apparently spooked Amasis to the point where he said he didn't think it was such a good idea for them to be allies anymore.

Sure enough, hard times soon came, as Samos was attacked. Still, Polycrates's luck held, and he managed to repel the invaders. At last however, his own greed got the better of him, and he went on a fool's mission to retrieve some boxes of gold and jewels from Magnesia, where he was viciously killed and his corpse crucified. Herodotus blamed ill luck for all this, but some might argue that Polycrates had no one but himself to blame.

Even Alexander the Great, who conquered the whole known world, couldn't seem to hang onto an emerald. According to legend, Alexander (who wasn't technically a Greek but pretended he was) used to wear a large emerald in his belt, but lost it in the Euphrates River on his return from India. He was only trying to take a bath when, alas, a snake leaped out of the water and bit the emerald right off, and then dropped it into the river, where it presumably remains to this very day. Alexander died very soon afterward. It's not clear where the emerald came from originally, but certainly not from India. India never had any emeralds worth stealing. At any rate, this is one emerald that never reappeared. Some people claim the "emerald" may actually have been a chrysoprase; it's hard to tell after all these years. No one has found any chrysoprase in the Euphrates either, so it makes little difference now. Oddly enough, one of the powers of emerald is that it is supposed to help retrieve lost objects. Since emeralds are lost so frequently themselves, this must be a bit of countermagic.

Where Are They Now?

Mineralogically (as opposed to mythologically) emeralds turn up, at least occasionally, on all continents except Antarctica. They are probably there, too, if anybody wants to bundle up and go looking for them. There's certainly enough pegmatite down there, which is the bedrock of emeralds and a lot of other things. Pegmatite is a coarse-grained granite comprising a variable mixture of mineral aggregates, including large crystals of quartz, feldspar, mica, and beryl. Because pegmatite is such a rich source of rare elements, it can also be economically important, the hiding place of not only beryllium, but also such exotics as niobium, tantalum, lithium, rubidium, cesium, and gallium.

Pegmatite is widely distributed in the earth's crust and has been observed in chunks as big as 3,000 meters long and 700 meters wide. The oldest pegmatite deposits (located in Canada, Greenland, and Russia) are nearly

3 billion years old, almost as old as the earth's crust itself, while the youngest deposits (Himalayan) are a mere 5 million or so.

It's now possible to determine the provenance of an emerald scientifically. Different locations have unique rock formations that leave telltale "fingerprints" on the stones they produce. This has been known for a long time, but identification has now been made remarkably accurate. A group of researchers, led by Dr. Gaston Giuliani of the Institut de Recherche pour le Développement and the Centre de Recherches Pétrographiques et Géomimiques-CNRS in France, developed a method to pinpoint the source of an emerald.

The breakthrough process first involved vaporizing a microscopic bit of the subject emerald with a laser, and then analyzing its ratios of oxygen isotopes. These values reflect the composition and temperature of the fluids that crystallized to form the emerald. This in turn told the scientist about the rock material through which those fluids traveled before they were consolidated into the gemstone. The technique checks for lines in emerald spectra that correspond to deuterated water, in which one of the hydrogen atoms of the water molecule is replaced by its isotope deuterium. Atoms of different rare earth elements that are present strain the water bonds, producing up to five additional bands in the pattern. In this way the researchers could identify the country and sometimes the actual mine a particular stone came from.

However, vaporizing even small bits of valuable or historical gemstones has its obvious drawbacks. So, the CNRS researchers, along with people from the National Polytechnic Institute of Lorraine, invented a new, nondestructive procedure that looks at the absorption of infrared light by different specimens. The scientists collected samples from forty-six emerald mines around the world and discovered that the spectra of the stones fell into five different groups, corresponding to their geographical regions. Even within a group, there were detectable differences between individual mines.

The group has now tested emeralds from the world's major emerald mines, and the results have been intriguing. In some cases it appears that emeralds coming from deposits supposedly discovered only in the twentieth century were actually from mines known as far back as Roman times, and not such recent finds after all. On the other hand, they discovered that three emeralds belonging to the Nizams of Hyderabad, which legend said came from Alexander the Great, hailed from Colombia in the sixteenth century. The researchers have also used the method to show that a putative Colombian emerald recently for sale at a gem show in Basle, Switzerland, was from Afghanistan instead.

Still, simply because emeralds are found on every continent doesn't make them common on any continent. On the contrary, they are rare everywhere.

Interestingly, emeralds seem to be most plentiful in places like Colombia, Russia, Zambia, Zimbabwe, Pakistan, and Afghanistan. Why more gems are not found around the Riviera is a mystery.

Perhaps there's even a cosmic dimension to all this. According to some New Age enthusiasts and purveyors of "therapeutic gemstones," emeralds are actually found all over the universe, at least on every planet where there is life. According to this notion, emeralds work to sustain life by providing "green ray" nourishment. Despite the charming mental picture painted by thoughts of gleaming green stones on Jupiter and beyond, there is no scientific evidence whatever to back up allegations that emeralds occur anywhere except on the planet Earth (although of course they may). There is also no evidence that they provide any green ray nourishment, whatever that may be.

The Birth of the Stone in Myth and in Rock

The story of the emerald is one that sweeps the planet from Egypt to Afghanistan, from India to Colombia. In fact, ancient Colombian peoples, the Muzo Indians, have at least two stories about its birth. In the best-known tale, the original, raw, unfinished landscape developed its current features as the sky god Are tramped slowly through the land, his shadow darkening the valleys, and the mountains bulging out on either side of his footsteps. He formed the first woman (Fura) and the first man (Tena) from the riverbank soil. At first, they were lifeless clay statues, but the god threw them into a river current, where they were purified by the river foam, and became living beings. At that time, Are gave them the first commandment: be faithful!

Tena and Fura lived peacefully in their land for a few centuries until a young man named Zarbí showed up apparently out of nowhere, like Cain's wife. Zarbí was hunting for a magical flower whose fragrance cured all pain and whose essence healed all illnesses. Seeing that he wasn't having much luck, Fura kindly offered to look around the forest with him. You can imagine what happened next—they fell in love, and ran off into the jungle to consummate their illicit passion. However, Fura's conscience got the better of her. She grew sadder and sadder, and began to age rapidly. Apparently, her previous fidelity had kept her young.

Noting the new wrinkles on his wife's face, Tena figured out what was going on and decided to get vengeance on the adulterous couple, and then kill himself. He chased Zarbí onto a bare, rocky stretch of ground that was eternally struck by the blazing heat of the sun. But Zarbí hit upon a unique

defense. He ripped out his own innards, and the resulting hemorrhage was converted into a torrential flood to prevent Tena from getting any closer.

Although this part of Tena's revenge was thus foiled, the rest of his scheme unfolded rapidly. He made Fura kneel down while he committed suicide by slicing himself across the heart and perishing on her lap. Fura was forced to remain in place three more days, weeping tears that cleansed the blood-soaked corpse of her husband. Then the flood of blood-water from Zarbí (the River Mero) poured down, separating the spouses. All this was too much for poor Fura. Her agonized screams tore through the jungle and broke into millions of butterflies. And her tears? Well, they were transformed by Are into a mountain range of emeralds.

At this point Are, fickle like most gods, restored Tena and Fura to eternal life among the emerald mountains. There they live still, protected from further temptation and from the rest of the world by raging rivers, blazing sunrays, and poisonous serpents. These things—blood, tears, storms, serpents, beauty, and immortality became part of the legend and history of the emerald. They have all served to make the stone and its history more mysterious, more precious, and more strange.

The second Muzo story, much briefer, is a typical forbidden fruit (or, in this case, "gem") tale. The primal couple was forbidden to touch one particularly sacred vein of emeralds, but they were talked into grabbing some prohibited stones by the demon Zarb (obviously another version of Zarbí). Then, the pair was turned into granite (the bedrock of emerald), and the emerald tears they wept formed the channel of the Minero River. This river still flows near Colombia's great emerald mines.

A Rocky Start

Heavenly jewels and magical mountains are all very well in their place, but for those whose mystical imagination is deficient, there's a more mundane version of how the emerald came to be. More mundane—but scarcely less miraculous. Because emeralds shouldn't exist at all. Or, if they do, it's by the quirky will of the gods, after all. Emerald is at least twenty times rarer than diamond. Its formation seems more a gift from the magic hand of chance than of the laws of physics, which, come to think of it, incorporate chance itself into the very structure of the universe. So perhaps emeralds should be expected after all. Let's go back several million years to witness the miracle of emerald birth.

Since emeralds are neither vegetable nor animal, it follows that they must be mineral. (A *rock* is technically a substance made up of two or more minerals.) Minerals are defined as inorganic, homogenous, solid substances with a chemical composition that is variable within quite narrow limits. They are

noted for their highly ordered atomic arrangement, which in most cases is crystalline. About 3,000 different minerals have been identified on earth, with untold numbers elsewhere.

Technically, a mineral is a *naturally occurring* substance. This means that a synthetic stone is not a mineral, *even* if it has the same chemical composition and structure as a naturally occurring one. Thus a synthetic emerald is in the rather odd situation of being a "real" emerald, but not a "real" mineral. However, this semantic morass should not detain us. We have bigger fish to fry.

Among the vast and extended clan of minerals, the emerald belongs to the charming and attractive beryl family. The word "beryl" comes from the Greek *berullos*, meaning "crystal." Beryl in turn is a member of the large group of minerals called "silicates," as reflected in its formal name: beryllium aluminum silicate. This simply means that it's made up of aluminum, beryllium, and silicon together with some oxygen. It's been said that what carbon is to living creatures, silicon is to the earth. However, you practically never find silicon on its own, but always combined with another element. Here the silicon combines with oxygen, forming silica. Silica is everywhere, not just in the valley.

Chemically, beryl's name is written like this: $Be_3Al_2(SiO_3)_6$. This is just a shorthand way of telling chemists the proportion of different atoms in the crystal. However, the formula is not as rigid as it looks; there can be some variations in the beryl's chemical composition, depending upon what if any stray atoms got mixed up in it when it was being made. For example, emerald and aquamarine are both beryls, although each includes a few atoms of some other material that changes its appearance and color, but does not alter the essential structure of the mineral. (In like manner, both ruby and sapphire are the mineral corundum, but each has been altered by "foreign" atoms that make them red and blue, respectively.)

Emeralds and beryl were first recognized to be one and the same mineral by the French Abbé René-Just Haüy (1743–1822) in 1798. (Haüy wasn't a real abbé, it was just an honorary title.) It is rumored that Haüy was also the first person to use the term "pegmatite," but he is most famous for discovering the geometrical law of crystallization. He was thrown into prison during the French Revolution, but was saved by the intercession of others, and was eventually appointed a professor of mineralogy under Napoleon. I'd like to say this was a happy ending, but the Restoration government laters deprived him of his appointment and he died in poverty.

Still, the good abbé is so important in mineralogical circles that the New York Mineralogical Club held a gala to celebrate the 175th anniversary of his birth on February 28, 1918. The adventurous menu included whale steak and pea soup.

The Beryllium Factor

Beryls cannot exist without their signature element, beryllium. Most people aren't very familiar with this metal, so here's a brief introduction. With an atomic number of only 4, it is light, hard, brittle, and silvery white. It is relatively rare. Only 1.5 parts per million of the earth's upper crust is beryllium. There's more beryllium in the earth than there is silver, but it's more expensive and difficult to extract from its ore. Its melting point is 1285°C and boiling point is 2780°C. One weird thing about this element is that the speed of sound (about 12,500 meters per second) is greater in beryllium than in any other element. But the most wonderful thing about beryllium is that it makes emeralds.

Like silicon, beryllium never occurs in isolation, combining readily with fluorine, chlorine, bromine, sulfur, selenium, and phosphorus. Besides being incorporated in beryl, it occurs in bertrandite (beryllium silicate hydroxide), a mineral found in certain volcanic rocks. Bertrandite is the major ore for beryllium. It is plentiful in Utah, which supplies almost all of U.S. beryllium production, which in turn is about two-thirds of the world supply. So what if the Saudis have the oil? We have the beryllium. If you went looking for beryllium, you'd find it in pegmatite, black shale, mica schist, and aluminum and silicon-rich magmas—the same places you find emeralds, actually.

The first person to isolate beryllium was Louis Nicolas Vauquelin (1763–1829), professor of chemistry and assaying at the School of Mines in Paris. He did the trick in 1798, the same year in which Haüy identified emerald as being a variety of beryl. Vauquelin was an analytical chemist, which meant that he spent most of his time breaking down various substances into their constituent parts. It may sound boring, but it was an absolutely essential step in understanding the makeup of matter. The late eighteenth century was the real beginning of analytical chemistry, and Vauquelin wrote 378 papers in all, analyzing first one thing and then another. Vauquelin should be honored by nutritionists, as he was the first person to separate fats, proteins, starches, and sugars from biological materials. In his spare time he thought about insects and breathing. His own death, the *Catholic Encyclopedia* assures the reader, was "very edifying."

Vauquelin was not successful in producing pure beryllium, although he came close with beryllium oxide. Beryllium itself was first obtained (although in an impure condition) in 1828 by two other analytical chemists: Antoine Alexandre Brutus Bussy of France (1794–1882) and Friedrich Wöhler (1800–1882) of Germany. Although both were credited with the discovery, they worked independently. They accomplished their aim by a reduction of beryllium chloride with potassium in a platinum crucible. Wöhler is also famous

for being the first scientist to isolate urea from ammonia in 1828. Aluminum too. He had wide interests. Bussy is apparently admired in magnesium circles, as he was one of the first to isolate that element.

In 1899 the French scientist P.M. Lebeau finally obtained pure beryllium in small, lustrous hexagonal crystals by electrolyzing the double fluoride of beryllium and sodium or potassium with an excess of beryllium fluoride. After he got it, however, no one knew what to do with it.

Star Power

Beryllium remained a sort of laboratory curiosity until 1932, when James Chadwick (1891–1974) used it to prove the existence of the neutron. Chadwick won the Nobel Prize for this achievement, although later he found out that a German, Hans Falkenhagen (1895–1971) had discovered neutrons at about the same time, but was too afraid to publish his results. (It takes courage to be a physicist.) Chadwick offered to share the Nobel Prize with him, but Falkenhagen refused, whether from modesty or from another reason is not really certain.

Although the human race had trundled on for millions of years without knowing of the existence of neutrons, within 15 years of their discovery we managed to make the world's greatest bomb out of them. Chadwick was involved with the nuclear project, along with fellow researcher Enrico Fermi (1901–1954), who was actually killed by beryllium.

Beryllium used to be called glucinum, which means "sweet," since it actually has a sugary taste. Unfortunately for the early chemists who were munching down on it, beryllium also happens to be highly toxic. Eating metal is nearly always a bad idea, as even the earliest scientists should have known. (Arsenic is a metal too.) In fact, microgram for microgram, beryllium is one of the most toxic elements on the periodic table. Breathing beryllium dust isn't very good for you either. When inhaled, the dust particles can produce beryllosis, which is similar to silicosis, and destroys the lungs in much the same way. Luckily, beryllium is locked up pretty tightly in beryl, so emerald wearers don't need to worry about being poisoned by their gems even if they grind them to powder and eat them, which has sometimes been done in an effort to achieve some magical cure.

Fermi was smart enough not to eat beryllium, but he did breathe in a lot of beryllium dust during his research. He later commented that he never thought working around "a little beryllium" would destroy his lungs and kill him, but it did. He also had stomach cancer. Oddly, some industrial workers seem little affected by the dust, breathing it with reckless abandon. Nowadays, of course, safety measures are in place.

Beryllium was designated a "strategic material" during World War II, not just for its excellence in bomb making, but also for the superior alloy it makes with copper. Now that the call for atom bombs seems to have temporarily slacked off, the greatest demand for beryllium comes from the telecommunications industry. It is also used to make x-ray machines.

But beryllium has an importance that goes far beyond its usefulness in killing or x-raying people (which is sometimes the same thing). While its role in emerald-making is our main concern, this element has a more cosmic pedigree. In fact, the history of the universe is etched in it. Without beryllium, life as we know it would not exist. How did this happen? That's a question whose answer lies not in the bowels of the earth but in the shining stars above.

All life, as we know it, is based on carbon. (And so are diamonds, of course. Diamonds are nothing but carbon atoms lined up in a special way.) But carbon itself could never have been born without the direct involvement of beryllium. In fact, beryllium "sacrificed" itself to make carbon in a process that ultimately ended with carbon becoming one of the most abundant elements on earth while beryllium turned into one of the rarest.

The technicalities of how all this happened belong to the realm of astrophysics, but thanks to the astronomer Fred Hoyle (1915–2001) for working it all out. The problem had to do with how the lighter elements managed to combine to form carbon. While other scientists remained stumped, for the life of them not being able to imagine how it all happened, Hoyle persisted. He grimly applied the so-called anthropic principle to his research: that is, "I am carbon-based, and I know I am here, so I know I got here somehow."

First he tried the usual blind alleys. Perhaps three helium atoms collided to make a carbon nucleus. This turned out to be statistically impossible. The chances of three helium atoms being in the same place, traveling at the right speed, and slamming into each other nearly simultaneously, are too slim, even on a cosmic scale, for any measurable amount of carbon to form. In fact, the chances are so remote that to explain it, Hoyle invented the analogy that a million monkeys chained to a million typewriters could write *Hamlet* sooner than enough random helium atoms could collide in sufficient numbers to make enough carbon.

Hoyle became entranced with his own analogy and went on to determine it would take a billion years or so for the monkeys to create a grocery list. Other scientists have developed other scenarios about how long it would take various numbers of monkeys to create various literary works, although it seems like sort of a pointless exercise. We should really return to the fascinating business of creating carbon.

Hoyle figured out that the only way carbon could be created in the universe in the quantities we now see (and carbon is the fourth most common element)

is if there was a match of nuclear energy levels (resonance) between the helium, hydrogen, and carbon. This "resonance" wasn't found in ordinary carbon, but Hoyle predicted that since it *had* to exist (otherwise he wouldn't be doing astronomy or anything else), there was some kind of "excited" carbon that would provide the correct matchup. This "excited carbon" was indeed found. The excited carbon was formed in a two-step process. First two helium collided to make an unstable kind of bereyllium (beryllium-8) with a third helium crashing into the beryllium (before it fill apart) to make "excited" carbon. Excited carbon has the normal six protons and six neutrons, but because of the extreme temperatures inside the stars where all this is taking place, they're hyperactive—jumping around in the nucleus more than usual. The matchup wouldn't occur often—but it would happen frequently enough to produce all the carbon presently existing in the universe. And that is the beginning of us. The process also helps explain why the earth is just crawling with life (literally) while emeralds are few and far between. And not so coincidentally, it explains why beryllium-based emeralds are so much rarer than carbon-based diamonds.

Human beings and emeralds, then, both owe their existence to this beautiful meeting of matter. Helium makes beryllium and beryllium makes carbon. And while most of the original beryllium in the cosmos gave itself up for carbon and diamonds, there was just enough left over for a few emeralds.

It is not for nothing that Fred Hoyle is called the "Father of Nucleosynthesis." He was never awarded the Nobel Prize, but he did get to be Royal Astronomer to the Queen.

Fred Hoyle was wrong about the Big Bang, though. It really happened. Hoyle was opposed to the idea because he thought that if there was a Big Bang, there must be a Big Banger (i.e., a creator) and as an atheist, Hoyle didn't like the idea. The fact is that a Big Bang theory doesn't necessarily imply a Big Banger, but Hoyle was too upset to see that. Later, he grudgingly conceded that there might be a god after all, but then suggested instead that perhaps we were all created by aliens. Where they were supposed to come from, I have no idea.

Back to Basics

It is time to come down from the stars and entrench ourselves rather deeply in the earth. There is no other way to plumb the deep mysteries of the emerald. To do this we will run across some rather technical terms like "greisen" and "schist," so steel yourselves. It's no worse than nucleosynthesis.

Earlier on, I mentioned that the existence of emeralds is a quirky thing. While some of the elements that constitute beryl are very common (silicon,

aluminum, and oxygen), beryllium is extremely rare in the earth's upper crust (1.5 parts per million or ppm). The coloring elements of emerald, chromium or vanadium, while not as rare as beryllium (185 and 230 ppm, respectively), are brought together with it only through an unusual combination of geological conditions.

Rocks are more complicated than they may seem. They come in only three basic varieties: igneous, metamorphic, and sedimentary, but each variety has a habit of turning into one of the other kinds under favorable conditions. This is called the "rock cycle," and over the eons rocks can be melted down and reborn as another kind of rock, in repeated and sometimes overlapping processes.

The three rock families are classified according to how they were formed, but all of them can make gems. Igneous rocks are born from fire. (You can see the word "ignite" in the root.) They have solidified from magma, the molten material raging within the earth's crust. The precise composition of any igneous rock depends upon where it collected and how fast it solidified. The kind of magma that gives birth to most emeralds is plutonic magma—magma that crystallizes slowly deep in the crust, and becomes what we call granite. (As hot blobs of molten igneous rocks called "plutons" cool under the surface, elements escape from them that chemically change the surrounding or "country" rock.) The more slowly a rock solidifies, the bigger the crystals that form within it.

The other kind of magma is the stuff that gets spewed out of volcanoes as lava. It's flashier at first blush, but usually not so productive in the long haul as far as rock formation goes. Still, African and Brazilian emeralds form from minerals that crystallized from direct volcanic activity into fine-grained material called rhyolite, which is similar to granite.

The second major category of rock is sedimentary, which are formed by the accumulation of weathered rock fragments. A common example of sedimentary rock is limestone. Sediment is an erosion product of igneous, metamorphic, or other sedimentary rock—you see how all this gets recycled. Sedimentary rocks are important sources of Australian opal, but we can forget about them as far as emerald formation is concerned. Still, many emeralds are found *in* sedimentary rock, even though they were not *created* there. These are called "secondary deposits," because they were originally formed by crystallization from magma or aqueous or pegmatite solutions or by metamorphic recrystallization.

The third class of rocks is "metamorphic" or "changed body" rocks. Metamorphic rocks are transmogrified from another kind of rock, such as sedimentary or igneous (or even another kind of metamorphic rock). They have changed form in response to heat and pressure, and come in an amazing

variety. Emeralds can develop in metamorphic rocks called *schist* and *greisen*. Greisen is a granitic (granite-like) rock formed from quartz and mica, while schist is a flaky stone characterized by coarse-grained minerals like mica. Most emeralds, other than those found in Colombia, occur in mica schist, which accounts for the predominance of black, mica inclusions within them. Schist can develop from basalt, an igneous rock; shale, a sedimentary rock; or slate, a metamorphic rock. Mica schist used to be clay or mudstone. Schist "foliates" or splits along its planes into thin shiny flakes or glistening slabs in a wavy, discontinuous way. Schists and associated host rocks are formed by the chemical interaction between granitic rocks and the enclosing, silica-deficient rocks. Here the beryl crystallizes, changing the original rock composition through a process scientists call *exometamorphism*. Unfortunately, from the collector's point of view, metamorphic rocks usually restrict the size of emerald crystals; large emeralds from metamorphic rocks are exceedingly rare.

One source, mercifully nameless (okay, it's the British Columbia Geologic Survey) presents this "capsule definition" of "schist-hosted" emeralds: "Emerald deposits principally related to mafic and ultramafic schists or unmetamorphosed ultramafic rocks in contact with felsic rocks, either pegmatoid dikes, granitic rocks, paragneisses or orthogneisses. Such contacts may be either intrusive or tectonic." It is language like this that explains why more people don't go into geology. They used to call these rocks "acidic" and "basic" respectively, but geologists now prefer the new terminology. Even when dealing with stuff as old as rocks, there's always something new.

Emeralds form in a variety of geologic environments, but there are two major ways to "make" them. One way depends on magma. The other process, called the hydrothermal process, depends on extremely hot (about three times the temperature of boiling water), mineral-rich water which flows through cracks in calcite-laden rocks. Calcite is calcium carbonate, the main ingredient of limestone and seashells. Most emeralds in the world result from the magma process, but the exceptionally large, pure Colombian emeralds are created hydrothermally; these emeralds are typically found in calcite or quartz veins, not in schist. You may be familiar with a simplified form of the hydrothermal process if you ever grew salt crystals in science class. However, it's a lot easier to make salt than to make emeralds.

In both the magma and the hydrothermal process, elements are exchanged, bringing together the components needed to form emeralds. The way things work out, the magma or hot water has part of what is needed to make the beryl or emerald—the surrounding rocks have the rest. However, both processes require the right ingredients in the right amounts and the right conditions at the right time. The hot water or magma provides beryllium and silica,

while the host rock supplies the aluminum. Even more important for beryl formation, granitic pegmatite is a major source for beryllium.

When beryl is in the making, its chemical ingredients, aluminum, silicon, and beryllium, "migrate" from the granitic material they call home into the adjoining rocks. This forms pegmatite, which is deemed an "intrusive igneous rock." The word "intrusive" has nothing to do with the rock's manners; it's simply geology talk for the rocks that form slowly within veins that have intruded into other rock. (The quick-cooling, small-grained rhyolite spewed out by volcanoes is called "extrusive.")

Minerals that develop in pegmatite typically get *a lot* bigger than minerals in other kinds of rock. In fact, pegmatite is rather famous in geological circles for creating big crystals. The largest known crystal in a pegmatite is a spodumene from South Dakota, which measured almost 13 meters (42 feet) long.

Most emeralds form in what is called "contact metamorphic" rock, a narrow zone in which hot magma comes into contact with limestone or shale. Limestone seems an ordinary rock, but it is remarkable stuff, formed chiefly from the remains of living organisms, mostly shells. All the limestone we know was originally at the bottom of some ocean. The glorious emeralds of the Muzo mine of Colombia are embedded in calcite veins found in limestone that run vertically through black shale. These emeralds are so beautiful that they can be displayed in their original matrix of white or black calcite. Nature can sometimes do a better job than Tiffany. However, since the real profit in emeralds isn't in display minerals, but in gems, thousands of fabulous specimens are brutally ripped from their matrices in order to be cut up into dinner rings.

Emerald Add-ons—Chromium, Bubbles, and Gastropods

To make an emerald proper and not just ordinary beryl, we now need only the missing ingredient—that sneaky chromium that colors the stone. It doesn't come easily. The chromium required to replace aluminum in the crystal structure and to color beryl green doesn't occur in sufficient concentrations in granitic rocks. Typically, beryllium is located close to the surface (8–10 kilometers), while chromium is concentrated much deeper in the earth (40–50 kilometers). In addition, chromium concentrates in the silica "milk" of the magma first, and beryllium last, so they are concentrated at opposite ends of the crystallization process. So, normally, these two elements are considered "geochemically incompatible."

Only when the two ends are mixed are emeralds born, an event that occurs in the course of extreme tectonic activity. Other beryls, including other pegmatite gems, have a more peaceful creation, taking shape in calm environments that allow them to grow into big crystals. Not so emeralds.

Emeralds are formed in wild geologic environments that are stormy, abrupt, and stressful. Really huge emerald crystals are therefore rare. According to the *Guinness Book of World Records*, the largest emerald in the world is Colombian, at 7,025 carats. This is the famous Emilia emerald. It is uncut, privately owned, and considered priceless.

The thrilling process of emerald creation imprints its trace in the very heart of the emerald in the form of tiny crystals or delicate gas bubbles. In some cases (notably with Colombian emeralds) enough time passes that there are actually *three-phase* inclusions: liquid-filled cavities, gas bubbles, and crystals. There can even be four-phase inclusions: a cavity with two immiscible (nonmixable) liquids, a gas bubble, and another crystal. These inclusions are absolutely unique to each individual emerald, providing a sort of a birth certificate.

One of the most interesting inclusions come from emeralds found in the Colombian mines of Muzo and Coscuez, and not elsewhere. These "trapiche-emeralds" contain black, carbonaceous impurities that form a six-ray star. The name "trapiche" comes from the Spanish word for the gears used in sugarcane crushing machinery, to which the Spanish fancied a resemblance. The sad history of the sugar industry in this hemisphere parallels in a queerly fitting way the history of emerald mining. So, perhaps the name really is appropriate.

Colombia's black shale, which contains the chromium needed for emerald, was washed off the western coast of the continent to collect on the sea floor. They would have stayed there forever, except for the fact that, the earth's crust does indeed move, in a process called plate tectonics. About 65 million years ago the Caribbean Plate smashed into the Brazilian Plate, pushing its entire sea floor of black shale onto South America. (The world's oldest emeralds are from South Africa—almost 3 billion years old. And the world's youngest emeralds are Pakistani; they are only about 9 million years old.)

As the tectonic plates continued their crashing dance, the earth folded and faulted, giving rise to conduits through which the hot, mineral-laden fluids could escape from the molten rock located deep in the earth's crust and rise through the black shales. If these fluids picked up enough vanadium or chromium (along with all the other necessary ingredients) emeralds may have formed as the hydrothermal fluids began to cool in fractured deposit veins or schist. These same hydrothermals also washed out most of the iron that often mars other emeralds. As soon as the circulation stopped, the emerald precipitated in these cracks as extremely pure crystals.

Once they are crystallized in the matrix, they tend to stay there. In Sanskrit, the emerald was sometimes called *acmagarbhaja*, which means "sprung from the rock," which says it all, if you can say it at all. One of the reasons for the high price of emeralds is the difficulty of extracting them from this host rock. This makes emeralds different from most other gems. When

gems are separated from their matrix by erosion and tumbled around and carried by rivers to a new destination, such as lakes, oceans, or streambeds, they are called alluvial. It is common to find diamonds, rubies, and sapphires this way. However, it's not very often you will catch an emerald in gem gravels or along a natural riverbank. Even if they get loosened somehow (usually by dynamite during the mining process) and cast into a stream, emeralds seldom survive. The characteristic faults and inclusions of the stone allow it to disintegrate before someone is lucky enough to happen across one.

If emerald-making sounds a bit complicated, it is. And now there's something new. The Institut de Recherche pour le Développement (IRD), in conjunction with the Centre de Recherche Pétrographiques et Géochimiques (Center for Petrographic and Geochemical Research, or CRPG/CNRS) and the Muséum National d'Histoire Naturelle have recently made the first ever identification of gastropods fossilized in Colombian emerald crystal. This event happened about 65 million years ago, while the general emerald-making process was in the works. Gastropod is a fancy name for a slug, but the ones under discussion are apparently a new species, although the fossils are not in good enough shape to tell for sure.

The encapsulation of these ancient slimy beings sheds new light on how the emerald deposits formed. Tectonic movements of the earth allowed the emerald parent fluids to pour along fault planes across a Lower Cretaceous sedimentary bed in which the gastropod-bearing strata were buried. Fluids from the sedimentary formations dissolved the shells, leaving cavities in the rock where the emerald could crystallize. The shells underwent a complex process of dissociation–substitution shell by the emerald. The substitution process, well known in the case of pyrite, carbonates, or opal, had never before been described for precious gems.

From Mine to "Mine": The Emerald Business

The rarity of emeralds, combined with their strange beauty, has turned emerald trading into a $2.2 billion industry. While not so popular as the ubiquitous diamond, whose hardness makes it suitable for everyday wear, emeralds seem to appeal to a more educated and sophisticated buyer. And carat for carat emeralds can be more valuable than diamonds of comparable quality. I say "can be" because the emerald market is notoriously soft and volatile, with prices rising and falling in response to numerous factors that seem only marginally related to the actual availability of the stone. Rarity, of course, is an interesting concept. For example, some stones are fairly common but the demand is so great for them that they seem to be rare. Truly fine amethyst, on the other had, is quite rare but, because people today don't appreciate great color in amethyst, this doesn't matter. The price for a very good amethyst remains quite low. Diamonds have a high market value not because they are truly rare (120 million carats are mined every year), but because there is a high demand plus a very carefully controlled distribution system. Let's call it a cartel.

The earliest known gem price concerns an emerald. In the fourth century BCE, a frugal but ostentatious flute player named Ismenias heard about an emerald engraved with the figure of the nymph Amymone for sale in Cyprus. The price was six gold staters, which probably comes to less than a couple of hundred bucks today. One stater was worth about four drachmas in ancient Athens, if that's any help.

Unfortunately, we don't know how big the gem was or how good the engraving was. And, of course, we don't know if it was really an emerald,

although it doesn't matter at this point. Ismenias sent out an agent to buy the stone. The poor man bargained the stone down to four staters, thinking he was doing his notoriously thrifty boss a favor, but alas, Ismenias took it the wrong way. He actually wanted the agent to buy the stone for its original selling price, so he could brag about how much he spent on it. He berated the poor fellow, telling him that he had seriously impaired the value of the stone by his hard bargaining. According to Pliny, Ismenias is said to have complained: "By Hercules! He has done me but a bad turn in this, for the merit of the stone has been greatly impaired by this reduction in price." So from the very beginning, gemstone prices have caused no end of trouble. If you're curious about Ismenias's abilities as a musician, I can only offer the comment (repeated by Plutarch) of Atheas, king of the Scythians. Atheas said, "I liked the music of Ismenias better than the braying of an ass."

To be sure, a price tag of six staters is a lowly beginning for an emerald, where a large, valuable emerald might sell for $30,000 per carat. Today, over a billion dollars worth of emeralds are mined worldwide every year—about 50 percent of this in Colombia, followed by Zambia, then Brazil, Pakistan, Zimbabwe; much smaller amounts are found in a dozen other countries.

Today, emeralds are probably the "softest" part of the "big four" gemstones market, with their value highly and sometimes wildly fluctuating. Part of the problem is the inability of governments, especially Colombia's, to control emerald production. And that's a by-product of the nature of the emerald business. For instance, in a typical mining operation, bulldozers slice vast areas across the mountainside; the miners follow up with hydraulic jacks and dynamite. Mining companies run lots of water over the "overburden" to expose the emerald veins. While this technique makes it easy to uncover the bigger crystals, many smaller ones are lost or carried down the mountains into muddy "riverbeds" where illegal "miners" search for them. It's considered good fortune if the mine owners actually end up with as much as 30 percent of the production.

Currently, emerald dealers are divided about marketing emeralds. Some favor a bourse or free-trade zone in Colombia. A bourse would favor the consumer, as it provides security for buyers and a code of ethics, as well as a gathering place. After all, most people don't want to stop at 2000 offices all over Bogotá. However, Colombia's small, independent miners are opposed to the idea, believing that it would create a monopoly by large dealers.

While emerald mining is usually a very labor-intensive process, it doesn't require a huge capital investment in equipment, although a few beryllometers and color sorters come in handy. Diamonds are another matter. A typical diamond mine investment is in the order of $600 million. Emerald mining costs nothing like that; a mere $2 million can set you up in some areas.

A Rose Is a Rose, and an Emerald Is a Crystal

Emeralds can be described scientifically in many ways—by crystal type and structure, by color and light properties, by hardness, luster, specific gravity, molar mass, and by the many other measurements that make the emerald what it is and not a diamond or a skunk.

One way to describe an emerald is by examining its basic structure. Emerald is a crystal. This means it is a solid body with flat planes, or "faces" arranged geometrically. A crystal is the next thing to a living being, growing and developing with an almost Aristotelian imperative. In the case of beryl, part of that imperative is also to grow into six-sided shapes. Something inside a beryl crystal cries out, "Be hexagonal!" and so it is.

A crystal possesses a regular, orderly arrangement of atoms repeated over and over about 100 million times per centimeter. This regular structure differentiates a crystal from say, glass, whose atomic arrangement is much more random and even disorderly. This more random arrangement is called "vitreous," and opals are the only gemstones which belong in that category. Thus, all gemstones except opals are crystals.

Crystals can grow in all kinds of different ways. Some end up long and thin, others are squarish, but until the Danish anatomist, geologist, and Roman Catholic prelate Niels Stenson (1638–86) came along, no one knew why. Stenson is better known as Nicolaus Steno, because that's his Lain name, and he preferred to write in Latin. This was wise of him; had he confined his work to Danish, it would have been years before anyone got around to reading it.

The result of Steno's work was the First Law of Crystallography, now called Steno's law, elucidated in 1669. He hypothesized that minerals must have some kind of internal order, and while the science of his day did not allow him to see how atoms were arranged in the crystal, he could measure the angles between the faces, and this, he discovered, was critical. Steno's law says the angle between any pair of crystal faces is always the same, and it is this constancy of angle, rather than the size of the crystal, that is characteristic of any particular mineral. (Steno also discovered the principle of horizontality and the law of superposition, both of which have to do with fossils and rock layers. In his spare time, he dissected shark heads. He discovered the excretory duct now called the duct of Steno of the parotid gland, which is one of the salivary glands, but we don't have to worry about spit right now.)

Atoms in a crystal occupy particular positions in what is called the crystalline lattice, the basic structure of the crystal. The chemical composition of the crystal determines what atoms go where in that lattice. Steno figured out that you can group crystals into 32 classes by the kind of symmetry they have and group those classes into seven systems based on the relationship of

their axes (imaginary straight lines drawn through the ideal centers of the crystals).

Crystalline objects have different sequences of atoms along the various directions of the crystal. This usually results in a difference in the physical and chemical properties in divergent directions. (The technical word for this state of affairs is *anisotropy*, which is also responsible for birefringence, which we will talk about soon.) Glass, on the other hand, is characterized by *isotropy* (equality in all directions). Anisotropy makes a crystal "grow" differently than glass would, if glass could grow. Let's pretend you have a real crystal ball. If you heat it, it becomes an ellipsoid, simply because the atoms are arranged differently along its several axes. Do the same thing with a glass ball, and it will get bigger, but it will stay spherical, because its atoms are arranged in an equal though random way.

This does not mean that crystals are asymmetrical; it means their symmetry can be complex. Some crystals have what is called "reflection symmetry." This means there is a plane of symmetry dividing the crystal into two "specularly equal halves" or mirror images. Other crystals, like emeralds, have "rotation symmetry." Rotation symmetry occurs around an axis about which the crystal is said to "rotate," and still show identical aspects. The third kind of symmetry, "inversion symmetry," occurs in relation to a center of symmetry, a point from which imaginary straight lines may be drawn to intersect identical points equidistant from the center on opposite sides. All these properties can be combined in a single crystal.

Emeralds have rotational symmetry because they are cyclosilicates, part of the hexagonal crystal system. (All hexagonal system crystals further belong to the dimetric crystal group, which simply means that there are two measurements of equality in two directions.) This means that they have three equal axes, intersecting at 60° angles in a horizontal plane, and a fourth, longer or shorter, axis, perpendicular to the plane of the other three.

If you look down one axis, you'd see stacked, hexagonal rings of silicon atoms (sixfold rings) each of which is surrounded by oxygen atoms in a tetrahedral arrangement. The silicon rings are connected by bonds between alternating aluminum and beryllium atoms. Each aluminum atom is surrounded and bonded to six oxygen atoms, and each beryllium atom is surrounded and bonded by four oxygen atoms. Like other beryls, emeralds belong to the most complete class of symmetry of the hexagonal system: holosymmetric, dihexagonal-bipyramidal. They are "first-order hexagonal prisms." If you can visualize this, you have what it takes to be a crystallographer.

How the crystal faces are oriented determines the overall "habit" of the crystal. Habit refers to the shape in which a certain crystal tends to "grow." Some minerals have only one habit—emeralds have several. Often they appear as well-formed hexagonal prisms, either flattened or elongated, with pincoid

terminations, rather like the eraser at the end of pencil. (This is common with emeralds from Colombia, for instance.) Very rarely, beryl can occur in a "twinned" form, which means two (or more) crystals have grown together, in accordance with certain natural rules of orientation. Twinned crystals have an additional element of symmetry. I suspect we have spent enough time on this subject.

If you subject something to enough stress, it cracks or breaks. That is the nature of the universe. How something breaks depends upon its internal atomic structure. There's a whole mineralogical vocabulary for smashing minerals. If a mineral breaks along irregular conchoidal *surfaces*, it's called a *fracture*. Fracture surfaces are usually uneven. Conchoidal fractures, the most common kind, break along smooth, curved surfaces, producing a shell-like (do you see the word "conch" in "conchoidal"?) and glassy (vitreous) sheen. Emerald, obsidian, and quartz, along with many other minerals, are subject to *conchoidal fracture*.

However, if the stone breaks along the *planes* of its crystal face, it's not fracture, but *cleavage*. Only crystals have cleavage; other substances fracture. Cleavage really means the preferred way that minerals "break" along certain lines. Brittleness, the tendency to break easily, is related to cleavage. Just as with crystal faces, the cleavage of a mineral gives a clue to the mineral's identity. It can be easy to mix up cleavage with a face, but a face is a *growth* surface, while a cleavage is a *breakage* surface, even they look rather alike to the untutored eye.

It's important for gem cutters to understand the cleavage of crystals, since it helps them to make attractive cuts. Some stones, like diamonds or mica, have perfect cleavages. Emeralds, on the other hand, although they do exhibit cleavage parallel to the base and perpendicular to the prism faces, have an indistinct, weak, seldom visible cleavage. This is but one element that makes emeralds difficult to cut.

"Streak" is another way to identify stones. If you rub a mineral across a piece of nonglazed porcelain (a streak plate) it will leave a trace of powder. The color of the powder can help identify the mineral. Emerald, even though it is green, leaves a white streak like talc. In fact, most translucent minerals which come in various colors (resulting from a "foreign" coloring agent not essential to the basic structure) yield a white streak, even if they appear to be another color. The mineral fluorite, for example, can appear as purple, blue green, or yellow, but it will always leave a white streak. The reason is this. Emerald's color comes from just a trace of chromium. Light needs a lot of "travel time" to pick up the coloring effects of chromium, which occupies very little of the crystal. This is one reason, too, why small crystals are often paler than large ones—and by the time we get to a speck of powder—the color effects are no longer visible.

At one time, hardness was practically the only way to identify stones even approximately, and it still has a place in the art of the mineralogist. Hardness measures the strength of a mineral's chemical bonds. In gemstones, hardness refers only to the "scratch resistance" or "scratch-hardness." Technically, scratch hardness is the gem's resistance to external stresses in only one direction. A true measure of hardness would include the stone's resistance to external stresses in two directions (abrasion) or even in three (penetration), but gemologists usually ignore these other definitions of hardness.

Gemstone hardness is generally rated on the Moh's scale. Predictably, the Moh's scale is named after Friedrich Moh (1773–1839), a German mineralogist living in Austria. He worked for a rich banker, and his job was to identify minerals in his employer's collection. In 1822, he hit upon the scheme of categorizing minerals by their scratch resistance. All he needed to do was find ten substances that he could use as measuring sticks. It seemed that everything scratched talc, so that it eventually ended up as the softest on his scale. Diamonds, on the other hand, were so hard that nothing scratched them. As scientists like everything to be stated in numbers, diamond got to be a ten, and talc a one. It is interesting to speculate on Friedrich scratching away madly on somebody else's gem collection, but perhaps it's unfair to pass judgment upon him now. You can actually buy a Moh's testing kit, which includes testing pencils, each of which is tipped with a Moh's mineral. However, it should be borne in mind that scratching a mineral is destructive. I wouldn't go around scratching anything important.

As mentioned, Moh's scale is based on ten "marker substances," each of which can scratch the mineral below it and can be scratched by the mineral above it. Here they are, in order of increasing hardness, although the intervals between them are not equal:

- Talc
- Gypsum
- Calcite
- Fluorite
- Apatite
- Orthoclase
- Quartz
- Topaz
- Corundum (rubies and sapphires)
- Diamond

The first two are soft enough to be scratched by your fingernail, which ranks about 2.5 on the Moh's scale, while nothing scratches a diamond. Everything else is in between. Harder stones usually have a higher commercial value, not only because of their relative immunity to scratching, but also because hardness enhances desirable optical qualities like refraction and luster.

Emeralds check in at 7.5 to 8.0 on the hardness scale. They are harder than steel. This number is exceeded by only a few other gemstones such as chrysoberyl at 8.5, ruby and sapphire (corundum) at 9, and diamond at 10. But scratch hardness is not the same as toughness or durability. Emerald's actual *toughness* is rated "poor to good" depending on the particular stone. Emeralds chip easily, a factor that must be taken into account in jewelry design. Inclusions also reduce toughness, and most emeralds have inclusions, which makes them vulnerable to fractures. They are almost too fragile to be worn safely in a ring, unless extreme care is taken.

Clarity is one of the most important measures of a gem's value. Clarity simply means "clearness." Crystals, especially big crystals, take a long time to grow. And as they grow they may swallow up smaller or earlier formed crystals. They can also trap some of the fluids or gases that constituted their birth matrix. A general rule is that solid inclusions are usually formed before the host stone; liquid and gas inclusions are often formed *at the same time* as the host stone. These faults can be caused not only by fissures and cracks (such stones are called "mossy"), but also by tiny inclusions of foreign material. (It's a cruel trick of fate that the finest colored emeralds are often the most included.)

Hydrothermally formed emeralds often trap water and other fluids within the growing crystal, as well as permit the inclusion of other material, creating inherent weakness in the stone. Still, if the crystal is built right, emeralds have an "inner glow" that makes up for minor inclusions (which can even be beautiful).

Typical inclusions are growth structures, solid inclusions (other minerals), fluid-filled cavities, and fissures, some of which are healed, and some of which are not. You might be curious as to how fissures can "heal"; after all, emeralds are not organic things. However, the fissures can heal because "nutrient solutions" sometimes continue to penetrate into the fissures and crystallize.

Cavities that occur while the crystal is forming are called primary cavities; those that show up later are called secondary cavities. Synthetic emeralds nowadays also have inclusions to make them seem more natural; however, synthetic stones don't typically have the wide range of inclusions we see in natural stones.

And unlike its flashier (but chemically simple-minded) cousin the diamond, each emerald is absolutely singular, an individual. While there is no "perfect"

emerald, the way there can be a perfect diamond, the rich complexity of the emerald—its difficult chemistry and odd inclusions—give each stone a unique signature that proclaims it a special creation of the universe.

While many gem buyers dislike inclusions, scientists are crazy about them, since they can tell a lot about the birth of the stone. In poetic language, the French call the emerald's inclusions its "jardin" or garden. Under a loupe, they can appear as club moss, ferns, and many other strange and elegant botanical wonders. Unique like ourselves, complex (or even flawed) like ourselves, this most human stone is truly akin to the living universe, its color the color of life that carries within it a garden of mystery. However, no mistake about it—the rare clear emerald is extremely prized. It is much more common for "emeralds" to be cloudy, dull, and thus not of gem quality.

However, no true emerald lover is overly put off by inclusions. It's an axiom in the emerald world that a beautiful richly green crystal with some delicate inclusions is more valuable than a dull, pale, and "flawless" stone. A "flawless emerald" would be one that has a perfect, uniform color and no inclusions, but stones even approximating this state are exceedingly rare. Because inclusions are almost universal in emeralds, they are not usually characterized as faults unless they are very large or occluding. While perhaps not desirable, inclusions or even cavities are acceptable in emeralds as long as they don't detract from the beauty or durability of the stone.

The Magic of Light

Most of the mysterious components that make up emeralds go unnoticed, just as the swirl of atoms that comprise a table are invisible. However, scientists have teased out the secret world of the emerald, and found that like everything else in the universe, the emerald is a marvel of matter and energy which comes to life only with the light.

Light is the most magical of all things. And it works a strange enchantment upon crystal. Scientifically, the way an object handles the light that strikes it are called its "optical properties." Let's look at some of them. These include absorption, reflection, refraction, and (even) diffraction

All kinds of exciting things happen inside the crystal, and what happens to light is no exception. Light has three main ways of behaving when it runs into something. It may be *absorbed* into the object, never to be seen again. This is what happens when light hits, say, cardboard or a basset hound. A substance that absorbs *all* light is called opaque. On the other hand, if the object absorbs *none* of the light that passes through it, it's called transparent. Everything in between opaque and transparent is translucent, meaning that the object lets through *some* light. Most emeralds vary from translucent to

opaque. An opaque emerald is not usually considered to be gem quality. On the other hand, a completely *nonincluded* transparent emerald is almost nonexistent.

Another possibility is that the light may be *reflected.* In this case, the so-called incident ray (the original ray) lands on the surface of the reflective object and then bounces right back into the air at a certain angle. This *angle of reflection* is dependent upon the *angle of incidence*—the angle at which the light originally hits the surface. The angle of reflection will always be equal to the angle of incidence. In other words, reflection is symmetrical. If a ray hits a reflective object at 45 degrees, it will bounce off it at 45 degrees.

Or it may be that the light is *refracted*, which simply means "bent." You know the old oar-in-the-water deal. Refraction occurs when the light ray is *deflected* from a straight path as it enters the polished surface of an object, rather than simply bouncing off it. Here the light is bent at an angle *different* from the angle of incidence. Unlike reflection, refraction is *not* symmetrical. Why does this happen? Well, light does not travel at the same speed through every medium. It goes more slowly through air than through a vacuum, even more slowly through water, and almost creeps (relatively speaking) through solids like quartz, emeralds, or diamonds. The speed of light equals its wavelength times its frequency. And while its frequency remains constant through various substances, its wavelength changes at the interface between different substances (such as air and emeralds) and this causes the light to bend.

As it passes through the crystal and strikes the *internal* side of the surface boundary between the crystal and the air, it will either be refracted or reflected back into the stone. How does light know whether to reflect or refract? It all depends on the *refractive index* of the object and the angle at which the wave front strikes the facet. The angle at which light decides to *reflect* rather than *refract* is called the *critical angle*. This angle varies with different substances. There's a mathematical formula for this behavior, which expresses this idea: the index of refraction (refractive index) of a particular substance equals the speed of light in empty space divided by the speed of light in the particular substance under consideration. Knowing the critical angle for each material they work with is absolutely vital for gem cutters to make the most effective cut.

The higher the refractive index of a substance, the greater the bend in the light. (There is a special refractometer designed for gemstones to measure refraction.) Since their arrangement of atoms depends upon their direction, crystals may have more than one refractive index. These are the so-called double-refracting or birefringent crystals. Emerald is one of them. All crystals except those in the "cubic" system like garnet and diamond are birefringent. (Emeralds belong to the hexagonal system.) The word birefringent literally means splitting a ray of light into two separate, orthogonally polarized rays,

which usually take different paths or "permitted vibration directions." The two rays are subject to different refractive indices, so the light traveling along each direction reaches the opposite side of the crystal at a different time.

Therefore, in birefringent crystals, the refractive index is reported as two values. The first value for natural emeralds is approximately 1.577 (range is ±0.017) and the second value is approximately 1.583 (range is ±0.017). The variation depends on the emerald's place of origin. The difference between these two values, known as the birefringence, averages about 0.006 and can be as low as 0.005 and as high as 0.009. This makes emerald birefringent only to a small degree.

In birefringent crystals, the different paths the light rays take result in different amounts of absorption and hence different colors depending on the viewing angle. This is called *pleochroism*, in which the stone exhibits distinctly different color patterns. How much pleochroism is present varies according to body color, with intensities from weak to distinct. Emeralds show a green primary body color with a bluish green secondary color.

Gemologists test for pleochroism with a dichroiscope. This simple instrument is made of a piece of Iceland spar, which rather amazingly actually comes from Iceland. The Iceland spar is contained in a brass tube about 2.5 inches long, and 3/4 of an inch in diameter. A sliding cap at one end has a perforation 1/8 of an inch square. The other end sports a lens that reveals a distinct image of the square opening when the cap is pulled slightly out. The dichroiscope distinguishes "singly refracting" minerals like diamonds, garnets, and spinels, from birefringent or "double refracting" stones like rubies and emeralds. You really can't be in the gem-detecting business without one.

When you look at a stone through a dichroiscope, two images appear. If the images are the same color, the stone is singly refracting. So, it could be a spinel or red diamond or garnet. Or glass. If two colors appear, it's doubly refracting. Maybe a ruby or beryl! The pleochroism of emerald is distinct: blue-green/yellow-green, meaning that two different shades of green show up—green and blue green. (Many emeralds have visibly yellow or bluish tones as well. Aquamarine is blue to darker blue, morganite is light red to light violet, and heliodor is greenish yellow to yellow.)

Emeralds with high percentages of foreign material (like sodium or magnesium, which may account for up to 7 percent of an emerald's weight) have higher refractive indices than do clean stones. The highest refractive indices are seen in emeralds from Austria, Pakistan, Madagascar, Zambia, Zimbabwe, and the Santa Terezinha de Goiás mine in Brazil, the same places that produce the more highly included stones. Lower indices are seen in emeralds from Colombia, Nigeria, Australia, and (of all places) Norway. These stones are much freer of foreign substances. Synthetic emeralds also have lower

refractive indices (usually 1.561–1.564) as they are freer of inclusions. In any case, the refractive index of emerald is quite low—not much better than glass at 1.52. The highest refractive index of all stones is that of a diamond at 2.41, which means that light travels 2.41 times faster through empty space than through a diamond.

Different colors of light are refracted at different angles in a single medium. Violet light (which is at the high frequency/short wave length end of the visible spectrum) is refracted at a greater angle than is red light, which is at the lower frequency end. It's not a huge difference, to be sure, but it's enough to separate white light into its component, spectral colors. Scientists called this effect dispersion, but gem lovers know it as "fire." The dispersion of emerald is low: 0.014. A low dispersion means less brilliance, and so an emerald is much less brilliant than the colorless diamond with a dispersion of 0.044.

Some substances exhibit absorption, reflection, and refraction simultaneously, with a preponderance of one or the other, depending on the nature of the light-struck object. Metals tend to absorb a lot and reflect a bit. They don't refract, though. Transparent materials refract, while their absorptive and reflective qualities vary, depending on whether and how deeply the material is colored.

There is one more way to describe the way light behaves in a gemstone—it's called *diffraction*. However, among gemstones, only opals display this quality, so luckily we don't have to go into it any further here.

Some people refer to the overall appearance of a gem as *luster.* Luster has two aspects. The first is objective—it refers to the amount of light reflected from the surface. The second aspect is the more subjective feeling of warmth or coolness that people get from looking at the stone. The actual degree of luster is related to its surface polish, which in turn is related to the hardness of the stone. Emeralds can take a high, brilliantly reflecting polish, but still manage a soft, almost velvety look. It's part of the magic.

The luster of a gem is commonly characterized by terms like adamantine (diamond) or metallic (hematite) or silky (gypsum). Turquoise is "waxy" and moonstone is "pearly." Stones with a mirrorlike luster are described as "splendent." Emerald (along with rubies, quartz, and in fact, most transparent gemstones) is classified as vitreous, or glassy. However, the vitreous quality of emeralds in not very pronounced, showing up best in medium light, and some stones have a more resinous luster. The emerald gleams, rather than glitters or sparkles, and its tones are warm and of the earth. The warm beauty of emerald does not come from a prismatic play of light as does the diamond's, but from some deep quality in its own heart. It is probably safe to say that the emerald's beauty requires a greater degree of sophistication to appreciate. It's more than "skin deep."

A very subjective element is a stone's "texture" or "feel." More technically, texture refers to a haziness that interferes with the passage of light in a gem. If it is very obvious it will interfere with a stone's "clarity" grade, but a slight haziness imparts a satiny texture to the emerald that many people like. It's this unusual texture that sets the emerald off not only from more sparkling gemstones of other colors, but also from the sharp, hard texture of the recently discovered tsavorite or glossular garnet, whose green in every other way rivals that of the emerald. The texture of the emerald is partly due to its relatively low refractive index and partly due to the typical way the stone is cut.

All beryls, emeralds included, may appear with asterism (star) or as a cat's eye (chatoyance) stone. These stones reflect light from parallel fibrous material like asbestos, or needlelike inclusions or tiny channels in the stone.

One set of parallel fibers produces a cat's eye, two sets a four-rayed star, three sets a six-rayed star, and so forth. The best cat's eye emeralds have a single bright line precisely in the middle of the stone, extending completely along in a vertical direction. The stones are cut in cabochon (half-rounds) to enhance the effect. When lighted directly from above, the line will appear single and sharp; under indirect lighting the band will seem more diffused. Cat's eye emeralds show to their best advantage in sunlight or single, incandescent light. Multiple light sources will produce multiple cat's eyes and ruin the effect. The cat's eye may disappear on cloudy days or under fluorescent lights. The cat's eye phenomenon exists only in paler stones. These very rare cat's eye and six-rayed star emeralds have been found in Brazil, and more recently, in the case of the cat's eye, from one mine, Coscuez, in Colombia.

Fluorescence is an optical effect that occurs only when a mineral is exposed to ultraviolet light. Most emeralds have no shortwave fluorescence; a few have a weak orange-red to green fluorescence. Under long-wave UV, emeralds are variable—from inert to red. Synthetic emeralds may fluoresce a dull faint red due to an indicator added during the synthesizing process and appear opaque under long ultraviolet light.

In addition, natural emerald shows bright red through the color or Chelsea filter, developed as the name suggests, in England. (Synthetics will appear dark red or too red, as they are overrich in chromium.) Using a Chelsea filter has been a classic way to distinguishing natural emeralds from synthetic ones.

Color It Emerald or Maybe Chromium

The color of any colored gemstone is worth at least half the total value of the stone. With emeralds it is the single most important feature. In fact, an occluded emerald of good color is worth more than a nearly flawless stone of paler hue. However, it's also true that "pure green" is not to everyone's liking.

Many experts say that some yellow (10 to 15 percent) in the stone enhances the dominant green color. Indoor incandescent lighting tends to bring out the blue note in emeralds. Therefore, experts like an emerald that is slightly yellowish in daylight, so that when the wearer brings the emerald *indoors*, where it's more likely to be examined closely, the emerald appears pure green. A blue-green emerald might look too blue if worn indoors. Others claim that the same amount of blue adds richness, and is preferable to the yellow note. Some emeralds actually have both secondary hues. This is mostly a matter of taste, obviously, and taste in emerald colors actually differs from culture to culture.

Some people believe that the darker the emerald is, the better it is, but that's a misapprehension. Most people prefer stones that are medium to dark green, but very dark green emeralds look black. In point of fact, most dark green emeralds get that color because of heavy and large inclusions.

So where does the color come from? Technically, color is an optical property, since the color of a gem depends upon the way and extent to which it absorbs light rays. White light is a mixture of all the colors. No doubt you first heard this in grade school and were disappointed when you tested the theory, mixing all the colors in your paint box and ending up with a muddy brown. Nonetheless, in the world of light (as opposed to pigments), it is true. When white light strikes a gem, these rainbow colors are preferentially absorbed. Every gem has its own "colorprint" or absorption spectrum that can be detected with a spectroscope. The spectroscope breaks up the light transmitted through a gemstone into its spectral colors, so the observer can note the various wavelengths that the gemstone absorbs. Wavelengths of light are measured in nanometers, in case you were wondering, or even if you were not. (Even in science, cultural preference plays a part. In the United States spectroscopes are used with the red end to the right, but everyone else in the world uses a spectroscope with the red end to the left. This is important to remember when looking at any gemstone and comparing with reference material.)

The spectroscope was invented in 1859 by the German scientists Gustav Robert Kirchhoff (1824–1887) and Robert Wilhelm Bunsen (1811–1899). Yes, it is the same Robert of Bunsen burner fame, although Bunsen didn't invent the Bunsen burner. Michael Faraday did, but Bunsen made a better one and scooped up all the credit. Bunsen also discovered the antidote to arsenic poisoning (iron oxide hydrate). Kirchhoff, while not the household name Bunsen seems to be, was the codiscoverer of cesium and rubidium. He found them in 1861 while studying the spectral composition of the sun. He also spent time developing laws of voltage and circuits, that sort of thing. But he didn't really play a big part in the story of the emerald. That is too bad, since his best-known work, the four-volume masterpiece *Vorlesungen über mathematische Physik*, is full of interesting little tidbits.

Gems can be divided into "allochromatic" and "idiochromatic" stones. In idiochromatic or "self-colored" stones, the hue comes from a substance that is an integral part of the structure of the stone. Peridot is perhaps the most noted example. Peridot is green because its color comes from iron, which is part of its essential structure (magnesium iron silicate). Without iron, there would be no peridots. By their very composition, peridots have to be greenish.

Emeralds, on the other hand, are *allochromatic* or "other-colored." Their green hue comes from chromium, which is *not* part of the essential chemical structure of beryl (beryllium aluminum silicate). Emerald is really nothing but a variety of beryl that has been kissed by chromium to color it a serene green.

To understand chromium, we must return to our old friend Vauquelin, who isolated not only beryllium, but also chromium. He made his discovery shortly after receiving some samples of crocoite or Siberian "red lead" ore in 1797. This ore was discovered in the Ural Mountains in 1761 and gets its name from the bright orange crystals it forms. It was prized as a pigment for oil paints, making a very nice bright yellow (not red), which soon became the trendy color for the carriages of nobility in England and France. Today it is used in industry to harden steel.

Vauquelin chose the name "chromium," for the new element, a name stemming from the Greek *chroma*, or "color." This is indeed a tribute to the wondrous color-generating properties of this material. Chromium itself is a steel-gray, lustrous, hard, metallic element that takes a high polish. Like beryllium, it is toxic, although a trace of chromium in the diet seems to be important for glucose metabolism. Currently you have about 4 chromium atoms in your body for every billion of every other kind of atom. I don't know how many that is. But anything more than a trace of chromium is pretty dangerous. Despite its toxicity, chromium, like vanadium, is used in some "herbal formulas" (although it is definitely not herbal) to help people lose weight and to manage their blood sugar. Whether it actually does any of this is beside the point. But we do know it can kill you, so I wouldn't gobble it down. Despite its dangerous side, chromium is truly a chameleon chemical that has the power to turn rubies red and emerald green.

To appreciate the magic, we need to look again at how light behaves. When we see color, what we are actually seeing are the only colors left after the rest have been absorbed by the object. An emerald absorbs red and blue light and that makes it look green to us. A ruby absorbs the blue and green light, leaving red for us to see.

To see how chromium absorbs *different* colors of light in the different gems, we need to delve into the arcane mysteries of quantum mechanics. Fortunately, we don't need to delve too deeply. While the mathematics of quantum mechanics is immensely complex, the basic principles are easy enough.

Every species of atom *emits* particular wavelengths (colors) of light, depending on its own atomic structure. The pattern of these emissions is a luminous fingerprint, marking that species of atom from all others.

Different colors of light have different levels of energy. Blue light, for example, has more energy than red light. Don't ask why or we'll get into an infinite regress here and never get back to emeralds.

Just as each kind of atom emits particular wavelengths, each kind of atom absorbs specific wavelengths. Light is absorbed when it interacts with the electrons in the atom. These tiny bits of negative electricity zip around the nucleus of the atom (a much bigger, positively charged bit of matter composed of protons and neutrons) in orbits something like the paths of the planets around the sun. These orbits are very precise, and a very precise amount of energy is needed to bounce an electron from one orbit to another. This precise amount of energy is called a quantum, hence the name quantum mechanics, and is supplied by a precise color. If you shine white light on an emerald, the electrons snap up most of the red and blue quanta as they jump around between orbits.

So why do rubies and emeralds, both of which are colored by chromium, absorb *different* colors of light? Because the location of the electron orbit isn't fixed, but is under the influence of neighboring atoms in the crystal. The chromium atom's electrons are being pulled by the beryllium and silicon atoms in emerald and by aluminum in the ruby. That makes the distance between electron orbits different in the two minerals. Different distances equal different energies and different colors of light absorbed.

However, that's only one theory. I prefer the one developed by the ancient Incans. They believed that emeralds were living things, which ripened and deepened in color like some exotic fruit, beginning as colorless stones and gradually becoming green, with the color change starting at the corner facing the Sun. The ancient Romans also thought that emeralds ripened into their color, so gems with light patches or consistent paleness were considered immature. Considering that pure beryl is indeed colorless, this is an interesting theory. It's also interesting in that many emeralds are most deeply colored at the surface—apparently that is as far as the chromium atoms were able to sneak in.

In its absolutely pure form, beryl is colorless, white, or cloudy. Colorless beryls are rare, but not valuable, because they are not especially attractive. In fact, no colorless stone compares favorably with a diamond. In the emerald, chromium atoms invade the crystal lattice and replace some of the aluminum atoms that make up the regular beryl. (There is some freedom, even for crystals.) Because the chromium atoms are bigger than the spaces in the atomic structure of beryl, it puts stress on the crystal structure, forming the characteristic "faults" in an emerald. Ordinary beryl doesn't have this problem.

An emerald might also get some green from iron. But since the shade of green that iron imparts is not considered desirable in emeralds (too bluish), iron is regarded an impurity. There's even a name for this color, the aquamarine component, since iron is the primary coloring agent of aquamarine, another beryl. (When a trace element imparts an undesirable characteristic to the stone, it's called an impurity. When a trace element provides the desired color, the mineral becomes a gem. The same principle applies to flowers. If something grows where you want it, it's an ornamental. If not, it's a weed.) The addition of various other "foreign substances" can color beryl several shades of yellow, orange, green, pale blue, pink, or even (very rarely) red. Different additions make different colors.

Too much iron or other impurity or too little chromium gets a stone downgraded from "emerald" to "green beryl," which can often be more yellow or blue than green. The Gemological Institute of America (GIA) provides standardized color sets and guidelines which jewelers can use to distinguish a "green beryl" from a true emerald. However, there is no real legal definition of an emerald, and many in the gem business are pushing to have the definition of emerald broadened to refer to any variety of green beryl, no matter what natural element makes it a desired green shade. That's currently the policy of some in the trade world—and with reason. You can get a lot more for an "emerald" than for "green beryl." In some cases, what is usually called green beryl is called "precious beryl" or "noble beryl" in order to enhance its supposed value.

Then there's the vanadium problem. Brazilian emeralds are likely to be colored green by vanadium instead of, or in addition to, chromium, acting in the same way chromium does, by replacing aluminum in the crystal lattice. (Vanadium is another rare silvery-white metallic element. It is named after Vanadis, the Norse goddess of beauty, who was once married to the God Od. Vanadium occurs throughout Earth's crust, but like beryllium, only in tiny quantities and never alone. Like chromium, it can be used to harden steel. In the health food market it is also sold for weight loss and sugar control.) Vanadium-shaded emeralds are found in Madagascar, Mozambique, Russia, and Nigeria, in addition to Brazil. These emeralds may also have a small amount of chromium or even iron in them to produce the color.

Although vanadium-colored emeralds may have wonderful color, they were originally "disqualified" from being true emeralds because that color didn't come from chromium. In the 1960s, when miners first discovered vanadium-colored green crystals in the Salininha mines of Brazil, there was a huge fight in the gem world as to whether or not they could properly be identified as emeralds. Some purists insisted these stones could not officially be called emeralds, but only green beryl, with a consequent reduction in perceived

value. The fighting grew even more intense as there is no scientific definition of an emerald, only of beryl. It was proposed that a bona fide emerald had to show the distinctive chromium lines in the absorption spectrum of beryl (a pair of sharp lines at 680 and 683 nm and another line at 637 nm). In 1963, however, the Gemological Institute of America issued an edict of sorts, proclaiming the vanadium-colored rocks to be "natural emerald."

And even where an emerald is colored by chromium, there's plenty to worry about. Too much chromium is as bad as too little. For example, 1/100 of 1 percent too much chromium will produce a blackish/bluish/green emerald. Similarly, a 1/100 of 1 percent too little chromium count may produce a yellowish-green stone.

Only beryls whose green falls within a certain range are admitted to the emerald club. The ideal color of emerald is sometimes designated "grass green." The term was most famously used by James Dwight Dana in his 1854 classic *System of Mineralogy.* However, the truth is that most emeralds are not grass green. In fact, even a lot of grass is not grass green.

There are a hundred shades of green, and it isn't all that easy to decide what the perfect color for an emerald is. While most people think of grass as a specific shade of green, anyone who has seen bluegrass knows that that's not exactly so. There's also a variety of Zoysia grass called "Emerald," an interesting example of back attribution, where the grass takes its color from the stone instead of the other way around. More recently, some people have referred to the ideal emerald color as "lime-jello green," a simile not available to the earliest writers, and perhaps reflecting our increasing urbanization. The advantage of lime-jello green is that it always actually *is* the same color, unlike grass. Still, there's something inherently unpleasant about comparing emeralds to jello. And though green is usually considered a cool color, emeralds are different. Bill Barron, a diver for Treasure Salvors, Inc. and discoverer of many "shipwreck emeralds" remarked, "When you hold an emerald in your hand, I swear to God you can almost feel its heat."

Samuel Taylor Coleridge, in his "Rime of the Ancient Mariner" talked about icebergs "as green as emerald," but no one refers to a fine emerald as "iceberg green" or even "iceberg lettuce green." The proper shade of green for emeralds remains a matter of some disagreement, and emerald experts now cautiously call the ideal emerald color "medium" green.

But that designation in itself leads to questions, particularly as "medium green" seems to refer to saturation. Saturation measures the vibrancy or purity of a color. A pure color is one with no gray mixed within it. In emeralds, gray will "modify" or dull the green tone. Some Zambian emeralds, for instance, have this grayish note, which is bad for the stone's value. But saturation is a largely a matter of personal choice. Some people simply prefer a darker or

lighter stone, and that is all you can say about it. Obviously, if everyone in the world suddenly decided green was just a bad color for gems, as they have decided that black or gray is, the bottom would drop out of the emerald market. The only emerald owners would be collectors of mineral curiosities.

In Aztec Mexico, the emerald was called Quetzalitzli, "stone of the quetzal," as its color resembled the brilliant green feathers of the quetzal bird. The kings of Mexico and Central America wore these plumes, and so the emerald was regarded as a royal gem, although other classes also wore emeralds. (The Aztecs also prized jadeite above other stones, imbuing it with great mystical significance, but the Spanish saw no value in jadeite at all.) Today I suppose we could call highly desirable emeralds "quetzal-colored" but then no one would know what we are talking about.

For Colombian emeralds, the term "Muzo green" is often awarded to stones which have the desirable grass green or lime-jello shade. "Muzo green" emeralds don't actually have to be from Muzo.

Whatever you want to call it, grass-green, lime-jello green, or Muzo, a good quality emerald retains its color under various light conditions. This color is stable, not changed by light or heat (changing color only between 1292° and 1472° F). This is more important than it seems, and is one way to test an emerald against emerald wanna-bes.

Every genuine emerald has a unique color distribution. Even in one stone, the color distribution can be irregular. Often the different colored portions occur in layers (usually perpendicular to the faces of the prisms). The very best stones are green all through, but this is rare. In most stones, the best color collects near the surface. In all cases, brittleness, holes, spots, graininess, and uneven coloring are considered faults.

In Weighing

One way to describe an emerald is by weighing or measuring it, and a common method to do this is by checking its specific gravity (SG). SG is a value that defines the weight of an object per unit volume. The specific gravity of an object equals its weight divided by the weight of an equal volume of distilled water. A volume of 1 cubic centimeter of water will have a weight of 1.00 gram and a specific gravity of 1.00. (The specific gravity of an elephant, say, would be much lower than that of an emerald, since elephants are mostly water.) A diamond has a higher specific gravity than emerald (it's denser). Therefore, a 1-carat emerald will be larger than a 1-carat diamond, if they are both cut in the same shape and proportion. In the same way, a 1-carat diamond looks bigger than a 1-carat ruby, everything else being equal, which it seldom is. A 1-carat emerald will appear larger in volume than a 1-carat

sapphire by approximately 30 percent, since the specific gravity of emerald is approximately 30 percent less than that of sapphire.

The specific gravity of a transparent flawless emerald is 2.72, but the more garden variety tests at 2.69 to 2.70. This classifies emerald (and all beryl) as low or medium on the "specific gravity" scale (if there was one, which there isn't really).

In addition, different types of beryl have different SGs. Most synthetic emeralds are slightly lower (2.65) than natural ones, while morganite is usually somewhat higher (2.80–2.90). Aquamarine and heliodor average 2.68, close to emerald.

Although SG determines the actual size or volume of the stone, emeralds are sold by weight, not by volume. And emeralds, like other precious stones, are weighed in carats and points.

A carat equals 1/5 of a gram and a point is 1/100 of a carat. It is easy to get "carat" mixed up with "karat," a term referring to the purity of gold. (It doesn't help that "carat" can be a variant of "karat.") Both terms probably come from the Arabic *qirat*, or carob bean pod. A carob is a Mediterranean tree with sweet fruit that some misguided people think is as good as chocolate. Pure gold is 24 carats or karats; this comes about because the ownership of a merchant vessel was traditionally divided into 24 shares.

If you haven't had enough of this, emeralds can also be measured by molar mass. The molar mass has nothing to do with a collection of rodents: it's the mass in grams of one mole of a substance. (Another way of saying this is that one mole of emerald weighs 537 grams.) In case you're wondering, a mole is a unit of measure which equals the number of atoms in 12 grams of carbon-12. This is called Avogadro's number. It's a pretty big number: 6.02×10^{23}. It's so big that if you could count atoms at the rate of 10 million per second, it would take about 2 billion years to count the atoms in one mole. (I dislike this kind of comparison, but sometimes it's necessary.) There is even a National Mole Day celebrated annually on October 23 from 6:02 A.M. to 6:02 P.M. For the significance of the date, look again at Avogadro's number.

Emerald's Poor Relations

It's time to roll out the beryl, so to speak. Emerald is not the only crystal that goes by the name beryl, although it is the most famous. Aquamarine, emerald's runner-up in value, is the pale blue, bluish-green, or yellowish-blue variety of beryl. It gets its name from the sea and its color from iron. The largest aquamarine ever found was a perfectly clear 520,000-carat crystal found in Brazil in 1910. It was subsequently heat-treated to improve its value,

the first aquamarine ever so treated. Most of the world's aquamarine comes from Brazil, which today also produces a large number of emeralds.

Most aquamarines are naturally pale green or blue, but are heated until they turn purer blue. Left untreated, aquamarine tends to have a greenish tinge, although not green enough to make it a real emerald. The yellowish-green variety of aquamarine is sometimes called aquamarine-chrysolite.

The yellow variety of beryl is known as golden beryl or heliodor, which means "gift of the sun." It gets its color from iron. While the terms golden beryl and heliodor are often used synonymously, golden beryl is generally a bit darker than heliodor, with the most prized specimens having a canary or bright gold shade. Heliodor has a more greenish tint, sort of like olive oil. Golden beryl is found in Brazil, often in the same deposits as aquamarine, while the best specimens of heliodor are from Namibia. Another greenish-yellow beryl is called davidsonite, which has been mined from a quarry in Aberdeen, Scotland. It is not much used for jewelry, being primarily just a collector's stone.

Morganite (pink or peach beryl) and red beryl (formerly bixbite) get their color from manganese. Its soft, lustrous pink is very attractive, and the stone is generally free of inclusions. Due to its beauty and rarity, it has a fairly high commercial value. Morganite was named after John Pierpont Morgan (1837–1913), the gem fancier, railroad baron, art collector, and steel tycoon. Despite his formidable reputation in the world of high finance, there is nevertheless a portrait of him at age five, in which he is shown wearing a plaid dress. George Kunz, Tiffany's most famous gem buyer, wanted to honor Morgan for a large donation to the gem collection of the American Museum of Natural History. Tiffany's has always had a habit of naming new varieties of mineral rather well, although this is now against the rules. Still, there is a kunzite, too.

Red beryl, discovered in 1904 by Maynard Bixby, is a beautiful and exceedingly rare variety of beryl. Its color is a strong red or raspberry. Most red beryls come from rhyolite and are therefore a product of volcanic activity. Red beryl has the same sort of inclusions, a result of internal stress, as does its green sister. It used to be called bixbite after Maynard, but that name was too easy to confuse with bixbyite, a manganese iron oxide with no gem value.

Most red beryl crystals are subcarat in size and are not even facet-able. (The world's largest gem-cut red beryl is only 8 carats.) The only known deposit of large, gem-quality red beryl is from the private Ruby-Violet claims in the oddly named Wah Wah Mountains of Beaver County in southwestern Utah. There is also some in the nearby Thomas range and also in the Black Range in New Mexico.

According to Kelly Hyslop, CEO of Gemstone Mining, Inc., "There is only one red emerald for every 150,000 diamonds, 12,000–15,000 emeralds,

and 7,000–8,000 rubies. Only one woman in 3 million can own a 0.80 carat or larger red emerald." Because of the meager production, the stone has been prized mainly by gem collectors. The recent decision to call the stone "red emerald" rather than the more modest "red beryl" will undoubtedly help its market value.

However, for many people, emeralds must be green, as their name suggests. The very word is a synonym for green. Other kinds of beryls are not sold as emeralds. Aquamarine is not sold as "blue emerald," or morganite as "pink emerald." Golden beryl is golden beryl and not "golden emerald." The reality is, however, "red beryl" or worse "bixbite," doesn't have the cachet of "red emerald." On the other side, some argue that different colored corundums are sold as sapphires, but then sapphires are not emeralds, and I'm not even convinced that that's completely kosher, although it's been going on for a long time. Many experts agree that "yellow sapphires" should technically be called orange or yellow corundum, or have new names altogether.

Bazzite is blue beryl, at least sort of. Named after its discoverer, the Italian engineer Alessandro Bazzi, who found it in 1915, it is typically found in small hexagonal crystals, getting its color from scandium. Most bazzite is found around Lake Maggiore, Italy, although there is some in Switzerland too, and even some in central Kazakhstan.

There is also perhaps another blue beryl, a deep-blue stone called Maxixe (pronounced ma-SHEESH) that comes from Brazil. There is a Brazilian dance of that name, an Africanized polka. The blue beryl going by that name was found in 1917 in the Maxixe mines of Minas Gerais, an area that is noted not only for emeralds and large aquamarine crystals, but beryls of nearly every other color. The Maxixe turns out to get its color from natural radiation, but the color was unstable, fading to almost white when exposed to sunlight and heat. The color could be restored, but not permanently, by artificial radiation. Maxixe is popular with collectors, but is of no use as gem. More of this crystal appeared on the market in 1973, but it turned out to have been artificially irradiated.

Still another odd blue stone was found in the Canadian Yukon near Whitehorse in 1976 and again in 2004, by a team searching for emeralds. This stone did not lose its color to heat or light. Everybody got excited by the find, and wild guesses were made about its putative value. Unfortunately, the samples contained many inclusions, which adversely affect their value. Even more unfortunately, the color of most of the sample was within the reported range for aquamarine, although one tested slightly darker. Optical tests also placed the stone closer to aquamarine than to emerald.

If all these impurities turn beryl into different colors, what does pure beryl look like? Perhaps you recall that "pure" beryl is a simple white or clear

stone. Its formal name is goshenite, which is sometimes called the "mother of gemstones." (The "ite" that so many minerals have incorporated into their names is from a Greek word for stone.) It's not called goshenite much any more though, as the gem trade prefers the term "colorless beryl." Perhaps goshenite has too much of a biblical ring, although goshenite was not named after Goshen, the land of Egypt, but rather after Goshen, Massachusetts, where the stone was first identified. This is rather too bad, as the old name evokes the fabulous emerald mines of Cleopatra, where we are headed next.

Emeralds in World History

Emeralds have always been highly prized, a fact which in itself is odder than it seems at first glance. The richly hued deep green emeralds we value now were essentially unknown to the ancients. Until the sixteenth century, when Colombian emeralds hit (and temporarily glutted) the European market, available stones were, by contemporary standards, definitely subpar. No Old World ancient gems ever found can compare to Colombian emeralds in size, color, or clarity. The ancients waxed passionate about large, gleaming emeralds, but these were products of an ardent imagination rather than an actual mine. In some cases, what ancient authors were really referring to was peridot or other less valuable stones, or even glass. True Old World emeralds were mostly small, lackluster, heavily included, often opaque, and of inferior color. Yet they were loved and valued.

Emeralds and Egypt

Emeralds have always been more than mere ornaments of the body. They are also the guardians of the soul. And nowhere is this more true than in ancient Egypt, where the first emeralds were mined. Most people associate Egypt with pyramids rather than with mines—what reaches into heaven always seems to have a little more cachet than what is hauled up out of the earth. But the truth is that most of the wonders of Egypt—its pyramids, temples, furniture, and of course its elegant faience jewelry, owe their existence to some holes in the ground. The Great Pyramid itself is made up of dressed blocks of basalt, limestone, and granite, and its builders did not fly in from space, no matter what some people think.

The early builders of Egypt had their feet firmly in the ground. In fact, many archaeologists believe that the earliest settlers in the Sinai region, who showed up about 8,000 years ago, were miners searching for copper and turquoise. These most ancient of ancient Egyptians dug up everything—limestone, granite, alabaster, copper, marble, gold, porphyry, basalt, dolomite, serpentine, salt, turquoise, amethyst, and of course, emerald. It's surprising there was any ground left. One of the most important mined materials was a fine-grained dark stone with the peculiar name of graywacke, used for statues and sarcophagi.

The very first mines were mere pits, but by the time of the Upper Paleolithic, the Egyptians had developed vertical shafts and even underground galleries, the main type of mining used during the pharaonic period. At one time there were thousands of open pits and underground workings. Ancient mining tools included hammerstones and picks made from gazelle horn. These early operations were tiny, at least compared to later pharaonic expeditions that might number 20,000 miners. The ancient miners worked through the softer phlogopite (a kind of mica) schist with flat-edged chisels and pointed picks, making shallow, open-cut trenches that follow the quartz/pegmatite veins. Some of these workings continue as much as 100 meters underground and are still largely unexplored.

The Egyptians had a passion for emeralds, not because they were rare, although they were, but because they were green. As with other ancient peoples, it is often impossible to know exactly to what stone the Egyptians were referring when they spoke of emeralds. They themselves didn't bother to differentiate among the various geologic species, as long as the subject stone was green. Green, the color of the papyrus plant, was the most important symbolic color in a culture that soaked itself in symbolic color. Green was the color of life, both the natural and immortal kind, and the Egyptians bedecked living and dead bodies in green stones of every sort: green jasper, malachite (used for paint pigment and makeup), green feldspar, prase, chrysoprase, olivine, serpentine, and most valued of all, turquoise, whose name in Egyptian means "joy." Later, during the Graeco-Roman period, they discovered what we now call emeralds. (They may have had real emeralds before this, but it's not certain, due to the name confusion and lack of identifiable specimens.)

In like manner, blue lapis lazuli symbolized the heavens for the Egyptians, while carnelian meant blood. Possibly because of this, red was a rather unlucky color for the Egyptians and they avoided it when they could.

The first historical mention of emeralds is Egyptian and comes from the Prisse Papyrus, named Emile Prisse d'Avennes (1807–1879), who stole it from the Egyptians. Prisse was an interesting case study. A Frenchman of British descent, and a brilliant linguist, he traveled all over the Orient, converted to

Islam, and had a hand (literally) in removing 60 priceless sculptured portraits from the Chamber of the Kings, in the Temple of Amon at Karnak. It was all illegal, but Prisse firmly believed (probably with reason) that the antiquities weren't safe where they were. They certainly weren't safe from him, for instance. Among the items he "rescued" was the papyrus, subsequently named after him, said to be the oldest manuscript in the world.

In 1844, after removing everything that wasn't nailed down (and some things there were) from the tomb, he packed it all up into 27 crates and shipped them to France. The Revue Archeologyae took note of his "gift," saying, "We are indebted to M. E. Prisse for having saved the Chamber of the Kings from vandalism . . . and from being removed by the Prussian Commission, which is exploring Egypt at the present time, and, *above all*, [emphasis mine] for having refused to sell it to England, where the famous Table of Abydos has unfortunately gone." Obviously, to the French, having Egyptian treasure removed to England was a fate worse than death. In 1845, Prisse was awarded the Legion d'Honneur, but he created something of a stir by refusing to swear obedience and loyalty to King Louis-Philippe, saying he "would not swear an oath to any man." This was a pleasant sentiment, but it ensured that Prisse never got above the order's lowest rank.

The Prisse Papyrus contains two treatises on morality. The relevant one for us is *The Maxims of Ptahhotep.* Ptahhotep was a vizier to the fifth-dynasty Pharaoh Isesi. Ptahhotep is full of good advice, such as "Never let anyone know you know more than they do." His reference to emeralds was simply, "Good words are harder to obtain than emeralds," an astute remark on the scarcity of both commodities. However, the word rendered as "emerald" could also be translated as "malachite" and sometimes is. One of the problems in dealing with most ancient sources is the term "emerald" itself. Many green stones, including quartz, peridot, feldspar, or even glass, were simply called emeralds, whether they met the contemporary mineralogical standards for that stone or not. But I am sure Ptahhotep was talking about emeralds, even if he didn't know it. Malachite has no cachet whatever. And it's not that rare.

Emeralds had more than a metaphorical use, however. The Egyptians also used to give their royal mummies a "papyrus scepter" or wand adorned with emeralds. The Goddess Isis herself is often depicted holding the papyrus scepter. This scepter wasn't actually made of papyrus, but merely shaped like the plant, which grew abundantly in Egypt, and partly for that reason, symbolized fertility, life, and rebirth. As a funerary amulet, the wand assured the deceased fertility in the world to come. Adding emeralds merely clinched the deal. Still, it is not clear one needs to be fertile in the next life, as no one is born there.

Because emeralds (and similar green stones) signified eternal youth, the Egyptian Book of the Dead instructed embalmers to place a green stone at the throat of every mummy to ensure that the "limbs of the soul" (which apparently occupy a different anatomical position than regular limbs) maintained a youthful strength during the mummy's long journey through the underworld, and to protect it from harm. Ideally, the stone was to have carved into the hieroglyph for verdure, the sign of eternal youth.

The great god Thoth, who was depicted as a man with the head of a wading bird, was reputed to be in charge of emeralds. In fact, the Egyptian Book of the Dead claims that the ancient Egyptians received the gift of emerald from him, although there is no myth that details the transaction. For those accustomed to the extraordinary richness of Greek, Roman, Norse, and Indian mythology, the paucity of Egyptian narratives detailing the doings of the gods is always disappointing. The Egyptian Goddess Isis also wore an emerald (or at least some sort of green stone) in her headband, and all who looked upon it were guaranteed a safe trip through the land. The idea of emeralds granting safety in travel was also a Greek idea, although it was possibly inherited from the Egyptians. For best results, the emerald should be worn in a band of silver or copper around the left wrist. This technique also dispelled demons, especially the ones likely to attack travelers.

The earliest known emerald mines are Egyptian, going back to about 2000 BCE, although they were probably not worked systematically until the early Ptolemaic period, when the first *provable* emerald finds occur (about 323 BC). However, although some of the workings were called Cleopatra's mines, she can't take credit for finding them, since (as mentioned) they may have been 2,000 years old before she was born. At least there were tools from the Ramses II era left there, so it's only natural to assume they were finding something—perhaps emeralds.

Even in early times, a large proportion of the miners were probably slaves, and that percentage seems to have increased as time passed. There are some ancient texts written by overseers bragging about how kindly they spoke to their laborers and how the workmen "rejoiced" in their situation, but really, you can't help wondering if there isn't just a bit of self-aggrandizement going on here. As you might expect, none of the workers themselves left any records saying how much they enjoyed their career as miners in the middle of the desert. We do know that the overseers demanded some sort of quota, also.

The mines were in continuous operation from about 330 BCE to 1237 CE, although most of the mining activity took place from the first century BCE through the sixth century CE. Nearly all the ancient emeralds stem from these mines. The most famous Ptolemy, Cleopatra (69–30 BCE), was inordinately fond of them, using them as seals for her royal documents. She is said to have

prized them above all her other gems. Although she supposedly dissolved her pearls in wine to impress Mark Antony with her extravagance, she kept her emeralds intact.

Remember, however, that Egyptians called *all* green stones by the same name. Some of what the ancients were mining as "emeralds" turns out to be amazonite (a green variety of microcline), a member of the feldspar family, mistakenly translated as "emeralds" by early archaeologists. Most amazonite is opaque and varies from yellow-green to blue-green, with some specimens possessing thin white streaks. (Even though it's now called amazonite, after the Amazon River, there's never been any amazonite from the Amazon region, although there is indeed some in Brazil, and the Amazon River is in Brazil, which seems to be close enough.) The best amazonite deposits were discovered around Pike's Peak about 1876. Like emerald, amazonite is supposed to make married life happier. This may be a bit of mineral-myth cross-fertilization.

The goddess of Egyptian mining was Hathor, the cow-headed goddess. She is one of the oldest and most revered of Egyptian deities, and sometimes is shown wearing a fetching vulture tiara. Nowadays there's a Hathor Exploration, Limited, a Canadian mineral-exploration company that obviously takes its inspiration from the goddess herself. The company seems to be more interested in uranium than in emeralds, however, so the Hathor connection seems weak at best.

The owners of the Egyptian mines held a veritable emerald monopoly until the Europeans discovered the vastly more plentiful and superior Colombian emeralds. Every once in a while a new emerald shows up out of Egypt, not from any new mining operations, but from the dumps of the old ones. These emeralds are of very poor quality, showing us that the ancients managed to get all the good ones out, if they were ever very good to begin with.

While Egyptian rock quarries were generally located close to the navigable Nile, the gem mines were in the middle of the desert. The world's earliest known emerald mine is located in a particularly nasty piece of terrain: the mountain valley of Wadi Sikait in Egypt's Eastern or Arabian Desert, east of Luxor between the Red Sea and Nile. To make it sound more inviting, they called it the "emerald city," although it had nothing to do with Oz. (There are also some old mines in the Western or Libyan Desert.)

In the 1990s, archaeologists from the University of Liverpool undertook to map the area and extract emeralds from several mining sites in the area, including Wadi Gimal, Wadi Nuqrus, Wadi Sikait, and Gebel Zubara. So far as we know, the Egyptians themselves mined only the Sikait mine proper; all other sites are Roman-Byzantine or Islamic (from the mid-sixth century onward). As you might expect, the Romans managed to make the most of

them, calling the area Mons Smaragdus or "Emerald Mountain." Very efficient people, the Romans.

The survey of Wadi Sikait found that emeralds and other green beryls occur within the contact zone between phlogopite schist and intrusive quartz and pegmatite veins. (Interestingly, the geological environment of beryl in Wadi Sikait, the world's oldest emerald mine, is essentially the same as for the world's newest emerald discovery—at Regal Ridge in the Canadian Yukon.) Samples from each mine were analyzed with an electron microprobe. Most crystals are smaller than 2 centimeters; the ones over 5 centimeters are rare. They are colored by chromium and iron, and often marred by fractures and both solid and fluid inclusions.

The purpose of the study was to clarify the history of emerald procurement and exchange. This will help historians figure out the relative importance of the Egyptian emeralds in the historical world market, and also to help understand the basis on which the mines were worked within the Egyptian Eastern Desert. This stage of the project was funded by the MacDonald Institute for Archaeological Research, University of Cambridge.

Eventually, the mines were largely worked out and for centuries, they lay lost and deserted. Apparently, the ancients scarfed up all the good emeralds for themselves, without a thought for posterity. (It's rather a rule in the emerald business that the first precious stones found in a working are the biggest and most perfect. The deeper you dig, the poorer the color and the less perfect the crystallization. There are, however, some pretty major exceptions.)

The mines were rediscovered after the Egyptian civil service department hired a French traveler named Frederic Cailliaud, a mineralogist, antiquarian, explorer, and assistant tomb robber, to find it. The force behind the move was Muhammad Ali, the Pasha of Egypt (although he was actually Albanian). The Pasha was interested in amassing and selling as many collectibles as possible. He is responsible for handing over priceless obelisks to other countries, notably "Cleopatra's Needle" (actually belonging to Thutmose III). He first tried to move it in 1819, but it was lost in a storm during transport and lay at the bottom of Biscay Bay until 1879, when it was hauled up and taken to England as a present for Queen Victoria. Its twin, the other "Cleopatra's Needle," but in this case a monument to Thutmose II, was the gift of a different Pasha. That one is in Central Park.

Cailliaud dutifully located the emerald mine in 1818 and made notes and drawings of the tools that he found lying around. He wrote up a memorandum about how fabulous the "lost city" of Berenice was. (It was renowned at one time for its importance in the elephant trade.) He also brought back about 10 pounds of rough-cut, poor-quality emeralds. He didn't mention that he had also stashed away some gems for himself before returning to Cairo.

However, when the most famous of all European tomb robbers, Giovanni Belzoni (1778–1823), got to "Berenice," to check it out, he disgustedly claimed that Cailliaud's reports were like the fantasies of Don Quixote. Cailliaud claimed, for instance, that he had spotted the remains of more than 800 houses, all standing. Belzoni found only 87, all in terrible shape.

Belzoni later rightfully claimed that he himself had discovered Berenice near the present-day town of Ras Banas on Foul Bay. He was pleased with his discovery, but it still didn't measure up to the legends about it. For one thing, he found no elephant remains, and that is always a terrible disappointment. Belzoni was more than a tomb robber and finder of lost cities. He had sampled various careers, from a monk to a strongman in a circus, before he found the one that best suited him. He also invented a hydraulic machine he named after himself—the Great Belzoni. He used some of his inventions to move enormous statues from the desert sands and have them shipped to England. He also discovered the tombs of Amenhotep III, Ramses I, Merneptah, Seti I, and Ay.

Despite his mistakes about Berenice, Cailliaud turned out to be right about the mines. He rightly decided that miners of a later period had discovered the mines and continued to work the tunnels long after the Queen's miners had ceased to dig. Even in the early part of the nineteenth century, a shabby sort of excavation was going on, although the shafts were highly dangerous and miners understandably rebellious and mutinous.

The French tried to reopen these mines, but they had been almost completely worked out, although a few low quality stones not worth bothering about were recovered from the schist. Trade in antiquities turned out to be much more profitable after all.

The Egyptian emeralds presently available are spotty in color, heavily occluded, feathered, and too light for today's taste. In fact, it's debatable as to whether or not they can properly be called emeralds at all, but merely "green beryl" tinted with iron rather than chromium or vanadium. This seems a distinction without much of a difference, although iron-tinted beryl never has the same perfect green as the other kind. However, the ancients loved them, and after all, they were all they had.

Emeralds in Scripture

Emeralds also show up in the two most debated scriptures of the current era: The Bible and the Qu'ran. Only three biblical books refer to emeralds: Exodus, Ezekiel, and Revelation, and in each case the reference is merely a passing one. In each case, too, the word or words translated as "emerald" are disputed. In actual fact, most biblical mentions of "emeralds" were probably referring to peridot, which occur in beautiful green crystals on St. John's

Island (Zabardgad) in the Red Sea. Real emeralds of the region were not only rare, but were of inferior quality. (While not in the Bible, Rabbinical legend mentions that four precious stones were given to Solomon by God—one of these was an emerald.)

The Book of Revelation devotes some time to discussing a visionary, heavenly Jerusalem. In 21:19, the fourth wall of the city of heaven is described as being made of emerald. There are twelve foundations altogether, the others being jasper (or perhaps diamond), sapphire, chalcedony, sardonyx, sardius, chrysolite, beryl, topaz, chrysoprase, jacinth, and amethyst. These "foundation stones" or "apocalyptic gems" have been the topic of endless heated discussion, as indeed has everything else in this heavily symbolic work. The most influential interpretation was that of Andreas, bishop of Caesarea, whose dates have been assigned anywhere from the fifth to the tenth century, and who connected each of these precious stones with one of the apostles, to wit:

Jasper	Peter
Sapphire	Paul
Chalcedony	Andrew
Emerald	John the Evangelist
Sardonyx	James
Sardius	Philip
Chrysolite	Bartholomew
Beryl	Thomas
Topaz	Matthew
Chrysoprase	Thaddeus
Jacinth	Simon
Amethyst	Mattias

Andreas made it his life's work to comment on the Book of Revelation, but with no more success in this regard than anyone else. But of the emerald, Andreas wrote: "The emerald, which is of a green color, is nourished with oil so that its transparency and beauty may not change; we conceive this stone to signify John the Evangelist. He, indeed, soothed the souls dejected by sin with divine oil, and by the grace of his excellent doctrine lends constant strength to our faith." Even today, as we have seen, many emeralds are treated with a "hot bath" of cedar oil or other oils to hide their flaws. There's nothing new under the sun.

The other reference to emerald in Revelation (4: 2–3) seems to be purely figurative: "And there was a rainbow round about the throne, in sight like unto an emerald."

In Ezekiel, the emerald is included in the listing of the gems belonging to the King of Tyre (28:13), a wicked man identified with the false Messiah and even Lucifer himself. "Thou hast been in Eden, the garden of God; every precious stone was thy covering, the sardius, topaz, and the diamond, the beryl, the onyx, and the jasper, the sapphire, the emerald, and the carbuncle, and gold." It's the same old story, however. While the venerable King James Bible identifies the stone as emerald, some more modern translations prefer "green feldspar," a term which has none of the cachet of emerald. It seems more likely that the King of Tyre, whatever his moral failings, wore real emeralds, particularly if he did indeed have any link with Lucifer, who also fancied them. Nor is it clear what the King of Tyre was doing in the Garden of Eden. However, Tyre, as an international trading port of some standing, would be a place where one could find emeralds.

The only other emeralds mentioned in the Bible appear in Exodus, in referring to Aaron's breastplate of judgment (39: 10–13). The word used, *nophek*, comes from an unused Hebrew root, meaning to "glisten." The emerald does not shine alone, however. There are other gems in the breastplate, including a sapphire and a diamond. While these probably symbolize the tribes of Israel, a good case can be made that they also stand for the 12 months of the year.

Andreas is not the only one to ponder the mystical meaning of the biblical stones. Maurus Magnentius Rabanus (or Hrabanus, Rabanus, Rhabanus, Reabanus, Raban, or Rabano), the Archbishop of Mainz (786–856), also had his say about their significance. Rabanus is most noted for his great charity toward poor people. He fancied himself a literary man and wrote several poems, whose quality, unfortunately, is dubious. He wrote books on grammar, numbers, and the calendar, as well as commentaries on the Old Testament. He penned a 22-volume encyclopedia of sorts, *De rerum naturis* (*On the Nature of Things*). Volume 17 contains his work on gems and minerals. (Volume 8 covers animals and the whole of Chapter 3 is devoted to "worms" including Areana, Cantarida, Multipes, Limax, Bombices, Eruca, Teredonas, Tinea, Lumbricus, Ascaridae, Tarmus, Ricinus, and Usia. No one today is quite sure what he was talking about.)

In regard to gems, he writes: "In the jasper is figured the truth of faith; in the sapphire, the height of celestial hope; in the chalcedony, the flame of inner charity. In the emerald is expressed the strength of faith in adversity; in the sardonyx, the humility of the saints in spite of their virtues; in the sard, the venerable blood of the martyrs. In the chrysolite, indeed, is shown true spiritual preaching accompanied by miracles; in the beryl, the perfect operation of prophecy; in the topaz, the ardent contemplation of the prophecies. Lastly, in the chrysoprase is demonstrated the work of the blessed martyrs and their reward; in the hyacinth, the celestial rapture of the learned in their high thoughts and humble descent to human things out of regard for the weak;

in the amethyst, the constant thought of the heavenly kingdom in humble souls."

The twelfth-century bishop of Rennes, Marbodus (1096–1123), also famous as a composer of hymns, repeated much of the ancient gem lore current at the time, including the belief that emeralds supposedly cure epilepsy. But he was most interested in the psychic powers of the stone, writing:

> Of all things which bounteous earth supplies
> Nothing in greenness with the emerald vies;
> Of mighty use to seers who seek to pry
> Into the future hid from mortal eye.

A later nonbiblical tradition connects emeralds with the Angel Muriel, the guardian of the birth sign Cancer, sometimes said to be ruled by emerald. Elsewhere it is claimed that emerald is said to be the stone of all the "Angel Princes."

The only Biblical character with a real connection to emeralds is the Queen of Sheba, although the connection is legendary rather than biblical. It is she, say the legends, who picked up the emerald dropped by Lucifer, and gave it to King Solomon.

No one is sure where Sheba was, although a good guess is southwest Arabia, about where Yemen is today. (Some sources place it in modern Ethiopia, which was in fact colonized by the people of Sheba.) Wherever it was, Sheba was noted for its gold, gems, and spices, such as frankincense, myrrh, cumin, saffron, and aloes. In those days caravans frequently traveled the 1,400 miles up the "Incense Road" and along the Red Sea to Israel.

The Queen of Sheba (whose first name, if she ever had one, is lost) was of supreme beauty. She had, so they say, a face of sorcery and cheeks to shame the blush of roses. She was "perfumed of herself," enthuse the old Arabic sources. At any rate, all the mines belonged to her, including the one on Mount Zabarah, where evil sprits guarded its emerald treasure. (These mines are supposedly identical with Cleopatra's mine of similar name, Zubarah.) The emeralds of Zabarah were truly special. According to the Arab explorer Al Idrissi, their size increased or decreased according to the season, and their color varied with the phases of the moon. He also believed that atmospheric conditions and wind had something to do with it. As we have seen, the ancient Incans had a similar idea, except that in their case they thought the color was due to the influence of the sun.

One story about the Queen and emeralds is told to illustrate the wisdom of Solomon, with whom she had some sort of relationship. Most sources believe this relationship was merely Platonic, but later legend claims their son was the founder of the royal house of Ethiopia, now defunct. At any rate, here's

how she tested his wisdom. It is said that she gave him a large emerald with a curved hole in the middle, and asked him to draw a thread through it. This is undoubtedly Lucifer's Emerald. The wise king sent for a silkworm, which crawled through the hole drawing with it a silken thread. The Queen was stunned by his brilliance. So am I, since silkworms were not known in that part of the world until a thousand years later. (The Chinese kept the source of the textile a deep dark secret as long as they could.)

Whether the emerald in the story is the same emerald that became the Holy Grail is not certain. Perhaps it was. Later on, some emerald belonging to the Queen ended up in the hands of Joseph of Arimathea. The Holy Grail had to come from somewhere, and there's a strong tradition that it was made of emerald. Some skeptics believe the Grail was made simply of green glass, but that seems unlikely too. While glass beads go back over 4,000 years, colored glass dishes appear much later and are unlikely to have shown up in first-century Jerusalem. The emerald theory is much nicer.

In any case the story is that Jesus drank from it at the last supper and Joseph of Arimathea used the bowl to catch Jesus' blood as he was crucified. It seems rather creepy that Jesus drank from a stone that once belonged to Lucifer, but in a way, it ties up some interesting theological tangles.

Thus, say the legends, the Order of the Holy Grail was founded. There are some people who claim today to be members of this group. A few even assert that in 1787 Thomas Jefferson translated the "book of the Holy Grail" (original author, again supposedly Joseph of Arimathea) from "the Grail Language." He didn't, but he did write the Declaration of Independence, which I suppose is worth something. He also wrote his own version of the Bible, or at least "The Life and Morals of Jesus of Nazareth Extracted Textually from the Gospels." He picked out the parts he liked best.

While on the hunt for the Holy Grail during the Middle Ages, crusaders and pilgrims alike grabbed thousands of green gemstones believing them to be emeralds. Many were traded around like money. Marco Polo brought lots of emeralds back from China, but that's not guaranteeing they came from there originally, if they were emeralds at all. They might even have been Egyptian. A lot of them ended up in crowns, thrones, body armor, and cathedrals. Most of these stones are probably peridots, including a lot displayed in cathedrals and castles as "emerald" but never verified to be such.

In Islamic lore, several texts mention Paradise as "carpeted" with emeralds. In one sura, the Qu'ran proclaims, "I shall descend upon thee a dome of light, made by my own hands, that will shine in the sky and in the air; I shall raise upon thee a wall of gold, a wall of silver, a wall of emerald, a wall of clouds, a wall of pearls, a wall of rubies . . ." Emeralds also make up part of the pebbles in the rivers of Paradise. And according to a fifteenth-century manuscript, the

Mi'raj Nameh, which deals with Muhammad's famous night-visit to heaven, the prophet found the "Emerald tree" studded with precious stones. The Arabic word for emerald is Yakootah, and is also a girl's name. In one Islamic tradition the first heaven (there are at least seven of them altogether) is of emerald. It is called Birqi and the angel Ismael is its guardian.

Another Qu'ranic story mentions that the Ten Commandments themselves were written upon emerald tablets, which is enough of a similarity to the Emerald Tablet story discussed later, to give one pause. Could it be that the Ten Commandments were the original emerald tablets?

Classical Emeralds: Greeks and Romans

The Egyptians, Jews, and Arabs weren't the only ones who had their eye on emeralds. The Greeks were also enchanted by the stone, even though they didn't have any of their own to mine. One Greek philosopher who touted the emerald as a health aid was that ancient botanist and mineralogist, Theophrastus, a native of Eresus in Lesbos. His real name was Tyrtamos, but his first nickname was Euphrastos, which means "well-spoken." It was soon upgraded to Theophrastus—divine-spoken. Traditionally, the ability to speak well is a gift of the emerald. He studied philosophy at Athens as a teenager, first under Plato, but afterwards under Aristotle. He was Aristotle's favorite pupil and succeeded him as director of the Lyceum, which he ran for about 35 years. He was once tried for impiety, like Socrates, but unlike Socrates, he was acquitted. Perhaps the eloquence of the emerald helped him out. According to tradition, Theophrastus eventually acquired 2,000 disciples, including the comic poet Menander, and was popular with several kings, including Philippus, Cassander, and Ptolemy.

He remained true to Aristotle's theories, being rather more Aristotelian than Aristotle in some respects, although he argued against Aristotle's proof for Prime Mover, or "God." The motivating force of his philosophic life was his attempt to find a link between what he called "the first principles" of nature and the actual objects he saw around him. It is a quest that still continues. He conducted many experiments on his own, although very little of his work survives today.

Theophrastus is often named "the father of botany." He is credited with instituting the truly scientific study of plants, documenting more than 300 plant names, and writing, "We must consider the distinctive characters and the general nature of plants from the point of view of their structure, their behavior under external conditions, their mode of reproduction, and their life history." He noted the various ways plants can grow (from seeds, cuttings, and the like), and various pollination methods. He classified plants into trees, large

bushes, small shrubs, and herbs. He was also the first to note that grapes can be toxic to dogs, something that contemporary toxicologists did not rediscover until the twenty-first century.

Not content to confine his studies to plants, and of more interest to us, Theophrastus also examined stones in his treatise, *Peri Lithon* ("About Stones"). Of all stones, Theophrastus recognized only the emerald as having health benefits. He believed that its use rested and relieved eye strain, a notion that has cropped up over and over again although there's no evidence to support it. Perhaps this is why Theophrastus is not considered the father of geology. He was better with plants.

Theophrastus was known as a convivial sort, sworn bachelor, and a gourmet. He perished after indulging too heartily at a wedding feast of one of his pupils. This sad event occurred in 287 BCE, when the philosopher was 87, 107, or 114, depending upon whom you ask. Tradition says that he died complaining about the brevity of human life—that it ended just when you finally had some insight into its problems. Since he may have been over a century old at the time, one would think that he had little to complain about.

Like the Greeks, the Romans didn't have any emeralds of their own, so they acquired them from those who did. They linked the green emerald with Diana, the Roman goddess of the forest and protector of women in childbirth. Thus, emeralds have long been credited with the ability to make childbirth easy and painless. They also dedicated the stone to Venus, who was Diana's opposite in so many ways. As the goddess of sex, Venus was the one who caused the childbirth situation in the first place. The Romans also believed the color of the stone reflected one's faithfulness in love and the emeralds of faithful lovers retain their clear green color. Those of the unfaithful turned dull or cracked. As emeralds are prone to cracking at the slightest provocation, or becoming dull over time as the oil used to treat them leaches out of the stone, it is impossible to say how many relationships foundered upon this green rock.

In like manner the Romans thought emeralds made people more honest, and that falsehood could not overcome an honest emerald. In fact, an emerald would turn pale in the presence of a lie, and when things got too bad, simply fall out of its setting. It would seem a prudent practice for habitual liars to avoid wearing emeralds completely.

For the Romans, as for the Egyptians, the emerald symbolized eternal youth and resurrection. Romans sometimes placed an emerald upon the index finger of a corpse, especially if the deceased were young. Let's consider Tullia, the beloved daughter of the Roman statesman Cicero (he called her Tulliola, apparently an affectionate nickname). She was buried with an enormous emerald—but there's even something more amazing about her tomb (if it really was hers, something not altogether certain). When the tomb was opened

early in the sixteenth century, the discoverer claimed he found a lamp still burning after more than 15 centuries. Rumor has it that a marvelous emerald was discovered on her corpse. Ever-burning lamps were a popular motif in the Middle Ages. Almost everybody had one. However, the incident makes one wonder about the whole story, although a slight mistake about the burning capacity of oil lamps doesn't necessarily invalidate the finding of a fabulous emerald. The story goes on to say that Tullia's lamp was blown out as fresh air wafted into the burial chamber. Tullia's tomb doesn't look like much now, just a bunch of grass and rocks on a hill.

Tullia's emerald eventually passed into the hands of the Marchesana di Mantova, Isabella Gonzaga de Este (1474–1536). She has been dubbed the "first lady of the Renaissance," and was known as an inventor, art collector, perfume patron, politician, musician, and ruler. She sort of ran Mantua after her husband was captured and taken as prisoner to Venice. In the best Renaissance tradition, she applied the principles of Machiavelli to her statecraft. She was also the mother of seven children and apparently had her eye on emeralds as well.

Isabella was very friendly with Pope Leo X, living with him for a while after her husband returned to Mantua from exile, apparently quite jealous of the power she amassed. She thought the climate would be healthier in Rome, and indeed, she ever after claimed that her heart would always be Roman. Titian, Leonardo, and others painted her picture. They owed it to her, since she was one of their best patrons. The portrait by Titian is exceptionally nice. He painted her when she was 36, but she asked him to make her look younger and he did. The portrait features Isabella wearing a stone in her headdress that may or may not be the reputed Tullia's emerald. Emeralds from South America were known and were just filtering into Europe about this time, so it's possible the reputed emerald was from Colombia. But we are getting ahead of ourselves and must return to the Romans.

One cannot talk about Roman emeralds without a close discussion of Pliny the Elder (23–79 CE), who was a Renaissance man, even though he was a Roman and the Renaissance hadn't been invented yet. In fact, the Roman Empire itself was just getting into full swing. That didn't stop Pliny from being less dull than the average Roman. Most Romans were busy drinking, building roads, and chasing around after Gauls and Goths, but Pliny had higher things on his mind. Being a Roman, he did his fair share of fighting as well, attacking Frisians and Chauci and the like, but his real passion was for writing encyclopedias.

Pliny was born in Como, Italy, although he is sometimes accused of being from Verona. He lived as a cavalry officer, advised emperors, and wrote at least 75 books without the help of a computer or even a fountain pen. He published the world's first encyclopedia, the 37-volume (the first volume

was an index and bibliography) *Natural History*, in the year 77, in which he modestly planned to "set forth in detail all the contents of the entire world." You can't say he wasn't ambitious. This work, by the way, is the first in history to include the now ubiquitous preface and table of contents. He also wrote a 20-volume history of the German Wars and a treatise on grammar, although the obvious connection between the two subjects apparently escaped him. His eight-volume *Problems in Grammar* is a real classic.

Pliny captured many of the emerald stories of his day (and may have been the first to actually call an emerald an emerald, at least in Latin). He believed that emeralds cured leprosy, if they were ground up and applied as a poultice. This measure would be worth it if it actually cured the disease; however, it turns out that this is just a waste of an emerald.

Pliny pronounced the emerald to be the only stone that delighted the eye without fatiguing it. He said of emeralds that "Nothing greens greener" and opined that emeralds were the only gem one could gaze at for a long time without tiring the eye. This may have given rise to the belief that emeralds guaranteed ophthalmic health. However, the gleam of emerald is not so soothing to everybody. Pliny the Elder records the tale of a marble lion with eyes of glittering emerald set over the tomb of a king named Hermias. The flashing eyes of the lion frightened the tunny-fish, to the despair of the fishermen. It took them a few months to figure out what was happening, but when they did, they insisted that the emerald eyes be removed and replaced with other green stones. The fish came back afterwards. And fish aren't the only ones made nervous by emeralds. In fact, the very sight of an emerald is deadly to serpents. This was a belief held by Greeks, Egyptians, and Arabs.

Still, Pliny recommended that those who had exhausted their eyes in close work should merely gaze upon an emerald for refreshment. Perhaps his advice was valid, because during the first few centuries of the Common Era, gem engravers are said to have kept some of them on their worktable, in order to gaze at them frequently to relieve eye fatigue. Pliny may not have been far wrong. Scientifically, it's been shown that green is more soothing to the human eye than any other color. The notion that emeralds are as soothing as oil also led many sailors to take one as a special talisman to calm the seas and bring good luck to their ventures. This practice also has its roots in the story that emeralds were good for those on a journey.

Pliny was a contemporary of the Emperor Nero (10 BCE–54 CE). Pliny was smart enough to retire from most public life soon after Nero's accession, realizing that Nero was not only mad and dangerous, but also rather stupid, preferring dancing girls to serious scholarship. However, perhaps Nero read up on Pliny's emerald pronouncements. It is said that the wicked emperor used to wear a clear, hollowed-out emerald monocle in order to "cool his eyes" as he

was watching the gladiator "games" at the Coliseum, perhaps using them as sunglasses. He is also said to have used the emerald eyeglasses to help him read his documents, as he was rumored to be shortsighted. He certainly had an ugly squint which did nothing to enhance his already rather marginal appearance.

Unfortunately, the whole Nero's eyeglasses story is suspicious. The inclusions characteristic of emeralds would have made it impossible for Nero to obtain a large stone clear enough to make spectacles. If the story is true at all, he was probably using pale aquamarine or perhaps even colorless beryl. Some suggest Nero actually wore emerald-studded glass spectacles. These wouldn't help his eyesight, but might have improved his looks.

In either case, if these were real emeralds he probably got them from the fabled Cleopatra's mines in Egypt. There is a body of opinion holding that the Romans were also familiar with an emerald deposit near Salzburg, Austria, although there's no real evidence that the mine was worked until the Middle Ages. We'll never know the source of Nero's eyeglasses, though. They're gone, if they ever existed in the first place.

Nero was not the only Roman ruler of his day with a passion for emeralds. Otho I (Marcus Salviu Otho, ruled 69 CE), one of Nero's best friends (and maybe even boyfriend), and later emperor, had an emerald in the handle of his knife. He was a small, bowlegged man whose feet stuck out on each side. Despite his looks, he was vain, and had his body hairs plucked out by his servants. He also wore a wig that was so well done he thought no one knew he was wearing one. This is not true, obviously, for if it was the previous sentence could not have been written in the first place.

Otho, however, got a bit too friendly with Nero's intended, Poppaea, and he was banished. It didn't matter in these circles that Otho was Poppaea's husband. Nero wanted her. Nero later kicked Poppaea to death when she was pregnant. Otho managed to struggle up the food chain to become Emperor, but the job didn't last. He only managed to survive for 3 months. He ended up committing suicide by falling upon his sword. One can only presume it was the one with the emerald in it.

Yet the savage world of Nero and Otho was also the world of the more refined Pliny. It was a strange world, which, according to Pliny's own encyclopedia, included dog-headed people who spoke by barking, and headless folk with eyes in their shoulders. He cautioned against the basilisk, a creature so toxic it destroyed bushes on contact. Even killing one was a dangerous proposition, as the poison rose through the killing-spear and would kill the wielder of the weapon, and even his horse, if he happened to be riding one. Should the reader doubt any of it, Pliny carefully cited sources for everything he wrote, naming 4,000 sources and about a hundred writers in all before he was done. Pliny is sometimes criticized for not having made any experiments

on his own and merely reporting the work of others; however, that is an unfair criticism. Pliny never claimed to be a scientist, merely a compiler. Although today his work is more valued for its insight about life in ancient Rome than for its scientific value, the work became the standard text for education during the Middle Ages, possibly explaining why they were so dark. Volumes 33–37 concern metals, stones, and their uses in medicine and architecture.

In one way Pliny was a typical Roman. He was a workaholic, beginning his labors before dawn. He made extracts of everything he read and used to say that there was no book so bad as not to contain something of value.

He considered all time not employed in study a waste, although he did take a break during his daily cold water bath. During his rubdown, however, he continued to read or be read to. He thought walking was a waste of time, as it took away time from useful work. (It's hard to read a scroll when walking.) He much preferred to be carried in a litter.

Despite his dedication to learning, Pliny also led an active public life. He had some real-life experience with emeralds, writing that he had seen Lollia Paulina, who became the third wife of the mad emperor Caligula (37–41 CE) ". . . covered with emeralds and pearls interlaced and alternately shining all over her head, hair, ears, neck and fingers, the sum total amounting to the value of 40,000,000 sesterces." That's not as much money as it sounds like—a paltry $1,488,000 at today's rates. However, Pliny confides, "Nor were these jewels the presents of a prodigal emperor; they were regular family heirlooms, that is to say, bought with the plunder of provinces." She must have been stunning, although Caligula divorced her after only 6 months, because she was infertile, although I daresay he didn't give her much of a chance. Caligula was more interested in his horse, which he made a senator.

Pliny's death was at least as interesting as his life. His last assignment was to command the Roman fleet in the Bay of Naples from its base of Misenum. In the early afternoon of August 24 of 79 CE, Mount Vesuvius erupted. Earlier, Pliny's wife had noticed a weird mushroom-shaped cloud arising from the top of Mount Vesuvius across the bay. Pliny thought she was worrying over nothing, but agreed to send out some inquiries of the inhabitants. His nephew Pliny the Younger was also aboard the ship, and it turns out that he has provided the only eyewitness account of what turned out to be the greatest natural disaster of the ancient world.

The true nature of the crisis appeared when Pliny the Elder learned that all escape routes on land were blocked. He went into rescue mode, and ordered his warships to approach Pompeii and to bring aboard anyone they found still alive. Ominously, small bits of ash and pumice floated down on the ship's deck, followed by hunks of blackened rock. Pompeii was buried, and the beach unapproachable. The sailors rowing the ship begged Pliny to return

home, but instead he ordered them to head for the harbor at Stabiae, a few miles further south.

There they landed, and Pliny spent the night with his friend Pomponianus, apparently undisturbed by the volcanic ash rising higher and higher outside his door. Apparently, he thought it was an an excellent topic for observation and research. He ate, bathed, and went to bed as usual, while everybody else nervously watched the disaster unfold at their feet, then at their knees. At dawn, they woke Pliny up, as it was obvious he was going to be entombed in the bedroom if he stayed there much longer. As they headed for the ships it became plain that Pliny wasn't going to make it. Apparently overcome by the toxic fumes, he collapsed and died in the arms of two slaves. Rock was crashing all around, and Pliny's friends, to save their own lives, fled the scene. They returned a couple of days later (after the eruption had subsided) and retrieved Pliny's body. It is a little sad that Pliny died without ever getting a chance to write up the event for his beloved *Natural History.*

Middle Aged Emerald

Slowly the glory days of the Roman Empire gave way to the Middle Ages. People living in the Middle Ages had a hard time of it. Most of them didn't have any emeralds, and in any case they believed the rock's main powers were medical not ornamental. Emeralds were used to treat eye disease, fever, gastrointestinal illnesses like dysentery, and contagious diseases. Emeralds were also rumored to help ease the pains of childbirth and even to cure the stings of venomous serpents and scorpions. Not, of course that Europe is overrun with either, but Europe does have some venomous adders, most notably the *Vipera berus*, and there are about half a dozen or so scorpion species on the continent, and even one that lives in the United Kingdom. Marbode of Rennes (1035–1123) in his *De Lapidibus* declared that emeralds alleviated depression.

More and more imaginary virtues were piled upon the precious green stone. As a result of this classical, medieval, and Renaissance load, it got to be a veritable panacea. To cure cancer, simply rub an emerald over the affected part. An emerald hung as an amulet on the necks of children was said to protect against plague, leprosy, epilepsy, and evil spirits (to the ancients epilepsy and evil spirits were much the same thing). However, their power was limited, for if the disease were too violent, the stone would break apart. The same is true with lustful love—too much passion and the stone just cracks up. Therefore this stone is not favorable to purely physical love. In fact, too much passion makes it nervous. Albertus Magnus talks about King Bela of Hungary (no relation to Lugosi, so far as I know), who owned an extremely valuable emerald—but when he embraced his wife, the thing broke into three

parts. Thus, it isn't recommended for newlyweds, since it impeded "conjugal happiness," although it does promote faithfulness. Much depends on what one expects out of marriage. Thus, while it is the talisman of love, the emerald is also the antidote for passion. It is a very complex stone, and I wonder if its natural inclusions lead to the complexity of its meaning.

According to Damigeron (an old-time magician of very uncertain date) in his *The Virtues of Stones*, the emerald should be engraved with a scarab, beneath which is to be a standing figure of Isis. The gem is then to be pierced longitudinally and worn in a brooch. After due ceremony, which included dressing up to the nine, the stone would become luminous with the light of God. Damigeron also taught how to produce a nut without a shell. He also had a recipe involving goat suet and turpentine.

Emeralds were also said to free prisoners, give the wearer the ability to foresee the future, allow people to recover lost objects, scatter demons, and cleanse pollutants. When worn upon the left arm it was of particular value in destroying evil and "witchiness."

Ahmed-ben-Abdalaziz or Teifaschi, a twelfth-century Arabian gem dealer, decided to test the theory that emerald was such an enemy to poison that a serpent could not even gaze upon one. He tells in his *Treatise on Jewels* (about 1150) just how powerful emeralds are. He managed to buy, rent, or borrow a viper from a local snake charmer and stuck it in a pot. Then he took a stick of wood, and attached a bit of wax to the end of it. He embedded an emerald in the wax. As soon as the doomed serpent raised his head, Teifashi waved the emerald-empowered stick at it. In an instant, the reptile, which up to then had been full of piss and vinegar, was blinded—its eyes "dissolving into a humor." It became understandably confused, and eventually fell into a coma or maybe died. At any rate, it stopped moving. Possibly for this reason, Teifaschi ranked emeralds above diamonds, rubies, and sapphires in price.

All this nonsense was given literary status in Thomas Moore's (1779–1852) poem, *Lalla Rookh: An Oriental Romance.* Here are the relevant lines:

> Blinded like serpents when they gaze
> Upon the emerald's virgin blaze.

He was paid 3,000 pounds for it, at that time the largest sum ever paid for a single poem, and nothing to sneeze at even today.

The vaunted powers of emeralds to cure all ills were repeated throughout the next thousand years without abatement, and continue yet.

Nor was emeralds' value as simple gemstones overlooked. No crown or scepter worthy the name would be without one. Undoubtedly, the most

famous crown of the period belonged to Charlemagne, even though its present whereabouts, if anywhere, is uncertain.

"By the sword and the cross" Charlemagne (742?–814) was the famous son of Pepin the Short and Bertha Greatfoot. Although this may not sound like a promising beginning, Charlemagne overcame his unattractive genetic heritage and became the greatest emperor of the Middle Ages. You may remember how the famous coronation took place. Charlemagne was kneeling in prayer in St. Peter's Cathedral in Rome when Pope Leo III showed up unexpectedly and simply crowned him emperor. Charlemagne professed to be utterly shocked, but didn't refuse.

There is a controversy about the crown. Many historians believe that it was the famous Iron Crown, presently residing at the Cathedral at Monza, near Milan, Italy. Some doubts have been cast upon its authenticity, however, and its age was recently tested using nuclear analysis. It was found to have been made between 750 and 780. As Charlemagne was crowned in 800, it's possible, based on chronology, that this is indeed the famous crown.

But there's another candidate. The French have always insisted they had the official crown of Charlemagne, a simple unadorned one that was, until the coronation of Louis XV in 1722, used by all the French kings at their crowning. (It was last used by King Louis XIV at his coronation in Rheims Cathedral in 1654.)

However, Louis XV commissioned jewelers Laurent Ronde and Augustin Duflos to create a new, more impressive crown, encrusted with diamonds, rubies, emeralds, and sapphires from the Crown Jewels (including the 140.5-carat Regent diamond). It was this sort of thing that brought on the French Revolution. This crown was kept for a long time as one of the treasures of St. Denis, but was melted down in 1793, during the aforementioned Revolution. It is not clear what happened to the first one.

One has to feel sorry for Charlemagne. He was a great fan of education, even persuading the great English scholar Alcuin to live at his court to improve the learning of the clergy. Alcuin was only too glad to stay on, as things weren't going so well in England at the time, what with the Danes wreaking havoc everywhere. Still, Charlemagne himself was a tough case. He studied Latin like mad but was never able to get much beyond his native German. And while he could read a little, writing was beyond him. He tried sleeping with a writing tablet under his pillow so that if he woke up in the middle of the night he could practice making letters, but it was no use. He said that he was too used to holding a sword to have much success with a pen. He used a stencil to sign his name.

Charlemagne died in Aachen, and was buried in the Aachen Cathedral in 814. In the year 1000, Emperor Otto III had Charlemagne's vault opened.

It is said the body was found in a truly remarkable state of preservation, seated upon a marble throne, dressed in imperial robes, with a crown on his head, the Gospels lying open in his lap, and his scepter in his hand. In fact, a large mural of Otto and his dumbfounded court gazing on the dead Emperor was painted on the wall of the great room in the Town Hall. In 1165, Frederick I (Barbarossa) opened the vault again and had Charlemagne's remains placed in a sculptured sarcophagus of Parian marble, rumored to be the one that Augustus Caesar had made for himself. He also ordered a bronze chandelier to be placed over the shrine, which is still there today. At Barbarossa's request, Charlemagne was actually canonized, albeit only by Guido of Crema (Paschal III), an antipope. The Catholic Church later had all this annulled.

In 1215, Frederick II, possibly not wanting to be upstaged, even by a long-dead emperor, quietly had Charlemagne's bones shoveled into a gold and silver casket and buried under a stone slab. And that's where they are now.

The medieval scholar Albertus Magnus (1206–1280), or Albert the Great, later Saint Albert, scientist and philosopher, and teacher of Thomas Aquinas, has some interesting attributed comments on emeralds and other stones, much of which he copied from Pliny. It is equally interesting that much of what he has to say about gems is merely attributed to him—the real author of his *Book of Secrets* is anonymous.

According to this "pseudo" Albertus, "Take the stone which is called *smaragdus*, in English speech an emerald [a helpful addition from the translator, as Albert, who was German, wrote in Latin]. And it is very clear, shining through and plain, but it that is yellow is better." His language is somewhat confusing, as he does not make it plain whether by "clear" he means transparent, colorless, or free from occlusions. His preference for a "yellow" emerald adds to the confusion on many levels.

At any rate, pseudo Albertus adds, "It is taken out of the nests of grypes or griffons." He continues, "The tales relate how the foreparts of these birds . . . resemble an eagle, though on a much larger scale. The posterior portion of the animal, including the tail and rear legs, looks like a lion. The forefeet have long aquiline talons, while the rear feet have short but massive leonine claws which they use as cups for drinking. . . . They are supposed to live in the mountains of the extreme North, are especially inimical to horses and men, and are so strong they can carry off a horse and its rider. Their mountain aeries are claimed to be laden with gold and gems, particularly emeralds."

Griffins are also said to guard the tree of life, the Scythian gold mines, the road to salvation, and the tree of the knowledge of good and evil. The Romans and Greeks carved griffins on their tombs to protect the corpses within.

According to John Milton, the main stealers of Griffin nests were the Arimaspians, a one-eyed people of Scythia. In Book II of that dreaded classic *Paradise Lost,* Milton writes:

> As when a Gryphon through the wilderness
> With winged course, o'er hill and moory dale,
> Pursues the Arimaspian, who by stealth
> Had from his wakeful custody purloined
> The guarded gold . . .

I won't go on in this vein any longer, and Milton shouldn't have either.

However, the treasure griffins guard most is emeralds, which they secrete in their golden nests and hide along with their young. That's probably where Pliny, Albert's original source for this material, got the wrong idea about their egg-laying habits. Most medieval experts agreed that griffins laid eggs of agate, with perhaps only an occasional emerald thrown in. Presumably some of them laid ordinary griffin eggs, too. Yet Albert was not quite so easily taken in by the entire griffin theory. "Their credibility as real animals is not based on the experience of philosophers or the evidence of natural science," he writes simply.

While Albert had his doubts about the whereabouts of griffins, he had none about emeralds. "If you would sharpen the understanding, increase riches and foresee the future," he counsels, "take an emerald. For prophesying, it must be placed beneath the tongue."

Next we come to King Alfonso VI of Castile (1030–1109). This is the same Alfonso who banished the Spanish hero El Cid, so he has a lot to explain. In 1085 King Alfonso VI took the great Muslim city of Toledo, despite the fact that the Arabs were on time with their tribute payments. Alfonso collected an enormous amount of treasure, including the fabulous "Table of King Solomon," supposedly an actual table carved from a single immense emerald. One story says he won it by beating the owner at an immensely long game of chess. King Solomon's Table is mentioned in the Bible (1 Kings 4:27) but it doesn't say it was made of emerald. At any rate, Europeans were so enraged that the infidels had hold of Solomon's Table in the first place and who knew what else, that it acted as another impetus for the Crusades.

Carlos Saura made a film about this famous piece of furniture in 2001, *Buñuel and King Solomon's Table*, a tribute to his friend Luis Buñuel. The film is about a search through Toledo for the legendary table. In the film, the table has a magically mirrored top that reflects the past, present, and future, just as the emerald itself is said to reveal the secrets of time. The movie features deadly dames, mad movie critics, and a giant robot. Not to be missed.

Hildegard von Bingen (1098–1179) was a famous medieval mystic (widely known as the Sibyl [or Sybil] of the Rhine) who had her own view of the origin of the emerald. "Emeralds," she wrote, originate "in the early morning sunrise [which is typically when the sun *does* rise] . . . It is a strong remedy against all weakness and disease of man." Of a fairly excitable temperament, she claimed visionary powers in addition to her "expertise" in natural history. In one such vision she saw "a huge round tower entirely built of white stone, having three windows at its summit, from which such brightness shone forth that even the conical roof of the tower appeared very clearly in the brightness of this light. The windows themselves were decorated round about with most beautiful emeralds." The emeralds, she wrote, are symbolic of the "green virtues" of the apostles.

Skeptical observers attribute her visions to migraine headaches. She corresponded voluminously with four popes, and several heads of state, including King Henry II of England and Frederick I (Barbarossa), who made such a big deal of Charlemagne. Dealing with Frederick Barbarossa was difficult for most people, but not for Hildegard. In fact, she invented her own language, an unseemly mix of German and Latin to do so. Hildegard is often referred to as a saint, but has not been officially canonized.

Another Middle Ager

Michael Constantine Psellus (1018–1078), is most famous for his *Chronographia*, detailing the lives of fourteen Byzantine rulers, but for our purposes it's his work on emeralds that's important. In his *De lapidum virtutibus* ("On the Powers of Gems"), Psellus says that a cataplasm made of emeralds was helpful to those suffering from leprosy. A cataplasm is not something you run across every day. A run-of-the-mill cataplasm is a soft, heated mass of meal or clay spread on a cloth and applied to the skin. In this case, you use ground up emeralds instead. Most lepers were far too poor to afford emeralds, ground up or otherwise, but that was not the fault of Psellus. He adds that pulverized emeralds would also check hemorrhages if drunk.

The Emerald Tablet

Emeralds as an antidote against poison got worldwide play, even though its signature constituent, beryllium, is incredibly toxic. In fact, the twelfth-century Spanish-Arab physician Abenzoar (1091–1161) wrote that after having eaten a poisonous herb, he placed one emerald in his mouth, applied another to his stomach and was cured. Obviously he wasn't foolish enough to start grinding up the family heirlooms himself, but that didn't stop him from

telling others what to do. Six grains of emerald, he believed, taken internally was the dose to cure dysentery, although on occasion he found that merely asking the patient to wear the stone was sufficient. Interestingly, Abenzoar also did a lot of work on diseases of the eye, conditions for which emeralds are said to be effective. Abenzoar, however, probably not having much luck with emeralds, worked on developing some of the world's first cataract surgery instead.

It's impossible to discuss famous emeralds, real or imaginary, without mentioning Hermes Trismegistus and the Emerald Tablet or Tablet Smaragdina. Even though the Emerald Tablet probably never existed, it's still worth talking about. There are a lot of things like that.

Maybe you've never heard of the Emerald Tablet. Most people haven't, although at one time, as we shall see, it was all the rage. Upon its face was engraved the secret of alchemy, the art of turning base materials into precious stuff. For most people, this means turning lead into gold, but there's a lot more to alchemy than that. For those proficient in the art, it means turning flesh into spirit.

The physical Emerald Tablet is described as a rectangular object of exquisite workmanship, with its sacred message written in bas-relief, using an alphabet similar to Phoenician (weird enough to be foreign, familiar enough to read). It became known to the Christian world after the fourteenth century through translations from the Arabic.

Supposedly this special tablet is made of *uat* ("matrix emerald"), or more likely, a single piece of green crystal, jasper, or jade. Emeralds, except maybe magical ones, simply don't come large enough to engrave lengthy alchemical secrets upon, although the engraving of emeralds is an ancient art.

In all probability, the purported tablet, if it ever existed, was made of nothing more exquisite than glass. One traveler who reports seeing it, wrote, "The matter of this emerald had once been in a fluid state like melted glass, and had been cast in a mold, and to this flux the artist had given the hardness of the natural and genuine emerald, by his art." Interestingly, glass is sometimes colored green by chromium just as emerald is.

Many consider the writing on the Emerald Tablet to be one of the earliest of all extant Western alchemical works. In mystical circles it is very *au courant*, popular not only with modern-day alchemists, who have given up trying to make gold and are working on the considerably harder task of transforming their spirits, but also with Jungian analysts and other present-day purveyors of deep truths.

The words of the Emerald Tablet are considered to belong loosely to the Hermetic Tradition, a non-Christian branch of Hellenistic Gnosticism. Hermetic writings are conveniently divided into two kinds—the philosophical treaties and the "technical" or magical/alchemical treatises. The latter group

included texts that teach you how to protect objects magically—we get the term "hermetically sealed" from this idea. The precise number of official texts is under dispute. One Roman historian lists it at 36,525 books, a number having something to do with the duration of Egyptian dynasties. Another writer reduces the number to a mere 20,000. Still another cautiously refers to "many books." Clement of Alexandria conservatively placed the number at 42 "essential texts"; others have been content with a mere 18. Many of these alchemical and mystical works are supposedly collected somewhere in a secret library who knows where. Every once in a while someone claims to have discovered one, but it always turned out to be a forgery.

The Emerald Tablet, however, stands in a class by itself. It is the only piece of non-Greek Hermetica to draw widespread interest in the West, and is one of the oldest extant examples of the genre. Its cryptic text purports to reveal the secret of the primordial substance and its magical transformations. Indeed, some consider it to be the ultimate Book of Magic. There's even one theory that the Emerald Tablet reflects supramundane wisdom brought to Earth by space aliens 12,000 years ago. I really have nothing to say about this, although it is certainly tempting.

For lovers of the mystical arts, what is so important about the Emerald Tablet is not that it's this really enormous piece of emerald, but that it contains the secret formula for alchemy—the transformation of spirit and matter. There are plenty of translations and copies of the Tablet, which most medieval alchemists kept hanging on the wall, but apparently some special element is missing from the translation, since the medieval alchemists just didn't have any luck making lead into gold. Or perhaps they misunderstood what the text is really about. Or both.

The secrets of the Emerald Tablet were reportedly handed down to Hermes Trismegistus (Hermes the Thrice Great, sometimes even translated as Hermes the Thrice Greatest, which seems to be going a little too far). Others claim the said Hermes to be the author of the Tablet, not merely its receptor.

The original Hermes, as you probably recall from your Greek mythology class, was the messenger of the gods, and the patron of good speech. He was also lord of magicians, and the emerald, the stone of magical transformation, was frequently associated with him. The emerald is also considered a protector of travelers. So was Hermes, including those who were making their final journey—to the underworld. Warriors wore emeralds in the hope that if they died in battle, the emerald would keep them safe in the next world.

However, the Hermes we are talking about here should not be precisely identified with that Hermes, although they have a certain family resemblance. When the Greeks settled in Egypt around the sixth century BCE, they decided that their Hermes was the same god that the Egyptians called Thoth. They had

a habit of mixing things up like this. They even insisted all their gods were the same as the ones the Romans had, which they were not. Nor is Hermes to be equated with Thoth, although they are similar in many ways. Both gods were associated and involved with eloquence and learning. The Greek Hermes invented weights and measures, while the Egyptian Thoth, who could see into one's inmost motives, was the weigher of the heart. The Greek Hermes protected travelers and the Egyptian Thoth was a guide in the land of the dead. In both cultures the emerald also protected those on a journey. In fact, the powers attributed to emerald are precisely the powers attributed to Thoth, Hermes, or a combination of the two: wisdom, protection, discernment, and eloquence. It is little wonder that the wisdom of Hermes/Thoth was said to be inscribed upon this gem.

For 300 years Hermetic writings were considered by the Christian Church to be ancient and authentic, and that they lent support to Christian doctrines. Even today, a huge fresco in the Borgia apartments of the Vatican shows Hermes, adorned with Hermetic symbols, ambling along with Moses. Later, they were deemed heretical.

Just because no one knows exactly who Hermes Trismegistus was, has not stopped a lot of speculation. Depending what source you consult, he was:

- A god
- A prototype of a god
- The Only Son of God
- Only a son of a god
- Seth, the third son of Adam
- Another son of Adam not in the Genesis account, who wrote the tablets to show us how to redeem ourselves from the original sin
- Moses
- Thothmoses
- An engineer from Atlantis who built the Great Pyramid (courtesy of Edgar Cayce)

He is a rather difficult figure to pin down. The difference between a son of a god and the son of God can is obscure. Christians had the same trouble with Jesus of Nazareth, and sure enough some believe that Jesus is a reincarnation of Hermes Trismegistus as well. Others believe that there was an entire line of H.T.'s. The Roman writer Cicero alone mentions about five men claiming the name. Arabian lore speaks of three, one who lived before the Flood (and was a *grandson* of Adam), and who built the Pyramids. Then there was a second one who was the teacher of Pythagoras. There was a third one who was a philosopher. It is very likely the name isn't a personal one at all, but

a title referring to a level of initiation along the esoteric path. The Hermes level may be equivalent to that of a "grand master." Whoever he was, Hermes Trismegistus or those writing in his name, are responsible for hundreds of texts all through Alexandrian and Gnostic literature. True Hermetic texts, however, are definitely not Gnostic; there is no concept of matter being evil or cursed, a central tenet of Gnostic thought.

Some Christian writers became so entranced with Hermes Trismegistus that they considered him to be a pre-Christian witness to their own theology. He was all things to all people. According to most scholars, however, the majority of available orthodox Hermetic texts date only to about 300 CE, although the earliest ones may go back to the times of the Pharaohs, depending how one defines "Hermetic." During the sixteenth century, Hermes was so revered in certain European quarters that there was actually a movement to have his works replace the traditional curriculum, which was stuffed with Aristotle.

Rather fortunately, as it probably turns out, the movement was quashed. In 1614 a certain Isaac Causabon declared that all Hermetic texts were not the work of Christian forebears, after all, but forgeries written by "semi-Christians" between 200 and 300 CE. Causabon did not specify who the semi-Christians were, but they are probably related to the semi-Christians of today. After that everybody condemned the same writings they had been upholding as supporting Christianity. Later they were picked up by Rosicrucians and Freemasons. Take, for instance, this passage from the *Morals and Dogma of Freemasonry*, a noted Masonic work (1871) by Albert Pike. "He who desires to attain the understanding of the Grand Word and the possession of the Great Secret, ought carefully to read the Hermetic philosophers, and will undoubtedly attain initiation, as others have done; but he must take, for the key of their allegories, the single dogma of Hermes, contained in his Table of Emerald." Even Henry Wadsworth Longfellow, of "Hiawatha" fame, wrote verses honoring Trismegistus. Here's an excerpt:

> Trismegistus! three times greatest!
> How thy name sublime
> Has descended to this latest
> Progeny of time!
> Happy they whose written pages
> Perish with their lives,
> If amid the crumbling ages
> Still their name survives!

I don't suppose you want to hear any more. In one place in the poem, Longfellow manages to rhyme "spacious" and "fallacious" and he wasn't even trying to be funny.

The confusion about Hermes Trismegistus, however, doesn't hold a candle to the confusion about the Emerald Tablet. According to one story, the Tablet was floated aboard Noah's Ark, hidden in a cave near Hebron, then discovered by Sarah. Another tale claims that the Tablet was given to Moses' sister Miriam who put in the Ark of the Covenant along with the Ten Commandments. And there it is still. If we knew where the Ark of the Covenant was, we could fish out the Emerald Tablet. Another story says that Hermes Trismegistus did not write the Tablet, but found it in a cave, not in Hebron this time, but in Sri Lanka. The idea of finding hidden texts in caves is not only very appealing, but actually happens once in a while. They found the Dead Sea Scrolls in a cave, if you recall.

For others, the Emerald Tablet's true origins go back 10,000 years, although it was "put on display" in Heliopolis, Egypt, in 330 BCE by Alexander the Great, who found it in the Libyan Desert. When Alexander departed from Egypt, he took the Tablet with him, and, before going on to conquer the rest of the world, hid it for safekeeping. Some say it was buried somewhere around or in the King's Chamber of the Great Pyramid to protect it from the enemies of occult knowledge. It certainly is not there now, although lots of people have gone looking for it. Pyramids are notoriously poor places to hide valuable items. People tend to notice pyramids and want to see what is in them.

However, it is in the nature of lost emeralds to suddenly show up again. This time the finder was a youth named Apollonius, who was born in Tyana in today's Turkey. (At times Apollonius is identified with a certain Balinas. Maybe they were the same person; maybe not.) Apollonius, a contemporary of Jesus, spent most of his time being a sage, wandering around Asia, working miracles and performing various acts of wizardry. He eventually settled in Alexandria, along with most of the rest of the intelligentsia of the Western world. He too found the Emerald Tablet in yet another cave (or as per another version) in the Great Pyramid. According to one story, he had to wrest it from the arms of Hermes Trismegistus's corpse. Could Alexander the Great have planted both the corpse and the Tablet in a cave?

I would like to tell you what happened to Apollonius, but I cannot. Some say the Romans accused him of conducting human sacrifice and put him on trial, but he magically vanished from the courtroom. Others say the Romans never heard of him and that he condemned blood sacrifices, although there is credible evidence that he convinced a mob of Ephesians that a poor old beggar was a "plague demon" and had him stoned to death. After he himself died, say other sources, he rose from the dead. In any case, his connection to the Emerald Tablet is too tenuous to waste any more time on him, although naturally there are some who claim that Apollonius was Hermes Trismegistus himself.

The truth, however, is that no one really knows who originally wrote the Tablet, or where it is now, if anywhere. Most of the dialogue about it is just

guesswork, scholarly or otherwise. The oldest (abridged) copy of the Emerald Tablet we have today is in Arabic, which was supposedly compiled by Jabir ibn Hayyan (c. 721–813), a Sufi alchemist known to the West as Geber. In fact, the ancient Arabs were possibly the first to call alchemy the "Hermetic art." E.J. Holmyard discovered the text in 1923. Before that, it had been known only in Medieval Latin. However the Arabic copy is probably based on a Greek original, and so it goes.

The Emerald Tablet does succinctly, if a bit awkwardly, express the central tenets of alchemy, and the idea that human beings can access some sort of ultimate truth from understanding the vital and mysterious relationship between earthly and heavenly things. In simplest, but most illogical language, its message is: "All is one."

Since the Emerald Tablet is the foundation of Hermetic Philosophy and alchemy, it merits a little closer examination. On the surface, the Tablet is an alchemical recipe for preparing the "philosopher's stone," that fabled item which is rumored to transform metals into gold. The "sun," for example, referred to in the Tablet stands for gold, according to standard symbology. However, alchemy has always been more a spiritual pursuit than a scientific one, and the Tablet is understood to have philosophical significance as well.

A rendition of the information on the original tablet (assuming the very uncertain question of its existence in the first place) probably first appeared in the West in editions of the *Secretum Secretorum* (*The Secret of Secrets*). This work was a translation of the *Kitab Sirr al-Asar*, a pseudo-Aristotelian compendium of advice to kings (possibly between 630 and 800, but it's not certain when or even if the Emerald Tablet was incorporated into it). The translator was Johannes "Hispalensis" or Hispaniensis, also known as John of Seville, who did the work around 1140, and dedicated it to "Queen T.," possibly Teresa. John translated a text about gout for the benefit, apparently, of a long-suffering pope—one of the Gregories. Many other translations were also made.

Paracelsus claimed its thirteen sentences are the universal recipe by which all things can be restored to their original, perfect state, a state in which the differences between mineral, floral, animal, mental, or spiritual spheres melts away. A nuclear explosion can do the same thing, of course.

One of the most famous versions of the Emerald Tablet has also survived in Latin (Tabula Smaragdina). Here it is, with my interlinear translation:

Verum, sine Mendacio, certum et verissimum:

It is true without falsehood, certain and absolutely true.

Quod est Inferius est sicut quod est Superius, et quod est Superius est sicut quod est Inferius, ad perpetranda Miracula Rei Unius. Et sicut res omnes fuerunt ab Uno, meditatione unius, sic Omnes Res natae ab hac una Re, adaptatione.

What is below is like what is above, and that which is above is like that which is below, for the performance of the miracles of the One Thing. And just as all things come from that One, through that One's meditation, so all things in nature are adapted from It.

This is the basic principle of alchemy, that there is a natural sympathy between the higher and lower, and indeed between all parts of creation. The "One" of course is the First Cause, Foundation of Being, Ultimate Meaning, the Infinite, or God.

Pater eius est Sol. Mater eius est Luna. Portavit illud Ventus in Ventre suo. Nutrix eius Terra est. Pater omnis Telesmi totius Mundi est hic. Virtus eius integra est si versa fuerit in Terram. Separabis Terram ab Igne, subtile ab spisso, suaviter, magno cum ingenio.

Its father is the Sun. Its mother is the Moon. It will carry the wind in its belly. Its foster-mother [matirix] is the Earth. Here is the father of all the perfected designs of the world. Its power is complete if it is integrated with the Earth. You will separate the Earth from the Fire, the Subtle from the Heavy, sweetly, with great genius.

This is a reference to the four traditional elements, upon which alchemy is based: fire (Sun); water (Moon); air (Wind); earth (Earth). Ascendit a Terra in Coelum, iterumque descendit in Terram, et recipit Vim superiorum et inferiorum. Sic habebis Gloriam totius Mundi. Ideo fugiet a te omnis Obscuritas. Haec est totius Fortitudinis Fortitudo fortis, quia vincet Omnem rem subtilem, Omnemque Solidam penetrabit.

It ascends from the Earth into Heaven, then descends again to Earth and receives powers from things below and above. Thus you will have the glory of the entire world. Therefore all obscurity will flee form you. This is the Force of all Forces, which conquers all subtle things and penetrates all solid things.

This passage describes the basic mechanism of alchemy, which draws its powers both from the earth and from heaven. It's a process of separation, isolation, and reintegration, a kind of journey of the hero transmuted into elemental form. Again, hermetic literature never denies the power and basic goodness of the material world.

Sic Mundus creatus est. Hinc erunt Adaptationes Mirabiles, quarum Modus est hic. Itaque vocatus sum Hermes Trismegistus, habens tres partes Philosophiae totius Mundi.

Thus the world is created. Here are miracles opened, the method of which is here. Thus I am called Hermes Trismegistus, who have three parts of the Philosophy of all the world.

Again a celebration of the earth and its miracles.

Completum est quod dixi de Operatione Solis.

What I have said of the operation of the Solis is completed.

And what is true of the sun is true of all created things.

The Renaissance of Emeralds

While the Renaissance brought with it a great awakening in learning, art, and culture, most of the old myths about emeralds remained in place. They also remained as popular as ever both as adornment and as stones of mystical meaning. Just as in the Middle Ages, emeralds were valued for their healing properties. Francisco Rueus, in his 1547 tome *De Gemmis,* maintains that 84 barleycorn weights of emerald powder will save the life of one dying from poison. In Rueus's time, New World emeralds had hit the market, and so the supply was considerably more plentiful than it had been in the Middle Ages. Still, they weren't cheap enough to grind up. More frugal writers suggested that a mere 70 barleycorn weights would counteract the poison. It is impossible to say how many fine old stones were ruined by grinding them up.

In like manner, a certain Michaele Paschali, a sixteenth-century Spanish physician, asserted that he had cured Juan de Mendoza, a Spanish grandee, of dystentery, by using emeralds. Much later, Wolfgang Gabelchover, of Calw, in Wurtemberg, writing in 1603, said he used emerald to cure dysentery with invariable success. And of course it cured fever, leprosy, and all the rest. At least in these cases, it didn't seem necessary to grind up the emeralds, so they could be reused for dinner engagements.

The Renaissance goldsmith Benvenuto Cellini used emerald for his gold and enamel works. In his autobiography (Book I, Chapter 27), Cellini wrote, "There came into my hands, among many other fragments, the head of a dolphin about as big as a good-sized ballot-bean. Not only was the style of this head extremely beautiful, but nature had here far surpassed art; for the stone was an emerald of such good color, that the man who bought it from me for tens of crowns sold it again for hundreds after setting it as a finger-ring."

There is a modern mythical story about an emerald given to Pope Innocent VIII by the visiting Sultan Bajazet II in 1488 as ransom for his brother, who had been taken captive by the Christians. The emerald was supposedly engraved with the head of Christ and was said to have been ordered by Tiberius. There is so much wrong with this story one hardly knows where to begin. The emerald does not exist now, and its proponents suggest it disappeared in 1527, during one of the many sacks of Rome.

A little earlier I discussed Theophrastus, the pupil of Aristotle. Believe it or not, yet another Theophrastus wrote about emeralds. This was Theophrastus Paracelsus (1493–1541) (undoubtedly not his real name). He wrote in his *Coelum Philosophorum* that the emerald "does good to the eyes and the memory. It defends chastity; and if this be violated by him who carries it, the stone itself does not remain perfect." Paracelsus also stated that emerald had an affinity to copper, which has led to the practice of crystal healers using emerald set in copper bracelets.

Theophrastus was much listened to during the Renaissance, for reasons unclear to me. He wrote, "The universities do not teach all things, so a doctor must seek out old wives, gypsies, sorcerers, wandering tribes, old robbers, and such outlaws and take lessons from them." Presumably, he thought he'd get better information this way, and he may have been right.

Why did the ancients prize these unremarkable stones? They seemed to know or intuit that emeralds were valuable, even though they themselves had never encountered a really fine one. It is surely part of the magic of emeralds that these wondrous stones of fancy really did exist in the world, even if not in the world the Europeans knew about. Perhaps they were imagined into existence.

Whatever the case, the age of the emerald is the age of the late Renaissance and early modern period. They are the children of the New World, but as they traveled back to Europe their splendor added glory to the Old.

The Mystique of Origins and the Great Emeralds

Although you might think an emerald could stand on its own facets, it turns out that where an emerald hails from adds something to its mystique, and hence its cost. Stones of equal "objective" value may go for quite different prices, depending on their supposed origin.

On this scale of imagined value, emeralds from the Muzo mine in Colombia generally rank highest. These stones are believed to set the worldwide standard for size, clarity, and color, even though this isn't always true. (Another prestigious source for emeralds is a secret "Old Mine of India," which doesn't exist, and probably never did.)

Interestingly, there is an "old mine" rumor about Colombian emeralds, just as there is about Indian gems. In this case, though, the legend is simply that all the great emeralds have come from the old mine worked back in the sixteenth century. This may be true, for as mentioned earlier, the best stones of any one mine have historically been uncovered first. However, excellent emeralds are still mined every day at Muzo and the other Colombian mines.

One very famous Muzo emerald is the Mackay emerald and diamond necklace. (The Mackay family made its money in the Comstock silver lode, though, not in emeralds.) The necklace features the 167.97-carat Mackay Emerald. Cartier set the stone in platinum (Art Deco style). In 1931, Clarence Mackay presented it as a wedding gift to his bride, Anna Case, a prima donna of the New York Metropolitan Opera from 1909 to 1920. This was of course the *second* Mrs. Mackay; the first one ran off with her doctor. In 1984 it was donated to the Smithsonian Institution; it is the largest cut emerald in the

entire Smithsonian collection and may be the largest fine-gem emerald ever set in a piece of jewelry. Actress Michelle Pfeiffer got to wear it for a publicity shot. In the same photo she held the Star of Asia, the Star of Bombay, and the Rosser Reeves Star Ruby.

The greatest Colombian emerald is probably the Duke of Devonshire stone. This natural, uncut crystal, hailing from the famous Muzo mines of Colombia, measures 2 inches across the basal plane, and weighs almost 10 ounces, or 1,347 carats. It is almost perfect as well in transparency, color, and structure. However, because of its many inclusions, this stone can probably never be cut.

As its name partially indicates, it was once owned by the 6th Duke of Devonshire, William Cavendish (1790–1858), Lord Chamberlain to both George IV and William IV. This Cavendish may not be the one you are thinking of. That was Henry Cavendish (1731–1810), the one who discovered hydrogen. Henry was the grandson of the 2nd Duke of Devonshire, so he and William Cavendish were cousins of a sort. (There are people who make a profession of keeping all this straight, but I am not one of them.)

The stone was presented to William in 1831 by Emperor Dom Pedro I of Brazil (1798–1834), an interesting study in himself. His full name was Pedro de Alcântara Francisco António João Carlos Xavier de Paula Miguel Rafael Joaquim José Gonzaga Pascoal Cipriano Serafim de Bragança e Bourbon, and he was the first emperor of Brazil because he said he was. He also proclaimed Brazil independent from Portugal.

Pedro was born near Lisbon; his father was the regent prince and was about to become King João (John) VI of Portugal. His mother was princess Carlota Joaquina, daughter of Charles IV of Spain. The whole family moved to Rio de Janeiro in 1807 (trying to avoid the Napoleonic Wars), where they would remain for 13 years. There, in 1817, Pedro married his first wife, the highly cultured Maria Leopoldina, Archduchess of Austria.

The rest of the family went back to Portugal in the 1820s, but not Pedro, who had taken a shine to the place and stayed on as regent. He was later demoted to "representative" after he sided with nationalists, however. Disgruntled with his demotion, he unsheathed his sword on the banks of the Ipiranga River, and declared "Independence or death!" Thus he became emperor of Brazil.

As emperor, however, he forgot some of his liberal ideas. On the death of his father, he was briefly Pedro IV of Portugal. Only if you are royalty can you be Pedro I and Pedro IV at the same time. It didn't last long either, as he was forced to abdicate in favor of his 7-year-old daughter Maria II. He asked his brother Dom Miguel to be the steward of the country during her minority, on the promise that he would marry Marie later. Uncle–niece marriages were allowed if you were royalty, apparently. However, it didn't work out. Little

Maria married Charles Auguste Eugène Napoléon de Beauharnais, whose sister turned out to be Pedro's second wife, Princess Amélie de Beauharnais von Leuchtenberg, whom he married in 1829. (The first wife, Maria, died after a miscarriage. She had already had seven children with Pedro, including the future Pedro II [1825–1891] and the aforementioned Maria [1819–53].)

The circumstances under which the emerald was presented to the Duke are somewhat cloudy, and it is not even certain whether it was a gift or a purchase. It is known that the Dom Pedro brought the emerald to England at the time of King William IV's coronation. The king gave a dinner for Dom Pedro on July 1, a dinner at which the Duke of Devonshire was present. They also were both at a levee for the king on July 10. The transaction, of whatever nature, may have taken place at one of those times.

In 1831, the same year he gave the emerald to the Duke, Pedro decided to go back to Portugal after all, abdicating his Brazilian throne in favor of his 5-year-old son Pedro II. The motive for his return was his pesky brother Dom Miguel (now King Miguel) who had usurped the Portuguese crown. There ensued the War of the Two Brothers, but luckily we don't need to go into all that. Pedro won in 1834, overthrowing his brother and restoring his daughter Maria II to her title.

Pedro died in Queluz, the place of his birth, at the age of 36. He didn't lack for heirs, however, for in addition to his legitimate children, he had nine children out of wedlock, including five with his paramour Domitila, Marquess of Santos, one with her sister, and one with a nun in Portugal. In 1972, his remains, as peripatetic as the man himself, were returned to Brazil and reburied in the present Ipiranga Museum.

In fact, the rather extensive Devonshire mineralogical collection was until recently in a rather sad state, scattered around the centuries-old Chatsworth manor that has 175 rooms, 21 kitchens, and 17 staircases. According to Michael P. Cooper, of the *Mineralogical Record* (May/June 2005), the collection was in a sad state as late as 1992: "Specimens were stored in a basement cupboard in piles of cardboard boxes, others were jumbled in two late eighteenth-century glass-fronted cabinets on the floor above, and hundreds more filled a row of wall cases running the length of a nearby corridor (the 'Cavendish Passage'). Decay and dilapidation were everywhere apparent. Dust and dirt and the ravages of pyrite disease had taken their toll; the bottoms of boxes were found—too late—to be home to loose number labels which could no longer be even tentatively assigned to the specimens from which they had fallen. Some pieces had labels held to them with perished rubber bands, notable mostly for their inaccuracy: one water-rolled galena pebble (probably from a Derbyshire cave deposit) was labeled 'matlockite.' Specimens crumbled between our fingers, and brittle labels fell away as

specimens were lifted from their yellowed newspaper wrapping." However, times have changed, and the collection has been revamped and dusted up.

There is a persistent rumor that the Devonshire Emerald is on permanent loan to the British Museum, or alternately, to the Natural History Museum. This is not true. Charles Noble, Keeper of the Devonshire Collection assured me via email that it still resides at Chatsworth, although as "a sensitive part" of the collection, it is not available for general viewing. However, it did go on tour of the United States in 2003–2005, along with other examples of rare items from Chatsworth.

Pre-Columbian Emeralds

The native people of South America were using emeralds for a thousand years before the Spanish, struck with *la fiebre verde*, the green fever, arrived to take them away from them. Oddly enough, the oldest known (500 BCE to 200 CE) emerald object in the New World is in Maine, at the University in Orono. It is also the only known pre-Columbian round carved emerald. This small figurine was donated to the university in 1982 by an alumnus, William Palmer III (along with 2,000 other objects). The statue is 5.63 cm high, 2.85 cm wide, and 1.37 cm thick, and its weight is 23.7 grams or 118.5 carats. The original source is unknown, as the dealer who sold it to Palmer remains silent upon the matter. This odd little object, possibly Olmec, represents a standing man wearing a short apron and headgear. His arms are folded over his belly. There are holes drilled through his head and under the armpits, purpose not determined. Nor is it known how the stone was cut.

Is it emerald? It's a true emerald green in color, although there are many small areas of blackish-green and yellow mottling. In most respects the stone passes the various "emerald tests." In other words, it looks like emerald and has a refractive index within the natural range of emerald. When the stone is viewed through a Chelsea filter, which absorbs most visible light but transmits the long red wavelengths and a band in the yellow-green portion of the spectrum, a definite reddish area appears. This is consistent with natural emerald from Colombia. The Chelsea filter test reveals the stone as consistent with stones from Colombia (or Russia, but that is not very likely).

Still there's something odd about this stone. Under UV light it displays a stronger, purplish-red glow than is typical of Colombian emeralds, although not unheard of. A color like that is more likely to appear with synthetic stones, but the trace elements in this stone do not appear in synthetics.

One of the strangest things about this stone is its specific gravity, which is heavier than any emerald ever measured, although it's within range of alkali

beryls. But alkali beryls are not green. More tests were done, including spectral analysis by scanning electron microscopy (SEM) and trace element analysis by x-ray fluorescence (XRF). X-ray fluorescence shows the figurine shares trace elements, including copper, barium, zinc, rubidium, and titanium, that are consistent with stones from the Muzo mine of Colombia. However, it also uncovered strontium and bromine in the emerald, which don't appear in any other known emeralds. On balance, experts conclude that the Emerald Man is real and genuine emerald, possibly Colombian. But there is so much that is just not "right" about this emerald, which does not seem to fit the profile of emerald from other mines, which has led some to pay more attention to rumors about an ancient emerald mine—an Old Mine somewhere in the jungles of Ecuador. Who can say?

The land that became the Inca Empire (1450–1532) is a forbidding place. It was a vast, ominous high-altitude country studded with volcanoes that periodically went off and buried hundreds of people. There were frequent avalanches and earthquakes as well. Much of it is desert, much of it was mountain, and some parts are both.

Yet despite the forbidding landscape, without writing or a functional wheel, the Incas managed to create an empire. Just as astounding, they did it in less than a hundred years, not quite up to Alexander the Great speed, but impressive enough. At its peak, the sprawling Incan empire stretched along the coastline from the northern tip of present-day Ecuador, through Peru and about halfway down the Chilean coast.

While the Incas never managed to figure out a good use for the wheel (which they used for toys), they were no slouches in technological development. The Incas were well known for their endeavors in the brain-surgery department, drilling, scraping, and cutting away at the skulls of various people who may have suffered anything from brain tumors to epilepsy. While about half of the patients lived through the surgery, it's not clear if all this hole-boring cured anyone either. It may have been just a fashion statement or religious rite. No one knows.

As in every other empire, there were taxes. Since there was no currency, people had to hand over their possessions. If they were too poor to have any possessions, they were forced to come up with a boxful of lice. Lice were apparently in plentiful supply.

Like other peoples of the regions, the Incans developed irrigation systems and elaborate building projects that included stone or adobe palaces, temples, and fortifications. Incan taste in architecture was plain, but their buildings were carefully crafted, with close-fitted stone masonry and trapezoidal doors and windows. Mountain Highland Inca cities like the famous Machu Picchu were carefully planned to harmonize naturally with the landscape.

They were good at constructing roads, tunnels, and high-tech bridges as well, with a network of stone-paved highways covering the whole empire. For difficult passages, however, the Incas invented a primitive cable car. There were two major north–south routes, one running along the coast for about 3,600 kilometers and the other inland along the Andes for the same distance, with many links between them. Unfortunately, there were no wheeled carts to travel them. You can't have wheeled vehicles without wheels.

The Incas grew corn, potatoes, squash, tomatoes, peanuts, chili peppers, coca, cassava, and cotton. Their domestic animals included guinea pigs, ducks, llamas, alpacas, and dogs. (The Incas were also adept at weaving bat wool, a feature replicated by few other cultures.)

They were also experts at smelting metals, which they used, among other things, for their religious ceremonies. The Incas had a variety of gods, including Viracocha, the Creator; Inti, or Apu Punchau, the sun god and his consort Mama-Kilya the Moon Mother; Apu Illapu, the rain god; Mama-Paca, the Earth Mother; and Mama-Qoca, the Sea Mother. The most important shrine in the empire was the Coricancha in Cuzco, dedicated to Viracocha, with minor altars to other deities. According to the Spanish, the Incans conducted religious ceremonies there all day and all night, and that the granite walls of the shrine were coated with 700 sheets of pure gold, weighing about 2 kilograms each. The courtyard was supposedly filled with statues of pure gold. Gold, silver, and emeralds were featured in the worship services. The Spanish took it all, melted the gold down and built the church of Santo Domingo on top of the former temple.

Although they had no writing system, they counted using dyed, knotted string. Apparently this was a great achievement of some kind and the Incans were able to keep enormous amounts of statistical data this way.

The Inca civilization originated in Paqari-tampu, a village about 24 kilometers south of Cuzco, in southern Peru. The Incas didn't call themselves the Inca. They called themselves the Tawantinsuyu, which is undoubtedly why they are known as Incas today.

The founder of the Incan dynasty was Manco Capac, who led his tribe to settle in Cuzco in the twelfth century. The Incan Empire itself began under the so-called Fourth Inca, Mayta Capac, in the fourteenth century, although the empire remained well within the bounds of the Cuzco valley. The next emperor, Capac Yupanqui, expanded this influence, and under the eighth Inca, Viracocha Inca, the nation began making permanent conquests. "Permanent," of course, is a relative term. The Incas don't run the place now. On the other hand, neither do the Spanish.

The headman was called the "Sapa Inca" (the "sole Inca," even though there were plenty of others) or most simply, "The Inca." Another of his titles was Sapan Intiq Churin, or the Only Son of the Sun.

The ninth ruler, Pachacuti Inca Yupanqui (1438–1471) took over most of the land in the area—south to the Titicaca Basin and north to present-day Quito, conquering the erstwhile powerful tribes of Aymara, Chancas, Quechua, and Chimú. Pachacuti wasn't born to the throne—he was only one of many sons of the eighth Inca, but he had a vision. In it the god Inti (with snakes coiled around his arms) showed him a further vision in a magic crystal of the kingdoms he would conquer. One can only imagine that the crystal was an emerald.

It worked. He overthrew his father and eventually developed an empire based on culture as much as upon military power. He was a strict ruler, who was carried around in a golden, emerald-encrusted litter rather than having to walk, and he held audiences from a high platform. He was reportedly gloriously gowned in vicuna wool and feathers, but the effect was somewhat diminished as his supplicants were not allowed to look at him. After his death, a struggle for succession ensued that lasted until the arrival of the Spanish in 1532.

The Incan Empire was highly stratified, with its powerful emperor, influential clergy, and a complex, repressive bureaucracy. They kept crime (including offenses such as slandering the gods or the Inca) under control by throwing the criminal off a cliff. Daring to have sexual relations with a virgin dedicated to the Sun would get the couple tied up to a wall by their hands and feet until they starved to death. Trying the same thing with an Inca's wife would also result in a wall hanging. Misdemeanors were punished by chopping off the hands or feet or gouging out the eyes. Some writers opine that theft was rare among the Inca as the people had everything they needed. The truth is that having everything one needs does not prevent one from stealing. That only happens if one has everything one wants, which is a different thing.

The Inca spread their culture by deporting whole groups of their own citizens into the invaded lands, which had the result of introducing a major Incan language, Quechua, over the entire empire. While everybody was allowed to keep on speaking their native languages, people were also required to learn Quechua—the official language. About 10 million people still speak it, although it has lost the cachet it once had.

The Inca did allow the conquered people to keep their own gods, however, as long as they also worshipped Inti. This was very important to Pachacuti, since he considered himself a descendant of this deity. As the Incan Empire expanded, it absorbed and amalgamated myths from its conquered peoples. This tactic (and part of it seemed to be deliberate) was useful in maintaining a facade of homogeneity among the disparate cultures that composed the empire. Eventually the Inca developed a special class of wise men, the Amautas, whose job was to refine, create, and coordinate myths of different peoples. (It's always difficult to disentangle myth from history. In the case of the Inca,

it's also difficult to disentangle myth from myth. The Amautas also decided what constituted a miracle and what did not, much like the Vatican today.)

All things considered, it was quite a totalitarian empire, which included modern Peru, Bolivia, northern Argentina, Chile, and Ecuador, At its peak the Incan empire numbered over 6 million persons, and they called their empire "Land of the Four Quarters." This is a very good name, since quarters, by their very nature, come in fours. The center of the empire was present-day Cuzco, the "navel of the world." The place was designed in the form of a jaguar, their sacred animal. The city was destroyed in 1533 by Pizarro, and the Spanish built a new one with a lot of churches, decorated with the plundered treasure.

As mentioned, the Inca Empire included the vicious mountain ranges of the Andes, where the Incas conducted their sacrifices, some of which occurred at heights over 22,000 feet. They were very serious about this, dragging rocks and dirt up the mountains to build platforms so that they could kill people. Contemporary researchers marvel at the Inca's ability to do all this without snow boots, pitons, crampons, nylon ropes, and other modern accoutrements, although the wonder is slightly soured by the knowledge that nearly all Incan victims appear to be children.

Like every other people who had them, the Inca loved emeralds, and had been using them in jewelry and religious rites for over 500 years before the Spanish came. Emeralds were not the Incas' only treasure, of course. They were also very fond of a colorful mollusk called *Spondylus*. No one is sure what the attraction was.

According to Cyrus Townsend Brady, author of the inimitable *South American Fights and Fighters*, Peru can be blamed for much that has gone wrong in the world. He writes, "It was the treasure of Peru that relieved the Spanish people of the necessity of wresting a national revenue out of soil by agriculture; which abrogated the auxiliary of agriculture, manufactures; which precluded the possibility of the corollary of the other two, commerce. It was the treasure of Peru that permitted the Spanish people to indulge that passion for religious bigotry which was stifling to liberty and throttling to development. . . . It was the treasure of Peru that kindled the fires of the Inquisition in which the best blood of the nation lighted it to its downfall . . ."

At the time of the Spanish conquest, an immense emerald crystal (the size of an ostrich egg), cut into the shape of a torso, was adored by the Peruvians in the city of Manta. This was the emerald goddess named Umina, the goddess of health, who was exhibited only on high feast days. Her image was an enormous emerald crystal, and smaller emeralds were said to be her daughters. (The Spanish were mistaken in thinking the Incas worshipped the actual stone.) Incan priests developed a rather clever scheme to get their hands on more emeralds, pointedly suggesting that the people bring emeralds

as a donation to Umina. The priests explained that smaller emeralds were the children of the big emeralds and so could be brought to her for sacrifice instead of the people's children. Apparently, this ruse worked. Large, oddly shaped emeralds are the invention of Hollywood mythmakers too. In the 1984 film *Romancing the Stone*, a heart-shaped emerald, El Corazon ("The Heart"), is discovered in Mexico and pursued by a Colombian. Michael Douglas and Kathleen Turner have a rip-roaring time as well. They fall in love.

The emeralds prized by the Inca were obtained through their northernmost and least stable holding—Ecuador, although it is more likely that the source was Colombian. Even today the few emeralds mined in Ecuador are called "Inca emeralds." There have long been rumors of a lost emerald mine in Ecuador. These were laughed at until the discovery of the Emerald Man discussed earlier, but now people are giving it more serious consideration. The Inca (and the Maya too, for that matter) believed that their gems were not just ornaments, but precious gifts given to them by their gods. Revealing the source of the stones would have been an act of apostasy. And that's what got them into even more trouble with the Spanish.

At the time of the conquest of Peru, the Spanish army sacked the Temple of the Sun and ripped off a huge collection of emeralds, but there is no record of their finding the Umina "mother emerald." The Incas weren't telling. Some say that the emerald was hidden by Peruvian priests so efficiently it has never been found to this day. Even Umina's special temple has disappeared.

The Emeralds of Conquest

It is very popular to dump upon the Conquistadors, but like everyone else, the motives that drove them were complex. It is safe to say, however, that the Spanish had no appreciation for the art of the native Americans. Artifacts of gold and silver were valued only by their weight. If they found art objects made of gold or silver, they usually just melted them down for more convenient shipping back to Spain. (Luckily, a few native artifacts eluded them.) Assuredly, they took all the emeralds they could garner, but their main use was for trade only. They traded them for yet more gold and silver. Soon there was a glut on the European market and emeralds were everywhere.

When one thinks of the conquest of South America, one thinks of the Conquistadors. And when one thinks of the Conquistadors, the name Pizarro stands out (not necessarily in a good way). Francisco Pizarro (1475–1541) was born in Trujillo, Spain. His father was an army captain, unfortunately (perhaps) not married to Pizarro's mother. There was a rumor that he was suckled by a sow, although this is almost certainly not true. Pizarro was raised

by poor relations and he never received a good education—in fact he remained illiterate all his life, never even learning how to sign his own name. This is somewhat of an anomaly—all the other Conquistadors could read and write, whatever their other failures.

He left Spain in 1502 for Hispaniola, the chief Spanish port in the New World (his father and brother were already there). His main job was to help suppress the Taino Indians, who were reluctant to become Christians, pay gold, and do all the Spaniards' dirty work. When the Spanish first arrived, there were perhaps 50,000 Tainos, possessed of a rich, elaborate culture. By 1544, only 60 individuals were left. There are none now. Earlier the Taino had suffered depredations from the fierce Carib Indians, who attacked them with poison-tipped arrows and enslaved many. Some apologists for the Spanish suggest that the warlike Caribs set the tone for the conquest of the Americas and had they been more peaceable, undoubtedly the Spanish would have cozied up to the natives and everything would have gone along just swimmingly. No one really believes this, but it's fairly safe to blame an extinct people, especially ones rumored to be fierce, for starting all the trouble.

In 1509, Pizarro took part in the first exploration of the Caribbean coast of the area, and in 1513 walked across the Isthmus of Panama with Balboa, thus becoming one of the first Europeans to see the Pacific Ocean. Balboa was later arrested and beheaded, although there's no proof that Pizarro had anything to do with it, but I don't suppose we should overlook the fact that Pizarro was the one who arrested him. But then he was only following orders.

For a while after this trip he appeared to settle down and became one of the most powerful citizens of Panama City. Powerful, but broke. Then he heard about a rich empire to the south: El Dorado. He trotted off to find it in 1524, along with Diego de Almagro, another impoverished conquistador, who managed the expedition but sailed in a different ship a little later. It was a bad trip, as they were attacked both by Indians and awful weather. They ended up at a place later named Starvation Island, where the men demanded to be led back. Pizarro, who has been described as "terribly persistent," merely sent back for more supplies. These arrived, but not before 20 members of the expedition had perished. Pizarro picked up a few gold ornaments, certainly not enough to make him rich, but enough to whet his appetite for the fabled El Dorado.

He tried again in 1526. On this trip, he managed to capture some Inca traders and trained three of them to be interpreters. Pizarro did not fail to notice their rich ornaments of gold and silver. Despite the tantalizing hint of untold riches, many of his soldiers once again decided they had had enough of disease and hunger. At this point Pizarrro, whose greed was matched by his courage, literally yanked out his sword and drew a line in the sand. "Comrades

and friends," he announced. "On one side of this line lie danger, nakedness, death, and riches—and on the other side lie comfort and poverty. Choose!" The thirteen who decided to hang in there with Pizarro later became known as the "Thirteen of Glory." (Some sources claim that there were 15 or 16 of them, but it really doesn't matter now.) No one knows what eventually became of the rest of them.

Pizarro didn't actually "find" Peru until 1527, when he reached the town of Tumbes. The innocent inhabitants told him about the wealth to be had all about, apparently never dreaming that Pizarro would be so rude as to actually come back and grab it. That was his plan, of course, but he realized he was presently unequipped to do so, so he made some hasty good-byes, took his bearings and dashed back to Panama to formulate his plans.

Gathering sufficient troops meant going back to Spain, where he could report his findings to Spain in person. (Being illiterate, he couldn't very well send a letter.) Charles V, impressed, appointed him governor of the place, although Peru had a perfectly good emperor of its own. In January of 1531, Pizarro, 183 men, and 37 horses arrived at San Mateo, disembarked and marched south. Eventually they added more men and horses as they met up with more Conquistadors. He founded San Miguel (now Piura) in 1532, built basically as a fortress. After it was done, Pizarro spent some time reconnoitering to discover little cracks in the Peruvian empire, of which there were plenty. While Pizarro is famous for conquering the Inca, he had some help. The Sapa Inca Huayna Capac was killed off by a disease, probably smallpox, against which the Incas had no immunity.

After death came chaos. His son and heir Huascar ("Gentle Hummingbird") was proclaimed successor by the nobles in Cuzco. (Huascar was not only Huayna's son, but also his nephew, as he had married his own sister.) However, another group of nobles centered in Quito preferred a different son, Atahualpa ("Turkey Cock"). (Turkeys were highly revered by the Incas. He was reportedly a handsome man with red eyes. Whether or not his red eyes had anything to do with his being named after a turkey, I cannot say.) Atahualpa ostensibly demurred from the honor of being named Sapa Inca and announced his loyalty to his brother, but everyone knew things were brewing for a fight. He kept away from Cuzco and his brother for several years, but finally sent down a few ambassadors as a test. Huascar had them tortured and killed and then sent up an army to have Atahualpa taken by force. The battle was pitched, with neither side giving any quarter. Atahualpa made the opposing general's skull into a cup and his skin into a drum, a fairly standard Inca practice. They used the bones to make flutes. When Atahualpa finally captured his brother, he butchered his wives, friends, and advisors in front of his eyes, and then imprisoned him.

The country was in a state of total devastation, so things were definitely looking up for Pizarro. There was the usual hesitation among his troops, but Pizarro went back to his old tricks of shaming them, this time promising them that even if they chickened out and went back to San Miguel, they'd have a share of the treasure won by their braver brethren. It worked and Pizarro returned to Tumbes in 1532, catching the Inca by a surprise attack. He had only about 180 men, but the guns and horses helped. The Spanish demanded to see Atahualpa himself, who was refreshing himself at the hot springs of Cajamarca. Atahualpa invited Pizarro to join him instead. Pizarro arrived with his small army, and was greeted by the much larger one (50,000 men) of Atahualpa. Both sides decided to wait it out. This whole episode shows the dull side of Atahualpa—he could easily have stopped the tiny army of Pizarro as it was struggling over the mountains. Instead he was taking a bath.

Fellow conquistador Ferdinand De Soto, who happened to be along for the ride, galloped up to Atahualpa on his charger, hoping to scare him with the presence of the powerful (and to the Incas, strange) beast. Atahualpa remained immobile (and later executed any of the rest of his party who flinched). Calmly, Atahualpa complained about the predations of the Spanish, but made a serious tactical blunder when he agreed to visit Pizarro the next day at sunset. For some reason, he got the erroneous idea that the Spanish weren't able to ride horses after dark.

Atahualpa had himself carried into Pizarro's camp on a golden throne lined with parrot feathers, in a state of immense, but precarious splendor. He was wearing a huge necklace of emeralds, which might not have been the smartest move, either. The centerpiece of the necklace may have eventually become part of the famous "Crown of the Andes," discussed later. Pizarro asked him to give up his religion, showing him a prayer book (which Atahualpa was no better equipped to read than was Pizarro himself). Atahualpa refused, mentioning that Pizarro's god Jesus was put to death, but his own was still around. The friar traveling with Spanish forces immediately absolved them of all their sins, and the attack was on. Six thousand Incas, and not one Spaniard, were killed.

Pizarro held Atahualpa for ransom. (Here he was taking a page out of Hernando Cortez's book, as Cortez conquered the Aztecs by kidnapping the emperor. But then Cortez and Pizarro were related.) In 20 days, the Incan chief learned to speak Spanish, and even to read a little of it (he was ahead of Pizarro there). Ultimately, though, it did no good. His subjects were ordered to deliver a room full of gold and a hut full of silver. They came up with over 13,000 pounds of gold and 26,000 pounds of silver. Gold and silver didn't mean all that much to the Incas, who considered them the sweat of the sun and moon, respectively. Atahualpa didn't quite manage to fill up the room, but Pizarro duly noted in an agreement before a notary that the ransom had been paid up.

Ornaments and idols were also handed over as part of the ransom. According to the half-Inca historian Garcilasso de la Vega, in the temple of the walled city of Pachacamac, an emerald was worshipped. The site was one of the holiest in the entire Andes, and pilgrims traveled there from far away. The main temple held a famous oracle (apparently connected with the emerald) that was dedicated to Pachacamac. Pizarro heard rumors about Pachacamac from the Inca, while he was holding Atahualpa hostage. Pizarro sent an expedition to sack the place. The mercenaries grabbed all the silver and gold from the site they could find as well as the "idol."

Meanwhile, Atahualpa seemed to worry that his brother Huascar would curry greater favor with the Spanish by surrendering even more gold. So he had him killed. Then Pizarro had Atahualpa killed. He was going to burn him at the stake, but hinted around that a kinder fate (garroting) would be available if Atahualpa consented to be baptized. The desperate Incan leader agreed, not because he was afraid of being burned, per se, but because he believed that unless his body was mummified his spirit would perish. So he agreed to convert in return for having his body restored to his people for mummification. (Mummies were such an important feature of Incan society that those of rulers were kept around, dressed, fed, and waited on hand and foot. There was even someone to shoo away the flies, of which there would have been many.) The Spanish garroted him and then burned his body anyway.

After that, Pizarro went to Cuzco, the Inca's mountain capital. (The Incas had hidden all their available mummies, fearful that they would be burned too.) Pizarro took control of the city in 1533, but allowed a surviving son of Huayna Capac, Manco Inca, to rule the place as a puppet governor. The Incas rebelled, but it was no use, and the entire culture collapsed. The last Inca leader, Pupac Amaru was captured and beheaded in Cuzco in 1572.

Using Peru as a base, the Spanish conquered most of South America. Small bands of Inca continued to resist, but it was futile. During the late 1530s Pizarro and his old friend Almagro had a slight disagreement about who was going to rule the area around Cusco. Pizarro won, and in 1538 he had Almagro killed. However, in 1541, Pizarro himself was killed by followers of Almagro's son.

The story of the treasures of the New World and its emeralds cannot be told without also telling the story of Hernando Cortez (1485–1547), who wiped out the Aztec Empire, as Pizarro had done with the Incas. They are exact contemporaries with Pizarro arriving in the New World only one year before Cortez.

Cortez was born in 1485 in Medellin; his family was of minor nobility. At the age of 14, he entered the University of Salamanca, where he intended to study law. However, he realized that he wasn't cut out for that profession, and dropped out of school, preferring the life of a drifter. He was, according to

one source, "rowdy, overbearing, restless, and in love with the profession of arms." In other words, perfect material for a conquistador. We know a little about his looks. He had pale hair, a thin beard, and "ashen" complexion. One of his contemporary biographers, Bernal Diaz del Castillo, said briefly, "Had his face been bigger it would have looked better." He was fond of dice, cards, and women, particularly those who were married to someone else.

In 1504 he drifted to what is now the Dominican Republic, and joined the army under the command of Diego Velázquez, who was busy conquering Cuba. After killing everybody he could, Velázquez became the governor of Cuba, and Cortez was chosen as the Mayor-Judge of Santiago.

The next stop was Mexico. Cortez begged Velázquez to give him command of an expedition to establish a colony in the Yucatan, the center of Maya civilization. He agreed (Cortez had enough money to finance the expedition) but after thinking it over, Velasquez had second thoughts. Cortez's ambition was a little scary.

Cortez ignored the canceled order and headed to Mexico anyway, with 11 ships, 500 men, and about 20 horses. The first victims of Cortez were the citizens of Tabasco, of later sauce fame. Lest you think that Cortez didn't have a tender side, here he met Malintzin, his guide, interpreter, and later paramour and mother of his son. (The Spanish called her Marina, apparently finding Malintzin too hard to pronounce.) The Tabascans actually gave her to him as a kind of peace offering. Of course that kind of thing never works, especially with the Spanish.

After settling in, Cortez ordered his ship burned to remove the possibility of his own men escaping and headed off to conquer the Aztecs—the Maya apparently not being enough of a challenge. Here Cortez decided to pretend he was Quetzalcoatl, the Plumed Serpent god, who, it was rumored, would eventually return. Well-read in the ancient doctrines, Montezuma Xocoyotzin II, the pious Aztec king, was prepared to believe that Cortez actually was the returning god.

In November 1519, he sent envoys to meet Cortez. The invading army simply fired upon them. Survivors reported, "Something like a stone came out of their weapons in a shower of fire and sparks. The smoke was stinking; it had a sickening, fetid smell." The new arrivals were characterized as folk with "very light skin, much lighter than ours. They all have long beards, and their hair comes only to their ears." The horses were a bit of a puzzle as well and the mounted invaders were described as having two heads and six legs.

Montezuma was unable to organize resistance and fatally failed to stop Cortez and his force from entering Tenochtitlan, the Aztec capital. Cortez established his headquarters there, and took Montezuma as hostage, forcing him to swear allegiance to Charles V.

By all accounts, Cortez was quite taken with one of Montezuma's palaces, especially its aviary. Montezuma even "gave" Cortez a fabulous Aztec headdress, the "Penacho de Montezuma," made from the emerald-green tail feathers of the male "Resplendent Quetzel." (Because of their delicate skin, the feathers are easily torn away. Birds like that end up very quickly on the endangered species list.) It was eventually put on display at the Ethnological Museum in Vienna, but I am afraid it's a little moth-eaten by now.

Despite his attraction to the aviary, Cortez made the mistake of leaving the turquoise and emerald-inlaid residence to go on another killing expedition. In his absence, the people of the Tenochitlan revolted. Upon Cortez's return to the Aztec capital, he was attacked by 600 Aztec warriors. Cortez thought everybody would just calm down if he brought out their supposed king Montezuma, but the enraged citizens stoned him and the king later died of his wounds. The Spanish fled in fear, but regrouped and returned in December 1520. The city fell on August 31, 1521, although the precipitating cause had more to do with a plague than with Cortez's military superiority. Cortez wanted the treasures but the new leader of the city, Cuauhtemoc, refused to tell, even under torture, where they were. In 1525 Cortez had him hanged.

One treasure in Montezuma's palace remains to be revealed—the so-called Stone of Judgment. According to the Aztec historian Don Fernando de Alva Ixlilxochitl, the palace of Tezcuco contained a human skull crowned with an enormous pyramid-shaped emerald. It was as broad as a human palm. Some sources claim you could see this famous emerald from 100 yards away. This is not possible. Either the stone could not be seen from 100 yards away or it was bigger than a human hand. Not both. Of course, it could be neither.

In any case, the stone had many functions. It was placed on the foreheads of sacrificial victims to comfort them. Perhaps it was to remind them of the eternal life that awaited them, or perhaps it was to gather the sun's rays to provide them with additional spiritual strength. Or perhaps the Aztecs, like the Egyptians and Romans, simply found that emeralds were soothing. In addition, when the sovereign had to make life-and-death decisions, he held a golden arrow in his left hand and with his right touched the emerald-crown skull and pronounced judgment. Perhaps Cortez appropriated the huge stone from Montezuma, although this is mere conjecture.

The whereabouts of the stone is now a mystery. But there are theories. Victor Benilous, president of Archaeological Discovery Ventures, Inc., also a restaurateur and founder of a theological seminary in West Palm Beach, claims he found the Emerald of Judgment (which he calls the "Isabella Emerald") as well as Cortez's signet ring in 1993 in a 1757 shipwreck. Of course, Cortez was long gone by 1757, but Benilous believes some of the shipwreck treasure belonged to him nonetheless. His theory is that Cortez acquired the Emerald

of Judgment, describing it to Queen Isabella of Portugal as "a mystifying powerful emerald crystal so large that it would fill the palm of her hand." This sounds like the Emerald of Judgment, to be sure. However, the reputed 964-carat emerald found by Benilous is, judging from the photos, a deep green *oblong* gem, not a pyramid as described in the literature.

According to the story, Cortez hinted around that the emerald was so large and powerful that it should be only owned by Charles V, the Holy Roman Emperor, King of Spain, and his Queen Isabella. He further hinted around that he'd like to be named the Governor of New Spain and be paid enough to go ahead and conquer the rest of the world. Alas, Charles V was bankrupt, and instead Cortez gave the stone to his girlfriend and soon-to-be second wife, Dona Juana de Zuniga. She loyally followed Cortez around in all his conquering adventures. Perhaps the name Isabella Emerald was given to the stone to soothe the irritated queen, but if so, the ploy didn't work.

In 1756, more than 200 years after Cortez's death, a courier came from Spain to the New World, apparently with instructions to bring back the Zuniga family fortune. The ship's manifest showed that the ship carried a hundred chests of emeralds. Some people believe that the Queen Isabella Emerald was on a fast track back to Spain as a bribe to the royal family to part with some land grants and other favors.

The Isabella emerald was not the only cargo. Benilous says he also found Cortez's signet ring aboard the wreckage, which would give added proof that the emerald is the Emerald of Judgment. Benilous says he knows the ring belongs to Cortez because on the face of the ring is the Cortez family's crest after he married into the Zuniga family. The two coats of arms on the ring represent each family in the marriage. The ring was more than pretty; it was official. When Cortez would send letters back to the King, he'd seal the letter with hot wax, and then stamp it with his signet ring to make sure it was not tampered with.

To find the wreck, Benilous and his wife enlisted the help of a couple of psychics, a side-scan sonar, and a bottom profiler. They identified three anchors of the Spanish colonial period about 12 miles off the coast of Florida between Cape Canaveral and Sebastian Island. They found a crystal skull, and soon the rest of the treasure. According to Benilous, wreckage divers also found up to 50,000 carats of cut emeralds, a million carats of uncut emeralds, an Aztec-carved crystal, gold ornaments, a massive uncut emerald crystal weighing 25,644 carats. Benilous claims that his "Isabella Emerald" could be worth more than $20 million, but he is not saying where it is now. You can buy an exact replica of the signet, if you like, from the A.D. Ventures online store.

Cortez had more than the Emerald of Judgment up his sleeve. He supposedly carried around five carved emeralds in the fanciful shapes of flowers and

fish. One was carved in the form of a rose, one in the shape of a horn, one as a fish with golden eyes, one like a little bell (with a pearl for a clapper). This bell had an inscription around the rim that said, "Blessed is he who created thee." The last one, most precious of all, was carved into a tiny cup with gold and pearls. Inscribed on it in Latin was, "Inter natos mulierum non surrexit major." In case your Latin is rusty, this translates into something like, "Among the offspring of women not one greater has arisen." This is taken usually as a reference to John the Baptist, and why Cortez ordered it inscribed on this cup is a total mystery.

All five currently are residing in the ocean floor somewhere off the coast of Barbary, and have been there since 1529, when Cortez was shipwrecked on his way to assist Charles I at the siege of Algiers. This all goes back to what I was saying earlier about emeralds. You just can't hang on to them.

However, lest you think that Cortez was simply a bloodthirsty conqueror, he had different views of himself. In his last letter to his emperor (February 3, 1544) he wrote, ". . . for forty years I have labored, going sleepless, eating poorly and at times not at all, bearing armor on my back, risking my life in dangers, freely spending my means and years, and all in the service of God, bringing sheep into his fold in a hemisphere far removed from ours . . ." and on and on in that vein until he reached the real purpose of his letter, which was to ask for money. On the back of the envelope was scribbled, "No need to reply."

So far as is known, these Mexican emeralds were born in Colombia. This may also be true of the Incan emeralds, although Ecuador is another possible source. They were called Spanish or Peruvian emeralds, although predictably not one of them came ultimately from either Spain or Peru.

Pizarro and Cortez have their aficionados, but even such relative unknowns as Quesada have something to be said against them. Gonzalo Jiménez de Quesada (1499–1579) is connected with two cities—the mythical one of El Dorado and the very real one of Bogotá. He landed in the New World in 1538, and was immediately impressed by the savannah. He founded the city he called Santa Fe, after the Santa Fe in Granada, Spain, his hometown, on August 6, 1538. Later, "de Bogotá" was added to the name, after "Bacatá," the name the natives gave to the place, but which the Spanish were apparently unable to pronounce. By 1819 it became simply Bogotá. Today its official name is Santa Fe (or Santafé) de Bogotá.

Although some say de Quesada was the model for Don Quixote, he managed to accomplish quite a bit. Like the other Conquistadors, this invader of Colombia was looking for gold, but he discovered the potato instead, which he duly transported to Spain. The Spanish thought that they were a kind of truffle.

Of course the Spanish weren't that interested in potatoes, although by any real scale of value they are worth more than trinkets. Still, the Spanish wanted treasure, gold and silver in particular, and de Quesada was hot on the trail of El Dorado, which he thought might be around Colombia's Magdalena River.

In 1536 he was commissioned to explore the river, which was not very satisfactory, as it features sandbars, rapids, and wildly fluctuating water levels. de Quesada suffered terribly, and an Andean tribe known as Chibcha (or Muisca) Indians gave him no little trouble. This highly developed people practiced intensive agriculture, growing maize, sweet manioc, beans, mushrooms, sweet potatoes, and fruit trees. They were such hard workers that they even had their own deity devoted to physical labor, a god reportedly named Chibchacum. They had a creator god too, a certain Chiminigagua, who created big ravens who carried light over the mountain peaks. He left the rest of creation to other deities, notably the goddess Bachue, who created humans.

The cultural founder of the Chibchas was Bochica, who gave the folk ethical laws. At this point the story attains a strange parallel with Judea-Christian myth. After Bochica wandered off into the west (departing cultural heroes always seem to go west), a woman named Chie told the Chibcha to forget about morality and live it up. Bochica turned her into an owl, but Chie still managed to convince the work god Chibchacum to flood the country. Bochica took mercy on his disobedient but wet people and came to them in the form of a rainbow, got the sun to dry things out, and created a river to wash the flood into the sea.

The Chibcha generally lived in homes raised on posts, with polygyny being the rule. They kept domesticated guinea pigs, but they were more edible than pettable. They were skilled in the melting and casting of gold and copper, the weaving of textiles, and the making of pottery. They mined emeralds, too. The Chibchas are credited with inventing the El Dorado legend in the first place. Literally, the words El Dorado mean "the gilded one." Variants of the name include *el India dorado* ("golden Indian" and *el rey dorado*, "golden king").

The name probably comes from a strange rite celebrated annually at Lake Guatavita. Using sugarcane tubes, the nobles applied a sticky layer of balsam gum to the king's body, and they blew powdered gold dust and emerald powder on him. Then the people made a raft out of rushes, decorating it and placing on its four corners lighted bowls in which they burned incense (*moque*). The king stepped onto the raft, while the people sang and played hymns. He took four naked nobles with him for company.

When the raft reached the center of the lake, the king and his attendants leapt into the water and arose anew, clean and shining, with the sins of the people removed, along with a considerable amount of gold dust and emerald powder. Then everybody had a party. This ceremony disappeared before the

Spanish arrived (the celebrants having been conquered by another tribe), but many folk claimed to have remembered it.

de Quesada was interested in any story that featured gold or jewels. Obviously he was very interested in the gold-covered kings, but soon learned that the Muisca people got their gold from elsewhere. It was a crushing disappointment. Still neither he nor anyone else ever forgot the legend of El Dorado, which over time became not a gilded man in a ceremony, but a city, a country, a dream, a hope, a legend, a myth. It always lay just beyond the horizon, quite literally. If the legend of El Dorado began in the Colombian Andes, it moved around to northern Peru (Lake Paitit), and the Guiana Highlands (Lake of Manoa), where it apparently settled down, at least in the minds of the Spanish explorers.

During this period de Quesada ran into a German explorer named Nicolas Federmann (1501–1542), although it's hard to imagine that he accidentally ran into another European. Federmann was working for some bankers named the Welser brothers, to whom Emperor Charles V had granted rights in Venezuela. Charles V did not own Venezuela, but he thought he did. At any rate, Federmann was more interested in El Dorado than in Venezuela and promptly set out looking for it. Instead he ran into de Quesada, who persuaded him to go back to Spain with him, where they could iron everything out. Federmann agreed to not dispute the latter's claims—in exchange for a large sum, of course.

No matter where the Muisca got their gold, however, emeralds were homegrown. The Indians made a mistake by giving de Quesada a gift of nine of them. It is very nice to be given a bunch of emeralds, but the Spanish wanted more. They wanted not just a few samples, but the entire mine, or preferably mines, where they came from. Quesada's partner in crime, Captain Pedro Fernandez Valenzuela, went hunting for the source of the stones. After about a year of looking around, they came upon the Chivor (later called Somondoco, which means "god of the green stones") region, where perhaps as many as 1,200 Indians worked the mines with wooden shovels during the rainy season. On March 12, 1537, Valenzuela held in his thieving hands the first emerald of the Chivor mines. The Spanish weren't very knowledgeable about the gem anyway, and decided that the test of an emerald was to try to smash it, apparently thinking that the genuine article was uncrushable. In consequence they smashed up a lot of emeralds. Valenzuela eventually repented of his evil ways, returned to Spain filled with remorse for his many cruel deeds, and eventually became ordained as a priest. He spent the rest of his life alone.

The official conquest of the area can be dated to 1538, at which point present-day Colombia, Panama, and most of Venezuela became "New

Granada." (In 1819 the whole area included Ecuador and became independent as Gran Colombia, a state set up by Simón Bolívar.)

Apparently the Spanish thought the Indians had enough emeralds to burn. And perhaps they did. Francisco Lopez de Gomara (1510–?) stated that the Indians of New Granada burned gold and emeralds before the images of the sun and moon. This is fairly unlikely, as it is hard to get a fire that hot. Gomara, however, was never in America, and was rather noted for "sins against historical truth" (*Catholic Encyclopedia*) on several occasions, despite his lively and engaging writing style. He did, however, trot about with Cortez when the latter made a little excursion to Algeria, and one supposes he picked up a number of stories from him.

One of the great emerald pieces from Chivor was the famous Crown of the Andes. This incredible piece had 453 emeralds (1,521 carats) from Chivor, Colombia, including the Atahualpa Emerald (45 carats) named after the Incan emperor. The emeralds are set in 2 kilograms of pure gold.

The crown itself was made between 1593 and 1599 (supposedly by poor villagers) to put atop the Madonna statue in Popavan, Colombia. From where the poor villagers got the 2 kilograms of pure gold and the fantastic emeralds is not clear, but the purpose of the crown was to save the town from the plague of 1590. The village was in fact spared, although skeptics claim this fortunate occurrence may have had more to do with the village's isolation than because of the crown. Some English pirates got hold of it briefly in 1650, but it was recovered and became a prize of the revolutionary war for independence from Spain waged by Simon Bolívar in 1812.

The crown was then held in trust by a brotherhood of nobles (the Confraternity of the Immaculate Conception, formed just to guard it) and hidden six times, sometimes by burying it or by taking it out into the jungle. Pope Pius X authorized the Church to sell it to someone to finance the construction of hospitals and orphanages. Czar Nicolas II of Russia contemplated the acquisition of the crown, but the communists killed him before he got the chance.

In 1936, a consortium of American businessmen bought it and, from time to time, the crown was exposed in exhibitions such as the one in Toronto in 1959. In November 1997, Christie's New York Auction House sold it. Its present whereabouts is not clear, but it is likely the crown was broken up and the emeralds sold separately. (The poinsettia, by the way, is also called the Crown of the Andes, but it's not the same thing.)

The Almanach de Bruxelles, a reference Web site dedicated to dynasties and nobility out of Europe, has selected the Crown of the Andes as a symbol. It seems an odd choice, but the Web site is rather disarming about it. It says that the crown is "one of the nicest reminiscence of the Inca Empire." It asks further, "Is there a more beautiful symbol of past suffering and present world

enlightenment of the idea of monarchy?" Statements like these leave no doubt why the royalty of Europe isn't what it used to be.

Even though one of the emeralds in the crown was named for Atahualpa, he never had it for himself. He did have an emerald necklace, however, that was ripped off his neck by the Spanish. Of course Atahualpa did have a crown, but it was made of feathers.

The tradition of the Conquistadors was kept alive right up into the twentieth century. In 1922, the author Samuel Scoville, Jr., featured emeralds in his immortal *The Inca Emerald*, which takes boy scouts Will Bright and Joe Couteau, and trapper Jud Adams to South America, on a quest for a legendary emerald. The heroes have to fight venomous snakes and vampire bats, but eventually—well, I won't tell you how it ends. Later, in 1948, the Broadway musical *Magdalena* featured humble Muzo Indians, priests, omen-birds, a "miracle Madonna," shrines, lots of big emeralds, and striking miners. The show was the most expensive ever presented on Broadway up to that time. When it closed, however, there wasn't even a cast album produced, because (ironically enough) of a musicians' strike. There's another lost jewel for you.

The pre-Columbian Indians most connected with emeralds were the Muzos, who lived in the mountains of Colombia north of today's Bogotá. According to early reports they were "uncultured" and even "warlike" (as opposed to the highly cultured and peaceful Spanish). The Spanish trudged around through the jungles, interrogating the Muzo Indians as to the whereabouts of the fabled mines, but the Muzos weren't telling.

It took Spain 50 years to overpower the Muzo Indians who occupied the mining area. During a fierce battle Juan Penago's horse kicked up a veritable treasure trove of emerald crystals from a stream. King Felipe declared it to be a "Royal Mine," but the Indians weren't buying any of it, and for the next 250 years did everything in their power to keep the Spanish from despoiling their land, refusing to reveal the source to the greedy Spanish, even under torture.

A Muzo queen, with a name suspiciously similar to the mythical Fura's, is said to have worn a crown with emerald beads that cascaded down to her heels. The stones were so bright they blinded anyone who looked directly at her. This reminds one of the serpent-blinding power of Old World emeralds.

The Spanish tried to find the source themselves, but it was hard work, as most traces of the mines were covered by the rapidly expanding jungle. However, one of the Muzo mines was uncovered about 1555, although the natives put up a fierce battle to protect their property, using poison arrows, formidable dogs, and anything else they could think of. (It is not true, probably, that the Muzos were cannibals. Cannibals are harder to come by than you might imagine.) However, the Spanish finally prevailed and in 1568 began

to plunder the mines themselves, using the enslaved Muzo to do the actual work. The Spanish crown claimed one-fifth of the take.

The Muzo hid their emerald deposits for 20 years. However, in 1594 the Spaniards found the present-day site of Muzo and made the Indians work the mines for about 15 years, before, as an observer (Pogue) delicately put it, desisting because of "labor difficulties." Slave labor is always causing some sort of problem. Interestingly, even though the Spaniards' desultory methods of finding emeralds were always rewarded, they didn't achieve any really systematic work in these deposits. In 1675 Charles II ordered the mines closed, and the jungle reclaimed the area. At that point, the Spanish Crown, irritated at the loss of revenue (they got a fifth of the take), reorganized the whole deal under the aegis of the Royal Treasury.

The plan appeared to be something along the lines of working the Indians even harder than before, with the somewhat predictable result that they refused. Some went so far as to die. Others had the audacity even to "steal" the emeralds they found.

In 1819 the country turned into a republic of sorts, and the new government, rather quickly figuring out that it had no idea how to mine emeralds either, contracted the mines off to private industry for 10 percent of the net profits. In 1848, the government changed its mind again, and insisted on nationalizing (at least on paper) the mine, although no one seems to have paid much attention. For a brief period, the Colombian government gave the rights to the Colombian Emerald Mining Company Ltd. (which despite its name was controlled by South African interests), but then took the mines back.

While the Spanish recognized the value of the green stones, their own eyes were blinded by the glitter of gold and shine of silver, their preferred treasures. They shipped the formerly Incan, now Spanish, emeralds east to Spain by the boatload. Joseph de Acosta wrote that when he returned from America in 1587, there were 200 pounds of emeralds on the ship. This created a veritable glut on the market. Soon after the Spanish Conquest a Spaniard visiting Italy showed a jeweler some superb emeralds that he thought would be a bargain at 200 or 300 ducats. The Italian was impressed with their quality, and probably he was being generous when he exclaimed, "Sir, these are well worth a crown each." The bottom had indeed fallen out of the market. Between 1567 and 1800 Colombia actually produced more emeralds than could be consumed.

The history of New World emeralds is also connected to various people named Napoleon. There is, for instance, the slightly disturbing story of the Empress Marie Louise Crown. Napoleon I gave this crown to his consort Empress Marie Louise on the occasion of their wedding in 1810. Set in silver, the 950 diamonds total 700 carats. The crown also contained 79 glorious

Colombian emeralds. However, long after the crown was sold at an auction in 1887, the jewelers Van Cleef and Arpels, removed the emeralds and replaced them with Persian turquoise cabochons. Between May 1954 and June 1956 the luscious emeralds were taken out of the crown and individually sold, advertised as "An emerald for you from the historic Naploeonic Tiara . . ." It seems that pure greed was the motivating factor, as turquoise in no way makes a satisfactory companion for diamonds, although at one time Persian turquoise was all the rage, especially among gentlemen. And Persian turquoise is some of the finest in the world, exquisitely pure blue and no black veins running through it. Still, I am certain Napoleon did not have this in mind. He preferred green. (He was so fond of the color that he was buried in his favorite green uniform.) No matter how nice turquoise may be, and the stones in the Marie's diadem are nice, emerald is emerald, and turquoise is only turquoise. At any rate, the crown is now in the Smithsonian's National Museum of Natural History. I am always slightly disappointed when I look at it.

Napoleon III (1808–1873), nephew of Bonaparte, also stepped into emerald history when he made green the imperial color. Emerald demand and prices shot up to a shocking extent, and all the best people were anxious to appear before the emperor wearing his special color.

Van Cleef and Arpels have another emerald switcheroo to account for. King Alexander (1888–1934) of Yugoslavia bought a diamond and emerald kokoshnik tiara that he gave to his wife Marie. (The term kokoshnik signifies a shield-shaped headdress worn by a married woman in central and northern Russia.) The emeralds had once belonged to Czar Alexander II and his wife, who presented them to their daughter-in-law, Princess Elisabeth of Hesse. Then they were reset into the tiara by Bolin and given to her niece, the Grand Duchess Maria Pavlovna, who sold the tiara to the Yugoslav king. When the Yugoslav monarchy fell, Van Cleef and Arpels bought the tiara, removed the emeralds and replaced them with paste. Apparently, the market for tiaras with real emeralds in it was not what it once was.

Emeralds Move East (and Some End Up in the Ocean)

The amazingly large and clear emeralds of Colombia were peddled east, to Turkey, Persia, and India, where the Ottomans and shahs and maharajahs and maharanis really took a shine to them (literally) and had them made into polished, sculpted, and engraved elegant jewelry that often (sooner or later) found its way back to Europe. (Examination of the inclusion patterns of these stones reveals their Colombian origin.) The new emerald owners of India and the Middle East produced fabulous pieces of jewelry and other artifacts between 1600 and 1900. In these old days, by the way, men adorned

themselves with jewelry of all sorts. This has rather gone out of fashion for men today, even royalty.

After the Spanish conquered the Philippines, the emeralds left South America westward across the Pacific route to China and the rest of Asia. In fact, one name still used for emeralds in China is the "Filipino stone."

Most of the emerald treasures of Europe arrived there compliments of the Spanish, primarily through robbers like Cortez. Cortez not only found treasure, he also left a good bit of it lying around in shipwrecks after him. Emeralds, jewelry, Aztec and Mayan artifacts, as well as a lot of gold and silver bullion and coins ended up in the bottom of the ocean. But not all of it forever.

The highest-profile emerald treasure found to date is that of the *Nuestra Senora Atocha*, a three-masted galleon, discovered by Mel Fisher (1922–1998) and his Treasure Salvors, Inc. on July 20, 1985. Actually, valuables from the ships had been dribbled out along the area for years, but the "mother lode," the ship itself (and its vast pile of emeralds) was not discovered until the date mentioned.

The ship's name translates into something like "Our Lady of Atocha," after a holy shrine in Spain. The *Atocha* was a true daughter of the New World, having been built in a Havana shipyard in 1620. She was specially armed to fight off pirates and privateers (usually British). The Spanish, having taken great care to steal the wealth of the natives, were singularly averse to having it restolen. However, to meet wartime deadlines (and the Spanish were always at war during this period) insufficient care was taken in building a safe ship. The number of spikes in critical joists was reduced from the normal five to two, and the deck timbers were not secured with nails. Truly, the *Atocha* was an accident waiting to happen. And in this case the accident was packing hundred-mile-an-hour winds.

The *Atocha* first stopped in Cartagena for gold and emeralds, then called at Portabella for the treasure of the South Seas Fleet before continuing on to Havana, and there meeting up with other treasure ships (to form the great Tierra Firma fleet of 28 ships) and set sail toward Spain. (A flotilla like this was assembled every year in July. Spain required all her merchant ships to sail in convoys.)

The *Atocha* was not only shoddily built, however, but overloaded with passengers and treasure: 15 tons of Cuban copper, 12 tons of tobacco, and 40 troy tons of registered treasure; there was quite a bit that was NOT registered—that is, smuggled. The registered treasure included 1,235 silver ingots, 250,000 silver coins, 161 gold bars and disks. There were 35 boxes of treasure earmarked for the Catholic Church, and probably an additional 7 troy tons of smuggled valuables. Smuggling was rife, since Spain levied a 20 percent tax (called the *quinto*) on proceeds of its trade. It also often charged

an additional tax (the *averia*), which could go as high as 40 percent, to pay for defending the fleet against pirates.

There were also 48 passengers, most of them wealthy, with their attendant luggage (which also included gold and treasure), as well as 217 soldiers and sailors. Of these 265 people, 260 would be dead within hours.

Included in the fleet was the *Santa Margarita*, also a new ship, bought in Cadiz only the year before. Although it carried fewer jewels and fewer wealthy passengers than the *Atocha*, it did have on board a substantial amount of gold and silver bullion, and was also seriously overloaded. The cargo ships were provided armed escort and commanded by two additional galleons, called the *capitana* (in the front) and the *almiranta* (from the rear). The *Atocha* was the *almiranta* of the 1622 fleet, selected for her speed and the fact that she had 20 bronze cannon to chase away any would be pirates. Unfortunately for the *Atocha,* bronze cannons have little effect on hurricanes.

Because of numerous delays, the fleet didn't actually weigh anchor until September 4, the heart of the hurricane season, and six weeks behind schedule. As the fleet headed north into the Gulf Stream, it ran right into a Really Big One. This was in the days before hurricanes got names, so it was an impersonal sort of encounter. The storm crashed through the waters separating Florida and the Keys, sealing the doom of the fleet as it propelled them to the coral reefs.

By Tuesday, September 6, five ships were swept toward the Florida Keys. The mainmast and foremast of the *Atocha* snapped and the rudder broke. The *Margarita* had no better luck. With her mainmast and tiller gone, she also wrecked.

One after another, the ships foundered, wrecked on the deadly coral: the *Atocha*, the private galleon *Nuestra Senora del Rosario*, the *Santa Margarita*, a Portuguese slaver, and a small ship serving as the fleet's tender (a vessel that ferries supplies between the ship and the shore). The only survivors from the *Atocha*, which smashed down violently onto a reef, tearing terrific holes in the hull, were three seamen and two slaves. The few survivors escaped death by lashing themselves to a rigging. The other 260 passengers and crew of the *Atocha*, who had gone below decks to seek shelter, were lost.

Spain itself searched for the vessel for 70 years before finally giving it up as lost. Through the intervening centuries, it was believed that the wreck of the *Atocha* lay near today's Matacumbe Key, halfway up the Florida Keys. However, Eugene Lyon found evidence that the ship had actually sunk near the Marquesas Keys, about 20 miles west of Key West.

The *Santa Margarita* had somewhat better luck, with a mere 143 passengers and crew killed, leaving 68 survivors. Although dismasted and drifting, she grounded on a sandbar only three nautical miles (which are a littler longer

than regular miles) from where the *Atocha* sank. The 68 survivors from the *Margarita* and five from the *Atocha* were picked up by a Jamaican vessel that afternoon and were returned to Havana.

The remaining ships of the fleet also returned to Havana. Authorities decided not to send any more treasure to Spain that year, but instead attempt to recover what was lost. Most of the cargo from the *Santa Margarita* was reclaimed after a salvaging effort that lasted 4 years. Using Caribbean pearl divers, the Spanish managed to reclaim hundreds of silver ingots, 64,000 silver coins, and even some of those oh-so-helpful bronze cannons. But the Spanish couldn't find the remains of the *Atocha.* They had located it early on (its mizzen mast was sticking out of the water) but the wreck itself lay too deep to salvage without better equipment. When they returned in October, the ship was gone, battered into pieces by another hurricane and impossible to locate.

Research and exploration, almost entirely done by the treasure hunter Mel Fisher and the historian Gene Lyons, finally located the *Atocha* site hundreds of years later. Lyons spent many a long day in Spanish archives poring over the ship's manifest. For over a decade, the Fishers undertook intensive (and expensive) search operations. And the *Atocha* still continued to claim its victims. In early May 1971, a 22-year-old diver, Gary Borders, died from the bends. In 1973, a child, 11-year-old Nicholas Littlehales, son of famed underwater photographer Bates Littlehales, was fatally injured while skin-diving. On July 19, 1975, Fisher lost his own son Dirk and daughter-in-law Angel as well as diver Rick Gage when their recovery vessel, the *Northwind*, sank.

For years, the *Atocha* continued to tease the team. Bars of gold and silver turned up, a priceless astrolabe, rosary beads, bronze cannons, even a working golden whistle that came with an accompaniment of grooming tools, including an earwax spoon. But emeralds and the "mother lode," as they called the main treasure, eluded the hunters. One emerald did turn up embedded in the bottom of an exquisite golden cup. However, it mysteriously "disappeared" during the cleaning process overseen by the state of Florida. This was but a minor skirmish between the salvers and the authorities. Laws regarding salvage are never very clear, and a three-way battle went on for many years between the Fishers, Florida, and the federal government about who got what. Two hundred hearings later (including a trip to the Supreme Court which ruled that Fisher owned it all), a compromise was reached.

Ten years to the day after the death of Dirk and Angel Fisher, divers found the mother lode. Kane Fisher, captain of the salvage vessel *Dauntless*, sent a jubilant message to his father Mel's headquarters in Miami. The wooden hull

of the ship contained Aztec and Mayan artifacts and a fortune in pure gold, silver, and copper.

The emeralds didn't show up until November. (The day the emeralds were discovered has been called "Emerald Rain Day" by the treasure-hunters.) On board was a dazzling emerald cross, set in gold, which Fisher later sold for $1.3 million. Two of the nine emeralds dangle from the arms of the cross like earrings. It's pretty impressive. The finest one, a gem of 27 carats could yield a fantastic cut gem of 15 carats or so. Experts agreed that the emeralds were from the Muzo mine. About 6,000 uncut, "raw" Colombian gems have been recovered from the wreck, as well as others that were cut, polished, and mounted into gold settings. While the *Atocha*'s manifest didn't include emerald treasure, Mel Fisher knew better. He said he remembered hearing from somewhere that there was a 70-pound box of emeralds aboard the ship. Eugene Lyon, the ship's researcher, who reviewed every available document about the ship, couldn't find a reference to any box of emeralds. But then he wouldn't if they were smuggled, and rumor had it that the admiral himself was the smuggler. Still, where could they be? "If I were the admiral," Fisher is reported to have said, "I'd be keeping those emeralds under my bed." And he pointed vaguely off to the northwest of the mother lode, presumably where he thought the admiral's bed had come to rest.

Fisher's son Kane decided to humor his father and dived into the water at the indicated spot. He emerged with an emerald the size of his thumb, worth $800,000. Later that day he found a 70-carat stone valued at well over a million dollars. Hundreds more appeared, probably worth in the neighborhood of $30 million altogether. In May of the following year hundreds more were uncovered.

One of the emeralds was a 77.76 uncut hexagonal emerald (valued at over $2 million) which has been traced to the Muzo mine in Colombia. This emerald doesn't appear on the ship's manifest, which strongly suggests that it was being smuggled.

In 1971, Fisher had also discovered the remains of the *Santa Margarita*. But because he believed the Spanish had already salvaged most of its treasure, he put it on the back burner and kept looking for the *Atocha.* He also very decidedly told no outsiders that he had found the *Santa Margarita*, and, in fact, this was not discovered until after his death many years later. However, when the *Santa Margarita* turned out to have treasure that the Spanish never found, Fisher did salvage it himself. *National Geographic* was on hand to record the event live in 1980, but like their viewing audience, the magazine had no idea that the ship itself had been discovered nine years earlier.

The finding of the *Atocha* was a great event in the annals of treasure hunting, certainly. Whether or not it was worth five lives is another question.

Colombia: The Emerald Mother Lode

Today, Colombia is the premier country for emeralds. It also has the highest murder and kidnapping rates in the world, as well as dangerous cocaine cartels and a perennial guerrilla insurgency. And so it well suits its famous anagrammatical nickname, "Locombia," the "mad country." But whatever political difficulties have plagued the country, its emeralds are glorious, famous for their color, size, and clarity.

However, glory comes at a price. Since the time of the Conquistadors, most mines were worked by slaves, who were not formally freed until 1889. At that time the Colombian Congress also nationalized most of Colombia's underground, although in a few cases the government allowed private individuals to pay taxes for some subsoil rights. However, in 1905, the government declared itself the owner of all mines discovered and started distributing licenses.

Colombia supplies about 60 percent of the world's emerald output, and about 80 percent of the best stones. (Colombian emeralds sell for about twice the price of gems mined elsewhere.) At one time Colombia accounted for 80–90 percent of the world's production, but the supply has been gradually decreasing in both quantity and quality. Although emerald production appears to be growing again compared to what it was at the turn of the current century, it's still a long way from the booming production of the 1990s. In 1995 Colombia exported about $452 million in emeralds, 6 percent of its legal exports. In 2005, that amount plummeted to $74 million, only half a percent of the country's legal exports. By 2002 emerald production slowed to 5.5 million carats, down from 8.5 million in 2000 and 9.4 million in 1998. Part of this drop was intentional—an oversupply of emeralds has sent prices sharply down. The reasons are a combination of violence, drugs, and nonexistent quality control. Part of it was also due to the economic downturn in Japan, which with the United States buys 75 percent of the word's emeralds. In addition, an increasingly wary public was concerned about emerald enhancement and the increasing supply of synthetic stones. Colombia is also losing market share to Brazil and Zambia. In addition, miners dig deeper to find good stones, and Colombia's always unstable politics has affected trade.

About 90 percent of the emerald trade is destined for export, but perhaps ten times as much money is earned from illegal as opposed to legal exports. If the emerald trade were completely and legally controlled, it would be Colombia's third biggest legal export product after oil and coffee. It is also assumed

by many Colombia watchers that the emerald business is, to a large extent, cocaine driven, as emerald mine operators decided to add drug trafficking to their resumes. Unlike diamonds and rubies, however, the emerald is not generally considered a "conflict stone," a term referring to gems that help fund the illegal purchase of weapons, although emeralds from the Muzo mines actually helped to fund Simon Bolívar's liberation movement. Today the Colombian drug trade is all too interested in this precious stone. No emerald-producing country is under international sanction on its exports. However, the emerald trade in both Colombia and Afghanistan has been linked to cocaine and heroin trafficking, respectively. This green treasure has cost much red blood.

To combat the disarray in the emerald business, the Colombian government established the National Emerald Federation, the country's first association of miners, exporters, dealers, and jewelers. The Federation will also administer a 1 percent tax on emerald exports and reinvest the money in the industry. The tax has been on the books since 1996, but no one bothered to collect it. Still, the very thought of an export tax, however, pushed a large portion of the emerald trade underground. Undoubtedly inspired by the tactics of the De Beers diamond cartel, Colombian mining bosses attempted (unsuccessfully) to boost prices by limiting production, controlling mine "leakage," and sitting on undeclared stock.

The main Colombian emerald-bearing zone is the Eastern Corderilla, deep in the Colombian Andes. (The word corderilla refers to an extensive chain of mountains.) The Eastern Corderilla is divided into two different stratigraphic and tectonic areas. Each area contains many individual "cortes" or mines. (There are nearly 200 emerald mining sites in Colombia but not all are presently being exploited.) The emeralds from each area are often different enough for an expert to distinguish between the different crystals, by studying inclusion, matrices (the rock in which it is embedded), and even color.

Most Colombian emerald matrices are the same basic materials: black and gray shale, gray and white calcite, and pyrite. However, the combination and percentages of these substances can differ from area to area, and experts can often tell where a crystal was mined from by examining the matrix. They can also examine the crystal for typical inclusions that can fingerprint a mine. The inclusions found in Colombian emeralds are typically light in color and don't severely affect their value.

Color alone is no sure guide as to what emerald comes from what mine. Although Colombian emeralds in general are said to "set the standard" for color, not all Colombian colors are the same. Some Colombian emeralds can be a relatively clear pure green (La Pita); others may be slightly yellowish-green (Muzo and Coscuez) or slightly bluish-green (Chivor). The emeralds from Chivor are lighter in color, although they also tend to have many fewer

inclusions. In any case, it often happens that any gemstone of the desired green shade is termed "Colombian," even if the stone comes from Africa.

The *Western* Zone (or Vasquez-Yacopi mining district) includes Coscuez, Yacopi, Peñas Blancas, Maripi, and most famously Muzo (including Tequendama, Palo Blanco, and Puerto Arturo).

The other part of the Eastern Corderilla is the *Eastern* Zone (or Guavió-Guatéque mining district), including Chivor, Gachalá (Vega San Juan, Las Cruces, El Diamante, El Toro, Mantecã) and Macanal. These emeralds are geologically older than those in the Western Zone and the mines contain none of the curious trapiche emeralds.

All over the world, the mining of colored stones is small-scale, dangerous, and fairly primitive compared to mining for oil, coal, gold, or even diamonds. In most cases the deposits are remote (and in some cases, even inaccessible). The natural environment is often hot and unhealthy, and the political climate downright frightening. At least 70 people a year die from explosions and cave-ins; thousands more are injured.

Over the centuries, emeralds have been mined with hands, hammerstones, picks, bulldozers, hydraulic jacks, and dynamite. Actually, many of the fissures common to emeralds have been caused by dynamite blasting, not from natural processes at all. One way of mining is by digging a tunnel or pit and crawling around inch by inch looking for them. The other way is to say the heck with it and blast the whole side of the mountain, dislodging and processing huge rock masses. This is not particularly good for emeralds though, as almost as much has been ruined as mined. The broad picture of mining in Colombia is that it began with tunneling, proceeded to blasting and pit mining, and now has returned to tunneling.

The Spanish generally tunneled through the ground, following the gem-bearing leads, but two problems presented themselves: waste removal and the very good possibility that they were missing all the best gems, which might have been lurking inches from their pick axes. Gradually, therefore, tunnel mining was replaced by open-pit mining.

Until very recently the method most commonly used is called "benching," a kind of pit mining in which narrow horizontal steps or benches are cut across the slope, exposing the working face of friable rock, which is then dislodged with steel bars and inspected carefully for emeralds. When the step was exhausted the miners cut out the next step above. Luckily for mining operations, the main mining areas are steeply sloped and have a good deal of water that allows efficient waste disposal. The water was pumped into a reservoir above the working area and then time-released to wash the area clean of debris. The leftover material was dropped on the step below.

The employees or *piedreros* received only about $600 per month, but the jobs were considered choice nonetheless, since a fringe benefit included the *picando* privilege. One day a month, the workers were allowed to keep some of the emeralds they dug out, after, of course, a mine representative went over them first, making sure they weren't keeping anything of real value. The company man selected out the best chunks, known as *gangas en bruto*, for the operators. The piedreros were then permitted to keep the rest as a bonus. The emerald-loaded shale was shoved over the hill where thousands of "unofficial miners" or *guaqueros* waited for the slurry mixture to pour down over the mountains, to dig through the leftovers, or tailings. The guaqueros are the descendants of the Muzo Indians, and they consider themselves to be the rightful owners of the gems, as indeed they are. These people are not paid by the mine, but were allowed to keep what they find, almost invariably low-quality emeralds called "morallas." This is a dirty and dangerous job, filled with internecine squabbles, fights over emeralds, alcohol, and women, in addition to the danger of the work itself. Officially, the tailings are strictly off-limits, but no one pays too much attention.

At one time the number of the guaqueros could have reached 40,000 people, but comparatively few are left, as the mining methods have changed. With improved technology and environmental concerns, there has been a return to tunneling. From 1986 to 1990, the state-run Mineralco, realizing that bulldozers and dynamite are not gifts to the environment (the emerald mountain at Cosquez is half destroyed by dynamite), attempted to "explore and produce emerald deposits in a more traditional manner." When the government took away the dynamite and disallowed pit-mining, the price of emeralds skyrocketed.

The guaqueros also poach on the mines, particularly along the Río Itoco in the Muzo valley. During the day they simply scour the riverbed keeping an eye out for overlooked emeralds legally mined. But at night they actually tunnel into the hillsides, making tiny shafts hardly wide enough for one person to squeeze through. Many a guaquero has been crushed or suffocated. However, should he be fortunate enough to secure his prize, he takes it to an *esmeraldero*, who transports the gem to Bogotá for sale. All this is illegal, but arrests are infrequent and penalties light. In fact, the guaquero is in more danger from rival guaqueros than from the cops, with many more being shot and killed than sent to jail. All this mining, legal and illegal, creates a lot of mud, which can be very dangerous, even during the dry season (March–May) when production slows down and emerald prices go up. Even the best-paid emerald miners are poorly paid, certainly not enough to purchase the precious stones they find. As a not-so-surprising result, there's a lively trade in smuggling emeralds, even though security guards armed with machine guns monitor every movement

the miners make. There's quite a black market in the green stone, and it's been estimated that almost every unusually fine emerald has at one time or another been smuggled somewhere by someone. Certainly, emeralds lend themselves to crime and the drug trade. You can hide them anywhere. You can pick them up and leave the country.

Up until the late nineteenth century, the ownership of Colombia's mines was a matter of dispute, anarchy, and sometimes outright war. In 1889, the government of Jose Hilario López freed the slaves and nationalized most of the subsoil. In 1905, the Colombian government declared itself owner of all mines. In 1946 it appointed the Banco de la República to administer Muzo, Coscuez, and a few smaller mines. The bank was also responsible for the cutting and marketing of the stones. (Hidden in its vault in Bogotá are five massive unnamed emeralds. The largest, weighing 1,796 carats, is one of the world's largest gem-quality emeralds. It is considered too valuable to cut.)

In the 1970s, the Colombian government privatized the Muzo and Coscuez mines. While the government maintained ownership, the mines were to be operated by Joint Ventures (consisting of its own agency, the Minerales de Colombia or Mineralco), and several private concerns. However, since no clear legal definition existed as to who controlled what area, a wave of violence, the infamous Green Wars, broke out over the country. Up to 3,000 people died in the struggle over emeralds.

The violence has subsided, at least to some degree. Today, nearly all mineral rights in Colombia are still owned by the state, but the government leases areas to private concerns. Chivor, which was discovered after the government took over the mines, is privately owned.

The 60 cortes belonging to the Coscuez mine area is a mine of ancient heritage. It has been operated ever since the Spanish "discovered" it, but was shut down in the 1700s, after a terrible fire that killed 300 miners. The jungle took over, and the mine wasn't rediscovered until the mid-1800s. Major production didn't begin until 1911. Until the recent discovery of the La Pita mine, the various Coscuez mines produced about 75 percent of Colombian emeralds; the figure is now probably closer to 20 percent.

The Coscuez area is still dangerous. It has several open tunnels, some filled with half a foot of water. Collapses are common, the tunnels are hot, and the ceilings are so low that miners have to crouch. One tunnel at the La Paz mine in the Coscuez area is a mile long. In Colombia, as in many other parts of the world, miners endure some of the most hazardous conditions imaginable to extract emeralds.

The Coscuez matrix is predominantly black shale in combination with gray calcite or a rust-colored layer of iron oxide. There may also be thin veins of pyrite running through the shale. The crystals exhibit a wide range of colors;

however, they also tend to be heavily included. They often appear as aggregate formations with multiple terminations. Many, such as the famous El Silencio emerald, have a stepped or tabular appearance.

Muzo has, at divers times, been a public and private enterprise, and was even once owned by a British firm. Currently, two companies, Tecminas and Coesminas, hold 10-year leases and do underground workings. Perhaps the first real picture of Muzo appeared in 1916. Joseph Pogue wrote (for the *Transactions American Institute of Mining Engineers*, Vol. LV, 1917) about the situation of the Colombian mines: "They lie about eight kilometers west of the small village of Muzo in the department of Boyaca, and embrace about eight great open cuts . . . and may be reached practicably only from Bogotá via rail to Cipaquira or Nemocon and thence by mule for 2 1/2 days over an execrable trail, nearly impassable in the rainy season.

"The region about the deposits is intensely tropical, characterized by excessive heat and high humidity, with a rank jungle growth that quickly obscures abandoned workings and makes exploration peculiarly difficult and costly. The region round about is sparsely inhabited by Indians who live in squalor and poverty." He continued that the "so-called Somondoco [now Chivor] deposits . . . and those of Coscuez are important historically." Pogue further commented that the Indians were "modified descendants of warlike aborigines, docile and peaceable, even servile. . . ." Pogue failed to remark that the ancestral warlike aborigines were consistently tortured for refusing to reveal the whereabouts of their treasures to the Spanish. Pogue's phrase "modified descendants" is also instructive, although I don't know of what.

Muzo now produces about 10 percent of Colombian emeralds. The Muzo Indians, who regarded the emeralds as sacred, were the first to mine this lode. The main mine has been worked for a thousand years, which is really astounding. Today, the operation looks like a big coal mine, located in a mountain largely composed of soft black shale. Alone among Colombia's mines it is not drilled into the side of a mountain, although it is surrounded by mountains. At present, most Muzo emeralds are mined from underground shafts. Once an emerald-bearing vein (carbonaceous shale or pegmatite veins of gray and white calcite) is exposed, the heavy machinery is shut down and miners use picks and shovels to dig out the stones embedded in the calcite veins. Only about a third of these stones found are worth cutting, though. Here miners use pickaxes and drills to remove the black shale which is then loaded onto carts and hauled to the surface for cleaning and sorting. Bulldozers are still used, but usually just to rip off the surface vegetation and topsoil.

Although production is greatly diminished from the mid-nineties, Muzo emeralds are among the largest and finest emeralds ever found. The crystals are usually embedded in pure white calcite deposits in the ubiquitous black

shale, along with crystallized pyrite and sometimes clear quartz. The rough is often "color-zoned" with a paler core.

Muzo emeralds are characterized by "three-phase inclusions": trapped liquid containing gas, fluid, and halite crystal. Inclusions of calcite and yellow-brown needles of parasite, a calcium rare earth carbonate with fluoride, may also appear. Sometimes it's called Muzite. Emeralds from Muzo tend to have more saturated color than those from Coscuez or Chivor; however, Muzo crystals tend to be shorter and without the characteristic terminations and clustering of emeralds from Coscuez or Chivor.

Nowhere is the search for emeralds more violent than in Colombia, and Muzo is considered the most dangerous mining area, from a trade point of view. While emerald buyers usually bring their own armed guards, that doesn't stop well-equipped bandits from attacking them. In addition, miners steal as many of the emeralds as they can (hiding them in their mouths) and try to peddle them to black marketeers.

In 1998 a major Emerald Conference was organized by 63-year-old Victor Carranza, Colombia's so-called emerald king and owner of Muzo and Coscuez. The event was attended by over 6,000 emerald miners and 200 geologists. Uninvited guests included the Colombian military, who arrested Carranza and charged him with organizing a right-wing death squad. Carranza got his start during the emerald wars, when he assembled the largest private army in Colombia and dedicated it to the dual purpose of destroying left-wing political opposition and guerrilla groups and protecting his emerald mines in Boyacá. Private armies weren't illegal in Colombia at the time. Everybody who was anybody had one.

At one time, a mass grave of 50 bodies was found on his property. Carranza beat that charge, however. He disappeared, and of course was acquitted. There is no point in convicting someone if you can't find him and put him in jail. Carranza was caught in 1990, but then let go, since there were no charges against him.

In 1998, though, the charge stuck, sort of. He was released from prison in 2002. Carranza tried hard at that point to make his emerald organization a sort of emerald De Beers Company, but he has been unable to create the demand for emeralds that diamonds have always enjoyed. Carranza claims that he's not trying to create a monopoly, of course, only trying to eliminate a black market. He said he expects to "reverse the 30 per cent drop in price and add 20 per cent on top in a relatively short period of time." Assuming he can stay out of jail, that is. More charges are pending.

Carranza's stay in jail was apparently a dark time for the emerald retailers. "There's been no direction for the emerald business; it just sort of wandered," said Arthur Groom, an emerald dealer and retailer based in New York City.

"Carranza's leadership should help make the world aware of emeralds once again," he added hopefully. That's one way of looking at it.

Around the turn of the twenty-first century, a new source, La Pita, was discovered near Muzo. The La Pita deposit began significant production in 1998–99 and produces about 12,000 carats of emerald crystals every 40 days. In type and quality, La Pita stones are almost impossible to separate from the emeralds of Muzo. It is also one of the largest emerald deposits in the world, responsible for producing about 65 percent of Colombian emeralds. In fact, the mine is so productive that work there has been slowed in an attempt to stabilize emerald prices.

Emeralds from La Pita are top-quality (recalling that the best stones are almost always found first), with less blue than Chivor emeralds and less yellow than Coscuez emeralds. They are large too; some of the cut and polished stones from La Pita have exceeded 40 carats.

It's worth noting that in the emerald trade, the terms "Muzo" and "Chivor" are often used not to indicate the source of the stone, but to describe its color. "Muzo" usually refers to a warm, well-saturated grass-green stone with yellow undertones, while "Chivor" emeralds have a bluish note and are often lighter. Even blue-toned African emeralds are sometimes called "Chivor." In this book, however, when I use the phrase Chivor emeralds, I am talking about emeralds that actually come from Chivor.

Chivor, the smallest mining area, lies northeast of Bogotá and 130 kilometers southwest of Muzo. It produces about 10 percent of Colombian emeralds. The emeralds here were formed during the lower Cretaceous period, like those of Muzo or Coscuez, although the Chivor emeralds are older. Unlike the rest of Colombia's mines, Chivor is privately owned. It was in one of the few areas that had not been nationalized

The Chivor mines were very productive before the Spanish conquest but were lost and not rediscovered until 1896. The country around is both rugged and covered in heavy jungle. Formerly it was called Somondoco, which means "god of the green stones." However, when Hernan Restrepo rediscovered the mine in the early 1900s, he restored its original Muisca Indian name. The development of the mine was coordinated by Fritz Klein, of Idar-Oberstein.

In 1920 Klein found the emerald he named Patricia, after, he said, the patron saint of Ireland, the "Emerald Isle." The Patricia emerald was uncovered, by dynamiting the vein. Rumor has it that in the process an even larger crystal was blown up. The Patricia uncut stone of superior color is one of the great emeralds, weighing 632 carats, and now housed in the American Museum of Natural History in New York. Not only is it one of the largest gem-quality emeralds in the world, but it is also dihexagonal, or 12-sided. (Most emerald crystals are six-sided.) It measures 21/2 × 1 inches. The stone has the flaws

characteristic of many emeralds, but it is of an unusual size and a rich color. Like many great emeralds, it remains uncut.

Many other great emeralds hail from this area. One is El Primero, purchased in 1984 for a private collection in Switzerland. This is a classic Chivor emerald crystal of extreme cleanness and a slight bluish tinge, typical of the region. It is still embedded in its matrix. The Las Cruces mine at Gachalá has also purportedly produced the 7,025-carat emerald sometimes called Emilia, found in 1969 and perhaps the largest gem-quality emerald ever found. The stone nicknamed El Monstro or more politely the Muzo Emerald (16,020 carats, possibly the largest emerald crystal ever found) is also said to have come from this region. There is also the Gachalá Emerald (858 carats), described as one of the most beautiful emerald gemstones ever known. It was found in 1967 in the Vega de San Juan mine, Colombia, and is remarkable for both its size and color. It is presently residing at the Smithsonian Museum of Natural History, a gift of jeweler Harry Winston in 1969. It is rather unusual that a stone of such remarkable size and color has escaped being cut into jewelry.

In 1996, a Canadian company, Chivor Emerald Corporation, Ltd., bought an 80 percent stake in the mine; this company uses computers and modern mining methods to explore for emerald. Its software plots mining moves with three-dimensional diagrams. However, so far they have found less than $500,000 worth of stones.

Chivor, the smallest of the three main mining areas, is separate from Muzo and Coscuez, which are adjacent to each other. Production at Chivor is more sporadic than at Muzo, partly because ownership changes hands rather rapidly. The two major mines of the district are Chivor itself and the nearby Gachalá.

The matrix material from Chivor tends to be much more fragile and "crumbly" than in the rest of Colombia, which results, unfortunately, in fewer intact specimens. Some of the matrix is a brown, brecciated mixture of calcite with layers of iron oxide, giving a "rusty" appearance to the matrix. Another matrix found in Chivor is gray, marbly calcareous shale and sandstone. Emerald crystals are found in veins invading the shale. Chivor emeralds are a mix of fine and commercial, but production is low.

Chivor emeralds have a lower specific gravity and lower refractive index than those from Muzo. They also tend to be more elongated and have been compared to thin gray pencils.

Chivor emeralds tend to be slightly bluish (cool green) rather than the yellowish-green characteristic of Muzo stones. Chivor emeralds often have many fewer inclusions than other Colombian emeralds; some may not even require oiling. What inclusions are present (such as pyrite, quartz, apatite and albite) are similar to the characteristic three-phase inclusions of Muzo.

The New "Colombia": Brazil

The first emeralds were discovered in Brazil in 1913, but only since the 1980s Brazil has been an important player. In sheer volume, Brazil is now one of the world's largest producers. Recently it has begun producing some glorious gems. Further, some very large (over 200 carats) stones have been found. In fact, according to the *Guinness Book of World Records*, the biggest emerald ever polished (a staggering 86,136 carats, about 40 pounds) was found in the Carnaíba mine at Pindobaçu, Bahia, in August, 1974. It was polished by Richard Chan in Hong Kong, and its value was later estimated to be worth $1,120,080. Brazil also holds the record for the world's largest aquamarine, a 20-pounder.

In some areas (Bahia, Minas Gerais, and Tocantins) emeralds were formed from the circulation of hydrothermal fluids around pegmatite, as in Colombia.

Brazilian emeralds tend typically to be more heavily included than Colombian stones, but recently Brazil has begun mining gems with very few inclusions, although their color is too light for contemporary taste, and some term these stones "green beryl." In addition, many Brazilian emeralds achieve their color by the addition of vanadium rather than the more usual chromium, a fact disliked by some purists. It was not until 1963 that these vanadium-colored emeralds were recognized as true emeralds, thanks largely to the work of Jules Sauer in obtaining the verification (and clarification) from the Gemological Institute of America in 1963. Brazil has also produced extremely rare cat's eye and true star emeralds.

And curiously, the quality of Brazilian emeralds also continues to improve with the depths of the mines. All existing emerald mines in Brazil are still productive, while new deposits are slowly being discovered and developed. Most of the deposits are small, and worked with primitive hand tools—pick, hammer, chisel, and crowbar. Most mining begins with an open pit—if it looks good, underground tunnels are dug.

In fact, because of the large numbers of emeralds recently discovered in Brazil and Africa, high-quality gems are more readily available now than formerly, which is good for consumers but bad for the trade. Many of the better stones are cut at home. Commercial quality gems go to India for cutting and are set into jewelry in Hong Kong or the United States or Thailand. Interestingly, while Colombian emeralds go on the market proudly trumpeted as "Colombian," Brazilian emeralds are sold anonymously.

The Brazilian state of Bahia is one source for emeralds, although production is currently low. The main Bahia mines are Salininha, Carnaíba (one of the world's largest), Socotó, and Brumado. Carnaíba, discovered in 1963, was

Brazil's most important emerald mine until the early 1980s when the rich deposits at Goiás were found.

Salininha was discovered in 1962. At one time it produced small hexagonal emerald rods almost uniform in size and sometimes wonderful vanadium-supplied color. It was the stones from this mine that touched off the debate about whether vanadium-colored stones could properly be called "emeralds." The Brazilian government has since flooded the mine to make way for a hydroelectric project, deciding that electric power was more important even than emeralds, and at this time Salininha has no commercial significance. However, the decision about coloring agents has changed the industry.

The Carnaíba mines are located in the mountains, with roads so bad that donkey-travel is the only practical means of transport. The Brazilian government, which had an official policy of favoring small miners (three or four people), allowed thousands of claims in this area. In fact, at one time there were 20,000 mines, each with a separate vertical shaft, some of which were located right in front of people's homes. In fact, there was a mine in the dead center of the town—50 feet across and 200 feet straight down. Upper Carnaíba, where the mining takes place, stands on the tailings (waste) of the mine. It has a picturesque view of the country but little else. Miners who have the money to do so bore a shaft deep (350 meters or so) into the mountainside, but their equipment is wretched and the conditions of the miners atrocious. They use large leather bags to winch the emerald-bearing ore to the surface. In some cases, workers are lowered into the mine on ropes, and they attempt to extract the emeralds using simple hand tools. After the crystals are located, the aboveground partner pulls up the rocks with a pulley system and evaluates the stones.

The stones are then moved in wheelbarrows to a spot where women and children shovel it into trays and wash the stone. If the mine crystals are good, they are traded in Carnaíba itself or in Rio de Janeiro.

The poorer people stay at the lower part of the village and dig through the tailings in hopes of getting anything the miners have missed. Some people, less tender, even blast into the mountainside with dynamite, hoping they won't destroy all the emeralds in the ore.

Santa Terezinha was mined as a huge open pit until 1981, when it was realized that emerald-bearing rocks reached at least 200 meters into the earth. Tunneling was then begun, although the costs of the necessary technology were beyond the reach of the independent miners—a collective was formed to extract the stone. If you want to start your own emerald claim in Brazil, be prepared to spend a couple of million bucks.

But watch out. One of the obvious problems with owning a mine and having someone else work the claim is the propensity of the workers to walk

off with the best specimens for themselves, a practice known as "high grading." In some cases, the owners actually have to buy back specimens from their own mines from the thieves to show would-be investors the quality of the gems obtainable from the mine.

The Santa Terezinha mine is famous for the excellent color of its emeralds (color donated by chromium as well as iron and vanadium—in fact the highest chromium content of any Brazilian emerald). However, most are rather small and turbid. There are no pegmatite veins in the deposit; the emeralds are disseminated in phlogopite schists. The tectonic activity that gave birth to these emeralds was a notable geological activity called the Brasiliano Event, which occurred 500–530 million years ago and affected the entire region. Santa Tereszinha de Goias was once Brazil's most productive source; however, present production has slowed somewhat.

The story is different in Minas Gerais, which includes the Itabira/Nova Era mines of Belmont, Piteiras, and Capoeirana). Emerald strikes are hit or miss, but reports indicate that Nova Era is producing some very fine emerald rough lately. Since 1990 this has been the richest emerald-producing area in Brazil. The emeralds of Minas Gerais are also colored by chromium, the way emeralds "should" be rather than by vanadium, as is true of many other Brazilian emeralds. The world's largest pegmatite zone runs across the entire state. Originally known for producing a very pale, low-quality gem, Nova Era has been producing gems as good as Colombian, including a crystal of 380 carats (although most are much, much smaller) and people are paying attention. New mines are popping up all the time in the region.

Itabira's (which is a town) two major mines, Piteiras (discovered in 1998) and Belmont (discovered in 1978), extract emeralds using advanced mining technology (unusual in Brazil) to produce a steady supply: about 60–80 kilograms of rough emerald per month at Belmont and about 12 kilograms per month at Piteiras. The Belmont mine is a family-run mine. For years it was an easily accessed open pit; the first tunnels were dug in 1996.

The nearby Capoerirna mine, discovered in 1988, is 10 miles southeast of Belmont, but it is worked in the traditional *garimpeiro* style from an open pit.

Piterias, on the other hand, is an underground, hard-rock, ramp-style mine. At this mine, the emeralds are hosted in a magnesium-rich phlogopite, a formation referred to as "black wall zones."

Unlike Belmont and Piteiras, the mines at Nova Era are operated by a large number of independent miners (*garimpeiros*) with little in the way of technology. Between Itabira and Nova Era is the Rocha, which has large deposits near the Belmont and Piteiras mines. Production runs between 70 and 80 kilograms per month, with quality ranging from poor to excellent. Mine owners expect the deposit to continue to produce for some time. As in

Colombia, Brazil is intentionally reducing its emerald production in an effort to stabilize prices.

Back to Africa

The emerald is returning to the continent of its birth, although not to Egypt. Sub-Saharan Africa has now begun to glitter in its own right. Today, stones from Africa dominate the middle and lower end of the emerald markets. Like Brazilian stones, many are colored by vanadium rather than chromium, which does tend to gray out the stone to some extent. However, some African emeralds are as good as Colombian—and sell for a quarter the price. There is no reason for this other than the fact that people have got into their heads that Colombian emeralds are better. Most of the African emeralds come either from Zimbabwe or from Zambia.

Emeralds from Zimbabwe are among the oldest gems on earth, but they weren't found until 1956. They were formed 2,600 million years ago, compared to some Pakistani upstarts that are a mere 9 million years old.

Zimbabwe has an excellent underground mine, Sandawana, in the Bikita district of southwestern Zimbabwe. This mine is known for producing high-quality gems of stunning deep-green color (high chromium content although some have iron also), evenly distributed throughout the stone. Many have a slight yellow undertone. The original prospectors had a penchant for myth and named the mines things like Zeus and Orpheus. The Zeus mine, now called Sandawana, was so profitable that its other nickname was the "Bank of England."

What is very interesting about Sandawana is that it is a major source of *untreated* emeralds. However, Zimbabwe crystals are small (half a carat or smaller), with the average weighing in at only 0.08 carat; they work best as small round or melee stones. Larger sizes, when they do occur, are heavily flawed.

Currently, Sandawana is the only major mining operation in Zimbabwe. The mines came under new ownership in 1993, and since then, a rather constant production has been established. The company has set up mechanized underground operations; the mine produces roughly 15–20 kilograms of rough emerald per month. The ore is processed in a standard washing/screening trommel plant. The company also owns its own cutting plant, and has tried to improve conditions for its workers by opening a clinic, school, and athletic facilities.

Zimbabwe emeralds are typically found in schists invaded by pegmatite and quartz veins. Like other African emeralds, Zimbabwe stones are characterized by inclusions of mica, tremolite, phlogopite, carbonates, cummingtonite,

apatite, and albite. Some are in the form of thin needle crystals. Their refractive index and specific gravity is somewhat higher than Colombian and Brazilian emeralds. Sandawana emeralds are noted for their bright green color; many have a slight yellowish tone (as compared to the blue notes of Zambian emeralds). The average size of the stone, however, is small—cut stones bigger than 1.5 carats are rare.

Sandawana has produced a steady quantity of emeralds, although probably not so many as is commonly believed; Zambian illegal exports are also termed Sandawana emeralds. Other mines include Mberengwa, Victoria, and Rio Tinto. Zimbabwe employs up-to-date technology, especially at the Rio Tinto mine, to run a very efficient mining organization.

Emeralds from Zambia have been known since 1928, although not commercially mined until the 1950s and not in a major way until the 1970s. The Zambian government estimates its emerald production to be from 500 to 1,000 kilograms annually. Mining has been the backbone of Zambia's economy, accounting for about 80 percent of export earnings; about a quarter of that is from gemstone mining. And about 80 percent of the gemstones mined are emeralds. Gemstone mining (including aquamarine, amethyst, and tourmaline) earns Zambia an average of $60 million each year in legal trade, although independent industry analysts say stones worth $600 million are smuggled out of Zambia each year.

The important mines are in Zambia's Kitwe district, the Miku mine, at Mufulira, and in the Kafubu district (near the border with the Democratic Republic of the Congo and named after the Kafubu River) in the Ndola Rural Restricted Area. The 170-square-kilometer area (about 65 square miles) is home to at least eighteen known emerald deposits. The Kafuku stones, especially, are of excellent color and good purity. For a while the government lost control of the mines, but regained it in 1984 with the establishment of Kagem Mining, Ltd., in which the government owns 55 percent of the stock. With a large infusion of American money, Zambia was (for a while) one of the world's most important emerald sources. However, after 1998, supplies fell off sharply as the open pits began to yield fewer and fewer emeralds, and depth mining became economically unfeasible.

Today, Zambia is trying to get more out of its native emerald resources by developing a lapidary industry as well as simply mining them. Most of the larger emeralds of high quality go to Israel and most of the rest go to India for cutting.

Although most Zambian miners are independent small-scale operators, the actual bulk of the production is mined by a few large companies with mechanized, large, open pits.

Zambian stones are often found in schists adjacent to pegmatites. Typical inclusions are partially healed fissures, as well as actinolite, phlogopite, biotite, tourmaline, dravite, fluorapatite, magnetite, and hematite.

Zambian emeralds have a relatively high refractive index and specific gravity. Some Zambian emeralds are truly fine. Excellent crystals up to 20 centimeters are found, with color ranging from pale green to green, colored by chromium and iron. The best ones (and there are many of these) are noted for their clarity and deep, rich, intense color. In fact, Zambian emeralds are famous for retaining a good color even in half-carat stones, which is very unusual. Zambian emeralds are just beautiful. They don't have exactly the same color as Colombians, but the color they do have is really special—very deep and very green. That green goes right through the stone; Colombians, by contrast, often have a pale core with the green color concentrated mostly at the outer edges of crystal. However, Zambian emeralds tend to be a bit darker than most Colombian emeralds and some have a bluish tone, as do some emeralds from Chivor. Zambian emeralds, however, are even bluer than Chivor's, excessively so, to some taste. Some have more than 15 percent blue, which shows up dark when such an emerald is worn indoors. As a general rule, the smaller the stone, the poorer the color. Other Zambians carry a gray note. As is the case with Brazilian emeralds, Zambian emeralds may be colored with vanadium rather than chromium.

However, the crystals are very pure, with few stress fractures; that makes them appealing to retailers. Most experts can recognize Zambian emerald by sight, even though they are often sold as "Sandawana" or even "Old Indian Mine" gems.

There is another advantage to Zambian emeralds. Because they are less porous than many other emeralds, they are less likely to be treated with fillers. Some have very few inclusions (mostly mica) and great clarity. In fact, Zambian emeralds challenge the notion that the very best emerald must always be rather heavily included. That may be the case in Colombia, but not in Zambia.

The greatest advantage of Zambian emeralds is price. Colombian emeralds are three to five times higher in cost than Zambian, for no other reason than that Colombian emeralds are simply perceived as better. For example, an extremely pure Colombian emerald might go for $20,000 per carat in sizes over 5 carats. A Zambian emerald of similar quality would cost between $5,000 and $8,000 per carat. The best Zambian emeralds are as fine as the best Colombian gems, and they are larger than Zimbabwe emeralds.

Zambia also has a reputation for smuggled emeralds. Many Zambian emeralds still leave the country illegally and are sold as "Sandawana" (Zimbabwean) emeralds (although an expert can tell them apart by sight). The government has trouble controlling its finds, and private mine owners often have no compunction at all about smuggling their goods out of the country to avoid taxes.

They usually go first to Switzerland and then to Israel for cutting. About 40 percent of emeralds sold in the United States are from Zambia, although most people don't know it.

Besides emeralds, Zambia also produces garnet, tourmaline, citrine, malachite, agate, aquamarine, and heliodor.

South Africa is mostly known for its diamonds and gold. Some emerald mining was done in 1890, although not much is known about that period. Between 1927 and 1929 emeralds were mined at Gravelotte in South Africa, although most of the mines went out of business during the Depression. However, the area is still Africa's largest deposit. The world's largest antimony mines are near here also.

Today the Cobra mine, one of the earliest, is still operating on a small scale. The emeralds are mined both by open pit and underground workings. Crystals average up to 3 centimeters, with good color (chromium and iron). There are lots of inclusions in most and the stones have color zones, with a relatively clear core. A few stones exhibit real quality. However, the number of emeralds produced is too low to make any real impact on the world market. The only colored gemstone mined in any quantity in South Africa is tiger's eye, for which it is a major world supplier.

Other African nations mining a small quantity of emeralds include Namibia, Ghana, Madagascar, Malawi, Mozambique, Nigeria, Somaliland, and Tanzania.

In Nigeria (Gwantu region), hydrothermal fluids leached chromium from the host rock and allowed it to invade the crystal. Good finds were first reported in the 1980s. The stones are colored by chromium, vanadium, and lots of iron (hence the blue). Nigerian green beryl is often found in granite and pegmatite vugs. A vug is just a little cavity in a rock, that's all. All through Africa, you'll find emerald associated with aquamarine and tourmaline. Nigeria also has a quantity of large and lovely green beryl; unfortunately, the stones just aren't quite green enough to earn the name of emerald. Nigerian "emeralds" are also known for their three-phase inclusions that are practically identical to the ones from Colombia. However, the stones do not match Colombians for quality. They have too much iron for one thing, much higher than the sum total for chromium and vanadium. Their color ranges from very pale greenish blue to light blue. Nigeria will just have to be satisfied with its aquamarine, tourmaline, garnet, topaz, and sapphire deposits. You can't have everything.

In the Manajary region of Madagascar, emeralds have been mined since the early 1960s. The country has long been known for other gemstones—emeralds are a fairly recent phenomenon. Although there is rarely anything of gem quality, some interesting collectors specimens have appeared. In fact, in 1989, a crystal was found weighing 76 kilograms, containing 127 emeralds

in a phlogopite matrix. The emeralds are colored by chromium and iron and are heavily included. The richest area is Morafeno, which produced several thousand kilograms of rough between 1983 and 1990. Madagascar remains an area of great interest to prospectors.

In the Morrua/Alto Ligonha region of Mozambique, the first reliable reports of emeralds began appearing in the 1970s. There are rumors of huge crystals (over a thousand carats being found); these are unsubstantiated. During a period of political instability, mining was halted in the 1970s until 1990 when in a joint venture between the government of Mozambique and an Israeli company the two worked together to reestablish the industry. However, it ultimately proved unprofitable. The emeralds so far discovered range from pale blue-green to green, and colored by chromium and iron. They are heavily included and full of cracks, so have not drawn a lot of interest.

In Namibia (Malta height area) a few small, poor-quality emeralds were found in 1992. Most of them are fractured, milky, and heavily included. Solid inclusions are typically phlogopite, mica, chlorite, quartz, actinolite, fluorite, and gadolinite.

In Tanzania (Mayoka region near Lake Manyara) the first finds were uncovered in 1969 by a local farmer. Crystals are small, usually only 2 centimeters or so, but of good quality. Colors range from pale blue-green to deep grass-green (chromium and iron). The government mine operated for only a couple of years, then was closed; however, many experts believe there is enormous potential for the deposit. After all, Tanzania is a famously gem-rich country, with over 40 varieties of gems stones known there. Another small mine that produced some lovely emeralds was discovered in 1994, but production is now halted.

There are rumors of emeralds in the Boorgama region of Somalia (in the far northwest of the country). The first reports came in 1999, but they are still unverified. The color of the emeralds is said to come from chromium and iron, with inclusions of phlogopite.

In 1994, a 3,600-carat emerald crystal was discovered somewhere in Africa. Reports of its origin ranged from Zambia to Madagascar. By September of that year it was exported to Thailand in search of a buyer. Fortunately, for emerald lovers the world over, it was decided not to break up the crystal into smaller pieces. Instead, it was dedicated to honor the Buddha. The posture chosen for the stone was the classical stance known in Thai as *Harm Yhard*, in which the Buddha admonished his disciples and family members to cease quarreling. Years of work went into the planning and design decision, and its importance was highlighted after the destruction of the giant Buddhas of Bamiyan, Afghanistan, by the Taliban. The idea of an immeasurably valuable Buddha, carved from a stone highly prized in Islamic literature, with a rebuke to "stoping quarreling," seemed highly symbolic.

Finding an artist was difficult. Europeans are considered the best gem carvers, but they were unfamiliar with Buddhist iconography. Eventually it was decided to select an experienced jadeite carver from Thailand who understood the complexities of the design. The owners of the crystal chose 36-year-old Aung Nyein, originally from Burma but who had lived in Thailand for 16 years and was a renowned master of carving Buddhas in jadeite. But jadeite is a much different material from emerald. Aung Nyein practiced, first with jadeite, then with low-grade aquamarine, so he could get the "feel" of beryl. Weeks later, he was ready to begin on the prize emerald itself—measuring, marking, cutting, grinding, and polishing. For the last stage, Aung used the finest diamond paper available in order to give the Buddha a beautiful high gloss.

In late February, 2006, Aung announced that he was finished. The final product is 2,620 carats; its dimensions are 154 × 66.5 × 43 millimeters, and is named the Sacred Emerald Buddha. (The ancient and historic "Emerald Buddha," housed in Wat Phra Keo, on the grounds of the Grand Palace in Bangkok, Thailand, is not emerald, but green jasper. This venerable image was, according to legend, accidentally uncovered after a lightning hit a temple in northern Thailand. It is still an object of great veneration to Buddhists of the region.)

Indian Emeralds?

Perhaps the most prestigious and certainly the most romantic source for an emerald might be India. At one time India and surrounding lands were fairly rolling in diamonds, rubies, and sapphires, but the country never did have many emeralds. In ancient Indian astrology, emerald is not listed as a traditional birthstone. It is probable that when the Indian birthstone tablets were drawn up, the compilers were just not familiar with this "outlandish" stone.

Later, during the development of Ayurvedic medicine, however, emerald earns a place as a curative gemstone. In this therapeutic modality, emerald paste (usually combined with honey) works as a remedy for kidney stones, colic, constipation, fever, vomiting, indigestion, and "swelling" of the internal organs. As what is termed in Ayurvedic medicine a "cold and sweet" stone, it countered hot and sour influences and was an antidote to poison. In fact, one name by which the stone was known in India is *garalari*, "enemy of poison." An old Ayurvedic medicine tradition says that soaking an emerald in raw cow's milk before wearing increases its healing power. However, Indian tradition, which holds them sacred, has more faith in the magical healing power of cows than most of the rest of the world.

However, some Indian astrological systems consider emerald a "hot" stone, although this seems counterintuitive. Its "hot" quality is supposed to cure

fickle-mindedness; again the stone should be ground to a paste for its best effect.

Not that just any old emerald will do. To be a curative, in Indian tradition, the emerald must exceed 3 *rattikas*. (One rattika equals 0.59 metric carats.) In his 1879 work *Mani-Mala* or *A Treatise on Gems*, Sourindro Mohun Tagore, wrote, "Emeralds that are smooth, and whose color is like the throat of a parrot, the back of a firefly, leaves of the water lily or the tail of the peacock, bring luck. . . . Genuine emeralds are a reliable agent against any poison . . ." Only the highest quality is worthy of attention, also. "An emerald that is not cool is called *rukshna* and can produce sickness. One with a yellow spot is called *bishfota*; whoever wears it must fear death by injury. . . . An emerald that is inseparably intergrown with its matrix has corrupting influences. . . . An ugly emerald is called *jathara*, and it leaves one susceptible to bites . . ."

It has always been a lucky stone. In the Vedas, the timeless holy scripture of Hinduism, the ancient rishis (inspired prophet-singers) proclaimed, "Emeralds promise good luck," or "Emerald enhances your well-being." This doesn't seem all that inspired to me, but it was cunning. Since the Indians didn't really have any emeralds at the time most of the Vedas were written, it was a handy way of explaining their bad luck.

On a more mystical level, some ancient Indian philosophers said that presenting an emerald to a god brought with it knowledge of the soul and of eternal life. In Hindu Tantra, the emerald works on the heart chakra (the Anahata), which is depicted as emerald-green with a pink to blood-red center.

According to Tagore: "Pure, heavy, cool, dust-free, and beautiful emeralds purify mankind from all its sins. . . . The emerald strengthens feelings of well being, bring luck in war and heals cases of poisoning . . ." Furthermore, "When a ruby and an emerald have the same weight, the emerald is the more valuable stone . . ."

The elegant four-story Stok Palace of Ladakh is supposed to have some eighteenth-century *thankas* illuminated with paint made from crushed rubies, emeralds, and sapphires. It is not really possible to paint this way, but you can ruin a lot of stones trying.

Even if the emerald-paint exists, the emeralds aren't from India. India produces almost no emeralds of gem quality, and there are no ancient Indian emerald mines. The emeralds it has now have come mostly from Colombia.

The earliest "Indian" emeralds probably came from Egypt, as did nearly all other historical emeralds. In fact, studies show that Indians traded for Egyptian emeralds from very ancient times until the Egyptian mines finally petered out in the thirteenth century. The better, and more modern emeralds, come from Colombia. That didn't stop many Indian maharajahs from claiming a more mystical origin for their gems: the mysterious Old Mine. There's something

apparently magical and ancient about the very idea of emeralds from India that makes these putative gems the most valuable of all. However, all known "emeralds" from India of any real quality are not Indian, but Colombian, Zambian, or something else.

The earliest verifiable Indian source of true emerald was discovered only in 1929 at Aravalli in Rajasthan; emeralds have been mined off and on there since 1943. The main source now for Indian emeralds is the mines in the Orissa district (an area that also produces alexandrite) and Ajmer. The quality of Indian emeralds is quite variable, but most of them are rather poor; they are generally turned into polished beads rather than faceted gemstones. India does have some green beryls, but of course they lack the true emerald color.

Indian emeralds can often be identified by their strange inclusions—rectangular cavities with "tails." Typical inclusions are phlogopite, apatite, quartz, chlorite, feldspar, amphibole, pyrite, tourmaline, and spinel. Almost all are of poor to medium quality. However, some of the stones are highly prized and have a bluish cast very appealing to many collectors. The best stones are from the Rajghar deposit; their color is a pale to deep green colored by chromium, making them "real" emeralds.

In South India, some emeralds were discovered in 1995 on the inner wall of a water well, of all places. Gem-quality stones are small (2–3 centimeters) and rare. They are colored by chromium and iron, and are full of inclusions. Many have healed fractures.

Still, even as good emeralds from Colombia have flooded the Indian market, there is continual chatter about the mysterious "Old Mine." In fact, people have been talking about this probably nonexistent Indian source for hundreds of years. Thakkur Ferru, writing in 1318, noted that according to Al Idrissi, an Arab trader, there existed an emerald mine "across the water, on a hill, at a place called Markat" (related to the Sanskrit word for emerald). That no doubt referred to Cleopatra's mines, not anything in India.

The fabled Old Mine is apocryphal, but that has not stopped buyers eager for a bit of phony antiquity to buy Old Mine emeralds at up to $30,000 per carat. Fred Ward, the famous gem collector, reports that in his extensive travels over India researching historical emeralds, almost every collector assured him that his particular collection included emeralds from this lost and fabulous source.

Like everyone else, however, Ward is convinced that all the so-called Old Mine gems are in fact Colombian. And he didn't guess. He not only found characteristic Colombian three-phase inclusions in the Old Mine emeralds, but shipped a bunch of high-quality "Old Mine" gems to France for spectral analysis. Some of them came from the famous collection of the Nizam of Hyderabad.

Three of these emeralds turned out to be Colombian (Cosquez, Pena Blanca, and Tequendama mines) and one was from Panjshir, Afghanistan. This was something of a disappointment to legend-mongers, who had assured everyone that the emeralds were really a present from Alexander the Great. (Ward even examined Indian artwork, and failed even to find any anything that depicted green stones that could be identified as even resembling emeralds.)

The Nizams were an interesting bunch. (Nizam is properly a title, sort of like "king," rather than a personal name.) They ruled Hyderabad since the early eighteenth century, but their ancestors came ultimately from Baghdad, arriving into India via Samarkhand. There were seven Nizams altogether, often unhelpfully listed as Nizam I, Nizam II, Nizam III, Nizam IV, Nizam V, Nizam VI, and Nizam VII. They have longer, fuller personal names, of course. For example, the first one was Asaf Jah Nizam ul-Mulk Qamar ud-din Khan, who ruled from 1724 to 1748. The last one, Mir Osman Ali Khan – Asaf Jah, ruled for 37 years (1911–1948). His dominion was larger than England and Scotland put together, and the Nizam had the money to go with it. During the 1930s, when everybody else was suffering through the Depression, the Nizam was said to have 100 million (GBP) worth of gold and silver and a further 400 million (GBP) worth of jewels.

Despite all this, he was supposed to have lived simply and to have worn cheap suits. However, simple living is a relative matter. His Louis XIV-inspired palace, Falaknuma, was designed in the shape of a winged scorpion. It has marble staircases and fountains everywhere, and a library which is replica of the one at Windsor Castle.

Mir Osman Ali Khan – Asaf Jah was the only Maharajah in British India who enjoyed the title of "Exalted Highness," possibly because he handed the Brits 25 million pounds to help them fight the First World War. But it didn't stop there. His other epithets included Great and Holy Protector of the World, Shadow of God, Mighty Holder of Destinies, Full of Light and Most Elevated Among Creatures, The Exalted, May God's Shadow Never Grow Less, and May God Protect Your Kingdom and Your Sultanate.

When India gained independence in 1947, the Nizam refused to join either India or Pakistan, preferring to form a separate kingdom (of 16 million people) within the British Commonwealth of nations. His preferences notwithstanding, India annexed the place in 1949, and split it up along linguistic lines. In many ways, this was a shame, since in its heyday, Hyderabad was renowned for its excellent governance and religious toleration. The Nizam was a generous and ecumenical ruler, contributing to Muslim theological schools, the Hindu University at Banares, and the Sikh Golden Temple at Amritsar. But then he could afford it and perhaps wanted to hedge his spiritual bets.

Today, his jewelry collection is the subject of a ferocious court battle between the Nizams and the Indian government. Part of it was settled in 1995 when the government forked over $47 million to the Nizam's heirs, but there is another dispute with another branch of the family. It doesn't help that there are suddenly thousands of people who also claim to be related in one way or another to the Nizams, demanding their share. Jah has been living off money provided by a family trust in 1954 and lives in Turkey with his fifth wife.

Other famous emeralds of India include those of the Mogul emperors of Delhi. They ruled India from 1526 to 1857 and used emeralds not only as jewelry but as talismans. These so-called Mogul emeralds can still be seen in museums today.

The New York Museum of Natural History has a pure emerald cup belonging to Emperor Jahangir (1569–1627). After his marriage in 1611 to a Persian widow, he devoted himself to cultivation of the arts, especially miniature painting. He let his wife run the country.

The most famous Mogul emerald belonged to Jahangir's son, Shah Jahan (1592–1666). He reigned from 1628 to 1656, and had a huge emerald (78 carats) around which was inscribed "He who possesses this charm will enjoy the special protection of God."

While Shah Jahan is most famous for the fabulous tomb he built for his wife (the Taj Mahal) and the Great Mosque of Delhi, he also arranged to have a nice palace built for himself. An inscription about it reads, "If there be Paradise on the face of the earth, it is this, it is this." The court painter Abu'l Hasan, whose humble nickname was "wonder of the world," painted what Shah Jahan admitted was a "good likeness" of him during his 25th year. The good likeness shows Shah Jahan with a fancy hairdo, including elaborate sideburns and a moustache. In the painting Shah Jahan holds up a gold spray containing a huge green emerald and a white diamond. He is also covered with gems himself. Unfortunately, Shah Jahan came to a rather bad end. He fell ill in 1657, which led to a war of succession among his sons. In 1658, his son Aurangzeb deposed him and had him imprisoned for the rest of his life.

Now Aurangzeb, the last of the of the great Mogul rulers, also owned one of the world's most famous emerald artifacts—the Mogul Emerald, which was recently sold for more than 1.5 million pounds ($2.2 million) at Christie's in London to an anonymous bidder. This was a new world record for a carved emerald from the Mogul Dynasty. The emerald is Colombian and somehow reached India through trade. The rectangular-cut, cushion-shaped stone weighs 217.80 carats and is 10 centimeters tall. It is of a rich, rare, and beautiful color and inscribed with a Shi'a prayer in the beautiful *naksh* script. It is dated 1107 A.H. (After Hegira, the date at which Muhammad emigrated

to Medina.) In regular years, the stone dates to 1695. The reverse side is carved all over with foliate decoration (rosette and poppies). Each of the four sides is drilled for attachments, and the beveled edges are carved with cross pattern incisions and herringbone decoration. It is the only known carved, inscribed, and dated emerald of the period. Sometimes the stone is called the Mogul Moghal, but perhaps that is just a bad pun.

Some wonderful Mughal emeralds ended up in the collection of Sheikh Nasser Sabah al-Ahmad al-Sabah, a collection which also includes more than 25,000 works of Islamic art from the seventh to the nineteenth century. During the first Gulf war, the collection was snatched by Iraq. Most of it was recovered by the UN, but three really important, beautiful early Mughal carved emeralds have gone missing, one the most important emerald known to scholarship, another which features a religious inscription, and a gemstone with royal Mughal inscriptions. There is no telling how or where, if ever, they will turn up.

A great emerald and diamond necklace goes by the frightening misnomer of "the Inquisition Necklace." It is true that it was created sometime during the Spanish Inquisition period, although there is no evidence that any of the Inquisitors (much less their victims) actually wore it. In fact, it was probably made in India. It consists of 15 Colombian emeralds (the centerpieces a barrel cut stone of 45 carats) and 336 Indian diamonds. The Maharajah of Indore brought the necklace back to India in the early years of the twentieth century, and his son sold it to Harry Winston in 1948. It is now part of the collection of the Smithsonian's National Museum of Natural History.

Still another great Indian piece is the the Chalk Emerald, consisting of a 37.8 carat Colombian stone. It is noted for its superb color and wonderful clarity. Legend says it was once the center stone of an emerald and diamond necklace belonging to a maharani of the former state of Baroda in India. At one time it weighed slightly more (38.40 carats), but was recut and set in a ring surrounded by sixty pear-shaped diamonds (totaling 15 carats), by Harry Winston Inc. The ring was a gift to the Smithsonian Institution by the Chalk family in 1972.

Indians, Turks, and Iranians

The famous Emerald Dagger was orignally meant as gift from Turkey to Iran. It was ordered made in 1747 by Ottoman Padishah Mahmud the First of Turkey as a gift for Nadir Shah of Iran. The said shah was actually an upstart Oguz from the Avsar tribe. His real name was Nadir Han and he overthrew the Safevi dynasty, took the throne of Iran as Shah Nadir, and embarked

upon a great series of conquests. Mahmud sent off an impressive envoy of messengers to bear this and other gifts, a sort of traveling embassy, as it were.

At the same time this was going on, the Iranians were presenting *their* gift to the Turks—the famous Peacock Throne, which of course didn't belong to either the Turks or the Iranians but to the Indians. However, just when the Turkish embassy was crossing the Iranian border, it heard that the Shah had been assassinated, so they turned around and went home. The dagger is now in the Treasury of the Topkapi Palace in Istanbul where it was made. The Topkapi Palace was also known for housing the world's most famous harem.

The Emerald Dagger has three brilliant emeralds the size of pigeon eggs. The point of the handle has an octagonal cover of emerald, which when lifted, reveals a watch. Even in the middle of slashing someone's head off, you may need to know what time it is. There's also a big emerald on the curved tip of the sheath.

In 1964, a caper film was made about this dagger, *Topkapi*, in which a gang of art thieves attempted to steal it. Even though you may never have heard of this movie, it's a good one, and in fact was the inspiration for the Mission Impossible series. It also won an Oscar for Peter Ustinov as Supporting Actor.

Still another great "Turkish" emerald (it's really Colombian) is a magnificent emerald pendant—which did not hang from the neck but was suspended above the head of Sultan Ahmet I whenever he sat down. The pendant is composed of a massive uncut hexagonal emerald, adorned with diamonds, rubies and natural pearls. It cost 6,000 pieces of gold back in 1617, when it was made.

Yet another great emerald with ties to Turkey is the 75-carat Hooker Emerald Brooch, now part of the Gem and Mineral Collection of the Smithsonian's National Museum of Natural History. This Colombian emerald is not only exceptionally large, but relatively free of inclusions, extremely unusual in a stone of this size. It was shipped out from Colombia by the Spanish conquistadors in the sixteenth or seventeenth century. It was once reputedly part of the belt buckle of the Turkish sultan Abdul Hamid II (1842–1918), one of the last rulers of the Ottoman Empire. Abdul Hamid also owned the Hope Diamond at one time, and that's never lucky. (In case you didn't know, the Hope Diamond is somewhat cursed.) He was eventually overthrown by an army and died penniless in Magnesia of all places.

New York's Tiffany & Co. purchased the gem at auction in 1911 and initially set it in a tiara, later thinking better of it and resetting it into a platinum brooch in 1950. (There are matching ear clips.) The market for tiaras is smaller than one would perhaps like. Janet Annenberg Hooker bought it in 1955 and in 1977 donated it to the Museum. For this and other reasons,

the Smithsonian named its entire Hall of Geology, Gems, and Minerals after her. The stone is cut in a beveled square, measuring 27 mm (1.06 inches) along each edge. The brooch is surrounded by 109 round and 20 baguette diamonds, which together weigh about 13 carats.

As to the Peacock Throne, some Turkish authorities believe it to be in Turkey, where it used to be called the Throne of Shah Ismail. It was among the "gifts" brought there by Mehmet Mehdi Han, Nadir Shah's right-hand man. Since the Shah had been assassinated, and his return to Iran would have meant death, he begged asylum from the Ottoman government. In this way, the Turks got their hands on a fabulous throne. Some call it the original Peacock Throne of Iran, but that is disputed, especially by the Iranians. It's quite an impressive piece of furniture, crafted as a sort of high-edged table resting on four legs. At the front is a low stool for the royal feet. The throne is covered with a cushion decorated with gold braid and pearls. The entire surface of the throne is covered with gold, with a red and green enamel wash and decorated with rubies, emeralds, and pearls.

But is this throne, after all, the real Peacock Throne? The throne situation is in a bit of muddle. The Shah supposedly brought back nine thrones from India, but none exists in Tehran today, having been lost or destroyed. Surviving thrones are copies of the originals. One throne which may be older is the Naderi Throne. Its origin seems to be a mystery. The Naderi was unique in that it was portable, and can be taken apart into 12 separate wooden sections. The whole thing is gold plated and enameled in red and green, and decorated with emeralds, rubies and pearls. The height of the throne is approximately 225 centimeters and it boasts 26,733 jewels, including four large spinels on the backrest, the largest of which is 65 carats. It has between 1,500 and 2,000 carats of emeralds, including four very large emeralds on the backrest, the largest of which is approximately 225 carats.

The largest collection of emeralds is reputed to be the [former] crown jewels of Iran, with between 1,500 and 2,000 carats of emeralds. The jewels are now located in the Central Bank.

Emeralds appear in a royal belt, the Pahlavi crown, the Naderi throne, and various necklaces. The crown, no longer in use of course, as it would look strange on the head of an Ayatolla, was created by a group of Iranian jewelers under the supervision of Haj Serajeddin, the famous jeweler who had been in the employ of the Amir of Bokhara and had later emigrated from the Soviet Union to Iran. The stones were selected from loose stones in the treasury, an old tradition in Iran. The design incorporates a motif popular in the Sassanid dynasty, which ruled over the Persian Empire from the third through the seventh centuries. This crown was worn by Reza Shah, the founder of the

Pahlavi dynasty, in his coronation on April 25, 1926. His son, Mohammad Reza Pahlavi, the last Shah of Iran, also used the crown in his coronation on October 26, 1967. He put it on his own head.

The Shah's crown is made of red velvet, gold, and silver. It's a squarish, with a width and height of about 8 inches each. On this rather modest surface are crammed 3,380 diamonds, totaling 1,144 carats, the largest being a brilliant-cut yellow diamond of 60 carats. It marks the sunburst in the front of the crown. In addition, the crown has 369 perfectly matching natural pearls in three rows, and five emeralds, too, totaling 200 carats, the largest being about 100 carats.

During the same ceremony, in a break with tradition, he placed a crown on the head of his wife, the Empress Farah. Until that date, the wives of Persian monarchs were not crowned, so a new crown had to be designed for the occasion. The job was done by the French jewelers, Van Cleef and Arpels. It took Pierre Arpels over 20 trips and 6 months of trundling around between Paris and Teheran before completing his work—the royal gems are not permitted to leave the country. Again, the stones were selected from those just lying around in the treasury. It's made of green velvet and white gold and has more than 38 emeralds, 105 pearls, 34 rubies, 2 spinels, and 1,469 diamonds. The largest emerald is located in the center of the sunburst on the front of the crown, and weighs approximately 91.32 carats. The Shah-ess already had a diadem, by the way. The Shah gave it to her when they were married in 1958. That one was designed by Henry Winston and had seven emeralds weighing from 65 down to 10 carats. It has seven emeralds and 449 diamonds. (During the Iranian Revolution, a popular poster was circulated showing a white female figure with raised fists smashing the Pahlavi crown, the symbol of the shah. Then the Iranians had a revolution and that was the end of the Shah. But the emeralds are still in the country.)

Another great emerald owned by the Shah is a heart-shaped, cabochon-cut emerald weighing around 175 carats, and set in a diamond-studded gold mount. It was probably something that Nader Shah had stolen from the Indians who had bought it from the Spanish who had stolen it from the Indians on the other side of the ocean.

The Irani State Treasury also possesses the famous Jewel-Studded Globe, of 110 centimeters high with a diameter of 45 centimeters. The whole thing is clotted with more than 51,000 gemstones; and its wooden base is covered with a layer of pure gold weighing 35 kilograms. The oceans are represented by emeralds, and land masses in diamonds, rubies, and spinels. The largest emerald in the globe is approximately 175 carats. According to legend, Nasseridin Shah (1848–1896) ordered its creation in order to help keep track of the loose

gemstones in the Treasury. At least this way, someone might notice if one got pinched.

Emeralds in Afghanistan, China, and Pakistan

One of the most interesting things about Afghanistan emerald is that some of the fabled Old Mine emeralds of India may in fact be from Afghanistan, at least according to some recent analysis on a few historic emeralds. No one knows when this mining began, but it probably wasn't done before the seventeenth century. So even the "Old Mine" is not that old. But emeralds are emeralds, and it turns out that even in the thick of the 2001/2002 war against the Taliban, when the place was being bombed daily, the emerald mining didn't stop.

Traditionally, Afghanistan has been most famous for its lapis lazuli, but it has rubies and emeralds too. Three areas of Afghanistan are currently mined for emeralds: Konar Province, Laghman Province, and the Panjshir Valley. Konar Province emeralds are a desirable grass green, but they are often clouded or milky, filled with inclusions and fractures. Gem quality is rare. The same is true of the Laghman Province stones, although they tend to be less included. But their color isn't very good.

The main source for Afghan emeralds is the Panshjer Valley district. These stones have a beautiful saturated green color from chromium. Gem-quality crystals are regularly found up to 5 carats, but with 10 or even 15 carats being sometimes seen. It is probably true that Afghan miners work under the worst conditions on the planet for mining emeralds. Most of the mines are reachable only by footpath, and the mines are accessible only a few months a year.

The emeralds are transported and sold in Peshawar, Pakistan, for cutting, since nobody wants to go to Afghanistan. Technically this is smuggling, but no one is really paying any attention. Most of the emeralds eventually are traded on the Asian market, especially Hong Kong.

Believe it or not, you can book yourself a 2-day tour of the Afghan emerald mines for about $5,900. The company sponsoring the tour will throw in another couple of days at a ruby mine in Jegdalek in the same country. Since the overthrow of the Taliban, gem traders report that the gem trade in general is more precarious than ever in the current multiparty government. One reason is that the government is trying to control the village-run mines, and the villagers are objecting. In addition, emerald production in the north is not meeting its once-promising potential.

It doesn't make things any easier when you consider the people doing the mining have little skill and no modern equipment other than dynamite, which ruins about as many stones as it produces.

In the early 1980s several emerald mines were uncovered in Yunnan, China. Rumor has it that there may be a lot of emeralds there, but current production is unknown. Crystals up to 6 centimeters in diameter have been found. Typical inclusions are biotite, phlogopite, quartz, K-feldspar, calcite, muscovite, phengite, fluorite, apatite, tourmaline, arsenopyrite, pyrite, chalcopyrite, pyrrhotite, and pentlandite.

Most of the Pakistani gemstone mines are located in the tribal regions (mostly Pathan) that cover the areas bordering Afghanistan. The two countries share a long (2,430 km), porous, and very troubled border. As a result, there is a tremendous influx of all types of Afghan minerals, including emeralds, into Pakistan. Today the Pathans serve as Pakistan's first line of defense along the so-called Durand Line (drawn in 1893) that separates Pakistan and Afghanistan. The people living in the region are a tough bunch. Attempts (by the Mughals, Afghans, Sikh, British, and Russians) to conquer them have all failed.

The main emerald deposits are found in Shamozai, Mingora, and Gujjar Killi, located in Swat Valley, in the Northwest Frontier Province about 200 kilometers northeast of Peshawar. Swat is optimistically called the "Switzerland of Pakistan." This applies only to the scenery, of course. In no other way is Pakistan anything like Switzerland, although the poet Edward Lear wrote a poem about the place in 1862. However, the area is truly beautiful and tourists who are fond of day-trekking and schlepping around archaeological sites may enjoy it. Those patriots who object to the Swat region being known as the Switzerland of Pakistan have resorted to "Paradise on Earth." The emeralds are located in the contact zone where the Indo-Pakistan plate slammed into the Kostan Island. The whole emerald-bearing arc is made up of a collection of blue and green schist.

The northern and northwestern parts of Pakistan are dominated by the romantic and dangerous mountains of the Hindu Kush, Himalaya, and Karakorum. Here are found nearly all the fine minerals Pakistan has available, including not only emeralds but also aquamarine, topaz, peridot, ruby, emerald, amethyst, morganite, zoisite, spinel, sphene, and tourmaline. Most of the emeralds are of good, even excellent quality. The deposits have the potential to produce millions of carats, but most of the area is not currently being mined. The largest deposit was discovered in 1958, but most experts assume that emeralds have been mined there since ancient times. In fact, a pair of emerald earrings reportedly from Roman times exhibits oxygen isotopic composition known only in emeralds from this region. The emeralds easily detach from their matrix, and most crystals are between 1 and 2 centimeters. These emeralds are colored by chromium and iron, and the color can be splotchy, even sharply zoned. They show various types of fluid inclusions.

In fact, some historic Roman emeralds that had been assumed to hail from Egypt, or possibly Austria, turned out upon analysis to come from the Swat region of Pakistan, although traditionally none of these are very important either for quality or quantity. Interestingly, Pakistan mines a lot of chromium, too. Pakistan emeralds characteristically have mica inclusions, as do stones from Zambia.

Besides emeralds, the gem-laden mountains of the area also contain garnet, tourmaline, topaz in various colors, peridot, and other materials yet unknown. In fact, according to one Pakistani mining company, the mountains are "infested" with gems, which is certainly better than being infested by snakes, although that too is possible.

Emeralds are also mined in the Federally Administered Tribal Areas of Mohmand, although these are of poor quality and no commercial significance. (And so far no one has compared the Federally Administered Tribal Areas to Paradise.) Most of the stones there are classified as green beryl rather than emeralds. Some of the stones are colored by vanadium, others by chromium.

The Bajaur region also has emeralds, although they are of no commercial significance. They are colored by chromium and iron. The Gilgit Region has emeralds that are full of inclusion and often fractured, few being of gem quality. They are pale or medium in color and colored by chromium and iron. Most range between 1 and 3 centimeters in diameter.

In 1981 the Guarkili deposit was discovered, and while it does not release actual production numbers, it seems to be doing well. Its entire stock is sold on the American market, and its crystals are an attractive dark green, usually between 1 and 10 carats in size.

Most of the mining is done by the people living in the region; there is currently little government involvement. The Pakistani government is rather desperately trying to develop its mining industry and attract foreign investors, but without noted success so far. For one thing, government-sponsored surveys and analysis reports have gained a reputation for unreliability. That never helps. Rather obviously, Pakistan's weak infrastructure, ill-educated workforce, and pervasive violence have hindered any real foreign investment in the place. However, Pakistan's establishment (in 2001) of the Gems and Gemological Institute, in Peshawar, may one day change things for the better.

Emeralds of Europe and Russia

The alpine land of Austria has some emeralds in the Legbach ravine of Habachtal, near the Salzburg Alps; they occur in mica schist. This is the largest emerald deposit in the Alps, although that's not saying much. It's been

worked locally since 1865, although emeralds were first reported there in 1797. These emeralds are no longer commercially mined because of their poor quality (heavily included and fractured), although occasionally some nice collectors specimens turn up. They are colored by chromium and iron. Solid inclusions are typically phlogopite, chlorite, epidote, quartz, plagioclase, K-feldspar, rutile, tourmaline, apatite, talc, actinolite, phenakite, ilmenite, pyrite, scheelite, and molybdenite.

It is rumored that the Romans got some of their emeralds from Austria, but this hasn't been substantiated. I should mention that in Room 7 of the Winter Palace of the Austrian emperor there's a 2,680-carat emerald that was carved into a salt cellar in Prague in 1641. As you have probably deduced by now, the emerald is not from Austria. It's Colombian. In addition, the famous Austrian Rudolphian crown is topped by a blue-green emerald which is supposed to symbolize heaven.

While emeralds mined in Austria have not attained fame, some Colombian emeralds owned by Austrians certainly have. The Maxmillian Emerald Ring, for example, features a 21.04-carat step-cut emerald, donated to the Smithsonian Museum by Marjorie Merriweather Post in 1964. The present design is by Cartier and includes six baguette diamonds. Not very surprisingly, the ring is worth more than a million dollars.

In a different setting this emerald was worn by Archduke Ferdinand Maximilian Joseph (1832–1867), the ill-fated emperor of Mexico. Max was a descendant of another Archduke Maximilian who in 1477 started the very expensive tradition of giving out diamond rings as engagement tokens.

Our present Maximilian was originally just an Archduke of Austria, but he was crowned emperor of Mexico in 1864 because of some political intrigue in Europe. He was actually tricked into becoming emperor, being told that he would be the "redeemer" of Mexico, and that the Mexicans just couldn't wait to have him come over right away and rule them.

He showed his political naiveté by supporting land reform, educating peasants, and encouraging disaffected American Confederates to move to Mexico. Although cruelly called the "Archdupe" by critics, he showed a fair amount of courage at his inevitable execution, 3 years after becoming emperor. He was executed by firing squad, and his last words were:

"I forgive everyone, and I ask everyone to forgive me. May my blood which is about to be shed, be for the good of the country. *Viva Mexico, viva la independencia!*"

(Edouard Manet painted a picture of the event, a painting that has been called the "beginning of the modern movement" [Bataille]. But there have been so many of those . . .)

Maximilian's wife Carlota didn't have a very good time of it either. She had the sense to get out of Mexico in 1866, ostensibly on a trip to plead for her husband's life, but things didn't work out quite as planned, mostly because she went mad and had to be confined to a castle near Brussels. Before her confinement, she did manage to gain an audience with the Pope, during which she began screaming that Napoleon was plotting to poison her and that he (the Pope) was possessed by the devil. It also turns out that Carlota was pregnant, but probably not by Maximilian, who was having his own affair. The father was rumored to be a Belgian officer in Maximilian's army, and the baby grew up to be General Maxine Weygand who surrendered the French armies to Hitler in 1940, paving the way for the collaborationist Vichy regime.

A previous Archduke, Ferdinand II (1529–1595), otherwise known as the Count of Tyrol, was also noted for his emeralds. He owned a specimen that had once belonged to the Aztec emperor Montezuma II. Montezuma gave the emerald as a "present" to Hernando Cortez. When the Archduke Ferdinand II got hold of it, he displayed it in Ambras Castle. At one time the Arts and Treasures Chamber at this castle was the most important of its kind. Eventually, however, its prestige diminished and it was acquired by the Imperial Museum of Vienna in 1881. This emerald is really a stunning piece, measuring approximately 17 centimeters by 16 centimeters. The only problem with it is that it's not really in one piece. In fact, it's composed of individual pieces. Part of it is from Muzo and the rest from Chivor. The whole thing is stuck together with pitch. This makes it historically more interesting, of course. But it's not a single crystal, and it's properly known at the Imperial Museum as the "Colombian Emerald Group." There's also a 4.5-inch vase in the Viennese Treasury carved from a single emerald crystal, which weighs 2,205 carats.

Even Bulgaria has a few emeralds, although they are not mined. Nor are they the classic emerald green in color; most are a sort of pale blue-green colored by chromium and iron. Most are rather milky and fractured. A few collector's crystals are marketed every once in a while.

A few emeralds were discovered in 1975 by a collector. A few crystals up to 5 centimeters were found embedded in a feldspar and biotite matrix. They are full of inclusions and fractures.

Some Russian emeralds were found in 1830 by a peasant charcoal burner named Maxim Koshevnikov when a tree on the farm was uprooted by a storm. It's fairly unusual for a tree to fall over and reveal a cache of emeralds, but that's what happened to Maxim. He took the stones to a gem-cutting operation in Ekaterinaburg, which at the time was controlled by Czar Nicholas. The Czar

decreed that his own "imperial lapidary" receive the best cut stones at the palace in St. Petersburg. However, a small collection of the best emeralds went to Germany instead and sold to a princeling. It is said that when this prince's wife later visted St. Petersburg, the Czarina admired the stones. She was then informed that they came from Russia. The furious Czarina ordered a search of the director of the cutting factory's house and, indeed, some emeralds were found. The director went to prison.

Still, until the end of the nineteenth century, only a few collectors specimens were dug. However, by 1918, the mine was the largest emerald producer in the world. Most mining occurred in trenches or open pits, although small tunnels sometimes followed the narrower veins. The crystals were large, but many of the stones were small, and of low quality. The Communists mined there for beryllium for nuclear reactors rather than for emeralds.

In former days, Russia was an important source of emeralds, with most coming from around the Takovaya River, a 100-square-kilometer area about 60 kilometers northeast of Ekaterinaburg (Sverdlovsk) on the Asian side of the Ural Mountains. Other gems found in the area include amethyst, aquamarine, blue topaz, quartz, phenakite, chrysoberyl, emerald, and alexandrite.

Like Egyptian emeralds, Russian emeralds occur in pegmatite and phlogopite schist. They tend to be yellowish and heavily flawed and feathered. Inclusions are typically phlogopite. Many are broken or fractured, and are either complexly color-zoned or irregularly colored. Some Russian emeralds are quite pale; others have a rich dark color but are heavily flawed. Some stones show a colorless core laid over with an outer green zone colored by chromium and iron. The mining is done both in open pits and underground workings, but drilling has revealed emeralds up to 1,100 meters beneath the ground. Some crystals reportedly reach dimensions of 40 centimeters by 25 centimeters. Famous emeralds from this mine include the 11,130-carat Kochubei emerald, discovered at the end of the nineteenth century and the 12,900 Kommerchesky emerald found in 1982.

A Canadian firm will invest $12 million (US) in the Capital emerald mine located in the central Urals, which belongs to Zelen Kamen (Green Stone). Donald Padgett, president of Canada's Tsar Emerald Corporation vowed to revitalize the mine, and Tsar Emerald has been brought in to provide the financing to make possible resumption of direct mine extraction of emeralds at the Capital site. In addition to Padgett, participants in the negotiations included Brendan Stanley, general director of Zelen Kamen and Kabal, and Paul Portis, vice president of Norfin. Talks are now in progress with a number of Ukrainian bureaus on the redesign of the Capital mine.

While perhaps not actually mined in Russia, there is a wonderful emerald (18 carats) and diamond brooch designed by Bulgari and now owned by

Elizabeth Taylor. It was given to her as an engagement present by Richard Burton in 1962, and she wore it with an emerald necklace she got from the same husband as a wedding gift. This was followed by a bracelet, earrings, and ring. Some of the emeralds in the set were from the collection of the Grand Duchess Vladimir of Russia (1854–1920).

This Grand Duchess, whose first name was Marie ("Vladimir" was her husband's name), was the former Princess of Mecklenburg-Schwerin. She was quite a character in her day, and got into tremendous trouble with her nephew, the Czar Nicholas, who had forbidden the play of roulette and baccarat. The trouble began when Nicholas discovered that a priest of one of the principal churches had pawned the church plate and jeweled icons to pay his gambling debts. The Grand Duchess, who was a German by birth and absolutely addicted to gambling, thumbed her nose at the czar. As a result she was banished from court, at least for a while. She barely escaped the Russian Revolution and died soon afterwards anyway.

This same Grand Duchess owned a huge rectangular emerald (107.72 carats) in a brooch. Catherine the Great had owned it before her. Supposedly, this stone is the "second most beautiful emerald in the world" surpassed only by another emerald of Catherine's (only because the other was bigger). At any rate, the emerald entered the market when Grand Duke Boris, her son, sold it to Cartier in 1927. It was remounted as a pendant to a necklace in 1947 designed by Raphael Esmerian, the famous New York lapidary and gem dealer. In 1954 Esmerian convinced Cartier to let him recut the emerald into a pear shape to remove a flaw. It ended up at 75.63 carats and was restored to the necklace, which itself had been made larger with the addition of another square emerald. In the same year, 1954, John D. Rockefeller bought it from Cartier.

The Grand Duchess's most famous portrait shows her draped in pearls, rather than in emeralds. Speaking of pearls, Burton also gave Taylor one of the largest and most historically famous pearls in the world—the pear-shaped 400-year-old La Pelegrina (203.84 grains). Her dog ran off with it briefly, but that's another story. We won't even talk about the diamonds. Taylor is equally famous for her perfumes—not that she creates them herself, of course. One of her latest is "Diamonds and Emeralds, a fruity floral with a hint of amber, sandalwood, and musk." Since it is petrified tree sap, usually with bugs inside, it probably has a very interesting odor.

In 1867 emeralds were discovered on the western shore of Lake Mjøsa (near Snarum), one of the very few spots in Europe where gem quality emerald existed, and even they weren't very good. An English mining company—"The Norwegian & General Exploration Company LTD"—operated the

deposit from 1899 till 1909. The maximum crystal size was only a few centimeters, with most stones occluded. Coloring came from vanadium, iron, and chromium. The mines were abandoned after only 10 years of operation.

A few emeralds have been found in Franqueira (Central Galicia, in the northwest of the country). Some emeralds up to 1 centimeter long have been discovered, but they are marred by inclusions. They are pale green, colored with chromium and iron. Solid inclusions are typically phenakite, chrsoberyl, phlogopite, quartz, pyrite, ilmenite, and anthophyllite.

England's Emeralds (or At Least the Queen's)

No emeralds have ever been mined in England, but that fact hasn't stopped the English from getting their hands on plenty of them. Aside from the previously mentioned Devonshire Emerald, there are also the Crown Jewels and the gems personally owned by Queen Elizabeth and her family. These are not the same thing. The Crown Jewels include the Imperial State Crown, created in 1937 for the coronation of George VI. It's set with 2,868 diamonds, 17 sapphires, 11 emeralds, 5 rubies, and 273 pearls. The queen wears the thing once a year at the opening of Parliament. When that happens, the crown in the display case is replaced by a small sign that says, "In Use."

The Queen of England has a lot of jewels. She has so many that there's a special room, 40 feet below Buckingham Palace, to hold them. I'm not talking about a closet either. The room is the size of a hockey rink. The Queen's personal jewelry includes (but is not limited to) 14 tiaras, 34 pairs of earrings, 98 brooches, 46 necklaces, 37 bracelets, five pendants, 14 watches, and 15 rings. Its value has been estimated at over 350 million pounds, which is even more in Euros. She received most her jewelry as presents, but not always. Take, for example, her most renowned piece, the Cambridge and Delhi Dunbar Parure, a fantastic suite of jewelry which includes an emerald diadem. This masterpiece jewelry was made from a box of 40 stunningly beautiful and extremely large cabochon emeralds, and they came into the present Queen's hands in this way. In 1818, King George III's seventh son, Adolphus, the Duke of Cambridge, married Princess Augusta of Hesse. On their honeymoon, while visiting Frankfort, there was a lottery held for charity, and amazingly enough, the princess just happened to win the prize box of emeralds. Once back in England the princess had some of the emeralds made into drop earrings and some more made into a necklace with pendant stones.

When she died in 1889, the earrings, necklace, and remaining emeralds were passed down to her younger daughter, Princess Mary Adelaide, Duchess

of Teck. The Duchess added a couple of the emeralds to a diamond stomacher she had bought from Garrards. The royals were always mixing, matching, resetting, redesigning, and destroying their jewelry, and it's a little hard to keep up.

This Duchess died without a will and her jewelry (including some more emeralds from various sources) was divided up among her four children. Her second son, Francis (1870–1910), got all the emeralds, including the ones that had been inserted into the diamond stomacher (which, sans emeralds, went to someone else). He gave them to his mistress. He died suddenly at the age of 40, and Queen Mary (daughter of Princess Mary Adelaide) sent an emissary to the fallen lady along with a stiff note asking for the return of the emeralds and she wasn't kidding. Around the same time Queen Mary just happened to come into possession of the 102 cleavings from the Cullinan diamond—six really big stones plus 96 brilliants.

Properly armed, so to speak, she set about the design of the suite of jewelry now known as the Cambridge and Delhi Durbar Parure. (Queen Mary combined most of the old jewels into new jewelry prepared for her coronation on June 22, 1911, and for her acclamation as Empress of India at the Delhi Durbar on December 12. The word Durbar means a "gathering of chieftains." Her husband George was proclaimed emperor.) She also had a charming 14-inch choker necklace prepared from the unused leftover box of Augusta's original emeralds.

In honor of the coronation, it just so happened also that the "ladies of India," including the Maharani of Patiala, presented Empress Mary with a necklace of eight large cabochon emeralds surrounded by diamonds set in two chains of small diamonds, with a single big diamond between each emerald as well as a very old engraved square emerald brooch to pin to her bodice. (The emeralds were the Queen's own idea. When the "ladies of India asked what the new empress would like, she coyly suggested "Indian emeralds." The ones she got were Colombian, although she probably didn't know it.) So she got another necklace to wear. She wore many of them at the same time in a royal, if overdone way.

The ladies of India also sent along a removable pendant pear-shaped emerald; Mary herself added a marquise cut 11.5-carat diamond (the Cullinan VI); the two stones hung in a negligé pendant of unequal length. (As for the engraved emerald, it was left to the present Queen, who has never been seen wearing it.)

Queen Mary still had 15 emeralds left from the Cambridge collection, and had them placed in pavé-set diamond mount. She also had a tiara modified so it could be worn with either diamond or emeralds drops, as the mood struck her. Later on Princess Diana, who got the necklace as a wedding present, had

the emerald choker necklace mounted on dark green Velcro (of all things) and wore it as a headband during a Christmas party.

The other royal emerald jewelry of note is the Godman necklace, presented to Queen Elizabeth II by two elderly sisters whose father had first bought it. They thought the necklace might have originally belonged to the Empress Josephine of France and thought the Queen might like it. The necklace turned out not to have been owned by Josephine after all, but the Queen graciously accepted it anyway. The sisters got a private audience with the Queen as a result. It is, after all, a very handsome necklace.

Emeralds Elsewhere

There are four emerald-bearing sites in Australia: Poona Village, Menzies, Wodgina (all in Western Australia), and Emmaville in New South Wales. Today it produces very little gem-quality emerald, although it has some interesting deposits.

In 1890, emeralds were discovered in northeastern New South Wales, Australia, in a place that was once known mysteriously as Vegetable Creek, now renamed Emmaville. A fellow named D.A. Porter, an inspector of public school buildings, found some green crystals while prospecting an abandoned tin mine called Cleary's Lode. Porter submitted a sample of these crystals to T.W.E. David, a Geological Surveyor who reported that "they are beryls of a colour sufficiently emerald green to entitle them to be termed emeralds."

These Emmaville emeralds occur in odd little bunches, stuck in a solid quartz-topaz-feldspar-mica pegmatite that intrudes surrounding Permian sediments. Typical solid inclusions are fluorite, quartz, cassiterite, and arsenopyrite. For the next 20 years, emeralds were mined sporadically in the Emmaville mines, producing over 53,000 carats of emeralds. A 100-meter vertical and three horizontal shafts were dug and the gems were hand-mined. The stones were small, pale, yellowish, and of generally mediocre quality. They are colored by chromium, vanadium, and iron. Some exhibit a rather dramatic multiple zoning parallel to the base.

More emerald-mining attempts have been made in Western Australia, most of it in the Poona district, about 500 kilometers northeast of Perth. Emeralds (and green beryl) were discovered by A.P. Ryan in 1912. The main mine is the Aga Khan mine, which was first worked as an open cut, and more recently as an underground operation. Most of the emeralds found are of low quality, and very difficult to remove from their encasing matrix. The stones are of good color, but full of inclusions and fractures. They are colored by chromium and iron, and are partly zoned often with the deepest color in the core rather than the edge.

Wodgina has produced over 1,000 tons of beryllium ore, along with a small number of gem-quality emeralds. Typical inclusions are quartz, albite, chlorite, phlogopite, apatite, and tantalite.

Menzies emeralds are rarely gem quality and found in small crystals up to 2 centimeters long. Most are heavily included with quartz, phlogopite, actinolite, chromite, chlorite, albite, and dolomite. They are colored with chromium and iron.

Poona Village emeralds were first discovered in 1912. This is the most productive emerald deposit in Australia. It was found by tin prospectors, actually. Their color (chromium and iron derived) is quite good, ranging from pale green to green porphyry. There is an increasing color intensity from core to edge. Typical inclusions are phlogopite, actinolite, muscovite, zinnwaldite, margatie, fluorite, topaz, chrysoberyl, quartz, zirson, monazitre, casseriterite, scheelite, apatiye, chlorite, epidote, albite, K-feldspar, tantalite, ferrocolumbite, and chromite.

However, in the early 1990s, a small deposit of fairly good quality emeralds was discovered in decomposed pegmatite located beneath an unsealed road near Torrington, a former tin-mining village about 20 kilometers east of Emmaville. Mining was conducted secretly, and it's now believed that the supply is exhausted.

An emerald mine in Hiddenite, located in western North Carolina (Alexander County), now produces stones that rival some of the best Colombian emeralds. The first finds occurred in 1875 by J.A. Stephenson, a collector. In 1907, a 276-carat dark green stone was discovered, and a vague sort of emerald rush was on. Emerald crystals up to 11 centimeters and 1,686 carats of pale green and blue green were discovered, colored by chromium.

Treasure hunter Jamie Hill discovered the lode basically in his backyard—only 12 feet beneath the surface, in an area he said was a "honeycombed nest of pockets just riddled with green."

Hill dug up his first crystal at the age of six, and has been hooked ever since. He made his great find on Thanksgiving Day, 1998, and it included what he later called the "Royal Family Collection," an 88-carat crystal later cut into two fine gems: an 18.88-carat pear-shaped stone (Carolina Queen) valued at a million dollars, and a 7.85-carat oval (the Carolina Prince). The Carolina Prince is considered to be one of the finest emeralds ever found in North America. It was set in a ring and sold for over $63,000 per carat or $500,000. There was also the 3.37-carat Carolina Princess. What is amazing about these stones is that most of them were found at a depth of only about 12 feet, as opposed to the deep mining typically done elsewhere in the world. Hill also found a 300-pound, 800-million-year-old quartz crystal (the largest

single one ever discovered) on his Hiddenite property—in only 6 inches of dirt. He says he dug it out of the ground with a screwdriver, although you'd think a shovel would be more practical.

The United States government put a temporary stop to his mining madness, making him meet certain ecological requirements and getting a commercial mining license. During his enforced mining hiatus, he hired a subterranean radar imaging company to take computerized images of the pockets below, enabling Hill to simply go and grab up the stones. It is probably no accident that Jamie Hill claims to be obsessed with the Wizard of Oz, the Yellow Brick Road, and of course, the Emerald City. One day after watching a rerun of *The Wizard of Oz* on TV he found a 1,300-carat emerald crystal, which he named "Emerald City." (Hill's "backyard" is now the North American Emerald Mines, of which Hill is the largest shareholder.)

The great emeralds of the Hiddenite area (most from Hill's backyard) are very great indeed. The largest emerald crystal ever found in North America is the uncut Empress Caroline, found on December 11, 2003, weighing 1,861.9 carats. Another great stone, the "Carolina Emerald," was also found at Hiddenite in 1970. When cut to 13.14 carats, the stone was valued at the time at $100,000 and became the largest and finest cut emerald in North America. There is also the lovely 3.40-carat heart-shaped Heart of Carolina and the 15.46-carat Kite Emerald.

Carolina's General Assembly of 1973 designated the emerald as the official State Precious Stone. Not every state gets to have a state precious stone. The same area produces another gem named after it, hiddenite. The name hiddenite does not mean "hidden stone," but honors its discoverer, William Earl Hidden. Hiddenite, is a form of spodumene, not beryl, although both contain aluminum, silicon, and chromium. Hiddenite has no beryllium; it has lithium instead. Hiddenite itself is a rare stone—other specimens have been found only in Siberia and India.

In September 1998, geologist Bill Wengzynowski, while hunting for copper in southeastern Yukon, near Finlayson Lake, stumbled across what he thought at first was green malachite. On closer inspection, however, he realized it was emerald. The deposit was first called "Crown Showing." Good crystals colored by chromium (usually) and vanadium up to 4 centimeters have been discovered. They tend to be bluish-green in color. The area is only accessible by helicopter. Most of the stones found are less than a carat in size when cut and need treatment.

Secrets of the Emerald Trade

The extraction of emeralds from the earth, however, is only the beginning of their strange adventure.

Once emeralds are mined, they must be cut and sold. Not surprisingly, perhaps, the United States and Japan together purchase more than 75 percent of the world's cut emeralds. The emerald you buy is not the emerald that comes out of the ground, and this has been the subject of some controversy. Obviously, emeralds are cut and polished. But the treatment goes further. An unenhanced stone is a rock in rubble. Nearly every gem to be worthy of the name must be cut, polished, or reworked in some way to effect the magical transformation from the earthly to the worldly. The emerald is no exception; indeed, it requires more care and treatment than any other gem. At various points along their travels, nearly all emeralds are enhanced by a variety of methods. (Even most museum pieces are enhanced.) This has been going on since Egyptian days; there's even a papyrus called the Stockholm Papyrus (c. 400 BCE) that gives out some of the recipes. The entire papyrus is devoted to various kinds of dye. It's fascinating reading, and gives out practical hints, mentioning that the "best of all dissolving mediums is, however, camel's urine. For this makes the Alkanet dye not only fast, but also durable." The Egyptians had plenty of camel's urine available. There's also a recipe to whiten pearls. Apparently, the procedure to enhance precious stones was to roughen the base of the stone and to make the surface porous. Then the pearl was heated and dipped in oil, wax, or solutions of alum, soda, salt, vinegar, or some complicated mixture of these. (In addition, the Egyptians apparently made fake emeralds from copper salts.)

Today some emerald-enhancing treatments are generally accepted by the industry as "okay," and some not. These treatments substantially improve the looks of the emerald, but they also necessitate special care of the stone, as improper cleaning can remove the oils.

The Lapidary's Art

The gem-making process begins by sawing the rough crystals into the desired number of pieces, which are then ground roughly into the shape wanted. Although beryl is pretty resistant to grinding and cutting, it can be split perpendicular to its crystal axis to produce hexagonal prisms of the desired length. Beryl can occur in quite long crystals, which as the Romans found out, were handy for making into eardrop jewelry, of which they were very fond. The artists of the Renaissance liked the stone as well. While most kinds of beryl other than emerald are held in a rather low regard nowadays, almost all varieties of this mineral were prized in antiquity. In fact, beryl was one of the most precious of all ancient gems. This is the trickiest part of the whole process and it's where most of the money is; a good decision here will yield the largest and best cut. The lapidary has to take into consideration every crack and inclusion in the stone. After the emerald has been "roughed," a flat surface is polished, so that the crystal can be stuck to the "peg" with heated wax. It is critical to align the stone properly to get a good cut. The cutter then selects the proper angles necessary for the best cut, and then lowers the peg to the running disk to facet the stone. The cutter continually keeps checking the angles during this process. A finer grit is then put on the disk to polish the stone. After the gems are cut into final form, they are cleaned with an acid solution to remove particles of the polishing disks and compounds that stick to surface imperfections. The stone is then usually oiled or otherwise enhanced.

The art of the lapidary is ancient, honorable, and extremely difficult. It is required for every emerald that is not simply going to a crystal collector. Not only are recently found stones subjected to this beautifying treatment, but also some of the older "great" emeralds are recut to give them more brilliance and color. While some mined emeralds are cut in the place of origin (Colombia cuts almost all its own gems, although it has no large cutting factories. It's a small family business), many more are sent to Israel or India. The latter nation has excelled in cutting colored gems for over 2,000 years. It is a profession shared among Hindus, Muslims, and Jains. Many gem cutters don't even have shops; they gather with others and do their work on a rooftop in Mumbai or Jaipur. Nor are the latest technological tools available to them, but merely a hand-turned wheel and a primitive cutting device. But the result is magic. Other emeralds are cut in Tel-Aviv.

No matter where they are cut, it is a difficult job, partly because of the many inclusions characteristic of emeralds. It requires a skilled craftsperson—a small change in orientation can make a huge difference in the final product. While emerald has a fair-to-good hardness, which to some extent protects it from scratches, its somewhat brittle nature and the fissures present in many stones make it difficult to cut, set, and even clean. (The birttleness is partly due to the chromium or vanadium that gives it color.) It's softer than ruby or sapphire and dangerously close to the lower limit of hardness for safely putting in a ring without undue wear. Traditionally, gem-cutting serves three purposes. The first (and most important in the case of the emerald), is to reveal its beauty and depth of color. The second is to bring out the interplay of light within the stone by making use of the reflective and refractive powers of light. The third is to fit the stone into its appropriate setting. Colored stones are usually cut with greater volume than are diamonds, so they will weigh more than the standard chart sizes, which are mostly geared for diamonds, and which, in turn, are usually cut according to strict mathematical parameters. When beryl comes into the hand of the gem cutter (lapidary), he has a choice about the cut. The lapidary tries to choose the cut that will show the stone to its best advantage, without losing too much of its size. In some cases, no matter how skilled the lapidary, over 70 percent of the stone is lost in the faceting process. Emeralds can be cut into several different shapes, including round, marquise, oval, pear, square, and cabochon (a hemispherical cut in which the flat surface is attached to the ornament). For an emerald, the best cut usually means some variety of the "step cut," also called the "emerald cut." (Many other deep-colored stones also look best with a step cut.) This traditional and popular cut was developed in the seventeenth century. The purpose of the step cut is to emphasize the rich color of a good emerald.

Most larger high-quality emeralds are cut in a step cut, although smaller stones are often cut in round, oval, pear, or even marquise cuts. The step cut not only shows off the emerald to its best aesthetic advantage, but it is also (usually) the most efficient use of the rough material, especially for Colombian emeralds, which tend to form in long crystals. The goal of course is to cut an emerald so as to reach its largest possible size. This is because the standard rectangular emerald or step cut emerald follows the crystal's natural shape. The step cut usually has a rectangular or square table or top, with 16 or 17 parallel long, narrow, "steplike" facets in the upper surface and 20 in the pavilion below. The best color is gotten when the emerald is cut with the table parallel to the C axis of the crystal.

The corners are often removed to help protect this brittle stone from breakage. This is called beveling. Faceting is usually done so that light entering from the crown is internally reflected by the pavilion and exits through the

facets on the crown. If too much light "leaks" out (which can happen if is it's refracted rather than reflected by the pavilion facets) the gem will appear less bright. Sometimes a stone like this is called a "windowed" stone, since the light has passed through the pavilion facets rather than being reflected back. However, since most of the color of many emeralds is concentrated along the sides (or rind) of the emerald, many lapidaries remove as little from the rind as possible, if it means windowing the stone.

Extra faceting (which is sometimes done with step cut diamonds) can provide more sparkle, but this is not what you want in an emerald. In fact, lots of faceting and sparkle may distract the viewer from the true glory of the emerald, its matchless color. Sometimes, less is really more. The correct step cut allows the observer the ability to gaze deep into the green interior of the stone. The very purpose of an emerald seems to be to invite the gazer to rejuvenate his spirit by gazing into its peaceful depths.

However, crystals with many inclusions are often not suited for the emerald cut. The inclusions make this cut dangerous, for one thing. These stones are often shaped into the rounded cabochon style (or emerald "pearls"), a cut very popular in India. The word "cabochon" comes from the Old Norman word for "head." The cabochon cut today is used only for relatively opaque stones like turquoise or, in the case of bigger emeralds where there are many inclusions. (It hides their flaws but shows off a good color. Nearly all emeralds were cut this way before the nineteenth century. However, today the Indian gem cutters are expert at faceting as well. As we have seen, a faceted cut allows the bottom facets to act as mirrors reflecting light and giving the stone increased brilliance.

The availability of high-quality emerald is limited, and in the late 1990s word got around about the sometimes shady methods used to disguise flaws and improve clarity. However, this is nothing new, and in the vast majority of cases, there is nothing shady about it. Even in ancient days, gem merchants immersed emeralds in clear oils and paraffin to improve their looks.

Today, almost all emeralds sold worldwide are "treated" before they are sold. The technical name for this is "fracture-filling," in which surface-reaching fractures are filled with colorless oils or resin to improve the clarity of the stone. Oiling the stone darkens it (usually improving the color) and makes it more transparent at the same time. It has been estimated that there are in fact over 4,000 different enhancement treatments. The Gemological Institute of America (GIA) divides treatments into different categories: oils, essential oils, resins, prepolymers/polymers, and wax. Each treatment has its special advantage or disadvantage.

There is nothing inherently wrong with such practices, as they both protect and beautify the stones. The dishonesty comes only when the consumer is not made aware of such treatments at the time of purchase.

The most common treatment for emeralds is "oiling." Emerald oiling is often done twice, first at the mines, and then at the cutters. Practically all emeralds are oiled within an hour after they are cut. In fact, many cutting factories even store the rough emeralds in oil. At the cutters, the first oil is removed from the emerald with alcohol or a similar solvent (not camel urine). Any abrasives that were used during cutting are also removed. The emeralds are "cooked" in an acid bath in a pressurized or vacuum vessel. This process dissolves any remaining foreign material and leaves the acid (HCl and HNO_3) in the fissures. Then the stone is rinsed to remove the acid and the emerald is soaked in a bath of colorless wax or oil under vacuum, pressure, or heat. This fills the cracks on a microscopic level, at least temporarily.

The heating forces the air out of the cracks in the stone and allows the oil to seep in. There is no special "emerald oil" used for this purpose, just regular oils adapted with differing levels of success to emeralds. Many, many different kinds of oils can be used, with mineral oil perhaps being the most common. Other traditional oils used for enhancing emeralds are Canada balsam (a light yellowish resin that liquefies at low temperature), clove oil, and cedarwood oil. However, baby oil, linseed, and even 3-in-1 oil are also popular. Once the gem is faceted, additional oil treatment such as cedar or balsam is applied. Finally, the excess oil is wiped away and the emerald is ready for sale.

Oiling the stone does minimize inclusions (although it won't help a heavily included emerald) and improves the clarity of the stone. Oiling is not permanent, however. One of the problems with the traditional oils is that most have a low viscosity, which means that they are thin and dry out. After 2 or 3 years, the oil evaporates and the cracks reappear, at least with traditional oils like cedarwood that can decrepitate over time. Some may also turn yellow after a while. The refractive indexes of traditional oils are also too low (about 1.50) for emeralds. Emerald-treaters prefer to use high-viscosity fluid fillers that are syrupy and sticky at room temperature but which thin out during their heated induction into the emerald's fissures.

Cedarwood (distilled from the leaves of *Junipers Virginian*) and Canada balsam are probably preferable to many others, as they are more viscous than either mineral oil or linseed oil, so they are better retained in the fissures of the stone. Cedarwood oil can, however, exude from the stone if it's overheated; however, lightly enhanced stones seldom change.

The fact that oils are temporary is both a curse and blessing. While emerald owners may resent getting their emeralds reoiled, the fact that they can be removed and the stone retreated and examined carefully is surely an advantage. Unfortunately, most owners of emeralds are unaware of the treatment their stones have almost certainly been subjected to for enhancement.

Other more lasting fillers than oil, such as glass or epoxy, may also be used. The best of them render the cracks nearly invisible to the naked eye. The older epoxy resins were difficult or impossible to remove; however, the newest ones are said to overcome this difficulty. One of the most popular new treatments is Opticon, a polymer with a refractive index that virtually matches that of a natural emerald, making it difficult or impossible to tell the difference. Opticon lasts longer than mere oiling, but some people dislike it because they find that it's too cloudy and too visible. Some have gone so far as to say they won't buy Opticon-treated stones. However, studies show that Opticon has about the same optical properties as the traditional cedarwood oil, and it certainly lasts longer. Brazilians were the first to use this product widely, starting in 1980, but they didn't disclose the fact to the public for many years, thus increasing the reputation of Opticon as a sneaky, underground practice. (In 1996 the Colombians followed suit.) It didn't help when evidence was produced that suggested many were also using green-dyed (rather than colorless) Opticon, which is definitely a no-no. For reasons like this, some dealers won't touch an Opticon or similarly treated emerald, although they are hard put to explain why it's any worse than oiling.

Opticon "covers" flaws a little better than oil, too (but not 40 percent better as is sometimes claimed by both Opticon friends and enemies). In addition, Opticon got some bad press, because of a mistaken notion. Opticon is a kind of epoxy resin, and so people got the idea that using Opticon on an emerald was rather like gluing it together instead of simply filling in faults. Actually, Opticon epoxy comes in two parts—a resin and a hardener. Generally, only the resin part is used. If the hardener is used, it is used to seal the surface, not to "glue the stone together." Such a use would make an emerald a doublet. Gem dealer, Ralph Esmerian, told Robert Genis of the *Gemstone Forecaster*, "It was the treaters who filled the goods with plastic resin that caused the prices of these goods to decrease by 50% or more. Everyone says it is the fault of the people at the mines for treating emerald. In fact, people were treating these goods in locations all over the world. We have to admit that we did it to ourselves." Today, prices for untreated and clean Colombian emeralds are out of sight, simply because natural, untreated emeralds (or rubies or pearls) have never been rarer than they are right now.

Many retailers still reject an emerald with the characteristic "flash effect" of Opticon, preferring the more "natural" cedar oil.

A similar enhancement technique is PermaSafe, another epoxy resin developed by labs in Bogotá. Very similar, from Clarity Enhancement Laboratory is ExCel, a colorless, hard, nondiscoloring, nonfading treatment (a lifetime guarantee is offered) that is easy to remove. It was developed in 1997 by Arthur Groom of Ridgewood, New Jersey, a well-known emerald buyer and

wholesaler, whose major goal in life seems to be to promote emeralds. He started to produce an enhancement technology that removed all previous treatments (including cedarwood and other oils and resins from surface-reaching fissures) and replaced them with what he first called Groom-Gematrat and later renamed ExCel.™ This treatment is probably a combination of vacuum, pressure, and powerful chemicals. Groom states that the most critical aspect of the whole process is cleaning the stone correctly, a process that may take months before refilling it with ExCel. He provides the treated stones with a certificate (formerly they were also marked by UV tracers) that marks the stone as having been treated. Today, Groom lasers information about the stone on the girdle, which includes the level of degree of the filler. He uses the American Gemological Laboratories (AGL) Emerald Grading Reports, on which the degree of filler can fall into nine different categories.

Some fillers are the worst of both worlds—they decompose and get completely stuck in the fissures, so they no longer beautify the stone, but are very hard to remove also. Epoxy, for example, can damage the stone if it is removed. Israeli cutters use a special wax or paraffin treatments whose exact composition is a secret.

One really bad filler that is used off and on is "Palma," a resin that turns milky white after a few months. A common treatment for stones treated in India is Joaban, a green oil that substantially improves the look of an emerald. Technically, it's cheating, as it is a form of dying. (Diamonds are sometimes "laser-drilled" to remove dark spots, but this procedure is not suitable for colored stones like emeralds.)

How can you tell if a stone has been treated? In some cases, treated cracks in oiled stones fluoresce a pale yellow in ultraviolet light, although most experts say untreated emeralds will not. In some cases, a heavily oiled stone actually sweats if exposed to a strong warm light.

Obviously, only cracks that reach the surface can be "filled." Emeralds are not heat-treated, however, to improve color, a process common with rubies and sapphires. For some reason, emerald coloring is not affected by heat unless it is extremely high (between 1292°F and 1472°F).

Emerald treatment is so common that it's not usually mentioned to the buyer, and it's not considered cheating. Gem laboratories all around the world have adopted a seven-step classification system to categorize the extent of treatment of emeralds:

1. Unoiled
2. Insignificant
3. Faint

4. Faint to moderate
5. Moderate to strong
6. Strong-Prominent
7. Prominent

Good stones in the first four classifications are rare and valuable. Stones in the last two are usually of poor quality, which is why they were oiled so much. However, it's perfectly possible for a really bad stone to be unoiled because nobody thought it was worth doing. If you are buying an emerald, ask the sellers if they will retreat the stone without charge, and be sure you get a written statement detailing any treatment the emerald has received.

Whatever treatment is used, however, it cannot include a green dye to enhance the emerald's color. That's cheating, but it is done.

A fine or extra fine emerald should not need oiling, and oiling such a stone could negatively impact its value. A nonoiled, fine, or extra fine gemstone commands between 30 and 60 percent higher price than its oiled cousin. Lightly oiled stones are worth more than equally good stones that are heavily treated. For stones of lesser value, the effect of oiling has a negligible impact upon the price.

The United States Federal Trade Commission has developed guidelines for the gem and jewelry trade, which require disclosure of any treatment to a gem material that substantially affects its value. In addition, all state deceptive trade practice regulations in the U.S. require that vendors not mislead customers as to the treatment status of gems they sell.

If you are in the market for an expensive, very high quality emerald, consider getting a laboratory certificate stating that the stone is natural and not oiled. Be prepared to pay extra, but make the sale contingent on an independent, third-party analysis. And remove yourself quickly from a dealer who will not submit the stone to an independent lab for a grading report. The cost of this evaluation starts at about a hundred bucks, plus the shipping of the stone. The bigger the stone the more it costs. The report won't tell you what the stone is worth (that's the job of the appraiser). But it can tell you how good it is: it will verify that it is indeed an emerald, tell you exactly how much it weighs, how it's been cut, its color, tone, and brilliancy, its imperfections on a standard grading scale, any treatments that have been done on the stone, and the country of origin.

The final treatment for the average emerald is its setting. Most of the familiar settings were really designed for diamonds. But a diamond setting can be disastrous for an emerald. Setting styles such as pavé, channel, or flush setting put far too much pressure on a fragile emerald and may actually cause it

to crack or chip, even when done by an expert. (These styles also require quite a bit of cleanup afterwards as well, further exposing the stone to abrasion.) Stones with major inclusions have to be set in such a way that the prong of the setting does not press against the inclusion and typically weaken the stone at the spot of occurrence. And while emeralds are sometimes set in channels, the jeweler will usually end up breaking one or more of them in process.

Stones of excellent color and transparency are mounted in an open setting of 18-karat gold or platinum. Most emerald lovers insist anything less is unworthy of the stone. Lesser stones can be mounted in 14-karat gold.

Stones with fissures or severe faults are protected by putting them in an encased setting, often with the bottom blackened. A jeweler with superior foresight will often design a setting with the knowledge that eventually the stone will have to be removed from its setting and cleaned. He will carefully design a setting to make this easier and less dangerous for the stone. It's common for emerald to be set with diamonds or white sapphires as accent stones (and also to protect the emerald from side impacts).

While we think of the setting of emeralds, we should not neglect the human element. Traditionally, emeralds are said go best on redheads, although they looked all right on Liz Taylor and Cleopatra (who in one sense are one and the same), at least in the movies.

While some gem dealers go straight to the source, usually Colombia, to buy fine emeralds, most decide to wait it out in the United States, out of concern for their own safety. The "rough buyers" purchase emerald crystals in all grades and sizes. Emerald "lots" are usually sold in 50,000–100,000 pieces, but some are even larger. With such a wide distribution, you'd think emeralds would be dirt cheap. And sometimes they are; in fact, the price range for emeralds is very wide. (Only crystals that are clear and of a rich color are prized as gems.)

Judging Quality

The *wearing o' the green* is not cheap. Rarer and more valuable than diamonds, top-quality, transparent, nearly flawless emeralds go for well over $2,500 a carat.

Here is a sample of how much you might expect to pay for a 1-carat emerald of no historic value.

- Commercial: $30 to $530
- Good: $530 to $1,125
- Fine: $1,125 to $3,000
- Extra Fine (Gem): $2,900 to 10,000 (a nearly perfect stone can go for $25,000)

Like other gemstones, though, prices take a huge jump for larger sizes. Let's go to a 5-carat stone:

- Commercial: $300 to $7,500
- Good: $7,500 to $15,000
- Fine: $15,000 to $32,500
- Extra Fine (Gem): $32,500 to $95,500

As we can see, things are getting a bit pricey, not surprising since a flawless emerald is less than one in a hundred thousand. But there's an out. You can buy a very big emerald (over 10 carats) at a very good price if you are willing to sacrifice color or brilliance. This isn't true of the other precious stones.

A rule of thumb is that as the carat weight doubles, the price quadruples. Premium emeralds with no visible flaws ("eye-clean"), of good color and size, can sell for more than 30 percent more than diamonds of equal quality. In 2005, a 5.27 Colombian emerald sold for over $31,000 per carat from Christie's. Back in 2000, the auction house Christie's sold a 10.11-carat Colombian emerald ring for $1,149,850 ($113,734 per carat). This set the record for the highest per carat price paid for an emerald.

Much of the value of emeralds depends upon who is wearing one. When Princess Mary of England chose an emerald for her engagement ring in 1922, emerald prices soared. A high-quality cat's eye emerald can cost upwards of $20,000.

Color is the main consideration, but brilliance and clarity also count. Any clear emerald is expensive, even if it is quite small. Because the world supply of emeralds is up, prices are generally fairly reasonable, at least for run-of-the-mill stones. A good emerald is about a thousand dollars a carat, a fine emerald is many times that figure. Very large stones fetch prices completely out of proportion to their size. Prices hit their peak around 1996 at close to $12,000 per carat for a fine, untreated gem. It's closer to $8,000 today. Very large, premium stones will go for more than $25,000 per carat.

The colored gem market is volatile, with prices wavering from year to year. Emerald dealers disagree about how emeralds should be marketed wholesale. Some favor a "bourse" or free-trade zone in Colombia; however, the independent miners of Colombia oppose the plan, believing it would create a monopoly by large dealers that would wipe out smaller players. Enthusiasts of the bourse insist that gem dealers need a central place to come to do their trading.

What is fine emerald? As is so often the case, the answer depends on what you want. Emeralds are graded mainly according to color, clarity, and shape. For simplicity, these grades are designated Commercial, Good, Fine, and Extra

Fine. How much a particular stone is worth depends mostly on its grade. It's not a simple matter grading emeralds. In fact, it is considered the hardest of all the precious stones to grade. The best grades have examples of very fine quality gems to compare them with.

While no perfect emerald exists, there is a template of sorts to measure up against. One such template was designed by the American Gemological Laboratories (AGL), which draws upon many different available elements to create a scale for comparison. These elements include shape and cut, carat weight, measurement in millimeters, color grade, tone, clarity, depth, "finish," average brilliancy, and so on.

Carat Weight: One carat or more. Emeralds are measured, like diamonds, in carats; one carat equals 1/5 of a gram. A "point" is 1/100 of a carat. Stones of good color and clarity are very, very rare in sizes above 2 or 3 carats. When we are speaking of small stones (under 5 carats), a small richly colored stone is prized above a larger, paler one, even if the larger stone has better clarity. Tiny emeralds (and other stones) are considered "melee." These stones range between 2 and 4 millimeters in size. Most of these emeralds are in fact opaque, with the crystal containing little usable material. You can pick them up for about a dollar a piece.

The sad truth is that a tiny emerald really doesn't show too much advantage. While even the tiniest diamonds sparkle like mad, an emerald has to be fairly large before it shows its true characteristics. Most jewelers consider a 1-carat emerald is an absolute minimum for a solitaire, although smaller stones can be used as accents.

Color: Good (6) or better. Color is a hard thing to measure. Today, color in stones is usually rated according to the AGL Colored Stone Grading Report. In this system, the color grade is based upon the purity of primary color. The greener the emerald (or the redder the ruby or bluer the sapphire) the lower the numerical grade on the scale. A sapphire rated 3.5 means that the stone has 70 percent blue as its primary color. Stones rating 1 or 2 are more theoretical than anything else; they developed the scale to account for all possible scenarios. For most stones a 3.5 is about as good as it gets, except for emeralds. An emerald rating 3.5 would be extraordinary. One lab I researched had found only one in 11 years of testing of hundreds of highest quality stones. But not to worry. Emeralds checking in at 4.5 are often highly desirable.

As you may have guessed, the color of an emerald is not a cut-and-dried affair. The GIA attempted to issue a rule about it in their 1998 *Gem Identification Laboratory Manual.* The color of emerald is "light to very dark green to strongly bluish green to slight yellowish green." Stones with a color too light, destaturated, or yellow to be called emerald get demoted to "green beryl." If they are completely the wrong color they are called heliodor or aquamarine.

For obvious reasons, gem dealers do not want emeralds to become known as green beryls. The difference between green beryl and emerald is ultimately perhaps a matter of personal preference, a slight difference in color, and often several thousand dollars. Many traders consider color alone to be the distinguishing mark of an emerald. Others want to see those characteristic chromium lines in a hand spectroscope. Still others think that the human eye should be sufficient, with an emerald being a beryl whose color matched certain shades of green on a standard table of some sort, such as the German designed Industrial Standards Norm or the Swedish Natural Color System. And so on.

Wise buyers look for a medium-dark grass green stone, remembering that emeralds look slightly different in daylight, incandescent, and fluorescent light. Observe the stone under all conditions. However, this is largely a matter of taste. People from the Middle and Far East prefer stones with more sparkle, while most Europeans and Americans like a darker stone. It's really up to you, isn't it? Pay no attention to where the stone is supposed to come from. The important thing is the stone itself. This does not, of course, apply to stones with a famous history or pedigree. In that case part of their value lies in the fact they once adorned an arm of an Empress. You can even buy poor specimens of emeralds for higher prices than they are "worth," because they came off a famous shipwreck.

Tone (the lightness or darkness of the stone): Medium to dark (65–85). Rubies and sapphires are in the same range. The ideal tone for other gem types varies from light to medium (20–65). The scale goes from 1 to 100.

Clarity (the degree to which the stone is free of inclusions): Any stone free of inclusions is labeled FI. In a Lightly Included (LI) gem you won't notice the inclusions. In a Moderately Included (MI) gem or Heavily Included (HI) gem you will. Stones labeled Excessively Included (E) gems are liable to breakage. About 98 percent of all emerald discovered is Heavily Included (HI) or worse. An MI2 is considered a relatively clean emerald, and that is about the best that can be hoped for. Almost all emeralds have visible inclusions, but avoid stones that are milky, opaque, cloudy, or spotted with black. They aren't worth anything for jewelry and presumably not for healing either. Don't be afraid to ask for a jeweler's loupe to check out the stone. It's nothing more than a magnifying glass, and you'll easily see all the inclusions, chips, and imperfections in the stone. How much they lower the value of the stone depends on how serious they are.

The Gemological Institute of America recognizes three clarity types for colored gemstones. (This is a different ranking from that for diamonds, and also somewhat different from the AGL.)

Type I stones, such as aquamarine, citrine, and topaz are "often virtually inclusion-free" while Type II stones like ruby, sapphire, red tourmaline, and

garnet, are "usually included." Emerald is a Type III stone, according to this scheme and Type III stones are considered "almost always included." Still, it's important to remember that even though emeralds are expected to have inclusions, the clearer (cleaner) the stone, the more it's worth, other factors being equal.

Each "type" of stone is further graded at ten-power magnification. There is no "flawless" designation for colored stones, as there is for diamonds. Instead, the highest rank a colored gemstone can achieve is VVS (Very Very Slightly Included). In emeralds this simply means that the inclusions are invisible to the naked eye. There are also six lower grades. Sometimes the term "eye-clean" is used, but this is an informal classification. Technically, a standard grade should be used, like VVS.

Heavily occluded stones are often cut in cabochon and used as beads, a form very poplar in India. But let's not be too hasty. A two-strand emerald bead necklace went for $1,127,500 to an American in 2004. The necklace, probably first bought by Doris Duke while on her honeymoon with her first husband brought in more than three times its high estimate and set a world auction record for an emerald bead necklace. There is a New Age side to beaded emeralds, also, at least according to certain crystal healers. Some believe that when an emerald crystal is cut into the shape of the Earth it is able to carry out its mission, which is apparently the "upliftment of humanity." The spherical shape, they believe, is more in harmony with "human consciousness" and allows gems to radiate their energy in an unlimited way, affecting the inner aspects of the individual."

Average Brilliancy: Fifty percent or more, which is common for colored stones. (This means that half the stone returns flash.) A diamond should have 100 percent average brilliancy. A stone with good brilliance can often compensate for a weak color.

Cutting/Finish (overall appearance of the polished gem): Good (6) or better. The scale goes from 1 ("excellent") to 9/10 for "poor." Most dealers give this between 10 and 20 percent of the value of the stone. This includes the gem's proportion, depth, brilliancy, and finish.

All of these elements are combined to form the Total Quality Integration Rating, which integrates the whole visual stone into a verbal description—a description which may or may not affect the actual price of the stone. Both the intensity and tone of color can be significantly affected by the proportioning of the cut.

Because its inclusions make an emerald somewhat fragile, even brittle, it must be kept away from high heat. Steam-cleaning them or cleaning them by ultrasound can remove the oils routinely used to protect and disguise the fissures. Some of the newer treatments claim that they can withstand ultrasound, but it may not be worth the risk. In like manner, cleaning solutions

that contain petroleum distillates or indeed *any* organic solvents (even if the cleaner says "jewelry cleaner" on the label) can be hazardous to an emerald's health. Most commercial cleaners are simply not compatible with the oil treatment the typical emerald gets. Chlorine cleaners can adversely affect a low-carat gold alloy setting.

While emeralds should not be cleaned more than necessary, it can be done at home if you are careful. Start by closing the drain; there is more than one emerald in a sewer pipe. Emeralds are best gently scrubbed clean with an old toothbrush, mild soap, and warm (not hot) water. Anything too hot for you is too hot for an emerald; hot water can cause thermal shock and damage the stone. A solution of gentle hand dishwashing soap is just fine; the emeralds can be soaked in it for 10 minutes, rinsed with warm water and patted. Even this gentle cleaning may remove some of the oil, but you can take your emerald for reoiling to the jeweler, who, when you come to think of it, should probably do the cleaning anyway. It can be reoiled at the same time.

It should go without saying that it's an extremely bad idea to wear an emerald ring while your hands are immersed in detergent, but perhaps I will say it anyway. These are brittle stones also and have to be guarded against being knocked about. Beveling edges was designed to minimize this problem, but can't prevent it. Emeralds are very sensitive to heat, so keep yours away from hot stoves and the like. Diamonds can be worn as everyday jewelry; emeralds are best saved for special occasions that do not include housework and cooking.

Repairing emerald jewelry can be risky because of its sensitivity to rapid temperature change. In some cases, the repairer coats the stone with borax or another heat-shield material, but it's probably better simply to remove the stone while the setting is being repaired. Expect to pay more for repair work to emeralds than for other precious stones; it is a much trickier operation.

Fake Emeralds and Their Kin: A Tale of Simulation and Dissimulation

Confucius said that the beginning of wisdom is to call things by their right names. But this is easier said than done, considering the conditions of the current gem market. In the emerald world alone, there are emeralds, green beryls, synthetic emeralds, stones that naturally resemble emeralds, stones that are dyed to resemble emeralds, emeralds glued to nonemeralds to make them look richer, and stones that are simply called some sort of emerald, even if they aren't.

Unfortunately, there is a lack of accepted definitions of many colored stones, including the emerald. As I mentioned in an earlier chapter, for example, the question as to whether a vanadium-colored stone could be classed as a true emerald or just another variety of nonprecious green beryl was and still is a hard-fought one.

Emeralds are more a state of mind than anything else. They are not recognized mineralogical species; in fact, every last one of them is just contaminated beryl.

As a matter of fact, there is no scientific definition of an emerald. CNMMN discourages the use of *any* varietal names for minerals whatever, including "emerald." This seems like a sensible plan. Emeralds are an art, not a science. Or perhaps, considering the commercial climate they live in, emeralds can be considered, as Dr. Wendell E. Wilson, editor of the *Mineralogical Record*, maintains, as a trade name, and that's all.

While naming affects a stone's value, it's not the only consideration. Value, of course, is a subjective term like emerald itself, and has many elements.

As far as gemstones go, two of those elements are beauty and perceived rarity. The value of any gemstone is directly proportionate to these criteria. (Another important feature of most gemstones is durability, although some highly prized material like pearl and opal fail miserably in this regard.)

Real emeralds are beautiful and they are rare. Most stones masquerading as emeralds are not quite so beautiful and are a lot less rare. However, there are some exceptions. There do exist rare beautiful green stones which lack the value of an emerald simply because they are not emeralds.

None of this is made any easier by the arrival of synthetic emeralds upon the scene. Synthetic emeralds are chemically the same as natural ones, but because they can be conjured up in a lab, they are not rare and therefore not precious. And of course they are not rare, either, or at least their rarity is something controlled by the owners of the labs, sort of like making "limited editions."

The problem of distinguishing true emeralds from similar stones and outright fakes is not new. As mentioned earlier, the ancients had no ready means of telling emeralds from malachite or tourmaline or peridot. They used the word we translate as emerald for stones we know as green corundum, turquoise, smithsonite, malachite, jasper, other varieties of green beryl, and even glass.

Emerald Wannabes

Today, ignorance is no excuse, but that hasn't stopped the crooks. In addition to the bona fide, real emerald, some unscrupulous folk in the gem trade recognize several other kinds of "emeralds" as well, in order to enhance their value. Here a few of my favorite fakes, although as will be explained synthetic emeralds are not fakes unless they are sold as naturals.

- African emerald—green fluorite (calcium fluoride) from Namibia and southwest Africa
- Biron emerald—synthetic emerald
- Bohemian emerald—green fluorite (calcium fluorite)
- Brazilian emerald—tourmaline. (Tourmaline is not a single mineral, but a group of minerals related in physical and chemical properties. The most colorful gem variety is elbaite or sodium lithium aluminum boro-silicate hydroxide.) Brazil has real emerald too, of course.
- Broghton emerald—glass
- Cape emerald—prehnite (calcium aluminum silicate hydroxide), not to be confused with the real emerald from South Africa.
- Chatham emerald—synthetic emerald
- Congo emerald—dioptase (iron aluminum silicate)
- Copper emerald—dioptase (iron aluminum silicate)
- Crystalline emerald—quartz (silcon dioxide)

- Emeraldine—chalcedony (a form of quartz) dyed green, and so doubly cheating
- Emeraldite—green tourmaline (elbaite or sodium lithium aluminum boro-silicate hydroxide)
- Emerald malachite—green fluorite (calcium fluorite)
- Emerald matrix—green fluorite (calcium fluorite)
- Emerauldine—dioptase (iron aluminum silicate)
- Endura emerald—glass
- Evening emerald— olivine/peridot (magnesium iron silicate)
- Ferrer's emerald—glass
- Gibsonville emerald—green quartz (silicon dioxide)
- Gilson emerald—synthetic emerald
- Indian emerald—quartz (silicon dioxide) or chalcedony dyed green
- Kimberley emerald—synthetic emerald
- Lennix emerald—synthetic emerald
- Linde emerald—synthetic emerald
- Lithia emerald—hiddenite, a variety of spodumene (lithium aluminum silicate)
- Mascot emerald—doublet of green glass and garnet
- Mother of emerald—prase (chalcedony or quartz)
- Medina emerald—glass
- Mount St. Helen's emerald—glass
- Night emerald—peridot (magnesium iron silicate)
- Oriental emerald—green corundum or chlorospinel
- Prismatic emerald—euclase (beryllium aluminum silicate hydroxide)
- Pyroemerald—green fluorite or diaptase
- Regency emerald—synthetic emerald
- South African emerald—green fluorite from Namibia
- Spanish emerald—glass
- Tecla emerald—doublet of green glass and garnet or soudé triplet
- Transvaal emerald—green fluorite
- Uralian emerald—demantoid (green) garnet
- Zerfass emerald—synthetic emerald

Perhaps the most interesting "faux emerald" is "bastard emerald," which as the name suggests, makes no claim to legitimacy. Bastard emerald is peridot, green quartz, or indeed practically any kind of green stone announcing itself as a confessed fake. Of course you never see it sold as "bastard emerald" by a dealer.

But the world of emeralds is a subtle one, full of fine distinctions. For example, while the "Brazilian emerald" (tourmaline) is a fake emerald but a

real tourmaline, an emerald from Brazil is not. Besides, it's a real tourmaline. To make things worse, most "Brazilian emeralds" are not even from Brazil, but from Tanzania. It has become a convention in the gem trade to refer to all bottle-green tourmalines as Brazilian tourmalines, no matter where they came from. And blue-green tourmalines are called African tourmalines, no matter where they come from, either. (You can find them in Pakistan and Afghanistan as well as Africa.) Whatever their origin, however, green tourmalines are beautiful stones whose color resembles that of emerald quite closely. (Tourmaline is classified as a "complex borosilicate" and has a hardness of 7–7.5 on the Moh's scale.) While tourmaline comes in many colors, most gem varieties are green, with shades varying from very light to very dark. The best-known gem variety of tourmaline is elbaite. In some cases, green tourmaline is called emeraldite, which is a made-up, unrecognized name.

The so-called chrome tourmalines come closest to true emerald with regard to color and fire. However, they are not emeralds, or even beryl, although some tourmalines are colored with chromium or vanadium, as are emeralds. Chrome tourmaline is also sometimes mistaken for another emerald look-alike, the tsavorite, whose fire and color are truly remarkable. However, chrome tourmaline trades for about a quarter of the price of tsavorite and is very difficult to find.

Tsavorite comes from the snake-infested, lion-haunted bushland between Kenya and Tanzania, close to the Tzavo National Park, after which it is named. The stone was not discovered until 1967 by Campbell R. Bridges, a British geologist. Bridges had a serious problem in getting an export license to remove the stones from Tanzania. However, he knew that the stone belt carrying the tsavorite probably extended into next-door Kenya, where in fact he did discover more of the stuff in 1971, and where he could officially register the stone and start exploiting it. Bridges said he lived in a tree house while all this prospecting and license-getting was going on and had the rough stones guarded by a large python snake. Apparently, he didn't trust the workers.

Like other garnets, it has a very high light refraction index (1.734/44), which makes it sparkle brilliantly. It is about the same hardness as emerald (7.5), and much tougher, being able to take rougher handling. It cannot be heated or irradiated, a fact that increases its value, as it's harder to "fake." Its brilliance makes it an excellent companion for other classically brilliant gems like diamonds, and because it's tough, it can be "close-set," or channel set, which is dangerous to do with emeralds. It requires no oil treatments, since it doesn't crack. Its only real shortcoming is size. Only rarely are stones of 5 carats or more found. This is an interesting phenomenon. Here is a stone as beautiful as emerald, as hard as emerald, less flawed than emerald, and rare as emerald. But since it is not emerald—you can get it at a modest price. This is especially true since the CNMMN has decided that tsavorite is not

an acceptable name after all; it is merely the green variety of grossular garnet. Tiffany and Company was extremely interested nonetheless, and the stone has been extensively promoted by it and some other dealers since the early 1980s. In fact, many people find tsvaorite even more beautiful than emerald. Tsavorite over a couple of carats sells for about a quarter the price of an emerald of similar quality, although the former is rarer.

Oriental corundum or "oriental emerald" is a green variety of corundum, not beryl. Since it is corundum, such a stone would be a green sapphire, anyway, not any variety of emerald. The term "oriental" is typically used in the gem trade to designate any variety of corundum that resembles another stone in color.

Uralian "emerald" is another name for andradite or demantoid garnet, a spectacular, fiery garnet, discovered in 1868 in Russia's Ural Mountains; it has not been actively mined since the Bolshevik Revolution. Modern demantoid garnet comes from the Klodovka Mine near Ekaterinburg. The Czar and his court were obsessed with this stone, and Fabergé used it in creating many of his art objects.

Demantoid derives its name from its diamond-like luster, but it's also an excellent "emerald substitute." As the name suggests, this rare and beautiful garnet is a subvariety of andradite garnet, but it's a brilliant green. Like emerald, it gets its color from chromium, and when first discovered it was thought to be emerald. It has a high luster, and brilliant color dispersion, greater even than diamond. The Uralian source has been mostly mined out, but a new source was discovered in Namidia in 1996.

Its only drawback is that it is quite soft (the softest of the garnets). However, it's important not to mistake hardness with durability. Although soft, all garnets wear quite well, compared to the brittle emerald. Demantoids are generally small as well, and like emeralds, Russian demantoid nearly always contains inclusions. In this case the inclusions are byssolite, a variety of the mineral actinolite. These beautiful feathery golden threads look like the tail of a horse, and are therefore referred to as horsetails. For some collectors, horsetail inclusions actually increase the value of a stone. Unfortunately, the Namibian demantoid garnet does not contain horsetails, and tends toward a yellowish-green, rather like peridot. It is therefore generally regarded as inferior to the Russian kind. However, the best demantoids are really good. Sotheby's sold a 5-carat demantoid garnet several years ago at $25,000 per carat, a price that a top-quality "precious" stone might command. For many, owning an untreated high-quality demantoid garnet is a much better investment than possessing a treated emerald.

There are even shakier candidates for the moniker "emerald": Green glass sold under fancy names. There's a "Mount St. Helen's emerald," or Mount Saint Helens obsidianite, dyed green glass made from fused volcanic ash.

The "gem" was born in 1980 when Mount Saint Helens erupted, causing a mud flow that buried the high-priced equipment of a local logging operation. When salvage teams attempted to unearth the machinery, using acetylene torches to salvage this equipment, they noticed the melting ash of the volcano was turning green. Workers quickly noticed that the grey ash of the volcano was melting and turning green. The resulting "gem" tests between 5.5 and 6 on the Moh's hardness scale.

Other glass "emeralds" are the so-called Broghton emerald, Ferrer's emerald, Endura emeralds, electric emeralds, Medina emeralds, and Spanish emeralds. Faceted green glass may be coated with a hard substance to mask its softness. In some cases, the refractive index and specific gravity of these materials have been adjusted to match that of emerald, and some contain artificial inclusions. However, these stones are isotropic and a 10X magnification reveals that the inclusions are clearly not natural.

One honestly named emerald look-alike is the vivid green chrome diopside. Chrome diopside is the most affordable gemstone with a pure green color, and is often cut like an emerald. It compares favorably with tsavorite and chrome tourmaline. However, it is too soft (5.5–6 on the Moh's scale) to be worn safely in a ring; large sizes are also hard to come by. The stuff is also difficult to cut (it has two planes) so only about 10 percent of the rough ends up as a gem. However, this is probably the most affordable gemstone in pure green, although you'd better be quick, as many dealers believe this stone is going to increase in value. Chrome diopside is mostly mined in Yakutia and Siberia, some in South Africa. Other sources include Burma, Pakistan, Austria, Brazil, Italy, and North America, Sri Lanka, and Finland. There is a star form from India.

The ancient Egyptians, who can't exactly be accused of cheating, had a stone referred to as mother-of-emerald in the Egyptian Book of the Dead. We think they were talking about prase or green fluorite, but it's hard to be certain. Prase is a translucent form of chalcedony, usually appearing as a dull green. The color comes from inclusions of the mineral actinolite.

Pyroemerald, Transvaal emerald, African emerald, and South African emeralds are all varieties of green fluorite, or calcium fluoride or fluorspar. You'll see the word "fluorite" on the above list several times over. The name "fluorite" comes from the Latin meaning "to flow." (Even though it contains fluorine, that's not where the name comes from.) It is called fluorspar when it is formed as a by-product of industrial processes, and fluorite when it is found in nature. (Spar is a generic term applied to any nonmetallic mineral that breaks easily to produce flat surfaces and which has a vitreous sheen.) It is rumored to be the most colorful mineral in the world. The green variety is sometimes called chlorophane and most green fluorite comes from Mexico. In the old days, miners used to call it "Blue John," although true Blue John is a unique blue form of the stone found only in Derbyshire, England, and discovered by the

Romans about 2,000 years ago. They were probably looking for lead. Blue John actually exists in white and purple bands separated by the third band that combines those colors into a glorious flame-like blue.

It melts easily and is often used as a flux for smelting metallic ores. It occurs in a variety of colors, including pale green, blue, purple, magenta, pink, yellow, or even a combination of several colors. Again, this is a very pretty stone, but it is very soft (4.0 on the Moh's scale). It has a pronounced cleavage that makes for a beautiful specimen piece prized by collectors.

Prismatic emerald, or euclase, a very rare mineral in its own right, gets its name from the fact it that it has an easy cleavage ("well-cleaved"). That makes it rather difficult to cut properly, but when it's done right, this is a highly prized and lovely gemstone, although it is more a darling of mineral collectors than of gem-wearers. Its colors tend to be splotchy. Chemically, it is similar to emerald in that it is a silicate containing beryllium and aluminum, but hydrogen is also present. The gem has a hardness of 7.5. It comes in shades of yellow and even (rarely) purple as well as various shades of green; there is also a colorless variety. It is found in Brazil, Kenya, Tanzania, Russia, Germany, and along with emeralds in the famous mines of Columbia.

The Cape Emerald is actually prehnite, found in South Africa. (South Africa has real emerald as well, to make it even more confusing.) It can also be found in New Zealand, India, Switzerland, Scotland, California, Colorado, and Michigan. It was named after its discoverer, the Dutch mineralogist Colonel Hendrik von Prehn (1733–1785). When found in nature, it often looks like a cluster of grapes. Some prehnite has a pleasant green color, others are pale green, yellowish, gray, white or colorless. In any case the stone lacks the characteristic luster of fine emeralds. Hardness is 6 to 6.5 on the Moh's scale.

The "Lithia Emerald" is hiddenite, a variety of spodumene (lithium aluminum silicate). Hiddenite comes from North Carolina and is not very well known or common. It has a strange green color that doesn't bear much resemblance to emerald or anything else. Its pink sister, however, is the beautiful kunzite.

The "Congo" or "copper" emerald is dioptase. Congo dioptase is another strong green stone, although most of them have a hint of blue. However, this stone is a silicate of copper, not beryl. This lovely deep green mineral it is soft (5 on the Moh's scale) and cleaves too easily for gem wear. It is found in Namibia, Zaire, Russia, California, Arizona, United States, and Chile. The mineral was discovered in 1797 by R.J. Hauyin, and named by him. "Dio" means "through" and "optose" means "visible." In some cases the green is so strong that the stone is opaque. The stone can be very beautiful, but again, it is not an emerald. The stone is sometimes called Emerauldine. The most famous find of dioptase was in Kazakhstan. The best samples were mistaken for emerald, and the error wasn't realized until the early nineteenth century.

Apatite, is a soft phosphate mineral (5–5.5 on the Moh's scale), but really striking nonetheless. While not well known to the public, it's highly sought after by collectors, and it comes in a wide range of colors, including an electric blue-green and asparagus. The more intense the color, the higher the price. It is not a coincidence that its name comes from the Greek word *apate*, meaning "to deceive." Apatite is found in Burma, Brazil, India, Kenya, Madagascar, Mexico, Norway, Sri Lanka, South Africa, and the United States.

Crystalline emerald, Gibsonville emerald, and Indian emerald are quartz that look (after treatment) sort of like real emeralds. The Indian emerald can be either dyed green cracked quartz or chalcedony. "Emeraldine," too, is dyed green chalcedony.

Evening, night, or emerald olivine is really magnesium iron silicate. In the gem trade, its more usual name is peridot. Calling peridot "evening olivine" or "evening emerald" is merely an attempt to increase its value. The name was first used by the Romans, by the way, who thought its best color appeared in the evening lamplight. (That's because you couldn't see it very well.) Its color is nothing like emerald, being typically a light yellow-green. The best peridots come from Burma and are never enhanced. You can get them large and cheap, even though they are quite rare.

Another interesting way to market an "emerald" is to create a doublet or triplet. These terms are sometimes used interchangeably, and sometimes not. In the opal trade, there is a clear difference between a doublet and triplet, but in emeralds, they seem to be the same, although sometimes the distinction is that in a doublet, the cement is colorless, but in a triplet it is deep green. Obviously, almost all emerald composites would be triplets using this definition, as correct color is most frequently lacking. In these creations, a colored layer of green cement or epoxy is placed between two layers of colorless beryl, garnet, quartz, or synthetic spinel. Sometimes the term "soudé" is used to refer to these stones also. Soudé means "soldered" in French. Sometimes the upper part or crown is true emerald, but the lower part or pavilion is glass. These composites will show green (not red as will real emerald) when shown under the Chelsea or color filter. Some unscrupulous people pass off all synthetic spinel triplets as emerald, which is double cheating.

Examples of doublets are the so-called mascot emerald and tecla emeralds. If you just dip the stone in a glass of water or oil, it will be clear you are dealing with a doublet. Distinct zones of color appear in a doublet or triplet when the stone is immersed in the liquid. A real gem will appear almost uniform in color. It is not unethical to sell doublets as long as the seller is not misrepresenting what he is selling.

Some shady dealers cross the line completely and cover a light or yellowish-colored beryl with green plastic to create an imitation emerald. It also can

happen that especially pale stones are "darkened" by placing some green foil *beneath* them.

Some people believe that if you place a drop of water on a real emerald, the drop will retain its shape while a water drop on an imitation emerald will spread all around. It is still believed by some that real emerald, when placed on the eyes, will feel cool and refreshing. An imitation is supposed to be warm and rather uncomfortable.

Synthetic Emeralds: The Daughters of Alchemy

And then there are the synthetics—the daughters of alchemy. It's the world's oldest dream: to create something from nothing, a silk purse from a sow's ear, gold from lead, treasure from trash. Alchemy is the magical art of changing what is base into what is precious.

Synthetic emeralds are sometimes known as "scientific" or "Zerfass" emeralds, but they are properly called "synthetic emeralds." The synthetic emerald is physically, and optically, very close if not identical to the natural gemstone. Today, the annual global production of synthetic emeralds is well over 500,000 carats.

In general, synthetic emeralds have a somewhat lower refractive index (1.561–1.564 in synthetics) and specific gravity (about 2.65 compared to 2.67–2.70 for natural stones) than the natural stones. They also vary in fluorescence (most naturals are essentially inert under SW light). Synthetics are transparent under SW light and more intensely red under a Chelsea filter. Synthetic gemstones even have the inclusions characteristic of the natural stone. However, natural emeralds often have natural inclusions like mica (seen in Zambian and Pakistan emeralds) never seen in synthetics.

Synthetic emeralds are tougher and less fragile than most natural emeralds, and they have no need for oil treatments. As for color, synthetic emeralds are usually the color of the finest Colombian stones. In fact, the first ones were so "clean" that they didn't even look like natural, somewhat occluded emeralds, so the manufacturers have obligingly arranged for their synthetics to have inclusions similar to natural stones, although you can often spot the origin of the synthetic by its inclusions just as you can for natural emeralds. Typical inclusions are "phantoms" (Biron), parallel two-phase inclusions, phenatikite (all hydrothermal processes), and "veils" (flux processes). Flux growth emeralds can be often distinguished from natural emeralds by their lower specific gravity and lower refractive index. Hydrothermic synthetic emeralds have characteristic inclusions such as two-phase feathers, nail-like microscopic crystals, and elongated flowing growth features. Some also have small tubular two-phase inclusions; these are probably growth tubes.

Both the flux and the hydrothermal methods require expensive equipment and are energy-intensive. It takes a long time to produce emeralds (usually a year, since emeralds grow only a fraction of a millimeter per day) and there is a low yield of cuttable gems. So synthetic emeralds are not cheap, although of course they are less expensive than the natural product.

Today, the most noted synthetic emerald-makers include: Biron Emerald (hydrothermic), Chatham Emerald (flux-growth or flux-melt), Gilson Emerald (flux-growth or flux melt), Kimberly (Biron) Emerald, Lennix Emerald, Linde Emerald, Regency Emerald, and Zerfass Emerald.

Emeralds have been synthesized since 1848, although no facet-able gems were produced until 1934; they became commercially available in the 1940s. However, most of these early stones were small and of rather poor quality.

The first emerald synthesizer was the French chemist Jacques Joseph Ebelmen (1814–52), who recrystallized powdered emerald in a boron oxide mix. The resulting crystals were very tiny, but it was a start. Jules Verne mentions him (although he misspells his name as "Ebelman") in *Journey to the Center of the Earth* as one of the many eminent scientists to consult Lidenbrock "on the most stimulating questions in chemistry." One of the earliest of all photographs shows Ebelmen on his deathbed. It is done as a negative to give him a more spiritual, even creepy, aura.

The first true synthetic stones were developed by in 1877 by the French chemist Edmond Frémy (1814–1894). Frémy also studied how leaves and flowers got their color. In his spare moments he interested himself in the composition of brains and bones. He also spent a good deal of time studying fermentation and decided that Louis Pasteur didn't know what he was talking about. His main achievement was supposedly the discovery of hydrogen fluoride, but to me that is nothing compared to the making of synthetic gems, a hobby he turned to later in life.

He used a "flux system" to create synthetic rubies, which were chemically and physically almost identical to the real thing. The flux process had been created in1888 by Paul Gabriel Hautefeuille and Adolphe Jan Edmé Perrey, although they were able to make emeralds of only 1 millimeter. Flux is a molten solvent that will synthesize compounds with high melting points. The most common flux, first used by Hautefeuille and Perrey and still used today, is lithium molybdate.

In the flux method, the powdered ingredients are melted and fused in the flux in a crucible. It has to be heated very hot and cooled very slowly in an open air, as opposed to a vacuum environment.

However, early flux methods didn't allow for the production of commercial grade rubies. That feat was accomplished in 1902 by another French chemist, Auguste Victor Louis Verneuil (1805–1873), who was the first to develop commercially useful large ruby crystals using a "flame fusion process." This

procedure produced a rotating "boule" (a tapering cylindrical rod with the same physical and chemical characteristics as ruby) from ground alumina (Al_2O_3), with a little chromium, using an inverted oxyhydrogen torch.

Flame-fusion remains the least expensive method of creating synthetic gems; however, it also produces the lowest quality in terms of purity and optical characteristics. In addition, the crystals produced by the flame-fusion process contain a huge number of light-trapping air bubbles that diminish dispersion and dull the stone, creating what is sometimes called a "sleepy" effect. And most important for our purposes, Verneuil was unable to produce an emerald with this process, since the melting temperatures of the aluminum oxide and chromium for "doping" or coloring the stone are much lower than those of beryllium needed for emeralds. In addition, the impure open-air environment didn't allow for infiltration of chemicals needed to induce the growth process on the seed material.

Thus, gem-quality emeralds were slower in coming than rubies. Early leaders in the synthetic emerald business were IG-Farbenindustrie (Bitterfeld, Germany), which began growing emeralds by what they termed a "flux reaction growth process" about 1929, a new and improved flux technique. (Farben also invented the polyvinyl chloride or PVC plastic after World War I. They also invented epoxy in 1939, so they have a double connection to emeralds. I suppose it could be reasoned that if you couldn't make money-creating emeralds, at least you could make money repairing their fractures.) In this process beryllium and aluminum oxides (with lithium chromate as the coloring agent) were placed in the bottom of a crucible as the nutrient. The crucible was filled with lithium molybdate, and seed crystals were attached to the upper part of the crucible, beneath a platinum baffle. Quartz plates (which supply the SiO_2) were placed above the baffle. The material was heated to 800°C during the growth process. At the end of World War II, the costly platinum apparatus was destroyed and never replaced.

During the1920s, Richard Nacken of Frankfurt, Germany, was also growing small emeralds using a flux process, but his methods were not revealed until 1978. This secretiveness was characteristic of most early synthesizers. An even better technology called "flux growth" was developed in the 1950s. The technique was first applied to rubies (which are commercially more important than emeralds).

In general, synthetic emeralds are created by one of two methods or a variant thereof: flux growth and hydrothermic. Most synthetic companies use both processes at various times, although they may favor one or the other. The details of making synthetic emeralds are not publicly discussed, and improvements are constantly being made.

The hydrothermal process is one that duplicates the underground conditions that give birth to Colombian emeralds. The first such emeralds were

produced by Johann Lechleitner in Innsbruck, Austria, toward the end of the 1950s. This method transforms low-grade melted beryl (the "nutrient") around a solid beryl "seed" in a hydrothermal environment. Color inducing chemicals, such as vanadium and chromium are melted along with it. The hydrothermic process starts by gradually heating the autoclave. Subsequent rise in temperature leads to rise in pressure, as a result of liquid expansion inside the inner vessel.

Once the temperature rises to about 600°C and pressure is around 800 PSI, the process reaches an ultimate equilibrium and a melt process begins. The seed attracts smaller particles of the same origin and the growth process begins, depositing layer upon layer on itself like pearl, resulting in undulated growth lines in hydrothermally grown gems. The process takes about four weeks. However, if the process is slowed down, the "layers" are deposited more slowly, resulting in growth lines being less clearly defined (more difficult to detect). Most hydrothermically grown emeralds have the following features:

- Refractive index: 1.571 to 1.578 D.R −.007
- Specific gravity: 2.678
- Clean color with constants close to those of a natural
- Pronounced red fluorescence under both SW and LW UV light
- Red glow can even be seen under strong white light
- Bright red under Chelsea filter
- Nail-like inclusions with the head being phenakite crystals

Hydrothermally grown synthetic emeralds were once manufactured by Union Carbide (1965–1970) as Linde-Created Emeralds. Linde was a division of Union Carbide. Other manufacturers who have used this method or a variant of it include:

The Regency Synthetic Emerald (Vacuum Ventures) is created using the original Linde technique and Union Carbide patents. Its properties are quite close to those of the natural stone, although the specific gravity is somewhat lower, at 2.68. This stone contains very little iron, so it has a high SW UV transmission factor and a strong red fluorescence (even under a beam of high-intensity white light). These stones often have wedge-shaped, daggerlike growth tubes, two-phase features stemming from phenakite crystals, and sometimes a "healed crack" feature. They can even contain fluid inclusion but lack the alkalis that one would expect to find in a natural emerald.

The Lechleitner hydrothermal method, a process developed in several stages over many seed plates of synthetic emerald (as with yogurt, you often need to have some emerald to make some more emerald) were placed over and over into an autoclave, thus growing several layers of emerald plate. Crystals

were then cut. Between the different growth phases, poorly colored or impure crystals were removed. The necessary apparatus is quite similar to the one used in early flux products.

Most details of the process are kept secret, but Lechleitner synthetic emeralds have the following features:

- Refractive index: 1.575 to 1.581
- Specific gravity: 2.69
- Inclusions not common to emerald
- Network surface of cracks

Another synthetic emerald producer using the hydrothermic method is Tairus Created Gems. The company had its roots in the late 1960s, when a group of young Russian scientists working on a top-secret project at the Siberian Branch of the Russian Academy of Sciences—to develop a perfect conductor for a guided laser beam, produced some fine emerald crystals using both hydrothermal and flux processes. Two years later they were ordered to stop, and they never again heard from the authorities who ordered these experiments. But they still had the rocks. The stones were very similar to the best emeralds from the Ural Mountains, and ranged in color from dark blue to bright yellow. The Russians had been more interested in technology than in gems, but were smart enough not to pass up a good thing. Later, during Mikhail Gorbachev's restructuring program, the Academy was encouraged to look for a way to marketing its creations and become an independent entity within the academic community. Thus, Joint Venture Tairus was born in 1989. Today this group is the only world producer of hydrothermally grown corundum (ruby and sapphires). It also grows fine "created" alexandrites, utilizing its own method of "floating method process," also known as "horizontal crystallization."

Tairus produced its first "Colombian-colored emeralds" in 2004, and its production demands are about 200,000 carats. Today, Tairus is the largest supplier of hydrothermally grown gems to the jewelry industry.

In 2001 Tairus bought Biron of Perth, Australia, the largest producer of synthetic emeralds. Biron also uses the hydrothermal process and produces large crystals almost completely free of inclusions. In this process the seed crystals and chemical constituents of emeralds are placed in water-filled pressure chambers; gem size and quality crystal can be produced in a month.

Features of the Biron synthetic include:

- Specific Gravity: 2.68–2.71
- Refractive index: 1.569
- Biron synthetic is inert to UV radiation

Biron has produced crystals of over 100 carats. Some Birons include gold as an inclusion (an interesting touch). Tairus has restarted production of Biron colored emeralds in early 2002.

The flux-growth method does not involve the use of water or a vapor phase and thus these synthetics don't have the fluid inclusions that are common in natural emerald. It is also time-consuming and expensive, but is still the most commonly used way to produce synthetic emeralds. Synthetic flux-growth emeralds made by Gilson and Chatham (two major makers) are sold in three, inclusion-based, grades (Gem, Fine, A). Each grade is priced per carat according to weight. "Gem" grade wholesale prices range from $245 per carat for 0.12- to 1.5-carat stones, to $450 per carat for 9- to 9.9-carat stones. Grade A stones of the same size run about one-third to one-half these prices.

In the 1930s, Carroll found a way to create synthetic emeralds in his San Francisco basement. He started with what was essentially magma—going back to how real emeralds can be born. He added emerald seed crystals (aluminum and silicon oxides and cooked them up to over 10000°C for over a year in an acidic solution of water and chemicals. This method speeds up crystallization at lower pressures and temperatures. Interestingly, his method can produce crystal clusters that are highly sought after by collectors.

Chatham's oldest son, John, improved the technique, which produces an extremely beautiful stone, very close to a natural emerald, although its specific gravity is marginally lower (2.65 as compared to 2.67–2.78 for natural stone). Chatham emerald inclusions are a part of the creation process of the emerald, just as they are with natural emeralds. And while an expert can distinguish a Chatham emerald from a natural emerald by its inclusion, so can the same expert distinguish between a Colombian and a Zambian emerald from their inclusions as well. Chatham's second son, Tom, began a marketing program. A Chatham synthetic emerald goes for several hundred dollars a carat.

Compared to natural emeralds, Chatham emeralds display the following features:

- Lower specific gravity (2.65)
- Lower refractive index (1.561 to 1.564)
- Distinct red fluorescence under UV light.
- Rather saturated color and absorption spectra because of more chromic oxide
- Wispy, resembling dispersed cigarette smoke
- Phenakite crystals
- Tabby extinction under cross polars
- Brighter red under Chelsea filter
- More transparent under SW UV light
- Pronounced afterglow under x-rays

Today the Chatham company has a plant in Athens, Greece, which makes both sapphires and emeralds.

Developed by M. Lens of France, these Lennix Synthetic emeralds are grown using the flux-fusion process. The stones emerge as rectangular rather than hexagonal crystals and have a tabular habit. Their physical properties are somewhat lower than those of the natural stone: refractive index 1.562, 1.566; D.R.= 0.004; specific gravity = 2.62–2.65).

These stones typically have two- and three-phase inclusions resembling feathers as well as particles of flux. Spiky cavities may also appear. However, their most notable features are small rosette-like crystal clusters.

In the south of France, Pierre Gilson developed a method for creating synthetic emeralds called the flux-transport growth process, which is somewhat different from the flux reaction growth process. It starts with natural or synthetic beryl or emerald as a nutrient, plus a doping agent. Compared to natural emeralds, Gilson emeralds display the following features:

- Lower specific gravity and refractive index, although in some stones iron oxide is added to increase specific gravity and refractive index
- Cleaner, purer color
- Wispy or phenakite inclusions
- Tabby extinction under crossed polars
- More transparent under SW UV light
- Pronounced afterglow under x-rays
- Dull red under the Chelsea filter
- Under LW they appear dull mustard to greenish yellow. Under SW, orange

No one knew what to charge for these synthetic stones at first, but now prices have stabilized on the low end of the spectrum.

A fairly reliable guide to distinguishing the natural from the artificial is by examining the inclusions. If you look at a stone under a microscope, you will notice that typically synthetic stones have a "wispy" or veil-like inclusion. Natural emeralds, however, characteristically possess inclusions of pyrite, calcite, and actinolite. In addition, synthetic emeralds are easily activated by UV light, while natural emeralds do not fluoresce well. Always ahead of the game, however, the emerald synthesizer, Gilson, found that mixing iron into the material prevented fluorescence.

What's Real and What Matters

Both synthetic and natural emeralds can be technically classed as "real" emeralds, and unscrupulous dealers have been known to imply a synthetic stone is a natural one by selling it as "genuine," which of course it technically

is. By the way, it turns out that the same fuss raised about vanadium coloring natural emeralds also appeared in the synthetic world. In the mid-1960s, an Australian company developed green beryl colored by vanadium (no chromium at all) that they sold as synthetic emerald. People complained. Another emerald maker in Germany found that he got the best color using chromium plus other material such as nickel compounds. The old argument about coloring agent resurrected itself. Classical natural emerald is colored by chromium. Vanadium is also a natural infiltrator of beryl and is now accepted as imparting true emerald color to the stone. Even iron can give a green tinge to beryl. But nickel does not seem to occur at all in natural emeralds.

Even a genuine emerald, of course, is not necessarily valuable. Many are so low grade that they probably should have been left in the dirt. Putting a poor stone in an expensive setting does nothing to enhance the real value of the stone. Today scientists have actually succeeded in creating synthetic gemstones of all varieties, stones that are chemically and optically identical to the real stone, and whose creation does not degrade the environment or entail human suffering (although you may get an argument from the poor miners who have no other way to earn a living). It should be pointed out that many of today's natural emeralds are strip-mined, a practice destructive to the environment. Natural emeralds are also always oiled or otherwise enhanced (a treatment that is not permanent) while a synthetic emerald needs no such work.

But there's a paradox here. Even as the natural emerald loses value with increased production, the flooding of the market with artificial gems depresses the price of both natural and synthetic stones. If the emerald-making process becomes too efficient, the inherent value of the stone is lost as much as if natural emeralds became as common as gravel. The inherent value of stone is heavily dependent upon its rarity, and while some rare stones are not valuable, every valuable stone is rare. Producers of both natural and artificial emeralds want to do two antithetical things: they want to sell as many stones as possible, and they want to get the highest price possible for each stone they sell. Since the two goals are incompatible, they face a precarious balancing act. The problem is especially acute for makers of synthetic emeralds. The market for emeralds has always been volatile, and while the public may not be fully aware of efforts to control the prices of natural emeralds, they well understand that the prices of synthetics are artificially maintained. This probably hurts the value of both kinds of emeralds in the long run.

One of the most successful ploys to improve the gem market has been the invention and commercialization of the "birthstone," which is actually quite a modern idea. The concept is dimly related to astrology, and the some of the first tentative connections were made by astrologers in regard to the

breastplate of Aaron, which goes to show that dissimulation is not confined to fake stones. Plenty of lies (or myths) have been told about real ones.

The twelve gems on Aaron's breastplate were taken by ancient astrologers to represent the twelve "houses" of the constellations. Jewelers have also appropriated (and periodically updated) this gem list for the purpose of better sales. The so-called modern birthstone list came from the American National Association of Jewelers, the old name for the Jewelers of America. The "traditional" birthstone list is an older version of that list. Both are based on societal birthstone traditions spanning from the fifteenth to the twenty-first century. No one knows for sure how the idea of a "birthstone" got started, but even the ancient Babylonians and Indians linked certain stones with certain birth months. The actual wearing of birthstone gems may have begun 300 years ago in Poland. The belief is that wearing your birthstone will bring you good luck.

The modern list of birthstones isn't that modern actually, being compiled in 1912, in Kansas City, Missouri. According to the traditional list, emerald is the birthstone for either the month of May or the astrological sign of cancer. For Arabs, Hindus, Poles, and Russians, the stone stood for May; while for the Hebrews, Romans, and Italians it was June. Parts of both months belong to Gemini and both are green, and so that seems appropriate. In popular culture, emeralds represent the thirty-fifth year of marriage.

In some astrological systems, a blemished emerald can cause mental and physical distress to the wearer, and even give sorrow to your parents. Such dangerous flaws include cracks, spots, brittleness, and brightness (emerald should be lustrous rather than bright). Hazy, dual-colored, and lusterless emeralds also mean trouble.

Astrologically, the peaceful emerald doesn't "fight" with other stones. The stone is actually said to promote peace, especially when cut into the shape of a frog.

More recently the idea of a "mystical birthstone list" has appeared. The mystical birthstone list is said to have originated in Tibet (presumably because Tibet is such a mystical place) and is supposedly over a thousand years old. More practically it serves as an alternate list for people who don't care for the birthstone traditionally assigned to them. Emerald is the "mystical birthstone" for January.

Emerald has not only a special month (May, June, or even July or January), but also a special day, which is Monday, Wednesday, or Friday. The confusion about the auspicious day has arisen because of the argument about what deity is associated with it. Diana is the moon goddess, and her day is Monday (moon-day). Wednesday is Mercury's day, and is particularly useful to folks who are troubled by the planet Mercury. For those on good terms with this sometimes irascible planet, emeralds provide intelligence, fluent speech,

confidence, wit, and discrimination. Mercury, after all, is the god of communication. The Hindu tradition also assigns the emerald to the planet Mercury, in a convergence of tradition. Emeralds obtained and worn on a Wednesday are supposed to have the strongest magic.

For general good fortune, wear the stone on the fourth finger of your right hand, especially on Wednesday. However, wearing an emerald on the index finger is said to be excellent for preventive health, especially eye health.

Friday is sacred to Venus/Aphrodite, to whom the Romans dedicated the emerald. In dissension from these views, the *Lapidario* of Alfonso X (1221–1284), also known as Alfonso the Wise, king of Castile and Leon, insists the stone is controlled by Jupiter, rather than the usual Mercury or Venus. What was he thinking? Still, Alfonso X was no one to fool around with. He had definite opinions about things. His most quotable quote: "If I had been present at Creation, I would have given some useful hints."

In any case, several traditions claim that the emerald's auspicious hour is two in the afternoon, when its magical powers peak. (A strange kind of magical power is that of perfume. And Emeraude, a wonderful evening perfume, has one of the most evocative scents of all. It was developed by Coty in 1925.)

In America, the land of green money, it is said that emerald can be used to promote cash flow. All you have to do is wear a gold chain around your neck with an emerald attached near the heart. If you are more interested in love, visualize the one you adore instead of money, and that person will be irresistibly drawn to you. For students, wearing an emerald will improve the memory. The catch, of course, is that few students are able to afford a good emerald, and the power of the stone seems directly linked with its quality. If a good quality faceted emerald is beyond reach, emerald beads are satisfactory.

In any case, for magical and healing purposes, the emerald's setting should be *gold*, never silver or platinum, and it should be set in the morning. In the West the emerald's "special direction" is northeast, although in the Hindu tradition it is northwest (Nararatnaparisha). This stone is considered especially fortunate for married women.

The emerald, in fact, is the stone for everybody. It is a beautiful paradox, a curious mix of material wealth and spiritual riches. When loved and cherished, it brings luck. When lost or neglected, it can take fearsome revenge. In legend, the emerald represents a plethora of sometimes contradictory powers and virtues: faithfulness, peace, discernment, healing, passion, foresight, and renewal. The most secret principles of alchemy, the science of change, are engraved upon an Emerald Tablet somewhere in the land of myth. And while the Tablet may be mythical, the emerald itself is a very real and physical delight—the prize of princes, kings, and conquistadors.

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