THE ELAHERA GEM FIELD IN CENTRAL SRI LANKA

By Mahinda Gunawardene and Mahinda S. Rupasinghe

Commercially important quantities of gem-quality sapphire, spinel, garnet, chrysoberyl, zircon, tourmaline, and many other gemstones are being recovered from deep gem pits and surface excavations in the Elahera gem field, a region in central Sri Lanka about 115 km northeast of the capital city of Colombo. Large-scale mining is being conducted in this highly metamorphosed sedimentary deposit by the State Gem Corporation in collaboration with the private sector. The chemistry and gemological characteristics of these gem materials are discussed; in many instances, characteristic inclusions were identified by microscopy, microprobe analysis, and X-ray powder diffraction analysis. It is estimated that the Elahera gem field currently provides approximately 35% of the gemstones exported from Sri Lanka. The continued steady production of good-quality gems is anticipated for the future.

ABOUT THE AUTHORS

Mr. Gunawardene is president of the Lanka Foundation for the research of gemstones, and director of MANYGEMS, a wholesale gem import firm in Hettenrodt, West Germany. Dr. Rupasinghe is a research associate at the Institute of Fundamental Studies in Kandy, Sri Lanka.

Acknowledgments: The authors thank the officers of the Gem Corporation of Sri Lanka for their permission to photograph the Elahera gem field, and the many miners and villagers who recounted the history of the area.

The island of Sri Lanka, often referred to as the "jewel box" of the Indian Ocean, has long been one of the major producers of fine-quality gemstones. Recent publications (e.g., Cooray, 1978; Munasinghe and Dissanayake, 1981; Zwaan, 1982) have yielded general information on gem occurrences in Sri Lanka but relatively little on specific gem fields. Although the major gem locality in Sri Lanka is still Ratnapura and its surroundings, Elahera, in central Sri Lanka, has become the second largest gem field.

Since the 1960s, Elahera has produced economic quantities of good to superior sapphire (figure 1), spinel, garnet, chrysoberyl, zircon, and tourmaline, as well as many other gem materials. Some of these stones are now in major museums or in the private collections of some of the world's wealthiest individuals. The poverty of those at the pits and the glitter of those who reap the benefits have been observed by the authors during the past few years and have led to the writing of this article on the history and geology of the Elahera region, as well as the gemology of the many fine materials found there.

HISTORY

Recent archaeological discoveries have revealed that Elahera was an active gem center for many centuries. During the regime of King Parakramabahu, who ruled during the 12th century A.D., even foreigners were allowed to mine in certain parts of the region. Recently, archaeologists excavated the remains of tools used to work the gem pits and even some engraved stones. However, civil wars and foreign invasions eventually forced the people to move to other areas of the country, leaving the troublesome kingdom. The Elahera gem mines were gradually abandoned, many covered over by rice paddies.

During the mid-1940s, a Sri Lankan engineer working on an irrigation project along the Amban Ganga (*ganga* means river) lost a ring along the side of the river

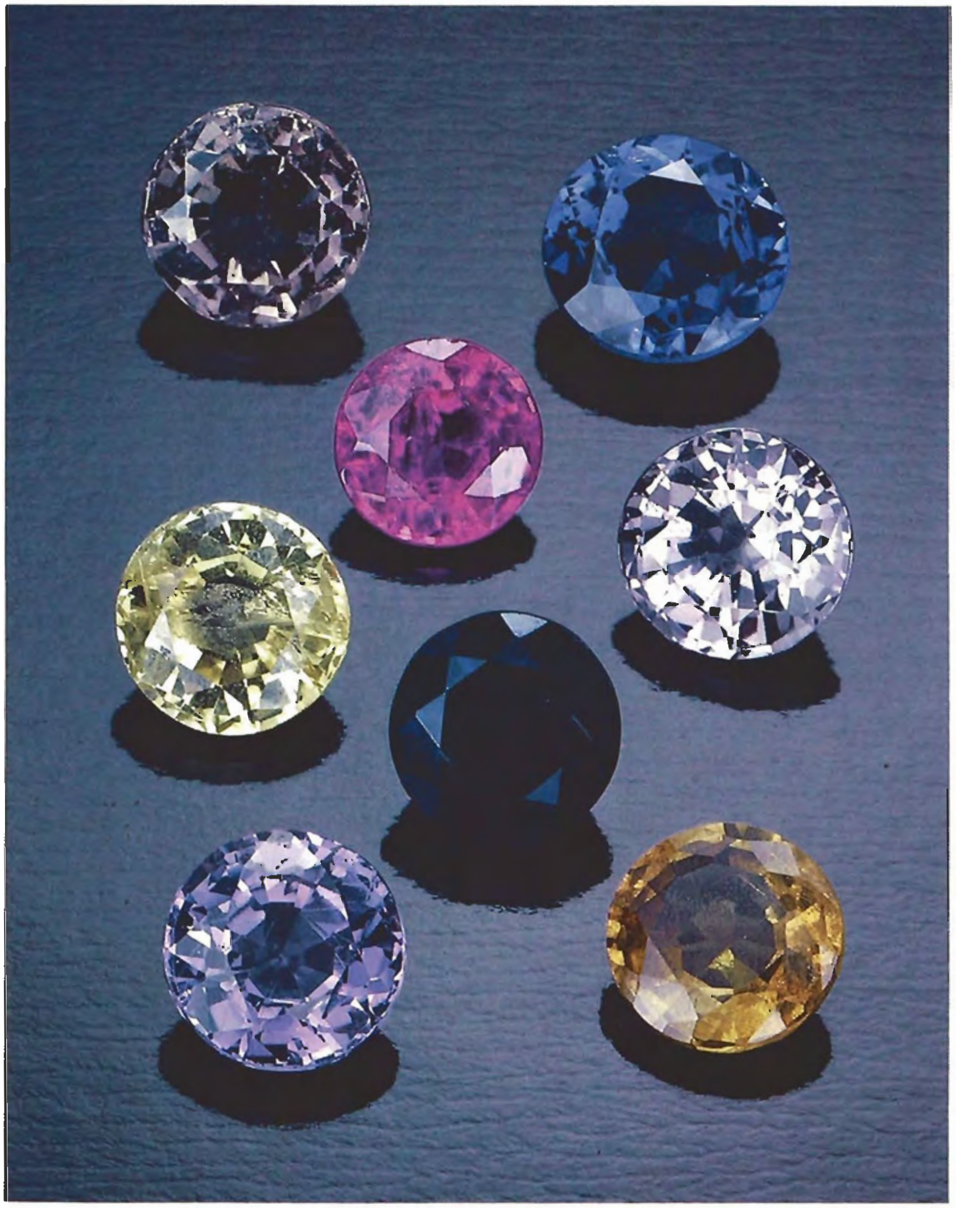


Figure 1. The gem corundums shown here illustrate some of the many colors found at the Elahera gem field, a major source of gem sapphires in the island nation of Sri Lanka. These stones average 1 ct. Photo © Tino Hammid.

while he was bathing. In the process of searching for the lost ring, he discovered a number of blue and red pebbles, which proved to be either corundum or garnets. He soon started mining but kept the discovery secret until early 1950. Around that time, construction workers on the Elahera-Pallegama road (see figure 2) found many pebbles of sapphire that had been exposed after a heavy rain. The news of their discovery gradually spread among the professional gem miners in Ratnapura, many of whom set up private, small-scale mining operations in the "new" district.

Gem-mining activity in Sri Lanka escalated after the government established the State Gem Corporation in 1971. The corporation took over the functions of issuing gem-mining licenses and leasing government land for mining. In Elahera, the local farmers even used their own rice paddies for mining. In the late 1970s, the state body undertook large-scale gem mining in collaboration with the private sector. Current mining in the Elahera area proceeds along the Elahera-Pallegama main road, particularly between the 19- and 24-mile posts (figure 2), and is concentrated in the areas of Wallwala, Hattota-Amuna, Laggala, and Dahasgiriya. The State Gem Corporation has reported that just one of the joint state/private industry projects in this region—the Laggala-Pallegama project—earned US$725,790 between June 30, 1981 and April 13, 1985.

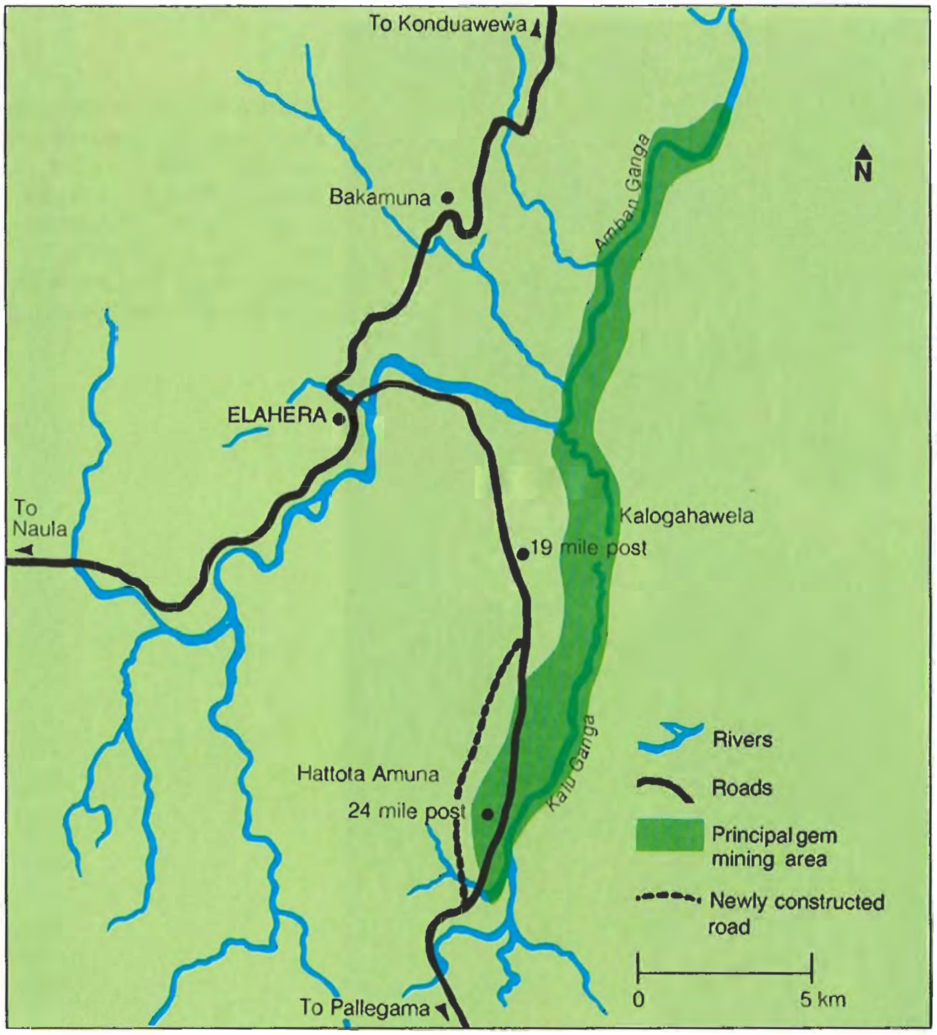


Figure 2. The Elahera gem field in central Sri Lanka is noted for its vast production of many gemstone varieties. The main gem mining activity is between the 19- and 24-mile posts.

LOCATION AND ACCESS

The Elahera gem field covers approximately 150,000 m^2 in the Matale and Polonnaruwa districts of central Sri Lanka. The map of the Elahera region in figure 2 extends from approximately 80°45′ to 80°55′ east and from 7°35′ to 7°50′ north. The principal gem-mining area is centered at 80°50′ longitude from north to south. Two tributaries of Sri Lanka's longest river, the Mahaweli Ganga, run through the main gem area. These are known as the Amban Ganga and the Kalu Ganga. The lower course of the river system almost parallels the main road between Elahera and Pallegama.

During the dry season, access to the gem mines is easily gained. During the rainy season (May to September and late October through February), however, the bridges are often under water.

The State Gem Corporation has encouraged local farmers to continue their rice cultivation without interruption. The area is attractive, with green landscape and blue sky, and the mines are concentrated along the former main road (figure 3). The corporation, at its own expense, has built a new road (marked in figure 2) to connect Elahera and Pallegama. The project area is closed to the public, and anyone who wishes to visit the mines must obtain a permit at the corporation's head office in Colombo.

GEOLOGY

The island of Sri Lanka is underlain almost entirely by Precambrian metamorphic rocks which have been subdivided by Cooray (1978) into three groups: (1) Highland Group (pyroxene-granulite facies), (2) Vijayan Complex (amphibole-granulite facies), and (3) Southwestern Group (cordierite-granulite facies). The Elahera region lies entirely within the Highland Group terrain. The Highland Group consists of hypersthene granites (charnockites), quartzites, marble (crystalline limestone), garnetiferous gneisses, hornblende gneiss, granulites, and pegmatites (Dahanayake, 1980). Gem mining is carried out in the residual,

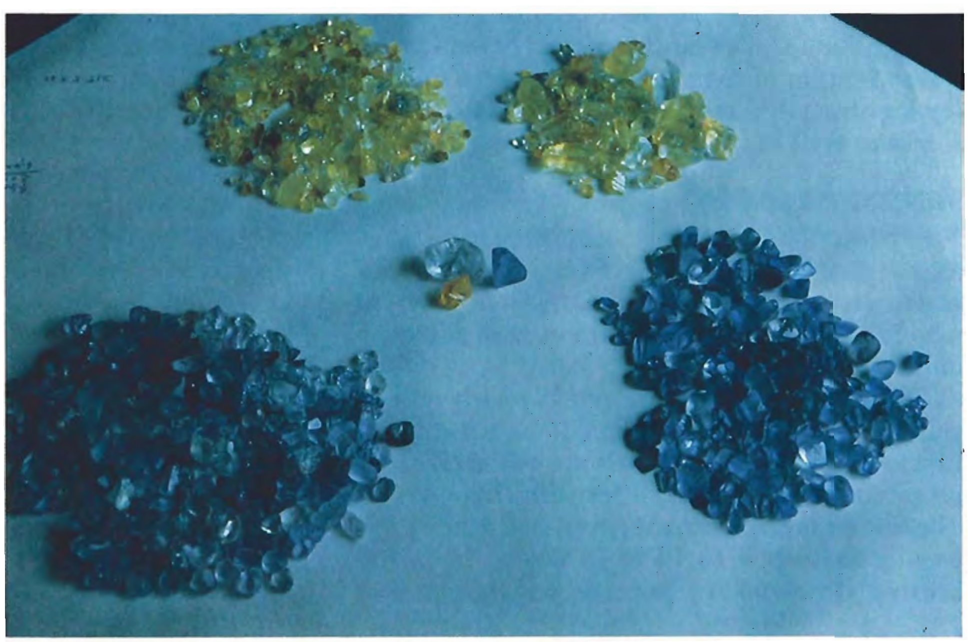
Figure 3. Large-scale gem mining is conducted along what was once the main bus route from Elahera to Pallegama, in the center of the Elahera gem field. Photo by Marion Gunawardene.

eluvial, and alluvial gravels overlying the Highland Group metamorphics. According to Dahanayake et al. (1980), the Elahera region is characterized by ridge and valley topography in a plunging synclinal structure. This structure forms the wide valley and floodplain of the Kalu Ganga. This floodplain is underlain by marble, while the bordering ridges consist of harder, more resistant garnetiferous gneisses, charnockites, and quartzites. Granites do outcrop as elongated intrusions along the length of the Kalu Ganga valley. Where the granites have intruded and come into contact with the marble, significant skarn deposits, consisting of diopside, tremolite, scapolite, spinel, and corundum, have developed.

The lithology and stratigraphy of the Elahera area have been described in detail by Silva (1976), by Dahanayake (1980), and by Dahanayake et al. (1980). Munasinghe and Dissanayake (1981), Asadi (1985), and Rupasinghe and Dissanayake (1986, in press) have also reported on the origin of gemstones in the island and are recommended for further reading.

The modes of occurrence of gem pits in Elahera can be divided into two main types: residual and alluvial. The residual gem pits contain large amounts of garnets, which are abundant in the gneisses. The gemstones found here are mostly eroded and only rarely retain their distinct original habits (figure 4).

Figure 4. A week's collection of rough blue and yellow sapphires found in Elahera are sorted here for faceting. Note the rounded appearance of the crystals, probably the result of water transport. Stones courtesy of MANYGEMS, West Germany.



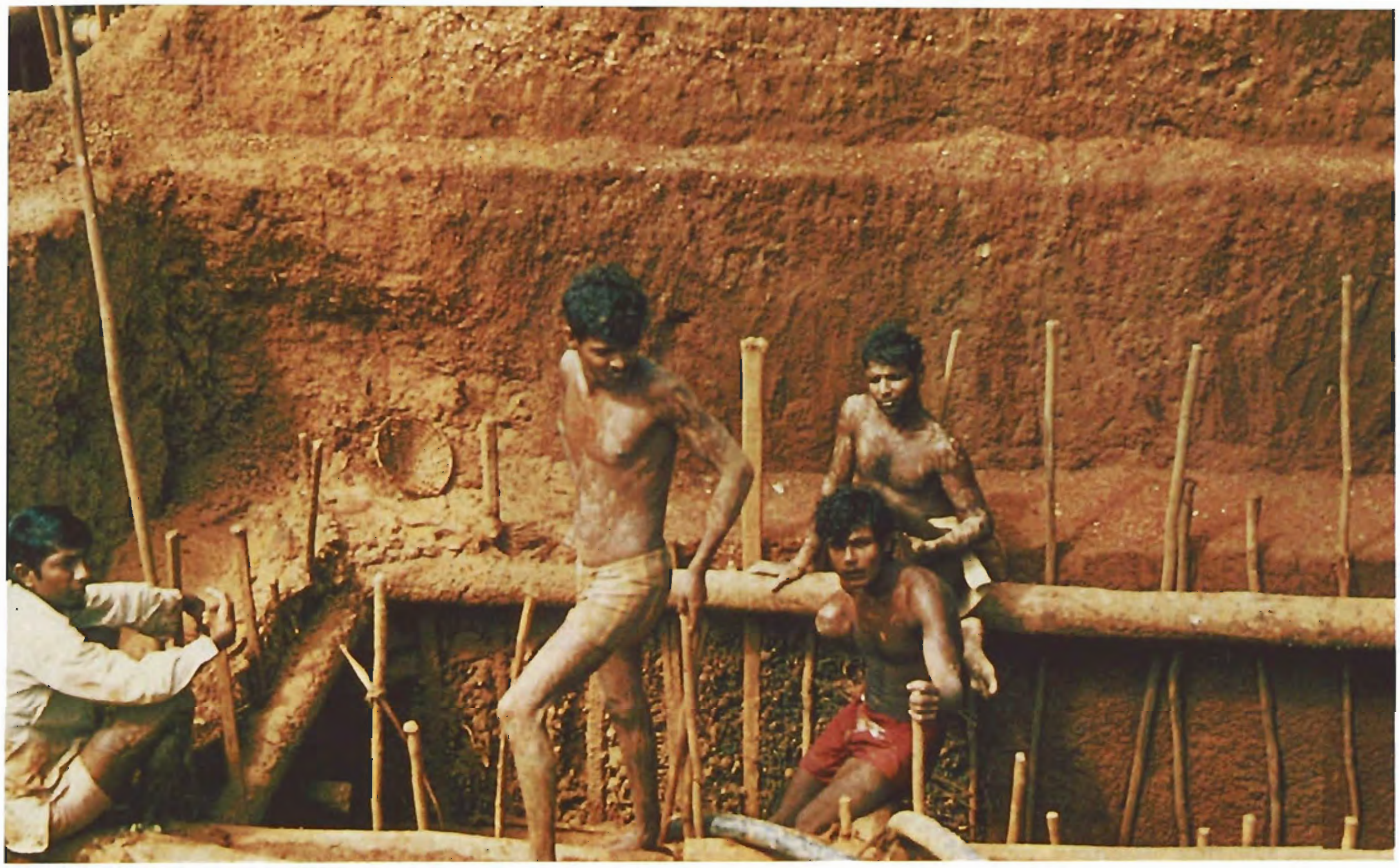


Figure 5. Two to three meters below ground level, the gem-bearing gravel is extracted by workers. Natives use picks and shovels to excavate the gem gravel, a common practice in pit mines in the Elahera field.

The alluvial gem deposits are characterized by clay and/or sand layers with abundant rock fragments. The gem minerals can be widely distributed. They exhibit evidence of having traveled over long distances and are often eroded. Most of the gem pits essentially indicate the alluvial nature of deposits in the area, which in turn also suggests that the various kinds of gemstones found in the deposits have different origins.

The Kalu Ganga has been a major vehicle for transportation of the gem materials into the valley, resulting in accumulations of deposits on hill slopes as well as along the banks of the river.

MINING METHODS

Traditionally, mining commences with astrological consultations and a short religious ritual offering foodstuff to "Bahirawaya," a spirit who is reported to be in charge of wealth hidden underneath the earth.

Because the soil in Elahera is relatively dry, gem mining is less complicated than in wet zones like Ratnapura. Two methods are primarily used: pit mining (figure 5) and surface mining (figure 6). The former is often carried out in rice paddies and usually extends 3 to 10 m in depth. The gem-bearing deposits are not far underground so this method is economical. However, pit mining is disappearing now that the State Gem Corporation has undertaken large-scale surface mining. The recovery methods currently in use include such modern techniques as scraping the overburden with bulldozers, which lowers the costs involved and increases the yield of gem materials. With both pit and surface mining, the gem-bearing gravel is first washed in cane baskets, sorted, and then dried in sunlight before it is again carefully sorted by hand to recover any glittering pieces that were not identified during the washing. More than 650 miners currently work in the Elahera gem field. Unlike the early years of gem mining in this region, when many of the operations were independent, virtually all of the current miners are employed by the State Gem Corporation and licensed private enterprises.

THE GEMSTONES OF ELAHERA

Elahera produces a wide variety of gem materials, including: blue, pink, yellow, violet, and "padparadscha" sapphires; marvelous color ranges of spinel; rhodolite and hessonite garnets; chrysoberyls (including alexandrite and chatoyant varieties); many colors of zircon; lovely green and "cognac" tourmalines; brownish green kor-

Figure 6. These surface-mining areas measure 20 to 30 m². The earth is first excavated by bulldozers to a level just above the gem-bearing gravel. The workers then carefully loosen the gem gravel with picks and remove it in cane baskets. Photo by Marion Gunawardene.

nerupines; near-colorless to yellowish or greenish sinhalites; and many rare stones such as gem epidote, sillimanite (fibrolite), and taaffeite. Also found in the locality are rock crystal quartz, amethyst, and topaz, but for the most part these are more of mineralogic than gemological interest. Elahera is particularly noted as a source of large gem-quality corundums; crystals weighing as much as 200 ct have been recovered.

More than 500 gem-quality sapphires, spinels, garnets, chrysoberyls, tourmalines, kornerupines, sinhalites, and rare gem taaffeites, epidotes, and sillimanites were examined during this study. The stones ranged in size from 0.30 to 45.00 ct. The gemological properties of each gem material will be discussed below. Electron microprobe and neutron activation analyses (NAA) were also conducted on samples obtained at various gem pits in the Elahera area. Details of these chemical analyses are available on request from the authors.

Corundum. Elahera produces particularly fine blue (figure 1) and blue star (figure 7) sapphires. The majority are of good to excellent quality, with even coloration and transparency. The best blue sapphires are comparable to the well-known Kashmir blues. The average-grade stones are lighter in color but still brilliant and internally clean. The asteriated stones are usually grayish blue, but fine dark blue star sapphires are found on occasion (again, see figure 7).

Corundum with a milky-white body color, called "geuda" sapphire, is commonly heat treated to produce attractive blue stones (as discussed by Nassau, 1981; Gunaratne, 1981; Hänni, 1982; Gübelin, 1983; and Scarratt, 1983). Recently, a large quantity of "geuda" sapphires from the Elahera area surfaced on the local gem market. They appear to produce particularly nice blue stones with heat treatment.

The Elahera gem field also produces fine yellow, pink, and violet sapphires (figure 1). The yellow stones vary in color from intense "golden yellow" (known as "golden sapphires" in the local gem trade) to light or pale yellow (see, for example, the uncut yellows in figure 4). Often they contain a tinge of brown or rosé; the latter tone is frequently misleadingly described as "padparadscha" (Crowningshield, 1983). Occasionally, good-quality "padparadschas" are found in Elahera (figure 8). Ruby is not common in Elahera, but the locality is noted for the particularly fine pink sapphires found there. Violet sapphires from Elahera are often heat treated to remove the reddish hue and obtain a blue color (Gunaratne, 1981; Gunawardene, 1984).

Color-change sapphires—blue in day or fluorescent light, purplish red in incandescent light—are occasionally encountered. The cause for the change of color has been detailed by Schmetzer et al. (1980). Corundum with color in only part of the crystal is also found in Elahera.

Chemical Analyses. Twenty different colors of corundum were selected from various gem pits in the Elahera gem fields and subjected to quantitative chemical (microprobe) analyses. They were found to have at least 99.43 wt.% Al_2O_3. The blue sapphires reveal an iron oxide content of 0.06 to 0.13 wt.% (as FeO) along with 0.02 to 0.05 wt.% TiO_2. Light red to pink gem corundum contains 0.01 to 0.09 wt.% of Cr_2O_3, and the yellow sapphires show 0.03 to 0.14 wt.% FeO. These concentrations are comparable to those determined for corundum of similar colors from other localities (Schmetzer and Bank, 1981; Schmetzer et al., 1983).

Figure 7. This 46.36-ct blue star sapphire found in Elahera indicates the availability of good gemstones in the area. Stone courtesy of H. Roos.

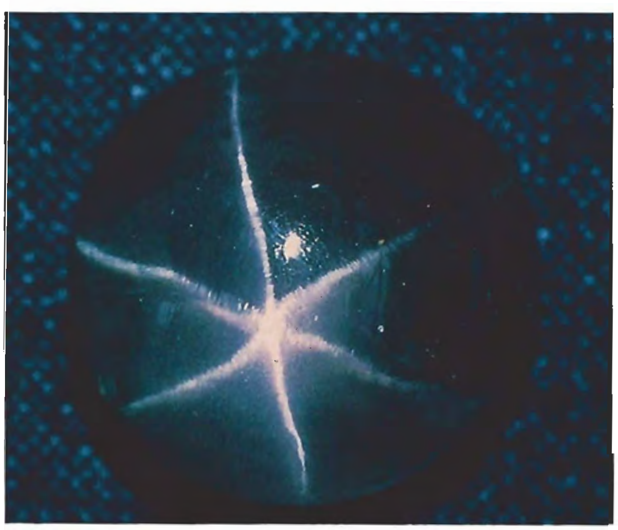


Figure 8. This rare gem "padparadscha" sapphire (2.95 ct) is representative of some of the fine stones of this unusual color found in Elahera. Stone courtesy of D. Humphrey; photo © Tino Hammid.

Optical Properties and Density. Refractive index, specific gravity, pleochroism, absorption spectrum, and ultraviolet fluorescence were determined for an assortment of colors of Elahera gem corundum, as detailed in table 1. The observed refractive indices and birefringences remain relatively constant, revealing no distinguishing variations either among the different colors or vis-à-vis corundum from other localities.

Inclusions. The gem microscope revealed many solid and liquid inclusions that were subsequently identified by X-ray powder diffraction and microprobe analyses. Abundant spinel crystals were common and proved to be the inclusion most characteristic of Elahera corundum (figure 9). Dark, platy, thin crystallites present were confirmed to be phlogopite, biotite, graphite, and ilmenite. Rutile, as hair-fine needles, was also observed in many of the corundums. One Elahera sapphire contained an oriented rod-like rutile inclusion (figure 10). As is common with other gems of Sri Lanka, the Elahera rubies and sapphires, particularly the yellow sapphires, revealed abundant

TABLE 1. Gemological properties of gem corundum, spinel, and garnet from the Elahera gem field.

Gem material[a]	Refractive index	Birefringence	Specific gravity	Pleochroism[b]	Absorption[c] (in nm)	Reaction to LW/SW U.V. radiation	Inclusions
Corundum							
Blue (95)	1.760–1.768	0.008	4.00	Greenish blue (M) Dark inky blue	450 (d) 460 (wk)	Light blue (SW)	Phlogopite, biotite, graphite, rutile, spinel, and zircon; healed "feathers," liquid "feathers," and negative crystals
Yellow (22)	1.760–1.768	0.008	4.01	Orange-yellow (W) Grayish yellow	694.2 (wk) 692.8 (wk)	Apricot reddish Apricot orange	Spinel, zircon, and rutile; healed and liquid "feathers," negative crystals
Ruby (2) and pink (12)	1.761–1.769	0.008	3.99	Reddish violet or pink (S)	694.2 (d) 692.8 (d) 668.0 (s) 659.0 (w) 476.5 (wk) 475.0 (wk) 468.5 (wk)	Distinct reddish Distinct pink	Rutile, apatite, zircon, ilmenite, and graphite; fingerprint-like liquid "feathers;" negative crystals
Star sapphire and ruby (16 total)	1.761–1.769	0.008	4.02	—	Same as blue sapphire or ruby	—	Rutile and other crystal inclusions mentioned above
"Padparadscha" (3)	1.760–1.768	0.008	4.00	Orange-yellow Yellowish orange	694.2 (d) 692.8 (d)	Strong apricot	Rutile and various liquid "feathers"
Spinel							
Red, brownish red, pink (35)	1.714–1.729 (mean 1.718)	None	3.58–3.60	None	680.0 (d) 675.0 (d) 650.0 (d) Broad absorption covering 585 to 500	Weak reddish or no glow in brownish red stones	Phlogopite mica typical; also spinel, apatite, and sphene
Blue, greenish blue, violet (82)	1.718–1.728 (mean 1.720)	None	3.58–3.62	None	455.0 (s) 470.0 (d)	None	Same as above
Green and bluish green (3)	1.716–1.753	None	3.60–4.05	None	Same as above	None	Same as above
Garnet							
Red (32)	1.749–1.778 (mean 1.765)	None	3.80–3.95	None	617.0 (w) 576.0 (d) 526.0 (d) 505.0 (d)	None	Rutile, apatite, and zircon; liquid "feathers"
Hessonite (20)	1.734–1.738	None	3.58–3.64	None	547.0 (d) 490.0 (d) 435.0 (d)	None	Apatite crystals surrounded by swirl-like structural features

[a]*Number of stones examined is given in parentheses.*
[b]*S = strong, M = medium, W = weak*
[c]*d = distinct, s = strong, w = weak, wk = very weak*

zircon crystals with their typical healed fissures and altered structure resulting from exposure to radiation (Rupasinghe, 1984). Fingerprint-like liquid and/or healed "feathers" were common in most of the sapphires. Also detected were groups of negative crystals, often in the form of feathers (figure 11).

Spinel. Various colors of spinel are recovered in this region of central Sri Lanka. The ratio of spinel to corundum is only 3:4 (see also, Munasinghe and Dissanayake, 1981). The predominant colors are blue, bluish green, greenish blue, purple, plum red, brownish red, lilac, and violet (figure 12). The stones are often of good transparency. The star (6

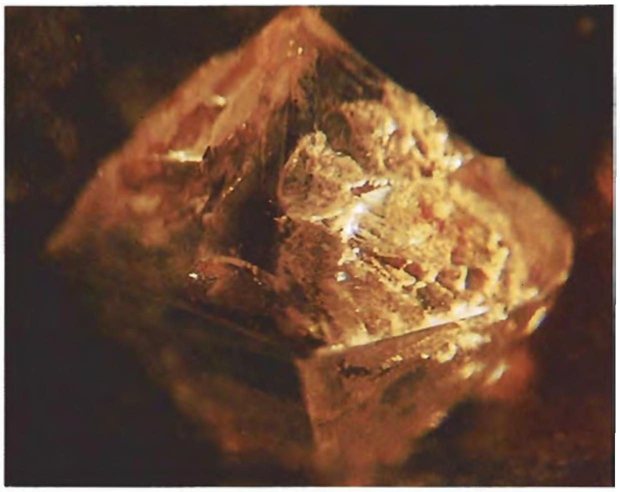


Figure 9. Characteristic of the locality, spinel crystals commonly occur in Elahera corundum. Magnified 80×, dark-field illumination.

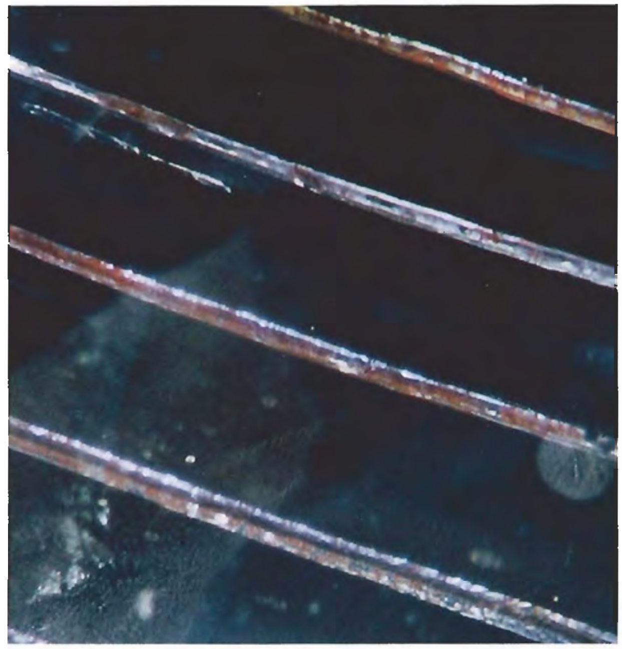


Figure 10. Rutile formations such as this one in a blue sapphire mined at Elahera are occasionally encountered. Magnified 60×, dark-field illumination.

rays) spinels are either dark brownish red, gray, or black in body color and are usually opaque (Bank, 1980). Change-of-color spinels are found occasionally.

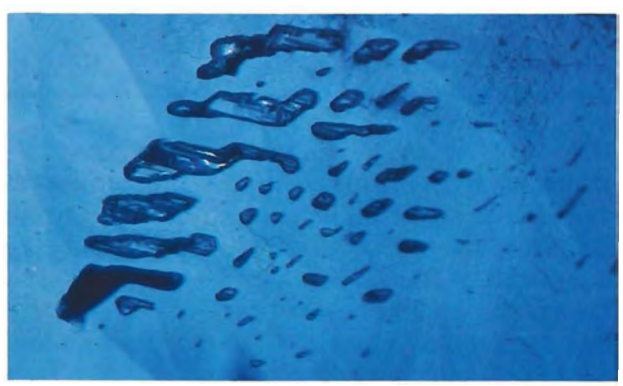
Chemical Analyses. To obtain detailed information on the chemistry of Elahera spinel, we subjected 10 samples to both electron microprobe and neutron activation analysis (NAA). The major chemical components, Al_2O_3 and MgO, are in normal proportions. The blue, green, and purplish red spinels investigated during this study contain iron (0.88 to 3.54 wt.% FeO) and extend into the spinel-gahnite solid-solution series. This was further confirmed by the amount of Zn present (350–750 ppm). The purplish red sample also contains 480 ppm of Cr. Anderson et al. (1937) and Anderson (1964) have detailed the properties of zinc spinels.

Optical Properties and Density. The refractive indices and density values of Elahera gem spinels fall into three categories:

1. The red, brownish red, and pink spinels have a refractive index range from 1.714 to 1.729 with a mean value of 1.718. Specific gravity ranges from 3.58 to 3.60.
2. The blue, greenish blue, and violet spinels have a refractive index range from 1.718 to 1.728 with a mean value of 1.720. Specific gravity ranges from 3.58 to 3.62.
3. The green and bluish green (spinel-gahnite series, or gahno-) spinels have a refractive index range from 1.716 to 1.753. Specific gravity ranges from 3.60 to 4.05.

Visible-light absorption spectroscopy of red spinels from Elahera revealed a strong absorption line at 685.5 nm; no other absorption lines were seen in these stones. Iron played an important role in producing absorption bands at 458, 478, and 508 nm in blue, blue-green, greenish blue, and some

Figure 11. Negative crystal inclusions arranged somewhat like a feather within a blue sapphire from Elahera. Magnified 40×, transmitted illumination with color filters.



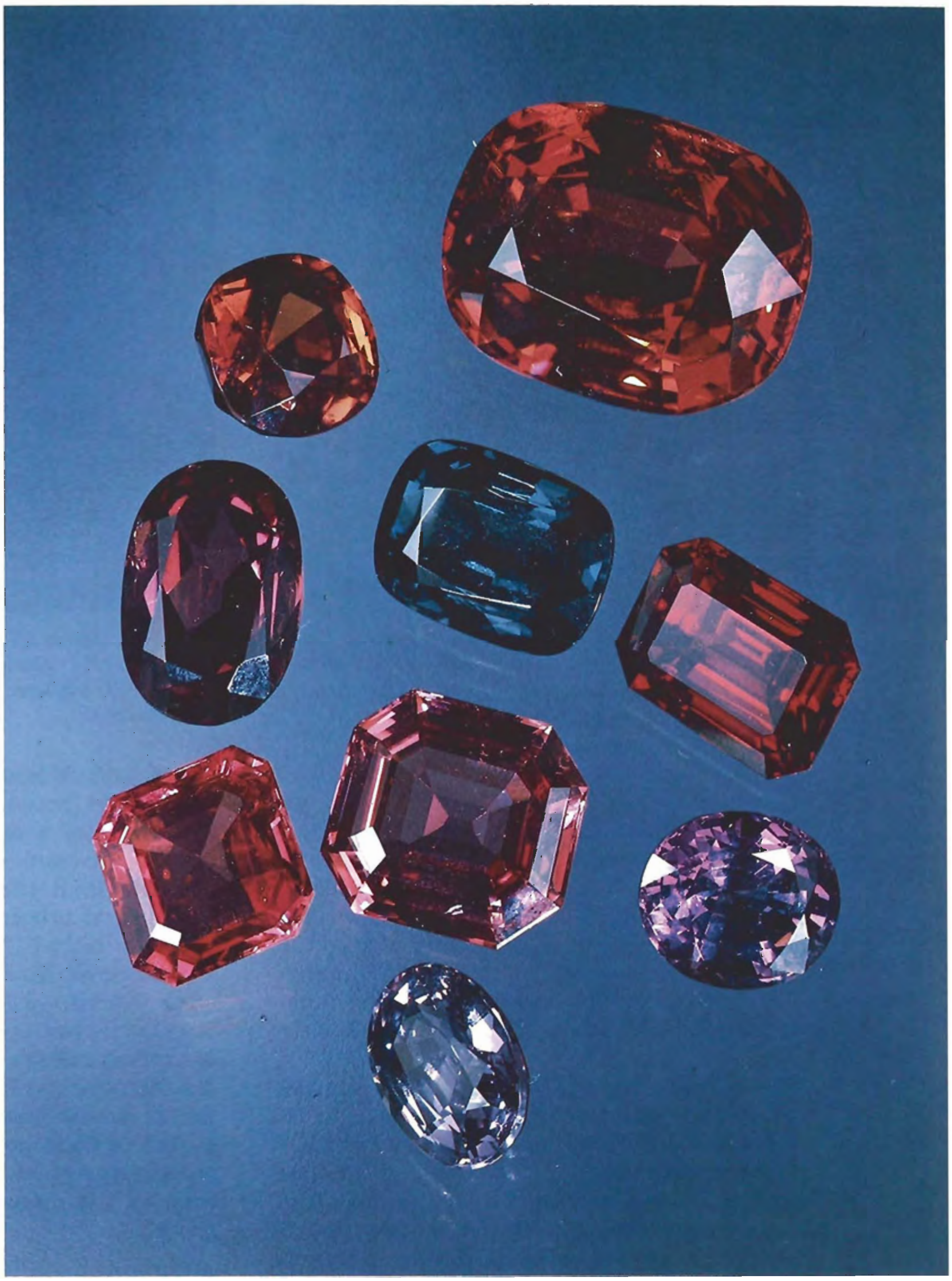


Figure 12. These gem spinels from Sri Lanka (6–55 ct) illustrate some of the many colors found at the Elahera gem field. Stones courtesy of the Hixon Collection at the Los Angeles County Natural History Museum; photo © Harold & Erica Van Pelt.

violet spinels. Much weaker absorption lines were also visible at 635, 585, 555, 443, and 433 nm.

Inclusions. Guest minerals detected in Elahera gem spinels include spinel (in feathery formations), apatite, and sphene. Phlogopite (figure 13) seems to be typical of spinels found in central Sri Lanka.

Garnets. Gemologically, the garnets found in Elahera can be classified as rhodolite and grossular (variety hessonite). The rhodolites, which are more abundant than the hessonites, commonly are transparent and range in color from pink to purplish red. The hessonites usually range from orange-red to yellowish orange, although some samples resemble malaia garnet, a rich reddish orange. However, the majority of hessonites from this locality tend to appear cloudy.

Chemical Analyses. Three purplish red garnets were analyzed by the microprobe. The SiO_2 con-

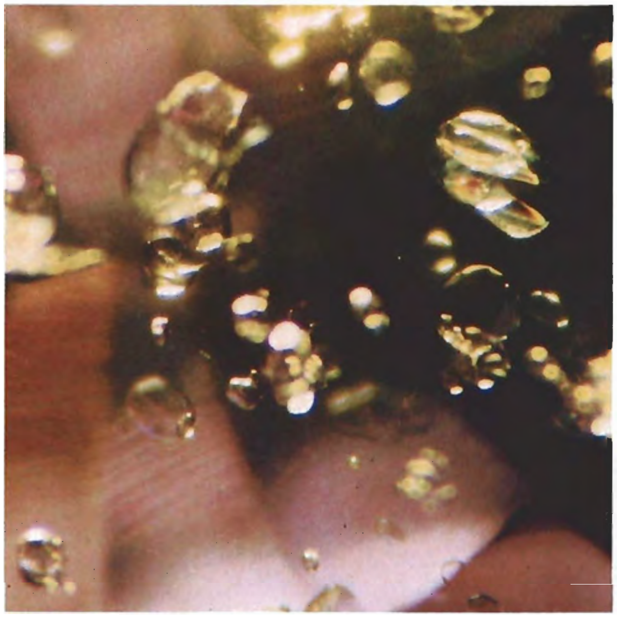


Figure 13. Phlogopite mica is a common inclusion in spinel found in central Sri Lanka. Magnified 35×, dark-field illumination.

tent varied slightly from 40.02 to 41.48 wt.%, and Al_2O_3 varied from 22.87 to 23.09 wt.%, whereas FeO and MgO contents were calculated as 18.14 to 15.82 wt.% and 13.93–15.01 wt.%, respectively. Less CaO (1.34–1.89 wt.%) and MnO (0.47–0.53 wt.%) were detected. On the basis of the data, these garnets can readily be classified as intermediate members of the pyrope-almandine solid-solution series (Manson and Stockton, 1981).

Optical Properties and Density. Refractive index and specific gravity were determined for 32 rhodolite and 20 hessonite garnets from Elahera. A refractive index range of 1.749-1.778, with a mean value of 1.765, was recorded for the rhodolites. These same stones varied in density from 3.80 to 3.95. The refractive indices of Elahera hessonite range from 1.734 to 1.738, with a density variation of 3.58 to 3.64.

The iron content in rhodolite garnets influences their absorption spectrum, which exhibits lines at 617, 576, 526, 505, 476, 438, 428, and 404 nm. The spectrum of the hessonite (also iron-related) shows peaks at 547, 490, and 435 nm.

Inclusions. Inclusions of rutile, apatite, and zircon seem to be common in the rhodolite garnets (figure 14). The apatite crystals were idiomorphic or euhedral. The internal appearance of the hessonite garnets is characterized by apatite crystals and swirl-like structural features.

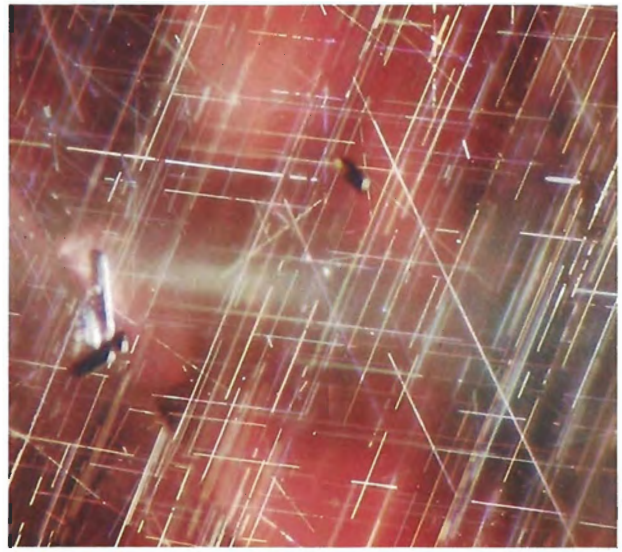


Figure 14. Idiomorphic apatite and three-dimensionally oriented rutile in a rhodolite garnet from Elahera. Magnified 30×, dark-field illumination.

Other Gem Materials. Twenty samples each of chrysoberyl, zircon, tourmaline, kornerupine, and sinhalite (see, for example, figure 15), as well as 10 samples of rare gem taaffeite, epidote, and sinhalite from Elahera were also studied. The gemological properties for these stones are reported in table 2. A number of the chrysoberyls, zircons, tourmalines, kornerupines, and sinhalites were also chemically analyzed by means of the microprobe and, in the case of zircon, by neutron activation analysis. Differences were noted in the chemistry of the Elahera stones as compared to that of similar material from other localities; the results of these analyses are available from the authors on request. Following are observations on some of the more important gems within this group.

Chrysoberyl. Brown, brownish green, and greenish yellow chrysoberyls (figure 15) are common in Elahera. Cat's-eye stones are also found here. The color-change variety, alexandrite, is seen, but only rarely.

When examined with the microscope, the Elahera chrysoberyls, including alexandrite and chatoyant stones, were found to be relatively clean and transparent. The most diagnostic features are growth zoning parallel to the crystallographic axes and liquid (monophase) inclusions. The growth zoning can be observed best under crossed polarized light (figure 16). The monophase inclusions occur as either feathery or single-cavity forma-

TABLE 2. Gemological properties of gem chrysoberyl, zircon, tourmaline, kornerupine, sinhalite, taaffeite, epidote, and sillimanite from the Elahera gem field.

Gem material[a]	Refractive index	Birefringence	Specific gravity	Absorption (in nm)[b]	Reaction to U.V. radiation: Long wave	Reaction to U.V. radiation: Short wave	Inclusions
Chrysoberyl							
Alexandrite (1)	α = 1.745 β = 1.749 γ = 1.755	0.010	3.70–3.72	680.5 (d) 678.5 (d) 665.0 (w) 655.0 (w) 649.0 (w) 640.0 to 560.0 (wd) 473.0 (wk) 468.0 (wk)	Weak reddish	Weak reddish	Growth zoning in various directions, liquid "feathers," and two-phase inclusions
Cat's-eye (5)	α = 1.741–1.745 γ = 1.750–1.757	0.009–0.012	3.70–3.74	445.0 (s)	None	None	Fine parallel oriented hollow tubes
Other colors (10)	α = 1.742 β = 1.748 γ = 1.757	0.008–0.015	3.71–3.73	504.0 (d) 495.0 (w) 485.0 (w) 445.0 (s)	None	None	Growth zoning in various directions, fingerprint-like liquid "feathers," and two-phase inclusions
Zircon							
Intermediate type (22)	ϵ = 1.838 ω = 1.830	0.006–0.008	4.04–4.06	653.5 (s) Many absorp. lines in the whole spectrum	Weak to distinct yellowish	Weak to distinct greenish yellow	Disc-like fissures, zircon crystals, various growth phenomena and partly healed "feathers"
Tourmaline (30)	ϵ = 1.618 ω = 1.638	0.018–0.020	3.04–3.07	A general absorption after 530.0	None	None	Zircon and apatite, negative crystals, and healed liquid "feathers"
Kornerupine (49)	α = 1.668 β = 1.679 γ = 1.680	0.012	3.33–3.36	503.0 (s) 446.0 (w) 430.0 (wk)	None	None	Apatite, zircon with circulating cracks, two-phase inclusions, and liquid "feathers"
Sinhalite (5)	α = 1.669 β = 1.702 γ = 1.706	0.036–0.037	3.48–3.49	525.0 (w) 493.0 (d) 475.0 (d) 463.0 (d) 452.0 (d) 435.0 (d)	None	None	Negative crystals and liquid "feather," two-phase inclusion
Taaffeite (5)	ϵ = 1.717 ω = 1.723	0.004–0.006	3.60–3.62		None	None	Well-formed apatite crystals; spinel, phlogopite mica, and zircon; "fingerprints" of negative crystals
Epidote (2)	α = 1.732 β = 1.746 γ = 1.767	0.035	3.44	457.0 (wk) 455.0 (s)	None	None	"Feathers" and growth lines parallel to the horizontal crystal axes
Sillimanite (3)	α = 1.660 β = 1.662 γ = 1.682	0.022	3.25	462.0 (d) 441.0 (d) 410.0 (wk)	None	None	Apatite and zircon with mica(?); "feathers" of negative crystals and liquid droplets; growth tubes parallel to one crystallographic axis in chatoyant stones

[a] *Number of stones examined is given in parentheses.*
[b] *d = distinct, s = strong, w = weak, wk = very weak*

Figure 15. This faceted light green chrysoberyl (8.95 ct) and the accompanying 17.57-ct crystal are representative of some of the material found at the Elahera gem field. Photo © Tino Hammid.

tions (figure 17). These inclusions are quite typical of Elahera alexandrite and can be used to distinguish it both from synthetics and from natural alexandrite found elsewhere.

Zircon. The various colors found at Elahera are either low or, most commonly, intermediate types. Brown, green, yellow, reddish brown, and yellowish brown zircons (figure 18) are mined here.

The chemistry and fluorescence behavior of zircon and its radioactive rare earth elements have been described in detail by Schwarz (1982) and Rupasinghe (1984). When viewed with the microscope, the Elahera zircons revealed many interesting internal features. Most abundant are the disclike fissures that parallel one another. These discs are randomly oriented with respect to crystallographic directions. Also noted were euhedral zircon crystals and secondary growth zoning.

Tourmaline. Elahera is not well known for tourmaline, but greenish brown and dark green stones are occasionally found (again, see figure 18). The Elahera tourmalines exhibit a yellowish brown pleochroism that is attractive when the stones are faceted in the proper direction. They are often clean and of good transparency. When viewed with the microscope, tourmalines from Elahera exhibit a large number of zircons, negative crystals, prismatic apatite crystals with two-phase inclusions, and various liquid and healed "feathers."

Kornerupine. Gem-quality kornerupine is quite abundant in Elahera. The most common colors

Figure 16. Polysynthetic twinning lamellae in natural alexandrite from Elahera. Magnified 25×, crossed polarized light.

Figure 17. Typical forms of liquid "feathers" and cavities in gem alexandrite from central Sri Lanka. Magnified 28×, transmitted illumination.

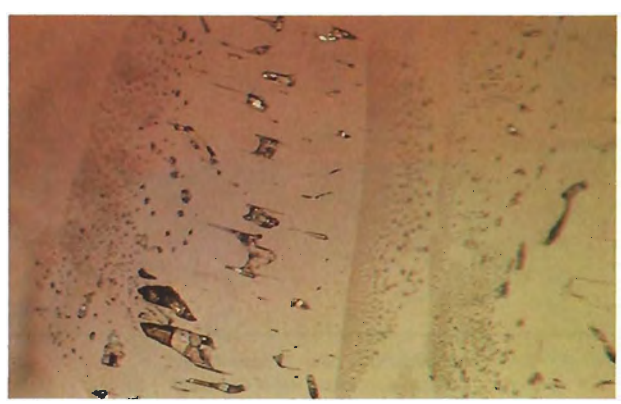


Figure 18. The color varieties shown here are typical of the following gems found at Elahera (clockwise, starting with the green stone at top): green zircon (4.43 ct), yellow zircon (2.78 ct), brownish green tourmaline (3.41 ct), reddish brown zircon (1.48 ct), green kornerupine (0.72 ct), dark green tourmaline (2.92 ct), and brownish yellow sinhalite (4.93 ct). Photo © Tino Hammid.

range from brownish green to greenish brown (again, see figure 18). Well-formed apatite and zircon crystals surrounded by tension fissures are common inclusions in Elahera kornerupines. Oriented two-phase inclusions were also seen in some of the stones studied.

Sinhalite. Near-colorless to brownish yellow sinhalite (figure 18) with good transparency is also often found in Elahera (Claringbull and Hey, 1952; Henn, 1985). When viewed with the microscope, the gem sinhalites from this region frequently appear clean. However, they occasionally exhibit a network of negative crystals and needle-like inclusions as described by Gunawardene and Gunawardene (1986).

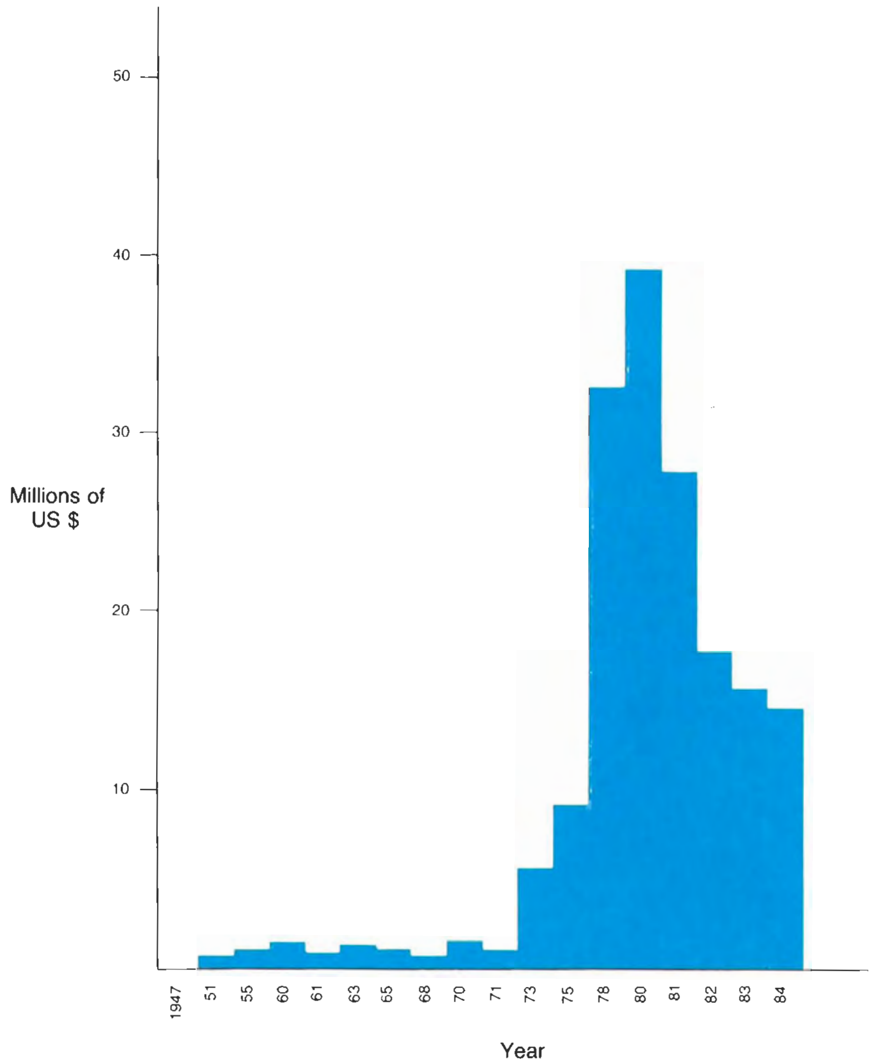


Figure 19. Export earnings by Sri Lanka for unset gemstones during the period 1947–1984, in U.S. dollars. Source: Sri Lanka Customs Department.

CURRENT PRODUCTION AND PROSPECTS FOR THE FUTURE

In Sri Lanka, the Elahera gem field is now second only to Ratnapura in the production of gemstones suitable for jewelry. While total exports of loose gems from Sri Lanka have dropped significantly from their 1980 peak of more than $40 million annually, they appear to have stabilized at between $15 million and $20 million in recent years (figure 19). Although specific production figures are as elusive for this locality as they are for most others, the authors estimate that Elahera contributes 35% of these exports, or approximately 15,000 kg of sapphires and 8,500 kg of other stones annually in recent years. The flow of gemstones from the Elahera district appears to be steady, so no significant fall-off in production is anticipated in the near future.

REFERENCES

Anderson B.W. (1964) Three stones for the record. *Journal of Gemmology*, Vol. 9, No. 7, pp. 215–221.

Anderson B.W., Payne C.J., Hey M.H. (1937) Magnesium-zinc-spinels from Ceylon. *Mineralogical Magazine*, Vol. 24, pp. 547–554.

Asadi B. (1985) Geochemische und petrographische untersuchungen an Edelstein-fuhrenden Gestein. Unpublished thesis, University of Mainz, West Germany.

Bank H. (1980) Sternspinelle aus Sri Lanka. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 29, No. 1/2, pp. 94–95.
Claringbull G.F., Hey M.H. (1952) Sinhalite, a new mineral. *Mineralogical Magazine*, Vol. 29, pp. 841-849.
Cooray P.G. (1978) *Geology of Sri Lanka*. In P. Nutaloya, ed., *Regional Conference on Geology and Mineral Resources, Southeast Asia*, Vol. 3, Bangkok, pp. 701–710.
Crowningshield R. (1983) Padparadscha: What's in a name? *Gems & Gemology*, Vol. 19, No. 1, pp. 30–36.
Dahanayake K. (1980) Modes of occurrence and provenance of gemstones of Sri Lanka. *Mineralium Deposita*, Vol. 15, p. 81.
Dahanayake K., Liyanage A.N., Ranasinghe A.P. (1980) Genesis of sedimentary gem deposits in Sri Lanka. *Sedimentary Geology*, Vol. 25, pp. 105–115.
Gübelin E. (1983) Identification of the new synthetic and treated sapphires. *Journal of Gemmology*, Vol. 18, No. 8, pp. 677–706.
Gunaratne H.S. (1981) "Geuda sapphires"—their colouring elements and their reaction to heat. *Journal of Gemmology*, Vol. 17, No. 5, pp. 292–300.
Gunawardene M. (1984) Contribution towards the identification of treated corundums: heat and diffusion treated rubies. *Journal of Gemmology*, Vol. 17, No. 4, pp. 298–310.
Gunawardene M., Gunawardene M. (1986) An unusual needle-like inclusion in gem sinhalite from Elahera, Sri Lanka. *Journal of Gemmology* (in press).
Hänni H.A. (1982) Characteristics of heat treated and diffusion treated corundums. *Journal Suisse de Horlogerie et de Bijouterie*, Vol. 5, 5 pp.
Henn U. (1985) Untersuchungen an Kornerupine und Sinhalit von Elahera, Sri Lanka. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 34, No. 1/2, pp. 13–19.
Manson D.V., Stockton C.M. (1981) Gem garnets in the red-to-violet color range. *Gems & Gemology*, Vol. 17, No. 4, pp. 191–204.
Munasinghe T., Dissanayake C.B. (1981) The origin of gemstones of Sri Lanka. *Economic Geology*, Vol. 76, No. 5, pp. 1216–1225.
Nassau K. (1981) Heat treating ruby and sapphire: technical aspects. *Gems & Gemology*, Vol. 17, No. 2, pp. 121–131.
Rupasinghe M.S. (1984) Radioactive gem minerals from Sri Lanka. *Journal of the Gemmologists Association of Sri Lanka*, Vol. 1, No. 1, pp. 5–12.
Rupasinghe M.S., Dissanayake C.B. (1986) Charnockites and the genesis of gem minerals of Sri Lanka. *Chemical Geology* (in press).
Scarratt K. (1983) Heat treated sapphires. *Retail Jeweler*, Vol. 22, No. 543, pp. 16 and 26.
Schmetzer K., Bank H. (1981) The colour of natural corundum. *Neues Jahrbuch für Mineralogie Monatshefte*, Vol. 2, pp. 59–68.
Schmetzer K., Bank H., Gübelin E. (1980) The alexandrite effect in minerals: chrysoberyl, garnet, corundum, fluorite. *Neues Jahrbuch für Mineralogie Abhandlungen*, Vol. 138, pp. 147–164.
Schmetzer K., Bosshart G., Hänni H.A. (1983) Naturally-coloured and treated yellow and orange-brown sapphires. *Journal of Gemmology*, Vol. 18, pp. 607–622.
Schwarz D. (1982) Chemismus und Fluoreszenzverhalten von Zirkon ($ZrSiO_4$). *Uhren, Juwelen, Schmuck*, Vols. 3 and 17, pp. 217–220 and 237–240, respectively.
Silva K.K.M.W. (1976) Some geological aspects of the Elahera gem field, Sri Lanka (abstract). Sri Lanka Association for the Advancement of the Sciences, 32nd Annual Session.
Zwaan P. (1982) Sri Lanka: The gem island. *Gems and Gemology*, Vol. 18, No. 2, p. 62–71.