ENSTATITE, CORDIERITE, KORNERUPINE, AND SCAPOLITE WITH UNUSUAL PROPERTIES FROM EMBILIPITIYA, SRI LANKA

By Pieter C. Zwaan

Gem-quality enstatite, cordierite, kornerupine, and scapolite with unusual properties have been recovered from alluvial deposits in the region of Embilipitiya, Sri Lanka. The occurrence of almost pure, completely colorless, enstatite appears to be unique in the world. The cordierites are also usually colorless and nonpleochroic. The diversity in the properties of kornerupine is mainly due to variations in the ratio of magnesium to iron. The strong "canary" yellow fluorescence of scapolites from this locality has not been observed in scapolites from other sources in Sri Lanka.

Since 1984, a group of mineralogists from Leiden, the Netherlands, have performed systematic field work in Sri Lanka. During the course of this research, they accumulated a representative collection of rocks and minerals from that country.

ABOUT THE AUTHOR

Dr. Zwaan is emeritus professor of gemology (Ph.D. Mineralogy) at Leiden University, The Netherlands, and retired director of the Netherlands Gemmological Laboratory, Leiden.

Acknowledgments: The author is much indebted to Dr. Charles E. S. Arps of the National Museum of Natural History, Leiden, for his cooperation, years of fieldwork in Sri Lanka, and critical reading of the manuscript; and to E. Gamini Zoysa, Mount Lavinia, Sri Lanka, for his valuable information and supply of material from different localities. The author also thanks E. A. J. Burke and W. J. Lustenhouwer, of the Institute of Earth Sciences, Free University of Amsterdam, for the Raman spectroscopy and electron microprobe analyses, respectively. D. van der Marel, of the National Museum technical staff, prepared the geologic map and photographed the cut stones. The financial support of the Foundation Stichting Dr. Schürmannfonds is gratefully acknowledged.

This article was developed in part from a paper presented at the 25th International Gemmological Conference in Rayong Resort, Thailand, October 1995. It was the last conference in which Robert C. Kammerling participated.

Gems & Gemology, Vol. 32, No. 4, pp. 262–269.

Although the well-known gem deposits of Ratnapura are still commercially the most important in Sri Lanka, other localities—such as Okkampitiya and Elahera—have also become interesting. Farther to the southeast, west of Kataragama, the Leiden researchers identified yet another locality of special mineralogic and gemological interest: Embilipitiya. Some gem minerals from this region were briefly described earlier (Zwaan, 1986). The present article discusses specific properties, and special aspects of these properties, for gem-quality enstatite, cordierite, kornerupine, and scapolite (figure 1).

GEM MINERALS FROM EMBILIPITIYA

Geoscientists have examined the geology, in particular the petrology, of Sri Lankan basement rocks for many years. To date, however, there has been no clear explanation for the origins of most of the gem minerals. The best summary of the results obtained thus far are the recent article by Dissanayake and Rupasinghe (1995) and the book by Gunaratne and Dissanayake (1995). Most important gems are recovered from alluvial deposits; the few gem minerals that have been traced to their *in situ* sources are not commercially important (i.e., of cutting quality).

Embilipitiya is a small village about 70 km (1.5 hours) by road southeast of Ratnapura. The village has a population of about 300 and is situated in a flat valley, about 25 km^2, surrounded by distant hills. The region is tropical, with both wet and dry seasons. Petrologically, it is in the Highland Complex, which contains Precambrian rocks of the metamorphic granulite facies (figure 2). Most of the gem deposits in Sri Lanka are located within this complex.

A variety of gem-quality minerals are found in the Embilipitiya region, in an area of about 6 km^2, primarily in alluvial deposits. Locals engage in small-scale primitive mining, digging narrow pits in the alluvium to a depth of 1.5–2 m (figure 3) to reach the gem-bearing gravels.

Of special interest, because of their unusual gemological properties, are scapolite and the Mg-rich minerals enstatite, cordierite, and kornerupine. Other gem minerals from this area include garnets, mainly almandine, and spinels. Since our first trip in 1984, we have visited the area several times and obtained several hundred carats of these unusual minerals from local inhabitants. During the last five years, however, greater demand by cutters and decreasing production have made it difficult to obtain more samples. These minerals are found mostly as broken and corroded fragments, seldom as rounded pebbles. Kornerupine is the most common of the four gems discussed in this article.

MATERIALS AND METHODS

During fieldwork in 1984, the author and his colleagues discovered Embilipitiya on the way from Ratnapura to gem localities in the southeast. At a lunch stop in the village, native people showed us *dullam*, pieces of rough gem minerals, that they were offering for sale. According to these villagers, the minerals came from the Embilipitiya area. At that time, we purchased about 3 kg of material, with a preponderance of colorless specimens. When we inspected these materials at the Netherlands Gemmological Laboratory in Leiden, we found that most of the samples were garnets and spinels, but we also identified a number of much less common gem minerals. During subsequent trips to Sri Lanka, we visited the village regularly and purchased almost every lot that was available.

Within the sample minerals were many fragments without crystal faces but with a recognizable—though usually corroded—prismatic habit. Using a polarizing microscope, we were able to group hundreds of specimens by species. The enstatites were selected for further study because of their range of color, from colorless to deep brown. About 20 rough specimens with a prismatic habit, approximately 10 to 30 mm long, were confirmed to be enstatite by their absorption spectra. In addition, we examined 10 cut enstatites; the largest was a 10.67 ct colorless specimen.

Figure 1. These four gem materials—cordierite (left, 3.75 ct), enstatite (top, 7.69 ct), scapolite (right, 3.08 ct), and kornerupine (bottom, 1.52 ct) —from the Embilipitiya area of Sri Lanka were found to have unusual gem properties. Photo by Shane F. McClure.

From among the cordierites, we selected about 40 rough samples (15 to 20 mm each) for further study. Most of these were nearly colorless, but some were pale blue. They were easily distinguished from the enstatites by their behavior in ethylene dibromide, in which the cordierites are almost invisible. Five cut stones, the largest of which was 3.75 ct, were available for examination.

A total of 56 rough kornerupines, varying in size from 5 to 20 mm and in weight from 0.91 ct (dark green) to 13.03 ct (dark brown), were selected for detailed study on the basis of their colors, inclusions, and physical properties (specimens with low and high refractive indices and specific gravities were represented). In addition, nine cut stones, the largest of which was 4.56 ct, were examined.

We examined 10 rough scapolites in detail. These were irregular, long prismatic, colorless-to-yellow pieces that ranged from 3.66 to 7.06 ct in weight and from 12 to 16 mm in their longest dimension. In addition, we studied seven cut scapolites from Embilipitiya, ranging from 0.80 ct (yel-

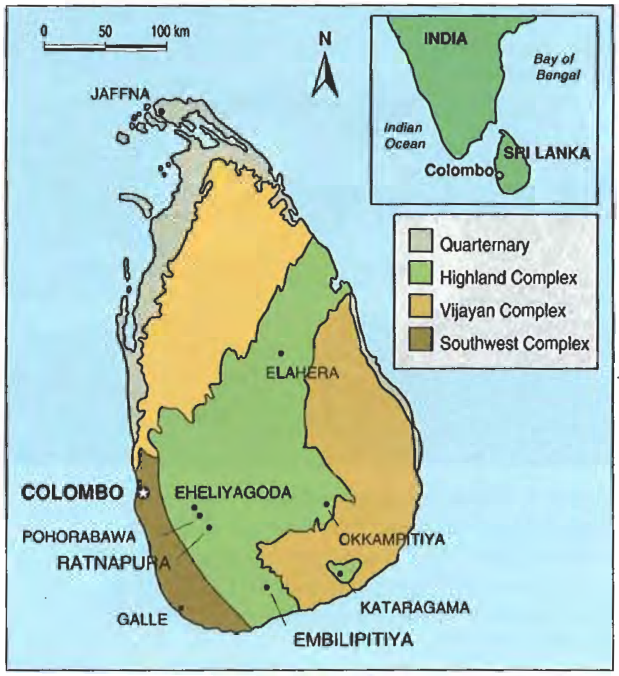

Figure 2. The village of Embilipitiya is about 70 km southeast of Ratnapura. It is in the Highland Complex, one of the main Precambrian geologic complexes that comprise the island nation of Sri Lanka.

low) to 17.79 ct (colorless), and compared their properties to those of 17 cut scapolites from elsewhere in the world. *Scapolite* is the name given to an isomorphous series in which marialite and meionite are the Na-rich and Ca-rich end members, respectively. The intermediate members are usually indicated by their molecular percentage (mol.%) of meionite.

The physical properties of all specimens were measured by standard gemological methods; for this purpose, two flat parallel faces were polished on each, thus forming a window. A Rayner refractometer with an yttrium aluminum garnet (YAG) prism was used to measure the refractive indices and birefringence. Specific gravity was determined with a hydrostatic balance.

The absorption spectra of all specimens were observed with both an Eickhorst handheld prism spectroscope and a Philips UV/ViS spectrometer (model PU 8730). X-ray powder diffraction photographs were taken on representative samples of all gem minerals using a Debye-Scherrer camera on an Enraf-Nonius Diffractis 582 apparatus. Chemical analyses were performed on eight kornerupines and six scapolites using an electron microprobe (JEOL model JXA-8800M), with three to five analyses per sample and the results averaged. The inclusions, mainly in the kornerupines and scapolites, were identified with a laser Raman microspectrometer (Dilor S.A. model Microdil-28).

ENSTATITE

The enstatites ($Mg_2Si_2O_6$) varied from colorless to deep brown (figure 4). The colorless stones had exceptionally low refractive indices (as low as n_α =1.650 and n_γ=1.658) and specific gravities (as low as 3.194). Microprobe analysis of one colorless stone revealed that 99.4 mol.% of the magnesium sites in this stone were occupied by Mg. This composition is very near the magnesium end-member of the enstatite-ferrosilite series. In fact, these were

Figure 3. The gems are recovered from shallow (about 1.5–2 m) alluvial pits in the Embilipitiya area. Photo by Pieter C. Zwaan.

Figure 4. The high-Mg enstatites from Embilipitiya are among the purest natural enstatites known. The enstatites shown here were all part of the study sample; the colorless 10.67 ct oval in the center is 20.5 mm in longest dimension.

the purest natural enstatites ever examined at the Netherlands Gemmological Laboratory.

The sample specimens had a distinct to very strong narrow absorption band at 506 nm, due to ferrous iron. The intensity of this band—which was present, though weak, even in the colorless stones—increased with the saturation of the brownish color, that is, with the Fe content. This absorption band was found to be characteristic of this material and, therefore, of diagnostic value. Most of the stones were relatively inclusion free, but some contained well-developed quartz crystals and two-phase inclusions. (For additional information on enstatites from this locality, see Zwaan, 1987.)

CORDIERITE

We prefer the mineral name *cordierite* ($Mg_2Al_4Si_5O_{18}$), instead of the gem names *iolite* or *dichroite*, for these colorless stones. All the crystals we examined had a prismatic habit and were broken and corroded. We found little variation in their physical properties (refractive indices and specific gravity). Their refractive indices varied from 1.520 (lowest n_α) to 1.541 (highest n_γ), and they had an average specific gravity of 2.570. Pleochroism, usually a diagnostic property for cordierite, was not visible because of the lack of color. In most cordierites, iron (and other trace elements) can substitute for Mg, producing color. However, microprobe analyses showed that these cordierites were very rich in Mg, up to 95 mol.% of the possible Mg sites. These confirm earlier microprobe analyses of some specimens (Zwaan, 1986), which also showed relatively high Mg content.

To the unaided eye, when cut these cordierites (see, e.g., figure 5) strongly resembled colorless enstatites from the same locality. Immersion in ethylene dibromide, however, was sufficient to separate the two gem minerals easily, because the R.I. of the liquid is very similar to that of cordierite. In addition, the cordierites do not have the 506 nm absorption band in the blue that is found in enstatite. Liquid inclusions were common but not of any diagnostic value.

KORNERUPINE

Although considered rare (see, e.g., Webster, 1994), hundreds of carats of kornerupine [$Mg_4(Al,Fe^{+3})_6(Si,B)_4O_{21}(OH)$] have been found in the Embilipitiya deposits (see also Zwaan, 1986, 1992). The author and colleagues saw large quantities of crystal fragments, varying from light brownish yellow, brown, or green to dark brown and dark grayish green (see, e.g., figure 6). Most of the specimens we examined were irregular in shape, because of fractures, and were corroded. Because we did not observe any crystal faces, we could not identify a typical habit. Note that chatoyant kornerupine has not yet been reported from this area.

Specific gravity, ranging from 3.283 to 3.346, generally increased with color intensity (table 1).

Figure 5. Also very high in Mg, the cordierites from Embilipitiya strongly resemble colorless enstatites from this locality. Here, the largest cordierite weighs 3.75 ct and is 11.8 mm long.

Figure 6. Kornerupine is usually considered a rare gem material. However, the author saw hundreds of carats of gem-quality kornerupines in Embilipitiya, which ranged from light brownish yellow to the dark brown and dark green stones shown here (the 4.56 ct stone at the center top is 12.3 mm in longest dimension).

Light brown specimens rose in methylene iodide (S.G. = 3.32), while dark brown samples slowly sank in this liquid. This behavior in methylene iodide, together with the very strong pleochroism in tones of greenish yellow and brownish yellow, appears to be a reliable test for kornerupine specific to this locality: Every green-to-brown strongly pleochroic gemstone from Embilipitiya that either rose or sank slowly in methylene iodide was kornerupine. The refractive indices varied from the lowest n_α of 1.665 (for a light brown specimen) to the highest n_γ of 1.690 (for a medium brown sample). The birefringence, however, was usually 0.012.

Electron microprobe analyses of eight rough specimens, onto which one or two flat faces had been polished, indicated that the color intensity tended to be directly proportionate to the Fe content (again, see table 1). In general, pale kornerupines have distinctly lower S.G.'s and R.I.'s than dark kornerupines, but hue (that is, whether the stone is brown or green) has no effect on these properties.

Most of the Embilipitiya kornerupines we examined had interesting inclusions. The solid inclusions were identified by Raman spectroscopy. Well-crystallized black inclusions with a submetallic luster, seen in about 25 samples, were found to be rutile. One specimen also had red crystals of rutile (figure 7). Another common inclusion was colorless zircon, often with beautiful haloes in polarized light (figure 8). Rounded apatite crystals occurred frequently. However, elongated quartz

TABLE 1. Properties, including electron microprobe analyses, of eight rough kornerupines [$Mg_4(Al,Fe^{+3})_6(Si,B)_4O_{21}(OH)$] from Embilipitiya, Sri Lanka.

	Sample							
Properties	A 1	A 2	A 3	A 4	A 5	A 6	A 7	A 8
Color	Light green	Brown	Dark brown	Light brown	Green	Dark green	Medium brown	Green
Weight (ct)	1.91	3.17	13.03	4.63	3.39	0.91	1.59	1.79
Oxides (wt.%)								
SiO_2	31.87	31.36	30.23	31.79	30.98	31.35	30.95	31.51
TiO_2	0.00	0.05	0.10	0.04	0.05	0.01	0.06	0.04
Al_2O_3	42.36	44.75	44.71	44.15	43.37	43.08	43.36	42.05
Fe_2O_3	1.85	2.51	6.61	1.63	5.40	5.13	5.17	4.60
MgO	19.55	18.49	15.82	19.52	17.21	17.62	17.39	17.80
MnO	0.01	0.02	0.05	0.03	0.07	0.10	0.05	0.05
CaO	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02
Na_2O	0.02	0.03	0.02	0.02	0.02	0.03	0.02	0.02
Total[a]	95.67	97.22	97.55	97.19	97.11	97.34	97.01	96.09
S.G.	3.288	3.283	3.346	3.284	3.337	3.339	3.335	3.332
n_α	1.668	1.669	1.672	1.665	1.678	1.672	1.678	1.668
n_γ	1.679	1.681	1.685	1.677	1.687	1.684	1.690	1.680
Birefringence	0.011	0.012	0.013	0.012	0.009	0.012	0.012	0.012

[a] *Note: The element B and the OH group could not be detected by the analytical method employed; hence, the totals are less than 100%.*

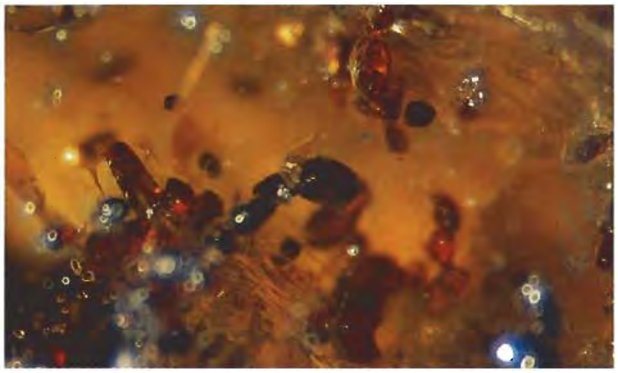

Figure 7. This Embilipitiya kornerupine specimen was observed to have red as well as black rutile crystals. Photomicrograph by Pieter C. Zwaan; magnified 35×.

and tourmaline inclusions, observed parallel to one another, were seen only occasionally. Some kornerupines revealed red-orange hexagonal plates of hematite. Many liquid and liquid-and-gas inclusions were also seen.

To summarize, kornerupines from Embilipitiya can be easily identified by their strong pleochroism and their behavior in methylene iodide. Pale-colored specimens contained considerably less iron than dark-colored samples. There were no distinctive differences between the optical (R.I.) and physical (S.G.) properties of brown and green kornerupines. Rutile appears to be a typical inclusion in kornerupine from this locality.

SCAPOLITE

The crystal fragments and faceted scapolites [$Na_4Al_3Si_9O_{24}Cl$—$Ca_4Al_6Si_6O_{24}(CO_3,SO_4)$] we examined were, for the most part, colorless to pale yellow (figure 9). We found that scapolites from Embilipitiya have mean refractive indices of n_ε = 1.550 and n_o = 1.578, an average specific gravity of 2.694, and an average meionite content of 59.4 mol.% (table 2). They fluoresce a strong "canary" yellow to long-wave UV radiation, comparable to the well-known fluorescence of scapolite (wernerite) from Quebec, Canada. This UV reaction is generally ascribed to sulfur (Webster, 1994).

Although most of these samples were remarkably clean, some contained yellow needle-shaped crystals, which Raman spectroscopy identified as pyrrhotite (figure 10). Pyrrhotite inclusions in scapolite have been mentioned by others (Graziani and Gübelin, 1981; Gübelin and Koivula, 1986).

The pale yellow faceted scapolites from Embilipitiya resemble some other gemstones from Sri Lanka, such as citrine and feldspar. However, the scapolites can be differentiated readily by their strong yellow fluorescence and their much stronger birefringence (0.028).

X-ray diffraction patterns were obtained from six samples. As expected, these patterns were almost identical to one another and were characteristic of scapolites in general.

Electron microprobe analyses were made of two scapolites from Embilipitiya and four scapolites from other sources (one each from Pakistan and Brazil, and two from Pohorabawa, a small village in the Eheliyagoda area that is the major source of colorless scapolite in Sri Lanka; figure 9). As evident in table 2, there were remarkable differences in chlorine content, and thus the marialite/meionite ratio, among the various scapolites.

Note also in table 2 that the one violet scapolite has the lowest specific gravity, refractive indices, birefringence, and meionite content (7.66 mol.%). Previously, the scapolites from East Africa were thought to have the lowest meionite content (10.80 mol.%; Zwaan, 1979). However, the meionite content of this violet scapolite from Pakistan was even lower. The properties of Embilipitiya scapolite, on the other hand, are very similar to those reported for scapolite from Madagascar (n_ε = 1.550, n_o = 1.571; S.G. = 2.686: Bank and Nuber,

Figure 8. In addition to the black rutile crystals, this Embilipitiya kornerupine specimen revealed zircon crystals with haloes visible in polarized light. Zircon is a common inclusion in this material. Photomicrograph by Pieter C. Zwaan; magnified 35×.

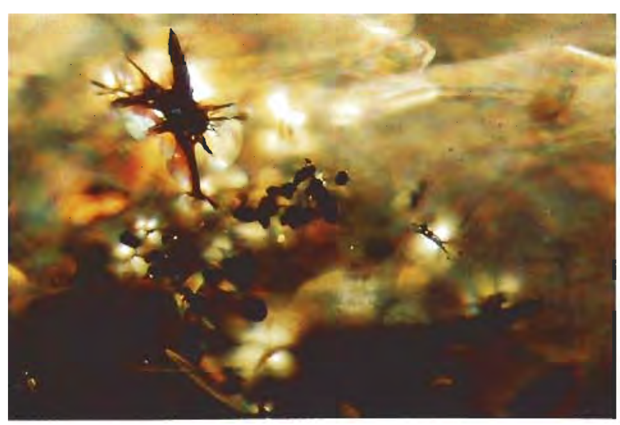

Figure 9. The study of Embilipitiya scapolites included stones from different localities. For example, the 1.58 ct violet triangle-cut scapolite is from Pakistan; the 3.01 ct yellow triangle cut is from Pohorabawa, Sri Lanka, as is the 17.79 ct colorless emerald-cut stone; and the 3.08 ct yellow marquise cut is from Embilipitiya.

1970; Zwaan and Arps, 1980), although the latter do not have the strong yellow fluorescence.

DISCUSSION: SPECIAL ASPECTS OF THE EMBILIPITIYA GEM MINERALS

All four of these gem materials are of special interest both mineralogically and gemologically. The enstatites have very uniform chemical compositions, which is consistent with the fact that they came from a very limited area. The extremely high Mg content of these truly colorless enstatites has not been reported in gem enstatites from any other locality. It is of particular interest that all the enstatites from Embilipitiya can be readily identified with a simple hand spectroscope, by the presence of the 506 nm absorption band.

Like the enstatites, the cordierites also showed little variation in chemical composition from one sample to the next; they, too, were found to have a very high Mg content. The refractive indices and specific gravities of the specimens tested were extremely low. The complete lack of color in most of the samples is exceptional for cordierite, as is the resulting absence of pleochroism.

Kornerupine occurs abundantly in different tones of green and brown. The extremely strong pleochroism, combined with a number of very interesting inclusions (in particular rutile, zircon, and apatite), make it an attractive collector's gemstone.

The chemical composition of the Embilipitiya scapolites varied little from stone to stone. The strong "canary" yellow fluorescence is a very interesting property that has not been found in other Sri Lankan scapolites (although it has been seen in scapolites from other localities).

The Mg-rich minerals in this area are probably derived from originally high-Mg rocks that have been subjected to deep-seated high-grade metamorphism. These are now represented by metamorphic rocks (i.e., metamorphic granulite facies of the Highland Complex), such as hypersthene gneisses (charnockites), sillimanite-garnet gneisses (khondalites), biotite-garnet gneisses, and crystalline limestones (marbles).

Orthopyroxenes, particularly enstatite, are typical minerals of the granulite facies (Deer et al., 1978). They also occur together with cordierite in medium-pressure/high-temperature metamorphosed pelitic rocks. Kornerupine is a typical mineral in high-grade regional and contact metamorphic rocks, whereas scapolite is commonly found in marbles, calcareous gneisses, and granulites. Petrologic studies have shown that many granulite facies rocks elsewhere in the Highland/Southwest Complex are also Mg rich. However, those in the Embilipitiya area seem to be inordinately so.

The gem minerals in Embilipitiya are mined from alluvial deposits. Strongly weathered granulites that contain enstatite were encountered in the field. These might be the host rocks in which

Figure 10. Some of the Embilipitiya scapolites contained needle-like pyrrhotite crystals. Photomicrograph by Pieter C. Zwaan; magnified 35×.

TABLE 2. Properties, including electron microprobe analyses, of six scapolites [$Na_4Al_3Si_9O_{24}Cl$—$Ca_4Al_6Si_6O_{24}(CO_3,SO_4)$] from Sri Lanka and elsewhere.

Properties	Sample 1004	RGM 164299	3.01	1006	98-5	R9
Origin	Pakistan	Brazil	Pohorabawa Sri Lanka		Embilipitiya Sri Lanka	
Color	Violet	Yellow	Yellow	Colorless	Yellow	Yellow
Form	Cut	Rough	Cut	Cut	Cut	Rough
Weight (ct)	1.58	19.88	3.01	8.03	1.13	4.47
Oxides (wt.%)						
SiO_2	62.11	55.96	55.16	55.35	48.56	49.15
TiO_2	0.05	0.02	0.04	0.01	0.02	0.03
Al_2O_3	19.07	22.83	22.47	22.71	26.00	26.16
Fe_2O_3	0.06	0.07	0.16	0.10	0.05	0.08
MnO	0	0.03	0.04	0.02	0.01	0.01
MgO	0	0	0.02	0	0.04	0.04
Na_2O	12.06	9.55	8.64	8.59	4.91	4.94
K_2O	1.45	1.24	1.40	1.32	1.04	0.95
CaO	1.87	6.88	7.55	8.16	14.55	14.77
SO_3	0.11	0.03	0.62	0	0.06	0.07
F	0	0.01	0.09	0.07	0.03	0.01
Cl	3.92	3.44	2.72	2.87	0.99	1.00
F=O	0	0	–0.04	–0.03	–0.01	0
Cl=O	–0.88	–0.78	–0.61	–0.65	–0.22	–0.23
Total[a]	99.82	99.28	98.26	98.52	96.03	96.98
Meionite (mol.%)	7.66	27.07	30.92	32.51	59.21	59.69
S.G.	2.584	2.622	2.651	2.632	2.694	2.694
n_ε	1.533	1.540	1.544	1.542	1.550	1.550
n_o	1.540	1.557	1.560	1.559	1.578	1.578
Birefringence	0.007	0.017	0.016	0.017	0.028	0.028

[a]*Note: The carbonate (CO_3) content of the samples could not be detected by the analytical method employed; hence, the totals are less than 100%.*

the gem minerals originally formed. In other parts of Sri Lanka, gem minerals that occurred in secondary deposits were found *in situ* in basement rocks; with the exception of some almandine garnets, however, none of the minerals found *in situ* thus far have been of gem quality.

REFERENCES

Bank H., Nuber B. (1970) Durchsichtiger Skapolith aus Moçambique. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 19, No. 2, pp. 47–54.

Deer W.A., Howie R.A., Zussman J. (1978) *Rock-Forming Minerals*, Vol. 2A. Longman Group Ltd., London.

Dissanayake C.B., Rupasinghe M.S. (1995) Classification of gem deposits of Sri Lanka. *Geologie en Mijnbouw*, Vol. 74, No. 1, pp. 79–88.

Graziani G., Gübelin E. (1981) Observations on some scapolites of central Tanzania. *Journal of Gemmology*, Vol. 17, No. 6, pp. 395–405.

Gübelin E.J., Koivula J.I. (1986) *Photoatlas of Inclusions in Gemstones*. ABC Edition, Zürich, Switzerland.

Gunaratne H.S., Dissanayake C.B. (1995) *Gems and Gem Deposits of Sri Lanka*. Publication of the National Gems and Jewellery Authority of Sri Lanka, Unigraphs (Pte) Ltd., Colombo, Sri Lanka.

Webster R. (1994) *Gems, Their Sources, Descriptions and Identification*, 5th ed. Rev. by P. G. Read, Butterworth-Heinemann Ltd., Oxford, England.

Zwaan P.C. (1979) More data on violet gem scapolite, probably from Eastern Africa. *Journal of Gemmology*, Vol. 16, No. 7, pp. 448–451.

Zwaan P.C. (1986) Gem minerals from the Embilipitiya and Kataragama areas in Sri Lanka. *Australian Gemmologist*, Vol. 16, No. 2, pp. 35–40.

Zwaan P.C. (1987) Orthopyroxenes from the Embilipitiya area in Sri Lanka. *Schweizerische Mineralogische und Petrographische Mitteilungen*, Vol. 67, pp. 119–125.

Zwaan P.C. (1992) La kornérupine d'Embilipitiya, Sri Lanka. *Revue de Gemmologie*, No. 110, pp. 5-6.

Zwaan P.C., Arps C.E.S. (1980) Properties of gem scapolites from different localities. *Zeitschrift der Deutschen Gemmologischen Gesellschaft*, Vol. 29, No. 1-2, pp. 82–85.