# INVESTIGATION OF A CAT'S-EYE SCAPOLITE FROM SRI LANKA

*By K. Schmetzer and H. Bank*

*A cut gemstone with intense chatoyancy that originated from Sri Lanka was determined to be a member of the scapolite solid-solution series. Indices of refraction and unit-cell dimensions were found as $\omega = 1.583$, $\epsilon = 1.553$ and $\underline{a} = 12.169$, $\underline{c} = 7.569$ Å, respectively; a meionite content of 69% was established by microprobe analysis. The chatoyancy is caused by needle-like inclusions with an orientation parallel to the c-axis of the scapolite host crystal. Microprobe analysis of these needles showed them to be pyrrhotite.*

Natural scapolites are members of the solid-solution series marialite, $Na_8[(Cl_2,SO_4,CO_3)\,|\,(AlSi_3O_8)_6]$, and meionite, $Ca_8[(Cl_2,SO_4,CO_3)\,|\,(Al_2Si_2O_8)_6]$. Scapolite crystals of gem quality occur colorless and in white, gray, yellow, pink, and violet. Cut gemstones are known from Burma, Brazil, Sri Lanka, Madagascar, Mozambique, Canada, Kenya, and Tanzania. Scapolites with chatoyancy, so-called cat's-eye scapolites, are known from Burma, Sri Lanka, Madagascar, and Tanzania. In general, the cat's-eye effect in this gem material is caused by needle- or rod-like inclusions running in a direction parallel to the optical axis of the tetragonal scapolite. These inclusions have been described in scapolites from Burma as rod-like cavities (Webster, 1975) or as needles of doubly refractive crystals (Eppler, 1973). In cat's-eye scapolites from Sri Lanka, parallel fibers or channels have been mentioned (Gübelin, 1968); samples from Madagascar contain hollow channels, liquid-filled channels, and needles of doubly refractive crystals (Eppler, 1958, 1973). The cat's-eye effect in scapolites from Tanzania is due to reddish brown inclusions of iron oxides or hydroxides; Tanzanian scapolites with asterism caused by two sets of parallel inclusions are known but are very rare (Schmetzer et al., 1977). By careful investigation of the mineral inclusions of two Tanzanian scapolites (chatoyancy not mentioned), the different mineral phases filling numerous growth tubes were determined to be lepidocrocite and $Fe_2O_3$ (maghemite or hematite). Furthermore, hexagonal plates up to 0.4 × 0.4 mm in size with metallic luster were determined to be pyrrhotite in these samples (Graziani and Gübelin, 1981).

This article describes a scapolite crystal from Sri Lanka that was cut into a 1.68-ct cabochon (approximately 9 mm × 5 mm) with particularly intense chatoyancy (figure 1). The ray of light crossing the surface of the cabochon is relatively broad compared to the sharpness of rays in other gemstones with chatoyancy or asterism, such as the more familiar cat's-eye chrysoberyls or asteriated corundum. The physical and chemical properties of this cat's-eye scapolite are presented, and the cause of the distinctive chatoyancy in this stone is explained.

## PHYSICAL AND CHEMICAL PROPERTIES

A small facet was cut and polished on the bottom of the cabochon in order to determine the refractive indices. The crystal was optically uniaxial negative with $\omega = 1.583(1)$, $\epsilon = 1.553(1)$, $\Delta = 0.030$. Using common gemological determinative tables, we identified the stone as a member of the scapolite solid-solution series. This result was confirmed by the X-ray powder diffraction pattern of the sample (Debye-Scherrer camera, diameter 114.6 mm, $FeK_\alpha$-radiation). From the powder pattern, the unit-cell dimensions were calculated as $\underline{a} = 12.169(3)$, $\underline{c} = 7.569(2)$ Å, $V = 1120.9$ Å$^3$.

Chemical data for the sample were determined by microprobe analysis (ARL-SEMQ). A meionite content of the scapolite was calculated as 69 wt% using the formula:

$$\%\ \text{meionite} = Ca/(Na+K+Ca) \times 100$$

The sulfate ($SO_3$) content of the sample was 0.46 wt%.

*ABOUT THE AUTHORS*

*Dr. Schmetzer is a research associate and Dr. Bank is an honorary professor at the Mineralogisch-Petrographisches Institut der Universität Heidelberg, D-6900 Heidelberg, Federal Republic of Germany.*

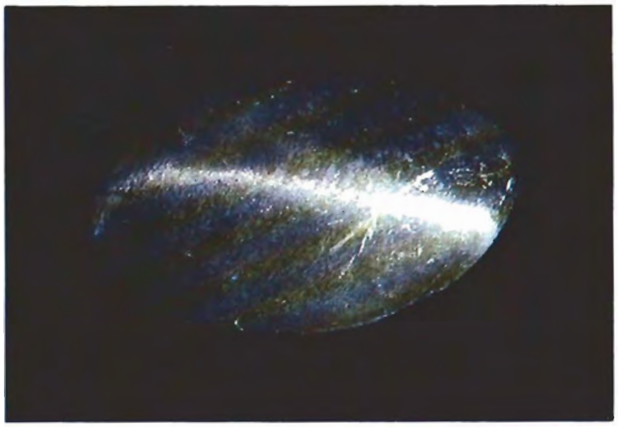

*Figure 1. A 1.68-ct cat's-eye scapolite from Sri Lanka. Photo by E. Medenbach, Bochum.*

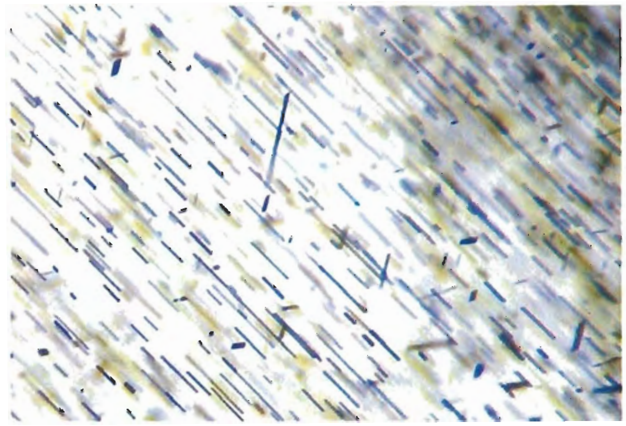

*Figure 2. Needle-like inclusions of pyrrhotite in scapolite from Sri Lanka. Magnified 30×. Photomicrograph by Th. Lind, Heidelberg.*

In the scapolite solid-solution series, the unit-cell dimension a as well as both refractive indices $\omega$ and $\epsilon$ increase with the increasing meionite content of the sample, whereas the unit-cell dimension c remains more or less constant (Eugster et al., 1962; Deer et al., 1968; Tröger, 1971; Ulbrich, 1978). Comparing the physical data of the scapolite investigated here with the optical data and unit-cell dimensions of scapolites with similar chemical compositions, as given in the literature, we found a good congruence of all values. The meionite content of approximately 70%, as established by microprobe analysis, was confirmed. Several scapolites with a composition near 70% meionite have been described in the literature (Ingamells and Gittins, 1967; Evans et al., 1969; Ulbrich, 1973; Graziani and Lucchesi, 1982); though rarer, cut gem scapolites of similar composition have also been mentioned in various articles (Krupp and Schmetzer, 1975; Dunn et al., 1978; Graziani and Gübelin, 1981; see also, Zwaan and Arps, 1980).

## THE CAUSE OF CHATOYANCY

The chatoyancy in the scapolite described in this article is caused by needle- or rod-like inclusions preferentially oriented parallel to the optical axis of the scapolite host crystal. Some of the needles, however, are also observed in an orientation different from this direction (as in figure 2). Identification of these needle-like inclusions was difficult because of their small size. Some of these inclusions ran in a direction perpendicular to the small facet that had been cut and polished for optical purposes; they were found to average 1 to 2 $\mu$m in diameter, with some even smaller. A qualitative microprobe analysis showed that the needles contained only iron and sulfur as the main elements. Quantitative analysis, however, was difficult. Because of the small diameter of the needles, only a quantitative analysis of both the inclusions and the scapolite host crystal could be done by the microprobe. Analyzing those needles of maximum diameter, we found iron contents of 22.4 to 31.8 wt%, and sulfur contents of 17.0 to 22.0 wt%. The atomic proportions of both elements calculated from these measurements, however, were found to be constant within the normal limits of error by microprobe analysis. Therefore, these data are thought to be useful for the determination of the inclusions. Ignoring the small analytical error caused by the 0.46% $SO_3$ content of the scapolite host crystal, we calculated the Fe/Fe+S atomic ratio to be in the range of 0.431 to 0.454. These values correspond to the ratio of these elements in pyrrhotite, $Fe_{1-x}S$ (Craig and Scott, 1974). The determination of pyrrhotite plates in scapolites of similar chemical composition by Graziani and Gübelin (1981) is in agreement with this finding.

A distinct cat's-eye effect is caused in a gemstone cut with a curved surface (cabochon) by the scattering of light by parallel needle-like inclusions and the refractive effect of the surface of the cabochon (Weibel et al., 1980; Wüthrich and Weibel, 1981). Since some of the needle-like inclusions in this scapolite from Sri Lanka are oriented in directions other than parallel to the optical axis, a broad ray of light is formed on the cabochon's surface; this ray is less sharp than those commonly seen in cat's-eye chrysoberyls, in which only one distinct orientation of the needle-like inclusions is observed.

## REFERENCES


Craig J.R., Scott S.D. (1974) *Sulfide Phase Equilibria.* Mineralogical Society of America, Short Course Notes, Vol. 1, Sulfide Mineralogy, Boulder, CO.

Deer W.A., Howie R.A., Zussman J. (1963) *Rock-Forming Minerals, Vol. 4, Framework Silicates.* Longman, London, England.

Dunn P.J., Nelen J.E., Norberg J. (1978) On the composition of gem scapolites. *Journal of Gemmology,* Vol. 16. No. 1, pp. 4–10.

Eppler W.F. (1958) Notes on asterism in spinel and chatoyancy in chrysoberyl, quartz, tourmaline, zircon and scapolite. *Journal of Gemmology,* Vol. 6, No. 6, pp. 251–263.

Eppler W.F. (1973) *Praktische Gemmologie.* Rühle-Diebener, Stuttgart, Germany.

Eugster H.P., Prostka H.J., Appleman D.E. (1962) Unit-cell dimensions of natural and synthetic scapolites. *Science,* Vol. 137, pp. 853–854.

Evans B.W., Shaw D.M., Haughton D.R. (1969) Scapolite stoichiometry. *Contributions to Mineralogy and Petrology,* Vol. 24, pp. 293–305.

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

Graziani G., Lucchesi S. (1982) The thermal behavior of scapolites. *American Mineralogist,* Vol. 67, No. 11/12, pp. 1229–1241.

Gübelin E. (1968) *Die Edelsteine der Insel Ceylon.* Gübelin, Lucerne, Switzerland.

Ingamells C.O., Gittins J. (1967) The stoichiometry of scapolite. *Canadian Mineralogist,* Vol. 9, Part 2, pp. 214–236.

Krupp H., Schmetzer K. (1975) Hochlichtbrechender Skapolith aus Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* Vol. 24, p. 162.

Schmetzer K., Gübelin E., Medenbach O., Krupp H. (1977) Skapolith-Katzenauge and Sternskapolith aus Zentral-Tansania. *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* Vol. 26, pp. 3–5.

Tröger W.E. (1971) *Optische Bestimmung der gesteinsbildenden Minerale, Teil 1 Bestimmungstabellen, 4. Auflage.* Schweizerbart, Stuttgart, Germany.

Ulbrich H.H. (1973) Crystallographic data and refractive indices of scapolites. *American Mineralogist,* Vol. 58, No. 1/2, pp. 81–92.

Webster R. (1975) *Gems: Their Sources, Descriptions, and Identifications,* 3rd ed. Butterworths, London, England.

Weibel M., Wessicken R., Woensdregt C.F., Wüthrich A. (1980) Sternsaphir und Sternquarz. *Schweizerische Mineralogische und Petrographische Mitteilungen,* Vol. 60, pp. 133–136.

Wüthrich A., Weibel M. (1981) Optical theory of asterism. *Physics and Chemistry of Minerals,* Vol. 7, pp. 53–54.

Zwaan P.C., Arps C.E.S. (1980) Properties of gemscapolites from different localities. *Zeitschrift der Deutschen Gemmologischen Gesellschaft,* Vol. 29, pp. 82–85.