

Star quartz asterism caused by sillimanite

Autor(en): **Woensdregt, C.F. / Weibel, M. / Wessicken, R.**

Objektyp: **Article**

Zeitschrift: **Schweizerische mineralogische und petrographische Mitteilungen
= Bulletin suisse de minéralogie et pétrographie**

Band (Jahr): **60 (1980)**

Heft 2-3

PDF erstellt am: **24.09.2024**

Persistenter Link: <https://doi.org/10.5169/seals-46662>

Nutzungsbedingungen

Die ETH-Bibliothek ist Anbieterin der digitalisierten Zeitschriften. Sie besitzt keine Urheberrechte an den Inhalten der Zeitschriften. Die Rechte liegen in der Regel bei den Herausgebern.

Die auf der Plattform e-periodica veröffentlichten Dokumente stehen für nicht-kommerzielle Zwecke in Lehre und Forschung sowie für die private Nutzung frei zur Verfügung. Einzelne Dateien oder Ausdrucke aus diesem Angebot können zusammen mit diesen Nutzungsbedingungen und den korrekten Herkunftsbezeichnungen weitergegeben werden.

Das Veröffentlichen von Bildern in Print- und Online-Publikationen ist nur mit vorheriger Genehmigung der Rechteinhaber erlaubt. Die systematische Speicherung von Teilen des elektronischen Angebots auf anderen Servern bedarf ebenfalls des schriftlichen Einverständnisses der Rechteinhaber.

Haftungsausschluss

Alle Angaben erfolgen ohne Gewähr für Vollständigkeit oder Richtigkeit. Es wird keine Haftung übernommen für Schäden durch die Verwendung von Informationen aus diesem Online-Angebot oder durch das Fehlen von Informationen. Dies gilt auch für Inhalte Dritter, die über dieses Angebot zugänglich sind.

Star Quartz Asterism caused by Sillimanite

by C. F. WOENSDREGT *¹⁾, M. WEIBEL ** and R. WESSICKEN *

Abstract

The asterism of star quartz from Ratnapura district (Sri Lanka) is caused by acicular inclusions of sillimanite, which can be identified by electron diffraction using a JEM 100C electron microscope. The sillimanite needles are preferentially oriented with their c axes parallel to $\langle 100 \rangle^*$ of the quartz host.

Keywords: asterism: star quartz, sillimanite, electron microscopy, gemmology.

Recently a new variety of asteriated quartz has been found at Niriella south of Ratnapura (Sri Lanka) in sedimentary deposits in the form of pebbles associated with corundum, tourmaline, zircon, garnet and spinel (Gübelin, personal communication). GÜBELIN (1968) mentioned cat's-eye quartz with fine asbestos inclusions in his extensive study of Sri Lanka gemstones as the only asteriated quartz variety. The Niriella star quartz is translucent white and shows a very distinct asterism in reflected light (Fig. 1) when cut cabochon with the c-axis normal to the base.

Optical microscopic investigations reveal the presence of acicular inclusions preferentially oriented parallel to (0001) of the quartz in three sets which intersect at 60° (Fig. 2). Parallel light scattered by these inclusions produces the star pattern, which can be considered as a multiple chatoyancy brought about by the scattering of light by coplanar cylinders and the refractive effect of the stone's surface (WÜTHRICH et al., 1981).

* Laboratory of Solid State Physics, Swiss Federal Institute of Technology, CH-8093 Zürich, Switzerland.

** Institute of Crystallography and Petrography, Swiss Federal Institute of Technology, CH-8092 Zürich, Switzerland.

¹⁾ Present address: Institute of Earth Sciences Utrecht; State University of Utrecht, P.O. Box 80021, 3508 TA Utrecht, Netherlands.

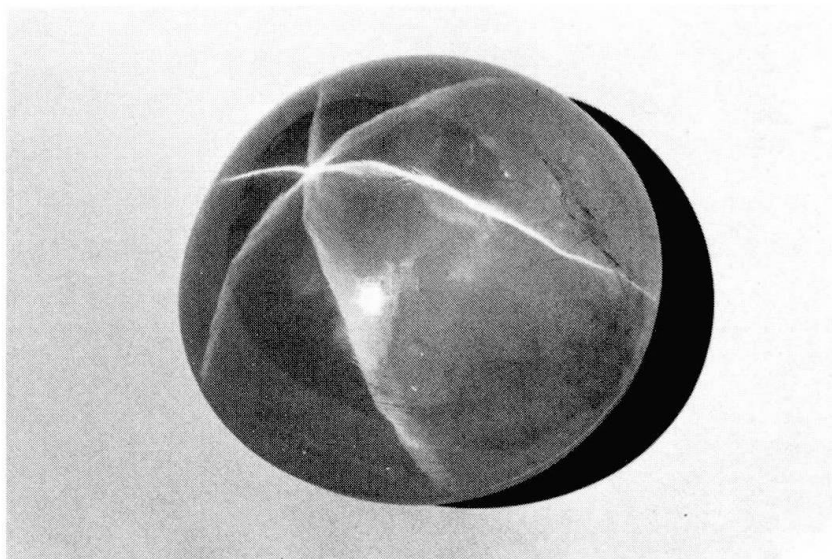


Fig. 1 Translucent white star quartz from Ratnapura district (Sri Lanka) cut cabochon. Diameter of the stone 40 mm, weight 56 g.

The inclusions in star quartz have not been identified before. With regard to asteriated corundum (star sapphire), PLETKA et al. (1972) reported that a «more Al rich precipitate than Al_2TiO_5 » is responsible for the asterism in sapphire. TAKUBO et al. (1978) and PHILLIPS et al. (1981) proved that the asterism in artificial star sapphire is caused by inclusions of rutile. ARMSTRONG (1971) supposed that rutile produces asterism in asteriated rose quartz as well.

We analysed the inclusions in the Ratnapura star quartz using qualitative X-ray microanalysis with a scanning electron microscope (SUTER et al., 1976) and by emission spectrographic analysis. As Ti is absent the inclusions cannot be rutile needles.

Specimens to be investigated with a JEM 100C transmission electron microscope have been prepared either by crushing the crystal fragments under methanol in an agate mortar, or by ion thinning. The specimens mounted on a holey carbon film have been observed at an accelerating potential of 100 kV. An electron diffractogram of a typical needle could be identified as a $[\bar{1}\bar{1}0]$ diffractogram of sillimanite (Fig. 4). The inclusions are elongated along the c-axis and have an apparent average thickness of about 20 nm (200 \AA) when viewed in the (0001) plane of the quartz. Many needles exhibit d_{110} fringes which correspond with a lattice row along $\langle 110 \rangle$ (Fig. 3). The sillimanite inclusions are preferentially oriented with their c axes parallel to $\langle 100 \rangle^*$ of the quartz host, which is perpendicular to the $\{10\bar{1}0\}$ prism of quartz (Fig. 5).

The acicular inclusions producing asterism in the Ratnapura star quartz are sillimanite needles. Since the rocks of the highly metamorphic Khondalite series

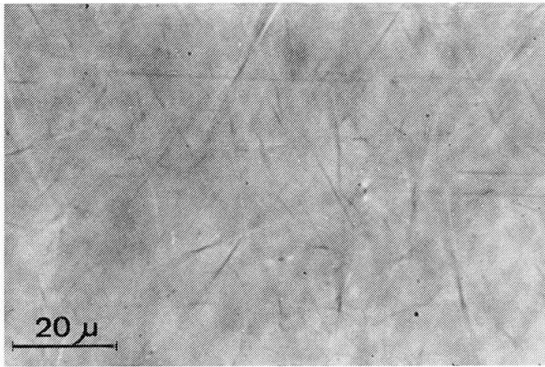


Fig. 2

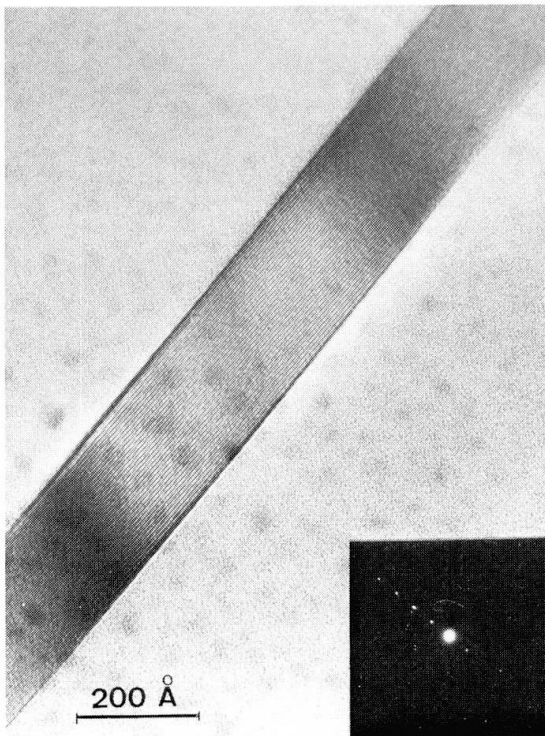


Fig. 3

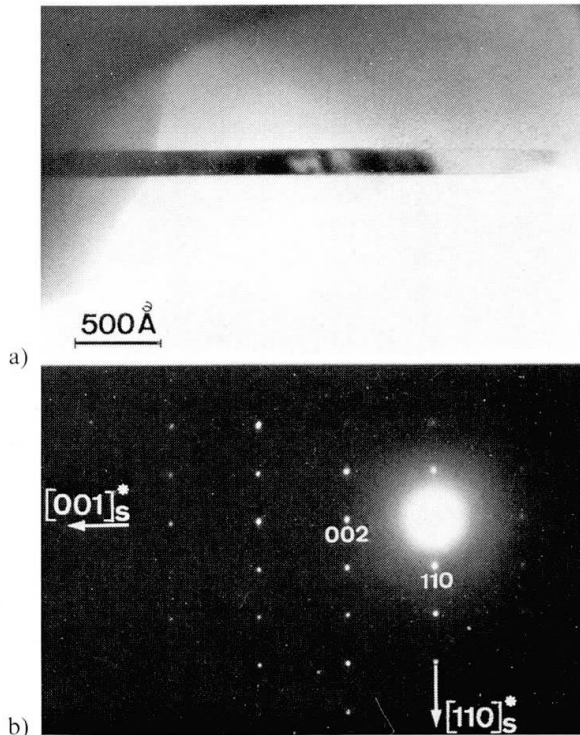


Fig. 4

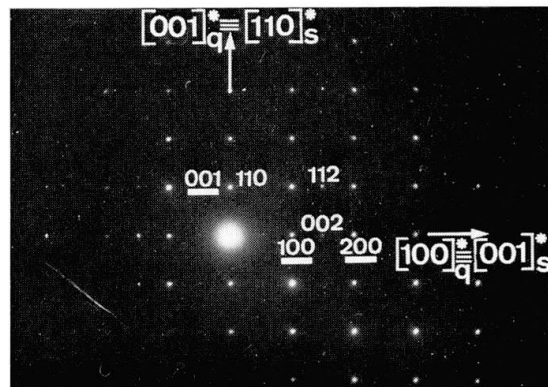


Fig. 5

Fig. 2 Optical microscopic photograph of a Ratnapura star quartz cut parallel to the crystallographic basis, exhibiting acicular inclusions of sillimanite.

Fig. 3 Transmission electron microscope micrograph of a single sillimanite needle and its electron diffraction pattern. Lattice fringes of $d_{[110]}$ are visible and the quartz has become amorphous owing to electron beam damage.

Fig. 4 $[1\bar{1}0]$ electron diffractogram of sillimanite. Analysed needle is shown above.

Fig. 5 Electron diffractogram of the oriented intergrowth of sillimanite s and quartz q. Underlined indices are quartz. $[001]^*$ of sillimanite is parallel to $[100]^*$ of quartz.

in the Ratnapure district contain sillimanite (WADIA et al., 1944; FERNANDO, 1948), it is most probable that the intimate intergrowth of sillimanite and quartz is caused by simultaneous crystallization during the metamorphism of pelitic rocks.

Acknowledgement

The authors thank Dr. H.-U. Nissen for critical reading of the manuscript. They are much indebted to Dr. E. Gübelin, who stimulated the present study and provided the specimens. The first author (C. F. W.) received financial support from the Schweizerische Nationalfonds during his stay at the ETH Zürich. The photographic work of Mrs. M. Brügger-Trombini and Mr. P. Wägli is gratefully acknowledged. Mrs. Dr. C. Strom kindly corrected the English text.

References

- ARMSTRONG R.D. (1971): A study of asterism in quartz. *Lapidary J.* 25, 1108-1116.
- FERNANDO L.J.D. (1948): The geology and mineral deposits of Ceylon. *Bull. Imperial Inst.* 46 (2-4), 203-325.
- GÜBELIN E. (1968): *Die Edelsteine der Insel Ceylon*. Luzern: Gübelin.
- PHILLIPS D.S., HEUER A.H. and MITCHELL T.E. (1981): Precipitation in star sapphire. I. Identification of the precipitate. *Phil. Mag. A*, 42, 385-404.
- PLETKA B.J., MITCHELL T.E. and HEUER A.H. (1972): Proceedings of the 1971 International Conference on Mechanical Behavior of Materials. Wenk H.-R. et al. (eds.). Kyoto: Society of Materials Sciences, 4, 413-421.
- SUTER M., NISSEN H.-U., WESSICKEN R. and WIEDERKEHR P. (1976): Electron microscopy in mineralogy. Wenk H.-R. (ed.). Berlin, Heidelberg, New York: Springer, 520-525.
- TAKUBO H., KITAMURA Y., KUME S. and KOIZUMI M. (1978): Preparation of star ruby containing large crystals of rutile. 11th General Meeting of IMA, Novosibirsk. Abstracts 3, 52.
- WADIA D.N. and FERNANDO L.J.D. (1944): Ilmenite, monazite, and zircon. Dept. Mining, Ceylon, Prof. Pap. 2, 11-44.
- WEIBEL M., WESSICKEN R., WOENSUREGT C.F. und WÜTHRICH A. (1980): Sternsaphir und Sternquarz. *Schweiz. Mineral. Petr. Mitt.*, 60, 133-136.
- WÜTHRICH A. and WEIBEL M. (1981): Optical theory of asterism. *Phys. Chem. Minerals*, 7, 53-54.

Manuscript received December 19, 1980.