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Star Quartz Asterism caused by Sillimanite

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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 ‹100›* 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).

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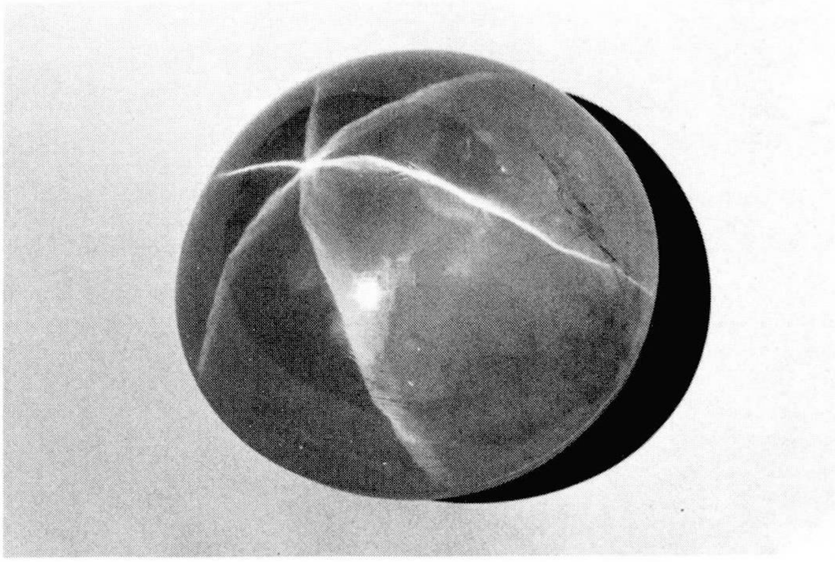

Fig. 1 Translucent white star quartz from Ratnapura district (Sri Lanka) cut cabochon. Diameter of the stone 40 mm, weight 56 g.

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 $[1\bar{1}0]$ diffractogram of sillimanite (Fig. 4). The inclusions are elongated along the c-axis and have an apparent average thickness of about 20 nm (200 Å) when viewed in the (0001) plane of the quartz. Many needles exhibit d_{110} fringes which correspond with a lattice row along ‹110› (Fig. 3). The sillimanite inclusions are preferentially oriented with their c axes parallel to ‹100›* 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

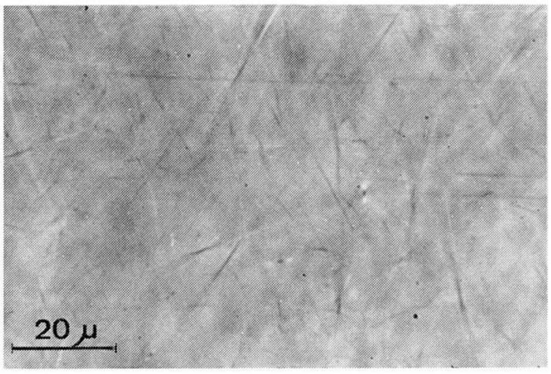

Fig. 2

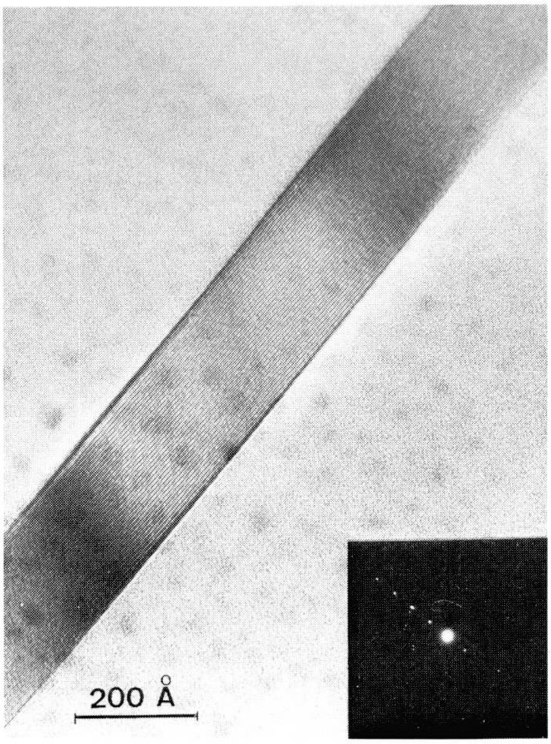

Fig. 3

a)

b)

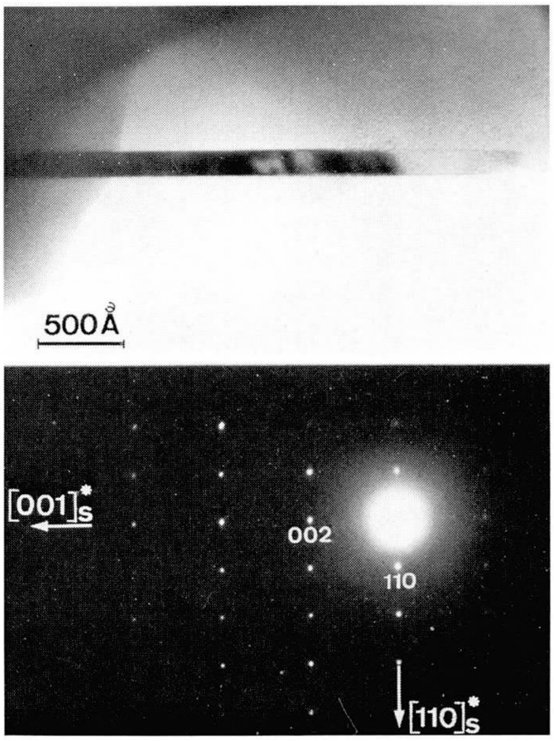

Fig. 4

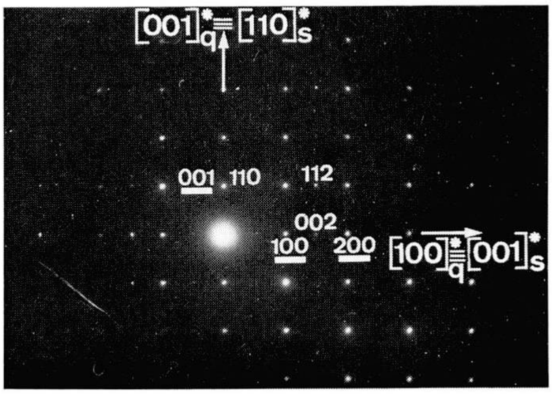

Fig. 5

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 $d_{[1\bar{1}0]}$ 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.

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