On the Arrangement of Micro-Crystals of Silica in the Onyx

By **Masami Ichinose**

(Received September 18, 1935)

Abstract

By means of an X-ray diffraction- photograph, it has been ascertained that micro-crystals of quartz in the onyx take a fibrous arrangement, whose common axis is [11$\bar{2}$0] and which is perpendicular to the surfaces of the banded layers in the mineral.

The onyx examined was one produced at Shiribeshi, Hokkaidô, Japan, and was semitransparent with milk-white coloured bands, as shown in Fig. 1, Plate I. From a portion of this sample where the bands are most dense and distinct, a thin plate of about 0.5 mm in thickness was cut out perpendicular to the layers of the bands, and a small pencil of X-rays, radiated from a Coolidge tube with a molybdenum target, was made to strike it in a direction perpendicular to its surface, that is, parallel to the layers of the bands. The diffraction photograph thus obtained on a photographic plate placed behind the specimen at a distance of 4 cm is reproduced in Fig. 2, Plate I. The vertical direction of this photograph is parallel to the normal to the layers of the bands.

Now the constants of a unit-cell of quartz, which belongs to the hexagonal system, are $a=4.90$ Å, $c=5.39$ Å, $\frac{c}{a}=1.10$, according to A. J. Bradley and A. H. Jay[1], and the diameters of six predominant rings in Fig. 2 coincide with the calculated values corresponding to reflecting planes (10$\bar{1}$1), (10$\bar{1}$2), (20$\bar{2}$0), (11$\bar{2}$2), (12$\bar{3}$1), (12$\bar{3}$2), (20$\bar{2}$3) and (30$\bar{3}$1) respectively, due to Mo Kα line, as shown in the third and fourth columns of Table I. The diffraction pattern in Fig. 2 shows clearly that micro-crystals of quartz in the specimen are fibrously arranged with the common axis in the vertical direction, that is, in the direction perpendicular to the layers of the bands. And the distance between successive lattice-points along the zone axis which is assumed to be the common axis, calculated from each distance between both vertices of three pairs of layer lines except one which pass through the centre, coincide with $a=4.90$ Å, the side-length of the unit cell of

1. A. J. Bradley and A. H. Jay, Proc. Phys. Soc., **45** (1933), 507.

Table I

Planes	Specings	Diameters		Directional angles φ	
		cal.	obs.	cal.	obs.
$10\bar{1}1$	3.33 Å	17.3 mm	17.4 mm	46°31′ 90°	46°30′ 90°
$10\bar{1}2$	2.28	25.9	26.0	61°58′ 90°	61°40′ 90°
$20\bar{2}0$	2.12	28.0	27.9	28°33′ 90°	27°30′ weak
$11\bar{2}2$	1.81	33.3	33.2	41° 0′ 67°50′	41°30′ 67°50′
$12\bar{3}1$	1.54	40.2	40.1	14°41′ 49°50′ 71°12′	15°10′ 50° 0′ weak
$12\bar{3}2$	1.38	45.9		29° 8′ 54°23′ 73° 5′	
$20\bar{2}3$	1.37	46.2	46.1	54°36′ 90°	30°10′ 54°20′ weak 90°
$30\bar{3}1$	1.37	46.4		29°50′ 90°	

quartz; this means that the common axis of the fibrous arrangement is [$11\bar{2}0$]. Further, the directional angle φ of each diffraction-spot measured from the vertical line taken as the initial line with the pole at the centre, is in good agreement with the value calculated under the assumption that [$11\bar{2}0$] is the common axis and by the employment of the formula $\cos\varphi = \cos\beta / \cos\theta$, in which β is the angle between the normal of each reflecting plane and the common axis, and θ the glancing angle to each reflecting plane. This is shown in the fifth and sixth columns of Table I, and the calculated positions of the spots are shown diagramatically in Fig. 3, which agrees well with the photograph Fig. 2. Thus the diffraction spots in Fig. 2 are fully explained.

In brief, the diffraction pattern shows that micro-crystals of quartz in the onyx take a fibrous arrangement, in which the common axis is [$11\bar{2}0$] and is perpendicular to the banded layers in the onyx.

In conclusion, the writer expresses his deepest thanks to Prof. U. Yoshida, of Kyoto Imperial University for his kind guidance in this work.

Masami Ichinose

Plate I

Fig. 1

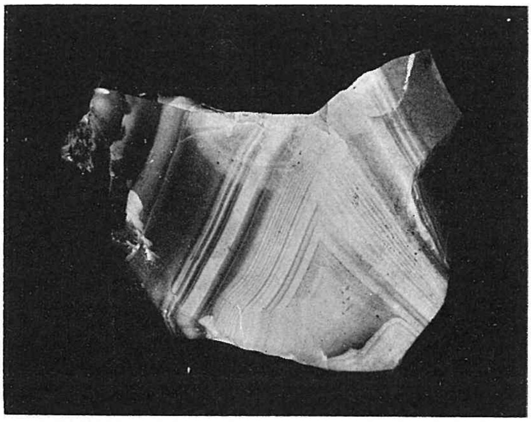

Fig. 2

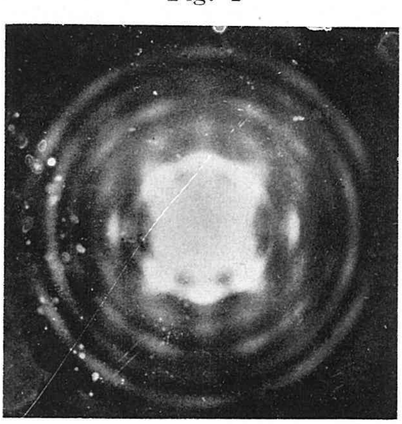

Fig. 3