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X-ray study of fibrous quartz

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1. Introduction

Mineralogists designate a mineral as fibrous when it consists of visibly distinct rods or threads, irrespective of whether these are separable or not from each other. Many gradations between a coarsely columnar and a finely fibrous structure are to be observed, the finely fibrous materials often exhibiting a silky lustre. In his *Handbuch der Mineralogie*, Hintze[1] reports the secondary quartz often appears as pseudomorphs of the original minerals which it has replaced, and that when such minerals had a fibrous structure, the secondary quartz formed therefrom is also fibrous.

The material examined in the present investigation was very kindly placed at our disposal by the Director of the Geological Survey of Mysore. It had been collected by Dr Pichamuthu many years ago and the following description of the circumstances in which it had been found is quoted from his monograph[2] on the iron formations of the Eastern Bababudan Hills in Mysore.

"The writer has collected from various parts of the Bababudans specimens of fibrous quartz. In some of the siliceous layers which are formed of fibrous aggregates of quartz crystals, the fibres are disposed at right angles to the plane of bedding and are separable in some cases. The fibres are not always straight, but often bent. These layers frequently exhibit a chatoyant lustre. In micro-sections, these quartz layers are seen to contain fibrous amphiboles. Though in no one place it was possible to trace a layer of fibrous amphibole passing into a layer of quartz, the collections made by the writer show that the quartz has replaced amphibole. Similar fibrous quartz has long been known to occur associated with the banded ironstones of South Africa. The prevalent view in South Africa is that fibrous asbestos has been pseudomorphosed by silica."

2. Optical behaviour

The material consisted of small rods each a few millimetres long and less than a millimetre thick. They were practically colourless. On the stage of the polarising microscope and immersed in a liquid of suitable index, the material appears transparent. When the vibration direction of the polariser is parallel to the length of the specimen, the refractive index is nearly equal to the extraordinary index of quartz as judged by the Becke line test. Between crossed Nicols, the extinction is almost perfect when the longer dimension of the specimen is either parallel or perpendicular to their vibration directions. When a quartz wedge is introduced parallel to the length of the specimen, the interference colour rises in the Newtonian scale, thereby revealing that the *c*-axis of the quartz is parallel to the length of the specimen.

3. X-ray examination

The foregoing inference from the optical observations is generally confirmed by the results of the X-ray diffraction studies. Two typical examples of X-ray diffraction patterns taken with the specimens set *at right angles* to the direction of the X-ray beam are reproduced as figures 1 and 2 in plate I, CuK_α radiation being employed. It will be recognised from the figures that the pattern is approximately a fibre diagram with the axis of the fibre nearly parallel to the *c*-axis of quartz which is set horizontal in the figures. There is however a certain lack of symmetry, indicating that the fibering is far from being as perfect as that shown by asbestos or by satin-spar. Figures 3 and 4 are photographs taken with the same specimen as in figure 1 and with unfiltered Mo radiation, but with the specimen set *longitudinally* to the direction of the X-ray beam. The two figures represent slightly different settings of the rod. Had the quartz been truly fibrous, we should have expected to obtain a diagram consisting of complete circles. This is far from being actually the case and hence it would seem correct to describe the material as polycrystalline quartz with a preferred orientation for the *c*-axis rather than as truly fibrous quartz. Micro-sections of the original formation prepared by Dr Pichamuthu and seen by us showed no break in continuity of the individual fibres along their length under the polarising microscope, thereby supporting the view of the structure indicated by the X-ray diagrams.

4. Comparison with chalcedony

The principal reason why we have felt it desirable to place the results of the present study on record is in view of the earlier publications[3,4] from this Institute on the structure of agate and chalcedony. Those studies had revealed that in the iridescent layers of banded agate, the crystallites of quartz are orientated predominantly along the *a*-axis, while in other regions the orientation is less specific. There were also indications of an alternative orientation for the fibre axis in chalcedony, namely the direction perpendicular to the first-order prism face of quartz. No case in which the fibering in chalcedony is parallel to the *c*-axis had been encountered by us. Had such a case been forthcoming, optical theory indicates that the material would have been transparent, almost resembling a single crystal of quartz in its behaviour.

5. Summary

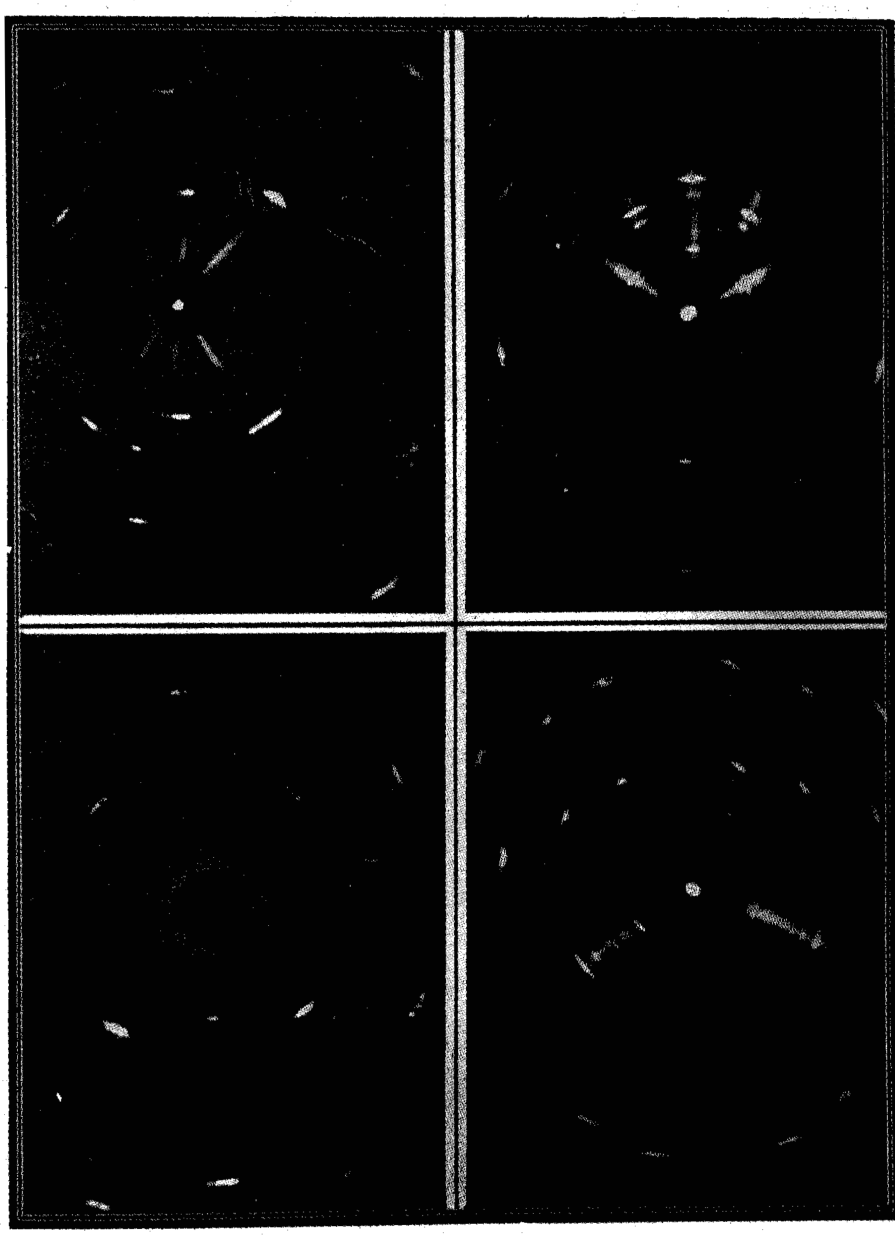
The results of optical and X-ray examination of specimens of fibrous quartz from the Bababudan Hills in Mysore are described. They indicate that the material may be described as polycrystalline quartz with a strongly preferred orientation for the crystallographic *c*-axis along the length of the fibres.

References

1. Hintze Carl *Handbuch der Mineralogie*, Erster Band, Zweite Abtheilung, 1915, p. 1348.
2. Pichamuthu C S *Mysore Univ. J.*, 1935, **8**, 1–48.
3. Raman C V and Jayaraman A *Proc. Indian Acad. Sci.*, 1953, **38A**, 199.
4. Jayaraman A *Ibid.*, 1953, **38A**, 441.

(1) (3)

(2) (4)



Figures 1–4

Plate I