## METASTABLE FORMS OF CORDIERITE FROM FUSED ROCKS IN INDIAN COALFIELDS

IN a recent paper, Jagapathi Naidu[1] has described in detail the optical properties of cordierites found in vitrophyres and hornfelses associated with coal seams in the Raniganj and Jharia coalfields. Venkatesh[2] has also made an excellent study of the development and growth of cordierites occurring in the para-lavas of Bokaro Coalfield.

The present note is intended to place on record immediately the important results of researches on the polymorphism of cordierite carried out by Dr. A. Miyashiro of the Geological Institute of the Tokyo University. Miyashiro[3] has already described a mineral resembling cordierite occurring in volcanic rocks, under the name *Osumilite*, and indicated that cordierites from such environments described in the literature may prove to be *osumilite*. I give below an extract from a letter received by me from Dr. Miyashiro discussing the cordierite phases found by him in specimens of fused shale from Bokaro Coalfield, sent to him by the Director, Geological Survey of India :

"In my study there exist at least four closely related polymorphic forms having cordierite composition. Among them two metastable forms were found in synthetic products only. But I considered that they may occur in some pyrometamorphic or related rocks. I was expecting that probably some of the cordierite-like crystals described by Venkatesh[2] are actually one of those metastable forms. My

expectation was justified, as all the cordierite-like crystals in the specimens of fused Bokaro shales examined by me, were one of the metastable forms.

"The most decisive distinction between the metastable form and true cordierite, lies in the fact that the space lattice of the former is hexagonal while that of the latter is pseudohexagonal. Since single crystals are not available for goniometric measurement, this difference can be demonstrated only by high precision X-ray measurements.

"Optical properties are very deceptive. The metastable forms usually show anomalous biaxial character with 2 V ranging from 0-80° (I confirmed it on the grains in the fused shale). The forms sometime show very complex twin-like optical structure between crossed nicols. However, the space group of the metastable form C 6/*mcc* is not compatible with twinning with twin plane corresponding to (110) and (130) as in the case of cordierite. I think that the twin-like optical structure is only an optical anomaly. As you know, lime garnet showing optical anomaly is usually divided into twin-like sectors and the form of the sectors is sometimes very complex. But this is only an optical phenomenon. X-ray measurements show that no twinning is present in the garnet. Similarly, twin-like sectors and consequent optical anomaly was proved in the case of milarite and xanthophyllite, so far as I am aware.

"Since the burning of Bokaro coal took place by natural causes the metastable form has become to fill all the conditions necessary for the strictest definition of a mineral. I am intending to call this new polymorph *Indialite* after India, for the natural occurrence is from India. This new metastable form is a very important compound in ceramic industry."

In an earlier communication Dr. Miyashiro had pointed out to me the presence of hexagonal and zoned crystals with variable 2 V in the specimens of Bokaro para-lava examined by him (these may be seen in the plate and drawing accompanying Venkatesh's paper on the cordierites of para-lavas). Most of these supposed cordierite grains are, according to Miyashiro, uniaxial or biaxial, with small optic axial angles (less than 30°) and considered to be the alpha form.

According to Jagapathi Naidu, two types of cordierite are found in vitrophyres and hornfelses of the Laikdih seam at Ramnagar, Raniganj. One type is recorded to display pseudohexagonal boundaries in basal sections, with minute lamellæ parallel to these faces. These grains of cordierite are stated to be uniaxial or biaxial with small optic axial angles (below 20°). These properties are certainly different from those of normal cordierite, and these grains are presumably the metastable form *Indialite*. The second type is stated to have values of 2 V ranging from 23-46°, which again is suggestive of it being one of the metastable polymorphs. The third type of cordierite described is from vitrophyres and hornfelses in the fifth seam at Jharia, and is also presumably a metastable phase though the values of 2 V are higher (according to Miyashiro the values of 2 V for the metastable forms range from 8-80°).

It appears to the writer that here in India, where we have occurrences of fused rocks resulting from natural burning of coal seams, *osumilite*, and the principal metastable phases of cordierite discovered by Miyashiro, will be encountered in them. Miyashiro's monograph on the polymorphism of cordierite is under publication elsewhere.* While recognising the value of the observational data presented by Venkatesh[2] and Naidu[1] in their papers, the aim of this note is to stress the importance of careful interpretation of data with the aid of X-ray studies and to focus attention on the excellent study of polymorphic transitions carried out by one of the foremost Japanese mineralogists.

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1. Naidu, Jagapathi, P. R., *Curr. Sci.*, 1954, 387-89.
2. Venkatesh, V., *Amer. Mineral.*, 1952, 831-48.
3. Miyashiro, A., *Proc. Japan. Acad.*, 1953, 321-23, *Mineral Abstr.*, **12**, (6), 304.

* Since writing this note the paper of Miyashiro and Iiyama entitled "A Preliminary Note on a New Mineral, Indialite, Polymorphic with Cordierite" has appeared in *Proceedings of the Japan Academy*, 1954, **30** (8), 746–51.