

NOTES AND NEWS  
A NOTE ON AENIGMATITE

NORMAN L. BOWEN, *Geophysical Laboratory, Washington, D. C.*

Aenigmatite, long a well-recognized mineral species, has recently been subjected to much reinvestigation. Examination of the crystal structure by Gossner and Mussgnug,<sup>1</sup> definitely removed the mineral from the amphibole group and suggested a new orientation. The remarkable new occurrences in the Chibina-Tundra, Russia, spurred further investigation both chemical and crystallographic,<sup>2</sup> and Palache has made an extended study of the morphology in the light of the orientation suggested by the lattice structure results.<sup>3</sup> Finally Fleischer has given us an interpretative chemical study, using the concept of atomic substitutions in the lattice, and suggests the formula  $X_4Y_{13}(Si_2O_7)_6$ , which gives  $Na_4Fe_9''Fe_2'''Ti_2(Si_2O_7)_6$  as a special case, a composition approached by several examples.<sup>4</sup>

In spite of all this new work no advance appears to have been made in our knowledge of the optical properties. The first quantitative measure of refractive indices was made by Larsen, who records it in his 1921 bulletin among the new data. There only the value of  $\alpha$  ( $1.80 \pm .01$ ) is given and it is stated that the birefringence is rather low. (Specimen from Naujakasik, Greenland.)<sup>5</sup> The birefringence had indeed been previously recorded and was given by Rosenbusch as small, measured with the Babinet compensator  $\gamma - \alpha = 0.0064$ .<sup>6</sup> As now recorded in tables of the optical properties of minerals the entry for aenigmatite appears:  $\beta = 1.80$  and birefringence 0.006, together with values for extinction angles and other properties long known from work upon thin sections of rocks and oriented plates. Very recently Kunitz has measured the refractive indices of aenigmatite from Pantelleria and gives  $\gamma = 1.799$  and  $\alpha = 1.795$ , without mentioning the method of measurement.<sup>7</sup> He thus agrees with the older determinations indicating a low value of the birefringence.

In working over some rocks collected by me in East Africa, in many of which aenigmatite (cossyrite) occurs both as small phenocrysts and as minute prisms in the groundmass, I noted that the minutest prisms showed bright between crossed nicols. This is hardly to be expected in a mineral of low birefringence and a measurement of the refractive in-

<sup>1</sup> Gossner, B., and Mussgnug, F., *Centralbl. Min.*, p. 5, 1929A.

<sup>2</sup> Kostyleva, E., *Neues Jahrb.*, 1931, Band 1, p. 350 (abstract).

<sup>3</sup> Palache, C., *Zeit. Krist.*, vol. 86, p. 283, 1933.

<sup>4</sup> Fleischer, Michael, *Am. Jour. Sci.*, vol. 32, p. 343, 1936.

<sup>5</sup> Larsen, E. S., *U. S. Geol. Survey, Bull.* 679, p. 71, 1921.

<sup>6</sup> Rosenbusch, H., *Mik. Phys.*, 1, 2, p. 383, 1905.

<sup>7</sup> Kunitz, W., *Neues Jahrb., Beil. Band* 70, A 1936, p. 399.

dices was accordingly undertaken. For this purpose it was necessary to use the phenocrysts, a few of which were picked out of a pantelleritic lava from Lake Niavasha, powdered, and the indices determined by the method of matching in immersion media. No great accuracy is obtainable in a mineral with such strong absorption. The results in sodium light are as follows:  $\alpha = 1.81 \pm .01$  (in substantial agreement with Larsen),  $\beta = 1.82 \pm .01$  and  $\gamma = 1.88 \pm .015$ .<sup>8</sup> The optic axial angle  $2V$  is therefore small and positive, a relation generally accepted for aenigmatite. The maximum extinction angle in the zone of the cleavages is  $38^\circ$  and the pleochroism very strong,  $\alpha$ =yellow brown,  $\beta$ =brown,  $\gamma$ =deep brown to black.

The refractive indices of three other aenigmatites were measured, one from Pantelleria, one from Kangerdluarsuk, Greenland, and one from Chibina-Tundra, all obtained from the U. S. National Museum through the kindness of Dr. Foshag. Although there is considerable variation of composition, the same values of the refractive indices, within the large limits of error stated, seem to suit all of them.

Aenigmatite is thus a mineral of high rather than low birefringence.

#### NOTES ON MINERALIZATION AT CRESTMORE, CALIFORNIA

VINCENT C. KELLEY, *California Institute of Technology.*

Recently, in connection with short field trips to the Crestmore quarries several interesting specimens have been collected which reveal some phases of mineralization heretofore unrecorded.

On one trip a large sample of sulphide ore in contact with coarse grained marble was obtained, which came from recent underground workings of the Riverside Cement Company. The sulphide mass is fine grained and bronze-brown in color. It is slightly banded parallel to the marble contact and bedding, suggesting replacement of the marble. Several sections of the sulphides were polished and examined in reflected light. Such study revealed the banding to be due to segregations into blebby stringers and layers of pyrrhotite and chalcopyrite in sphalerite, the last mineral forming the continuous matrix. A few cross veinlets of chalcopyrite cut the other two sulphides. Likewise there is evidence that the sphalerite replaced the pyrrhotite. Also scattered sparingly through the mass are small lenses of hard sulphide. These were found to consist of centers of

<sup>8</sup> The absorption of  $\gamma$  for yellow light is very great. In red light the mineral does not approach opacity so closely for that ray and conviction of the high value of  $\gamma$  is somewhat more readily reached by using red light.