Conclusion

It may be conjectured that during the crystal growth of mica some impurities collect together and precipitate in the form of a group, producing imperfections in the crystal which is attacked during etching, leading to the curved bottomed pits and pits with halos. It may be assumed that the point bottomed pit nucleate at the termination of a linear dislocation. That the ratio of the lengths of the longer diagonal to the shorter diagonal remains constant in all the samples irrespective of the sizes of the pits suggests that the pit shape on all the samples remains the same. The density of imperfections will vary from crystal to crystal because it will depend upon the environments under which the crystal has grown. This explains the wide variation in the density of the pits observed in the present investigation. It may be conjectured that these imperfections might play an important role in the insulating properties of micas.

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NEW DATA ON MARGAROSANITE

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Occurrence

Margarosanite was first described by Ford and Bradley (1916) on the basis of a chemical analysis and partial physical data. The specimens studied (Brush Collection No. 5938) were collected in 1898 from the Parker Shaft, North Mine Hill, Franklin, New Jersey and were given to Yale by the Foote Mineral company. The original material, including several fragments from a vial labled "Material for chemical analysis" by Bradley, was used for the measurements reported in this paper. One year after Ford and Bradley's paper a second occurrence of margarosanite was reported by Flink (1917). The material studied by him came from "Lukas

Ort" and "Bjelkes Schacht," Långban, Sweden. His description repeated the physical and chemical data given by Ford and Bradley with only minor differences and also included interfacial angles for a crystal which he considered to be margarosanite. Since that time no additional work on the mineral has been reported.

At Franklin, New Jersey margarosanite occurs as lamellar masses of thin plates packed closely together. The plates themselves show the rhombic outlines of the two lesser cleavages. Ford and Bradley (1916, p. 160) report its association with almandite, hancockite, roeblingite, nasonite, franklinite, willemite, yellow axinite, datolite, manganophyllite (?) and barite. At Långban nasonite, schefferite, apophyllite, calcite and thaumasite are associated with masses and crystal "stalks" approximately two mm thick and two cm in diameter (Flink, 1917, p. 439–441). An occurrence of margarosanite crystals was reported by Flink, but there is a possibility that some error was involved, as the crystal data he reported (p. 443) are irreconcilable with any reasonably simple indexing relative to the unit cell of the mineral determined in the present study. Powder patterns run on massive material from Långban in the Brush collection confirm its identification as margarosanite. The agreement of Flink's other data with those of Ford and Bradley make it quite certain that at least some of the material studied by him was margarosanite. No other occurrences of the mineral are known. The information supplied in this paper should facilitate recognition of margarosanite from other localities.

Physical and Optical Properties

Margarosanite is colorless and transparent with a distinctly pearly luster on the faces of cleavage plates; streak is white; hardness is 2.5–3; specific gravity is 4.33 (measured on a Berman Torsion Balance), 4.30 (calc.); and cleavages are {010} perfect, {100} good, {001} fair.

Margarosanite is colorless and non-pleochroic in transmitted light. It is biaxial $(-)$ and has the following optical properties:

$$(Na_D)$$

α	$1.727 + 0.002$	$2V_X = 78°$
β	$1.771 + 0.002$	$v > r$, strong
γ	$1.798 + 0.002$	
$\gamma - \alpha$	0.071	

Cleavage fragments show α' 1.731 and γ' 1.797 with the α' direction nearly bisecting (41°, 37°) the 78° acute angle of the cleavage fragment.

Figure 1 shows the relationship of the optic directions to the cleavage faces and the crystallographic directions for this mineral.

CRYSTALLOGRAPHY AND X-RAY STUDY

Single crystal x-ray rotation and Weissenberg photos were made using CuK_α radiation. Margarosanite is triclinic with space group $P1$ or $P\bar{1}$. The cell dimensions are:

a 6.77 + 0.01 Å	α 110°35′
b 9.64 + 0.01 Å	β 102° 0′
c 6.75 + 0.01 Å	γ 88°30′

unit cell volume   402 Å³

axial ratio   .702:1.000:.700

An unindexed powder pattern is presented in Table 1. The intensities are visual estimates. Ninety-nine peaks between 10° and 135° 2θ are listed.

No crystals were available for this study. Goniometric measurements on the three cleavages gave axial angles within 30′ of those calculated
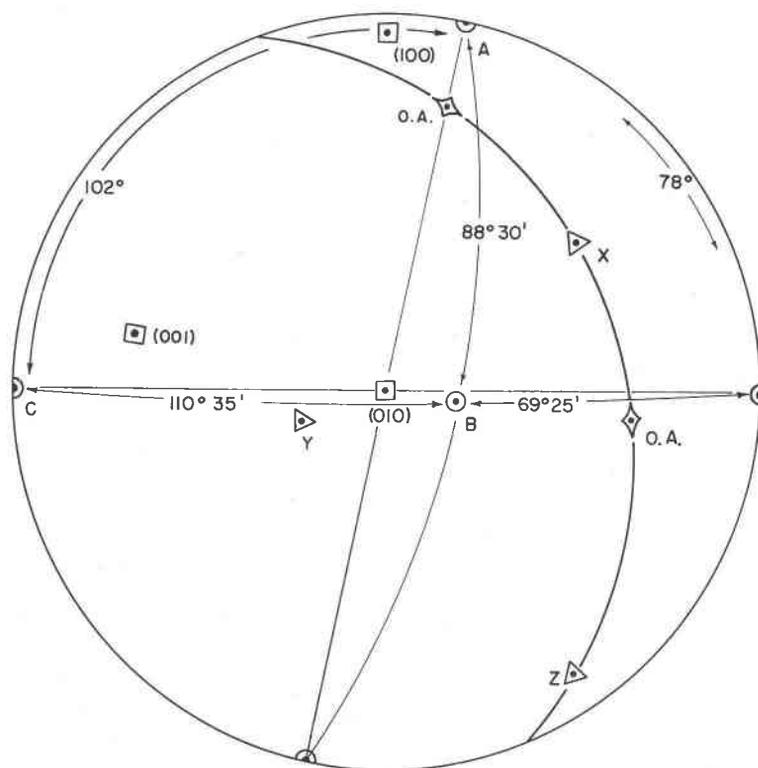

Fig. 1. Stereographic projection of optic and crystallographic data. Squares surround cleavage poles, circles surround crystallographic axes, diamonds surround optic axes, triangles surround axes of the optic indicatrix. Plane of projection is that of the best cleavage.

TABLE 1. X-ray Powder Data

Cu radiation Ni filter λ = 1.5418 Å

d Å	I	d Å	I	d Å	I
8.95	1	2.194	2	1.487	2
6.57	2	2.189	.5	1.461	.5
6.13	1	2.144	2	1.413	1
5.18	2	2.099	1	1.388	.5
5.08	3	2.083	2	1.365	1
4.47	2	2.038	1	1.334	.5
4.371	2	2.029	1	1.321	1
4.120	1	1.994	1	1.307	1
3.889	.5	1.967	1	1.278	.5
3.756	2	1.940	.5	1.243	1
3.489	2	1.928	2	1.218	.5
3.356	1	1.906	.5	1.196	.5
3.269	.5	1.886	1	1.184	.5
3.243	.5	1.870	.5	1.1685	2
3.196	3	1.852	1	1.1567	1
3.156	3	1.840	.5	1.1328	1
3.073	1	1.822	2	1.098	.5
3.028	5	1.807	.5	1.0912	1
2.978	10	1.786	.5	1.0725	1
2.921	2	1.765	.5	1.054	.5
2.760	1	1.742	1	1.0428	.5
2.688	3	1.721	.5	1.0261	.5
2.673	4	1.670	1	1.0109	.5
2.651	1	1.640	.5	.9920	1
2.636	.5	1.617	.5	.9750	.5
2.611	3	1.598	2	.9635	.5
2.528	.5	1.582	.5	.940	.5
2.442	.5	1.565	1	.911	.5
2.414	.5	1.559	.5	.894	.5
2.347	.5	1.538	1	.879	.5
2.312	1	1.524	.5	.858	.5
2.245	1	1.513	.5	.852	.5
2.232	1	1.495	.5	.841	1

purely from the x-ray data. Successive goniometric measurements on different fragments including material from the vial labeled "margarosanite" by Bradley agreed within 5′. Numerous attempts were made to reconcile Flink's crystal-face angle data (1917, p. 443) with the crystallographic data obtained in this study but with no success.

Chemical Properties

Chemical analyses given by Ford and Bradley (1916, p. 161) and Flink (1917, p. 46) are reproduced in Table 2. The analyses are in excellent

agreement with the formula $Pb(Ca, Mn)_2(SiO_3)_3$. Hydrogen appears to be present within the crystal structure but has not been included as an essential part of the chemical formula. The number of cations in each coordination site is closer to an integral value when hydrogen is considered to be present within the structure, and the calculated and measured densities are in best agreement if hydrogen is not excluded from the calculation. Such a situation is probably common in silicates, but as a rule no modification of chemical formula is made to accommodate it. Manganese is

TABLE 2. CHEMICAL DATA

	Chemical Analyses		Atoms in Unit-Cell with 18 Oxygen		
	Flink (p. 46)	Ford and Bradley (p. 161)		Flink	Ford and Bradley
SiO_2	34.72	33.71	Si	5.94	5.77
CaO	20.28	21.73	Ca	3.72	3.98
MnO	2.17	1.14	Mn	.31	.17
MgO	0.20		Mg	.05	
PbO	41.74	43.50	Pb	1.92	2.00
BaO	0.69		Ba	.05	
H_2O	0.10	0.58	H	.12	.66
Total	99.90	100.66			

present as a minor constituent in both analyses. The extent to which it may substitute for calcium is not known. In Table 2 the chemical analyses are recast to show numbers of atoms in a unit cell with 18 oxygen. The unit cell contains two formula units.

Ford and Bradley (1916, p. 159) report that margarosanite is fusible with difficulty in the oxidizing flame, an amethyst glass being produced. In the reducing flame it fuses easily at ~2 to an opaque gray glass while giving a pale azure-blue flame with an outer pale green border. With fluxes on charcoal lead oxides and a metallic globule of lead are produced. Tests for manganese are positive and the mineral decomposes in nitric acid with the separation of silica. These data were not confirmed.

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GEOLOGIC IMPLICATIONS OF JAROSITE, PSEUDOMORPHIC AFTER PYRITE

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Jarosite, $KFe_3(SO_4)_2(OH)_6$, occurs in the Boy Scout-Jones molybdenite prospect, Halifax County, North Carolina, where it exists sparingly as thin encrustations on fracture surfaces or as an alteration product of pyrite or mica. It is finely crystalline, but pure material gives a sharp x-ray pattern. X-ray line and peak values may vary slightly but are well within the limits of a relatively pure Jarosite end member as proposed by Warshaw (1956).

The sulfide deposit in which the jarosite occurs is hosted by a granite body enclosed by gneiss and cut by quartz veins and irregular areas of siliceous replacement (*U.S.B.M., Rept. Inves.* **4156,** 1947). All the units may contain zones of abundant to sparse pyrite with molybdenite and minor amounts of accessories. Jarosite occurs in the outer portion of the oxidation zone, which limits its formation to, or very near to, normal atmospheric temperature and pressure conditions. It is further limited in extent to the immediate presence of pyrite and mica or potassium-bearing feldspar.

All components of the jarosite were derived locally, at or very near the site of crystallization. During oxidation of pyrite in this zone, iron sulfates and sulfuric acid were released. This process is discussed by Merwin and Posnjak (1937). The ferric sulfate furnished iron while excess sulfuric acid released potassium from the mica and feldspar. A similar process for the derivation of potassium from volcanic rocks is discussed by Srebrodolsky (1959). In reference to his own work and that of other Russian workers, he states that during oxidation pyrite gives rise to cold sulfuric acid solutions which mix with potassium-bearing andesites and tuffs to give rise to a strong potassium sulfate solution. This later forms jarosite.

Deposition from such solutions along fracture systems accounts for most of the jarosite volume in the Halifax County deposit. Rapid dilution of the transporting solutions through the addition of surface water took