material as observed by metallographic examination. This would indicate that the hexagonal structure calculated by Groeneveld Meijer (1955) is not correct since it does not fit all of the lines reported by Sholtz (1936).

No further work is planned on the structure of the compound PtTe at this time.

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COMPARATIVE STUDY OF THE ETCH PATTERNS ON MUSCOVITE FROM DIFFERENT SOURCES

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INTRODUCTION

Etching of micas has been reported by several workers, chief among whom are De la Vault (1944), Patel and Tolansky (1957), Pandya and Pandya (1958) and Patel and Ramanathan (1962). Their studies were mainly confined to muscovite from a particular deposit.

Patel and Tolansky (1957) reported that the etch pattern produced by HF acid consists of large individual, isolated and small, widely distributed pits. The density of the small, widely distributed pits is so large that even in the early stages of etch they interfere with one other, and hence in many cases it is not possible to determine its value. Patel and Ramanathan (1962) established the correspondence in the etch patterns of the large individual isolated pits on the opposite sides of a thin mica flake and hence attributed their origin to the existence of linear dislocations in the body of the crystal.

In the present investigation we have collected muscovite mica from different sources: 14 samples of which are from India and one from Australia. They have been etched in HF acid simultaneously, and the etch patterns produced on them have been critically studied with a view that it might shed some light on the history of growth of the crystals.

EXPERIMENTAL DATA AND OBSERVATIONS

The particular mica to be investigated was cleaved and the freshly cleaved surfaces were treated with 40% HF acid. The etch patterns produced were examined optically and by light profile microscopy (Tolansky, 1952) after deposition of thin silver films.

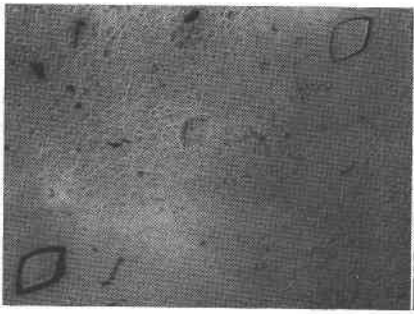
As usual the etch patterns produced on all of them were invariably similar consisting of (a) large localized isolated pits and (b) random distribution of micropits. A typical photomicrograph illustrating the general etch patterns as described above is given in Fig. 1, which is produced by etching muscovite mica from Bhuti Mine, Kodarma, for 36 hours in HF acid. The large individual isolated pits and random distribution of micropits are clearly seen. In this investigation only the individual isolated pits on all the samples under investigation are critically examined and their particulars are noted. These pits could easily be classified from the appearances of their structures mainly into four catagories:

1. Point bottomed pits with wide terraces
2. Point bottomed pits with narrow terraces
3. Point bottomed pits with halo
4. Curved bottomed pits

Figures 2, 3, 4 and 5 represent respectively point bottomed pit with wide terraces, point bottomed pit with narrow terraces, point bottomed pit with halo and curved bottomed pit. In order to make a comparative study of different samples of mica and the etch patterns produced on them, about five different specimens from each sample were selected and etched simultaneously in HF acid for 36 hours. The time of etching was so adjusted that the sizes of the pits produced could be conveniently studied. They were then examined by means of an optical microscope. The sizes of the longer and the shorter diagonals of the number of pits described above were measured. Their depths were obtained with the help of measurements made with a light profile microscope. From measurements made on number of different types of pits on all the five specimen of mica from the same sample, only two observations pertaining to each category of the different types of pits mentioned above are given. In the case of terraced pits with and without a halo, the first observation relates to the wide-terraced pit while the second to the narrow-terraced pit. In the case of curved bottomed pits these observations relate to pits having maximum and minimum depths. The procedure is extended to all the samples, and all these observations are represented in Table 1.

Careful study of the data given in table reveals the following:

1. The sizes of the pits on the different samples are not the same.
2. The sizes even vary in the case of pits on the same sample.
3. The ratio of the two diagonals is approximately the same for the pits on all the samples.
4. The depths vary with different types of pits. In the case of terraced pits, pits with wider terraces are deeper compared to pits with narrow terraces.



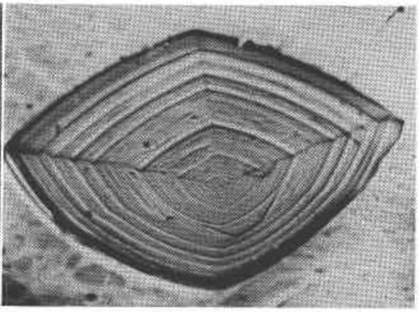
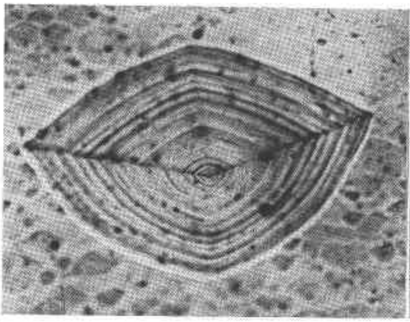


FIG. 1 (left). Etch patterns on muscovite mica from Bhuti Mine etched for 36 hours in HF acid (×350).

FIG. 2 (right). A point bottomed pit with wide terraces (×800).



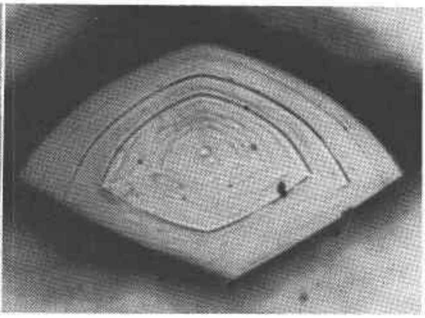


FIG. 3 (left). A point bottomed pit with narrow terraces (×800).

FIG. 4 (right). A point bottomed pit with halo (×800).

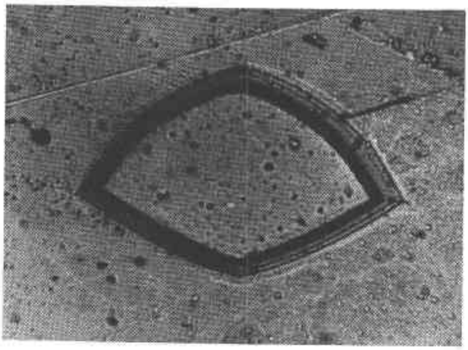


FIG. 5. A curved bottomed pit (×800).

TABLE 1. OBSERVATIONS ON MUSCOVITE MICA

Source (1)	Pit Type (2)	Length of shorter diagonal in μ (3)	Length of longer diagonal in μ (4)	Depth in μ (5)	Ratio of diagonals (6)	Av. no. of pits/cm^2 (7)
1. Arandhawa Mine	Point Bottomed	(i) 46.07	71.01	10	1.538	276
		(ii) 40.70	61.71	3.42	1.543	
	Point Bottomed with Halo	(i) 37.28	57.42	6.57	1.540	
		(ii) 36.80	56.43	5.00	1.533	
	Curved Bottom	(i) 43.00	65.72	3.85	1.529	
		(ii) 32.28	49.85	1.14	1.542	
2. Seva Dhab Mine Kodarma	Point Bottomed	(i) 37.02	56.57	2.29	1.528	86
		(ii) 34.85	53.52	1.71	1.536	
	Point Bottomed with Halo	(i) 34.94	53.43	6.28	1.529	
		(ii) 36.85	56.14	3.70	1.524	
	Curved Bottom	(i) 26.86	41.18	2.14	1.534	
		(ii) 47.43	73.00	2.85	1.539	
3. Thargati Mine Kodarma	Point Bottomed	(i) 44.57	68.00	8.00	1.525	245
		(ii) 52.70	80.70	2.14	1.532	
	Point Bottomed with Halo	(i) 58.57	89.73	8.00	1.532	
		(ii) 57.00	88.28	4.43	1.549	
	Curved Bottom	(i) 51.70	78.84	4.42	1.525	
		(ii) 52.58	79.71	2.86	1.523	
4. Rex Mine Australia	Point Bottomed	(i) 44.29	69.28	2.57	1.564	155
		(ii) 50.15	76.28	3.14	1.522	
	Point Bottomed with Halo	(i) 57.72	88.15	7.41	1.527	
		(ii) 61.57	94.96	5.43	1.543	
	Curved Bottom	(i) 62.29	95.85	5.00	1.539	
		(ii) 64.13	98.72	2.14	1.539	
5. Bhuti Mine Kodarma	Point Bottomed	(i) 35.43	67.14	1.57	1.546	39
		(ii) 38.00	56.01	1.42	1.545	
	Point Bottomed with Halo	(i) 38.43	58.70	5.00	1.528	
		(ii) 29.74	45.57	4.71	1.532	
	Curved Bottom	(i) 40.43	62.00	6.42	1.533	
		(ii) 38.00	56.01	2.29	1.545	

Table 1.—(*Continued*)

Source (1)	Pit Type (2)	Length of shorter diagonal in μ (3)	Length of longer diagonal in μ (4)	Depth in μ (5)	Ratio of diagonals (6)	Av. no. of pits/cm^2 (7)
6. Muscovite from Latehar, Ranchi	Point Bottomed	(i) 57.43	86.77	1.714	1.518	373
		(ii) 50.28	76.81	1.14	1.528	
	Point Bottomed with Halo	(i) 33.14	50.83	11.43	1.534	
		(ii) 37.86	57.86	5.43	1.529	
	Curved Bottom	(i) 40.57	62.29	3.14	1.535	
		(ii) 41.71	63.57	2.14	1.524	
7. Jamuna Mine Kodarma	Point Bottomed	(i) 51.00	78.29	3.43	1.535	116
		(ii) 41.15	63.71	1.86	1.548	
	Point Bottomed with Halo	(i) 64.42	99.00	6.71	1.537	
		(ii) 55.43	87.14	3.57	1.544	
	Curved Bottom	(i) 56.56	85.86	2.14	1.545	
		(ii) 49.91	76.43	1.43	1.531	
8. Lattri Mine Kodarma	Point Bottomed	(i) 37.13	57.41	5.00	1.546	70
		(ii) 37.43	56.57	1.29	1.527	
	Point Bottomed with Halo	(i) 39.28	60.29	10.00	1.535	
		(ii) 46.86	71.86	3.704	1.553	
	Curved Bottom	(i) 30.14	46.86	5.28	1.554	
		(ii) 37.00	56.86	2.29	1.537	
9. Ruby Mica Ganjam, Orissa	Point Bottomed	(i) 28.43	43.43	2.57	1.520	135
		(ii) 45.43	70.57	2.29	1.553	
	Point Bottomed with Halo	(i) 36.84	55.86	11.43	1.551	
		(ii) 47.85	72.85	5.72	1.523	
	Curved Bottomed	(i) 38.00	58.42	1.714	1.537	
		(ii) 39.43	60.86	2.57	1.554	
10. Ruby Mica Kodarma	Point Bottomed	(i) 36.85	55.86	6.85	1.510	93
		(ii) 32.15	48.57	1.14	1.521	
	Point Bottomed with Halo	(i) 31.43	48.72	15.15	1.550	
		(ii) 38.00	58.29	5.29	1.534	
	Curved Bottomed	(i) 45.71	69.13	2.86	1.51	
		(ii) 39.00	60.15	1.72	1.543	

TABLE 1.—(*Continued*)

Source (1)	Pit Type (2)	Length of shorter diagonal in μ (3)	Length of longer diagonal in μ (4)	Depth in μ (5)	Ratio of diagonals (6)	Av. no. of pits/cm^2 (7)
11. Ruby Mica (Starke and Co. Delhi)	Point Bottomed	(i) 24.57	38.28	1.71	1.556	39
		(ii) 29.57	45.29	3.29	1.534	
	Point Bottomed with Halo	(i) 25.86	40.01	8.43	1.547	
		(ii) 28.00	42.85	7.00	1.531	
	Curved Bottom	(i) 22.57	35.29	8.59	1.525	
		(ii) 21.14	32.15	1.43	1.521	
12. Mica Black spotted (Starke and Co, Delhi)	Point Bottomed	(i) 46.86	71.57	5.43	1.527	39
		(ii) 47.14	73.70	3.43	1.56	
	Point Bottomed with Halo	(i) 35.43	54.00	10.42	1.524	
		(ii) 46.56	70.57	9.31	1.516	
	Curved Bottom	(i) 50.14	76.43	6.28	1.525	
		(ii) 37.71	50.86	1.00	1.555	
13. Mica Vegetable Stained (Starke and Co, Delhi)	Point Bottomed	(i) 53.00	81.14	2.86	1.531	171
		(ii) 51.73	78.84	2.14	1.524	
	Point Bottomed with Halo	(i) 55.43	83.43	5.72	1.505	
		(ii) 53.71	82.56	3.43	1.537	
	Curved Bottom	(i) 54.15	82.28	8.14	1.519	
		(ii) 50.29	77.14	1.71	1.538	
14. Mica Heavily Stained (Starke and Co, Delhi)	Point Bottomed	(i) 38.86	60.42	6.43	1.55	140
		(ii) 32.14	49.43	1.29	1.538	
	Point Bottomed with Halo	(i) 53.14	79.00	7.14	1.516	
		(ii) 54.86	84.14	5.00	1.533	
	Curved Bottomed	(i) 37.15	57.15	8.86	1.538	
		(ii) 40.15	63.14	1.14	1.553	
15. Mica Black Spotted, Madras	Point Bottomed	(i) 45.86	71.57	5.43	1.561	66
		(ii) 46.71	71.99	5.14	1.54	
	Point Bottomed with Halo	(i) 46.56	70.57	8.86	1.516	
		(ii) 46.71	71.99	5.14	1.54	
	Curved Bottom	(i) 36.29	56.57	6.71	1.559	
		(ii) 51.14	76.43	6.29	1.525	

(5) In the case of curved bottomed pits, their depths vary between wide limits, on the same sample and from sample to sample.
(6) The pit density also varies between wide limits.

Discussion

The observation that point bottomed pits with wide terraces are deeper compared to narrow-terraced pits may be explained by assuming precipitation of some impurities along the dislocation lines, at which these pits may be assumed to be nucleated. These impurities during etch may inhibit the action of the etchant *i.e.* the pit will continue to grow at the same rate in extension but along the depth the attack will be stopped for some time because of the inhibitive action of the impurity and then will continue. Where the attack is stopped, a terrace will be formed. According to this mechanism, if the impurities are widely spaced along the dislocation line, the inhibitive action will be operating at long intervals, which will result in a pit having wide terraces. If the impurities are not very widely spaced, the inhibitive action will operate at short intervals, and this will result in a narrow-terraced pit. Thus during a particular period of etching, the inhibitive action will be operating a greater number of times in the case of narrow-terraced pits compared to wide-terraced pits. The result will be that the wide-terraced pits will be deeper than the pits with narrow terraces. The nucleation center of the terraced pits with halos may be assumed to be the termination of a dislocation line around which large numbers of some other impurity atoms might have been precipitated. On etching, these impurity atoms might be attacked by the etchant all at the same time with the result that initially a deep pit will be produced, giving the appearance of a halo. When the attack of the etchant on the impurity atoms is over, the dislocation line alone will be left and will be etched at a normal rate, producing the terraced pits described above. Hence these pits, though terraced, will have some halos. The halo is nothing but deep region produced in the pits at the outset. Thus the terraced pits with halos will be deeper than those without halos. No doubt depths do depend on the extent of the halo and the type of terracing. That the depth of curved bottomed pits varies between wide limits, suggests that the nucleation of these pits may be assumed to be at such places where a group of impurity atoms are precipitated. Because of the precipitation of this group of impurities, the etchant will react with these impurities with the result that a curved bottomed pit will be produced. The depth of such pits will depend on the depth in the crystal up to which such impurities exist. This might vary between wide limits, and hence the depths of such pits should vary between wide limits, as is observed.

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