be seen the successive papers obtained with a suspension (in distilled water) of a coal-measure shale from the Grove seam in the West Midlands. At the bottom are papers obtained after 5 ml. of a 1 per cent solution of potash alum had been added to 100 ml. of the same suspension in order to produce flocculation of the solid matter. The reduction in the penetration of the filter papers (Whatman No. 4) is quite evident and should be amenable to quantitative measurement.

Thus it appears that Prof. Fahraeus's technique could offer a method not only for measuring the coagulation of blood but also for the flocculation of shale and clay suspensions.

R. L. WHITMORE

Department of Mining and Fuels,
University of Nottingham.
Dec. 19.

Etch Pits on Calcite Cleavage Faces

THIS communication describes some of the effects observed on calcite cleavage faces after etching with dilute acid. Puchegger[1] has reported etch pits which formed a rib-like pattern on either side of scratch marks made on calcite. More striking features are described here.

Rhombohedral crystals, freshly cleaved from a large block of natural calcite, were etched and examined on each face in turn. Etching was carried out in 1 per cent nitric acid, after which the crystals were washed with distilled water, ethanol and carbon tetrachloride, and dried. Etching times varied from 5 sec. to 5 min. The crystals were examined and photographed on a Vickers projection microscope using oblique illumination by a mercury-vapour lamp with yellow-green filter.

The same general features were found on each face and no features were found to be peculiar to any single face or pair of opposite faces. Numerous etch pits were observed occurring singly, in small groups, and in lines of overlapping pits. No pits were observed on unetched faces. Three types of pit were observed; three-sided 'flat iron' pits depicted in Fig. 1*a*, referred to hereinafter as type 1; four-sided pits (Fig. 1*b*), type 2; and five-sided pits (Fig. 1*c*), type 3. Types 2 and 3 predominated. Steps were observed on the faces of many of these pits and may be seen in Fig. 1*d*. Some pits retain their shape for long etching times, others cease to increase in depth relative to the general surface-level after a few seconds etching and then only increase in area to give flat-bottomed pits, some of which may be seen in Figs. 1*a* and *b*. These pits eventually overlap others and fade out to leave a shadowy outline. New pits sometimes start to grow in the flat bottom of an old one. Some pits persist for several minutes etching time and become visible to the naked eye; such pits have very rounded sides. A few highly pitted regions were observed. They appear within 5 sec. etching and persist with little change in configuration for 3 min. or more (Fig. 1*e*). These pits were all of type 3; but in the figure dark shadow makes it difficult to distinguish the intersection of two of the faces.

Visible fracture planes in the crystal, both parallel to and along the diagonals of cleavage faces, etched into deep grooves (Fig. 1*f*) with a rib structure similar

a b c d e f

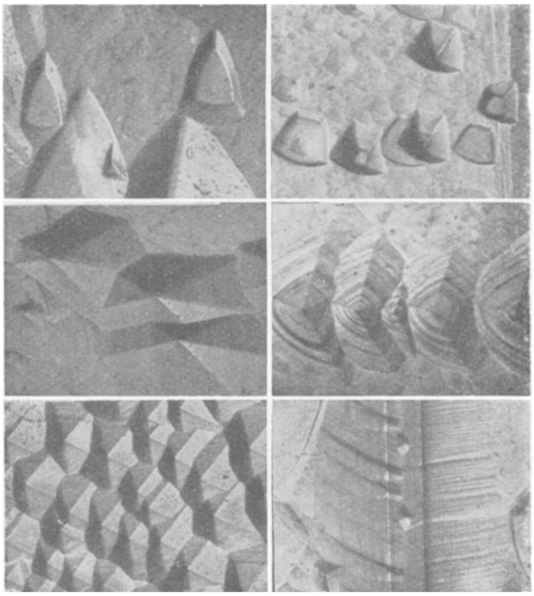

Fig. 1. *a*, Three-sided etch pits, type 1, 90 sec. etching; *b*, four-sided etch pits, type 2, 5 sec. etching; *c*, five-sided etch pits, type 3, 30 sec. etching; *d*, line of overlapping pits, 45 sec. etching; this line extended for more than 2 mm. on the crystal; *e*, highly pitted region, 60 sec. etching; *f*, etch groove at fracture plane—note width of ribbed region and pits in groove. (All *c*. × 100)

to but more pronounced than that observed by Puchegger[1]. These grooves sometimes contain a few deeper pits, as may be seen in Fig. 1*f*.

The fact that some pits lie in lines across the crystal (Fig. 1*d*) suggests that they are formed by preferential etching at the site of dislocations in the crystal[2]. The highly pitted regions would be regions of high disorder. The width of the ribbed region in Fig. 1*f* seems to indicate that slip along a fracture plane in the crystal disturbs a large region on either side of the plane.

The steps on a pit face make it possible to determine if that face is flat or curved, if it is presumed that all steps are parallel to the original surface before etching. All faces on pits of type 3 are flat, all pits of type 2 have at least one curved face, while all faces on pits of type 1 are curved. Pits of types 1 and 2 are probably degenerate forms of type 3 pits. Replacement of a pair of flat faces in type 3 by one curved face would give type 2; at the same time two other faces often become slightly curved. Type 1 pits would be formed from type 2 by continuing two faces to meet at a point.

It is difficult to envisage a mechanism whereby a five-sided etch pit can arise in a rhombohedral crystal. In view of the importance of etch pits to dislocation theory, I feel it is worth directing the attention of others to these effects at the present time.

I am indebted to Mr. W. T. Denholm for discussions.

H. WATTS

Bonython Laboratory,
South Australian School of Mines and Industries,
Adelaide.
Dec. 12.

[1] Puchegger, F., *Naturwiss.*, 39, 428 (1952).
[2] Frank, F. C., "Chemistry of the Solid State", edit. by Garner, W. E., 14 (Butterworths, 1955).