

In the steep roll of the bank near the brook, in 40 feet, are represented strata of the

Great Oolite,  
Fuller's Earth,  
Inferior Oolite,  
Upper Lias,  
Middle Lias,

the wasted remnant of a thousand feet of rock and clay of the higher north-west Cotteswolds.

The dip into the hill on the downs of the Tainton Great Oolite freestone suggests the probability of a high fault line along the downs parallel with the low line of fault described. It may be safely surmised that the curved line of fault mapped by the Survey joins the one at the Waterworks nearer Tainton, and it is probable that the upper line of fault meets the long fault seen to be trending from east to west above Burford and near Waterloo Farm.

---

ADDENDUM.—NOTE ON THE MICROSCOPIC TYPE OF THE MARLSTONE OF TAINTON.

The stone is of the usual dull green colour, weathering to a reddish brown. It has the granulated appearance of the bottom stone of North Oxfordshire, though it is really not of so oolitic a type.

In section it is shown as a mass of ferro-crinoid segments, held together by a matrix of clear calcite of which but little is seen. The segments or plates are pentagonal, ovoid, orbicular, or of irregular shape, and are pierced with rounded openings.

Scattered throughout the mass are olive-coloured patches or granules of ferrous carbonate, with oolitic grains of the same colour, of ovoid or irregular shape, and of small size. When solidified they pass from a pale olive brown to a deeper rich brown colour. The interspaces and passages of foraminifera and other organisms are filled with the same mineral. There is no trace of concentric banding or lamination in the oolitic grains, which appear to be decomposed rather than fully formed.

It is remarkable that in strata of such great waste the organic structure of the ferro-crinoid, which I have elsewhere shown to be the main constituent of the Middle Lias ironstone, should remain, and that the oolitic stage should be so feebly developed.

---

NOTICES OF MEMOIRS, ETC.

AN ENQUIRY INTO THE VARIATION OF ANGLES OBSERVED IN CRYSTALS, ESPECIALLY OF POTASSIUM-ALUM AND AMMONIUM-ALUM.<sup>1</sup> By Professor H. A. MIERS, M.A., D.Sc., F.R.S.

CORRESPONDING angles measured on different crystals of the same substance usually differ slightly. On cubic crystals the theoretical angles are known. Pfaff professed to have established

<sup>1</sup> Abstract of a paper read before the Royal Society, March 26, 1903.

that only those cubic crystals which display birefringence exhibit divergence from the theoretical angles, but Brauns showed that in lead nitrate, ammonia-alum, and spinel, for both isotropic and birefringent crystals alike, the octahedron angle may differ by as much as 20' from that of the regular octahedron.

The author has endeavoured to trace the changes of angle upon one and the same crystal during its growth by measuring it at intervals without moving it from the solution in which it is growing. This is accomplished by means of a new telescope-goniometer in which the crystal is observed through one side of a rectangular glass trough, and the changes in the inclination of each face are followed by watching the displacements of the image of a collimator slit viewed by reflection in it. The crystal is held by a platinum clip which it envelops as it grows. Small movements of the image are followed by means of a special micrometer-eyepiece which accurately measures the magnitude and direction of the displacement.

Examined in this way an octahedron of alum (ammonium or potassium) is found to yield, not one, but three images from each face; and closer inspection shows that the crystal is not really an octahedron, but has the form of a very flat triakis-octahedron. It often happens that of the three faces which nearly coincide, one is large and the remaining two very small, so that of the three images one is bright and the others are very faint and can only be discerned with difficulty; in such a case the crystal as measured in the ordinary way would appear to be an octahedron whose angle differs from the theoretical value by a few minutes.

When a growing crystal of alum is watched for several hours or days, it is found that the three images yielded by an apparent octahedron face continually change their position; one set fades away and is replaced by another set which are generally more widely separated than those which they succeed. The images move in three directions inclined at  $120^\circ$  to each other, and indicate that these faces always belong to a triakis-octahedron. The point in which the lines of movement intersect within the field of view of the telescope would, therefore, be the position of the image reflected from the true octahedron face. Measured in this way the octahedron angle of alum is found to be the theoretical angle  $70^\circ 31\frac{3}{4}'$ .

The images do not move continuously, but *per saltum*, indicating that the reflecting planes are vicinal faces which probably possess rational indices, and must therefore be inclined at certain definite angles to the octahedron face; but the indices are very high numbers.

Observations upon sodium chlorate, zinc sulphate, magnesium sulphate, and other substances show that other crystals exhibit the same behaviour. The faces of a crystal are in general not faces with simple indices, but vicinal planes slightly inclined to them, and they change their inclinations during the growth of the crystal; they also change their inclinations when the crystal is immersed to a greater or less depth in the solution.

Every point within a crystal has at some time been a point on the surface, and has been subject to the conditions of equilibrium

between crystal and solution which prevail there. It is believed by the author that a study of the vicinal planes and of the liquid in contact with them, may lead to some understanding of these conditions.

In order to ascertain the composition of the liquid, attempts were made to determine its refractive index by means of total reflection within the crystal. This appears, indeed, to be the only method which can give direct information concerning the ultimate layer in contact with the growing face, and it is somewhat remarkable that it has not been applied before. Considerable difficulty was experienced in making this measurement, but ultimately good readings were obtained which gave the value 1.34428 as the refractive index in sodium light, at 19° C., of the liquid in contact with a growing crystal of alum. The refractive indices of a series of solutions of known strength, ranging from dilute to supersaturated, having been previously measured, the above index was found to correspond to a liquid containing about 10.80 grammes of alum in 100 grammes of solution. A saturated solution at 19° C. was found to have the refractive index 1.34232, and to contain about 9.01 grammes of alum in 100 grammes of solution.

Sodium chlorate was examined in the same way: it was found that the liquid in contact with a growing crystal has at 19° C. the index 1.38734, and contains about 47.8 grammes of salt in 100 grammes of solution; a saturated solution of sodium chlorate at 19° C. has the index 1.38649, and contains about 47.2 grammes of salt in 100 grammes of solution.

The liquid in contact with a growing crystal of sodium nitrate has at 19° C. the index 1.38991, and contains about 48.45 grammes of salt in 100 grammes of solution; a saturated solution at 19° C. has the index 1.38905, and contains about 48.1 grammes of salt in 100 grammes of solution.

In each case the liquid in contact with the growing crystal is slightly supersaturated. It was not found to exhibit double refraction even in the case of sodium nitrate. No experiments seem to have previously been made upon the nature of this liquid.

G. Wulff has suggested that vicinal faces are due to concentration streams in the solution. In order to test this view, crystals of alum were measured after growing for several hours in solution kept continually agitated in order to eliminate the action of the concentration streams. Almost no effect was produced upon the angles of the vicinal faces.

In sodium chlorate and sodium nitrate the solute is about 45 times more dense in the crystal than in the adjacent liquid. Now planes with high indices in a space-lattice contain fewer points in unit area than planes with simple indices. The author suggests that vicinal faces grow upon a crystal in preference to simple forms because the crystallising material descends upon the growing face in a shower which is not very dense.