

minerals of more than one family, which will rarely be the case, the rule is to choose those which are most abundant. The family-name being thus obtained, observe next upon what basis the family is subdivided, whether it is by the nature of the ferromagnesian mineral, by the kind or quantity of felspar present, or by some other property. All the constituents of the rock, essential and accessory, being now considered, it will be easy to assign the rock to its right subdivision, supposing one already exists. If, on the other hand, the rock is a new type and no place awaits it, a new subdivision can be created and named in accordance with the general system.

The only rocks which it will be found difficult to name are those which do not contain the index minerals of *any* family. In such cases the association of the rock is the first point to be considered. If any such rock clearly forms part of an igneous mass which can be readily assigned to a family, let the doubtful rock also be assigned to the same family, and give it a name in which the missing index mineral is preceded by the privative *a-*. If, however, besides being entirely new, the rock does not appear to be associated with any known type, it becomes a question whether a new family should be established. This course must be adopted only when there is really no other way of naming the rock, and the family name selected should be, as far as possible, descriptive of the rock's peculiarity in mineral or chemical composition.

I cannot end without expressing my gratitude to Prof. Bonney, my first master, for the interest with which he has followed my work upon classification and nomenclature and for the many suggestions which he has freely offered. To Prof. Rosenbusch also I am deeply indebted for the kindly instruction received at Heidelberg, which has opened my eyes and smoothed my path in many ways, but more especially in this research.

### III.—NOTES ON THE TOURMALINE OF THE WHITE GRANITE OF MELDON, DARTMOOR.

By Lieutenant-General C. A. McMAHON, F.R.S.

THIS "remarkable variety of granite" was briefly described by Mr. J. J. Harris Teall, F.R.S., in his "British Petrography" (1888), p. 316, and an interesting account was given in a footnote of the process by which the author was able to identify the topaz found in the rock.

In a paper on Dartmoor published in 1893 (Q.J.G.S., vol. xlix, p. 385), I described in some detail the mode of occurrence of this intrusive rock and some of its characteristics; and in the following year (Q.J.G.S., vol. L, p. 338) I noted the occurrence of a second outcrop on the flank of South Down.

None of the above references to the white granite of Meldon contain a description of the tourmaline found in it, and as this mineral presents some unusual features a few remarks on it may interest students of petrology.

White tourmaline (achroite) has not yet, so far as I am aware, been found in the British Islands, but the tourmaline of the Meldon granite approximates to colourless tourmaline sufficiently closely to render it probable that if the attention of mineralogists is drawn to the subject true achroite may yet be detected in British rocks.

The following remarks are based on the study of a good suite of thin slices made from hand specimens collected by me, and of numerous fragments of tourmaline separated from these specimens with the aid of a heavy solution. When I was at Meldon the granite was being quarried, and I was able to get unweathered samples.

Fragments of tourmaline examined with a powerful pocket lens are seen to be in part colourless and in part of pale-brown colour.

Under the microscope, when examined with the aid of transmitted light, the tourmaline in thin slices (as thin as those "made in Germany" for instance) is absolutely colourless and devoid of dichroism. It is consequently difficult to distinguish from the topaz with which it is associated. This difficulty is increased by the fact that both minerals, as seen in thin slices of the Meldon rock, closely resemble each other in habit. Both are allotriomorphic and occur in irregular shaped grains. The tourmaline rarely presents itself in prismatic form, whilst the cleavage, usually so characteristic of topaz, is rarely to be seen in the topaz of the Meldon granite. As, moreover, the refraction of both minerals is higher than that of Canada balsam, and of the felspar and quartz with which they come in contact, the difference in the refraction of topaz, as compared with that of tourmaline, does not help one to discriminate between them.

The positive character of the double refraction of topaz could not be made out in any of my slices, as no bisectrix could be seen in converging polarized light. The axial angle in topaz from different localities varies very much, and it is probably large in the variety found in the Meldon granite.

The rock under consideration affords an illustration of the help that may sometimes be afforded by our much abused thick slices of English manufacture. In such slices the Meldon tourmaline presents a somewhat more normal appearance. Even in thickish slices, however, the mineral is sometimes colourless in whole or in part, but more often a reddish or reddish-brown streak or patch is to be seen in the otherwise colourless grains which exhibits the characteristic dichroism of tourmaline.

The appearance of these coloured stripes and patches suggests to me the possibility that the colour may be due to the alteration of an originally colourless tourmaline; namely, to the oxidation of the iron contained in the mineral. Iron is not an essential constituent in this complex silicate, and my previous studies have familiarized me with the idea that iron may be removed, or oxidized, without breaking up the fundamental silicate of which it is more or less a casual unessential member.

The tourmaline in the Meldon granite very rarely exhibits prismatic outlines in thin slices, but in the isolated fragments both

this mineral and the topaz show a slightly increased tendency to do so. The tourmaline, however, even in thin slices, is frequently elongated in the direction of the vertical axis ( $c'$ ); and as the greatest absorption takes place at right angles, and compensation with the quartz wedge occurs parallel to this direction (viz. to  $c'$ ), a ready and sure means of identifying the mineral exists in such cases.

When this observation can be made one cannot remain in doubt as to which is tourmaline and which is topaz, as the latter is not dichroic in thin slices, and compensation with the quartz wedge, in the case of topaz takes place at right angles to  $c'$ , and in the case of tourmaline parallel to  $c'$ .

When dichroism is apparent in the Meldon tourmaline the change is from colourless ( $e$ ) to a yellowish or reddish-brown ( $o$ ).

In cases where the above-mentioned observation cannot be made, namely, when dichroism is absent, I have found the following methods very useful.<sup>1</sup>

I have often, when examining the topaz in my slides, been able to obtain in converging polarized light the interference figure of an optic axis, namely, a single bar, or a bar bisecting the first ring of the interference figure, which remained without change of character during a revolution of the crossed nicols through  $360^\circ$ . When this interference figure is obtained it shows clearly that the mineral is a biaxial one, and consequently that it is topaz and not tourmaline. Axial sections of the latter mineral, on the other hand, may be obtained in my thin slices, which in converging polarized light yield a negative uniaxial cross which does not open out on revolving the nicols. Sometimes when the section has not been cut quite normal to the vertical axis of the crystal, only two of the arms of the cross can be seen, and sometimes their point of junction is outside the field. In such cases, with one of Swift's improved one-sixth objectives, I can generally get the two arms just on or just outside the edge of the field, and can make sure that the arms are those of an uniaxial mineral. In cases of doubt I am able to confirm this observation by inserting the one-fourth undulation mica plate, when the double refraction of tourmaline being negative, one dot (only half of the cross being visible) appears in a line with the axis of the mica plate and well within view.

Observation of the strength of the double refraction also affords, in some cases, a method of distinguishing between the two minerals. The birefringence of topaz does not exceed 0.010, whilst that of tourmaline is 0.020. The colour of the former mineral, as seen in thin slices, does not rise above the indigo-blue of the second order of Newton's scale, and very often falls below that. On the other hand, the colour shown by the tourmaline in my sections frequently rises to the indigo-blue of the third order.

Lastly, the character of the metamorphism effected by aqueous agents affords a useful test. Tourmaline alters to steatite, mica,

<sup>1</sup> I confine myself to optical tests and those which can be applied to thin slices.

*chlorite*, and *cookeite*;<sup>1</sup> whilst topaz changes to steatite, mica, and *kaolin*.

In my Meldon specimens the green tint seen in some of the tourmaline is probably due to the birth of ultra-microscopic particles of chlorite in the originally colourless crystals. The topaz, on the other hand, sometimes exhibits partial kaolinization, and when it does so it is clear that the mineral is topaz and not tourmaline.

On the whole, I think it probable that the somewhat partial and patchy colour seen in the Meldon tourmaline is due to the post-genital alteration of an originally colourless variety of this mineral. I do not think the faint colour now visible is due to the bleaching of an originally dark-coloured tourmaline. An operation of this kind would imply the bleaching of the whole of the white granite itself, which I do not think probable. Moreover, it would involve chemical action to an extent that must have left very powerful marks on the feldspars and other susceptible minerals contained in the rock, that could not remain unobserved.

#### IV.—AN ABNORMAL SECTION OF CHLORITIC MARL AT MUPE BAY, DORSET.

By A. STRAHAN, M.A., F.G.S.

IN "The Geology of the Isle of Purbeck and Weymouth" (p. 152) I referred to some green sand which occurs next below the Chalk in Mupe Bay, Dorset, as somewhat resembling Chloritic Marl, but as being too thick for that bed. As it was followed by the Gault, I concluded that it belonged to the Upper Greensand. The section was subsequently visited by Mr. W. Hill, who collected from the sand in question *Holaster subglobosus*, var. *altus*, and *Echinoconus castanea* among other fossils, and inferred that it was Chloritic Marl. He considered that though it passed up insensibly into the Chalk it was faulted against the Gault, but that there had been also considerable contemporaneous erosion of the Upper Greensand. In April of this year I revisited the section in company with Mr. Hill, and was fully satisfied as to the correctness of his views. The following account has been drawn up from our observations:—

The Lower Chalk becomes extremely impure in its lower part, and contains much glauconite; it thus graduates insensibly downwards into a gritty glauconitic sand. The sand contains a few phosphatic casts, more or less worn or corroded, scattered throughout it, but has a well-marked nodule-bed crowded with these casts at its base; other fossils with the shell preserved and not filled in with phosphate occur also throughout the whole bed.

Below the sand comes a sandy glauconitic clay, forming part of the Gault, but the fact that the separation is sharp, and that the chert-beds of the Upper Greensand and the passage-beds down into the Gault are absent, proves that the two are faulted together, although the fault-plane is parallel to the highly inclined bedding.

<sup>1</sup> See Dana's textbook, last edition.