THE PETROGRAPHY OF DARTMOOR AND ITS BORDERS.

Part I.

BY R. HANSFORD WORTH.

(Read at Bideford, July, 1902.)

"It is not really possible, so far as Dartmoor is concerned, to suggest any condition or gradation of felsitic material, in composition, structure, or metamorphism, that is not represented, or that is not linked by intermediate phases to all the rest. What we attempt to distinguish as separate rocks in this connection are, in fact, nothing more than stages, the differentiation between them pathological and not generic. Their condition and appearance vary with their history, but at bottom they are essentially one and the same, and nowhere in the series can any hard and fast line be drawn."—*R. N. Worth*, 1895.

In scope and in intent the present paper is a partial effort to carry forward my father's work on the geology of Dartmoor. Granted the two essentials, time and opportunity, that work admits extension in certain definite directions. New varieties of rock may be found; known varieties may be obtained from new localities; rocks, previously only known as constituents of detrital deposits, may be found *in situ;* and rocks formerly described with reference to their macroscopic characteristics may be subjected to microscopic examination.

In no one of these directions can any striking novelty, leading to a broad variation of general principles, be anticipated. Some modification of detail there must be, and some addition to the general outline.

The subject is so wide that exhaustive research is impossible, but at least with adequate care the ground can be secured as we go. To this end one simple precaution should largely contribute: the locality of each specimen, whether taken *in situ* or not, has been marked with a distinctive number on the six-inch Ordnance map; the specimen itself has been labelled with this distinctive number, following the reference of the six-inch quarter-sheet, and with the latitude and longitude of the point from which it was taken. Each specimen label thus gives a locality with close approximation, and in practice this system is not more troublesome than the result attained warrants. The following is a facsimile of a complete label:—

> **DARTMOOR**
>
> CVI. S.E. 1^a
>
> Lon. . . 4° 1′ 55″
>
> Lat. . . 50° 32′ 29″
>
> Swell Tor Quarry
>
> *In situ*

In this instance "CVI. S.E." indicates the six-inch quarter-sheet of the Ordnance Survey covering the area in which the specimen was found, "1^a" is the distinctive number of that specimen as marked on the quarter-sheet, the latitude and longitude enable the same point to be marked on any map or plan, and for additional information the name of the locality is added as well as the remark "*In situ.*"

It may be noted that every six-inch quarter-sheet of the Ordnance Survey bears the degrees of latitude and longitude on its border.

Microscopic sections have full facsimiles of the labels of the specimens from which they have been cut.

One other matter may be referred to in this connection. Specimens actually taken from the "living rock" are referred to as "*in situ*"; others may be spoken of as "*practically in situ,*" when the conditions under which they are found leave no doubt that they are not far travelled from their centre of origin. Such conditions exist when a defined area of soil at any point is thickly strewn with fragments of a definite rock, which fragments do not occur in the same profusion elsewhere, and especially are not to be found on the hillside *above* the area. All other specimens are marked "*not in situ.*"

It is intended that individual descriptions shall precede any general observations, with the exception of the following remarks on nomenclature and classification :—

NOMENCLATURE AND CLASSIFICATION.

The felsites and granites of Dartmoor range from compact subvitreous rocks with conchoidal fracture to coarsely crystalline giant granite; from a matrix in which a few specks of quartz, barely visible to the unaided eye, represent the whole of the porphyritic constituents, to holocrystalline rocks with felspar crystals of several inches in principal dimension, and the other minerals proportionately developed.

Between these extremes lies the unnumbered host of varieties. The felsites grade through micro-porphyritic rocks, in which by the development of crystalline structure the whole felsitic matrix may ultimately be lost, and pass into fine-grained granites; from which minutely crystalline but fully differentiated rocks to the coarsest textures all intermediate forms occur.

Or the most compact felsite without other visible porphyritic constituents may develop sporadic crystals of felspar to be measured by inches, and grains of quartz from half to three-quarters of an inch in diameter, while on the other hand an apparently holocrystalline granite may prove to have a felsitic matrix.

The same transitional gradations apply to the mineral, although probably not to the ultimate chemical, composition of these rocks.

At times these gradations can be followed through successive adjacent portions of the same rock mass; more frequently specimens from different localities are necessary to exhibit to the full the intermediate forms.

Confronted by the necessity for adopting some nomenclature applicable to the whole of these varieties, it becomes evident that a few simple types, around which the other forms can be grouped, present the only logical system.

The following terminology has accordingly been adopted:

FELSITE.

(The Compact Felspar of early writers corresponding in part with Elvan, Elvanite, Eurite, Felstone, Hälleflinte, Hornstone, Petrosilex, and Porphyry, in part also with Granophyre, Felsophyre, and Micro-granite and Micro-granulite.)

It is comparatively useless to enter upon an historical discussion of the varied application of the above list of names, each of which has been used in its time as in part synonymous with felsite, and most of which have, on the other hand, been applied by some one authority or more to other rocks than typical felsites. It is in fact necessary in using any one of the names given to state clearly what author is followed.

The attitude of a few recent writers toward this item of nomenclature may be stated as under:—

The term as the name of a rock species is rejected by *Cole*,[1] on the ground that it is so differently used by different writers that its reputation is lost. He proposes in its place the "Eurite" of d'Aubisson, "since that seems to cover admirably the fine-grained and compact forms of granite, known commonly in England as 'Quartz-Felsite,' and on the Continent as 'Micro-Granulite,' 'Quartz-Porphyry,' etc."

Teall[2] treats Felsite, Eurite, and Petrosilex as practically synonymous, and he recognises Quartz-Felsite, etc., as species.

Rutley[3] inclines to maintain a distinction between Felstone and Eurite, regarding the true Eurite as a more readily fusible rock than the true Felstone: he also recognises Quartz-Porphyry and Felspar-Porphyry as at least subspecies differing from typical Felstone.

Seeley[4] treats Felstone or Felsite-rock, Petrosilex or Eurite, as synonymous, and applies these names to rocks having a compact felsitic matrix, sometimes with crystals of quartz and felspar.

Bonney[5] proposes to use the term Felsite for certain hemicrystalline rocks and abandon the name Porphyry.

Merrill[6] writes of Porphyritic Felsites when describing rocks having a felsitic matrix and porphyritic constituents; and finally, *Williams*[7] gives the synonyms Felsite, Felstone, Eurite, Petrosilex, using these for a rock without porphyritic constituents and designating all porphyritic rocks with a quartz-felsitic matrix as Porphyries.

At some time or other most petrographers are driven to

[1] *Aids in Practical Geology*, 1893, p. 201.
[2] *British Petrography*, 1888, p. 291.
[3] *The Study of Rocks*, 1884, p. 209 *et seq.*
[4] PHILLIPS, *Manual of Geology*, 1885, p. 37.
[5] *Q.J.G.S.*, vol. xli. part ii., 1885, p. 71.
[6] *Report of Smithsonian Inst.*, 1885–6, part ii. p. 427.
[7] *A Manual of Lithology*, New York, 1886, p. 58 *et seq.*

use the term "felsitic matrix," and this with an approximately constant value. *Cole* avoids this difficulty by making the ground mass of his "Eurite" "micro-granitic and often micro-pegmatitic"; this at once places the name beyond the range of possibility as a substitute for Felsite, since many of our typical felsites have no micro-granitic or micro-pegmatitic structure, although others may and do pass into rocks of that type.

R. N. Worth[8] adopts Felsite for all rocks with a felsitic matrix, generically[9] and with the constant use of qualifying expressions for the various species[9] and sub-species. Thus utilising the name as identical with both the Felstones and Porphyries of many writers. This accords with *Bonney's* desire to abandon the term Porphyry, and in adopting this method of nomenclature two advantages are obtained. One broad bond of union between a series of rocks is kept in constant view, and a useful field name is retained which can follow the specimen through all stages of its examination under the microscope or in the laboratory. Sufficiently inclusive for the hammer, it admits ready modification for the study.

There appears to be a general agreement as to the true meaning of the words "felsitic matrix" or "felsitic matter," and the following definition has been drafted to accord with most, if not all, of the authorities.

Felsitic matter consists of an intimate micro-crystalline, crystalline-granular, crypto-crystalline, or indiscriminate admixture of felspar and quartz, the felspar being chiefly or, possibly, entirely orthoclase. The constituent minerals are indistinguishable and irresolvable with the aid of an ordinary lens. Macroscopically it is essentially compact and stony, sometimes flint-like, in which latter case it is translucent at the edges of flakes, and exhibits a more or less conchoidal fracture. Except in a very few extreme instances, bright spots of reflected light, due to the presence of minute blebs of quartz, can be detected on broken surfaces.

The microscope reveals a considerable range of structure. In the thinnest sections and under the highest applicable powers no detail may be discernible, and the rock may show only a species of aggregate reaction and dappled

[8] "Materials for a Census of Devonian Granites and Felsites," *Trans. Devon. Assoc.*, 1892.

[9] The terms "generic" and "specific" are not used in the same strict sense as in Biology.

appearance with polarised light; it is, however, clearly distinguishable from a glass. The trace of structure apparent in this type may perhaps be described as "indiscriminate." The confused appearance is largely due to the impossibility of cutting a section which shall be less in thickness or no thicker than the average dimension of the constituent crystalline particles. The thinnest possible section affords room for two or even three such particles within its depth, and since the crystal axes lie in all possible directions, each of these particles is liable to reverse or modify its neighbour's action upon polarised light, only the resultant effect reaching the eye.

1. This *Indiscriminate* structure is an extreme modification of the crystalline-granular, into which it passes when the particles of the constituent minerals become sufficiently large to be distinguished under the microscope, the discrimination being aided by the fact that many of the granules then occupy the whole thickness of a section from side to side.

As the particles become larger, while still remaining microscopic, definite varieties of composition and structural arrangement are recognisable.

2. *Micro-granular.*—The ground mass is granular, and consists wholly or almost wholly of quartz and felspar.

3. *Micro-pegmatitic.*—The quartz and felspar form intergrowths as in graphic granite (the term "pegmatite" being used in the strictly limited sense adopted by Häuy, its originator).

4. *Micro-granitic.*—Quartz, felspar, and mica (or amphibole or pyroxene) are present, and the structure is granitic.

In a ground mass of either of these types dominant mineral constituents may appear, either granular or possessing more or less definite crystal outline. If these constituents are visible to the unaided eye, the rock is *Porphyritic*, and *Micro-porphyritic* if only to be detected by the aid of the microscope. These together form the Porphyries of many writers.

If, however, we adhere to the name "Felsite," a convenient way of indicating that the rock contains porphyritic constituents, and at the same time stating the minerals which occur porphyritically, is by prefixing the name of such mineral or minerals. In this manner the term *Quartz-Felsite* came into existence, but since felsites containing porphyritic quartz very frequently contain orthoclase crystals also, the use of this term has been extended to cover rocks containing both porphyritic quartz and felspar in a felsitic matrix. More exactly these should be described as quartz-orthoclase-felsites. It is now hopeless to attempt to revert to this more exact nomenclature, and it remains to state definitely if and when the term is used whether the quartz-felsite does or does not contain porphyritic felspar crystals.

Turning to the more coarsely crystalline rocks, in which the structure and mineral constituents are visible, either to the unaided eye or at the most by the aid of a hand lens, there is more general agreement in definition.

GRANITE.—*MUSCOVITE-GRANITE* and *BIOTITE-GRANITE* are used in their ordinary acceptations.

TOURMALINE-GRANITE marks the presence of tourmaline as an accessory and probably secondary mineral, mica still being present in fair quantity and the tourmaline less prominent than in :—

LUXULYANITE, which term is used for felspar-quartz-tourmaline rocks in which the mica has practically all disappeared, and the quartz and tourmaline together form a ground for the crystals of orthoclase.

APLITE is applied to rocks composed almost entirely of quartz and felspar. These were all included as "Pegmatite" by R. N. WORTH, in his paper on "Devonian Granites and Felsites," but it should now be noted that "Pegmatite" is for present purposes restricted to graphic granite.

GRAPHIC GRANITE (or Pegmatite of Häuy), an aplite in which the quartz and felspar form intergrowths, the quartz being imbedded in and subdividing felspar areas,[1] each of which shows simultaneous extinction between crossed nicols.

GREISEN, quartz-mica rocks.

SCHORL ROCK.—Quartz-tourmaline.

FELSITES.

On and around Dartmoor felsites occur:—

(*a*) As dykes and bosses, having no visible connection with the granite mass of Dartmoor.

(*b*) As dykes and veins springing from the main mass of granite and penetrating the surrounding rocks (*Apophyses*).

(*c*) As veins in the granite.

(*d*) As masses of irregular shape and widely varying size

[1] Describing the appearance of section only, it must be remarked that felspar in the rock has three dimensions.

PLATE I.

FIG. 1. View of Dyke, CANN QUARRY.

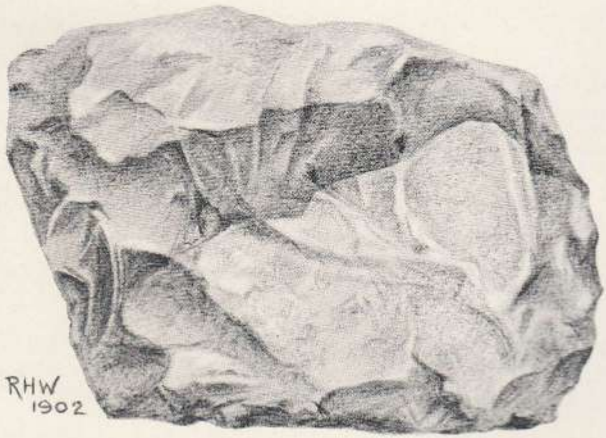


FIG. 2. Hand specimen, from CANN QUARRY, with Green Vein in Buff Felsite. Natural size.

included in the granite and sometimes imperceptibly grading with it.

(*e*) As sheets applied to the outer surface of the granite and lying between it and the surrounding rocks.

(*f*) It has not infrequently been stated that veins and dykes of felsite (or elvan) occur, which penetrate both the granite and the surrounding rocks, continuing as dykes on both sides of the junction. De la Beche, in his report on Cornwall and Devon, gives a Cornish instance, at Carn Silver, near Rosemodris, on the authority of Mr. Carne (1818).[2]

It is obvious that felsites occurring as independent dykes and bosses present no possible evidence as regarding their date relative to the granite, except such as may be derived from the age of the rocks which they penetrate, and doubtfully from their lithological character and their mineral composition.

Felsites springing as dykes and veins from the granite are at once recognisable as of the same period as the latter.

Veins in the granite itself have been constantly recognised as of later date than the rock in which they occur. It remains to be seen, however, that some at least of such veins may be cotemporaneous with the granite.

Sheets of felsite applied to the outer surface of the granite and lying between it and the surrounding rocks are undoubtedly of the same age as the granite in those cases in which the two rocks grade regularly the one into the other. Where there is an apparent abrupt junction the case is analogous with that of veins in the granite.

Felsite dykes penetrating both granite and the surrounding rock, if and where such occur, must probably be of later date than both.

CANN QUARRY.

An elvan course extends from Boringdon Woods through Cann Quarry, across the Plym, by Colwell and Fursden toward Knackersknowle, a total distance of about two miles.

At Cann Quarry the dyke is not continuous; two parallel veins show on the face of the quarry: one dies out westward before reaching the river, one persists across the river, but in turn dies out at a short distance from the far bank; the dyke then recommences in line with the termination of the southern vein first mentioned and runs past Colwill Farm.

[2] *Trans. Geol. Soc. of Cornwall*, vol. ii. p. 67 (1822).

On both sides of the river the stone has of late years been worked for road metal, the quarries having first come into existence as roofing slate quarries.

At the present time the northern vein in Cann Quarry, on the eastern side of the river, has been worked back in such manner as to present an excellent section of a felsitic dyke intrusive in Devonshire slate. The illustration (Plate I. Fig. 1) is partly sketch and partly photograph. The extreme height of the dyke from the quarry floor is 110 feet, its average width 27 feet, its strike 13° N. of E., and the dip 50° southward.

The dyke has thrust apart the slate laminæ, and its dip coincides with the cleavage; near the quarry floor, however, a point will be noticed at which the lamination has been broken across. Some old quarry rubble partially obscures the surface of the slate in places.

A notch in the crest of the cliff on the extreme right of the sketch indicates the position of the southern dyke.

This felsite is mentioned in *Devonian Granites and Felsites*, on page 190, the second entry on the page. The description there given applies to the rock as it was known until within the past few months, but recent quarrying has developed interesting additional features.

Originally, while the more easterly end of the dyke was being quarried the rock was of fairly uniform nature throughout.

In colour it was cream, with a slight shade of purple-grey; its fracture was stony with tendency toward splinteriness, a distinctly lithoidal texture; quartz blebs and small occasional flecks of white mica were visible, calcite and pyrites occurred on some joint faces, and dendritic markings near the junction with the slate.

The mass is still the same, but as the excavation proceeded westward a new rock has made its appearance; the colour is light olive-green (Indian yellow and indigo), the texture compact, and fracture subconchoidal; broken surfaces are in some instances smooth and in others splintery; the edges of flakes are translucent.

The writer first observed this rock in heaps of metalling by the roadside. Sometimes a piece of metalling consists wholly of the green rock, sometimes partly of the green and partly of the cream-coloured, and at other times a piece of cream-coloured rock is found with a vein of green traversing it. There is a constant tendency in the stone to split along the junction of the two varieties, but some pieces show a gradual passage in place of a junction, and some of the green fragments are junctions with slate rock.

Thus the evidence from these roadside heaps is in itself very suggestive as to the relationship between the rocks, while a visit to the quarry proves even more instructive.

Here, in the quarry, at the base of the exposure, the green rock is seen to form the margin of the dyke, in contact with the slate; in places it passes in a distance of six to eight inches toward the centre of the dyke into the cream-coloured felsite by uniform gradation. At places there is a fairly clear line of junction between the two, roughly parallel to the side of the dyke. And at places the green rock is seen to pass out from the margin of the dyke and penetrate nearly or quite to its centre as a vein in cream felsite. In a space of two or three inches from the slate the green rock, which is more highly coloured when it touches the slate, is banded parallel to the junction, the bands being narrow in all cases, but narrower, darker, and closer to each other next the junction, amounting, indeed, to little more than lines.

As an instance, in one case the sequence is as follows: First the junction of slate and felsite, then 3½ mm. towards the centre of the dyke is the centre of a darker line parallel to the junction face, 4 mm. further in is the centre of the next dark line, others occur at the following intervals, 3½ mm., 5 mm., 5 mm., and the next 10 mm. distant from this. The first four lines are distinct, and not more than half a millimetre in width at the extreme; the sixth mentioned above is not sharply defined, is lighter, and 1½ mm. in width.

The green veins which traverse the body of the dyke are frequently darker at their immediate margin, the edge being defined by a line; but in many cases at least this line is due to a formation of secondary minerals along the plane of junction of the two felsites, similar to the formations on the joint faces, and sometimes dendritic.

Plate I. Fig. 2 is a sketch to full size of a hand specimen showing a portion of a vein of the green rock at one end and a branch vein from this traversing the specimen longitudinally.

In one instance at least a compound vein has been observed *in situ*, the sequence from side to side being as follows: First the mass of cream felsite, then a three-quarter inch vein of green felsite, then a band an inch wide of cream felsite, followed by a vein of green felsite one inch in width, beyond which lay once more the mass of cream felsite. This compound vein was traceable for some feet.

In places the jointing of the dyke coincides with the face of a green-felsite vein or mass.

The strike of all the green veins at present seen is inward and upward from the margin of the dyke, following the line of flow of the molten material.

It is obvious that the green felsite is the selvage of the dyke, differentiated from the mass by its contact with the slate and consequent more rapid cooling. It is true, however, that higher up the quarry the cream felsite itself, little altered, is found in immediate contact with the slate in places. Among other things, it must be remembered that we are near the end of the dyke in this quarry.

The conditions under which this green rock may have been first formed and partially cooled are these.

When the elvan wedge started penetrating the slaty laminæ it did not at once open out and occupy the full width, or height, or length it now shows. The upper edge of the wedge and the outer end, taking the length, would of necessity be thinner than the main body of the elvan, would cool more rapidly, and would be in contact with cooler sedimentary rock. Hence these would acquire a certain viscosity and tend to solidify in a minutely crystalline state, while the main, deeper body of the rock remained fluid. The intrusion of the dyke would neither be instantaneous nor absolutely regular, periods of comparative rest occurring, during which the top and end edge might cool considerably and become much less plastic than the lower portions. An advance of the material constituting the dyke might then take place, opening out the sedimentary rocks and moving past the partly solidified material which had originally formed the apex of the wedge, but which would now no longer flow readily. Some of this cooled material (the green felsite) would remain in contact with the walls of the dyke, some would be torn away and carried on in the general flow, with which its superior density, consequent on its lower temperature, and its viscosity would not permit it to mix. Stream lines of green felsite would thus occur in the body of the dyke, all trending with the line of flow. The ends of these lines would in some cases be reheated, remelted, and die out into the mass.

The inner portion of the green felsite lining the walls would also be in places reheated, and would grade into the cream-coloured rock. If the advance were sufficiently

Green Felsite. Mica. Buff Felsite.

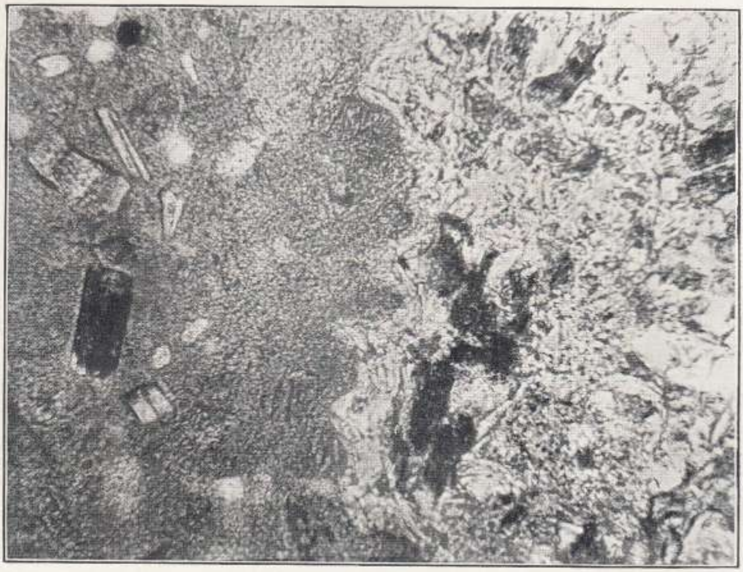


Fig. 1. Section of CXVII. S.W. 1*b*. ×137 lin. Junction of Green and Buff Felsites with development of Mica at plane of contact.

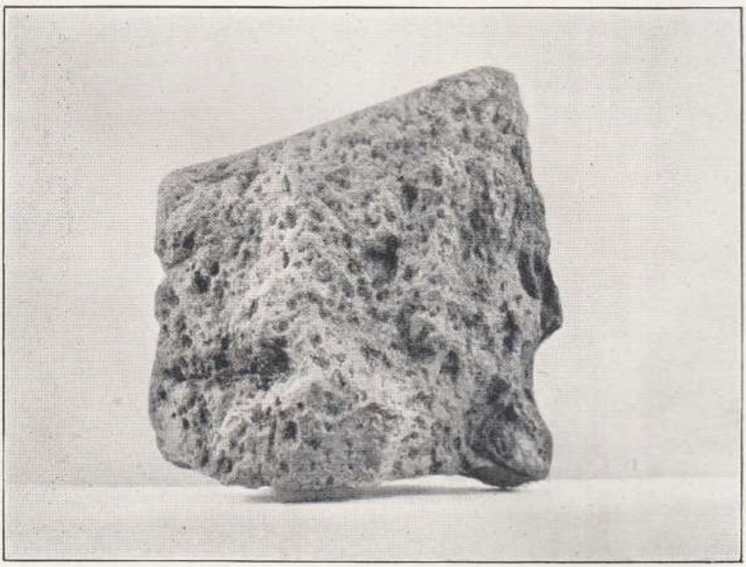


Fig. 2. Pitted Weathered Surface of Felsite "A." Specimen taken from bed of River Plym, below Hen Tor Brook (not *in situ*). Natural size.

marked and a broad enough body of molten material injected between the walls of the dyke, the conditions for the formation of the more compact green rock might not recur, at least until the next halt took place, since the larger body of molten material would be longer in cooling, and its margins would borrow some heat from the centre.

In this manner would be obtained an elvan dyke composed in the main of one uniform felsitic rock, but traversed by sharply differentiated veins of another colour and texture, derived none the less from the same magma and absolutely cotemporaneous with the mass.

It needs no great imagination to apply the conclusions to be derived from the examination of this small dyke to the consideration of many circumstances connected with even the larger granite bosses, and to admit that veins of various felsites and fine-grained rocks traversing these granites need not in all cases be necessarily of later date than the rock they penetrate, may even in some instances have passed some way toward the solid condition when their present surroundings were still fluid and unchilled.

The following are details of the composition and microstructure of the Cann Quarry felsite:—

BUFF FELSITE. *Cann Quarry*, forming body of dyke. CXVIII. S.W. 1. *Long.* 4° 4′ 39″, *lat.* 50° 26′ 2″.

I. *Colour*,[3] cream, with a shade of purple-grey. *Texture*, lithoidal, fracture at times splintery. *Specific gravity*, 2·634. Occasional distinct quartz and white mica; calcite and pyrites developed as joint faces, and at places dendritic markings, especially near junction with the slate.

II. Very numerous light brown, cloudy, lath-shaped felspars, mostly ill-formed and especially indefinite at their ends; mingled with these are irregular felspar areas which sometimes show an approach to crystal form. These felspars are embedded in a colourless ground crowded with a fibrous mineral which lies parallel to the boundaries of the felspar crystallites and spreads irregularly into the open spaces between. At the edges of the fibres this mineral can be seen to be lamellar, its double refraction is strong, and with its extinction corresponds to that of mica. Tested with the quartz wedge this identification is borne out. (No power under a $\frac{1}{6}$-in. objective will serve

[3] Following COLE (*Aids in Practical Geology*), under heading I. in dealing with each rock will be found characters observable in the field or in the hand specimen, while under the heading II. will be found the microscopic characters.

to thoroughly examine this rock.) The other constituent of the colourless ground mass is a quartz mosaic.

An occasional quartz crystal can be found with good outline. One which occurs cut nearly parallel to the base measures almost exactly one millimetre across the longest diagonal of the hexagon. There are in this crystal four enclosures of the ground mass, each micaceous, and one patch consisting of mica only, besides several cross-sections of plates of mica. There are also numerous small cavities, some of which show bubbles. The quartz of the ground mass has larger and more numerous cavities. Grains of orange "ferrite" occur irregularly.

Little as it may so appear in the hand specimen, this portion of the dyke is a true micro-granite, the only deviation from the type being the ragged ends of the felspars The repeated twinning of plagioclase is conspicuously absent.

As regarding the distribution of mica (sericite) in this rock, compare *Sorby*, Presidential Address to the Geological Society, 20th February, 1880, p. 53, on *Mica in Deposited Rocks*.

GREEN FELSITE. *Cann Quarry*, margin of dyke at places and as veins in the Buff Felsite. CXVIII. S.W. 1a, 1b, etc.

I. *Colour*, light olive-green (Indian yellow and indigo). *Texture*, compact lithoidal, with sub-conchoidal fracture; at times smooth, at times splintery; flakes translucent at edges. *Specific gravity*, 2·654. Occasional distinct quartz and white mica associated. Calcite, pyrites, and dendritic markings as in Buff Felsite.

II. Tabular and lath-shaped felspars, some comparatively clear, but all show a cloudiness, and some are considerably darkened by brown dust, ends usually square or ragged, but occasionally the traces of $\bar{P}\infty$ & OP are well defined. The longer axes of the majority of these felspars trend in one direction, but there is no absolute uniformity. Some few are twinned on the Carlsbad type. The average length of the more prominent crystals is a little over ·2 mm. Many reach this length, and some are as long as ·5 mm. and over. The ratio of width and length varies greatly.

Quartz grains are frequent, and, while rarely regular, usually show some approach to crystalline form. Liquid enclosures with bubbles are frequent, passing in definite planes through the larger grains, which have the more perfect crystal outline. Under a fairly high power the quartz is frequently seen to be bounded by blades and plates of mica, which apparently project into it from the ground mass, while mica inclusions and small inclusions of the ground mass are common. There is an occasional tendency to micro-pegmatitic intergrowth with felspar, and with this mica is always associated.

Sections of white mica of fair size compared with the other constituents are sparsely scattered, one such section showing perfect basal cleavage measures ·6 mm. by ·155 mm. The ground mass is minutely granular and pale green in colour; typically its structure is *Indiscriminate.* At places, however, in the sections one is tempted to believe that minute mica can be detected. The whole shade of the section is darker than in the case of the Buff Felsite. Grains of orange ferrite are scarcer.

The rock is a quartz-orthoclase mica-felsite, with indiscriminate ground mass.

At the junction of the two felsites, when that is well defined, there is sometimes a considerable development of microscopic mica, in no way to be detected in the hand specimen.

Plate II. Fig. 1 is from a photograph of such a junction; it is hopeless, however, to attempt to reproduce clearly the mineral character of the rocks.

Every intermediate form between the two felsites can be found. The following features of contrast between the extremes are to be noted. The micro-porphyritic constituents have the more perfect crystal outline in the Green rock, if we except the largest quartz crystals, which are about equally perfect in both forms. On the whole the felspars, although less perfect, are, perhaps, somewhat the larger in the Buff rock. Quartz crystals with corroded outlines are common to both. Prominent mica with fairly clear outline is much more frequent in the Green than in the Buff. Some allowance must, however, be made for the difference in the ground mass in each case, the darker and more compact ground of the green affording a more perfect contrast to the micro-porphyritic constituents. The network of mica bending round the other constituent minerals is clearly discernible in the Buff only.

The chilled Green rock has thus developed more perfect micro-porphyritic constituents than the somewhat slower-cooling Buff, but the latter is as a whole much more coarsely crystalline. The minerals are identical, although, perhaps, their proportions are different, and the difference in specific gravity is in favour of the more rapidly cooled rock, which is the heavier. This is comprehensible in view of the fact that glass does not enter into the composition of either. It is difficult to explain the contrast in colour, but it would appear to be largely physical and consequent on the micro-crystalline structures.

The order of crystallisation appears to have been—(1) Orthoclase, (2) Mica, (3) Quartz, (4) Ground mass, in which the previous order was probably again followed, but with much less difference of period.

The superior specific gravity of the margin of this dyke is quite in accord with theory; thus TEALL[4] cites LAGORIO on SORET'S principle as follows:—"Suppose a mass of molten material to be injected into a fissure and to remain stagnant for a considerable length of time, the mass will be cooled at the margins, and the compounds with which the solution is most nearly saturated will accumulate in the marginal portions, leaving the centre richer in those which play the rôle of solvent medium," certain dykes are even glassy in the central portion instead of at the margin. In this manner it is possible also to explain the more perfectly crystalline form of the micro-porphyritic constituents at the margin of the dyke. We have already seen that precisely such periods of stagnation as are required by this theory have probably occurred in the history of this intrusive mass.

It should be noted that the extreme selvage of the dyke for a depth of, say, half an inch everywhere approximates to the Green type of rock, without in all cases agreeing exactly with it in character. It is universally of finer grained ground mass than the centre, but the micro-porphyritic crystals are variable in size and completeness of crystal outline, and the colour is rarely distinctive.

Since writing the above a specimen has come to hand, the mass of which is buff felsite, but this surrounds a patch of well-charactered granite, measuring 4 cms. by 2·5 cms., thus further extending the range of mineral structure of the dyke.

An application of the principles which seem explanatory of the mutual relationship of the two felsites of the Cann Quarry dyke would go far toward solving many difficult questions in banded intrusive veins. The supposed necessity for two original magmas, each welling from its own deep-seated reservoir and joining forces to form veins of composite and alternative banded structure, may be abandoned in

[4] *British Petrography*, p. 402.

most if not in all cases; provided differentiation of one original magma during a period of stagnation be allowed and followed by a further forward movement, during which the denser portion of the mass is drawn out into stream lines by the flow. There is no real novelty in this suggestion, except that an instance is now cited where the evidence of such action has been unusually clearly preserved.

A TYPICAL DARTMOOR FELSITE (FELSITE "A").

It is convenient now to turn to a felsite which is immediately associated with the Dartmoor Granite, and with very slight differences in structure is found under identical conditions over a wide range of country.

It invariably occurs as a sheet applied to the outer surface of the granite and lying between it and the surrounding rocks (see heading (*e*), p. 503). In places it lies exposed in folds of the granite, the sedimentary rocks having been denuded from its surface. To the present it has nowhere been found typically developed within the mass of the granite itself.

In its extreme development this rock may be described as follows:—

I. *Colour*, rich Indian red, translucent at edges of flakes. *Texture*, compact lithoidal, subvitreous, fracture conchoidal and smooth. *Specific gravity*, 2·624. *Weathers*, through shades of warm buff to cream, and finally pure white; the surface can then be fritted away by the thumb-nail. Weathered surfaces are sometimes irregularly honeycombed and sometimes develop parallel ridges simulating lamination. Where the weathering has been slight, or where a weathered surface is purposely ground back, the rock is seen to be banded—a fact which can be detected in some freshly broken specimens if sufficient care is exercised in their examination. Schorl, when present, may emphasise the banded structure by occurring finely disseminated and coincident with it. From the fact that oxidation and solution attack some bands sooner and to a greater extent than others, it is evident that, although the colour contrast is very slight, the mineral composition varies, the more resistile being probably more siliceous, the less, more felspathic. The bands are narrow, as many as six frequently occurring within one millimetre. They are at times rectilinear, but at others contorted, and frequently form concentric, irregular ellipses and ovals, simulating the "grain" of a flooring-board.

There are no truly porphyritic constituents, but minute glancing spots can be detected if the specimen is held at the correct angle, and these are quartz blebs with very rare small felspars. Excepting the extremely slight difference in colour in adjacent bands, the rock appears absolutely homogeneous.

Cracks, due probably to contraction on cooling, occur in every mass of a few ounces in weight. Some of these cracks are extremely fine, and almost all have been recemented with secondary quartz. Occasionally, however, joint faces occur which have not been thoroughly recemented, but are lined by a mere film of schorl, showing no crystalline character under the hand lens. Occasionally, too, in specimens otherwise conforming to the above description, large blebs of quartz may occur, and isolated felspar crystals of from one and a half to two inches or more in length, one inch in width, and possibly half an inch or more in thickness. These large felspars are usually very fresh and unaltered, with perfect cleavage, and are of a light buff colour and glassy lustre; but, on the other hand, the colour of the crystal may be identical with that of the ground mass, in which case it is rarely idiomorphic.

The freshest and most compact forms of the rock are usually nearer the granite, while duller and more open textures, due to incipient decomposition, more frequently occur near the slates. This is merely equivalent to stating that decomposition has proceeded from without—inward.

II. Typically the structure is *indiscriminate*, producing the effect of an irregular and extremely fine stipple in shades of orange-brown. A reticulated appearance is common, resulting from the lessening of the pigment in rounded patches at fairly regular intervals; between the patches the darker ground simulates, in section, a network. This structure is always somewhat ill-defined. Occasionally micro-pegmatitic and centric structures are suggested.

Flecks and plates of hematite (?) form part at least of the colouring matter; here and there these congregate into little spherical or irregular clouds, and are often more closely set than elsewhere around the minute quartz blebs, which constitute the sole porphyritic mineral. Many of these latter are only clearly distinguishable with magnifications of 300 and upward, yet the larger contain minute hairlike microlites and crystal inclusions. They also contain liquid enclosures with bubbles, and at times cubic crystals. Schorl is very usually present in the rock in isolated crystals, grains, and minute irregular aggregates. Small grains of almost colourless tourmaline occur.

Extremely thin sections and magnifications of 700 diameters and over resolve the structure into a series of irregular interlocked granules, and reveal the completely crystalline character of the mass; but still with the thinnest section the resolution is incomplete, and the mineral identity of the granules cannot be ascertained.

The large felspars which sometimes occur, and appear strikingly fresh in the hand specimens, are seen to be traversed by closely set parallel striæ, apparently formed by innumerable rod-shaped microlites. Small crystals (at times simply twinned) and crystalline areas of felspar are present as enclosures, the crystal axes of which bear no definite relation to those of the large felspars. Quartz enclosures are frequent, some apparently original, others secondary and associated with schorl; in both cavities with liquid, bubbles, and cubic crystals occur. Some of the smaller quartz shows fair crystal outlines.

That this felsite lies near the junction with the slates is very clearly evidenced even in those cases in which no actual exposure *in situ* can be found. For there can be obtained, wherever it is known to occur, on the one hand, actual junction specimens consisting of both the felsite and the altered sedimentary rock of the neighbourhood, and, on the other hand, specimens showing an abrupt transition to red granite, or else a series of intermediate forms between the granite and felsite.

In addition to this, the fragments found at the highest levels, when subsoil fragments only are available, are invariably found at or near the border of the granite.

Associated with the type above described are a number of variants, differing more or less widely in colour and structure from it and from each other, but equally constant to their own characters over a wide stretch of country.

As regards distribution, for twelve miles and more along the western and southern periphery of the Dartmoor granite, from *Legis Tor* in the *Plym Valley* to *Ugborough Beacon*, the rock in question and its variants occur at frequent intervals, and continuously for considerable lengths; the details of this district have been worked out. For eight miles more, to *Forder Gully*, *Pupper's Hill*, it occurs at intervals, but the survey has not been completed. North of *Legis Tor* on the west, and north of *Pupper's Hill* on the east, it is also known, while at the extreme northern point of the Dartmoor granite it appears at *Cosdon Beacon* over *Sticklepath*, in addition to exposures elsewhere.

This divison of the known localities into sections is, it must be clearly understood, purely artificial and dependent solely on the time the writer has been able to devote to the several localities; within narrow limits the characters of the rock are the same wherever observed.

The hardness, compactness, and uniform texture of this felsite exceptionally qualify it to resist stream and wave action destructive to softer or more granitic rocks. Accordingly, on the beaches at the mouth of the *Yealm* and *Erme* its pebbles are found in a proportion compared with the total number of other granitic and felsite pebbles which its actual present area of inland exposure would not appear to justify. In part, no doubt, this must also be explained by the necessary denudation, before the granite itself could be uncovered, of any rock which occurs outside and over the granite.

From *Slapton Sands* an extreme type of this or a similar rock has been obtained, which is exactly matched by a sub-angular fragment (angular in form, but with edges rounded) obtained from the Permian (?) Breccia at *Preston Lane*, near *Paignton*. For an opportunity of examining this latter specimen the writer is indebted to Mr. Alexander Somervail.

The following notes are arranged geographically, commencing at *Legis Tor* and proceeding southerly and westerly toward the limit at present reached by the detailed survey.

LEGIS TOR. CXII. S.E. 10. *Long.* 4° 0′ 50″, *lat.* 50° 28′ $19\frac{3}{4}''$. *In situ.*

This specimen was taken from the north-east side of the pile of rocks crowning *Legis Tor* in the Plym Valley, the mass of which is red granite, passing on the east and north-east into the red felsite which has been described above. This was the first locality where the latter was found *in situ* in its typical form. The junction with the slate lies a little distance north.

I. *Colour*, Indian red, translucent at the extreme edge of thin flakes only. *Texture*, compact, lithoidal; fracture, with hand lens, appears somewhat splintery. *Specific gravity*, 2.62. *Weathers*, light pink and ultimately white; weathered surfaces very irregular, pitted, and crossed in all directions by fine ridges corresponding to the quartz cementing the joints in the unweathered rock. Weathered surfaces are easily cut by a knife, or even in extreme cases scraped by the thumb-nail and reduced to powder.

Quartz, except along the joint faces, is not prominent, and felspars are practically absent. Spheroids of schorl occur, some of which are 3 mm. in diameter; the average distance between adjacent spheroids is 8 mm.

Another part of the same specimen shows the first steps toward granitic structure. The ground mass retains its character, except that the schorl spheroids practically disappear; bright cleavage surfaces of felspar in Carlsbad twins appear, the crystals being about 12 mm. in length, lighter in colour than the ground, and hyaline; an occasional felspar is white or pale cream, and opaque; quartz shows some tendency to crystalline form, and schorl has attacked slightly some of the paler felspars and the irregular red felspar areas which also occur. The porphyritic constituents are prominent in this portion of the specimen.

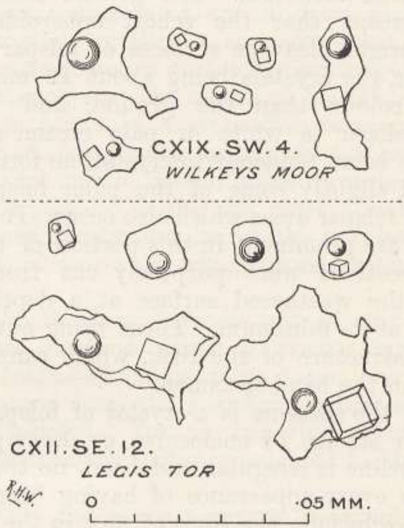
II. Two sections were purposely cut from the inner portion of the weathered surface at a depth where the alteration is at its minimum. These bring out very clearly the banded structure of the rock, which cannot, however, be detected in the hand specimen.

In one of the sections is a crystal of felspar turbid and clouded with strings of enclosures or decomposition products; its outline is irregular and bears no trace of crystal form; it has every appearance of having been the subject of partial re-solution; the lines of flow in the ground mass bend round this crystal. The other section affords instances of a similar character, and an instance of the manner in which schorl has in many of these rocks attacked certain bands in preference to others. Both sections contain small felspars partially replaced by schorl, and the second-named exhibits centric or radial structure in the ground mass when examined in polarised light.

CXII. S.E. 12. *Not in situ.* *Legis Tor*, not far from and north-east of summit.

I. Precisely similar to last, except that the passage toward granite is not displayed, and quartz blebs of 8 mm. diameter and downward occur.

II. The section exhibits a quartz crystal with rounded and much corroded outline and inclusions of the ground mass. The crystal is traversed by strings of fluid enclosures with bubbles, and is also plentifully besprinkled with other fluid enclosures which cannot be correlated in strings or planes. Some of the cavities contain cubic crystals in addition to the fluid and bubble. See Figure in text for drawings of some of these inclusions as well as similar inclusions from another locality. In this same section there is also a small crystal of plagioclase. The general structure is microgranular and indiscriminate. Dusty ferrite or hematite is generally distributed and also collected into numerous little cloudy aggregates.



Fluid inclusions with bubbles and cubic crystals in Quartz crystals of Felsite "A." ×575.

The ground mass is studded with small colourless or nearly colourless grains, clear and transparent, and having very irregular outlines. Ten of these grains were counted in an area of 2 × 1·5 mm., or 3 sq. mm., using magnification of 60 diameters. The largest grain on the slide is ·16 mm. in diameter and the next largest ·09 mm.

It will be necessary to frequently refer to similar grains in describing other specimens, and it may be well to deal with the matter in detail at once.

The petrologist's microscope has its limitations, and it would almost appear that these have been reached when an attempt is made to assign these minute blebs to any mineral species.

The following description gives all the data. Form irregular in the extreme, the grain sending out frequent small projections, and its surface being irregularly indented; some grains are of prismatic habit. The boundary is well defined by a dark line against the other minerals or the ground mass, indicating apparently an index of refraction higher than that of quartz, and more nearly corresponding to the refractive index of tourmaline. This point, however, is debatable, since the sharply rounded edges and angles of the grains might partly account for a dark margin. The grains are so small that it is impossible in most cases to say whether the surface has been bared in cutting the section, or whether, on the other hand, it is still slightly covered by other mineral or minerals. It does sometimes appear that the surface is slightly pitted as viewed in reflected light, which would indicate a refractive index higher than that of balsam.

There is no doubt that some grains must be described as colourless, but one may almost be persuaded that others show a very faint green tinge.

Apparently there are minute enclosures in some instances. No grain in all the slides gives strong double refraction; even in cases where the quartz in the same slide gives bright colours of the first order the grains polarise in shades of grey only. There is a possible ambiguity here, since few if any grains extend completely through the thickness of the slide, and lower tints would be expected than those given by minerals of the same double refraction of the full thickness of the section. Still it does at first appear that the double refraction of the mineral really is weak.

There is a suspicious likeness in outline between some of the grains and grains of undoubted tourmaline which occur on the margin of schorl aggregates in sections of these rocks.

The questions are, Whether the grains are all of one and the same mineral or of different minerals; and of what mineral or minerals?

It is very probable that the grains are not all of one mineral, although a large majority certainly belong to the same species. There are difficulties attached to any identification. If quartz be suggested, then the refraction is apparently too high and the double refraction too low; if tourmaline, the refraction might pass, but the double refraction would appear to be much too low unless comparison is made with the ends of some schorl prisms which, lying slightly obliquely to the plane of the section, can sometimes be found cut extremely thin; some of the grains are obviously thicker than this. There is no trace of pleochroism, but the colour is so slight, if any, that that could hardly be expected. If garnet be suggested, then the refraction would suit, but the double refraction would be anomalous; many of the grains do certainly suggest an isotropic substance over and underlain by doubly refracting minerals, and many garnets exhibit anomalous double refraction. Still there is an entire absence of larger individuals, such as might reasonably be expected to be discoverable in hand specimens.

There is a mineral that would fill the rôle perfectly were it not that some idiomorphic crystals should also be found, and that is beryl. The suggestion is not far-fetched, since beryl occurs as a constituent of contact granite near Legis Tor. It would be a bold thing, however, to claim it as a prominent constituent of these felsites on the faith of such observation as can be made on these minute and almost formless blebs.

The probability appears to be that some grains may be quartz, the remainder tourmaline; and this suggestion is strongly supported by an examination of the outliers of undoubted tourmaline aggregates in certain sections in which the grains are most thickly distributed. Considering that many grains are only ·008 mm. or, say, $\frac{1}{3000}$ of an inch in diameter, pleochroism and strong double refraction could hardly be anticipated. Grains which appear isotropic may be those which happen to correspond to basal sections.

Topaz[5] might have been mentioned as one of the possible minerals to which to attribute these doubtful particles; but although this occurs at Meldon in a granulite, as first pointed out by Teall, its double refraction puts it beyond the range of possibility in the present instance.

The slopes of *Legis Tor* supply, in addition to the form of this felsite which has been selected as a type for present purposes, at least one of the variants which are its constant companions.

The following specimen is selected as the type of this variant, because in the first place its appearance is sufficiently distinctive to make it a rock easily recognised in the field, and in the second place it has the advantage of having been found *in situ*.

[5] Topaz is a common constituent of greisen, and its presence there is readily understood.

Slope of Legis Tor, on path to Ditsworthy Warren. CXII. S.E. 3. *Long.* 4° 0′ 23″, *lat.* 50° 23′ 20½″. *In situ.*

I. *Colour*, mottled, warm grey, buff, light Indian red, splotched with black; general effect a ruddy buff or pale red. *Texture*, lithoidal; fracture minutely saccharine, but texture is compact; the rock cubes well under the hammer. *Specific gravity*, 2·57. *Weathers*, buff to very pale cream, practically white.

Grains of quartz of 6 mm. diameter and under are fairly frequent. Areas of crystalline felspar with imperfect outline occur. One such area is 20 mm. long by 10 mm. wide; smaller felspars are more perfectly developed, and are to be seen in every ordinary-sized hand specimen, while pieces have to be picked to show the larger. The felspars range in colour from pale cream to rich Indian red. Spheroids and aggregates of minutely crystalline schorl are frequent; the larger patches are frequently 8 mm. or more in diameter, and in some instances are pseudomorphs after felspar areas.

To afford an idea of the relative frequence of the more prominent minerals an area 50 mm. × 35 mm., casually examined without a lens, supplied four small felspars, ten quartz blebs of varying size, and fifty spots of schorl, some of the latter under 1 mm. but eight over 4 mm. in diameter.

II. The section is cut from a buff and light red portion of the rock. With a magnification of 60 diameters the ground mass is clearly divisible into light red or buff felspar and granular quartz. The felspar predominates and forms a ground in which the quartz grains are set. There are no considerable areas of uniform extinction of either mineral discernible with polarised light, and indeed the felspar is seen under higher powers to largely consist of irregular microlites, ragged, bent, and mutually interfering, yet some sufficiently developed to exhibit simple twinning. Only a portion of one of the small porphyritic orthoclase crystals happens to have been included in the section.

Small quartz crystals with rounded and corroded boundaries occur, and these are crowded with fluid enclosures, by far the greater number of which are furnished not only with bubbles, but also cubic crystals, clearly discernible with a magnification of 240 diameters.

A large schorl spheroid is seen to consist of brown, green, and blue tourmaline, with a considerable admixture of quartz. The tourmaline has an ill-defined radial arrangement; it is partly granular, and partly occurs as irregular short prisms.

The slide is traversed by a narrow crack infilled with quartz, which contains small needles of tourmaline. The rock is a quartz-orthoclase-tourmaline felsite, with microgranular structure tending in places toward the micropegmatitic. Small grains of almost colourless tourmaline are frequent in places in addition to the coloured variety.

There is no doubt that it is very near the slate, but although it is obtainable *in situ*, the actual junction has not yet been found.

Legis Lake, western bank, just outside Brisworthy Farm enclosure. CXII. S.E. 9. *Long.* 4° 1′ 12″, *lat.* 50° 28′ 16″. *Not in situ.*

I. Kindred to the last; texture of ground mass a little more compact. Olive-brown hyaline felspars, and Indian red opaque felspars. The olive variety shows the more perfect forms, but is frequently mingled with or surrounded by the red. The red colouration of this rock is mainly confined to the felspar areas.

Legis Tor, south-west from summit, about half-way to the river. CXII. S.E. 18. *Long.* 4° 0′ 48″, *lat.* 50° 28′ 13½″. *Not in situ.*

I. Kindred to two last; texture of ground mass more compact. *Colour*, warm grey to pink. *Texture*, compact, lithoidal. *Weathers*, nearly white. Weathered surfaces show a pseudo-lamination, and are soft enough to leave a dust on the fingers when the specimen is handled. Quartz and pink felspar crystals stand out prominently from this surface; the felspars are softer than those in the body of the rock and paler in colour, some of the latter being a fine Indian red. Porphyritic crystals of olive-coloured hyaline felspar are present. Schorl is plentifully but fairly minutely distributed.

II. The ground mass is light buff, and appears minutely granular in ordinary light; with polarised light and magnifications of 740 diameters and over it appears dappled but hopelessly indiscriminate. It is absolutely crowded with ovoid and irregular grains of a colourless or very pale green mineral of high refractive index, sometimes isotropic when a grain is sufficiently large to occupy the greater part of the thickness of a section, in which case it is probably viewed basally. There can be little doubt that this mineral is tourmaline. So closely are these tourmalines set that areas of ·15 mm. by ·05 mm., or ·0075 sq. mm. contain on the average about forty separate grains. Not only do they appear in the ground mass, but also as enclosures in the felspar crystals. The majority of the grains range from ·008 to ·002 mm. in diameter; some reach ·07 mm. It is these tourmalines which give the granular appearance to the matrix.

Quartz crystals with rounded outlines are present, and include portions of the ground mass containing tourmalines (?). Fluid enclosures with bubbles and cubic crystals are common.

Cloudy brown orthoclase microlites are frequent, and an occasional larger specimen (1 mm. long or thereabouts) shows good crystal outline. There is one skeleton crystal of orthoclase in the slide with which are associated two smaller crystals, which, had the larger completed its growth, would have appeared as inclusions. This skeleton crystal has been attacked at both ends and partly replaced by tourmaline. Throughout the slide aggregations of tourmaline (schorl) can be found, strongly suggesting pseudomorphs after felspar microlites.

One felspar contains fibres of a mineral of strong double refraction, which may be mica; if so, it is the only indication of the presence of that mineral in the rock.

From a point a little north of CXII. S.E. 3 the junction of the granitic rocks and the slate runs a little south of east toward Hen Tor, turning when it reaches Hen Tor Brook (otherwise Wallabrook) and running north-east or thereabouts to Shavercombe waterfall; thence it doubles back to a little south of the actual summit of Eastern Tor, and thence westerly to a point a little south of Gutter Tor. The loop of slate overlying the granite reaches a point which at Shavercombe waterfall is over one and a quarter miles distant from its limit as shown on the unrevised Geological Survey.[6]

Where the line of junction passes under the detritus in the Plym Valley it is necessarily obscured, but at or near Hen Tor Brook its location can be fixed with fair certainty.

Hen Tor Brook. CXII. S.E. 11. *Long.* 3° 59′ 41″, *lat.* 50° 28′ 11″. *Not in situ.* A small boulder or large unrounded

[6] It is well to remember that the original geological survey around Dartmoor is frequently inaccurate. Lieutenant-General McMahon (*Q.J.G.S.*, Aug., 1893, vol. xlix. p. 387) suggests that much of the mapping in this part of Devonshire seems to have been filled in from surface boulders and stray stones in walls. And the present writer has referred in an Appendix to one of the Dartmoor Committee's Reports to a glaring instance at Whittor, near Mary Tavy.

stone from a beach on Hen Tor Brook at a point a little below the junction of the felsite and the slate.

I. *Colour*, dark Indian red. *Texture*, compact, sub-vitreous; fracture conchoidal and smooth. *Specific gravity*, 2·633; a fair percentage of schorl may possibly somewhat raise the specific gravity.

Weathers, light buff to cream; the weathered surface is pitted in a highly irregular manner, which would hardly be expected in a rock so homogeneous in apparent texture. See Plate II. Fig. 2 for photograph, full size, of such surface. This specimen came from the bed of the Plym below Hen Tor Brook. Minute blebs of quartz are the sole porphyritic constituent; rarely a grain may reach 1½ mm. in diameter. Irregular aggregates of schorl and specks of the same material are tolerably uniformly distributed through the rock. No trace of banded structure can be detected.

II. This rock has been selected for illustration (see Plate III. Figs. 1 and 2). Fig. 1 shows a portion of the slide magnified 365 diameters and viewed in ordinary light. Fig. 2 shows another portion of the same slide magnified 400 diameters and viewed with crossed nicols. Both figures are half-tone blocks from photographs, and in Fig. 2 especially there has been some loss consequent on the processes of photography and reproduction. A somewhat minuter granulation should be visible, not more distinct than that shown, and of identical character. The section from which these photographs were taken is under ·02 mm. in thickness.

Matrix, light orange-brown, somewhat more granular in some parts than in others, and the more granular portions appear the clearer. The appearance of minute interlocked granulation is elusive, whether viewed with polarised light or with ordinary. The boundaries of the grains frequently appear to be marked out by dark outlines in polarised light, but this, with the most critical inspection, amounts only to a line mottling added to and superimposed on the usual dappled appearance.

Bright red to brown ferrite is scattered through the slide in minute dust, with an occasional larger fleck or little cloudy aggregate.

Blue-green schorl appears in prisms and irregular plates of involved outline. Its basal sections are six-sided, and it also occurs in a circular form.

In neither of the two slides cut from this specimen is there a sign of a felspar microlite or crystal. One or two aggregates of schorl do, however, look like pseudomorphs

PLATE III.

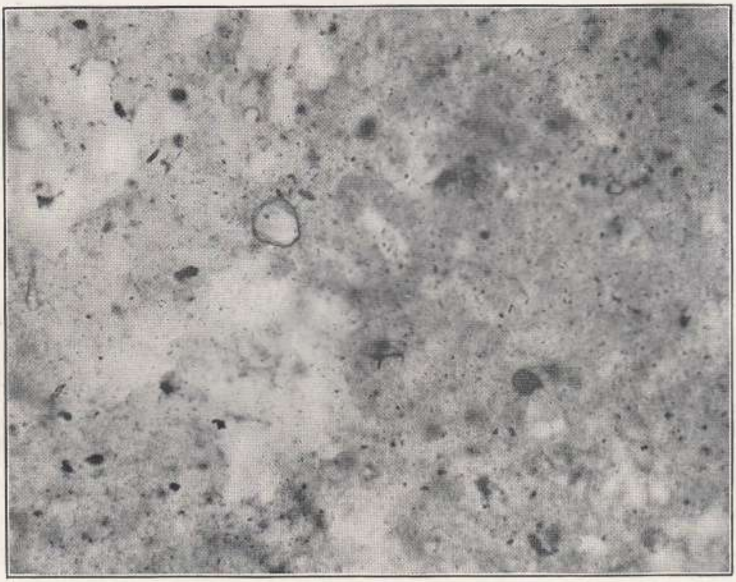


Fig. 1. CXII. S.E. 11. Section × 365 lin. Ordinary light.

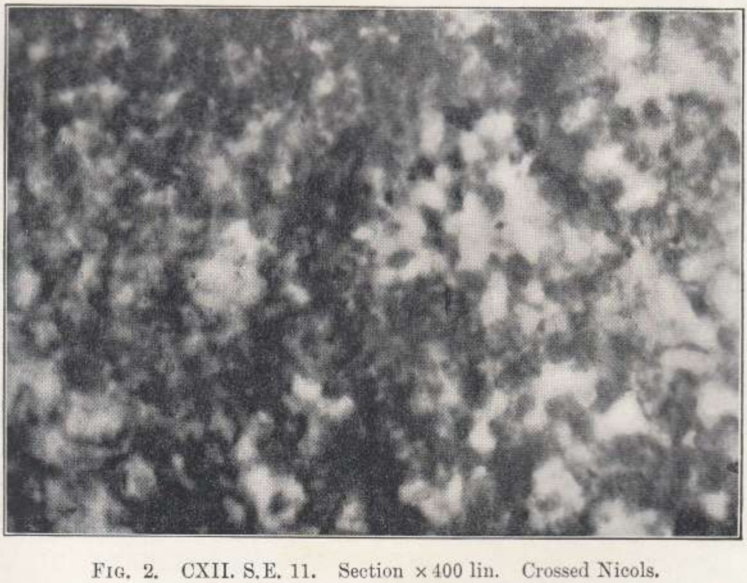


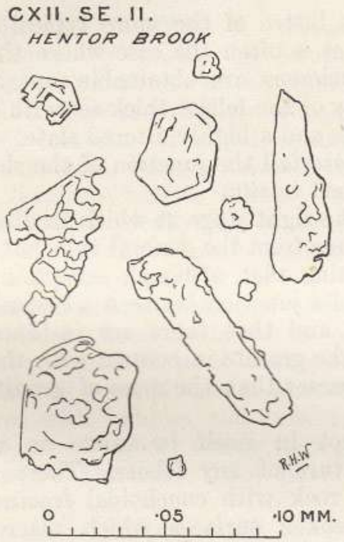
Fig. 2. CXII. S.E. 11. Section × 400 lin. Crossed Nicols.

after this mineral, and one may have a little residual felspar in the centre.

The schorl is sometimes accompanied by a minute quartz mosaic, and sometimes by an occasional bright red irregular plate of ferrite (?).

Liquid inclusions with bubbles occur in the one quartz bleb visible, but no cubic crystals appear in the liquid; this absence may, however, be a mere chance, as the quartz area is very small.

Minute tourmaline (?) grains are extremely numerous in the matrix, excelling in number those in specimen CXII. S.E. 9. Some of the minutest grains are decidedly blue-green in colour. The accompanying figure, the magnification of



Grains of Tourmaline in CXII. S.E. 11. × 300. Felsite "A."

which is approximately 300 diameters, will give an idea of the appearance of the larger of these granules gathered from various parts of the slides. A few of more ordinary size have been included in the figure for comparison. These are really drawings of solid objects, and the markings within the outline indicate the contour of the surface.

In following up the course of the Hen Tor or Walla Brook from CXII. S.E. 11. less compact forms of this felsite are plentifully found. Quartz becomes more frequent, and prominent large red tabular felspars are developed associated with smaller hyaline felspars of pale cream colour, with very perfect cleavage. Large masses of rock occur in which there are in addition numerous small schorl aggregates very uniformly distributed. These spots of schorl are from 1½ to 3 mm. in diameter, and are on the average 4·25 mm. apart measured from centre to centre. Their presence gives the rock a very regular spotted appearance. On weathered surfaces these little nests of schorl persist as little knobs standing above the general level. The rock is found practically *in situ*.

Immediately above *Shavercombe Waterfall*, CXIII. S.W. 4, *long.* 3° 58′ 50″, *lat.* 50° 28′ 35½″, the red felsite is to be found *in situ*.

The vitreous lustre of the more typical form is lost in this specimen, as is often the case where this rock touches the slate. Specimens are obtainable containing a slightly granular variety of the felsite thick-set with quartz granules, a coarse granite, and a highly altered slate.

Below the waterfall the junction of the slate and a coarse granite is exposed *in situ*.

This is not the right stage at which to discuss the reasons for the divergence from the general rule, but it may be right to note in passing that, although exceptional, it is not so very rare to find a junction between a coarse-grained granite and the slates, and that there are instances where for a short distance the granite in contact with the sedimentaries may even be coarser than the mass of granite of the neighbourhood.

Colour cannot in itself be taken as a constant distinguishing feature of any felsite. There occurs on Hen Tor a banded rock with conchoidal fracture and slightly splintery or broken surfaces which macroscopically and microscopically is readily recognisable as a variant of the red felsite, although its colour is a fairly uniform warm buff. It has not been found *in situ*.

Another rock, not found *in situ*, is dull puce in colour, and develops small porphyritic crystals of bright Indian red felspar; this is yet one more variant of the same felsite, and also occurs associated with it on Hanger Down, several miles from Hen Tor.

Following the margin of the granite southward, after retracing our steps to Ringmoor Down, the first point at which the rock we are dealing with is again met with will be *Shaugh Lake* Clay Works, CXII. S.E. 21, *long.* 4° 1′ 41″, *lat.* 50° 27′ 30″, *not in situ.* Here it occurs as occasional fragments which, when broken, are found to be nearly bleached through their whole thickness; a patch of unaltered material here and there renders the identification certain. The fragments are obviously not *in situ*, but form a part of the head over the clay, and are derived from the hill above. As they lie at Shaugh Lake they would be well within the border of the granite.

On *Saddleborough*, above the clay works, the parent rock is found under circumstances which leave no doubt of its being, to all intents and purposes, *in situ.* It occurs slightly to the east of the brow of the hill, and one of the best localities for obtaining it is the track leading from Shaugh to Lee Moor.

Saddleborough, CXVIII. N.E. 2. *Long.* 4° 2′ 2,″ *lat.* 50° 26′ 56″. *Practically in situ.* Selected as a type from this locality; lies on the border of the granite.

I. *Colour*, dull Indian red, slightly translucent at edge of chips. *Texture*, compact, lithoidal, somewhat vitreous; fracture, flat conchoidal, broken surfaces smooth. *Specific gravity*, 2·64. *Weathers*, buff to white. Very small quartz blebs the only visible porphyritic constituent. An occasional grain of schorl. In fresher specimens the vitreous nature of the rock is emphasised.

II. Ground mass has somewhat the reticulate appearance which has previously been described in other specimens. Some small and irregular blebs of quartz are present, with one crystal, which has accomplished an almost perfect outline; liquid enclosures with bubbles and cubic crystals are very frequent. Felspars of lighter colour than ground mass are developed at wide intervals; these have much corroded outlines and are very turbid.

Blue schorl with associated quartz occurs in nests which from their form suggest replacements of similar felspars. Granular tourmaline is thickly scattered over the whole slide; it is blue in colour, and in this case at least there is no doubt as to the identification of the granules. The ground mass corresponds closely to that of CXII. S.E. 11.

Southward on *Collard Tor* there are red granular felsites, but these cannot be claimed as bearing any family resemblance to the vitreous rock whose localities are now being traced. The "Census of Devonian Granites and Felsites" gives, however (p. 190), "Collard Tor (near)—red, weathering to pale pink: vitreous felsite weathering to earthy, with a few small granules and pyramidal crystals of quartz (the disappearance of some of which have left cavities) and light patches where crystallisation has begun in the felspathic base." The specimen is in the writer's possession, and it is only necessary to add that there are small crystals and aggregates of schorl here and there in the rock. Recent search has not revealed the exact locality from which this specimen came; it is a typical example of the red felsite.

All the specimens hitherto described can be matched from the collection on which the census of granites and felsites was based. The references are: Hen Tor, page 195, first item, second item, third item. Plym Valley (Cadover), page 200, sixteenth item. Plym Valley, page 201, fifth item, tenth item.

From Collard Tor southward and eastward there appears to be a considerable interval, from which this felsite is absent; it is by no means certain, however, that further search will not result in its discovery.

The next exposure is on the bank of a stream flowing down the slope of Pen Beacon, between Highouse Waste and Rook Tor, and joining Broadall Lake at Dendles Green. Here the rock lies between the granite and the slate, and junction specimens with the slate are obtainable.

CXIX. N.W. 8′. *Long.* 3° 57′ 37″, *lat.* 50° 26′ 28″. *In situ.*

I. *Colour*, Indian red, translucent at edges of thin flakes. *Texture*, compact, lithoidal, subvitreous. Fracture, flat conchoidal, smooth to slightly splintery. *Specific gravity*, 2·65. *Weathers*, lighter shades to white. Weathered surface sometimes indicates banded structure, and quartz and schorl stand out from the surfaces attacked.

Small quartz blebs are fairly numerous; some quartz crystals reach 12 mm. in length.

Hyaline, cream-coloured felspars of 4 to 10 mm. in length are not uncommon. Larger felspars of a light olive-buff, and with very perfect cleavage and bright cleavage faces, reach as much as 4 to 5 cms. in length and 2·5 cms. in width. These are not frequent. Spheroids of schorl, from 1 to 3 mm. in diameter, are irregularly distributed through the mass. Some joint faces are lined with schorl.

II. Usual structure of this rock. Ill-defined felspar microlites and small crystals sparingly present; larger felspar areas, representing the large crystals, exactly correspond to description of the type (see page 513). Brown and green schorl, which has attacked and replaced some of the small felspars. Tourmaline granules in the ground mass are not very numerous.

Quartz in much corroded forms with numerous fluid enclosures, which in turn enclose bubbles and cubic crystals.

Ground mass granular but indiscriminate; in places, however, has a distinct tendency toward micro-pegmatite, and with a power of 500 diameters portions of the felspar can be discriminated from the quartz.

Geographically this affords, perhaps, as convenient a place as any at which to pause. For the purposes of the paper enough has been written to show, even should the work stand at the point now reached, that there exists on the border of the granite a rock, not continuously but at intervals, which carries its characteristics practically unaltered at its various exposures. Apparently merely a chilled granite, and cotemporaneous with the intrusion of the mass, it points from its constancy of form, structure, and composition to an original uniformity of the magma from which the Dartmoor granite has consolidated, which will, perhaps, prove to have been unsuspected by most observers.

In following the work up, if opportunity serve and the patience of the Association permit, less detail as to this one rock will in the future be necessary, since its small variations have already been largely described. If the work is yet further extended, it will be found that there are other and numerous felsites and felsitic rocks that similarly occur true to their individual character at intervals over the expanse of the moor, and under, to some extent, constant conditions. Side by side with the great variety afforded by the igneous rocks of Dartmoor there is a remarkable uniformity discoverable over the whole area, and exhibited by series of most widely separated types.