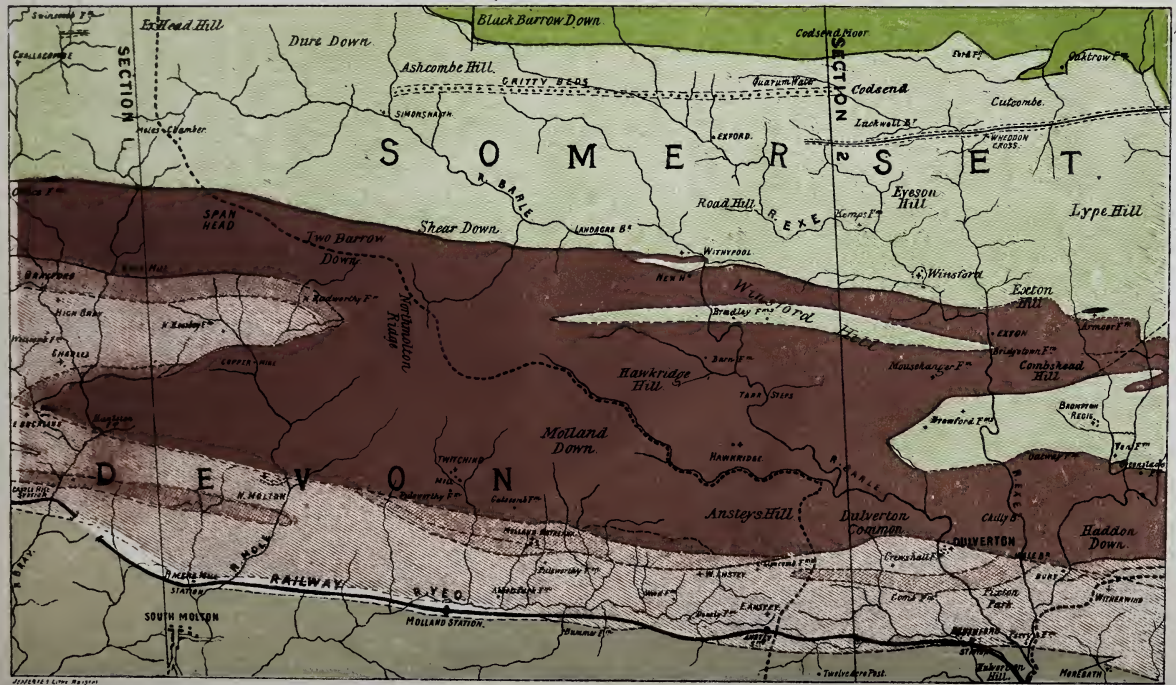
Geological Map

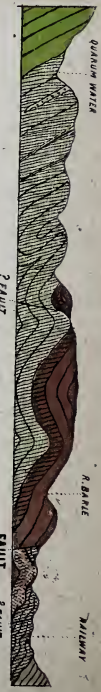
OF W. SOMERSET AND N. DEVON, DISTRICTS OF DULVERTON AND S. MOLTON.

by W. A. E. Ussher.

SCALE 1 INCH = 3 MILES.



SECTION 1.



SECTION 2.

INDEX.

- Culm Measures
- Bittadon Felsite
- UPPER DEVONIAN: Pilton Beds; Baggy Beds; Pickwell Down Beds
- MIDDLE DEVONIAN: Morte and Ilfracombe Slates; Limestones; Hangman Grits

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PAPERS, ETC.

On the Geology of Parts of Devon and West Somerset North of South Molton and Dulverton.[1]

BY W. A. E. USSHER.

THE Devonian rocks of North Devon are characterized by the uniformity of their occurrence, each division occupying a definite band striking from about West 5° North to East 5° South, but, as is only natural from the flexures consequent on the great cosmic changes that intervened between their deposition and the present time, we find many exceptions to this uniform adherence to lines of latitude, and in no part of the area are these rule-proving exceptions better exemplified than in the district of which I propose to give a brief description in this paper.

This district embraces parts of four sheets of the ordnance maps, viz., 27 and 26 on the west, and 20 and 21 on the east. Its base is formed by the basement beds of the Culm measures between South Molton and Morebath—a distance of 15 miles,—and it extends northward for about 9½ miles to the outcrop of the Hangman grits (base of the middle Devonian), thus forming a parellelogram of about 142 square miles in extent.

In this area not only is the uniform strike of the divisions interfered with by curves, but the gradual passage from the

(1). With the permission of the Director-General of the Geological Survey.

base of the upper Devonian beds into the middle Devonian slates is well shewn, and in such a manner that boundaries between them are often arbitrary.

Scenery is so intimately dependent on the rocky framework of the globe, and on the changes it has undergone by physical causes, that I may be pardoned for attempting a brief sketch of the features of the district under consideration.

Between South Molton station and Morebath station the railway runs along a tract of low lying land, varying from one-quarter to 1 mile in breadth. From the Mole valley to the Yeo at Veraby this low tract would seem to indicate an old east and west line of drainage, over which the debris of the Culm hills from the south, and upper Devonian slates from the north has been shed, forming a thick soil or head, obscuring alike the junction of the Culm and Devonian rocks and any relics of old fluviatile deposition that may have been left prior to its desertion for the present north and south courses of the tributary streams.

From Mornacot and Veraby to East Anstey the low lying land is tenanted by the Yeo and its tributaries, concealing the Culm and Devonian junction under their gravels and talus as far as West Barton, thence to Brushford their junction appears to be normal, and not far from the line laid down by Sir H. De la Beche on the old Geological Survey Map.

Between East Anstey and Anstey Farm a narrow watershed boundary separates the drainage of the Exe tributaries from those of the Taw; it runs north to Ansteys Hill whence it follows the high ground of the range formed by the Pickwell Down division, descending thence from Span Head to Moles Chamber over the middle Devonian slates.

From Anstey Farm to Dulverton station the low lying tract is rather hilly. From the Exe valley to Morebath station it runs through Culm measures along the courses and across the watershed of tributary streams. To the south of this band of low lying land the Culm measures form an area of hilly land, of such general uniformity in elevation that it may be regarded as a table land rami-

fied by numerous narrow stream valleys: to this uniformity exceptions are furnished by the features, conical or hogbacked in shape, made by the variety of the basement Culm rocks forming ridge-like hills in Tawstock Park, the ridge of Coddon Hill, the conical hills of Swimbridge, but only exhibiting these characteristic features in the district under consideration between Twelve Acre Post (west of Brushford) and Morebath. To the north of the low-lying land a belt of hilly land, averaging $1\frac{1}{2}$ miles in breadth, exhibits the bold rounded hill features of the flexured argillaceous slates of the upper Devonian (Pilton beds and Baggy beds). This tract is bounded by the dominant range of moorland hills formed by the upper Devonian grits (Pickwell Down beds). This elevated tract in the rounding of its slopes resembles the lesser elevations made by the Pilton beds, but differs from them in the continuity of its summits, forming extensive, barren, and flattish moors, separating the drainage of the Barle and its tributaries from that of the Mole and Yeo.

From North Radworthy Farm on the west of North Molton ridge to Higher Combe Farm, north of Dulverton, the Pickwell Down sandstones attain their greatest superficial breadth throughout the whole of North Devon and West Somerset, exhibiting their characteristic dominant barren hills and ridges over a tract of not less than 4 miles in breadth from north to south. This great breadth is occasioned by flexures, for we find flexured Pilton and Baggy beds on the west of North Molton ridge, their characteristic features being bounded on the south by Pickwell Down grits, forming a bifurcation from the main mass of North Molton ridge, and Twitching, and extending as far west as East Buckland.

Between Dulverton and Winsford the underlying slates of the middle Devonian are brought up by faults and anticlinals causing a bifurcation of the feature of the Pickwell Down beds near Higher Combe, Drayton, and Slade. South of Withypool and Winsford, although the ground retains its general dominant barren character, the basement beds of the Pickwell Down

series are flexured in almost undistinguishable association with greenish slates of the middle Devonian.

To the north of Span Head, Winsford, and Exton, the middle Devonian slates form a broad tract of lesser elevation than the Pickwell Down range to the south. This tract is from three to four miles in breadth, and is bounded on the north by the Moorland ranges, formed by the Hangman or middle Devonian grits, which rise gradually to the summits overlooking the lower Devonian area, of which Dunkery Beacon forms the most distinguishable feature. The middle Devonian slates form high, long-backed hills, differing in this respect from the upper Devonian; but in the continuity of their summits they resemble the grits rather than the slates of that division, probably owing to the greater homogeneity of their mass. Near their junction with the Hangman grits the middle Devonian slates exhibit minor ridge-like features, diversifying the slopes of the Exe valley or occurring in craggy cones, by its alluvia. This character will be recognised as a repetition of the strike features forming the Tors of Ilfracombe.[2] Somewhat similar minor crag features characterize the Lynton beds in the Oare valley, but that is beyond the area under consideration. The middle Devonian slates form steep, bold slopes in several places where the Exe valley intersects their strike.

I shall now proceed to describe separately each set of strata included in the area under consideration, in descending order, the table being as follows:

1. Culm Measures.

2. Devonian
   - Upper: Pilton beds with basement green slates, and occasionally brown grits, (Baggy beds), Pickwell Down grits, often slaty.
   - Middle: Morte and Ilfracombe slates, greenish and steel grey, glossy, apparently unfossiliferous in the upper parts; fossils and occasional limestone bands in lower part.
   - Hangman beds, grits, often coarse and siliceous.

(2). As also Stowey Ball.

CULM MEASURES.

Between South Molton and Hacche Mill the Culm measures are represented by dark bluish-grey shales, and even-bedded, rather fine, hard grey grits, dipping to the south at from 60° to 80°. Anthracite seams occur in these beds toward South Aller. To the north of the Mole, gravel occurs between Hacche Mill and Barkham. Either Pilton beds (upper Devonian) extend to more than one-quarter mile south of De la Beche's line, or we pass insensibly into them without any appearance of lithological break.

From the Mole valley to Molland Station the Culm and Devonian junction is hidden by the low-lying land. Ten chains to the south of Molland Station, a quarry in the Culm measures exposes even-bedded bluish and grey grits, interstratified with dark-bluish shales, dipping south at 60° Near Bummer Farm thin-bedded, fine Culm grits and blue-black shales dip south at 70°. Pilton slates are shewn in the adjacent railway cutting, so that De la Beche's line seems to be correct, as also near Yeo Mill and Horkswell, where no distinct lithological separation can be traced. South of Yeo Mill, light and dark-grey shaly slates (cleavage, dipping at a high southerly angle), contain crinoidal remains common to both Culm and Devonian rocks, but affording no distinctive species; to judge from the fossils, the bedding does not appear to concord with the cleavage, but may dip south at from 15° to 25°. In the railway cutting at Brushford light-grey slates, with *Petraia Celtica*, appear to pass upward into Culm measures of the same character. The dominant conical feature of Hulverton Hill is formed of thick Culm shales, evenly bedded, fine, and often chertoid; buff, dark-grey, and yellowish in colour, breaking up into small angular pieces through numerous even joints. These beds have been named Coddon Hill shales, from the locality wherein they are typically developed. Their distinctive characters appear to be due to metamorphism, as suggested by my friend Mr. Hall,[3] but no igneous rocks have been detected in association with them.

(3). *Trans. Devon Assoc.*, vol. iv, p. 623.

South of Perry, in the angle made by the confluence of the Exe and Barle, Coddon beds are shewn dipping South 30° East at 50-70° ; their junction with the Pilton slates being a fault, as the latter are shewn on the west of Perry Farm, dipping in the opposite direction, at an angle of 50°.

At Pool Farm, even-bedded grits with very dark bluish-grey shales, appear to overlie the Coddon beds.

On the north-west of Morebath Church, Coddon beds dip South 8° West at 60-65°, continuing thence along the feature to the Exe valley, but apparently terminate in a sharp angle on crossing the path (now representing the old high road for one-quarter mile north from Morebath), caused by a fault bringing up a re-entering angle of Pilton slates, with *Petraia Celtica*. On the west of Morebath Church white Coddon beds are shewn dipping south. Near Pin, south of Morebath, grey clayey shales are shewn in the railway cutting. Proceeding thence westward, a long cutting exposes blue-black shales, resembling those at Fremington Station (weathering pale grey within ten feet of the surface), containing nodular films and lenticular bands of crinoidal limestone.

The Coddon Hill beds appear to pass into blue-black thick shales and thin grits or mudstones, which form the basement beds of the distinctive Culm measures on the south of Clayhanger, and at Ashbrittle ; below them the boundary of Culm measures and Devonian is palæontological, and may not therefore adhere to a very definite persistent stratigraphical horizon. This uncertainty as to boundary, and the masking gravel and drift in the valley between Morebath and Clayhanger, render the junction indefinite, and the probability of faults repeating the Culm measures makes it still more uncertain.

The dark shales, with crinoidal limestone films, in the cutting west of Morebath Station seem to represent the horizon of the blue-black shales of Fremington, and to offer a faint connecting link between the limestones of Holcombe Rogus and West Leigh, on the one side, and those of Venn near Swimbridge, on

the other. In this way the fitful occurrence of the Culm limestones is more intelligible, than on the supposition that they have been persistently cut out by faults between the typical localities. There is every reason to conclude that the Coddon beds underlie the limestones, or their representatives, both near Venn, Morebath, and Ashbrittle.

UPPER DEVONIAN.

Although it is easy to distinguish the mass of upper Devonian slates from the grits and slaty beds of the Pickwell Down series, it is extremely difficult to distinguish the Baggy beds from the Pilton slates, of which they constitute the base. This difficulty is especially felt in the part of the area under description, as the Pilton beds are much disturbed by flexures, apparently accompanied by faults, and as the grits occurring in them at Braunton and Stawley, near Wiveliscombe, are sometimes indistinguishable from *Cucullæa* grits, without the aid of fossils. The greenish slates of the Baggy series, though often forming a well marked band at the junction with the Pickwell Down beds, are not always distinguishable in disturbed districts, unless we lay great stress on colour; whilst to map a contorted district like this upon palæontological evidence, would entail an enormous amount of very detailed investigation.

Between Hacche Mill and North Molton Church the Pilton slates are affected by anticlinals, one of which is exposed in a quarry at about half-way between Barkham and South Molton, by a stream. The quarry consists of thick-bedded, grey, micaceous grits, with thinner beds of grey and brown grit, in places associated with grey slaty beds; annelid tracks are not infrequent on the surfaces of the beds. These may be an appearance of the *Cucullæa* grits of the Baggy beds, as similar brown and grey grits appear, folded in with the Pilton slates, near Brayley Farm, and at Crossberry, between Castle Hill Station and East Buckland. But, if this is so, the attenuation of the Pilton beds, the absence of grits equivalent to those of Braunton and Stawley, and the non-appearance of the *Cucullæa* grits further north, can only

be accounted for by faults. Near Barkham we have evidence of a fault affecting tough bluish schists (irregular slates) ; the crack contains manganese.

At North Molton Church the Pickwell Down beds come on abruptly, their junction trending West 11° North, to East 11° South ; whilst the Pilton beds in North Molton strike east and west. The junction is therefore a fault of sufficient magnitude to cut out the Baggy beds altogether. Near East Buckland the fault is further proved by contrary dips at East Buckland Mill and the termination of the Pickwell Down beds.

In the lane from East Buckland, by the Mill, to Charles, greenish, purple, and lilac slaty grits, of the Pickwell Down beds, dip North 30° West, at 30°, under a trough of lower Pilton and Baggy beds which extend northward from Newton Bridge to Little Brayford, where they are terminated by the main feature of the Pickwell Down beds. The troughed Pilton and Baggy beds extend to the foot of North Molton range, near North Radworthy, being bounded on either side by the Pickwell Down sandstones. The Baggy beds exhibit no very definite relations in this troughed area; brown and greenish-grey grits interbedded with the slates at Charles, probably belong to the *Cucullæa* zone. The beds are so flexured, and apparently faulted, that the Baggy beds may be almost entirely absent, through a faulted junction with the Pickwell Down grits, between North Radworthy and North Heasley. The cupriferous grits, north of Heasley Mill, are of a warm grey colour and associated with greenish beds, whilst the upper beds of the Pickwell Down division are generally slaty, and of a lilac-red colour, as shown on the northern border of the synclinal at Hole Mill, north-east of High Bray.

In the Bray valley, between Charles and High Bray, on the east of Wellcomb Farm, a synclinal is evidenced, in Pilton slates associated with hard brown and grey thick-bedded grits, with brown bands—apparently decomposed limestones. Pilton slates are exposed in a quarry between North Radworthy and

North Heasley, striking toward south-west and north-east, and nearly vertical. The structure may therefore be described as a large synclinal, bounded on the north and south, and terminated on the east, by underlying Pickwell Down grits; the beds troughed are the lower beds of the Pilton slates, containing grits, passing into the green slates of the Baggy beds, the *Cucullæa* zone being either faulted out, or occurring as grit beds intercalated in the base of the Pilton slates and in the upper part of the Baggy slates.

Between North Molton and West Molland Farm (south of Twitching), the fault, cutting out the Baggy beds at the former place, either passes out or loses its effect, as dark-brown sandy grits, apparently passing into grey slaty grit, are exposed by the valley south from West Molland Farm; whilst, to the north of the Farm, a band of greenish slates bounds lilac slaty grits of the Pickwell Down beds and may represent the grits and slates of the Baggy beds. The former undulate, and would appear to pass out into the Pilton beds eastward; but near Gatscombe Farm, north-west of Molland Botreaux, the greenish slates of the Baggy beds contain irregular brown gritty bands, resting on lilac grits and slaty beds of the Pickwell Down division.

In rather rough lilac grits at the base of the Baggy beds in the Tone valley (which I had regarded as Pickwell Down sandstone), my friend, Mr. Hall, found *Cucullæa*, so that I am forced to believe that that fugitive denizen of the upper Devonian waters thrived where the sediment favoured him, and left his remains in the upper part of the Baggy beds, between Twitching and Baggy Point; but that east of Twitching he distributed his favours according as the local sandy sediments prevailed in the upper, or lower, part of the Baggy beds—his habitat shading into the Pilton beds in the one case, and into the Pickwell Down division in the other. An interesting section by the lane to Gatscombe shews hard greenish grits passing into slates, with arenaceous films exhibiting a micaceous glaze, and irregular, slaty, grey and brown grits. A synclinal, probably faulted, disturbs the beds.

Owing to this gritty development at the base of the Baggy beds, some uncertainty prevails as to their junction with the Pickwell Down division, between Gort Farm and Woodland (near West Anstey). The green slates of the Baggy beds run through Molland to West Anstey Church (not always presenting their characteristic colour), thence their breadth of outcrop dwindles, till, near Lipscombe Farm, they are no longer traceable on the slopes of East Anstey's Barrow : this appears to be due to a deflection of a great fault from Dulverton, forming their southern boundary for three miles to the west of East Lipscombe Farm. The fault south of Gatscombe Farm may affect somewhat similar beds in the mine near Gort.

Grits, sometimes suspiciously like the *Cucullæa* zone, are associated with the Pilton slates, near Wood Farm, where they are apparently cut off by fault; at Pulsworthy, and between Molland and Abbot's Park. A quarry in the last-named locality shows slaty limestone associated with grits and slaty beds containing Pilton fossils. In the same locality a gentle anticlinal is well shewn in a bluish slate quarry. On the east of Slade Farm (south-west of West Anstey), dull-grey argillaceous slates, in places of a dark bluish-grey hue and with films of calcareous matter, are exposed in a very fossiliferous quarry. The beds dip to the North at 20°; an appearance of fault was detected in them. Near Wood Farm (between Slade Farm and West Anstey), grits, like those of Braunton, are associated with the Pilton beds, and have a general northerly dip.

The prevalence of northerly dips in the Pilton beds, between Molland and Brushford, can only be accounted for by a great fault at their junction with the Culm measures, or by a series of inverted folds, aided, perhaps, by small faults.

At Densley Farm (south of West Anstey), a small quarry discloses fossiliferous Pilton slates, passing in places into limestone, and containing brown bands, apparently decomposed limestones.

At Bucket Hole (north of East Anstey), thin beds of fos-

siliferous brown sandy stone occur in the slates, and probably represent decomposed limestone.

Between West Lipscombe Farm and the Barle valley, along a tract running between Crewsball and Comb Farms, brown grits frequently come to the surface; also yellowish-brown fissile sandstones. They may be the crests of anticlines, or faulted portions, of the *Cucullæa* zone, which would then form the sole superficial representative of the Baggy beds between East Lipscombe Farm and Hele Bridge (east of Dulverton); as the green slates are cut out by a fault, throwing Pilton beds, with northerly dips, against Pickwell Down sandstones. This is the more probable as the Pilton slates bounding the band of grits dip off them to the north and south respectively, proving a considerable anticlinal. In company with Mr. Hall, I traced the brownish grits in the north of Pixton Park. They are exposed in a quarry near the gate-house, and end off abruptly along the fault which runs along the high road between the gate house (lodge) and Hele Bridge. At Bury the green slates of the Baggy beds appear on the north side of the fault, and flank the southern margin of Haddon Down, resting on the lilac slaty grits of the Pickwell Down beds, north of Witherwind Farm, and west of Leigh Barton. A bold feature overlooking the lower ground of green slates consists of coarse brownish grit, with iron shot grains, and containing *Cucullæa*, judging from the stones on the surface: so that we have here a patch of *Cucullæa* grit occupying its normal position above the slates, and bounded on the south by the fault. If a basement grit occurs in the Baggy beds on the slope of Haddon Down hill, it is indistinguishable from the Pickwell Down grits. Toward Raddington the main fault is merged into a system of small dislocations, affecting the relations of the Pilton and Baggy beds. About Skilgate the green slates of the Baggy beds attain a considerable superficial development, but the *Cucullæa* grits within the short distance of a mile appear to have passed out into individual beds or thin strata of grit, in association with grey slaty beds.

Between Brushford and Raddington the Pilton beds, south of the great fault, seem to be much flexured. Their junction with the Culm measures is, as we have seen, a line of fault to the south of Pixton Park.

Near Combland, and at Timewell, filmy beds of limestone occur in the slates (to the north of Morebath). Near the high road, east of Brushford, a quarry in which the slates are vertical afforded the late Prof. Phillips many of his best specimens of Pilton fossils.

Near Morebath Church, on the north-east, and between Bowdens and Lower Town, east of Morebath, the Pilton beds are of a very dark bluish-grey colour, and scarcely distinguishable from Culm measures, except by discovery of *Petraia Celtica*, or some characteristic Devonian fossil.

From their thick soil and infrequent exposures, it is hardly necessary to trace the composition of the Pickwell Down beds throughout the area. Their general characters may be gleaned from the following sections :—

East of East Buckland, near Huntston Farm, lilac slaty grits overlie massive-bedded purplish-red and faint greenish-grey grits, with a tendency to slaty structure. Dip, south-west at 40°.

Between Span Head and Two-Barrow Down, an adit discloses green and purple slaty grit.

Near Sandy Way, on North Molton ridge, grey grits are exposed.

In the Mole valley, above North Molton, grits of red and pale greenish colours are exposed, the former affording iron ore.

Near Twitching, pale lilac sandy grits, weathering brown, exhibit a tendency to cleavage in distribution of joints and molecular constitution. Purplish-brown and dark-grey sandstones, with greenish intercalations, occur at Pulsworthy Farm, and have been worked for hæmatite near Twitching Mill, a little to the north of it.

Near the confluence of the Barle and Dunn's Brook, a road section, on the south side, exposes red, purplish, and lilac grits,

and irregular slaty grits, with occasional beds of light-buff, grey, and purplish shale, either affected by a fault, or sharp anticlinal. At the confluence of the streams fine lilac grit was noticed, in massive even beds, dipping West at 10° to 12°. Towards their surfaces the beds exhibit a finely cleaved structure.

West of Zeal Farm, near the bend in Dunn's Brook, faint greenish and purple grits, in part slaty, are exposed on each side of a valley, with north and south dips, proving the existence of an anticlinal.

Coarse greenish grits are exposed by the Barle, at the bend on the north-east of Hawkridge common; they dip north at 50°, are in places micaceous, and jointed and bedded irregularly: they appear to rest on purplish slates; succeeded by grits varying from fine saccharoid to fine friable textures, and of greenish, grey, or reddish colours; and slaty beds, purple, lilac, olive green, and grey. Grey slates are visible at Tarr Steps, dipping North at 20° to 40°. The cleavage dipping in the same direction apparently ranges from 40° to 70°. About 80 yards up stream a pretty little cascade falls over a cliff 10 to 15 feet in height, composed of purplish or chocolate-red, slaty, and schistose grits, distintly bedded, dipping North 20° West at 20°—30°: the cleavage approximates to the vertical, the planes being wavy.

At the stream mouth, between Tarr Steps and Barn Farm, purple grits, apparently dipping quaquaversally at low angles, are intersected by vertical cleavage planes. Near Wheel, at the bend in the river, crags of purple and dull grey slaty grit, dipping South 15° East at 45°, the cleavage being vertical, break through the slope above grey crags, in which wavy cleavage runs parallel to the bedding. Four chains further north crags of purple and light greenish slaty grit dip South 15° East at 75°; the cleavage is wavy. Twenty chains further north crags of grey slaty grit, with nearly vertical cleavage planes, dip South 15° East at 50°.

As there is evidence of a faulted or natural anticlinal bringing

up the greenish grey slates of the underlying Morte series (middle Devonian) on Winsford hill, east of Bradley Farms, and on the road to Withypool, west of the Barle valley, I have entered thus minutely into detail to show the passage of the upper into the middle Devonian, which is so noticeable in this area where the basement, Pickwell Down beds, almost invariably, consist of purple slates and slaty grits, associated with beds of greenish or grey slate as they approach the underlying quartziferous slate series. This is shewn by the slates striking across the road to Withypool near New House, and is still better exemplified in the lanes south of Winsford and south of Exton. South of Winsford the basement purple slates of the Pickwell division, which form the northern summit of Winsford Hill, appear to run in an inverted (and perhaps faulted) synclinal along the Exe valley, crossing it at Widlake Farm,[4] north of Exton, and thence continuing eastward as far as the eastern slope of Blagdon Hill, opposite Withil Florey.

On the east of Farmers Farm, near Withil Florey, the Bittadon felsite makes its appearance in association with Morte slates. Although the strip of Morte slates, before referred to on Winsford Hill, appears to pass under purple slates of the Pickwell series at Bridgetown, the proximity of the latter at Exton precludes its more easterly extension. Near Combshead, on the east of Bridgetown (south of Exton Hill), the junction between the Morte and Pickwell divisions is well shewn in a gradual interchange of the purple and greenish grey tints. The junction of the upper and middle Devonian, west from Withypool to the Bray valley, follows the feature (not shewn on the map on Shear Down, the south part of which is higher ground); it passes along the face of Two-Barrow Down and Span Head: no junction sections are obtainable. From a contrary dip (apparent) at Kedworthy, in hard chocolate-red and fine grey grits, it is not impossible that a fault may separate the divisions for some distance.

(4). In the *Quarterly Journal of the Geological Society* for Aug., 1879, p. 536, the extension of the Pickwell series to Widlake Farm is not indicated, having been subsequently discovered. In pp. 540, 542 of that paper, read Tone for Torre, and in p. 545, line 12, read Putsham for Hutsham.

To the east of Office Farm, in the valley of the Bray, we get traces of the appearance of the Bittadon felsite, which I am inclined to agree with Mr. Bonney in regarding as intrusive. It also appears in the upper beds of the Morte and Ilfracombe series near Armoor Farm, to the east of Exton Hill, as well as near Withil Florey.

To return to the Pickwell Down grits. Near Drayton Farm (north-west of Dulverton) green grits, in part slaty, dip north at about 20°. Similar green grits occur throughout the whole area in the Pickwell series; they are especially noticeable in the lower part of the division on Bratton Down, and at about 200 feet from its top in the coast reefs on Woolacombe beach.

By the Barle toward Dulverton even bedded purple, grey, and pale buff grits, in places slaty, are exposed in several quarries, in one of which the beds are very massive, attaining to 15 feet in thickness.

On the south and west of Haddon Down the Pickwell beds are slaty and of a lilac-red colour.

Between Court Down, Barlynch Abbey, and Upton, they vary in colour, from grey, reddish-brown, and faint lilac tints, to green.

The junctions between the upper and middle Devonian, west of Brompton Regis, though well marked by feature, are by no means so satisfactory as in the Winsford and Exton district, already noticed, probably owing to impersistence or very partial development of the slaty base of the Pickwell series.

From Main Down to Rainsbury, near Upton, the junction follows the feature, being deflected by its curves. A fault, however, runs through Rainsbury, in the direction of Raddington, stepping the junction nearly three-quarters of a mile further north, whence it follows the feature round Upton Hill, crossing the lane, north from Stert Bridge, either at Greenslade Farm, or 12 chains to the north of it. At Ven Farm, between the tributary streams, the continuity of the junction line appears to be broken by two north and south faults stepping it for a few chains successively to the north. On the hill south of Ven

Farm there is every appearance of conformity in the junction between the faults, but the strike has altered to West 30° South, and East 30° North, as shewn in crags of purplish and lilac slaty beds, under greenish grits and above a parallel range of greenish slates and slaty grit. The junction beds of Ven Farm, if not stepped by a fault on the west, must considerably alter in strike to allow of their trend westward, through Red Cross to Oatway Farm. A synclinal is shewn in the Morte slates, by the stream south-west of Coultings Farm, near the junction.

By the high road west of Red Cross the Pickwell basement beds consist of sombre grey, brownish, and greenish grits—often slaty. From Oatway Farm the junction follows the feature into the Exe valley, whence it runs along the north of Court Down, not, however, exposing any sections of the basement beds of the Pickwell series. The termination of the Morte beds on the anticlinal axis takes place at about half a mile from Higher Combe Farm: from this point the boundary runs to the north of East and West Browford, probably along a line of fault which crosses the Exe valley near Clammer and is shown in section near the twelfth milestone on Combshead Hill, where rough grey cleaved Pickwell grits are thrown against Morte slates. On the common between West Browford and Mousehanger, a pit shows greyish and dull brown grits, and purple slaty beds in the Pickwell division.

The green slaty beds shewn at Clammer appear to be included in the base of the Pickwell division. The Morte slates of the main anticlinal yield a variety of contrary dips in the Exe valley, shewing the prevalence of minor flexures. The slates exhibit bluish or steel-grey tints in places, their colour, in this respect, lacking the uniformity that is displayed by this division towards its typical locality, Morthoe: a still further divergence is exhibited in the raddled shales and slates of this series about Croydon Hill and on the Quantocks. From Combshead the basement purple slates of the Pickwell beds are found on both sides of the Combshead Hill fault; they cross Blagdon Hill in

association with the greenish-grey quartiferous slates of the Morte series, in which they are apparently troughed in inverted synclinals.

The great middle Devonian slate series is palæontologically divided by Mr. Hall into an upper unfossiliferous mass of quartz-veined slates, and a lower mass, containing middle Devonian fossils and impersistent limestone bands. These varieties are respectively named from their typical districts, Morte and Ilfracombe slates.

Stratigraphically, no persistent horizon can be drawn between the fossiliferous and unfossiliferous portions of the series. In the district under consideration quartz veins are distributed pretty generally throughout; and Mr. Winwood informed me that he had obtained crinoids in the Winsford slates, which would appear to be high up in the series. The main characteristics of the upper varieties are, however, broadly distinguishable from the lower throughout the area. The impersistent limestones of Ilfracombe being represented here and there along the same general strike in the lower beds. The greater impurity illustrated by arenaceous films and beds of sandstone in the slates about Ilfracombe, is exemplified by a belt of bluish grits, partly calcareous, weathering brown, striking east and west across Dure Down and Ashcombe Hill, along the Exe valley to Downscombe, and thence to Hankton and Codsend.

Near Codsend the gritty beds are cleaved in irregular planes, coinciding in direction with the southerly dip of 40°. On the moor, south of Codsend, a bed of dark red cleaved grit occurs in the steel-grey slates. On the moor, about three-quarters of a mile west of Codsend, the gritty beds are buff-brown and cream-coloured, with a tendency to slaty structure; they are overlain by bluish-grey, buff-stained slates, apparently dipping in direction of the cleavage, southward at 30°; beneath them, steel-grey shimmery slates form the hill side, and are exposed in the bed of Quarum Water, dipping South at 40°, in a direction coincident with their wavy planes of cleavage.

On the Lynton road, north of Simonsbath, the gritty band is

represented by pale buff siliceous grit, in bluish slates. The slates in the Barle valley, east of Simonsbath, appear to be slightly calcareous in one spot where they dip South at 60°. Limestones are only noticeable between Wheddon Cross and Luckwell Bridge.

At Luckwell Bridge Mill about 30 feet of dark bluish-grey limestones, cleaved in directions coincident with bedding, dip South 10° East, at 45°; traces of crinoids and corals were noticed. The limestones appear to die out near Horsecombe, in the direction of Exford, but to pass along in impersistent strips eastward, toward Croydon Hill. Gritty beds occur in the slates in the Barle valley, at the junctions of the Ordnance Sheets 20 and 27.

The greenish and bluish tints, though generally prevalent in the upper and lower parts of the division, repectively, are locally distributed throughout all horizons. Steel-grey and silvery tints prevail to the east of Exford.

Although the prevalent dips are to the south, their varying amounts render the prevalence of inverted curves exceedingly probable. Down the Barle valley contrary dips in the slates (between Simonsbath and Landacre Bridge) afford proof of several flexures. At Landacre Bridge an anticlinal is indicated by dips to North at 45°, and to South-East at 60°.

An appearance of anticlinal structure is observable at the disused copper mine, one mile and a half from Simonsbath. It is unnecessary to describe all the slate quarries observed, a good section may suffice. To the east of Kemp's Farm, in the Exe valley, at the foot of Eyeson Hill, a quarry exposes silvery-grey slates, with close, uneven cleavage planes, as at Ilfracombe; the surfaces of the planes are stained yellow and reddish: the beds dip South 20° East, at from 45° to 50°: the cleavage dips in the same direction at about 60°. Vertical even joints intersect the beds, running East 15° South, and West 15° North.

The Morte and Ilfracombe slates are characterized by frequent conical or ridge features, diversifying the valleys of the Exe and Barle with their crags.

In the Barle valley, near Simonsbath and Landacre Bridge, conical features are noticeable.

In the tributary stream valley near Blaggrove, north of Withypool, the grey silvery slates form a series of low ridges about 20 feet in height, reminding one of the Lynton bed features in the valley near Oarford.

In the Exe valley, at the foot of Road hill, an *arrête* of slates forms a minor ridge culminating at about 100 feet above the valley bottom ; its crest runs along the strike, the gentler slope being southward with the dip. In the same valley, three miles above Exford, a little craggy mound feature affords a pleasing diversity from the steep slopes on either side.

The junction of the Morte and Ilfracombe slates with the Hangman grits (forming the base of the middle Devonian) follows the nascent course of the Exe, between Oare Oak and Dure Down Hills ; the steep slopes being made by the outcrop of the slates, whilst the grits generally rise from low banks, in broad expanses of moorland, with increasing elevation to the north. This character is displayed near Dure Down, and on Codsend Moor, above Quarum Water. In the tributary valley near Pitsworthy, north of Exford, the junction is scarcely distinguishable by feature. Actual junctions have only been obtained in the Exe valley, near the junctions of Ordnance Sheets 20 and 27, and in the high road near Cutcombe; in intervening localities the lithological evidence of the presence of the Hangman beds is confined to a plentiful scattering of their characteristic saccharoid grit fragments.

On the south of Black Barrow Down, at the map junction, the slates cross the Exe, striking east and west, and forming on the northern slope of the valley a castellated break, or excrescence, so to speak, marking their outcrop ; whilst the presence of the Hangman grits is evidenced by an abundant scattering of their siliceous fragments on the surface. At the junction the slates are bluish, superficially stained with red here and there ; they dip to the South at 60°, the cleavage being vertical.

At the bend in the high road near Cutcombe, on the north, an actual junction is visible, the slates passing downwards through slaty and schistose grits, into rather coarse grits of the Hangman series, the whole dipping South 30° East, at 10° to 13°.

CONCLUSION.

The general structure of the country described in this paper has been worked out by original observations, which, although they supplied me with copious materials for its elucidation—of which parts only have been extracted for this paper—are not sufficiently elaborate to enable me to attempt a minute description of the various minor disturbances affecting individual divisions, nor to arrive at any definite conclusions regarding the thickness of the Devonian rocks. Such observations would require much palæontological research, as well as considerable time, extending, perhaps, over as many years as the months during which my investigation was made. But the infilling of these details could in no wise invalidate the general structure here described, however they might throw light on the great question of the general relations of the Devonian rocks, upon which it is not my province here to enter. Such being the nature of the investigation, I have abstained from quotations, restricting myself to a condensed selection from my own notes.

ADDENDA.

I have since found, that reddish shaly beds with occasional grit intercalations, probably belonging to the Hangman series, prevail between Croydon Hill and Luckham Barrows. The junction beds near Cutcombe appear to be the topmost beds of this type.

There is certain evidence of shales of the Ilfracombe series between West Harwood, Northcombe, North Hill and Langham Farms, and of limestone, rich in corals, on the East of Ford Farm. The Ilfracombe series, therefore, extends up on the Moor for a mile and a half North-West from Cutcombe, forming an angular deflection as shewn on the accompanying map : this may be due to the inverted curve near Oaktrow.