Chapter 6 The Peel Sandstones

Historical and general

These rocks occupy a strip of the western coast about one and three quarter miles in length, extending from Peel [SC 24265 84279] north-westward to Will's Strand [SC 26924 86048] in a range of bold and picturesque cliffs averaging 50 to 60 feet in height. They consist of red and sometimes mottled sandstones with partings of red shale and with bands of pebbly conglomerate and lenticles of impure concretionary limestone. Fossils occur sparingly in the calcareous pebbles and concretions, consisting principally lof fragments of corals in poor state of preservation, referable to the genera *Amphipora, Heliolites, Favosites, Cyathophyllum,* etc., all of which are unfortunately of wide range in time, along with stems of encrinites and a few imperfect shells (see p 276)

Unlike the Carboniferous Basement Conglomerate of the south of the Island, the pebbly layers in the Peel Sandstone contain little, if any, material derived from the Manx Slates. A few fragments of shale and grit may possibly have had this origin, but the majority of the pebbles are composed of quartz, quartzite, agate, sandstone, limestone, chalybite, and a porphyritic igneous rock which cannot be traced to any visible source within the Island.

Both eastward and westward the Sandstones are faulted off against the Slates; and their inland extension is hidden by a drift, so that except in one locality they are not visible at a greater distance than one quarter of a mile from the coast. The exception referred to occurs one mile inland, in the valley of the Neb at Glenfaba [SC 24191 83118] due south of Peel; but the exposure is very limited (p. 277), and considerable doubt exists whether it is continuous beneath the drift with the main outcrop on the coast, or whether, as Prof. Boyd Dawkins believes, it constitutes a small separate faulted inlier. For reasons given on a later page (p. 277) the former hypothesis has been adopted in the Survey map.

In the coast sections the sandstone is tilted steeply at an angle usually ranging between 30° and 50°, towards points between N. and N.W. Traces of folding are visible in one or two places, and the finer layers and calcareous bands are occasionally somewhat Crumpled. A few small N. and S. faults, parallel to the boundary faults, are revealed in the cliff-section; and there are traces of other fractures, probably also of limited dimensions, along the strike of the beds, but none seems to be of structural importance except those which occur at the east and west boundaries.

The Peel Sandstone, being the only "freestone" of the Island, is noticed in all the old topographical descriptions. Of the geological writers, Berger, in describing its stratigraphical features, linked it with the Conglomerate of Langness.<ref>Op. cit., p. 45.</ref> Macculloch gave a full dbscription of it and noted the occurrence of "thin beds of coarser grit and breccia". He considered that "in a geological view it must rank before the [*Carboniferous*] Limestone", and suggested that the calcareous strata following it were concealed by the sea.

<ref>Op. cit., pp. 493–4.</ref> Henslow added further details, and showed it on his map by the same colour as the Conglomerate of Langness.<ref>Op. cit., pp. 535and 547–550</ref>. In the geological map which forms the frontispiece to Conybeare and Phillips' "Outlines of the Geology of England and Wales" (1822), it is however coloured and lettered as "New Red Sandstone", but there is no reference to the Isle of Man in the text.

Cumming in his first paper<ref>Quart. Journ. Geol. Soc., vol. ii., p. 320.</ref> classified the Peel rocks, along with the Conglomerate of Langness, as Old Red Sandstone, stating that " it is of moderate thickness (not more than 300 feet) and covers from one to two square miles". He remarked that "the small patch of limestone which once existed on the surface of the Old Red Sandstone as it dips rapidly seaward, has some time since been wrought out,<ref>This is not quite correct, since a small portion of this limestone-band which could not be quarried without great danger, still remains overhanging the sea. (See p. 275.)</ref> and it is difficult now to determine absolutely whether it belonged to the mountain limestone, or was merely a thin band of cornstone". Among the additional information on the subject contained in his later work is the following: "The upper portion is greatly charged with carbonate of lime, and effervesces strongly with acids. It contains characteristic Devonian fossils such as *Favosites polymorphic,* though there is every probability that it passes very soon into the lower carboniferous series of the Island".<ref>"Isle of Man", p. 200. The same

statements are repeated in the "Guide", p. 159.</ref> No further details are given in regard to the fossils, nor are the specimens now to be found in the Cumming collection at the College at Castletown.

The occurrence of fossils in the Peel Sandstone was next noticed by Mr. J. [E.] Taylor, who remarked that "the imbedded pebbles are many of them of quartz but none of slate; while these are accompanied with limestone pebbles, in which may be seen fossils of an undoubtedly Silurian character. I have many a time chipped out fossil corals and portions of shells from these imbedded pebbles; and after a shower of rain, when the rocks are clean, they may be observed plentifully strewn among the fragments forming the Conglomerate".<ref>Trans. Manchester Geol. Soc., vol. iv. (1864), p. 77.</ref> From the size of these pebbles Mr. Taylor thought they could not have been carried far.

This statement as to the comparative abundance of fossils which are now quite rare, may perhaps be explained by the fact that the exposed surfaces of conglomerate are of limited extent, and weather very slowly; so that there may not have been time since they were ransacked by the earlier collectors for a fresh crop to appear. Mr. Taylor classified the deposit with the Langness Conglomerate which he regarded as forming "a sort of passage from the Carboniferous downward, rather than a representative of the Devonian formation".

The presence of fossils in the conglomerate-bands at Peel Was observed again in 1875 by Mr. J. Shipman, who procured a good example of the fossiliferous limestone fragments from a quarry half a mile north of Peel.<ref>Referred to in report of lecture to Nottingham Naturalists Society published in a local Nottingham paper in 1876. Mr. Shipman has kindly permitted us to examine the specimen (see fossil list p. 276).</ref>

Mr. Horne incorporated a description of the Peel sandstone in his paper on the geology of the Island published in 1874, correlating it, along with the Langness Conglomerate, with the Calciferous Sandstone Series of Scotland. As doubt has recently been thrown on this correlation, the following passages in which Mr. Horne states his opinion deserve careful attention, the author's personal knowledge of the Scotch rocks lending great weight to his conclusions.

"There is one important feature connected with this patch of red sandstones: it is the occurrence in them of some thin bands of cornstone, which strongly resemble the cornstones of the Calciferous Sandstone series in Scotland… . Cumming found in this cornstone a specimen of *Favosites polymorpha,* Devonian form, from which he inferred that these beds are truly of Old Red Sandstone age. My colleague, Mr. R. Etheridge, Junior, F.G.S., suggests the probability of this specimen being the *Favosites polymorpha* (Phillips), which is the equivalent of *Favosites dubia* of Blainville, a true Devonian cora1.<ref>See Edwards and Haine, "British Fossil Corals", 1850, p. 216.</ref> If this be true, then it only proves that some of these characteristic Devonian forms survived the close of the Old Red Sandstone period, and flourished in Lower Carboniferous times"… .

"From these data it is highly probable that the red sandstones, cornstones, and brecciated conglomerates in the Isle belong to the Calciferous Sandstone series. Lithologically, they resemble the members of the same series in Scotland…

…Not more than 40 miles off, on the Kircudbrightshire coast, there are beds belonging to this series which are in many respects identical with most of the Manx sandstones and breccias".<ref>Trans. Edinburgh Geol. Soc., vol. ii., part iii., pp. 7–8.</ref>

No further additions were made to our knowledge of the deposits until 1894, when Prof. W. Boyd Dawkins published an important paper on the subject, in which he gave fuller details respecting the succession and thickness of the series than had hitherto been attempted, and claimed that they were of Permian age.<ref>Trans. Manchester, Geol. Soc., pt. xxi., vol. xxii., pp. 1–7; also Rep. British Assoc. for 1894, p. 776.</ref> In later papers he re-affirmed his opinions, and stated that he had also recognised part of the series in a deep boring in the north of the Island. It will be shown, however, in the following pages that these views as to the age of the deposits can scarcely be considered proven; but before entering further into the discussion, it will be desirable to extract from the above-mentioned papers, the chief points of Prof. Dawkins' argument.

In his first paper on the subject, Prof. Dawkins states that the Red Sandstone series of Peel is 1,368 feet in thickness,<ref>These measurements seem to be based upon calculations of the angle of dip and extent of visible outcrop; but as the base of the series is sot seen, and the structure is less simple than at first appears, it may be doubted

whether results obtained by the method are reliable. It will be noted that Cumming considered the total thickness to be " not more than 300 feet", but this must be an under-estimate (se p. 271).</ref> and consists of the following divisions, in ascending order.

1. The Red Sandstones forming the headland of Creg Malin [SC 25035 84517], at the base of the series. "Their thickness is about 426 feet, calculated in the line of the dip as far as the southern end of Traie Fogog" [SC 25235 84687].
2. Reddish grey sandstones and irregular conglomerates, in the cliffs of Traie Fogog, with a thickness of 385 feet.
3. Brighter-coloured red sandstones and irregular red conglomerates, with sub-ordinate layers of red marl; 102 feet thick.
4. The calcareous conglomerates and breccias of the Stack series, about 455 feet thick, showing the following sequence in the east end of Traie Fogog.
    1. Conglomerate composed of limestone pebbles embedded in a red sandy magnesian paste, about 10 feet.
    2. Bright red marls with grey spots and grey calcareous concretions, about 10 feet 6 inches.
    3. Red sandstone, faulted and slickensided, 4 feet 6 inches.
    4. Conglomerate of the same character as (a), about 5 feet.
    5. Red sandy marl mottled grey, about 12 feet.
    6. Irregular layer of doloinitized limestone about 18 inches thick, with irregular calcareous concretions and conglomerate with red sandstone, 8 feet.
    7. Bright red sandstone and calcareous conglomerates, and concretions of dolomite embedded in red paste, more than 20 feet in thickness.

"The conglomerates are composed of pebbles of hematite, marl, sandstone, jasper, cornelians, and amygdaloidal basic rock containing chalcedony, and of carboniferous limestone. This last is more or less dolomitized, and presents traces of corals and shells *Euomphalus* ?, *Spirifer* ?, *Orthis* ? or *Strophomena* ?. The pebbles are imbedded sometimes in a bright red magnesian paste, and at others in a white calcareous base. The conglomerates are in places replaced by breccias of angular fragments. There are also dolomitic concretions which have been formed in a red sandy base, and are locally developed into irregular and highly-jointed layers of limestone, curiously acid-worn and honeycombed. This may be studied at the north-east end of Traie Fogog and in the Stack. The whole series is so irregular in its constitution that it is almost impossible to define the subdivisions. It agrees exactly with that so well described by Prof. Sedgwick at Barrow Mouth, near St. Bees".

The evidence as to Permian Age

<ref>This paragraph is quoted in full.</ref>

"These rocks may be divided into two distinct groups. First the Peel Sandstone series, which includes Nos. 1, 2 and 3 of the section, and presents a thickness of 913, and the calcareous conglomerates of the Stack series, which are 455, together a total of 1,368 feet. Their true base is concealed. The pebbles of Carboniferous Limestone in the conglomerates point to a post-carboniferous age, and the physical characters of both divisions are identical with those of the Permian rocks of the north of England, and more particularly with those of the Lake District, of the Vale of Eden, and Barrow Mouth, described by Sedgwick, Harkness, Binney, Eccles, and Nicholson.

"The Peel Sandstones are the equivalents of the Rot-todt-liegende of the Continent and the Lower Permian Sandstones of St. Bees' Head and the Vale of Eden. The Stack Conglomerates and Breccias represent the base of the Magnesian Limestone series of the Upper Permians and the upper (rotten) Brockram; or conglomerate, of Mr. Binney. The thickness of the Permian rocks of the Isle of Man is more than 1,368 feet. In Hilton Beck, in the Vale of Eden, it is more than 2,000, according to Nicholson.

"The presence of the calcareous rocks of the Stack series resting upon the thick Peel sandstones renders it impossible to classify the series with the Triassic strata, in which the conglomerates are below and the sandstones above. The Permians of Cultra, on the south side of Belfast Lough, described bv Binney, present a similar relation of the

conglomerate to the Rot-todt-liegende. It is therefore clear that north-eastern Ireland, the northern part of the Isle of Man, and the area of the Lake District including the Vale of Eden, were parts of the same Permian marine basin, in which, as it approached southern Lancashire, the waters gradually were more highly charged with mud, the calcareous element being conspicuous in the one, and being replaced in the other by thick accumulations of marl".

The same paper contained an account of the discovery of Triassic rocks in the deep borings in the north of the Island, a discovery which no doubt had considerable influence upon Prof. Dawkins' opinion as to the age of the Peel rocks.

In a paper in the following year, Prof. Dawkins gave further details of the boring at Ballawhane [NX 39726 01308] (which had in the interval been carried through the Triassic Rocks), and stated that it had revealed the Triassic Sandstone, equivalent to the St. Bees' Sandstone of Cumberland, resting unconformably on Permian rocks of the Stack Series which were faulted off downwards against Carboniferous Limestone.<ref>Trans. Manchester Geol. Soc., pt. vi., vol. xxiii., p. 147; and Report British Assoc. for 1896, p. 777.</ref>

His reading of the Ballawhane section was as follows:

"Boulder Drift sands, gravels, and clays	171 ft.
Triassic Sandstone, red and grey	373 ft. 2 in.
Permian Marls and Sandstones of the Stack Series	136 ft 2 in.
Carboniferous Limestone, grey and red, with crinoids	37 ft 10 in.

"In this section the Triassic Sandstone cores prove a dip of 10°, while the Stack Series below have a dip of from 30° to 40°. The absence of the Peel Sandstones proves that the Permians are faulted against the Carboniferous Limestones. The Triassic Sandstone probably belongs to the Lower or Bunter Series". (Rep. Brit. Assoc.)

If this interpretation of the Ballawhane section [NX 39726 01308] had been correct, it would, of course, have gone far towards establishing the Permian age of the Peel rocks. But, on behalf of the Geological Survey, I had made a careful examination of the cores while the boring was in progress, and had secured a set of specimens, now preserved at the head-office of the Survey, which afforded clear evidence of the Lower Carboniferous age of the supposed Permian rocks; and I am permitted by Prof Dawkins to state that after a recent inspection of these specimens he no longer regards the strata between 544 and 680 feet as Permian, but agrees with me that they form part of the Lower Carboniferous series. There is, indeed, little or no resemblance between any of the rocks of this boring or of the other borings and the Peel strata, so that no direct correlation is possible between them.

It follows that the deductions which Prof. Dawkins has drawn from the supposed break between the Permian and Trias<ref>The Permians had been lifted up above the sea and worn down into a marine floor, composed of highly inclined strata before the Triassic age. On this floor the Triassic Sandstone was accumulated. This point, so clearly proved in the section is the clue by which the Permian and Triassic geology of the Lake District, now so inadequately represented in the maps of the Geological Survey, may be unravelled". Trans. Manch. Geol. Soc., pt. vi., vol. xxiii., p. 162.</ref> in this section, are untenable so far as concerns the Isle of Man.

Although no rocks directly comparable to the Peel Series have been reached in any of the borings, probably because the equivalents of the series lie deeper than the lowest strata touched, the sections afford two strong arguments against the Permian age of the Peel Series. In the first place, in two of the borings the New Red rocks, from the St. Bees Sandstone downwards to their base, were passed through in normal sequence and included true "Permian" strata, resembling those of the opposite mainland but differing both in lithological features and in stratigraphical arrangement from the Peel Series. And secondly, in three of the borings the Carboniferous Limestone series was found to include much sandstone, usually red in colour, which, though not indeed particularly resembling the Peel Sandstone, at any rate shows that the conditions in the basin of deposition were favourable for the production of arenaceous rocks in Lower Carboniferous times. All these Carboniferous strata, moreover, possessed the high dip of the Peel rocks, while the overlying New Red group invariably lay unconformably upon them at a low angle (see p. 291).

Thus the evidence of the borings goes far to disprove Prof. Dawkins' contention. The other grounds on which he has rested his argument are (1) that "the physical characters… are identical with those of the Permian rocks of the north of

England, and more particularly with those of the Lake District, of the Vale of Eden, and Barrow Mouth"; and (2) that pebbles of "Carboniferous Limestone" occur in the conglomerates.

With regard to the first point, which refers to the general lithological aspect of the series, it has already been noted that Mr. Home considered that these rocks bore a close resemblance to the Lower Carboniferous (Calciferous Sandstone) series of the Kircudbrightshire coast; and the supposed Permian aspect has likewise failed to impress several other observers conversant with New Red rocks. From my own examination of the coast - section at Barrowmouth south of Whitehaven, referred to by Prof. Dawkins, I can bear testimony to the close resemblance of the "Permian" Brockram-conglomerate there with that revealed in the deep borings at Knock-e-Dooney [NX 40577 02303] and Ballagenney [NX 43948 02485]?, but failed to detect any resemblance with the Peel Series; and the same result attended my investigation of inland sections of Permian rocks in the Eden Valley.

The second argument is one on which Prof. Dawkins lays much stress. It may be granted that some of the pebbles of limestone which occur sparingly in the conglomeratic bands at Peel may be of "Carboniferous Limestone", though the evidence is still unsatisfactory. In Prof. Dawkins' paper it is mentioned that- they contain "traces of corals and shells, Euomphalus ?, Spirifer ?, Orthis ?, or Strophomena ?"Since his paper was published, Prof. Dawkins has collected further specimens which he has kindly allowed me to examine. These include individuals of a smaU finely ribbed *Chonetes* identified by Prof. Dawkins as *Chonetes Buchiana,* and portions of a small trilobite supposed to be of Carboniferous age. My own collection from the calcareous and conglomeratic beds at Lhoob y Reeast includes some determinable corals of wide range in time and some indifferently preserved shells, which point to an Upper Devonian or Lower Carboniferous origin; but these are contained in a somewhat gritty calcareous matrix of concretionary character and may, I think, be contemporaneous. Their whole facies is very different from the fossils of any Carboniferous Limestone which is known to occur in the Island (see p. 276). In the sections a little farther south there are isolated pebbles of encrinital limestone in beds which are not markedly calcareous; with these are associated fragments of soft red shale and sandstone such as might have been derived from any of the shaly and sandy beds of the Peel Series, which I am inclined to regard as evidence of contemporaneous erosion of slightly older beds, already partially consolidated, while the newer beds were being deposited; and the same explanation will, I think, hold good for the limestone pebbles.

Cumming suggests that these rocks were accumulated as a shore deposit of the Lower Carboniferous sea, while limestone was being formed at a slightly greater distance from the land; and under such conditions the presence of fragments of the calcareous rock, even if these are proved beyond question to contain Lower Carboniferous fossils, does not necessarily signify the Post-Carboniferous age of the series. Conglomerates made up largely or wholly of fragments of the same general age as the pebbly bed have now been recognised at various horizons throughout the geological scale, being perhaps commonest among calcareous sediments and stiff coherent clays, which soon consolidate sufficiently to undergo short transportal. The term "Intra-formational Conglomerate<ref>See C. D. Walcott, "Palaeeozoic Intra-formational Conglomerates", Bull. Geol. Soc. America, vol. v. (1894), pp. 191–198.</ref>" has been applied to breccias of this character by American geologists. The shore-breccia sometimes surrounding coral reefs might be cited as a modern illustration of the structure.

For an analogous example of an admixture of "contemporaneous" pebbles with others of older date, attention may be directed to the conglomerate of Lower Carboniferous age, interbedded with limestones and shales, which is exposed on the opposite coast of the Irish Sea, at Rush, co. Dublin, wherein blocks and pebbles of limestone belonging to the Carboniferous series are mingled with fragments derived from Silurian and other sources.<ref>See Mem. Geol. Survey of Ireland on Sheets 102 and 112, pp. 61 et seq.</ref> In the Lower Carboniferous rocks of Anglesey, also, pebbles of Carboniferous limestone occur in sandstone interbedded with the limestones<ref>E. Greenly, Quart. Journ, Geol. Soc., vol, lii. (1896), p. 629.</ref>; and in Derbyshire and Staffordshire a "beach-deposit" of rolled shells and limestone fragments forms part of the Carboniferous Limestone series.<ref>J. Barnes and W. F. Holroyd, Trans. Manch. Geol. Soc., vol. xxv. (1897), pp. 119–125; and *ibid.,* pp. 181–184, and p. 308. See also H. H, A. Bemrose, Proc. Geol. Assoc., vol, xvi. (1899), pt. 4, p. 174.</ref>

One of the strongest points in the argument against the Permian age of the Peel rocks is that the true Permian breccia or "Brockram" found at the base of the Red Rocks, and in no other part of the series, in two of the northern borings had nothing in common with the Peel conglomerates (see pp. 285, 288). It contained fragments of undoubted Carboniferous

Limestone in abundance, both large and small, thoroughly dolomitized on the exterior and often partially hollow in the interior, like the limestone inclusions in the Permian bro3kram of the mainland, but quite unlike the Peel pebbles which are always solid, horny in texture, and only slightly dolomitic; and the other materials of this brockram were also totally unlike the assemblage of pebbles of the Peel conglomerates. Other data bearing on this question will be found in the subsequent descriptions, and in the next chapter dealing with the concealed strata of the northern plain. Meanwhile I think that sufficient evidence has already been adduced to show that the Permian age of the Peel Sandstones has not been proven and that they are probably not newer than Lower Carboniferous.

With regard to the thickness of the series, there must necessarily be much uncertainty, in view of the lack of more definite information as to the base and the inland extent of the rocks. The continuously high dip of the rocks in the coast sections shows that the thickness must be considerable; but the many small faults and the decrease in the angle of dip which may be observed in the exposures most remote from the cliff lead me to think that Prof. Dawkins' estimate of 1,368 feet for the beds actually seen in the coast-strip is excessive, though if the series extend so far inland as I have supposed its aggregate thickness, including the concealed portion, may possibly be as much as this or even more. Cumming's valuation of "about 300 feet"<ref>"Isle of Man", p. 240,</ref> is in any case too low. In the eastward or inland prolongation it is unlikely that the steep dip of the coast-sections will be retained, unless accompanied by folding or overthrusting. That the series everywhere rests directly upon the Manx Slates is almost certain; but the character of the Junction has not been proved. When we remember the many signs of lateral disturbance in the Carboniferous rocks of the southern basin, and in those of the same age which underlie the northern plain, the possibility that the Peel series may have been pushed forward upon the slopes of the old massif, and may have an overthrust plane at its base, deserves consideration, especially as the rocks themselves in places bear traces of compression and crumpling In fact the more closely one studies the stratigraphy of the Island the more strongly does one become impressed with the idea that lateral movement at different stages has been the dominant factor in the arrangement of the strata,—first crumpling up the older rocks into a central ridge or massif; and long afterwards driving in the Carboniferous deposits upon the more or less rigid core. We have already seen that the later of these movements took place after the deposition of the Lower' Carboniferous rocks but before the accumulation of the New Red rocks of the northern plain, which are practically undisturbed. Hence the evidence of disturbance in the Peel Series affords another argument in favour of the Pre-Permian age of these rocks (see also p. 291).

Detailed description

Coast sections

The boundary fault which brings in the Peel Sandstones on the east is clearly exhibited at Will's Strand (six inch, (Sheet 6)). In the cliff at the south side of this recess, rather thickly bedded red sandstone of fine grain, with manly partings, is let down against crushed slate by a dislocation which hades towards the west at about 70°. Heavy slips of drift obscure the cliff to the northward, but the fault may be traced at low water across the shore, striking a few degrees west of north. Towards low tide the hade of the fault becomes much less steep and suggests an overthrust, being in places as low as 30°. The crushed and stained red and greenish slate has at this place the appearance of passing beneath the sandstone, and this appearance is probably the basis of Cumming's statement that " near Lhergydhoo the Old Red Conglomerate or Sandstone is seen to rest unconformably on the upturned edges of the claret-coloured schists"<ref>Guide Book, p. 113,</ref>. The dip of the sandstone is steeply (40° to 50°) to N.N.W. or nearly in the direction of strike of the fault.

In the headland to the southward of Will's Strand, the sandstones are considerably disturbed, and there seems to have been some lateral movement along a sharply defined plane at the foot of the cliff. Between this place and White Strand 400 yards farther south some pebbly and calcareous bands make their appearance, which Prof. Dawkins recognises as belonging to his "Stack Series". The distinction between this series and the "Peel Sandstones" of the same author is, however, ill defined, the field-evidence suggesting that the calcareous and conglomeratic bands are in this quarter more or less lenticular, and irregularly dispersed among the sandstones. There is nothing in these sections comparable to the thick cornstone of Lhoob-y-Reeast presently to be described. The curious and suggestive structure of some of the thin calcareous layers among the red shaly beds as shown in the foregoing figure (Figure 74) implies that there has been greater disturbances in these strata than one would suspect from a cursory examination, and raises the suspicion that

some of the calcareous beds which are now lenticular or nodular may originally have occurred as continuous bands.

Besides the above-mentioned nodular or lenticular calcareous seams there are, in this quarter, true pebbly layers containing, along with fragments of chalybite, agate and other rocks, a few pieces of impure limestone, in one of which encrinite-stems were embedded; and in another instance a single detached ossicle of the same fossil was seen in the pebbly band. As at Lhoob-y-Reeast [SC 25724 85101], these bits of limestone occasionally show faint indications of coral structure.

In the bluff at the northern extremity of White Strand [SC 26681 85642] a sharp synclinal plication is revealed1 which produces a striking effect upon a two-feet bed of sandstone overlying a few inches of shale, the under surface of the sandstone in the trough of the fold being rucked up, as roughly shown in (Figure 75), into a pillowy structure or "knobby-side", like that on a larger scale already described in the Manx Slates (see p. 75).

On the shore at high-water mark in this locality, some thin calcareous shaly layers which intervene between rather thick-bedded sandstones above and pebbly calcareous strata below, are crumpled, partially brecciated, and cut by two parallel planes along which there appears to have been a certain degree of lateral displacement. Similar indications of pressure and disturbance are repeated in the sections farther south; and I regard them as affording indirect evidence of the age of the series, since in the seep borings in the north wherever the Lower Carboniferous rocks were pierced they showed signs of similar or greater disturbance, while in the overlying Triassic and Permian strata such indications were absent.

In the middle of White Strand [SC 26576 85520] the red sandstones dip towards N. or N. 10 E., at from 15° to 25°; but in the headland to the southward they are interrupted by two or three fault-like breaks, striking approximately N. to N.N.W., possibly with a westerly downthrow, beyond which the dips change to N.N.W. or N.W. Along one of these fractures a short adit has been driven into the cliff. Similar and parallel fractures recur at intervals throughout the range of the sections, but none seemed individually of sufficient importance to be worth showing on the published map. Their cumulative effect may, however, be of some consequence; and they must in any case render difficult and uncertain the calculation of the thickness of the rocks from the dip and width of outcrop (see foot-note p. 266).

Between White Strand [SC 26535 85533] and Cass Strooan [SC 26185 85322] (the more southerly of the two little streams draining to the coast quarter of a mile farther south), the cliffs and foreshore are occupied by fine red or mottled sandstones in thickish beds, with shaly partings and a few thin lenticular bands of conglomerate. The sandstones are sometimes cross-bedded, and sometimes possess ripple marked surfaces. The mottling seems to be due to the semi-concretionary segregation at the smail quantity of lime contained in the rock. In places the structure presents a curious reticulate arrangement of intersecting planes, as shown in the above figure (Figure 76), giving rise on weathering to the "honey-comb" appearance commented on by Prof. Dawkins.

At Cain's Strand [SC 26241 85349] the sandstone has been quarried in the cliff. The deep ravine which extends backward from this place to the highroad, a quarter of a mile to the east, seems to be cut entirely in drift, the present stream evidently following the course of a pre-glacial drift-filled hollow. But Cass Strooan [SC 26192 85301], 150 yards farther south, reveals the sandstone for at least 250 yards backward from the cliff; and in this valley a shaft has been sunk in search of coal in the sandstone 150 yards from the shore (see p. 279). To the eastward of the highroad the last-mentioned stream occupies a shallow trench obscured by alluvium; but at one place, 230 yards south-east of the road, it exposes traces of red rubbly material which may be either the weathered top of the sandstone, or a local drift derived from it.

Lhoob y Reeast

On the coast S.W. of Cass Strooan we find thinly-bedded lenticular sandstone with calcareous concretions and partings of red shale, for the most part dipping at about 40° towards N.W., the dip slopes undercut by the sea, forming a somewhat treacherous cliff. At Lhoob y Reeast [SC 25722 85101](6-inch, (Sheet 9)), 400 yards E. of The Stack [SC 25386 84986], a jutting forward (if the coast-line brings in fossiliferous calcareous strata overlying shaly sandstones; and near this place is the section which is by far the best for fossils in the whole range of exposures. The old lime-kiln

mentioned by Cumming still exists at the top of the cliff in the little recess 200 yards W. of Lhoob y Reeast. Immediately below it are dip-slopes of pebbly calcareous grit, and this was originally overlain by a band of limestone, which has been stripped off to supply the kiln except at one spot overhanging the sea, Where further operations would have been dangerous. A rough chemical examination of specimens of this limestone and of the "pebbles" or concretions in the conglomeratic beds associated with it, was made by my colleague Dr. Pollard, and showed that they consisted essentially of carbonate of lime with only a little magnesia. It is on these slopes that the fossils may be obtained, and though the surfaces are uncomfortably steep they are not dangerous to anyone accustomed to cliffs. The following (Figure 77) shows the section at this place.

The fossils are best seen when the rock is wet, as noted by Mr Taylor (p. 264), but at all times it needs a close search to discover them, as they are both rare and inconspicuous. By far the most abundant are the corals, and in fact the majority of the limestone fragments show traces, more or less obscure, of coral structure. Some are clearly pieces broken from larger masses and partially eroded, but others are intermingled with the red grit and appear as though they might be proper to the W. Shells though not entirely absent are extremely rare, and very poorly preserved. Like the corals, they occur sometimes in a rolled condition in the gritty calcareous matrix of the bed, and sometimes in pebbles of limestone. In the following list of the fossils of the Peel Series the specimens, with one or two exceptions, were all obtained from this locality. The determinations have been made by Messrs G. Sharman and E. T. Newton.<ref>Prof. Boyd Dawkins has recently shown that many of ticfosssil in his collection are Ordovician forms: see postscript at end of chapter, p. 279.</ref>

List of fossils from Calcareous Conglomerate in the Peel Sandstone between the Stack and Lhoob y Reeast

Corals

Alveolites?

Amplexus (near to tortuosus).

Cyathophyllum sp.

Favosites fibrosa? *Goldf.*

Favosites Gothlandica ? *Goldf*

Favosites ? (with distinct septa).

Heliolites tubulata, *Lonsd.*

Monticulipora tumida ? *Phil.*

Pachypora (Favosite) cervicornis, *de Blainv.*

Brachiopoda

Chonetes?

Orthis sp.

Productus?

Spirifera sp.

Besides the above the following specimens have been found: sponges Polyzoa, Encrinite fragments, a large and a small Gasteropod. A specimen collected by Mr. J. Shipman in a quarry near Peel, and kindly presented to the Survey,

contained the following forms: *Fasosites?, Fistulipora, Monticulipora,* and *Syringopora.*

From Lhoob y Reeast [SC 25717 85106] the set of strata above-described is prolonged south-westward to The Stack, though the thicker cornstone bands seem to be lenticular and not continuous in the same plane for many yards. These conglomeratic bands and cornstones, as Prof. Dawkins has shown, appear to overlie the sandstones, and thus form the highest visible portion of the Peel Series. A line of crushing and fracture runs E.N.E., with the strike of the beds, along the foot of the cliff between Lhoob y Reeast and The Stack [SC 25388 84995], and the arrangement of the confused bedding in the central mass of The Stack suggests a sharp fold, though it may possibly be due to bold false-bedding only.

A band of pale impure concretionary limestone several feet thick has been quarried in a little gully in the cliff (above "Cave" of the six-inch map) 80 yards S. of the Stack. This may represent the thick cornstone of Lhoob y Reeast, but if so, it has probably been shifted slightly southward by small faults; a similar, or perhaps the same, band is revealed at low water at the bottom of the cliff, 80 or 90 yards farther S., at the next "Cave" marked on the six-inch map. Some dyke-like veins of dolomite and calcite, referred to by Macculloch, traverse the strata between these places. Beyond the Stack the more southerly trend of the coast cuts out these calcareous strata and brings the underlying beds into the cliff, the prevalent dips being still about N.N.W. at 40° to 50°. At Traie Fogog [SC 25197 84701] 350 yards S.W. of The Stack, the rocks are chiefly thin-bedded and current-bedded red and mottled sandstone including pale yellowish calcareous concretions, interstmtified with partings of red shale or marl and bands of fine conglomerate or breccia containing subangular fragments of red shale and sandstone together with limestone, chert, jasper, agate, chalybite, etc. At Creg Malin [SC 25046 84517] 200 yards farther S.W., where the cliff-sections cease abruptly, the rod' sandstones are more thickly bedded and the shale partings and conglomerate lenticles correspondingly less prominent; the rock has been extensively quarried at this place in the steep bluff overlooking the strip of Raised Beach on which stands the lower part of the town of Peel.

The depression between Creg Malin [SC 25045 84513] and the high slate ridge of Peel Hill [SC 23839 83978] (p. 148) has been a Pre-glacial channel of erosion, during a period of elevation in which the solid rocks have been cut down below sea level. This hollow has afterwards been partly filled with thick drift. The faulted junction of the Peel Sandstones with the slates occurs in the hollow and is thus completely hidden. The foundations for the sea-wall in the eastern part of Peel Bay revealed only sand and shingle<ref>I am indebted to Mr. T. Corrin of Peel for this information, which was confirmed by Mr. Woods, who had personal charge of the work.</ref>; and the submarine work in connection with the deep water extension recently made to the Pier running eastward into the Bay from St. Patrick's Isle showed that the sea-floor at the mouth of the channel was occupied by glacial deposits (see p. 442). Hence the position and direction of the boundary fault at this point must remain more or less conjectural. On the Survey map, the line adopted is the prolongation of the fault visible at the inland exposure of the Conglomerates at Glenfaba Bridge [SC 24207 83072]?, described in the next paragraphs. It differs from the boundary chosen by Prof. Dawkins for the purpose of his sketch-map,<ref>Op. cit., Trans. Manch. Geol. Soc., vol. xxii., pt. xxi.</ref> but has the practical advantage of making the one known fault serve, without the introduction of a second about which nothing is known.

Inland extension of the sandstones

The inland boundary of the Sandstones is everywhere drift-covered, and the available information is for the most part insufficient to fix its limits within ½or even ¾ of a mile. That the series extends up from the coast to the Kirk Michael highroad is certain; but its supposed extension beneath the broad strip of drift-covered low ground to the south-eastward of the road, as shown on the published map, is hypothetical and open to much doubt, being based only on the shape of the ground (which is smooth and low in this tract, but is broken by hillocky rock-features where the Manx Slates rise through the drift along its margin), and on the presence of the conglomerate so far inland as Glenfaba Bridge in the Neb Valley [SC 24207 83072].

Quarries near Peel

There are extensive quarries in the sandstone near the coast at Ballaquane, 300 to 400 yards east of Creg Malin [SC 25379 84490], in which the direction and amount of dip agrees with the coast-sections, the rock being rather fine grained

and arranged in lenticular beds bounded by layers of coarse shaly conglomerate. Similar rock with a rather lower dip, is exposed on both sides of the high road north of Ballaquane House.

Glenfaba Bridge

The exposures around Glenfaba [SC 24298 82750] and Raggatt [SC 24298 82750], nearly a mile south of Peel, is now alone remain to be described. Prof. Dawkins considers these to form Bainoic small faulted outliers, separated from the main mass by a concealed strip of slate ¾ mile in width; but his version of the ground does not take into account the fault striking N. 12° to 15° E. which is clearly exposed under Glenfaba Bridge [SC 24298 82750]; and while I would readily acknowledge the possibility of there being two parallel faults downthrowing in opposite directions between the main outcrop and Grenfaba, as represented by Prof. Dawkins, it seems preferable, as already stated, in the absence of any definite evidence to the contrary to simplify the reading by adopting the prolongation of the Glenfaba fault as the continuous western boundary of the sandstones, thus extending the main mass of these rocks farther inland than Prof Dawkins would allow.

Above and below Glenfaba, the river Neb flows across flats of ancient alluvium resting on a floor of drift; but at this place, its valley is constricted for 200 to 300 yards into a narrow rocky ravine which probably marks a local divergence of the present river from the channel of its preglacial fore runner. Slate is revealed in both banks of this ravine below the bridge, and also in the bed of the stream; but the western buttress of the bridge stands on pebbly conglomerate, which is faulted off suddenly against the slate in the steep bank immediately below. Similar conglomerate is exposed in the shallow railway cutting on the S.E. side of the bridge, adjacent to Glenfaba Mills [SC 24218 83052], and may also be present, in a much overgrown and drift-covered condition, on the high river bank under the N.W. side of the high road. The direction of the fault, as given above, can thus be fixed within a few degrees. These exposures of the conglomerate are much weathered and too limited to show much character, but the rock differs in many respects from that of the coast, being apparently largely made up of material derived from the Slate series, as we might expect to find in beds low down in the succession, if not actually at its base. The dip is scarcely recognisable, but is not the same as on the coast; in the railway cutting it appears to be on the whole easterly, at an angle of over 50°.

The highroad from Peel after crossing Glenfaba Bridge [SC 24198 83073] turns sharply to E.S.E. and continues for 270 yards along the edge of an alluvial flat bordering the river; and then turning again southward, at Raggatt [SC 24363 82841], ascends a low slope and leaves the main valley. On this slope, red sandstone and pebbly conglomerate, closely resembling those of the Peel sections, are exposed by the road-side for about 100 yards, and appear to have been quarried in a garden lying to the E. of the road, where the indications denote a gentle northerly dip. On the opposite side of the road, in the bed of a streamlet which runs behind the farmstead of Raggatt [SC 24363 82841], decomposed slate is seen towards the top of the slope, and red conglomerate 20 or 30 yards lower down, suggesting that we have in this vicinity the uncon-formable overlap of the base of the conglomerate upon the older rocks. Slate has also been reached in an old mining trial on the slope 40 or 50 yards to the W. of the road. Again, at the sharp bend in the bed of the Neb 50 yards E. of Raggatt, red sandstone and conglomerate crop out in the west bank and in the bed of the stream; and decomposed slate may be seen 30 yards farther up-stream when the water is low. The position of these exposures is shown on the accompanying ground-plan of the valley between Glenfaba [SC 24198 83073] and Raggatt [SC 24362 82839].

Borings near Peel

[SC 24450 84231] About thirty-five-years ago companies were formed to search for coal in the vicinity of Peel, and several borings were made, respecting which it is unfortunately difficult now to gain definite information. The only documentary evidence which we have been able to obtain, is the journal of a boring "near Peel", given on 587, for which we are indebted to Messrs. Craine Bros. of Liverpool. It indicates Drift, 37 feet thick; resting on Red Sandstone, 50 feet 3 inches thick; on "grey fakes", "fireclay", "whinstone", etc. (evidently the Slate series), 294 feet 3 inches; the total depth of the boring being 381 feet 6 inches. We have found no means of identifying the site, but whether the record refers to the vicinity of Glenfaba [SC 24198 83073], or to one of borings which were made to the north-eastward of Peel, it is of importance in demonstrating that the Red Sandstones are directly underlain by rocks of slaty type.

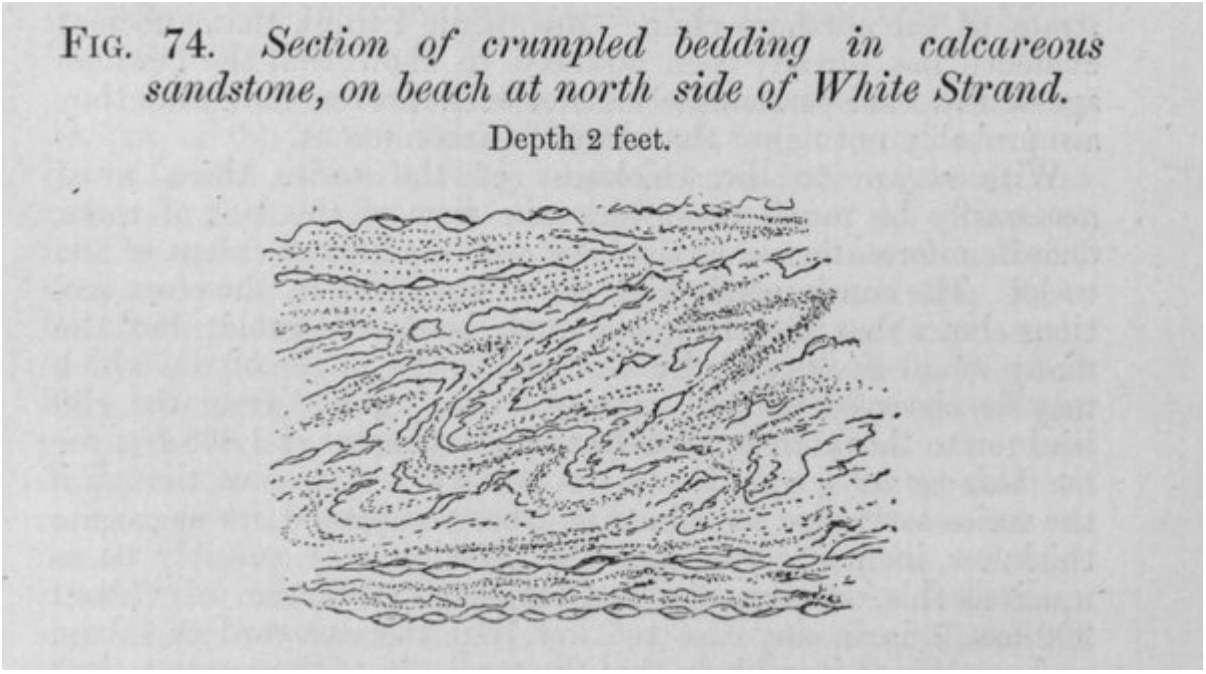
The approximate site of another of these borings is shown in the preceding plan (Figure 78). From one source I learnt, on hearsay evidence, that "broken-up slate such as is worked for bricks at the brickyard above the harbour" was met with in this boring; and from another source, that clay, sand and gravel extended downward to 90 feet, with 2 feet of grey sandstone at 120 feet, and blue fireclay (slate ?) down to 150 feet.

A third boring was made 1½ miles farther N., near the northern termination of the Sandstones in the N.W. corner of the field containing the old earth-works marked The Court on the map [SC 26746 84451], 200 yards south of Ballagyr farm [SC 26109 84544]. I was informed by the occupant of the adjoining farm, who remembered the boring being made, that it went through "shingle" into "blue clay" but did not strike the red sandstone. Another informant, however, who claims to have had a direct interest in the work, was positive that the red sandstone was met with; and upon the merits of conflictory evidence of this kind, it is of course now impossible to decide.

[POSTSCRIPT, AUG., 1902.—While the final proofs of this Memoir are in hand, Prof. W. B. Dawkins has communicated to the Geological Society of London two further papers on the subjects dealt with in this and the next chapter, under the titles — 1, "The Red Sandstone-Rocks of Peel, Isle of Man;" and, 2, "The Carboniferous, Permian and Triassic Rocks under the Glacial Drift in the North of the Isle of Man". In these papers Prof. Dawkins reiterates his conviction that the Peel Rocks are of Permian age. At the time of writing, the full text of these papers has not been published; but so far as I can judge from hearing the reading of the papers, and from the printed abstracts (Abstr. of Proc. Geol. Soc., May 28, 1902, No. 762), the arguments on this point which I have employed in the foregoing chapter, and my opinion therein expressed, remain unimpaired; and the text of the chapter has therefore been allowed to stand unaltered.

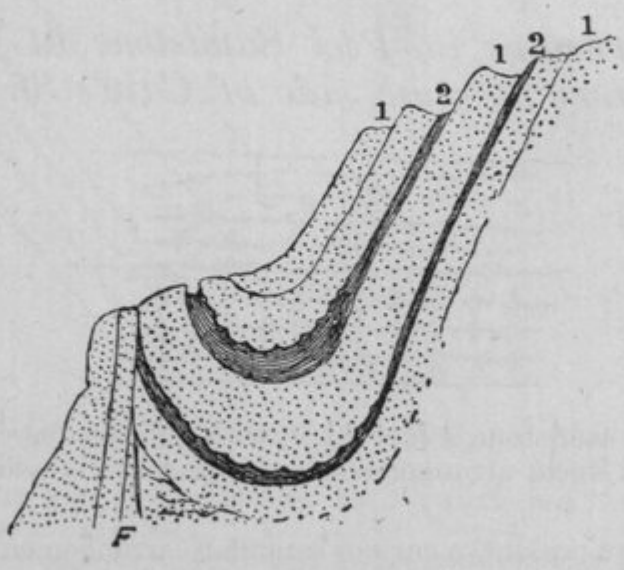
Great interest, however, attaches to Prof. Dawkins' statement that several of the fossils from the limestone-fragments in the Peel Rocks have been identified with species found in the Keisley Limestone, which is of Ordovician age; but others are still claimed as Carboniferous species.

The second paper contained an account of all the borings described in the next chapter.]



(Figure 74) Section of crumpled bedding in calcareous sandstone, on beach at north side of White Strand. Depth 2 feet.

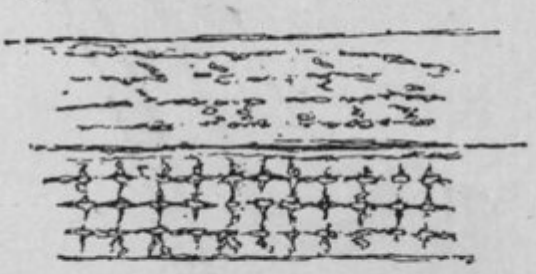
FIG. 75. *Cliff-section in Peel Sandstone at north side of White Strand. Height about 20 feet.*



1. Courses of red sandstone, showing curious swellings on under surface in trough of fold. Diagrammatically rendered.
2. Shale partings.
F. Fault ?, with crushed rock in vicinity

(Figure 75) Cliff section in Peel Sandstone at north side of White Strand. Height about 20 feet. Courses of red sandstone, showing curious swellings on under surface in trough of fold. Diagrammatically rendered. Shale partings. F. Fault ?, with crushed rock in vicinity

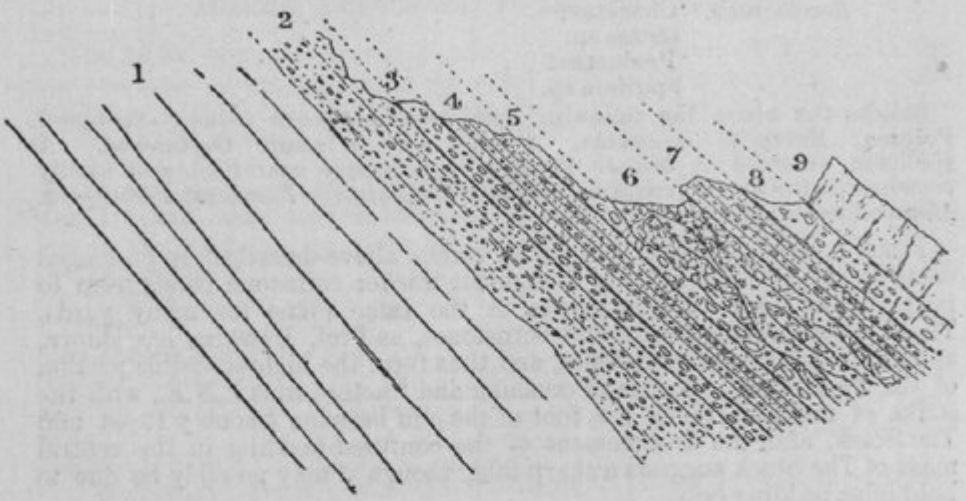
FIG. 76. *Structure in Peel Sandstone at foot of cliff below quarry on south side of Cain's Strand.*



Two beds of red sandstone, 4 feet thick, with yellow concretions tending in the lower bed to a linear arrangement both horizontally and vertically.

(Figure 76) Structure in Peel Sandstone at foot of cliff below quarry on south side of Cain's Strand. Two beds of red sandstone, 4 feet thick, with yellow concretions tending in the lower bed to a linear arrangement both horizontally and vertically.

FIG. 77. *Cliff-section below the old lime-kiln 200 yards west of Lhoob y Reeast near Peel.*



9.	Pale nodular gritty limestone ; nearly all quarried away - - - - - - - - thickness	3 feet.
8.	Lenticular pebbly cornstone with palish red limestone concretions - - - - - - -	1½ „
7.	Sandy and gravelly band, with calcareous cement and small fragments of limestone : some corals -	2 „
6.	Lenticular patches of coarse and fine subangular conglomerate with limestone pebbles, and also calcareous concretions and cement ; fragments of encrinites and other fossils - - - - -	3 „
5.	Pale red nodular limestone band - - - - -	3 to 6 inches.
4.	Red sandstone, grit and fine gravelly conglomerate : some fossils - - - - - - - - - -	2½ feet.
3.	Pebbly band with pebbles and also concretions of limestone : fossils : among the pebbles are agate, quartzite, vein quartz, sandstone and chert - -	1 foot.
2.	Red sandstone interbedded with fine gravelly conglomerate, less calcareous than above : fossils,— polyzoa and some detached fragments of corals -	3 to 6 feet.
1.	Sandstone, etc., not exposed in this section.	

(Figure 77) Cliff-section below the old lime-kiln 200 yards west of Lhoob y Reeast near Peel. 9. Pale nodular gritty limestone; nearly all quarried away — thickness 3 feet. 8. Lenticular pebbly cornstone with palish red limestone concretions — 1½ feet 7. Sandy and gravelly band, with calcareous cement and small fragments of limestone: some corals — 2 feet 6. Lenticular patches of coarse and fine subangular conglomerate with limestone pebbles, and also calcareous concretions and cement; fragments of encrinites and other fossils — 3 feet 5. Pale red nodular limestone band — 3 to 6 inches. 4. Red sandstone, grit and fine gravelly conglomerate: some fossils — 2½ feet. 3. Pebbly band with pebbles and also concretions of limestone: fossils: among the pebbles are agate, quartzite, vein quartz, sandstone and chert — 1 foot. 2. Red sandstone interbedded with fine gravelly conglomerate, less calcareous than above: fossils, — polyzoa and some detached fragments of corals 3 to 6 feet. 1. Sandstone, etc., not exposed in this section.