

ART. XXXVII.—*Remarks on the Sedimentary Formations of New South Wales, illustrated by references to other Provinces of Australasia*; by the Rev. W. B. CLARKE, M.A., F.G.S., F.R.G.S., etc.*

IF we inspect the map of Australia, we observe that the coasts of Victoria, New South Wales and Queensland, follow the general directions (with some irregularity) of the Cordillera, or elevated land separating the waters flowing directly to the coast from those which, draining the interior, disembogue to the S.W.

The Murray river receives some part of its tributaries from the highlands of Victoria, and others from New South Wales; whilst the Darling and its tributaries collect the remainder of the supply, from as far north as 25° S.

The Cordillera thus sweeps round in an irregular curve from W. to E. to the head of the Murray—and thence, northerly and northeasterly, to the head of the Condamine; trending northwesterly from that point to 21° S., whence it strikes to the north, terminating its course at Cape Melville, in 14° S., about the meridian of 144° 30', which is that of Mount Alexander in Victoria.

The more westerly and southerly trend of drainage is represented by the Thomson and Barcoo rivers, which carry off the waters of the Cordillera at the back of the Barrier Ranges to Spencer's Gulf. The meridian of the head of that gulf is, therefore, the western limit of East Australia.

The Cordillera itself, described by Strzelecki in 1845, was traced by him through a considerable part of its diversified course

* From a pamphlet received from the author.

(as understood by him), from the southern point of Tasmania to the parallel of 28° , in longitude 152° ; but not further westward than 146° on the parallel of Mount Alexander. It is, however, doubtful whether the ranges between this furthest western point and Wilson's Promontory, where he considers the Chain to be cut off by the sea, is anything more than a spur in that direction.

But the extent of the Cordillera westerly, to its termination on the border of South Australia is so well defined, that there can be no question that the S. W. and W. extension has as true a character as any part of the Northern prolongation. This may be geologically deduced from researches of the Geological Survey of Victoria. That province is limited, at its eastern corner, by a line joining Cape Howe and the head of the Murray, so that the boundary crosses very near the highest point of all Australia, which Strzelecki made 6,500 feet above the sea, but which subsequent observations have shown to be 7,175 feet. This correction rests on observations made by myself, in 1852, and a re-discussion of them, in comparison with results obtained by Professor Neumayer in 1862. On 8th May, 1852, I made the highest point of Kosciusco, 4,077 feet above my then base, at 3,098 feet above the sea, which therefore came out 7,175 feet; and in February, 1863, Professor Neumayer wrote me word that he made the highest peak in November, 1862, 7,175 feet. This makes Kosciusco's summit above the crossing place of the Indi or Hume river, at Groggan's, 5,425 feet.

The 144th meridian to the northward limits very nearly all the high land of the East Coast to Cape Melville, whilst the 142nd meridian limits to the westward the basin of the Darling, including part of the drainage along the Thomson and Barcoo from the head of the Flinders, to where it passes into South Australia, on the 141st meridian.

Thus, all this enormous drainage of western New South Wales and southwestern Queensland is, as it were, bounded by ranges of high geological antiquity, the Grey and Barrier groups being of undoubted similar age to the mass of the Eastern Cordillera.

It has long been known that the strike of the older sedimentary rocks all through the Cordillera, in Victoria, as well as in New South Wales, it is generally meridional; so that in the former province the beds strike across the Cordillera, whilst in the latter they form various angles from parallelism with it to a transverse direction, as the Chain doubles and winds irregularly in its course.

This is the experience of the Victoria Survey, and my own traverses across various points of the Cordillera in New South

Wales and Victoria, establish the fact of a normal meridional strike of the older strata. So distinct, indeed, is this characteristic, that the settlers in various parts of the country have been accustomed to trace the direction of north and south by the strike of the slates.

It sometimes happens that, owing to the high angle of dip, and the effect of denudation on the overlying formations, the Cordillera itself becomes in places almost knife-edge, so that in New South Wales it presents occasionally a *divisa aquarum* not more than nine paces in width; whilst in Maneero to the south, and New England to the north, it spreads out in a plateau, on which eastern and western waters rise close together, and sometimes overlap. These different features have a variable geological aspect as well as value; for owing to the strike of the older rocks, the breadth of the Silurian formations, which, as in other countries, are repeated by recurring folds, may be more exposed in Victoria than they are in New South Wales; and owing to the curve of the Cordillera, probably the same beds are traceable to the north which occur in the south; as, for example, the auriferous rocks of Omeo and Peak Downs, which are on the same meridian; and thus the meridional strike is exhibited along the northeast coast, where there are alternations of old rocks forming precipitous cliffs, with low valleys and beaches separating those alternations.

Independently of this arrangement, the whole of the Central area inside the Eastern Cordillera has a trend to the south and west, so that the waters collected between 22° and 37° S., on the east of South Australia, find their way to the sea at the eastern corner of that province.

We might naturally assume that the same order of deposits is to be expected throughout the Cordillera; but there is a singular exception. Whilst marine deposits of Tertiary age are found along the coast of Western Australia, and along the southern coast from Cape Leuwin to Cape Howe, there are no known *marine* Tertiaries in any part of the coast of New South Wales and Queensland up to the Cape York Peninsula; and the reason of this may be, that, as indicated by phenomena before pointed out by me, but which on this occasion cannot be further dwelt upon, the eastern extension of Australia has been cut off perhaps by a general sinking (which is in accordance with the Barrier Reef theory of Mr. Darwin), and which has some support from the fact that there is repetition of Australian formations in the Louisiade Archipelago, New Caledonia, and New Zealand, in the latter of which occur abundant tertiary deposits, in which case the intervening ocean may be supposed to cover either a great synclinal depression or a denuded series of folds.

Relatively speaking, therefore, the Cordillera of the Eastern Coast has not been subject to the changes which introduced the relics of a Tertiary ocean. At any rate, no evidence is known to me of *marine* Tertiaries on the lands north of Cape Howe.

Another fact worthy of notice, as showing the probable ancient geological vicissitudes of Australia is, that the great Carboniferous series which is so prominent in New South Wales and in parts of Queensland, but which is less distributed in Victoria, and there only partially and irregularly as to the portions still remaining, has been broken up and carried away, so as to have left the various members dislocated, ruined, and separated in such a way as to allow no clear view to be taken of the whole till all the separate portions have been separately examined; and to the want of this personal examination on the part of certain Paleontologists and others, who have never yet seen the Carboniferous formation of New South Wales, is to be attributed the perseverance with which they so long disputed facts as attested by geologists in New South Wales, who are familiar with the latter and with Victoria also.

In consequence of the absence of marine tertiary deposits in New South Wales, and the occurrence of a more complete series of the strata in the sections of the Carboniferous formation, there has arisen a difficulty in collating the gold deposits with those of Victoria; and, in this respect, at present the upper deposits in the former province cannot be assigned with any precision to the epochs adapted by Mr. Selwyn for the latter. And it also follows, that his view of the distinct ages of Pliocene auriferous and Miocene non-auriferous gravels cannot be tested in New South Wales; if, indeed, it has not already been tested by the actual discovery of gold in the so-called Miocene deposits themselves as they occur in Victoria.

So far as is at present known, the gold is derived chiefly from the Lower Silurian formation; but researches conducted for me at H. M. Mint in Sydney, prove that it exists in almost every distinctive rock in New South Wales. In this province the alluvial deposits are not so extensive as in Victoria; but this probably arises from the fact previously mentioned of the strike being in Victoria transverse to the direction of the Cordillera; by which means the currents which distributed the drift had a wider area of gold-bearing materials to denude than in New South Wales, where, I conclude from numerous examples, the principal currents were to northward, so that in that province they would coincide with the direction of the Cordillera, and not accumulate the deposits in such low-lying extensive regions as those of the Murray Districts. The same objection would obtain, on the supposition of gradual waste

and accumulation from less powerful agency than that of a general rush of water. It is not, however, to be doubted, that there is an enormous amount of gold yet untouched in numerous places in New South Wales, not only in the quartz lodes (or reefs), but in gullies and plains where alluvial gold diggings will yet be discovered.

The distinctive differences in material mineral wealth between Victoria and New South Wales are not altogether confined to gold, or tin, which latter metal is well represented in the New South Wales Court; but coal, iron and copper, and perhaps lead, also exhibited, prove more than an equivalent of the great amount of gold at present in Victoria.

At the Universal Exhibition of 1854 the present writer exhibited a collection of rocks and fossils, illustrating the whole of the geological formations of Australia, and these were enumerated in their stratigraphical order in the published catalogue. On this occasion, it has not been possible to complete a similar and more extended collection, owing to the effects of protracted illness; but it may be useful to introduce a few remarks on the various geological epochs as they represent themselves in New South Wales, with a brief statement as to their connection with other portions of Australasia.

AZOIC AND "METAMORPHIC" ROCKS.

There has not been sufficient evidence yet collected to show that these rocks have been ascertained to exist in Eastern Australia, although in Tasmania rocks of a doubtful class (and which may, perhaps, be only highly altered Lower Silurian) have been referred to them by Mr. Gould. The existence of gneissoid strata and of slates of very ancient aspect, has also been well known in New South Wales, with occasional unfossiliferous limestones; but it would be premature to place them, without doubt, under the present head. Some of those mentioned under the First Epoch of Strzelecki have, on close inspection, appeared to the writer to be merely the products of transmutation, nor is such an improbable result, seeing that in Australia some slates have apparently been changed into granitic rocks. It is, at least, certain that such rocks, except in Tasmania, generally occur in the immediate vicinity of granites, though the latter frequently occupy large areas both in Manero and in New England, as well as along the Cordillera, and in independent masses along the coast. In Western Australia, where an enormous region is occupied by granites, and the older formations are represented only by small patches of slates, whilst the granites themselves remain bare, these patches are found on the flanks of the granitic bosses, and at extremely wide intervals;

nor have I been able to detect, among the numerous collections which have passed through my hands, distinct evidence of any but doubtful examples of those foliated rocks which belong to the so-called Primary epoch. In Southern Australia, also, there does not appear to be any considerable amount of strata which could be referred to this epoch.

LOWER PALEOZOIC ROCKS.

Of these there are undoubted evidences in some limited districts of Tasmania, whilst in New South Wales and Queensland considerable areas are occupied by them.

The greater mass of them, in the two latter provinces, appears to belong to Upper and Middle Silurian; the mudstones of Yarralumla, with *Encrinurus* and *Calymene*; the Coralline and *Pentamerus* beds of Deleget and Colalamine; the *Tentaculite* and *Halysites* beds of Wellington and Cavan; and the beds with *Calymene*, *Encrinurus*, *Beyrichia*, and others with *Illoenus*, *Harpes*, *Bronteus*; *Brachiopoda*, including *Strophodonta* and *Radiata* embracing *Star-fishes*, point to the existence of at least the Upper Silurian formation on both flanks of the southern part of the Cordillera. There are also numerous corals included in the list given by me in the *Southern Gold Fields* (p. 285), which also confirm the same determination; and it may be added that the above, and other fossils of this age mentioned by me elsewhere, have been examined by Paleontologists of eminence in Europe. Such are the genera *Favosites*, *Cœnites*, *Ptychophyllum*, *Calamapora*, *Syringopora*, *Emmonsia*, *Alveolites* and *Cystophyllum*, &c. These, perhaps, might not alone satisfy a doubt, but with them occurs *Receptaculites*; since 1858, when these were determined, I have detected *Halysites*, which may settle the question as to Upper Silurian. *Wenlock* beds seem to be well developed on the Deleget.

In Victoria, numerous species of *Grapolites* have been found, but during my explorations of New South Wales I discovered none. It is only recently that they have been found in the most southern part of the province on the M'Loughlan river and also in other spots in the basin of the Snowy river, near the boundary of Victoria.

In Tasmania I saw fossils similar to those of New South Wales, from beds on the Gordon and Franklin rivers; but Mr. Gould has since placed them partly as Lower Silurian. Lower Silurian beds also occur on the Deleget river, where both the upper and lower have a generally meridional strike, but varying dips.

In Queensland, Mr. Daintree has confirmed the fact of the

existence there of Silurian rocks identical with those of Victoria ; and my own examination of the Brisbane Slates led me to compare them with the auriferous slates of the Anderson's Creek Gold Field. The quartz veins of that neighborhood were found by me in 1851 to hold gold, and some very recent researches have increased the expectation of valuable deposits there, in addition to those which have already been opened on the Burnet, Crocodile Creek, Mount Wyatt, the Burdekin, Talgai, and Star Creek ; about Peak Downs, and in other places.

The Gold Field of Fingal in Tasmania is also partly occupied by rocks of Silurian age, the lithological structure of which is identical with rocks in New South Wales and Victoria.

Copper is abundant in strata which may be referred to the same epoch ; but a peculiarity which I have observed in most of the copper localities is, that the ores do not occur in lodes of the usual character, but sometimes, as on Peak Downs in Queensland, they follow the planes of the strata, and generally in New South Wales assume a dome-like form, rising in bosses at intervals without continuous surface connection. The Burra Burra Copper Mine of South Australia has also something of the same character. I have in my possession *Pentamerus* from Bombala, in which the shells are embedded in copper ore.

Specimens are exhibited from Bombala and Cavan, not only of Fossils, but of Copper, Lead, and Iron. (No. 475 & 474.)

MIDDLE PALEOZOIC ROCKS.

Mr. Jukes has shown cause why the term Devonian should be eliminated, referring the so-called beds to the bottom of the Carboniferous formation.

It is probable that such will have to be the fate of certain strata in Australia, the fossils of which have at once a Silurian and a Carboniferous aspect ; being connected with the former by certain corals, and with the latter by the occurrence of *Lepidodendron*, *Sigillaria*, and other Lower Carboniferous plants.

There is undoubtedly a regular passage downward from the marine fossils of the acknowledged Lower Carboniferous beds of New South Wales, to others which very much resemble the so-called Devonian beds of England ; and a series of shells, corals, &c., from the Murrumbidgee, which I submitted some years ago to Messrs. Salter & Lonsdale, through Sir R. I. Murchison, Bart.,* excited doubts as to their belonging to any but Silurian and Carboniferous deposits. Among these were *Phanerotinus*, *Laxonema*, *Atrypa reticularis*, *Orthis resupinata*,

* See Murchison's "Siluria," 3d ed. p. 296.

Murchisonia, Strophomena, and Spirifera of various species, some like Devonian. *Loxonema* is known to me as occurring in the lower marine beds of the Hunter river basin—certainly below the upper coal beds.

There appears to be an intermixture, and such is the case with certain strata to the westward of Wellington, in which some of the fossils have the Carboniferous type and others the Silurian. In the list before mentioned these are included in Passage beds.

In Victoria, near Mount Tambo, in Gipps Land, and again near the head of the Murray, there are some limestone beds with fossils, which I visited in 1851, and then believed to be of the same age as the lowest Carboniferous rocks of New South Wales. The Victorian geologists consider them Devonian.

In Queensland, the Burnet Range and tracts about the Bowen Gold Field and Burdekin (in which river limestones with fossils occur), are strewn with spoils of a formation which Mr. Daintree calls Devonian. From the former locality I have had many collections, and among them all I find *Productus* in alliance with *Trilobites* which appear to be older than Carboniferous. But, if Mr. Jukes's arrangement holds good these will probably be placed in the latter formation. On the western flanks of the Cordillera, near Yass, and on the eastern, along the Shoalhaven river, and again near the Hanging Rock, New South Wales presents numerous bands of limestone full of such fossils; and it may be doubtful at present whether these lie on the horizon of the Devonian, or whether they belong to some portion of the Upper Silurian. As these beds appear to range all through the country on a nearly meridional strike, on both sides of the Cordillera, they are traceable in widely different places; and it may eventually be determined that, though in close contact, there is really a distinction of formations, only to be detected by accurate survey. So far as *Lepidodendron* is concerned, that plant occurs in some places in association with beds that are decidedly younger than any called Devonian, near Pallal on the Horton river, and on the Manilla river in Liverpool Plains, and in the gold drift of the Turon river, which has been derived from beds of transmuted sandstone belonging to the coal beds at the head of the river. Near Wellington, also, *Lepidodendron* has been found in hardened rock of similar origin. At Canoona Gold Field, in Queensland, *Lepidodendron* occurs in hardened shales; and at Goonoo Goonoo, on the Peel river, in New South Wales, it occurs in fine grey sandstone, with *Ferns* and *Sigillaria* in close proximity to beds of marine fossils which are certainly Lower Carboniferous.

Besides these fossiliferous evidences of supposed Devonian

age, there are beds of grit, sandstone, and conglomerate, occupying positions of extreme doubtfulness as to age, not only in Victoria, but also all along the coast ranges of New South Wales, which, as described by me, and confirmed by Mr. Daintree, are certainly older than some parts of the Carboniferous formation. They make a near approach to the "Old Red" of Europe. In my Report to the Government of New South Wales (6th March, 1852), I have mentioned that I had traced these beds "from the head of the Shoalhaven to the head of the Genoa;" and Mr. Daintree, in his Report to Mr. Selwyn, Director of the Victorian Survey (26th May, 1863), adopts my description, word for word, as applicable to "the Grampian sandstones, the conglomerates south of Mount Macedon, of the Avon river and Tambo, Gipps's Land;" and he adds, "there can be little doubt they are all members of one great formation."

At Mount Tambo, according to Mr. Selwyn (1866), they underlie the limestone of that locality, which he therefore considers as probably Carboniferous; and this, as stated above, was my view in 1851.

About Eden (Twofold Bay), and Panbula and Merrimbula, to the north, there occur a series of beds which, in 1851, I also ranked as Devonian; but, on visiting the district in 1865, I was inclined to think they might be much older. Nevertheless, they are connected with Porphyries, with double-headed hexahedral crystals of quartz, which are common in countries assumed to be of the age of "Old Red." After all, there will have to be an adjustment of this and other questions, which may hereafter distribute very differently parts of formations which at present are considered fixed.

In Western Australia, Mr. H. Gregory indicated on his map, and in his Report, the existence of Devonian rocks near York, and in other parts of that colony. Having examined the rocks so indicated, I can only state my belief that they have no pretension to any such antiquity, and are probably mere collections of loose granitic matter and other drift cemented by ferruginous paste, which has since become transmuted into concretionary nodules and hæmatite. There are also pebbles of trap, much decomposed, in the so-called Devonian.

UPPER PALEOZOIC.

That this division of rocks is fairly represented in New South Wales there can be no dispute. It has been long determined by all Paleontologists, that the lower Carboniferous marine beds of Europe are represented by the beds immediately below the Upper coal measures of the Hunter river, of the Illawarra, Talbragar, &c.; and we know also, that fossils of the

same age occur in a part of Western Australia, near the Irwin river in Queensland; in Tasmania, and in Victoria.

Associated with them, both above and below, in New South Wales, Coal beds of various thickness (from 3 to 30 feet) occur. In the Newcastle basin alone there are at least 16 seams more than 3 feet thick, sections of which have been published by John Mackenzie and W. B. Clarke, and are exhibited. (See No. 477.) Up to a comparatively recent period, it was not known that under the marine beds below these coal seams, other seams occur bearing the same genera of plants as in the upper beds, of which *Glossopteris* and *Phyllothea* are very abundant. When this fact was first published by me, it gave rise to controversy; but the truth of my conclusions has been confirmed since by Mr. Daintree, who, visiting and examining the spot in dispute, found four or five seams in the position to which they had been assigned. Now, below these lower coal measures there is an enormous thickness of fossiliferous strata, in which the fossils (as before stated) gradually assume what has been called a Devonian aspect. The opposition to this determination has arisen from a preconceived idea that strata bearing *Glossopteris* could not be Paleozoic, and therefore, that the upper coal measures of Newcastle had no right to be considered older than *Oolitic*. But whilst these upper measures produced a fish of undoubted Paleozoic character (*Urosthene australis*), *Cleithrolepis granulatus*, *Myriolepis Clarkei*, and other Ichthyolites, examined and determined by Sir P. de M. G. Egerton, Bart., to be Paleozoic, have been found by me at least 1,000 feet higher, and of which photographs are exhibited on this occasion. (See No. 351.)

This dispute, therefore, ought long ago to have been settled; but unfortunately it was taken up out of the Colony, and found some support in the writings of DeZigno, author of "*Le Piante Fossili dell' Oolite.*" Since then he has modified his views, and, in a subsequent publication, in the "*Rivista periodica*," Padova, vol. xiii, 1863, admits that the Australian coal beds are rather *Triassic* than *Oolitic*. He still, however, does not quite comprehend the whole question.

Above the coal measures, including *Urosthene* and *Glossopteris*, *i. e.*, in the Hawkesbury and Wianamatta beds, in which *Cleithrolepis*, *Myriolepis* and *Palæoniscus* occur without *Glossopteris*, Baron De Zigno imagines, from the way in which the evidence has been put before him, that beds with *Pentacrinites*, *Ammonites*, and *Belemnites*, which will be mentioned hereafter, interpolate the beds with *Palæoniscus*, &c. Nothing, however, of the kind has ever been found in Hawkesbury or Wianamatta beds; and the only fossils of the genera named occur in

Queensland, full 600 miles distant. Professor M'Coy having believed the coal of New South Wales to be Oolitic, and believing the Pentacrinites, &c., to be Oolitic also, and Lepidodendron having been stated to be found in beds below the coal in marine beds of assumed Devonian age, it was too hastily inferred that Professor M'Coy and myself were writing of two distinct *coal* epochs.

That the coal measures of New South Wales are, however, truly Carboniferous, has been since determined by plant evidence; for in Queensland, where the Newcastle coal measures can be identified, a plant very near to, if not the same as, *Alethopteris lonchitica*, has been found, and there are in the present Exhibition several examples of it. (See No. 470.) Moreover, near Stroud I long ago detected a magnificent fern, in beds which belong to the Hunter river coal measures, which Sir C. Bunbury has named *Adiantites eximius*.

Whether the masses of coal exhibited look more like a Secondary than a Paleozoic coal, may be fairly left to the decision of competent judges. (See Nos. 214—233.)

Another ground on which the age of the New South Wales coal beds was disputed is, that in Victoria there are certain beds which (*me teste*) resemble some of my Wianamatta beds, and therefore, assuming them to be *Oolitic*, New South Wales was involved in that dictum also. Now, the true European coal measures (according to Mr. Selwyn), "so far as is known at present, do not exist in Victoria;" nor has *Glossopteris* been found there at all. Moreover, the Survey has sunk through 4,000 feet of consecutive beds, without finding a profitable seam anywhere; and, though the limestones of Gipps's Land are acknowledged as Lower Carboniferous or Devonian, there is not an atom of evidence to be obtained in Victoria as to the Secondary age of the New South Wales coal. Thus stands the question at this moment. If now we turn to Tasmania, we have clear evidence as to the occurrence there of true Paleozoic coal, and if we pass on to Queensland we have equally clear evidence; and, what is more, there are sections on the Bowen river (full 1,000 miles from Sydney), in which the whole history of the coal beds may be read off without error.

Mr. Daintree writes thus:—"The Bowen river Coal series would afford more conclusive sections in the upper portion than your own; since, besides the seams of coal lying at the base of the Bowen river series, *interstratified with beds containing a marine fauna*, which Professor M'Coy acknowledges to be *Carboniferous*, there are likewise beds *containing a nearly similar fauna, resting on beds with abundance of imbedded Glossopteris.*"

I learn also, from the examination of both Fauna and Flora, specimens of which were in my possession before Mr. Daintree had visited Queensland, that the former contains the identical species described by M'Coy (*Annals Nat. Hist.*, vol. xx), such as *Productus brachythærus*, *Pachydomus globosus*, *Allorisma curvatum*, whilst the latter contains *Phyllothea australis* and *Glossopteris Browniana*, and others, which were assumed to be Oolitic at Newcastle, but must be admitted to be Paleozoic on the Bowen river.

The coal seams on the Bowen river are of variable thickness, but a ten-foot seam has been noticed.

Mr. Gould, in his Report to the Government of Tasmania, October, 1861, also states that the Mersey river worked coal seam belongs to the formation with the same marine fossils as in Queensland, and on the Hunter in New South Wales.

Having visited the Tasmanian locality for the purpose of inspection, I can confirm all that has been stated respecting the occurrence of the marine Paleozoic fossils, *Orthonota*, *Spirifera*, *Fenestella*, *Pachydomus*, *Theca*, &c., in association with and immediately above the coal.

So far, then, the question about the age of some of the Australian coal must be considered as settled; and if, as in Illawarra, the coal beds overlie the marine beds, as they do also in the Fingal district of Tasmania, it would appear that all these separate occurrences belong to one thick series, in which marine beds and fresh-water beds interpolate each other. But, assuredly, in that case, the arrangement adopted must express the order as follows:—

4. Upper coal measures.
3. Upper marine beds.
2. Lower coal measures.
1. Lower marine beds.

So far as I know, the latter rest frequently on a conglomerate, which in Tasmania I found to contain undoubted Carboniferous fossils.

Since the Exhibition of 1862, on which occasion, in a paper on the Coal Fields, I noticed the occurrence of Oil-bearing Cannel Coal at the foot of Mount York, and at Colley Creek in the Liverpool Ranges (not on eastern waters), the former has been in great request for the purpose of producing illuminating oils; and the produce has been brought into the market. In the former locality, and in Burragorang, I have made some recent researches, which have satisfied me that these can only belong to the Upper coal measures, for they bear distinct evidence in the fronds of *Glossopteris*, which are very clearly impressed upon the beds at Mount York; whilst at Burrago-

rang the blocks of Cannel are found in an intermediate position, between the top of the coal measures and the upper marine beds, which, if not the overlying measures, bear the very strongest resemblance to the Hunter river series.

In Illawarra, also, there are shales which are above that geological position, and which produce oil for illumination, but are not of the peculiar character of the Cannel at Mount York, which, in a great degree, resembles the Bog Head mineral of Scotland, only it is more valuable. Specimens of all the products under the present heading will be found in the Exhibition. It has been an object of inquiry whether Petroleum springs exist in New South Wales. Such have been reported from the Corong in South Australia, and from Taranaki in New Zealand, and from Victoria. The former is, we learn, a mistake; being probably at a point where certain animal substances have decomposed. In New South Wales there are also two localities, known to me for many years, in which Petroleum exudes; and there are two or three in Western Australia, the products from which I have examined. Nothing of value has as yet been found. (See Mr. Keene's collection exhibited in London, 1862, and again exhibited, pp. 81-89.)

SECONDARY ROCKS.

I have previously made mention of the Hawkesbury and Wianamatta beds; and a collection of them, illustrated by a catalogue, was exhibited at Melbourne. Some of these were also shown in the Universal Exhibition of 1854, and therefore have not now been repeated.

Whether they be acknowledged hereafter as Paleozoic (which the fishes determined by Sir P. M. de G. Egerton, Bart., would justify), or whether, with Mr. Selwyn, we consider them (against that evidence) to be Secondary—or whether we suppose, with him, that the beds in Victoria called by him Secondary are a portion of my Wianamatta beds—there is nothing to explain the statement made by de Zigno, in his valuable paper before the Academy of Science, in Padua, on 23rd April, 1863, in which he says:

Altri depositi pure d'incerta classificazione ci si schierano innanzi prendendo ad esaminare i terreni a combustibile fossile della Nuova Galles meridionale e della Tasmania, che il M'Coy aveva fino dal 1847, collocati nel piano dell' Oolite, mentre Clarke annunciava di avervi rinvenuto i Lepidodendri dell' epoca carbonifera.

Successivamente le nuove indagini instituite dal M'Coy lo ponevano in grado di chiarire come i resti trovati dal Clarke appartenessero a depositi collocati ad una grande distanza di quelli le cui piante accenavano ad un' epoca più recente.

* * * * *

Egli cita in questi ultimi depositi la presenza di quattro Cicadee e di una *Tæniopteris* molto affine alla *Tæniopteris vittata* dell' Oolite di Scarborough, e nota come presso Wollumbilla abbia trovato Belemniti, Pentacriniti e varie conchiglie che s' approssimano alle specie proprie dell' Oolite inferiore, del Lias e del Trias. (p. 148-9).

Now in this statement are three things to be reconsidered:—

1. It has not been said by me that the *Lepidodendron*, &c., were in the same beds with *Glossopteris* (though evidence has come out recently to the effect that these plants have been found together at Newcastle), but it has been held that the *Glossopteris* Coal beds and the *Lepidodendron* beds are part and parcel of one great formation.
2. In New South Wales no *Cycadites* and no *Tæniopteris* have been ever found, though they occur in Victoria in the beds considered by the geologists there to belong to the Wianamatta beds.
3. Neither in the Victoria beds, nor in the Wianamatta beds, has ever been found a Belemnite, a Pentacrinite, or any shell, save a fresh-water *Unio* in Victoria, and one shell in New South Wales from the fish-bearing shales.

There is, however, a far more important matter to be rectified.

When I first reported the discovery of Secondary fossils from Wollumbilla in Queensland, it was as *Cretaceous* or *Jurassic*; but Professor M'Coy described them, in September, 1861, as *Lower Secondary*, and as the marine representatives of the formation, to which belonged, in his opinion, the Victoria "carbonaceous" beds, and the coal measures of New South Wales, *i. e.*, of the age of the Scarborough Oolite. Among the Wollumbilla fossils were some which looked older than Cretaceous; and therefore, certainly guided by Prof. M'Coy's determination, I adopted his view of an older period, and even considered that some of the fossils indicated a Triassic age; (there was certainly a brachiopod which looked older than Triassic;) consenting to the possibility that the Wollumbilla beds might prove really to be of the same age as the Wianamatta beds. But I have learned two things since, first, that the fishes of the latter are Paleozoic, and secondly, that the Wollumbilla fossils on comparison and examination in Europe, whither I sent them, are by geologists there considered to be really *Cretaceous*; and as Professor M'Coy has himself published two Cretaceous species from Queensland, in 1865, and as I have collected evidence to geologically connect their localities (Flinder's River) with that of Wollumbilla (though otherwise so widely separate), there will be the less difficulty in allowing the Cretaceous epoch, first suggested by myself as applicable to

fossils in *situ*, to be acknowledged as well developed in Queensland. But we shall then see how little is its relationship with the Wianamatta, and how still less with the Victorian beds.

This reference to a very important circumstance leads me to suggest, that whether the Wianamatta series is to maintain a Paleozoic pretension or whether it is to ascend to the Trias, the arrangement which will be found most correct will probably be represented somewhat in this wise :—

4. Cretaceous. Wollumbilla, Flinders, &c., (Queensland) and Western Australia.
3. Inferior, or Great Oolite. Deposits at Wizard Peak, &c., Western Australia.
2. Trias, Victoria.
1. Paleozoic. Wianamatta, Hawkesbury, and Coal beds of New South Wales.

In which arrangement, I would place the Victorian “carbonaceous” above my Wianamatta beds. Of course, subsequent discoveries may modify such a view, and lead to a final settlement of opinion, by enabling geologists to fill up the *gaps* which undoubtedly exist ; proving, perhaps, that the Cretaceous fossils picked up in drift by Mr. Selwyn indicate the former existence of Upper Secondary rocks in that province, as the Ammonite brought to me on the Clarence River Coal Fields in 1853, may indicate the former presence there of an Oolitic formation.

That Cretaceous or Jurassic rocks formerly occupied and still occupy an enormous range in Queensland, I can now assert, having obtained some of the additional information which I proposed to collect in 1861: I have now been able to discover that rocks of the above epochs range from the east of Wollumbilla across the Maranoa and Warrego to the Nive and Barcoo ; thence along the head of the Thomson to the Flinders, and so round by Tower Hill and the Belyando back to the Amby and Maranoa Rivers ; not, of course, in one uninterrupted area, but resting on the Carboniferous and other Paleozoic formations, thus exhibiting a very extensive distribution of Secondary rocks ; and it will probably be found that various groups of the Jurassic epoch are represented there.

It is certainly singular that some well-known species of European reputation, or their representatives, are found in the Western Australia Oolite, such as the following of the Great Oolite :—*Trigonia costata* ; *Ostrea Marshii* ; *Ammonites Moorei* ; *Lima pectiniformis* ; *Avicula Munsteri*, &c.

None of these have, however, been found in Queensland, New South Wales, in Victoria, or Tasmania ; but in the latter island, there are undoubted equivalents of some part of the Wianamatta series, as well as of the Coal measures and lower Carboniferous beds of New South Wales.

In New Zealand the greater part of the Coal measures is not Paleozoic, but some of it is said to be Secondary, to which epoch also belong the Jurassic Plesiosaurus and Ammonites; and Triassic *Aviculæ* and *Monotis*.

In New Caledonia, there is also a distinct Triassic series, of which some of the fossils are akin to those of New Zealand. But, at present, neither has this nor the Belemnites of Queensland been found in New South Wales.

So far as the question of Coal is concerned, no Coal seams (but only thin patches or very limited layers) have been found in the Wianamatta or the Hawkesbury rocks, that can be compared even with the alleged Secondary deposits of Victoria; and in Queensland, where workable seams do exist, the fossils of New South Wales are also found. In the Secondary marine beds of Wollumbilla and the Amby, gold in minute visible particles was found by me in some of the quartz pebbles cemented with the shells, and a small quantity was detected by crushing the whole, shells, pebbles, and the calcareous cement together.

TERTIARY ROCKS.

Throughout the whole of Eastern Australia, including New South Wales and Queensland, no Tertiary *marine* deposits have been discovered. There are, however, in various places of New South Wales, patches of *plant deposits* which, according to the frequent notices of geologists, may be referred to some period of the Tertiary epoch. A silicified sandstone, or quartzite, of this kind, full of impressions of ferns and leaves of trees, but not known to be now living, occurs at Jerara Creek, not far from Yass. (See No. 475.) It is probably Miocene. On the summit of the Cordillera, near Nundle, above the Peel River Diggings, occurs a ferruginous bed full of leaves. Both these localities are represented by specimens in the Exhibition. On the Richmond River occurs a white magnesite, full of yellowish impressions of leaves. At Keewong, in the county of Gowen, there is a bluish deposit of fine aluminous matter with black impressions. From a depth of 60 feet in a shaft near Bungonia, a pale yellowish white deposit with similar impressions was brought up; and on the summit of "a made" hill, above Kiandra Gold Field, at a height of 4,000 feet above the sea, and in a region now partly covered with snow many months in the year, there is a deposit of black clay with such casts of leaves as occur in similar clay near Hyde in New Zealand.

No botanist is prepared to declare what is the exact age of such deposits. But some of the leaves are supposed to represent among others the foliage of *Fagus*; yet, it was only in 1866 that a beech forest was discovered, by the Director of the

Botanical Gardens, growing on the Clarence River. On comparing the living leaves with the impressions in the various deposits mentioned, I can see no identity. This is a point in Geology not yet fully dealt with.

The most remarkable instance I have met with is on the coast, about forty-two miles north of Cape Howe, where, at a place called Chouta (between Tura and Boonda) a cliff about 100 feet high, formed of sand and white silicate of alumina, contains beds of lignite charged with sulphid of iron, and which are full of phytolites much allied to the living vegetation. From the clays, some of which are nearly kaolin, articles of pottery have been formed, which, with the clays and sands, are exhibited. (See Nos. 269 & 371.) It has been proved that, by distillation, a fair proportion of lubricating oil may be produced from the lignitiferous clay, and other products are expected to result from these deposits. The cliff is about 60 feet thick from the sea to the top of the clays, and borings below the sea level have shown a still greater thickness.

These deposits lie between the horns of the little bay at Tura and Boonda, resting at one end on the highly undulating Paleozoic rocks, and at the other on a mass of Porphyry. They were, formerly, no doubt, deposited in a depression among the slopes of the hills, but the wearing away of the coast has left a cliff of clay and sand instead of the original cliff of hard rocks. It is remarkable that, at the south end the rocks assume the character of a breccia of quartz, cemented by siliceous matter (probably like a deposit mentioned by Mr. Gould as occurring in Tasmania) and in its analysis has detected the presence of gold, though some quartz veins at the north end contained none.

My impression at first was that the lignite was recent, but I place the deposits under the present head because it may be possible the plants are not recent; and some of the hardened clinker-like sands covering the clays remind me of the sands on the coast of Dorset, at Studland, and Bourne Mouth. If this be really a Tertiary locality, it does not contradict the general assertion at the commencement of this section, for no shells of any kind have been detected in any part of these beds. Swampy and stunted plants still grow on the sands which are very wet, and probably reproducing the phenomena beneath them, with the exception of the white clays which were in part derived from the decomposed felspathic matter of the Porphyry. In various parts of Manero there are lignite-like local thin deposits, but on analysis they have proved valueless.

It may be well to mention, that although there are no such positive indications as exist in Victoria, as to the age of the

Gold drifts which are by Mr. Selwyn referred to Upper and Middle Tertiary, yet there are parallels in New South Wales to certain phenomena that have been observed in that province. Thus, the gold alluvia of the Uralla resting chiefly on granite are covered by a great thickness of basalt, as in various Victorian fields, and at Lucknow, near Orange, as well as at Uralla, under the basalt and with the gold alluvia are found stems and branches of trees, as is the case at Daylesford, in Victoria.

These may be Miocene, or perhaps Pliocene, but the proof must rest on evidence not yet attainable.

PLEISTOCENE AND RECENT ACCUMULATIONS.

In many parts of the existing region, all over the surface, wherever the basal rock is not denuded, as near Sydney, there are local deposits which might be called "till," were any Tertiary found in them; and in the interior there are widely-spread accumulations of drift pebbles, which, as on the Hunter and Wollondilly, are rounded by attrition in their long journey from the mountains whence they have been derived. Sometimes, also, the breaking up of conglomerates has contributed to this drift.

In more than one instance, it is clear that the present river channels have deepened since the drift first began to crowd their banks. I have traced one of these drift streams, sometimes at great heights above the valleys, for more than 80 miles. In other places I have found upon the surface, as Strzelecki did in other parts, minerals (especially ores of copper, tin, and lead) which were at a great distance from their sources; and in two instances, that rare mineral, Molybdate of lead, of which no habitat has ever been yet found.

In the great plains of the interior, bones of various gigantic marsupials, fishes and reptiles, are found bedded in black muddy trappan soil; and on Darling Downs in Queensland, univalve and bivalve shells are found in some cases attached to the bones, or deposited over them in a regular series of layers, at intervals of several feet; and of these shells some are yet living in the water-holes of the creeks. These facts are generally known, but it was not till recently that the osseous relics have been found in different creeks throughout the whole of the slopes and plains at the base of the Cordillera in Eastern Australia.

Similar to this are the accumulations of bones in caverns, as at Wellington—at Boree, near the head of the Colo river—at Yesseba on the Macleay river, and other places.

In the Exhibition is a magnificent collection made by Mr. Krefft, from the former locality, and several specimens of bone breccia from the latter place, discovered by Mr. Rudder. (See Nos. 483e & 469.)

Along the coast are found ranges of Dunes, with a variety of shells, some of them rare, others recent, as on Port Hacking and Cronulla beach; along the shores of Botany Bay; on the great flat between the Hunter and Port Stephens, and along the Macleay river which now passes for many miles through the shelly accumulations; and about Moreton Bay and in more northern coast openings, shells and marine refuse form deep deposits, from which, as in Illawarra and Broken Bay, a considerable profit is obtained by dredgers and shell-collectors, for the production of lime.

Mr. Rudder illustrates the case of the Macleay by collections of the shells, and by a carefully-drawn map defining the limits of the Pleistocene deposits. (See No. 469.)

All along the coast, from Torres' Straits to Bass's Strait, drift pumice may be found wherever there is a lodgment, generally in the north corner of the little shore bays. That this has gone on for ages is apparent, as in one part of the coast south of Sydney there is an accumulation of water-worn pumice, some distance from the shore, and beyond the reach of the present waves. It is supposed to come in during easterly gales, from the volcanic islands to the northeast.

Raised beaches occur also at various heights on rocky projections of the coast, indicating elevation of the land, of which there is distinct evidence in the recent period, not only in Moreton Bay, near Sydney, and thence to Bass's Strait; but on both sides of that Strait, and as far as Adelaide and King George's Sound. Mr. Selwyn gives data for assuming the elevation of the land to have reached occasionally 4,000 feet in Victoria, but he has no evidence of Tertiary marine fossils above 600 feet. Unfortunately, on the eastern coast, having no marine Tertiaries, we have to found our deductions, as respects New South Wales, on less secure data. Yet we have here evidence of another kind, and pot-holed surfaces of considerable extent have been found by me at various heights from 300 to nearly 3,000 feet.

In a brief abstract like the present, it is impossible to quote authorities, nor has time allowed a more satisfactory digest or a wider range of statements. Nor has opportunity permitted the preparation of sections (save of the Newcastle Coal Field, No. 477) or map to point out relative positions of the formations mentioned by me in this paper. The places named can, however, be seen on such maps as are probably exhibited by English publishers; if not, reference can be made to Petermann's map of Southeast Australia, in Stieler's Hand Atlas, No. 50c.

I have not named the occurrence of the ferruginous deposits of the Cape York Peninsula, (though I possess a map, and

collections made from about the new settlement and along the coast), because I am not at present aware whether they are Pleistocene or Tertiary. They are very extensive, and cover the bases of Porphyry hills. On analysis of the ironstone, no gold was detected.

W. B. C.

St. Leonards, near Sydney, 17 January, 1867.