OUTLINES OF THE GEOLOGY OF TASMANIA.

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Tasmania is the separated southern terminal of the Australian Continent. The western half of the island consists of folded Pre-Cambrian and early Palæozoic strata, moulded by denudation into high ranges with crests between 3000 and 5000 feet in height. The central tableland and eastern borders are composed of more or less horizontal beds of late Palæozoic marine strata and Mesozoic sediments, relics of the vanished Gondwana Land. Denudation has exposed huge sills of diabase in these, now crowning the high plateaux and mountains in that part of the island. The plateaux are known by the name of "tiers," and sink by successive faults to sea-level on the east coast. Tertiary fluviatile, lacustrine, or estuarine drifts occupy the floors of the broader valleys, and fill old stream-channels which are now concealed by flows of basaltic lava.

The great movements of igneous material leaving their mark upon the present configuration of the land have been acid and sub-acid irruptions in Cambrian times, the consolidation of gabbro and granite in the Devonian, the intrusion of widespread diabase sills at the close of the Mesozoic, and the effusion of basalt lavas in Mid-Tertiary.

In Pre-Cambrian times Tasmania appears to have been beneath the Algonkian ocean, which received its sediments from continental land to the west. The surface of the deformed Algonkians was subsequently exposed, and furnished material for the Cambrian sediments, which in their turn were eroded and redeposited in the Ordovician and Silurian seas under which most of the present area of the island lay. In the Devonian, land surfaces must have prevailed, as no marine strata of that age are recognisable, and in the Permo-Carboniferous and during the Mesozoic a partial land connection with Australia continued, with shallow waters of a retreating sea. During the Cretaceous, Tasmania was still connected with a part of the adjoining continent, but after the close of that period a separation occurred. Subsequently the land connection was restored, to be again broken, since which time insular conditions have continued. The last land bridge across the straits is supposed to have

been between Wilson's Promontory in Victoria, and Cape Portland in Tasmania, *viâ* Flinders Island, and the Kent Group. It is estimated that an elevation of 300 feet would lay dry a strip of the present sea-bottom between Victoria and Tasmania.

The difficult features and inaccessibility of the uninhabited mountainous parts of the island have greatly impeded geologic research. It has, however, been possible to settle the stratigraphy of a large portion, though the lower Palæozoic strata and the Pre-Cambrian schists still require further study. The following systems or groups of systems are recognised:—

I. Pre-Cambrian.
II. Cambrian.
III. Ordovician.
IV. Silurian.
V. Devonian.
VI. Permo-Carboniferous.
VII. Mesozoic.
VIII. Tertiary.
IX. Quaternary.

I.—Pre-Cambrian.

Strata belonging to this group of systems come to view in the western, north-western, and south-western parts of the island. Whatever horizons may be established for the great breaks in this group, the known Pre-Cambrian rocks developed in Tasmania belong to the upper divisions, called Algonkian by the United States Geological Survey, and comprising dominantly rocks of sedimentary origin (Proterozoic of Chamberlin and Salisbury). The Archæan or lower series, consisting of granitoid rocks and igneous schists, has not been identified in the island. A solitary boulder occurs at the 29-mile peg on Innes' track from Liena to Barn Bluff, having a distinctly Archæan facies, and it may be that the Archæan rocks will be found in the neighbourhood. Up to the present no discovery has been made.

The Algonkian is extensively developed. It forms the platform on which the Cambrian strata have been laid down, and wherever its upper boundary is exposed, rocks of the Cambrian system are in unconformable juxtaposition. Its lower limit has not been seen, but naturally the basal beds must ultimately rest upon rocks belonging to the Archæan complex. No organic remains have been found in them. In some parts the metamorphism is suffi-

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ciently intense to obliterate all traces of any life forms, while elsewhere the deformation and alteration have been slight and the rocks have the aspect of merely indurated or crystalline sandstones. In general the Algonkians consist of schistose quartzites, quarzitic, sericitic, and occasionally argillaceous schists.

The possibility of subdivision of the Algonkian is rendered likely by the discovery of what seems to be an upper horizon, indicated by bedded quartzites lying nearly horizontally upon the normal strongly-folded quartzitic schists prevalent in the valleys of the Franklin and its tributaries near the Raglan Range and Frenchman's Cap.

Denison Zone.—The largest continuous development is in the west and south of the island. Lofty schist ranges in parallel north-and-south lines traverse the country west of the King William and Denison Ranges and Mt. Wedge and the area in the south-west between the New River and Port Davey. These schists form the Raglan and Collingwood Ranges, the Frenchman's Cap, the greater part of Mt. Arrowsmith, the lower slopes of Mt. Gell, and the Loddon Range. From below the conglomerates of which the Denison Range is composed, and which strike N. 20° W., quartzitic schists rise with a north-easterly strike, and the same general bearing (with numerous local variations) prevails throughout the whole of the schist country further west. The eastern boundary of the schists is prolonged south of the River Gordon, west of the Wedge River, and then in a direction east of south to the south coast west of New River. The mica schists of the Collingwood River valley are intersected by dykes of garnet-zoisite-amphibolite. Three occurrences of this rock lie between the intersections of the Balaclava and Cardigan rivers with the Collingwood.

South of the Gordon the dominant strike of the schist is between N. 5° and 30° W., and this is also the case in the Port Davey district.

Cox's Bight and Port Davey.—Schistose quartzites and micaceous schists are pierced by tin-bearing granite at Cox's Bight, at the southern end of the Bathurst Range. The bight is 6 miles across, and is divided into two bays by a small promontory called Point Eric, which rises to a peak 160 feet above sea-level. This headland consists of alternate layers of micaceous sandstone and saccharoidal quartzite, contorted and dipping at low angles to the south-west. The strike of these is north-north-west to north-west, and this is the general strike of all the schists and quartzites in

the locality, excepting in the range of dark schists in the eastern bay, where the strike is about north and south. The junction with granite is observable at the neck of the Point Eric promontory, and the igneous rock then forms a spur with rocky knobs rising north from sea-level to 600 feet, where it again junctions with quartzite, which continues to the summit of the Bathurst Range, 2800 feet above sea-level. Cox's Bluff Range is a high headland (about 1000 feet), forming the western horn of the bight, and consisting of dense white quartzite, like many of the bluffs which jut out on this part of the coast, with bare snow-white crests visible for many miles. The white quartzite of Port Davey has long been assumed to be of Pre-Cambrian age. This series of schists and quartzites continues westwards to South-West Cape, and eastwards to the high land west of the New River.

Barn Bluff and Dove River.—The country round Barn Bluff consists principally of foliated quartz schists with a general east-and-west strike, or slightly north of west and south of east. Micaceous and argillaceous schists are also present. This Pre-Cambrian country continues as far north as the Dove River.

Ulverstone and Forth.—At the mouth of the River Leven, quartzitic and sericitic schists and schistose conglomerates, with beautifully stretched quartz pebbles, are well exposed along the beach eastwards as far as Button's Rivulet, where they are covered by basalt of Tertiary age, with a general strike of N. 10° E.; and westwards past Picnic Point to halfway across Barkworth's Bay, west of Goat Island, where their junction with the overlying Dundas and Leven Cambrians is hidden by a flow of lava. The striped slates and breccia a little further west appear with a strike of from N. 15° to 25° W., showing their strongly unconformable position on the Algonkian schists. The schistose conglomerates at Goat Island furnish classical examples of dynamically deformed pebble beds, the quartz pebbles being stretched into lenticles and long narrow strips without fracture. The strike of the schists west of Goat Island ranges from N. 12° to 30° E., with a north-westerly dip.

At Hamilton-on-Forth a picturesque river gorge exposes the ancient rocks beneath a thin covering of Tertiary basalt, which occasionally assumes a felsparless or limburgitic facies. To the north-west of the township crags of saccharoidal white quartzite overlook the river. This

is bounded on the west by the basalt. Further south along the road there emerges from below the basaltic sheet a small exposure of serpentine about a chain wide. The next body of rock westerly is micaceous quartz schist striking N. 10° W., and dipping south-west. South-east of this, and on the same strike, is a belt of garnet-zoisite-amphibolite with a north-westerly bearing. This is succeeded on the west by mica schist and micaceous quartzite with strike of from N. 10° to 30° W., and a south-westerly dip. The schist is sometimes graphitic. Further south intrusions of porphyroid occur, and the Algonkian platform sinks below the Cambrian slate and breccia series.

Rocky Cape.—A series of quartzites and quartz schists is exposed along the north-west coast of Tasmania from Jacob's Boat Harbour west of Wynyard to Rocky Cape, which forms a promontory on the east side of the bay extending to Circular Head.

The Rocky Hills form a high range of massively bedded quartzite, which trends south or a little east of south from the coast to about a mile south of the main road, when it sinks rather abruptly, and subsides in the country which extends south across the Arthur River towards the Heazlewood and Long Plains. Immediately west of the Cape are contorted quartz schists, which are a part of the complex of schists and quartzites which succeed one another on this part of the coast. The strike of the quartzite at Rocky Cape port is north of east, and of the curled schist west of same N. 80° E. The quartzite here is coarsely bedded and not schistose.

The same series extends eastwards to Jacob's Boat Harbour, where the strike is north-west, with a north-easterly dip.

Rocky River Schists.—This formation is met with on the Waratah-Corinna-road, at 26 miles from Waratah, and continued to 31½ miles with a strike of about N. 10° W. and a north-easterly dip. The observed width of the belt is about 1½ mile. On the east it is bounded by the Long Plains series of quartzitic, sericitic, and graphitic schists. The country to the west has not been closely examined, but slate and quartz schist occur in it. The Rocky River schists continue north-west for 10 miles to the Savage River, and perhaps 3 or 4 miles further north. For this distance they maintain their lithological characteristics, and at intervals expose their characteristic ore outcrops. These comprise large lenses of magnetite and hematite, with a variety of associated minerals—gold, silver, copper,

pyrrhotite, pyrite, barytes, arsenide and antimonial sulpharsenide of nickel, cobalt molybdate, asbestos, siderite, dolomite, calcite, arsenopyrite, &c. On each side of the ore-bodies, and separated from them only by bands of more siliceous schist, are the amphibolitic schists of this zone, which are sometimes gneissoid and fissile, sometimes typically foliated, or compact, or granular with irregular fracture. Smooth talc-like schists are frequent. The elements forming the amphibolite are a rather fresh-looking acid plagioclase in large plates, a green amphibole, sometimes decidedly bluish-green in thin section, with the extinction angles of common hornblende; apatite in large formless crystals; quartz; and much epidote. The rock obviously belongs to the amphibolitic crystalline schists, and possibly was once gabbro, the pyroxene of which has been replaced by hornblende and the basic felspar transformed into more acid felspar and quartz. The presence of nickel ore and the frequent development of serpentine in the joint planes of the rock harmonise with this supposition.

At the junction of the Whyte River with the Nine-Mile Creek, where some copper ore mining has been carried on, this zone contains actinolite schists.

Long Plain Schists.—The rocks on the Long Plains between Waratah and Corinna may be placed in the Pre-Cambrian. They comprise sericitic, graphitic, and quartz schists striking a little east of north. A good deal of loose gold has been obtained from the creeks north of the plain (in nuggets up to 5 ozs. in weight), as well as from the angular hill detritus. Gold in ragged, spongy, and crystalline forms has been obtained from softened zones in the schist.

Asbestos Range.—This is a majestic linear range 5 or 6 miles west of Beaconsfield, terminating northwards in promontories at Badger Head in Bass Straits. No asbestos has been found in it. The range has been so named from its lying immediately to the west of the Anderson's Creek belt of serpentine, in which veins of chrysotile or serpentinous asbestos exist. The serpentine intrusion obscures the junction of the schists of this range with the Cambrian grits and sandstones of the Beaconsfield district. The rocks of which the range is composed are micaceous schists, slates, and grits, striking N. 10° to 20° W.

Ore-deposits in Pre-Cambrian Rocks.—Ores of copper, antimony, and lead occur in the schists at Port Davey, copper and nickel ores (with gold and silver) in the Rocky

River belt, gold in the Long Plain schists, and disseminations of copper ore in dykes traversing the quartzite at Rocky Cape and Jacob's Boat Harbour. Gold has been found in sericitic quartzite at the Gell River, 19 miles north of the Great Bend of the Gordon, and has been reported from several points in the schist area. Copper ore occurs in the Asbestos Range schists, and in quartzite and actinolite rock at Barn Bluff.

II.—Cambrian.

The base of the system, where observed, rests unconformably upon the upper Pre-Cambrian rocks, which were subjected to foliation and erosion before the overlying Cambrian strata were deposited. Recent information has shown that the clay slates and breccias which in early literature were called Cambro-Silurian, and more lately Cambro-Ordovician, may be regarded as belonging to the Cambrians. The West Coast conglomerates, the schistose porphyries of the West Coast Range, and the felspathic schists of Mt. Lyell, about which uncertainty has been felt for a long time, may be almost certainly placed in the same system.

The grouping of the beds in the Cambrian is somewhat provisional at present, as investigation is still proceeding, but the following groups have been recognised:—

(4) Dikelocephalus sandstone at Caroline Creek and the Florentine.

(3) Discoidal sandstone in the Loddon River valley and at Caroline Creek near Dulverton.

(2) Tubicolar sandstone at Middlesex, Five-mile Rise, Mt. Claude, Lemonthyme Hill, Black Bluff, Zeehan, Loddon River Valley.

(1) Conglomerates, pebbly sandstone, and quartzite on the West Coast Range, Mt. Zeehan, the Thumbs, Denison Range, Railton, &c.

Incertae Sedis.

(*a*) The Dundas slates and breccias, the Dial Range, and Leven slates, breccias, tuffs, and porphyroids; the felspathic porphyries of Mts. Lyell, Jukes, and the West Coast Range generally.

(*b*) Slate and sandstone at the Needles and in the neighbourhood of Mts. Mueller and Wedge.

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(1) *Conglomerates.*

The great Denison Range flanks the valley of Rasselas to the west as one proceeds north of the Gordon Bend. First comes its southern offshoot (Mt. Wright), which forms a high wall on the west for about 5 miles, and then the main ridge of the Denison in continuation of the Thumbs and the mountain north of Clear Hill comes to the front and rises above the plain in lofty peaks. The western face of this range is composed of crystalline and pebbly sandstone, weathering into a visible conglomerate, the small pebbles of quartz showing on the weathered surfaces. These beds are succeeded to the west by strong bands of medium-grained and coarse conglomerate, which, with beds of sandstone, continue to the summit of the range. Behind these are quartzites, dipping conformably below them. Still further west are similar alternations. The whole forms the basal formation of the Cambrian system, striking N. 30° W., and dipping 45° to 50° north-easterly. The beds plunge below the Ordovician limestone on the east, and transgress the Algonkian strata on the west. The latter strike east of north. At the junction of the systems is a basal breccia bed composed of large angular stones of quartz and quartz schist. This is the lowest bed which has as yet been noticed in the Cambrian system.

No essential distinction can be made between these conglomerates and those of the West Coast Range. The series extends as far south as the head of the Florentine River. The general colour of the conglomerate is white or pink (reddish where fine-grained), and the pebbles are of quartz and quartzitic schist. Such conglomerate appears on nearly all the mountains of the West Coast Range, and on many in the north of the island, such as Valentine's Peak, Mt. Roland, &c. It exists near Railton behind the Cambrian beds. It underlies tubicolar sandstone at Mt. Zeehan, and is associated with similar sandstone at Black Bluff. It forms the footwall of the felspathic schists at the Mt. Lyell Mine. It underlies Ordovician limestone at the Upper Blythe. The steadily growing evidence seems to require its inclusion in the Cambrian system, though it has hitherto been considered as being of much younger age.

The beds of quartz grit, conglomerate, and sandstone, which form the Cabbage Tree Hill at Beaconsfield, pass below the Ordovician limestone in the eastern part of the township at an angle of 45° to 50° to the north-east.

The strike of the beds is north-westerly. A fault exists at the junction of the two systems here.

Some casts of orthis have been found in the whitish sandstone of the Cabbage Tree Hill; and on the surfaces of light grey slate from the Tasmania and Salisbury Mines undetermined markings and tubular forms have been found and referred to planolites and fucoids.* The term planolites covers various obscure cylindrical impressions supposed to be casts of the tracks of worms travelling over the surface of sand or mud.

(2) *Tubicolar Sandstone.*

This is a white crystalline sandstone seen in the Middlesex and Mt. Claude districts, at Zeehan, and in the Loddon River valley. It is known locally as "pipe-stem rock," from its abundant fossil forms, taken to resemble the stem of an ordinary clay pipe. These are sometimes straight, sometimes slightly curved. Sometimes they lie parallel with the bedding, sometimes vertical. Their forms project from or lie in relief on the weathered surfaces of the rock or stones, but their substance is wholly made up of quartz grains, and no signs of structure can be detected even by microscopic examination. Any name given to them must be entirely conjectural. They may be worm tracks, or possibly the fillings of dwelling tubes constructed by some tubicolar annelid. For the present, the rock carries the non-committal name of tubicolar sandstone. It plainly forms such an excellent stratigraphical horizon that its relations with its associated beds are important for Tasmanian geology.

Silurian fossils have been collected from the Bell Mount and Five-mile Rise districts, but the stratigraphy of these areas has not been worked out closely, and for a long time the tubicolar rock has been believed to be of Silurian age: but recent investigations lead to the conclusion that it must be Cambrian. It directly overlies the basal Cambrian conglomerate at Mt. Zeehan. These tubicolar forms have been found in the Cambrian conglomerate of Mt. Lyell Peaks. The rock is associated with Cambrian conglomerate at Black Bluff; it underlies Ordovician limestone on the eastern side of the Forth River near Lorinna.

(3) *Discoidal Sandstone.*

In the valley of the South Loddon the tubicolar rock is overlaid conformably by a whitish sandstone, which is

* By Mr. R. Etheridge, Jr.

charged with impressions of a peculiar discoid form, in appearance somewhat resembling encrinital stem segments. Similar forms, though much smaller, occur in a thin bed in the Upper Cambrian sandstone on the railway-line at Caroline Creek. It may be added that in the valley of the South Loddon River, the tubicolar sandstone overlies unconformably the Algonkian schists.

(4) *Dikelocephalus Sandstone.*

Yellow friable sandstones, grits, and claystones, with the Dikelocephalus fauna, underlie Ordovician limestone at the Railton lime quarry; and the same series of beds crosses the railway-line at the Caroline Creek, 2 miles north-west of Dulverton Siding. The following organic remains have been obtained from these beds:—Dikelocephalus tasmanicus (Eth.), Asaphus sp., Ophileta sp., Ptychoparia stephensi (Eth.).* A univalve, referred by Mr. Etheridge to Raphistoma, has been found in the Cambrian beds behind the quarry. All these beds strike north-west and dip south-west. In the south of the island on the west flank of Mt. Stephens (Tim Shea locally) in the Florentine Valley, belts of yellow claystone and soft sandstone have yielded another form belonging to the same genus of trilobites, viz., Dikelocephalus florentinensis.

(*a*) *Dundas and Leven Slates and Breccias, &c.*

Green and purple slates, breccias, and brecciated conglomerates prevail in the North Dundas district, intruded by porphyroids or dynamically altered quartz and felspar porphyries, and interbedded with the tuffs of these (clastoporphyroids). Some of the latter have the appearance of indurated sediments, and lithologically resemble European greywackés, but their origin is probably attributable to volcanic action, and in all likelihood they were submarine tuffs. Slate on the North-East Dundas railway has yielded indistinct graptolite markings, interpreted as belonging to the Dendroidea, and probably to the genus Callograptus. At 12½ miles from Zeehan, on this railway-line, some slate was collected, showing monoprionidian graptolite thecæ.†

The central and western portions of the Zeehan field comprise a series of slates, tuffs, and breccias, which are lithologically identical with those of the Dundas and Leven series. They form a clearly marked horizon in a great

* Formerly Conocephalites stephensi. † Determined by Mr. T. S. Hall, M.A.

sedimentary series, which consists for the most part of dark grey slate and white sandstones and grits.

Interbedded with these latter are beds of tuffs and isolated areas of vesicular lava sheets and dykes. Petrologically these effusive rocks at some points resemble the spilite or amygdaloidal diabase of German authors; at others, they display clearly marked porphyroidal affinities. The majority of the Zeehan lodes are enclosed within these rocks.

Lithologically similar breccias, tuffs, and slates occur in the Leven Gorge, at Gunn's Plains, where they underlie the Ordovician limestone with an unconformable angle of dip. Intrusive porphyroids are associated with them here also. On the North-West Coast, in Barkworth's Bay, west of Goat Island, this breccia series rests unconformably upon the Algonkian schists and schistose conglomerates. The series is exposed all along the beach from Lodder's Point to the Penguin township, and on the Dial Range.

This series may be distinguished from the conglomerate on the West Coast ranges by the abundant breccias, the cherty nature of the fragments, and general absence of quartz pebbles.

The varied massive and schistose porphyries intimately associated with them correspond with similar developments of igneous rock at Mt. Lyell, Mt. Farrell, and on the West Coast Range generally, for which a like age must be accepted as probable. These are the dynamically affected quartz and felspar porphyries, to which the convenient descriptive term "porphyroid" has been applied. They are associated with granites and syenites, which are generally more basic than the Devonian granite, and they constitute a complex group of acid and sub-acid porphyries and porphyrites, with some, as yet, imperfectly understood basic varieties.

The Leven porphyries extend as far south as Bell Mount, where they may be seen in the road cutting round that hill; and in the axial line of the West Coast Range they stretch from Bass Strait to Birch's Inlet, on Macquarie Harbour. Fragments of this kind of porphyry enter into the composition of the Permo-Carboniferous conglomerates in regions drained by the Gordon and Derwent Rivers and their tributaries, and when released from the matrix have frequently misled the searcher for granite exposures.

No intrusion of porphyroids has been observed in Ordovician strata, and from the evidence accumulated in various portions of the island the period of eruption must have

terminated before the close of the Cambrian. It is still difficult to precisely define the exact horizon occupied by the slates and porphyroids, but stratigraphical evidence appears to indicate that these rocks belong to the Upper Cambrian.

(*b*) *Slate and Sandstone at the Needles, &c.*

At the eastern base of the Needles, between Mt. Stephens (Tim Shea) and Mt. Mueller, a belt of reddish and purple slate and quartzite strikes north-west with a north-easterly dip. It underlies Ordovician limestone on Wherret's Look-out, and forms the country rock at the Humboldt Copper Mine.

Clay slates and quartzites of Cambrian age are also seen west of Mt. Mueller and all round the base of Mt. Wedge, but it is uncertain what horizon they occupy in the system.

III.—Ordovician.

The actual sequence of Ordovician strata in Tasmania has not yet been ascertained. The Gordon River limestone, however, has been observed succeeding Upper Cambrian beds at Railton, and it is taken as being the base of the system. Accordingly, the Ordovicians are divided as follows:—

(2) Slate and sandstone in the goldfields of Lefroy, Mt. Victoria, Mathinna, Mangana, &c.

(1) Limestone on the Gordon, Florentine, and other rivers, at Railton, Mole Creek, Beaconsfield, &c.

(1) *Gordon River Limestone.*

This is exposed at various places throughout a great portion of the island from north to south and from west to centre. It appears at Point Hibbs, in the Lower Gordon, in the Franklin, Denison, and Jane Rivers, in the Valley of Rasselas, in the Florentine Valley, on Mt. Humboldt, Mt. Müeller, at the Junee Caves, on New River, at Mt. Farrell, Upper Blythe, Gunn's Plains, the Don River, Railton, Chudleigh, Mole Creek, Winkleigh, Beaconsfield, &c.

The limestone at Railton strikes N.W.-S.E., with a dip to the south-west. It rests with a slight unconformability on the Dikelocephalus-bearing sandstones of the Caroline

Creek series. It has yielded numerous specimens of Actinoceras.

The organic remains determined from the occurrences along the Gordon River include Favosites, Halysites, Syringopora, Stenopora, Orthoceras, Phragmoceras, Lituites, Orthis, Rhynchonella, Raphistoma, Euomphalus, Murchisonia, and the following species established by Mr. Johnston:—Straparollus tasmanicus, Scalites gouldii, Trochonema etheridgei, Tellinomya jonesii, Modiolopsis gordonensis.

The Gordon River from the entrance to the Gorge eastwards at the Great Bend shows numerous bars of this limestone crossing its bed, forming a limestone belt about 1½ mile wide. The rock here is dark grey, regularly bedded and somewhat argillaceous. On the hills near the Gorge it contains some impressions of Orthis. Its strike is N. 25° W., and its dip north-easterly, at about 70°. It is evidently the bedrock of the Gordon Plains and the Rasselas Valley. It is underlaid on the west by the crystalline pebbly sandstone, conglomerate, and quartzite, which form the front wall of the Thumbs and Mt. Wright, and which there is reason to believe are Lower Cambrian.

Similar limestone is met with a few hundred feet west of the Florentine River, and again east of the river, striking N. 10° E., and dipping north-westerly. It is also exposed east of the Little Florentine River, with about the same strike and dip. It reappears on the shoulder of Mt. Field West, and again at the Junee River, striking north-west and dipping north-easterly. Impressions of fossil shells resembling Orthis lenticularis are met with in this limestone at the Junee River and in the Valley of Rasselas.

Further south the limestone occurs at the head of the Styx River, and between that place and the Upper Florentine Valley. At the junction of the Gordon and Port Davey tracks it is faulted against the Cambrian conglomerate of Junction Hill. In the extreme south of the island it exists on the New River.

At Copper Creek, on Gunn's Plains, the same rock lies unconformably on the Dial Range breccias and conglomerates, and the same relations obtain at the Upper Blythe. At Beaconsfield it is faulted against the Cambrian grits and conglomerates of the Cabbage Tree Hill.

Its occurrence at Mt. Farrell is in the bed of the Macintosh River, a short distance above the junction of the latter with the Sophia River, where it is fossiliferous.

(2) *Auriferous Slate and Sandstone Series.*

This series is assumed to be of Ordovician age, partly from its analogies with Victorian strata, partly from the absence of Silurian fossils. It is, however, strange that no grapholites have been discovered. The strata form a well-recognised belt of clay slate, arenaceous slate, sandstone, and quartzite, extending from Fingal and Mangana through Mathinna to Mt. Victoria and Warrentina. To the north-west the zone widens so as to embrace Lisle and Lefroy. The general strike of the strata throughout the belt is N. 20° to 30° W., with varying dips due to anticlinal folds. From St. Patrick's River to Back Creek the dip is north-easterly, but changes to the south-west a few miles from Lefroy. As a north-easterly dip prevails on the west side of the Tamar, the river is either in a synclinal valley or masks a fault.

The gold quartz reefs which run through the belt apparently began to form after the close of the Silurian, and are a constant feature of the entire belt.

IV.—Silurian.

This system is represented by the following subdivisions:—

(2) Eldon Valley clay slates.
(1) Fossiliferous limestone, sandstone, and slate at Zeehan, Heazlewood, Queen, and Nelson Rivers, Lorinna, &c.

(1) The Silurian strata at Zeehan, believed, on the evidence of their contained fossils, to be of Middle Silurian age, comprise slates, limestone, and sandstones. These beds occupy a position to the eastward of the Cambrian sandstones, slates, and breccias, save where by faulting, the isolation of small Silurian areas within Cambrian boundaries has occurred.

Lithologically there is a very close resemblance between the Silurian and the Cambrian sediments on the Zeehan field, a fact which has been responsible for the massing of the two groups in previous geological literature. There are, however, marked differences between the assemblages of organic remains preserved in the rocks of the two systems.

The general strike of the Silurian sediments in the Zeehan field is between 45° and 80° west of north. Post-Silurian faulting has disturbed the beds, and minor varia-

tions of strike are frequent. The limestones appear to be the basal members of the system.

Mr. Etheridge has determined the following organic remains:—

From the Despatch Limestone—
- Asaphus, sp. ind.
- Hausmannia meridianus (Eth. fil and Mit.).
- Hausmannia, sp. ind.
- Illaenus johnstoni (Eth. fil).
- Amphion? brevispinus (Eth. fil).
- Leptodomus? nuciformis (Eth. fil).
- Eunema montgomerii (Eth. fil).
- Orthoceras, sp. ind.

From blue-grey Slate at Zeehan—
- Cornulites tasmanicus (Eth. fil).
- Cromus murchisoni (De Kon.?).
- Rhynchonella borealis (Schlotheim?).
- Rhynchonella cuneata (Dalman).
- Strophodonta, sp. ind.
- Tentaculites, sp. ind.

From white Quartzite at Zeehan—
- Lophospira, sp. ind.
- Murchisonia, sp. ind.
- Raphistoma, sp. ind.

The Silurian beds are penetrated by dykes of granite-porphyry, which have suffered faulting and crushing by later earth movements.

To the west of the Zeehan field is a large development of gabbro and serpentine, forming the aureole of the granite mass of Mt. Heemskirk.

Numerous silver-lead veins intersect the field in all directions, and at least one valuable lode of stannite exists.

At the Heazlewood, in the vicinity of the Whyte River, are limestone and sandstone strata of the same age as the Zeehan series, striking N. 40° W., and dipping generally to the north-east.

Mr. Etheridge has determined the following forms from these beds:—
- Cornulites tasmanicus (Eth. fil).
- Cromus murchisoni (De Kon.).
- Rhynchonella decimplicata (J. de C. Sow.).

[n] NOTE.—For much of the palæontology of this paper the works of R. M. Johnston, A. C. Seward, E. A. Newell Arber, R Etheridge, Jn., J. Shirley, Dennant and Kitson, V. Ellingshausen, Feistmantel and others have been consulted and used. Mr R. Etheridge and Mr. F. Chapman have freely given assistance in several determinations.

Rhynchonella capax (Conrad).
Tentaculites, sp. ind.

Silurian sandstone with abundant casts of Rhynchonella occurs near Lorinna, on the Five-mile Rise.

Grey, white, and yellowish gritty sandstones, plentifully charged with impressions of brachiopods, are found in the valleys of the Queen and Nelson Rivers, and west of Queenstown on an old track leading to Howard's Plains. Some brachiopod-bearing sandstone occurs at the Mt. Lyell Mine in close proximity westwards to the large clay course, which runs in a northerly direction through the Reward claims. Rock met with underground in the Lyell Blocks Mine has yielded specimens of a Rhynchonella, which, *vide* Mr. Etheridge, is, in all probability, R. Capax (Conrad). Similar specimens occur behind the township of Gormanston. Fragments of similar rock have been found on the Gordon track, 5 miles from Tyenna.

Trilobite-bearing Silurian rocks exist also near the Wilson River, north of the Pieman. On the north-west face of Mt. Arrowsmith Silurian sandstone dips west at a low angle.

In the Eldon Valley are clay slates and mudstones, with undetermined forms of Calymene, Orthis, Cardiola, &c., which have been placed provisionally at the base of the Silurian.

At the White Hawk, north of Mt. Farrell, a bed of limestone occurs between a sandstone on the west and pebbly sandstone on the east, the whole dipping westward. The sandstone below the limestone contains impressions of Rhynchonella borealis, and that above has many impressions of Rhynchonella capax. (Conrad), var. meridionalis (Etheridge).

V.—Devonian.

The gap between the Silurian and Permo-Carboniferous is not bridged by any record of sedimentation. Doubtful beds occur near Fingal and in the Eldon Valley, but they are too insufficiently known to admit of classification.

This period, however, was marked by the intratelluric consolidation of a great mass of igneous rock, subsequently exposed and appearing in various parts of the island in the form of granite and serpentine. The serpentine is generally a peripheral mantle of serpentinised gabbroid and ultra-basic rocks surrounding the granite masses on the West Coast. Occasionally between the granite and serpentine is an aureole of actinolitic rock. On the East

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Coast, however, serpentine has not been met with. The localities where serpentine is known to occur are as follows:—Trial Harbour, Comstock, Dundas, Parson's Hood, Heazlewood, Hamilton-on-Forth, Styx River, Upper Florentine River, Boyes River. Aplitic and other granitoid veins have been noticed to invade serpentine at the Heazlewood and Anderson's Creek; gabbro, in the North Dundas tinfield, is also traversed by granite-porphyry dykes. There is a junction of granite with serpentine on the beach at Trial Harbour. At the contact the serpentine is highly altered, and is penetrated by small dykes of porphyry, which proceed from the granite mass. These facts indicate the prior consolidation of the basic rock.

Granite occurs in a meridional line down the East Coast, extending from Flinders Island to Maria Island. It forms Mt. Cameron, Mt. Stronach, the Blue Tier, Freycinet's Peninsula, and is exposed at Ben Lomond, ~~Lyell~~, Lisle Golconda, and at the base of Mts. Arthur and Barrow. Exposures are also seen at Middlesex, Granite Tor, Upper Blythe, Hampshire Hills, Heazlewood, &c. The Meredith Range and Mt. Heemskirk are huge granite massifs. The most southerly occurrence is at Cox's Bight.

Granite or acidic vein-matter penetrates all rocks of earlier date than Permo-Carboniferous; but granite itself has not been seen intrusive in strata of the latter age.

An important feature by which the Devonian granite is lithologically distinguishable from the older granitic and syenitic rocks of the porphyroid group is its uncrushed character. It has not been subjected to the dynamic stresses which the Cambrian granites and syenites have undergone.

The normal rock is a biotite granite. In the tin-mining districts a development of muscovite or lithia-bearing mica takes place, and greisen formations frequently occur, accompanied by patches and veins of pegmatite. Where granite exists on the goldfields of the North-East (round Mts. Barrow and Arthur) hornblende enters into its composition. Tin-bearing lodes occur in the granite at Ben Lomond and Mt. Heemskirk, while on the Blue Tier floors or stocks of altered granite form large tin-ore bodies of low grade. Quartz or granite-porphyry dykes at Mt. Bischoff have shed the vast accumulation of tin ore which has been mined there for the last 36 years with wonderful success.

The quartz-porphyry and granite-porphyry dykes in the Dundas district, the tourmaline-gold-copper lodes at Mt.

Black, the axinite veins at the Colebrook, and the stannite lodes and quartz-porphyry dykes at Zeehan, all denote a granitic reservoir below the mineral fields of the West Coast; and the gold quartz reefs of the eastern part of the island may be similarly interpreted. Serpentinised rocks at the Heazlewood, Dundas, and Trial Harbour carry lodes of silver-lead, copper, and nickel ores. Osmiridium (iridosmine) is a constituent of sands in the neighbourhood of serpentine masses (always associated with gold). An extraordinary feature is the occurrence of tin ore with serpentine at Dundas.

VI.—Permo-Carboniferous.

This system in Tasmania represents a time interval which is too late in the geological record to be called exclusively Carboniferous, and as a whole too early to be exclusively Permian. It shows no traces of the Carboniferous Lepidodendroid flora and Calamites. Cooler, or even frigid, climatic conditions were ushering in the Glossopteris flora, which had already appeared in the Australian Carboniferous. Such characteristic forms as Productus semireticulatus, Spirifera striata, and the Phillipsia trilobite, which lived in Australian Carboniferous waters, are unknown in Tasmania, though many other Carboniferous species still lingered. On the other hand, Stenopora, Strophalosia, &c., give a Permian facies to the marina fauna. Generally an impoverishment of marine forms of life was in progress.

During this time a continued process of withdrawal of the sea took place, finally leaving the surfaces of the older, folded strata, covered with comparatively shallow sheets of water, forming probably chains of lakes and arms of the sea. Oscillations of the strand level were inconsiderable. The sedimentation would seem to have been largely in enclosed or partially enclosed seas, or at most, on an epicontinental sea-floor. The base of the system rests upon the ancient rocks (Cambrian, Ordovician, or Silurian); sometimes upon the Devonian granite, which was then in places already exposed by denudation.

Glacial conditions prevailed at the time of the deposition of the basal conglomerates. Similar conditions are known to have existed in Australia, India, and Southern Africa during this period. The similarity of the Permo-Carboniferous and Mesozoic flora in these three continents (including Tasmania) is suggestive of a mutual land connection—that of the hypothetical Gondwana Land.

The Permo-Carboniferous strata in Tasmania are usually horizontal or gently inclined. They have not been deformed by folding, but have been greatly depressed or raised by faulting. The sills of diabase, which have penetrated them on an enormous scale, do not seem to have tilted them to high angles. Innumerable displacements, however, have been caused by faults.

The thickness of the maximum development of the beds belonging to this system is estimated at about 2000 feet.

The strata comprise conglomerates, grits, limestones, sandstones, and mudstones, with shales and thin coal seams, all indicative of shallow-water conditions. They appear at the surface over a large area, being exposed in nearly all parts of the island.

The subdivisions are as follow:—

Upper—

(6) Elæolite and alkali syenites with various alkaline porphyries at Port Cygnet and along D'Entrecasteaux Channel. Precise age unsettled.

(5) Southport sandstones and shales.

(4) Mt. Cygnet and Adventure Bay sandstones and shales.

(3) Upper Marine mudstones overlying Mersey coal; Porter Hill shales and sandstones, Sandy Bay.

(2) Lower coal measures (= Greta horizon, N.S.W.), Mersey Basin, Preolenna, Henty River; Tasmanite beds.

Lower—

(1) Conglomerates, grits, limestones, and lower marine mudstones throughout South-East, North-East North-West, and Midlands. Glacial conglomerates, grits, micaceous sandstones, and slaty flagstones in thick beds form the base of the system.

(1) The base sometimes consists of marine gritty conglomerates, as on Bruni Island, with erratic boulders; sometimes of limestone and conglomerate with a calcareous cement, also carrying erratics; or of glacial till, conglomerates, and sandstones with erratics, as at Wynyard, or of marine mudstone with boulders, as on the banks of the Derwent. The glacial beds at Wynyard, where a full development of them occurs, have been estimated by Prof.

David to represent a thickness of 1200 feet. The basal beds are well represented on Bruni and Maria Islands.

On Maria Island, north-east of Darlington, are coastal cliff sections, below Mt. Maria (with its twin peaks, the Bishop and Clerk), showing nearly 600 feet of limestone and mudstone, the lower 10 or 12 feet of which consist of boulder limestone and conglomerate, with large erratic blocks of granite, slate, and sandstone. The series as here developed has been divided by Mr. R. M. Johnston into palæontological zones as follows (in descending order):—

(v) Crinoid zone.
(iv) Productus zone.
(iii) Fenestella zone.
(ii) Pachydomus zone.
(i) Erratic zone.

(i) Some of the erratics in this zone weigh over a ton. The matrix between the boulders is impure limestone.

(ii) This zone, in which Pachydomus predominates, is 80 feet in thickness, and comprises beds of limestone and calcareous shale. One bed, 40 feet thick, is almost entirely composed of shells of Pachydomus. The following are characteristic fossils of this zone:—Pachydomus globosus (J. de C. Sowerby), P. de koninckí (Johnston), P. hobartensis (Johnston), P. gigas (McCoy), P. carinatus (Morris), Eurydesma cordata (Morris), Notomya gouldii (Johnston), N. trigonalis (Johnston), N. beddomeii (Johnston), Deltopecten limæformis (Morris sp.)*, D. fittoni (Morris sp.), Aviculopecten squamuliferus (Morris), Platyschisma ocula (J. de Sow), Conularia tasmanica (Johnston), Stenopora tasmaniensis (Lonsdale), S. informis (Lonsdale), S. ovata (Lons.).

(iii) This zone consists of mudstones 124 feet thick, replete with crushed specimens of Fenestella internata (Lons.), F. plebeia (McCoy), Protoretepora ampla (Sow.). With these are Spirifera tasmaniensis (Morris), S. darwinii (Morris), S. glabra (Morris), S. duodecimcostata (McCoy), Productus brachythærus (G. Sow.), Strophalosia clarkei (Eth. fil), Pleurotomaria morrisi (McCoy).

(iv) This zone includes a group of blue hydraulic limestones worked at one time for Portland cement. Beds of

* = Aviculopecten limæformis (Johnston). Deltopecten is a genus formed by Etheridge fil in 1892, occupying an intermediate position between Aviculopecten and Pecten proper. *Vide* Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales, by R. Etheridge, Jr., and W. S. Dun, 1906, p. 22.

calcareous shale and mudstone separate the limestone bands. The limestones contain Stenopora, Fenestella, Crinoids, Spirifera, Strophalosia, Productus, Deltopecten, Pachydomus.

(v) The Crinoid zone embraces limestones which are composed principally of Crinoid remains, and is about 30 feet in thickness.

The dip of the entire group of beds is to the south-east.

The lower division of the Permo-Carboniferous is also developed on Bruni Island, in D'Entrecasteaux Channel. The eastern shore of this island abounds in cliff escarpments, the stratified rocks dipping south of west. The core of the island is diabase. A narrow strip of sandy beach, 6 or 7 miles long, connects North with South Bruni. The marine Permo-Carboniferous beds flank the diabasic backbone of the island up to a height of 300 or 400 feet. The basal beds here are marine gritty conglomerates, with Spirifera strzelecki, S. darwinii, Pterinea macropteris, and trunks of conifers. At One-tree Point, North Bruni, the lower beds are grits, conglomerates, limestone, and white and yellow arenaceous mudstones. Stones of granite, porphyry, slate, &c., are common in the conglomerate. Some of the boulders are of huge size, and their transport is ascribed to the agency of ice. Overlying the conglomerate is a bed of limestone 4 feet thick, composed nearly entirely of large specimens of Stenopora ovata (Lons.). Large conifer trunks are embedded in both the limestone and conglomerate.

At Variety Bay, a little north of Cape Frederick Henry, the fossiliferous mudstones are well exposed. Mr. R. M. Johnston gives the following descending section.

	Feet.
6. Fenestella Zone.—Finely laminated mudstone, with abundant Fenestella fossula and Protoretepora ampla	70
5. Spirifer Zone.—Siliceous limestone, with casts of Spirifera convoluta, S. strzelecki, Dielasma (Terebratula) sacculus, Deltopecten limæformis, Deltopecten fittoni, &c.	12
4. Pleurotomaria Zone.—Hard, dense, siliceous rock replete with thin layers almost wholly composed of the casts of Pleurotomaria morrisiana	4
3. Siliceous limestone and mudstone, with occasional casts of Pleurotomaria morrisiana.....	10
2. Hard conglomerates and grits without fossils	4
1. Diabase.	

These beds have a westerly dip of from 15° to 20°

For 5 miles along the sea coast east and west of Wynyard the basal glacial beds of the Permo-Carboniferous system are exposed at water-level, dipping north-westerly at low angles. They consist of glacial till, conglomerates, with ice-scratched boulders, sandstone, and clay shale, and rest upon dark Ordovician slate containing Phyllograptus, Diplograptus, various Phyllocarids and brachipods allied to Obolella.

The Lower Marine mudstones are exposed all along the Derwent Valley, near Hobart, at Glenorchy, Bridgewater, New Norfolk, on the Styx River, near Tyenna, &c. They rise by a succession of faults to a height of 2000 feet on the slopes of Mt. Wellington. The Huon-road, as it rises from the city of Hobart, shows good sections of these beds.

The main subdivisions are—

3. Fenestella mudstones, at Cascade, Grange, Porter Hill, &c.
2. Spirifera and Strophalosia mudstones, Huon-road.
1. Pachydomus limestones and sandstones, Cascades, Bridgewater.

The principal organisms found in the above are as follows:—

Pachydomus Zone.

Pachydomus konincki
„ globosus
„ hobartensis
Eurydesma cordata
Spirifera convoluta
„ stokesii
Productus brachythærus
Aviculopecten (Deltopecten) limæformis
„ „ fittoni
Pleurotomaria morrisiana
Pterinea macroptera
Conularia derwentensis
„ tenuistriata
Lithodomus gouldii

Spirifera Zone.

Spirifera darwinii
„ duodecimcostata
„ convoluta
„ strzeleckii
„ glabra
„ tasmaniensis
„ oviformis
„ lata
„ vespertilio
„ stokesii
Orthotetes crenistria
Terebratula (Dielasma) sacculus
Deltopecten limæformis
„ fittoni
Aviculopecten squamuliferus
Chænomya (Sanguinolites) etheridgii
Stenopora tasmaniensis
„ crinita
Platyschisma ocula

Fenestella Zone.

Fenestella internata
„ plebeia
Protoretepora ampla
with organisms of the other two zones

At Eaglehawk Neck the lower beds occur. The coarse grits and conglomerates form a level floor on the sea beach, with rectangular joints filled with oxide of iron. This is known as the Tesselated Pavement. The jointing is possibly due to the vicinity of a concealed body of intrusive diabase. At the Blow Hole, near the above, Mr. R. M. Johnston gives the following section:—

	Feet.
3. Yellow or white chalky mudstones with Spirifera glabra, Dielasma sacculus, &c.... about	150
2. Mudstone and calcareous sandstone, with Fenestella, Productus, Spirifera, Pachydomus, Platyschisma, Deltopecten, Pleurotomaria—about	60
1. Basal grits. Thickness not known.	

At the Middle Arm of the Tamar is a small development of the Lower Marine limestone resting upon the older Palæozoic rocks. The upper part represents characteristically the Fenestella zone, while the lower part contains Eurydesma in abundance.

On the Meander, near Cheshunt, the mudstones contain Spirifera, Productus, Dielasma, Pachydomus, Eurydesma, Pterinea, Deltopecten, Aviculopecten, Platyschisma, and Pleurotomaria.

Limestones occur in the Fingal Valley, at Marlborough, Eastern Marshes, and with the mudstones and conglomerates all round the borders of the Western and Central Tiers.

In the north-eastern part of the island, on the right bank of the River Piper, not very far from Lilydale, foraminiferal limestone—with Nubecularia stephensi (Howchin) and Spiroloculinæ—of this system has been found. The Lower Marine mudstones are exposed for a thickness of about 400 feet on the Jessie River, Preolenna, south of Wynyard. Below the coal of the Mersey (= Greta) horizon there fossiliferous mudstones come in for about 150 feet, containing Fenestella, Spirifera, Aviculopecten, Pachydomus, &c. These overlie non-fossiliferous mudstone, which extends down to the Jessie River, 200 feet or more.

In the neighbourhood of the Eldon Valley mudstones occur, with dwarfed varieties of Spirifera and Rhynchonella.

Round the base of East Pelion and Mt. Pelion are mudstone and limestone, with Fenestella, Spirifera, Productus, Aviculopecten, &c. Similar beds underlie the coal measures

on the Henty River, West Tasmania, yielding the following:—Spirifera tasmaniensis, Spirifera avicula, Spirifera convoluta, Chænomya, Fenestella internata, F. plebeia, Protoretepora ampla, Stenopora tasmaniensis.

At Port Cygnet the succession is:—(3) Fenestella zone; (2) Spirifera zone; (1) shaly mudstone. The fossiliferous sandstones occur all round Lovett and Lymington.

The Lower Marine beds in the Mersey basin have been disclosed by boring at Tarleton, where 105 feet of pebbly sandstone and conglomerate containing Permo-Carboniferous marine fossils rest upon Ordovician limestone. The organic forms are Stenopora tasmaniensis, Spirifera tasmaniensis, Fenestella plebeia, Dielasma sacculus, and Pleurotomaria morrisiana.

(2) The lowest beds of the upper division of the Permo-Carboniferous are the sandstones and shales which enclose the coal seams of the Mersey horizon. These correspond with the Greta series of New South Wales, and, like those measures, separate the Upper Marine series from the Lower Marine.

The Mersey coal measures consist of grits, sandstones, and marls, with seams of coal generally not exceeding 2 feet in thickness. The analyses of the coal from different collieries in the district are as follows:—

	Fixed Carbon.	Gases, &c.	Ash.	Moisture.
(1)	36·5	46·6	4·0	12·9
(2)	36·6	41·2	9·8	12·4
(3)	40·5	44·4	5·8	9·3
(4)	41·7	48·0	2·4	7·9

Remains of the vertebral column and ribs of a small amphibian(?) were found on the spoil heap from a shaft sunk near Railton in these measures.

The plant remains are the forms characteristic of the Permo-Carboniferous, viz.:—

Glossopteris browniana (Brongn.)
„ ampla (Dana)
„ indica (Schimper)
Gangamopteris angustifolia (McCoy)
„ cyclopteroides (Feistmantel)
Noeggerathiopsis hislopi (Bunbury)
Phyllotheca australis (Brongn.)
Cardiocarpus sp.

In this basin, near the Great Bend of the River Mersey, near Latrobe, are beds of Tasmanite shale, consisting of sand and mud charged with oil-bearing vegetable spores,

and considered to be of value for the manufacture of lubricating and illuminating oils. The precise local relation which they bear to the coal seams is not known, but geologically they are on the same horizon. The fossils contained in these beds are as follows:—Spirifera tasmaniensis (Morris), Cardiomorpha gryphoides (de Kon.), Pachydomus hobartensis(?) (R. M. Johnston), Pleurotomaria morrisiana (McCoy), Pteronites latus (de Kon.), Aviculopecten sp.

At Preolenna, south of Wynyard, between the Flowerdale and Jessie Rivers, yellow sandstone and clays with seams of coal (with Glossopteris) attain a thickness of 250 feet. The proximate analysis of the coal, from seams varying from 20 inches to $3\frac{1}{2}$ feet in thickness, ranges from 44 per cent. to 52 per cent. fixed carbon, 41 to 50 per cent. volatile matter, and 5 to 9 per cent. ash. Portions of these seams consist of kerosene shale or cannel coal, containing 76 per cent. gas and 21 per cent. fixed carbon. The coal-bearing beds are covered by fossiliferous mudstone, and rest on similar strata.

The beds of the coal measures series are developed on Mt. Pelion, Mt. Ossa, Mt. Oakley, at the north end of the Du Cane Range and on the Eldon Range. A seam of coal is known at Coal Hill, west of Lake St. Clair. The coal measure basin appears to deepen going south.

Near Barn Bluff is a seam of coal in a band of black micaceous shale, containing remains of Glossopteris and Noeggerathiopsis. The coal bed there rests upon conglomerate, and is overlaid by Permo-Carboniferous marine strata. A cannel coal similar to that at Preolenna has been found near Barn Bluff in loose blocks, supposed to be remnants of a wasted seam. Ice-action has been invoked to account for the breaking up of this seam.

On the north side of the Henty River, between the Henty and Badger, the lower coal measures are hard dark-grey shales, which contain Glossopteris browniana (Bngt.), Glossopteris ampla (Dana), Gangamopteris cyclopteroides (Feistm.), and Noeggerathiopsis hislopi (Bunbury).

At Harefield, in the Fingal coal basin, 97 feet of conglomerate, sandstone, and shale, with coal stains and impressions of a plant resembling Schizoneura, have been shown by boring to underlie beds belonging to the Upper Marine series.

(3) *The Upper Marine Series.*—In this are included the fossiliferous mudstones which overlie the Mersey coal

measures. Many of the organic remains in these are identical with those in the Lower Marine; some of the latter, however, have disappeared. The genera Fenestella, Spirifera, Dielasma (Terebratula), Pleurotomaria, Pachydomus, Aviculopecten, Cardiomorpha, Pterina, &c., have been recorded.

The upper zones of sandstone and shale at Porter's Hill, Hobart, correspond with the Upper Marine beds of the Mersey. Two hundred feet of these are exposed along the Derwent, containing, besides fragments of the plant Gangamopteris, the following forms:—Cythere tasmanicus (Johnston), Spirifera tasmaniensis, S. darwinii, S. duodecimcostata, Dielasma sacculus, Avicula, Arca, Aviculopecten, Eurydesma, Edmondia, Inoceramus, Pachydomus, Pleurotomaria, Conularia, &c.

At Harefield, in the Mt. Nicholas Valley, a bore revealed 313 feet of Upper Marine beds below the Mesozoic coal measures. These consist of sandstone, shale, conglomerate, and limestone, containing remains of Fenestella and other forms.

(4) The Mt. Cygnet and Adventure Bay coal measures may be taken as corresponding with the Newcastle series of New South Wales.

At Mt. Cygnet the measures rest on the Fenestella beds, and the coal seam, 3 to 4 feet in thickness, is enclosed in sandstone, which is occasionally pebbly. The proximate analysis of the coal is: fixed carbon, 63·9 per cent.; volatile matter, 13·2 per cent.; ash, 22 per cent. The shale of this seam contains impressions of Vertebraria australis and Gangamopteris spathulata.

At Adventure Bay, on Bruni Island, coal measure seams and shales lie comformably on the Lower Marine mudstones, &c. They contain dwarfed forms of Glossopteris browniana var. præcursor (Brgt.), Gangamopteris spathulata (McCoy), Gangamopteris obliqua (McCoy).*

(5) At Southport sandstones and shales rest upon conglomerate and pebbly sandstone, with marine shells. A diamond-drill bore reached the basal conglomerate beds at a depth of 500 feet. The recorded plant remains from the shales are Vertebraria australis and Pecopteris lunensis (Johnston).

(6) The alkaline rocks which form a N.E.-S.W. belt running from the Huon River through Port Cygnet to

* These forms of Gangamopteris are referred by Arber to G. cyclopteroides (Feistmantel). *Vide* "The Glossopteris Flora," by E. A. Newell Arber, 1905, pp. 104–5.

Woodbridge and Kettering are referred provisionally to the close of this period. It is definitely known that they are intrusive in the Lower Marine sandstones and mudstones, and they appear to be cut through by the diabase, which is considered to date from the close of the Mesozoic.

The belt comprises the following rock varieties: —

Alkali Syenites.	*Elaeolite Syenites.*	*Essexite.*
Quartz-augite syenite	Pyroxene foyaite	Essexite
Aegirine-augite syenite	Mica foyaite	
Alkali-syenite porphyry	Jacupirangite	
	Amphibole foyaite porphyry	
	Sölvsbergite porphyry	
	Mica sölvsbergite	
	Tinguaite porphyry	
	Monchiquitic nephelinite	

Auriferous quartz and pyrites have been developed near the line of contact of these igneous rocks with the Permo-Carboniferous sediments, and a good deal of alluvial gold has been recovered from the creeks and flats.

VII.—Mesozoic.

In Tasmania no essentially marine sediments are known to have accumulated in Mesozoic times. The process of retreat of the oceanic waters evidently persisted. Land plants, fish, and amphibian remains point to sub-aerial, fluviatile, and lacustrine conditions. The poverty of the fauna and the aridity of climate indicated by saliferous beds tend to confirm this view.

The lowest beds of this era rest conformably upon the Upper Permo-Carboniferous. The total thickness of the Mesozoic strata is tentatively estimated at about 1200 feet.

The intrusive sills of diabase which penetrated the Permo-Carboniferous strata forced their way also between the beds of this era, and as the upper coal-bearing beds have been affected in this way, it is evident that the diabase invasion took place at the close of the Mesozoic or in the early Tertiary.

Modern geological theory postulates a general shrinkage of the earth's mass upon its centre, and, as a consequence, the dominant movements are downward, not upward.

There has been, however, a greater relative sinking of the ocean floors (which are believed to have a higher specific gravity than that of the land areas). This subsidence is supposed to have been attended by a compression, and incidentally a raising of the continental segments. The

elevated land tracts subsequently proceeded to settle down to the level of isostatic equilibrium.

Possibly some diastrophic action of a minor character, and certainly the processes of base levelling, would also lower the surface of the land and bring about transgressions of the epicontinental seas. Finally, stresses would be developed, causing fracturing and faulting down the epicontinental platforms and margins of the land, and originating generally broad physical features identical with those which we see in our late Palæozoic and Mesozoic areas.

If this interpretation is correct, the huge step faults marked by the eastern escarpments of the diabase-capped central and eastern tiers can be explained. The successive tiers between the centre of the island and the eastern coast may be considered as successive steps leading down from the central "horst" to the coastal plains.*

The Mesozoic strata in Tasmania cannot as yet be broken up with any certainty into divisions corresponding with those of Europe, owing to the absence of stratigraphic breaks and adequate palæontological evidence. The utmost that appears possible for the present is to divide both stratified and igneous rocks into Lower and Upper Mesozoic, with a ternary subdivision of the lower group. Thus:—

(2) Upper Mesozoic—
  (iv) Diabase in intrusive masses, sills, or dykes.

(1) Lower Mesozoic—
  (iii) Fingal series or upper coal measures.
  (ii) Ida Bay series.—Sandstones and slates with coal at Ida Bay.
  (i) Knocklofty series—Variegated sandstones with Vertebraria indica (Royle),† remains of heterocercal fish and amphibians.

(i.) *Knocklofty Series.*—The sandstones at Knocklofty, the Domain, Tinderbox Bay, Sandy Bay, and probably at Ross, belong to this horizon. From the Cascades to Knocklofty are about 1000 feet of sandstone, from which the

* "In considering the coasts of Australia we must leave out of account the east coasts of Australia and Tasmania, which appear for many reasons to be a fractured margin of recent age, presenting no indications of negative movement"—The Face of the Earth: E. Suess, 1906 (Sollas' transl. Vol. II., p. 521).

† Arber has united Vertebraria australis (McCoy) with V. indica (Royle), "since there do not appear to be any good characters which clearly separate them" (Glossopteris Flora, 1905, p. 99).

remains of the fish Acrolepis hamiltoni (Johnston and Morton) have been recorded. These authors give the ascending section of the beds as follows:—

	Feet.
1. Yellow fissile sandstone	20
2. Flaggy sandstone with fish remains	5
3. Mottled shales with plants	60
4. Thick sandstone beds, quarried for building	715
	800

Sandstone near Tinderbox Bay is on the same horizon as the Knocklofty beds, and has yielded remains of a fish described by Messrs. Johnston and Morton under the name of Acrolepis tasmanicus. This sandstone overlies conformably the uppermost beds of the Permo-Carboniferous mudstones, as developed at Tinderbox Bay, Huon-road, and Waterworks Valley near Hobart.

This series of sandstones and shales contains the plant remains Vertebraria indica (Royle) [= V. australis, McCoy]. Vertebraria was discovered by Zeiller in 1896 to be the rhizome of the fern-like plant Glossopteris. In Tasmania it is restricted to the above series, and to the Southport beds.

Mr. Johnston considers the Lower Sandy Bay mudstones exposed 3 miles from Hobart on the Brown's River-road to be the base of the system. They contain obscure plant impressions.

The building stone at Ross probably belongs to this series of beds; as also possibly the saliferous sandstone of the midlands. Several salt pans occur on the estates of Mona Vale, Ballochmyle, Lower Park, and Ellenthorpe, in a chain extending for 7 miles N.W.-S.E. The individual lagoon beds or pans are from 1 to 100 acres in area. In dry seasons hundreds of tons of salt have been taken from them, and used for farm and domestic purposes. They were prized by the aboriginals, and were often the cause of tribal conflicts. Saliferous sandstone exists also near Richmond, on the Coal River 3 miles east of Colebrook, and reappears south of the town. Early settlers used to collect salt for household use from the caverns in this rock all along the line of the Richmond hills. Whether these saliferous sandstones belong to the Lower or Upper Mesozoic is a matter which needs investigating.

(ii) *Ida Bay Series.*—This comprises coal-bearing shale and sandstone at Ida Bay. About a mile south-west of the bay and 150 feet above sea-level are the coal-bearing beds. In the shales above the coal are impressions of Zeugophyllites* and Pecopteris lunensis (Johnston).

The beds of these two subdivisions of the Mesozoic are regarded as being on the horizon of the Narrabeen-Hawkesbury series of New South Wales (Trias.).

(iii) *Fingal Series or Upper Coal Measures.*—The upper coal measures of Tasmania are, from the affinities of their plant remains, considered to be on the Hawkesbury-Wianamatta horizon of New South Wales (Rhaetic?). The critical species for the Clarence measures, Tæniopteris daintreei (T. spathulata), has not been found in them. The only two forms of this genus hitherto discovered are T. tasmanica (Johnston) and T. morrisiana (Johnston). The most abundant plant impressions in these measures are those of Thinnfeldia odontopteroides, Alethopteris australis, and Zeugophyllites elongatus. The equisetal genus Phyllotheca is also common.

The Mesozoic coal measures of Eastern Australia have recently been transferred from the Trias-Jura to the Jura. Mr. W. S. Dun remarks†:—"It would appear advisable to (1) discontinue the use of the term Trias-Jura usually applied to this formation by Australian geologists; and (2) consider the Eastern Australian Mesozoic coal measures—characterised by the relatively great abundance of Tæniopteris daintreei (= spathulata), Alethopteris australis (= Cladophlebis denticulata), and numerous types of conifers and Thinnfeldia, together with the Lake Eyre beds, as Jurassic."

In accordance with this the Ipswich formation in Queensland, the Clarence measures and Talbragar fish beds in New South Wales, and the South Gippsland and Otway coal measures in Victoria, all of which contain Tæniopteris daintreei, are now assigned to the Jurassic system.

The Wianamatta, Hawkesbury, and Narrabeen beds have not yielded this plant, nor have the Tasmanian Mesozoic measures. The evidence certainly is negative, and consequently inconclusive. For the present, however, the

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* Zeugophyllites elongatus (Morris) has been transferred by A. C. Seward to the genus Phoenicopsis of Heer. See Arber: Gloss. Flora, p. 183. On the other hand Dr. F. Kurtz includes it under Podozamites elongatus (Morris), Feistm. Q. J. Geol. Soc. 1903, p. 25.

† Geol. and Min. Resources of the Western Coalfield, by J. E. Carne, Mem. Geol. Sur. New South Wales, 1908, p. 42.

whole of the Mesozoic groups of strata in Tasmania are regarded simply as Lower Mesozoic. The Knocklofty beds appear to correspond lithologically with the Hawkesbury sandstones. The upper coal measures have been looked upon by English authors as Rhaetic.

The strata occupy discontinuous areas, which are separated from one another by intrusive masses of diabase. Much faulting occurs. They occupy positions varying from sea-level to nearly 3000 feet above the sea. Their vertical thickness, as observed, is not less than 1200 feet, and probably exceeds this. They lie horizontally or at low angles, usually not exceeding 10° or 20°. Lithologically they are yellow, brown, greenish, and bluish-grey sandstones, frequently markedly felspathic, alternating with grey or bluish-grey shales.

The coalfields probably at one time belonged to one basin, but as they are now disconnected, it is convenient for purposes of reference to class them geographically in separate divisions. The following division embraces the different fields: —

Northern—

(1) Longford basin.

Southern—

(2) Colebrook (Jerusalem) and York Plains basin.
(3) Ouse basin.
(4) Derwent and Richmond basin.
(5) Huon basin.
(6) Recherche basin.

South-Eastern—

(7) Schouten and Spring Bay basin.
(8) Tasman Peninsula Basin.

Eastern—

(9) Fingal basin.
(10) Llandaff and Douglas River basin.

(1) *Longford Basin.*

The upper coal measures crop out near Norwich from below the sediments of the Launceston Tertiary area, and apparently succeed the fringe of Permo-Carboniferous marine strata which skirt the northern face of the Western Tiers. The coal seams have a thickness of 3 to 4 feet.

(2) *Colebrook (Jerusalem) and York Plains Basin.*

The Mesozoic strata fringe everywhere diabase-crowned hills. At York Plains sub-anthracitic seams of coal up to 4 feet in thickness occur in these beds. The coal assays 60 to 67 per cent. fixed carbon, 13 to 14 per cent. gas, and 16 to 23 per cent. ash. At Colebrook bluish-grey sandstone overlies a seam of coal 2 feet thick; and other seams up to 3 feet have been met with.

At Green Ponds horizontal beds of these sandstones have been preserved. At Mike Howe's Marsh, 17 miles north-west of Oatlands, soft yellow sandstones dip north-westerly, and contain coal assaying 62 per cent. fixed carbon, 18 per cent. gas, and 10 to 11 per cent. ash.

(3) *Ouse Basin.*

The strata of this coalfield comprise soft yellowish-brown felspathic sandstones and grey shales with characteristic fern impressions. The general dip is to the west, at an angle of about 3°. Fragments of silicified wood are frequent. Seams of coal from 2 to 5 feet thick exist at this horizon. Analyses show from 53 to 63 per cent. fixed carbon, and 21 to 25 per cent. volatile matter. Below the coal-bearing sandstones are a series of siliceous or quartzose sandstones, corresponding with the freestones quarried at Knocklofty, Ross, &c. The coalfield is nearly encircled by igneous rocks—by basalt to the north-west and diabase on the north-east, east, and south.

(4) *Derwent and Richmond Basin.*

Mesozoic sandstones and shales flank the ranges round Mts. Wellington, Direction, and Dromedary, along the valley of the Derwent between Hobart and Bridgewater, and again between Bridgewater and Richmond.

Coal-bearing beds of shale and sandstone are met with round New Town, where they repose on the grey and yellow building stone, the beds of which belong to the Knocklofty series. The coal shales contain plant impressions characteristic of the upper coal measures, the most abundant forms being Alethopteris australis (Morris), Thinnfeldia odontopteroides (Morris), and Neuropteris tasmaniensis (Johnston). Zeugophyllites elongatus (Morris) and the common species of Phyllotheca also occur.

North of Mt. Direction sandstones of this division carrying coal dip gently towards the west. The associated shales

contain impressions of Thinnfeldia, Phyllotheca, and Zeugophyllites.

(5) *Huon Basin.*

Felspathic sandstones and shales occur on the divide between the Huon and North-West Bay River basins. They contain several coal seams from 1 to 6 feet in thickness, and have a general dip to the north-west at angles varying from 5° to 10°. These seams are known as the Sandfly group. The assays range from 50 to 56 per cent. fixed carbon, 25 to 30 per cent. volatile matter, and 15 to 17 per cent. ash. An anthracitic seam also occurs, assaying 80·8 per cent. fixed carbon, 8 per cent. volatile matter, and 9 per cent. ash. The crowns of the hill ridges consist of diabase.

(6) *Recherche Basin.*

The Upper Coal Measures occur in a belt of country flanking Recherche Bay, and continuing across Catamaran River to South Cape Bay.

At the head of Recherche Bay is the settlement of Leprena, and south of this the coal measures form the coastal range, which rises to 900 feet and dip in a north-westerly direction. They extend also to the east side of the bay. The outcrops of the coal on the range are about 200 feet above sea-level. The coal contains, by assay, 54 per cent. fixed carbon and 26 per cent. volatile matter.

North of the Catamaran River the coal-bearing sandstones and shales contain Thinnfeldia odontopteroides, var. obtusifolia, Zeugophyllites elongatus, and Phyllotheca australis, and continue across the river to the south, where some coal has been found overlaid by shale and white sandstone. The shale carries impressions of Thinnfeldia odontopteroides.

The Catamaran coal assays 67 per cent. fixed carbon and 25 to 27 per cent. volatile matter, and under 4 per cent. ash.

The same beds crop out along the coast-line between South and South-East Capes, containing identical plant remains and trunks of silicified conifers.

(7) *Schouten and Spring Bay Basin.*

The Prosser's Plains and Spring Bay strata consist of white or yellow freestone, of good building quality and the usual greenish-grey or yellowish felspathic sandstone. The freestone seems to overlie the felspathic variety, which, in

its turn, overlies the coal, at any rate round Spring Bay. Much false bedding prevails, but a main gentle northerly dip of one or two degrees exists. Coal seams up to 5 feet in thickness occur at Triabunna. At Prosser's Plains are seams of coal dipping to the south-west, at high angles (40°).

On the north shore of Schouten Island a seam of coal was worked at one time by the Imperial Government. This is associated with fireclay enclosed in soft carbonaceous sandstones and shales.

(8) *Tasman Peninsula Basin.*

The Mesozoic rocks, yellow and white sandstone and blue and grey shales, with coal seams, flank the diabase-capped ridges of the northern part of the peninsula, and form low cliffs on the coast-line. Some of the coal seams were at one time worked extensively by the Imperial Government. The north-easterly extension of these shales at Dunalley has yielded numerous plant remains, which have been determined by R. M. Johnston as follows: —

Pecopteris buftoni (Johnston).
Pecopteris caudata (Johnston).
Thinnfeldia buftoni (Johnston).
Thinnfeldia polymorpha (Johnston).
Macrotaeniopteris wianamattae? (Feistm.).
Gleichenia dubia (Feistm.).
Trichomanides spinifolium (T. Woods).
Neuropteris tasmaniensis? (Johnston).
Ptilophyllum oligoneurum (T. Woods).
Pterophyllum, sp.

(9) *Fingal Basin.*

At one time this plainly embraced all the measures between Ben Lomond and Mt. Nicholas in the north, and Llandaff in the south, though continuity has since been interrupted by diabase intrusions. The limits of the field are quite arbitrary, as continuity southwards can be established indefinitely. The Mt. Nicholas Range rises to a height at the trigonometrical station of 2800 feet above sea-level, and consists of about 1000 feet of coal measure sandstone crowned by columnar diabase. This descends below the valley-floor for over 200 feet, and rests upon the Upper Marine beds of the Permo-Carboniferous system, giving about 1200 feet of vertical thickness for the Upper Coal Measures here.

Strong coal seams are being worked on the south flank of the range. A section of the range at the Cornwall Mine would give approximately the following succession in descending order: —

	Feet.
Diabase—about	300
Coal	6
Sandstone	200
Coal	4
Sandstone	250
Coal	20
Sandstone	70
Coal	6
Clay	4
Coal	8
Sandstone	15
Clay	7
Coal	9
Coal measures sandstone to floor of valley...	480

Recent assays of the coal worked at the large Cornwall and Mt. Nicholas collieries are as follows: —

	Moisture.	Hydro-Carbons.	Fixed Carbons.	Ash.
(1)	6·50	26·30	57·70	9·50
(2)	7·48	26·14	58·36	8·02
(3)	8·72	23·10	58·88	9·30
(4)	8·60	18·20	61·40	11·80
(5)	6·66	21·48	56·76	15·10

Several unworked seams occur at different horizons all round the mountain. The Mesozoic strata continue westwards to Fingal, and thence along the valley of the South Esk to St. Pauls, Ben Lomond, Mt. Rex, and Avoca. Southwards from Mt. Nicholas they extend south in a coastal belt down the eastern shore-line. Mt. Logie (Elephant) south of St. Marys forms a north and south ridge a mile long, capped with diabase and fringed with Mesozoic sandstone and Permo-Carboniferous sandstone. Beyond this to the east granite stretches away to the coast-line. Further south are coal seams near Thompson's Marshes, in the usual soft greenish-grey felspathic sandstones.

Avoca township is on Tertiary basalt, below which are Tertiary sediments resting upon Mesozoic sandstone and Permo-Carboniferous limestone. At Mt. Rex and on the

Bona Vista estate are strong seams of coal 6 to 12 feet in thickness. The coal analyses of the Mt. Rex seams are:—

Moisture.	Hydro-carbons.	Fixed Carbons.	Ash.	Sulphur.
1·2	35·0	54·5	8·5	0·8
1·7	28·2	55·0	15·1	—
—	38·2	52·9	8·9	—

(10) *Llandaff and Douglas River Basin.*

Strictly speaking, this is a continuation of the Fingal area, but is so far south as to justify geographical separation. The diabase-capped mountain range parallel with the coast near Bicheno and Seymour is flanked by Mesozoic sandstones up to 800 or 900 feet above sea-level, and above this diabase ascends for about 300 feet further. These sandstones have been shown by sinking and boring to descend to a depth of at least 350 feet below sea-level. The horizons are, however, affected by faults, so as to render an estimate of thickness difficult. The coal-bearing beds consist of yellowish-green felspathic sandstone and shales, with fossil imprints of Thinnfeldia odontopteroides (Morris). They have a gentle inclination to north-west and south-west. The seams of coal vary in thickness from 2 to 12 feet, and the quality is also variable. The good qualities range from 50 to 57 per cent. fixed carbon and 27 to 34 per cent. volatile matter.

The following is R. M. Johnston's list of Tasmanian Mesozoic plants:—

	Upper Coal Measures.	Ida Bay.	Lower Sandstones.	Remarks.
Ferns.				
Alethopteris australis (Morris)	1	...	...	=Cladophlebis denticulata (Brongn.) var. australis (Morris)
„ serratifolia (Johnston)	1			
Cardiopteris tasmanica (Johnston)	1			
Cyclopteris (or Salisburia) australis (Johnston)	1			
Gleichenia dubia (Feistm.)	1			

	Upper Coal Measures.	Ida Bay.	Lower Sandstones.	Remarks.
Glossopteris moribunda (Johnston)	1	...	...	Lord's Hill, New Town
Macrotaeniopteris wianamattae (Feistm.)	1			
Neuropteris antipoda (Johnston)	1			
" tasmaniensis (Johnston)	1			
Odontopteris crispata (Johnston)	1			
Pecopteris buftoni (Johnston)	1			
" caudata (Johnston)	1			
" lunensis (Johnston)	...	1		
" odontopteroides (Morris)	1			
Rhacophyllum coriaceum (Johnston)	1			
Sagenopteris tasmanica (Feistm.)	1			
Sphenopteris morrisiana (Johnston)	1	...	...	
" flexuosa (McCoy)	1	...	...	Considered by Arber as = S. lobifolia
" germana (McCoy)	1	...	...	
" hastata (McCoy)	1	...	...	
" lobifolia (Morris)	1	...	...	
" plumosa (McCoy)	1	...	...	
" alata (Brongn.)	1			
" elongata (Carruthers)	1			
" tasmanica (Johnston)	1			
Strzeleckia gangamopteroides (Johnston)	1			
" tenuifolia (Johnston)	1			
Taeniopteris morrisiana (Johnston)	1			
" tasmanica (Johnston)	1			
Thinnfeldia buftoni (Johnston)	1			
" feistmantelli (Johnston)	1			
" obtusifolia (Johnston)	1	...	...	Considered by Shirley as = T. odontopteroides
" media (T. Woods)	1			
" polymorpha (Johnston)	1			
" superba (Johnston)	1	...	...	Considered by Shirley as = T. odontopteroides
" trilobita (Johnston)	1			

	Upper Coal Measures.	Ida Bay.	Lower Sandstones.	Remarks.
Trichomanides spinifolium (T. Woods)	1			
,, etting-hauseni (Johnston) ...	1			
Equisetaceous Plants.				
Annularia australis (Morris) ...	1			
Phyllotheca australis (Brongn.)	1			
,, hookeri (McCoy)	1	...	...	Considered by Arber as = P. australis
,, ramosa (McCoy)	1			
Lycopods.				
Lepidostrobus muelleri (Johnston)	1			
Cycads.				
Podozamites distans ? (Presé)	1			
Pterophyllum dubium (Johnston)	1			
,, risdonense (Johnston)	1			
,, strahani (Johnstor)	1			
Sphenozamites feistmantelii (Johnston)	1			
Ptilophyllum oligoneurum (T. Woods)	1			
Conifers.				
Baiera tenuifolia (Johnston) ...	1			
Ginkgophyllum australe (Johnston)	1			
Salisburia hobartensis (Johnston)	1			
Zeugophyllites elongatus (Morris)	1	1		
Affinities uncertain.				
Cryptophyllites tasmanicus (Johnston)	...	...	1	
Vertebraria australis (McCoy...	...	...	1	United by Arber with Vertebraria indica (Royle)

(c) The close of the Mesozoic or beginning of the Tertiary was marked by an extensive irruption of basic materials in the form of intrusive sheets and dykes of diabase, which have penetrated all the rock-systems earlier than Tertiary. The rock is of fine to medium grain, of typically hypabyssal structure, and is composed essentially of pyroxene and lime-soda felspar. The general absence of olivine is one of the most useful field criteria for distinguishing the rock from Tertiary basalt. The following are two analyses of the rock from the north and the south of the island respectively, made by Professor Ditrich and Dr. Pohl:—

	Enstatite-augite-bearing Diabase from Launceston.	Quartz, or Konga Diabase from North-West Bay.
SiO_2	52·49	56·74
TiO_2	0·62	1·26
Al_2O_3	16·44	15·46
Fe_2O_3	2·60	3·08
FeO	5·30	7·58
MnO	trace	trace
MgO	6·18	2 54
CaO	11·71	7·64
Na_2O	2·06	3·08
K_2O	1·09	1·59
H_2O under 110°	0·15	1·28
H_2O above 110°	1·42	
P_2O_5	trace	0·15
	100·06	100·40

It should be mentioned that the quartzose variety, though frequently met with in the south of the island, is not quite typical for Tasmanian diabase. All the signs of the occurrence of diabase in Tasmania indicate its intrusion into overlying rocks. Its base is not glassy, but rather a felspathic mesostasis; the rock is never scoriaceous, has no horizontal partings between separate lava flows as in basalt, and is sometimes almost gabbroid in texture. The numerous dykes injure the quality of the coal in their proximity, and affect adjoining sandstone and shale by converting the former into quartzite, and the latter into chert or adinole. Most of the coastal headlands in the south-east and west are composed of diabase. In the North they form the promontories at Cape Portland, Tamar Heads, Port Sorell Point, and Mersey Bluff. Over half the island, from the central tableland to the east and south-east, the dissected and faulted country

exposes everywhere sections of the great diabase sills, from which their former Permo-Carboniferous or Mesozoic covering has been removed by erosion. Outliers of the Eldon sill exist as far west as Mts. Sedgwick and Dundas, which are capped by this rock, and there is a dyke or other intrusion at Mt. Heemskirk. While no doubt exists of its invasion of the Permo-Carboniferous and Mesozoic strata, its actual relations to them in the field are frequently obscure, owing to the contacts being more often than not concealed.

VIII.—Tertiary.

A great stratigraphic break exists between the Mesozoic and the sediments of the Tertiary system. While it is very likely that the time divisions of the Cainozoic era adopted in Europe and America rest upon basic principles of world-wide applicability, it does not at present seem possible to adopt in Tasmania other than a binary classification.

(*b*) *Neogene or Upper Tertiary* (= approximately Pliocene)—

(4) Terrace drifts and clays overlying basaltic lavas.

(*a*) *Palæogene or Lower Tertiary* (= Miocene to Eocene)—

(3) Basalt lavas.

(2) Fluviatile and lacustrine clays and sands. Gold and tin-ore drifts and deep leads. Lignitic clays and leaf beds.

(1) Marine beds at Wynyard, Montagu, Cape Grim, and Heathy Valley, Flinder's Island.

The oscillations of the land surface in the north are difficult to follow. A Pre-Eocene land connection with the continent is considered to have existed; then followed an Eocene depression. At some time in the early Tertiary the land in northern Tasmania must have been higher than now; but prior to the Mid-Tertiary basalt eruptions a prolonged subsidence was in progress, when the clays and gravels of the Launceston basin were laid down as deposits reaching a thickness of 1000 feet. Subsequently many valleys were filled with lava sheets. In Post-basaltic or Pliocene times a rising movement again set in, which restored the Bassian land bridge for a time. The changes of level, however, finally left the floors of the deep leads at Beaconsfield, Lefroy, Back Creek, &c., still below sea-level at their outlets.

In southern Tasmania the indented shore-line of the estuary of the Derwent indicates drowned valleys descending seawards. The leaf beds on the shores of the Derwent have been depressed to below sea-level, and bear witness to late Tertiary or Quaternary advance of the sea on the land.

For the most part, Tasmanian Tertiary deposits are non-marine. In other parts of the world the Tertiary is known as the age of lakes, and this island offers no exception, for lacustrine and fluviatile deposits of the period are the prevailing ones. In them are preserved leaf impressions and remains of extinct deciduous trees, *e.g.*, oak, elm, beech, &c., together with eucalyptus, banksia, cinnamon, and various conifers. Examples of these deposits are the lacustrine or estuarine beds of the valley of the Derwent and of the Launceston Tertiary basin. Other deposits fringe existing rivers or were the beds of ancient streams, as along the South Esk and the deep auriferous and stanniferous leads at Lefroy and in the Ringarooma district.

(1) *Marine Beds at Wynyard, &c.*

At Wynyard, on the west side of the mouth of the River Inglis, are beds of fossiliferous limestones of Eocene age. The Sandy Cove bluff, rising to a height of about 170 feet, consists of stratified rocks about 80 feet in thickness, overlaid by about 80 feet of the basaltic lava, which commonly separates the Lower and Upper Tertiaries.

The fossiliferous series comprises a Crassatella bed at the base only a few feet thick and superincumbent Turritella beds nearly 80 feet in thickness. These are heavily charged with marine shells and corals, of which 316 specific forms have been identified. The Turritella beds have yielded impressions of leaves of Pteris Belli, Sapotacites oligoneuris (Ettingsh.), besides remains of an extinct marsupial, Wynyardia bassiana (Spencer).

The species of Turritella which have been identified are:—

T. warbutonii (T. Woods), abundant.
T. sturtii (T. Woods).
T. tristira (Tate).
T. conspicabilis (Tate).
T. acricula (Tate).
T. murrayana (Tate).

And of Crassatella:—

Crassatella (Crassatellites) oblonga (T. Woods).
Crassatella communis (Tate).
Crassatella aphrodina (T. Woods).

These beds repose horizontally on the Permo-Carboniferous glacial beds of the Wynyard formation, which dip north-westerly at low angles up to 10°.

At Cape Grim polyzoan limestone in horizontal beds, dipping eastward under basalt, composes the sea front on the West Coast, immediately south of the cape. These beds extend eastwards to the Welcome River. Besides polyzoa, they contain Tertiary echinoderms and brachiopods.

On Flinders Island, near the Patriarchs at Heathy Valley, is a Lower Tertiary shell limestone with marine shells, some of which (Cucullea, Nucula, Turritella) resemble forms found in the Eocene beds at Wynyard.

(2) *Derwent Tertiary Basin.*

The valley of the Derwent exhibits a series of Tertiary sands and clays bordering the present river. They indicate the former existence of lacustrine conditions in the lower Derwent. These beds attain a maximum height of 40 or 50 feet above sea-level, and may be seen at One-Tree Point, Sandy Bay, Cornelian Bay, Lindisfarne Bay, Geilston Bay, &c. At Pipeclay Bluff, Cornelian Bay, where the beds rest horizontally on diabase, the white pipeclay contains remains of the fruit Plesiocapparis leptocelyphis (Mueller) and impressions of various leaves. These strata probably extend below the basalt at the Cemetery Bluff, and correspond in age with the infra-basaltic beds of the Launceston Tertiary basin.

At Geilston Bay beds of clay and limestone (known as the Geilston Travertin) occur, containing the following:—*

Helix geilstonensis (Johnston).
Helix huxleyana (Johnston).
Helix sinclairoides (Johnston) or (H. sinclairi, Pfr.).
Vitrina barnardii (Johnston).
Bulimus gunnii (Sowerby)
Cypris alburyana (Johnston)

* *Fide* R. M. Johnston in Geol. of Tasmania, p. 285

These beds constitute a fragment of the floor of the ancient lake of the Derwent, and were once continuous with corresponding deposits on the west side of the estuary. The preserved flora of the Derwent Tertiaries is characteristic of the Palæogene in Tasmania, viz., leaves of betula, alnus, quercus, fulgus, salix, cinnamomum, araucaria, sapotacites, with the fruits platycoila, penteune, conchotheca, plesiocapparis, cordia, &c.

Higher up the Derwent, near its confluence with the Styx River, are beds of light-coloured clay associated with lignite, apparently derived from conifers. Near Glenora clay leaf-beds occur below the basalt, yielding leaves of fagus and cinnamomum. Near the Ouse bridge the river flows through Tertiary beds of lignite and clay, containing large tree trunks.

Launceston Tertiary Basin.—This comprises the wide plain within the drainage area of the Tamar and its tributaries. It contains layers of irregularly bedded sandstones and clays, often with lignite. These cover an area of 600 square miles, and attain a thickness of 1000 feet. The plateau has a general height of 500 to 600 feet above sea-level.

The lowest beds are, perhaps, those between Muddy Creek and Supply River, on the Tamar, where a series of horizontal ferruginous sands and white and bluish clays occurs, dipping slightly to the north-west, the lower strata containing Anodonta tasmanica (Eth. fil), Unio johnstoni (Eth. fil), and numerous leaf impressions (Cordia tasmanica, Ettingsh., and Premna drummondi, Ett.).

In the auriferous lead at Brandy Creek, Beaconsfield, 270 feet below sea-level, a stratum of black carbonaceous clay has yielded the Palæogene fossil fruits Spondylostrobus smythii (Mueller), Platycoila sullivani (Mueller), Plesiocapparis leptocelyphis (Mueller), Cordia tasmanica (Ettingsh.), Elaeocarpus bassii (Ett.), Penteune allporti (Mueller), Conchotheca turgida (Mueller), and leaves of cinnamomum polymorphoides (McCoy); also large trunks of conifers. Similar beds occur at Dilston and Windermere on the east bank of the Tamar. Lignitic beds of Tertiary clays and sands occur east of Mt. George.

The false-bedded sandstones of the Windmill Hill and Sand Hill, Launceston, are Upper Palæogene. They contain leaf imprints of deciduous and other trees (betula, fagus, quercus, cinnamomum, banksia). At Carr Villa, near Launceston, the boring core showed an impression

of a betula leaf, at a depth of 500 feet. Leaf-beds appear on the railway-line at Breadalbane, with lignite impressions of banksia, betula leaves, &c.

A bore at Belmont went down in the Palæogene sandstone and shale to 894 feet without reaching bottom. This is equivalent to about 200 feet below sea-level. The common leaf impression, Betula launcestoniensis, was found.

North-East.—In the north-east the high plateau of sand and gravel, with alluvial tin ore, near Branxholm and Derby, which is capped with basalt, marks the ancient course of the Ringarooma River before it was choked with lava and diverted to its present channel. At Gladstone, the old Mussel Roe stanniferous lead contains fossil wood.

East.—Tertiary leaf-beds also occur in the tin-ore drift in Thureau's Deep Lead, at St. Helens. At Tullochgorum in the valley of the South Esk, sandy clays, with lignite, have yielded fossil leaves similar to those at Muddy Creek.

North-West.—Palæogene alluvial beds occur on the North-West Coast below the basalt sheet which caps the coastal plateau. At Burnie, in a white pipeclay below the basalt, imprints of leaves of European and other types have been found. At Waratah leaf imprints have been obtained from greyish Tertiary sandstone beneath 45 feet of basalt, at a height of 2000 feet above sea-level. These leaves have been identified as follows:—Eucalyptus kayseri (Johnston), Laurus sprentii (Johnston), quercus bischoffensis (Johnston), Ulmus tasmanicus, Cycadites microphylla (Johnston).

West.—Leaf-beds of similar age, and containing impressions of Cinnamomum polymorphoides (McCoy) and Sapotacites oligoneuris (Ett.) also occur in the carbonaceous clays and ferruginous sands which form horizontal beds along the shores of Macquarie Harbour from Strahan to Pillinger. The lower beds form a lignitic series, in which leaf forms belonging to the Lauraceæ and Cycadaceæ are found. At Farm Cove, near Pillinger, beds contain fossil resin.

At the Henty River are lignite beds, with remains of leaves, Fagus jonesii (Johnston) and Acacia meiringii (Johnston).

(3) *Basalt Lavas.*

Towards and at the end of, the Palæogene, a great outpouring of basaltic lava took place in nearly all parts of

the island. This rock is the effusive expression of a gabbroid magma. Its mineral components are lime-soda felspar and pyroxene, with or without olivine. It is here, however, usually olivine-bearing. The olivine mineral is extremely abundant in some varieties, generally in rounded or corroded crystals, but occasionally with perfect crystal form, as in the hyaline lavas of Sheffield. Every variety of structure and condition is represented. In some parts of the island the basalt is highly vesicular (*e.g.*, Conara, Benham Plains, Bothwell, Waratah, Hampshire, &c.). Tachylyte, or basalt glass, with a weathered crust of a beautiful blue colour, occurs at Richmond and Nietta. Columnar structure is common, as at Burnie and other places. On the North-West Coast the basalt occasionally assumes a limburgitic (felsparless) facies, as at Wynyard, on the Wilmot-road, south of Hamilton-on-Forth, and in a dyke on the Emu Bay railway-line, 7 miles from Burnie.

No cinder cones have been observed, but crateriform cones or plugs occur, *e.g.*, east of Lake Sorell, and on the Shannon Tier. The extensive basaltic sheets probably issued from fissures rather than from the more familiar cone vents. The lava choked the river valleys towards the close of the Palæogene, sealing up stanniferous and auriferous gravels, and protecting deep leads, which are now worked for gold and tin.

Some of the basalts belong to the alkaline division of igneous rocks, *e.g.*, at Table Cape, Shannon Tier, and at Sandy Bay, Hobart.

The coarse basalt which forms the promontory of Table Cape, a bold headland near Wynyard, rising 580 feet above sea-level, is composed of labradorite, augite, olivine, abundant apatite, and iron oxide with analcime. Nepheline has been identified in it by Prof, Rosenbusch, who considers that the rock belongs to the trachydolerite group. A similar basalt forms the promontory of the Nut, at Circular Head.

On the Shannon Tier are some small volcanic cones (Haystack, Beehive, Anthill) consisting of melilite—nepheline basalt, erupted through the diabase which crowns the tier. A coarse nepheline-augite rock is associated with the finer grained basalt, but both probably form a geological unit. The constituents of the basalt are nepheline, melilite, olivine, pyroxene, perofskite, apatite, and magnetite. Dr. F. P. Paul's analyses of this rock* are as follows:—

* Foyaitisch-Theralithische Gesteine aus Tasmanien. Dr. F. P. Paul, Vienna, 1906, p. 37.

	I.	II.	III.
SiO_2	36·17	37·96	33·89
TiO_2	2·15	2·93	0·64
Al_2O_3	11·88	10·14	9·93
Fe_2O_3	11·37	3·69	15·63
FeO	4·17	7·59	—
MgO	14·22	14·69	16·14
CaO	11·54	16·28	15·19
Na_2O	5·38	2·18	2·86
K_2O	2·07	0·69	—
H_2O	—	1·82	2·90
P_2O_5	0·84	1·13	1·41
ZrO_2	—	—	—
CO_2	—	—	1·41
MnO	trace	0·22	—
Cr_2O_3	—	0·08	—
V_2O_3	—	0·05	—
NiO	—	0·04	—
SrO	—	0·05	—
BaO	—	0·06	—
SO_3	—	0·03	—
S	—	0·04	—
Cl	—	—	—
	99·79	100·13	100·00
Specific gravity	3·147	3·150	3·04

One variety of the Shannon Tier rock has been determined by Dr. Paul as nepheline-eudialyte basalt, in which the mineral eudialyte takes the place of melilite as an essential constituent. Dr. Heidenreich's analysis of this rock is as follows:—*

SiO_2	36·03
TiO_2	1·13
ZrO_2	0·21
Al_2O_3	15·19
Fe_2O_3	5·94
FeO	9·55
MnO	0·17
MgO	8·60
CaO	15·52
Na_2O	4·23
K_2O	1·85
P_2O_5	1·38
Loss on ignition	0·58
	100·38
Specific gravity	3·079

* Dr. F. P. Paul, *ibid*, p. 44.

A melilite-bearing nepheline basalt occurs at the Alexandra Battery, Sandy Bay, near Hobart. Its constituent minerals are nepheline, olivine, pyroxene, melilite, apatite, and magnetite. Dr. Paul has detected in it a little orthoclase and cossyrite. The iron olivine fayalite crystals are visible to the naked eye as red spots in the rock. An analysis of this rock by O. E. White and W. A. Macleod * gives its composition as follows:—

SiO_2	47·21
Al_2O_3	16·06
Fe_2O_3	11·87
FeO	4·43
CaO	7·34
MgO	0·12
K_2O	2·40
Na_2O	7·51
Ignition loss	2·55
	99·49
Specific gravity	2·81

IX.—Quaternary.

This comprises the Pleistocene and Recent periods. The main topographical features of Tasmania during this era were essentially the same as exist to-day. There were the same mountain ranges, the river systems, the central plateau, the western highlands. Tasmania has remained insular throughout the era.

Since Pleistocene times the north-western part of Tasmania has apparently suffered an uplift relative to sea-level, evidenced by the existence of extensive elevated peneplains. These are strikingly evident along the northern coast and in the west of the island, between the ocean and the West Coast range. The recent river systems, rejuvenated by the upward crustal movement, have deeply dissected the area, and seamed it with profound gorges.

Some further change of strand level has taken place subsequently, producing raised beaches on the northern coast and in the islands of the straits. Dune formation has been in progress along the coast lines; terrace drifts show the deepening of channels by existing streams; ossiferous cave breccias have been formed on the floors of caves and in fissures in the Ordovician limestone. Moraine material was transported into valleys by glaciers on the high ranges

* Notes on a Fayalite Basalt from One-Tree Point. Proc. Roy. Soc. Tas. 1898-1899, p. 78.

in the western and central parts of the island. Finally man appeared, and in the course of time, the indigenous race became extinct.

The Quaternary may be divided as follows, but in view of the difficulty of establishing a sequence, it would be unsafe to rely implicitly on the order of succession. Some of the events in the separate divisions may have been actually contemporaneous.

Recent—

(6) River alluvium and sand dunes. Native shell beds.
(5) Raised beaches.
(4) Helicidæ sandstone.

Pleistocene—

(3) Glacier indications in the Western highlands.
(2) Cave deposits.
(1) Pebble and terrace drifts.

Pleistocene.

The Pleistocene period in Tasmania, though not distinguishable by any remains of characteristic organic forms, shared with other countries the climatic features of a glacier epoch. Although Pleistocene glaciation affected the northern hemisphere more profoundly, it was nevertheless a world-wide phenomenon, and the southern hemisphere was not wholly exempt. Tasmania was not buried under a general ice sheet like that which covered Europe and America: no evidence has been discovered of any glaciation in the eastern part of the island, but glaciers unquestionably were developed in the highlands of the west where none exist to-day.

(1) *Pebble and Terrace Drifts.*

At different levels in the large river valleys, terraces of drift were formed which were cut down into later by the rivers as their channels deepened. These are relics of the flood plains of the past. Examples are present in the valleys of the Derwent, North and South Esk, and Gordon rivers. Drift beds of this age occur in various river valleys, containing pebbles of silicified coniferous and other wood, and relics from Palæogene leaf-beds.

(2) *Cave Deposits.*

In Pickett's cave, in the Chudleigh district, a number of sub-fossil bones have been found on the stalagmitic floor,

and in crevices of the Ordovician limestone. These belonged to existing species of kangaroo, kangaroo rat, wallaby, wombat, opossum, &c.

(3) *Glacial Deposits.*

Evidences of the Quaternary glaciation of the highlands are abundant on the mountains of the west and on the elevated plateau of north-western Tasmania. Glaciated rock surfaces can be traced on Mts. Tyndall and Sedgwick to near their summits. The lakes between the western ranges are bordered by moraines. On the western slopes of the West Coast Range numerous moraines occur. The township of Gormanston is on beds of glacial boulder clay of this age, which have been cut through by the Linda Creek. Sections of these beds are exposed in creek banks between the Gormanston Gap and the Linda township. Glacial deposits continue for miles down the valley of the King River. Erratics in the Mackintosh valley and the notable moraines on the Cradle Mountain and Barn Bluff plateau belong to the same age. The plateau between Mt. Pelion and Barn Bluff is characterised by the prevalence of low, rounded hummocks and numerous tarns or lakelets. On the slopes of Barn Bluff are lines of moraine ridges, and from here towards Granite Tor rolling hummocks still occur. Erratics and glaciated surfaces are features of the country round Lakes Dixon and Undine, and on the Frankland Range. On the west side of the Craycroft Range moraine material with large boulders occurs at a height of about 250 feet above sea-level. All round the promontory west of Farm Cove, Macquarie Harbour, moraine boulder material is present at sea-level. From the Denison Range an immense number of ice-borne conglomerate boulders have been carried down and spread over the valley of the Gordon River, and from their disposition with reference to existing topography it may be inferred that the glaciers were active in Quaternary times. The same conclusion may be drawn from the glacial deposits on the north-western plateau, which are well preserved, with fresh-looking rock scorings, and are evidently of an age subsequent to the establishment of the existing configuration of the country.

(4) *Helicidæ Sandstone.*

A shelly sandstone, consolidated dune sand, or arenaceous limestone occurs on most of the islands in Bass Straits (Cape Barren, Badger, Green, Chappell, and Kan-

garoo Islands) up to 100 feet above sea-level, resting in horizontal beds on the granite or older stratified rocks. Its organic remains are shells belonging to various living species of Helix, Bithynella, Succinea, Pómatiopsis, Physa, Bittium, Truncatella, &c. Bithynella nitida (Johnston) is doubtfully distinct from an existing form, and Helix simsoniana (Johnston), found in the white calcareous sandstone or limestone of Kent's group, is not known as a living species in Tasmania.

On Flinder's Island, 2 miles up the River Arthur, and 30 feet above sea-level, is an oyster bed with untravelled shells, suggestive of alteration of level.

(5) *Raised Beaches.*

These are on the same geological horizon as the helicidæ sandstone. They exist all along the northern coastline, and on the Straits Islands. Some of them on the latter underlie the consolidated sand dunes (helicidæ sandstone), and are found 40 or 50 feet above sea-level. Elevated beaches of marine shingle are seen at the mouths of the Blythe and Emu Rivers, and elsewhere, on the shore of Bass Straits. In the extreme south-west of the island, at Cox's Bight, the flat marsh land along the coast indicates a slight elevation of the country there within the recent period.

(6) *Native Shell Beds.*

Comminuted burnt shells are found in heaps and layers several feet thick at various points on the coast-line and on the shores of estuaries. associated with worked aboriginal flakes. These are the Kitchen middens of the extinct Tasmanian race, and are deposits of, perhaps, greater interest to the ethnologist than to the geologist. The last of this race (Truganini) died in Hobart in May, 1876. When and how woolly-haired negritoid man entered Tasmania is a debatable question. It has been generally supposed that he crossed from Australia before Bass Straits were formed, but if the last separation of the island from the mainland took place as far back as the Pliocene this supposition would involve a greater antiquity for man in Tasmania than is suggested by the insignificant tribal divisions and the superficial nature of the deposits in which remains of his handwork are found.

Ore-deposition.

It is a question whether some ore-deposition (copper) is not connected with the porphyroid or granitic eruption of Cambrian age, but undeniably the period during which the deposition of most of our ores was active was the interval between the Upper Silurian and Permo-Carboniferous. Ore-deposition of this period was associated principally with the consolidation of the Devonian gabbroid and granite masses. Nickel sulphide and iridosmine owe their origin to serpentine at the Heazlewood, Trial Harbour, and Dundas. The granite magma is responsible for the silver-lead lodes at Zeehan, the tin and wolfram lodes all over the island, and for the gold quartz reefs of Beaconsfield, Lefroy, Mathinna, &c. A few barren quartz veins occur in the Permo-Carboniferous strata, but outside the exceptional alkaline porphyries at Port Cygnet, the chapter of metal-bearing lode action closed with the Devonian period. Within the term between the Cambrian and Devonian were deposited the great stores of mineral which the mining industry of Tasmania is now drawing upon. The mines of gold, silver, lead, copper, and tin rank among the famous mines of the world. When the small area of the island (26,000 square miles) is considered, her mineral wealth may be regarded as remarkable.

THE GEOLOGICAL SUCCESSION IN TASMANIA.

Group.	*System.*	*Representative Formations.*
QUATERNARY	RECENT	1. River alluvium and sand dunes. Native shell beds. 2. Raised beaches. 3. Helicidae sandstone of the Straits Islands
	PLEISTOCENE	4. Glacier indications in the western highlands 5. Cave deposits at Chudleigh 6. Pebble and terrace drifts
TERTIARY	NEOGENE	7. Terrace drifts and clays overlying basaltic lavas
	PALAEOGENE	8. Basalt lavas 9. Fluviatile and lacustrine clays and sands. Gold and tin ore drifts and deep leads. Lignitic clays and leaf beds 10. Marine beds at Wynyard, Montague, Cape Grim, and Heathy Valley, Flinders Island
MESOZOIC	UPPER MESOZOIC	11. Diabase in intrusive masses, sills, or dykes
	LOWER MESOZOIC	12. Fingal series or Upper Coal Measures 13. Ida Bay series. Sandstones and shales with coal at Ida Bay 14. Knocklofty series. Variegated sandstones with Vertebraria indica (Royle), remains of heterocercal fish and amphibians

THE GEOLOGICAL SUCCESSION IN TASMANIA—continued.

Group	*System.*		*Representative Formations.*
PALAEOZOIC	PERMO-CARBONIFEROUS	UPPER	15. Elaeolite and alkali syenites, with various alkaline porphyries, at Port Cygnet and along D'Entrecasteaux Channel. (Precise age unsettled.) 16. Southport sandstones and shales 17. Mt. Cygnet and Adventure Bay sandstones and shales 18. Upper Marine mudstones overlying Mersey coal: Porter Hill shales and sandstones, Sandy Bay 19. Lower Coal Measures (= Greta horizon, New South Wales); Mersey Basin, Preolenna, Henty River; Tasmanite beds
		LOWER	20. Conglomerates, grits, limestones, and Lower Marine mudstones throughout the south-east, north-east, north-west, and midlands; glacial conglomerates, grits, micaceous sandstones, and slaty flagstones in thick beds form the base of the system
	DEVONIAN		21. Granite, aplite, granite porphyry usually associated with previously consolidated gabbros and peridotites
	SILURIAN		22. Eldon Valley clay slates 23. Fossiliferous limestone, sandstone, and slate at Zeehan, Heazlewood, Queen and Nelson Rivers, Lorinna, &c.

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	ORDOVICIAN	24. Slate and sandstone in the goldfields of Lefroy, Mt. Victoria, Mathinna, Mangana, &c. 25. Limestone on the Gordon, Florentine, and other rivers, at Railton, Mole Creek, Beaconsfield, &c.
	CAMBRIAN	Insertae sedis: 26. Dundas slates and breccias; the Dial Range and Leven slates, breccias, tuffs, and porphyroids; a similar series at Zeehan; the felspathic porphyries of Mts. Lyell, Jukes, Darwin, and the West Coast Range generally. 27. Slate and sandstone at the Needles and in the neighbourhood of Mts. Mueller and Wedge 28. Dikelocephalus sandstone at Caroline Creek and the Florentine Valley 29 Discoidal sandstone in the Loddon River Valley and at Caroline Creek, near Dulverton 30. Tubicolar sandstone at Middlesex, Five-mile Rise, Mt. Claude, Lemonthyme Hill, Black Bluff, Zeehan, Loddon River Valley. 31. Conglomerates, pebbly sandstone, and quartzite on the West Coast Range, Mt. Zeehan, the Thumbs, Denison Range, Railton, &c.
PRE-CAMBRIAN	ALGONKIAN	32. Amphibolites of the Rocky River; garnet-zoisite-amphibolites of Hamilton-on-Forth and the Collingwood River Valley 33. Quartzitic, sericitic, graphitic, and argillaceous schists and schistose conglomerates of the Frenchman's Cap, Prince of Wales Range, Cox's Bight, Port Davey, Barn Bluff, Ulverstone and Forth, Rocky Cape, Long Plain, Asbestos Range
	ARCHAEAN	Not yet found *in situ*.